Approved August 22, 2012

Implementation Plan for Three Total Maximum Daily Loads for Indicator Bacteria in the Carters Creek Watershed

Segments 1209C, 1209D, 1209L

Assessment Units 1209C_01, 1209D_01, 1209L_01

Water Quality Planning Division, Office of Water

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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TMDL implementation plans are also available on the TCEQ website at:
<www.tceq.texas.gov/implementation/water/tmdl/>

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Brazos County Health Department
USDA Natural Resources Conservation Service, Brazos County Field Office
Brazos County Road and Bridge Department
Brazos County Soil and Water Conservation District #450
Brazos River Authority
City of Bryan
City of College Station
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Texas AgriLife Extension Service
Texas AgriLife Research
Texas Department of Transportation, Bryan District
Texas Parks and Wildlife Department

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List of Acronyms

AU	Animal Unit
BC	Brazos County
BCAD	Brazos County Appraisal District
BCHD	Brazos County Health Department
BMP	Best Management Practice
BRA	Brazos River Authority
COB	City of Bryan
COCS	City of College Station
CRP	Clean Rivers Program
DMR	Discharge Monitoring Report
E. coli	*Escherichia coli*
EQIP	Environmental Quality Incentives Program
E&O	Education and Outreach
FG	Allowance for Future Growth
FOTG	Field Office Technical Guide
GIS	Geographic Information System
I-Plan	TMDL Implementation Plan
LA	Load Allocation
LIP	Landowner Incentive Program
LDC	Load Duration Curve
MCM	Minimum Control Measure
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
NPS	Nonpoint Source Pollution
NRCS	USDA Natural Resource Conservation Service
OSSF	On-site Sewage Facility (aerobic and conventional)
QAPP	Quality Assurance Project Plan
SSO	Sanitary Sewer Overflow
SWCD	Soil and Water Conservation District
SWMP	Stormwater Management Program
SWQMIS	Surface Water Quality Monitoring Information System
Texas A&M	Texas A&M University at College Station
TIAER	Texas Institute for Applied Environmental Research
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWRI	Texas Water Resources Institute
TxDOT	Texas Department of Transportation
USEPA	U.S. Environmental Protection Agency
WLA	Waste Load Allocation
WQMP	Water Quality Management Plan
WWTF	Wastewater Treatment Facility

Implementation Plan for Three TMDLs for Indicator Bacteria in the Carters Creek Watershed

Executive Summary

The Texas Commission on Environmental Quality is considering *Three Total Maximum Daily Loads (TMDLs) for Indicator Bacteria in the Carters Creek Watershed (Segments 1209C, 1209D, and 1209L)* for public comment and simultaneously considering this associated Implementation Plan for public comment.

This implementation plan, or I-Plan:

- describes the steps that watershed stakeholders and the TCEQ will take toward achieving the pollutant reductions identified in the TMDL report
- outlines the schedule for implementation activities.

The ultimate goal of this I-Plan is to restore the contact recreation uses in Segments 1209C, 1209D, and 1209L of the Carters Creek watershed (Figure 1) by reducing bacteria concentrations to levels established in the TMDL.

The TMDL identified regulated and unregulated sources of *Escherichia coli (E. coli)* in the watershed that could contribute to water quality impairment. Regulated sources identified include permitted dischargers, such as industrial discharges, municipal separate storm sewer systems (MS4s), and wastewater treatment facilities (WWTFs). Sanitary sewer overflows, dry weather discharges, and illicit discharges are a subset of these regulated sources.

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

This I-Plan includes six management measures and two control actions that will be used to reduce the level of bacteria in the Carters Creek watershed. Implementation of these management measures will largely be dependent upon the availability of funding. Progress will be reviewed under the TCEQ's adaptive management process.

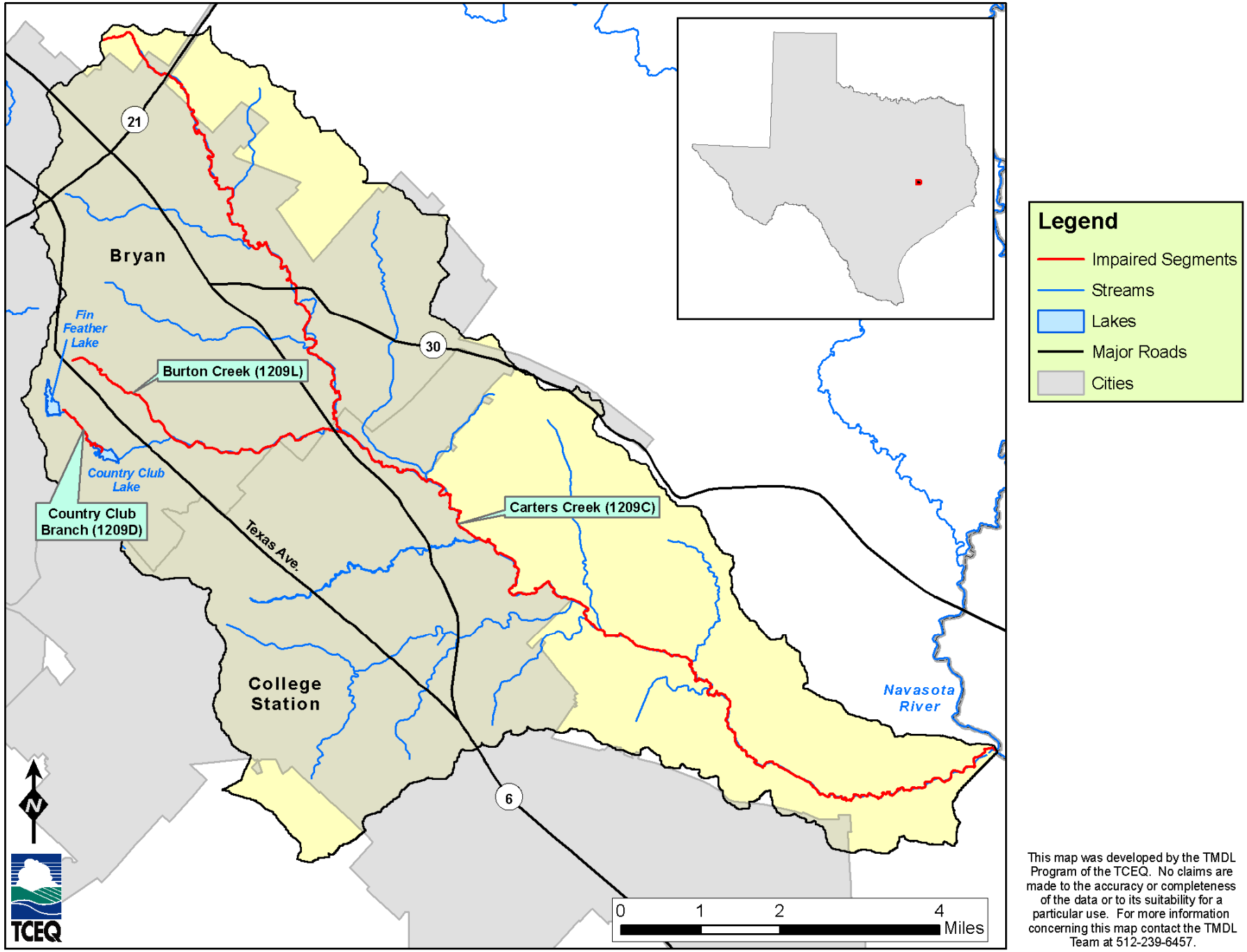

Figure 1. Carters Creek Project Segments

Management Measures

1. *Coordinate and expand existing water quality monitoring in the watershed and conduct a watershed bacteria source survey.*
2. *Determine feasibility of modifying tax valuation requirements for agricultural lands and quantify expected water quality impacts of modifications and impacts of transitioning from agriculture to wildlife valuations.*
3. *Work to improve OSSF identification, inspection, pre-installation planning, education, operation, maintenance and tracking to ensure proper system functioning.*
4. *Implement sanitary sewer overflow (SSO) initiatives as appropriate across the watershed.*
5. *Implement voluntary Best Management Practice (BMPs) on agricultural or undeveloped properties.*
6. *Continue existing efforts and work to establish new mechanisms that encourage and promote future development and redevelopment that will mitigate adverse water quality impacts in the watershed.*

Control Actions

1. *Implement entity-specific MS4 Phase II Stormwater Management Programs (SWMPs) throughout the watershed.*
2. *Monitor WWTF effluent* E. coli *concentrations according to individual permit requirements.*

This I-Plan identifies the responsible parties, technical and financial needs, monitoring and outreach efforts, and a schedule of activities for each of the management measures and the two control actions. It describes the process that the TCEQ and stakeholders will use to assess progress and adjust the plan periodically. The TCEQ will report results and evaluations from implementation tracking to stakeholders as needed.

Introduction

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

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

This I-Plan is designed to guide activities that will achieve the water quality goals for the Carters Creek watershed as defined in the TMDL. It is a flexible tool that governmental and nongovernmental organizations involved in implementation use to guide their activities to reduce bacteria loads. The participating partners

may accomplish the activities described in this I-Plan through rule, order, guidance, or other appropriate formal or informal action.

This I-Plan contains the following components:

1) A description of control actions and management measures[1] that will be implemented to achieve the water quality target.
2) A schedule for implementing activities (Appendix A).
3) The legal authority under which the participating agencies may require implementation of the control actions.
4) A follow-up tracking and monitoring plan to determine the effectiveness of the control actions and management measures undertaken.
5) Identification of measurable outcomes and other considerations the TCEQ and stakeholders will use to determine whether the I-Plan has been properly executed, water quality standards are being achieved, or the plan needs to be modified.
6) Identification of the communication strategies the TCEQ will use to disseminate information to stakeholders.
7) A review strategy that stakeholders will use to periodically review and revise the plan to ensure there is continued progress in improving water quality.

This I-Plan also includes causes and sources of the bacterial impairment, management measure descriptions, estimated potential load reductions, technical and financial assistance needed, educational components for each measure, schedule of implementation, measurable milestones, indicators to measure progress, monitoring components, and responsible entities. Consequently, projects developed to implement unregulated (nonpoint) source elements of this plan that meet the grant program conditions may be eligible for funding under the EPA's Section 319(h) grant program.

[1] Control actions refer to regulated sources reduction strategies, generally TPDES permits. Management measures refer to strategies for reducing unregulated pollutants, generally through voluntary best management practices (BMPs).

Watershed Overview

The Carters Creek watershed (highlighted areas in Figure 2) lies within the Navasota River watershed. Located within the Brazos River Basin, the Navasota River watershed is the second largest basin by area in Texas (Brazos River Authority, 2007), with a drainage area of approximately 2,235 square miles. The Navasota River flows 125 miles south to its confluence with the Brazos River (Brazos River Authority, 2007).

Carters Creek, historically an intermittent stream, is now perennial due to wastewater inflows. It originates in central Brazos County and flows 17 miles before joining the Navasota River. Burton Creek is a tributary of Carters Creek, which is also a perennial stream in its lower reaches due to wastewater inflows. Country Club Branch is a tributary of Burton Creek with intermittent flow. The drainage area of the Carters Creek watershed is about 58 square miles. Portions of the growing cities of Bryan and College Station, defined in the 2000 U.S. Census as urbanized areas, lie within the Carters Creek watershed.

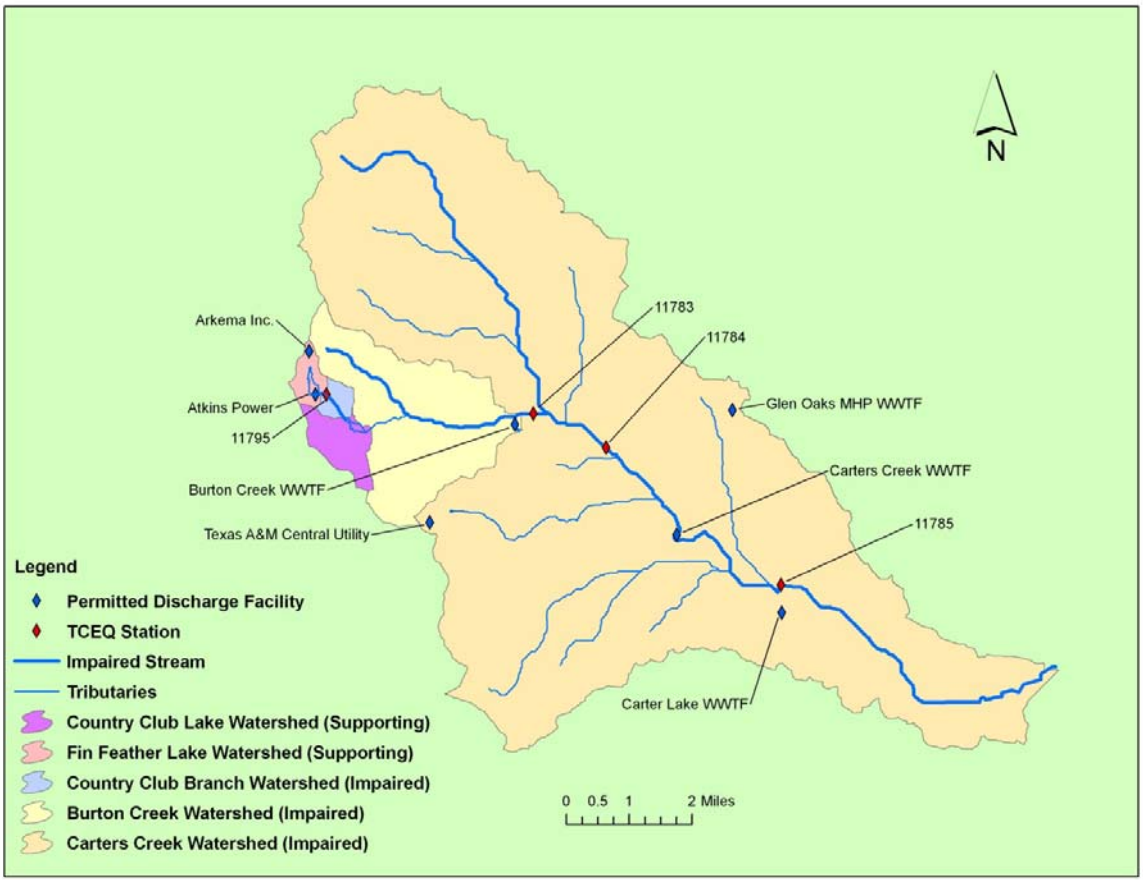

Figure 2. Carters Creek Watershed

Illustrates water quality monitoring stations, permitted dischargers, and subwatershed areas.

The western portion of the watershed is dominated by developed urban area; the eastern portion is predominantly rural. The Burton Creek and Country Club Branch subwatersheds are dominated by urban landscape, with residential and commercial/ industrial land uses combining to cover almost 100 percent of the area. Exceptional growth is being seen throughout the watershed and its surrounding areas. As a result, the rural areas of the watershed are slowly transitioning to residential and commercial uses.

The cities of Bryan and College Station are rapidly growing urban areas. Their combined estimated population of 133,600 in 2000 has grown to 170,058 in 2010. Based on population data from the 2000 census, the population of the entire Carters Creek watershed was estimated at 91,211, of which 23,006 were estimated to be in the Burton Creek watershed (US Census Bureau, 2009). These population estimates were obtained by multiplying the tract-level census data by the proportion of each census tract within each watershed. This estimation procedure assumes that the population is uniformly distributed within the area of each census tract.

Summary of TMDLs

This section summarizes the information developed for *Three Total Maximum Daily Loads for Indicator Bacteria in the Carters Creek Watershed.* 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 draft TMDLs for the Carters Creek watershed. Unless otherwise noted, all information contained in this section was derived from the *Technical Support Document for Bacteria TMDLs, Carters Creek Watershed (Segments 1209D, 1209L & 1209C)* (Millican, 2011).

Carters Creek (1209C) was first listed as impaired for elevated bacteria levels in the *1999 Clean Water Act Section 303(d) List and Schedule for Development of Total Maximum Daily Loads* (TCEQ, 1999). Country Club Branch (1209D) and Burton Creek (1209L) were first listed as impaired in the *2006 Texas Water Quality Inventory and 303(d) List* (TCEQ, 2006).

Segments 1209C, 1209D, and 1209L are listed due to impairment of their primary contact recreation uses, which is caused by elevated levels of indicator bacteria. The standards for water quality are defined in the *Texas Surface Water Quality Standards* (TCEQ, 2010b).

E. coli are the preferred indicator bacteria for assessing the recreational use in freshwater, and were used for analysis to support TMDL development for the Carters Creek watershed. The criteria for assessing attainment of the primary contact recreation use are expressed as the number (or "counts") of *E. coli* bacte-

ria, given as the most probable number (MPN). For the *E. coli* indicator, if the minimum sample requirement is met, the primary contact recreation use is not supported when:

- the geometric mean of all *E. coli* samples exceeds 126 MPN per 100 mL;
- and/or individual samples exceed 399 MPN per 100 mL more than 25 percent of the time.

Table 1 provides a summary of the water quality data from January 2001 to December 2010 and illustrates the current water quality at the monitoring station and stream segment levels. Data collected from each site were well above the bacteria criteria, indicating that the contact recreation uses of the creeks are not supported.

Table 1. Summary of routine monitoring *E. coli* data, August 1997 – December 2010

(Data source: TCEQ SWQMIS)

Segment	Station	Location	No. Samples	Range of Measured *E. coli* Concentrations (MPN/100 mL)	Station Geometric Mean (MPN/100 mL)	Segment Geometric Mean (MPN/100 mL)
1209D	11795	Duncan Street	13	2 - >2,500	583	583
1209L	11783	State Hwy 6	30	12 - >24,000	517	517
1209C	11784	State Hwy 30	34	4 - >24,000	643	705
	11785	Bird Pond Road	44	4 - >24,000	757	

Pollutant Sources and Loads

Sampling for the Carters Creek TMDL consisted solely of routine, quarterly water-quality monitoring conducted between September 2001 and October 2007 by the Brazos River Authority (BRA) through the TCEQ's Clean Rivers Program. The geometric mean concentration of *E. coli* exceeded the criterion of 126 MPN/100mL at all sites under all flow conditions. No additional monitoring was conducted as a part of the TMDL development process.

The TMDL analysis identified potential bacteria sources that could elevate bacteria levels in the Carters Creek watershed. Unregulated sources identified in the TMDLs include malfunctioning OSSFs, agriculture practices, development, and waste from pets, wildlife, and unmanaged animals. Regulated dischargers in the Carters Creek watershed include WWTFs, industrial facilities, and regulated stormwater discharges.

Load duration curves (LDCs) were used to analyze sources and determine load reductions for the TMDLs. LDCs define the relationship between flow (volume per time) and loadings (mass bacteria per time). The procedures for developing LDCs are explained more fully in the TMDL report. The TMDL allocations are based on the high flow conditions (flows above the 90th percentile).

A TMDL estimates the maximum amount of a pollutant that the stream can receive in a single day without exceeding water quality standards. It also establishes maximum pollutant contribution levels from source categories that will result in achieving water quality standards. The pollutant load allocations were calculated using the following equation:

$$TMDL = \Sigma WLA + \Sigma LA + \Sigma FG + MOS$$

Where:

WLA = waste load allocation, the amount of pollutant allowed from permitted dischargers

LA = load allocation, the amount of pollutant allowed from unregulated sources

FG = future growth associated with regulated facilities

MOS = margin of safety of 5%

Updates to TMDLs are made through the TCEQ's Water Quality Management Plan (WQMP), which provides long-range planning and technical data for management activities, as required under the Texas Water Code and the federal Clean Water Act.

Waste Load Allocation (WLA)

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

Wastewater Treatment Facilities

WWTFs regulated under the Texas Pollution Discharge Elimination System (TPDES) are allocated a daily waste load (WLA_{WWTF}), calculated as their full permitted discharge flow rate multiplied by the instream geometric criterion after reductions for the margin of safety (MOS) (Table 2). This is expressed in the following equation:

$$WLA_{WWTF} = \text{criterion} * \text{flow (MGD)} * \text{conversion factor} * (1 - F_{MOS})$$

Where:

Criterion = 126 MPN/100 mL

Flow (MGD) = full permitted flow

Conversion factor = 3.7854E+07 100 mL / MGD

F_{MOS} = fraction of loading assigned to MOS (5% or 0.05)

Table 2. Waste Load Allocations for TPDES Regulated Facilities

Segment	TPDES Number	Out-fall	NPDES Number	Permittee/Facility Name	Final Permitted Flow (MGD)	*E. coli* WLA_{WWTF} * (Billion MPN/day)
1209L_01	WQ0010426-001	001	TX0022616	City of Bryan / Burton Creek WWTF	8.0	36.25
Total					**8.0**	**36.25**
1209C_01	WQ0010024-006	001	TX0047163	City of College Station / Carter Creek WWTF	9.5	43.05
1209C_01	WQ0004002-000	001	TX0002747	Texas A&M University / Central Utility	0.93	4.214
1209C_01	WQ0012296-001	001	TX0085456	R&B Mobile Home Park LLC / Glen Oaks MHP WWTF	0.013	0.0589
1209C_01	WQ0013153-001	001	TX0098663	City of College Station / Carter Lake WWTF	0.0085	0.03851
Total					**10.4515**	**47.36**

* Load includes a reduction for MOS of 5%

Regulated Stormwater

Stormwater discharges from MS4, industrial, and construction areas are considered regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). A simplified approach for estimating the WLA for these areas was used in the development of these TMDLs due to the limited amount of data available, the complexities associated with simulating rainfall runoff, and the variability of stormwater loading. Further detail on how the WLA_{SW} was calculated can be found in the *Technical Support Document for Bacteria TMDLs, Carters Creek Watershed (Segments 1209D, 1209L & 1209C)*. The calculation used to calculate allowable loads from regulated stormwater is expressed by the following equation:

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

Where:

ΣWLA_{SW} = sum of all permitted stormwater loads

TMDL = total maximum allowable load

ΣWLA_{WWTF} = sum of all WWTF loads

LA = tributary load allocations entering the segment

ΣFG = sum of future growth loads from regulated facilities

MOS = margin of safety load

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

Load Allocation (LA)

The load allocation is the sum of loads from unregulated sources. The load allocation is the sum of the tributary bacteria load (LA_{TL}) entering the segment and all remaining loads in the segment from unregulated sources (LA_{SEG}):

$$LA = LA_{SEG} + LA_{TL}$$

Where:

LA = allowable load from unregulated sources (predominately nonpoint sources)

LA_{SEG} = allowable loads from unregulated sources within the segment

ΣLA_{TL} = tributary load allocations entering the segment

The LA_{TL} is calculated as:

$$LA_{TL} = Q_{Trib} * Criterion$$

Where:

Criterion = 126 MPN/100 mL

Q_{Trib} = median value of the very high flow regime at Station 11783 on Burton Creek, which represents the tributary inlet to an impaired segment

The unregulated loading within the segment (LA_{SEG}) is calculated as:

$$LA_{SEG} = TMDL - \Sigma WLA_{WWTF} - \Sigma WLA_{SW} - LA_{TL} - \Sigma FG - MOS$$

Where:

LA_{SEG} = allowable load from unregulated sources within the segment

TMDL = total maximum allowable load

ΣWLA_{WWTF} = sum of all WWTF loads

ΣWLA_{SW} = sum of all permitted stormwater loads

LA_{TL} = tributary load allocations entering the segment

ΣFG = sum of future growth loads from regulated facilities

MOS = margin of safety load

Allowance for Future Growth (FG)

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

Currently four municipal WWTFs that service the Bryan/College Station area discharge into Burton Creek and Carters Creek. To account for the probability that new flows from WWTF discharges may occur in both assessment units, a provision for future growth was included in the TMDL calculations. The provision is based on an estimate of the population increase for the cities of College Station and Bryan from year 2010 estimates to year 2030 projections obtained from the Texas Water Development Board (TWDB, 2006). Assuming an even distribution of estimated and projected populations the percent increase calculated was directly applied to current discharge amounts for each WWTF. The discharge from the Texas A&M Central Utility plant was not included in the future growth estimate since population growth should not directly affect future discharges from this facility.

Thus, the future growth (FG) term is calculated as follows:

$$FG = \text{criterion} * (\%Pop_{30} * \Sigma DMR) * \text{conversion factor} * (1 - F_{MOS})$$

Where:

Criterion = 126 MPN/100 mL

$\%Pop_{30}$ = estimated percent increase in population between 2010 and 2030

Σ DMR = sum of average discharges (MGD) of the WWTFs in the assessment unit as reported in the discharge monitoring reports (DMRs) for January 2008 – May 2009 (or most recently available data on January 4, 2010)

Conversion factor = 3.7854×10^7 100 mL / million gallons

F_{MOS} = fraction of loading assigned to MOS (5% or 0.05)

Total Maximum Daily Load (TMDL)

The TMDL was based on the median flow in the 0-10 percentile range (very high flow regime) for flow exceedance from the LDC developed for the most-downstream station within each assessment unit. Allocations are based on the current geometric mean criterion for *E. coli* in freshwater of 126 counts/100 mL for each component of the TMDL.

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

$$TMDL = \Sigma WLA_{WWTF} + \Sigma WLA_{SW} + LA_{SEG} + LA_{TL} + \Sigma AFG + MOS$$

Table 3. TMDL Allocation Summary for Impaired Creeks (loads in billion MPN/day)

Segment	Stream Name	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA_{SEG}	LA_{TL}	Future Growth
1209D	Country Club Branch	14.38	0.2746	0	5.217	0	8.890	0
1209L	Burton Creek	199.9	8.428	36.25	116.7	1.409	31.31	5.785
1209C	Carters Creek	814.6	30.74	47.36	269.8	259.2	199.9	7.625

Implementation Strategy

This plan documents six management measures and two control actions to reduce bacteria loads. Management measures are voluntary activities, such as working to identify OSSFs in the watershed. Control actions are regulatory activities, such as implementing the TCEQ MS4 Phase II Stormwater Management Programs (SWMPs). Management measures were selected based on feasibility, costs, support, and timing. Implementation activities can be implemented in phases based on the needs of the stakeholders, availability of funding, and the progress made in improving water quality.

Adaptive Implementation

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

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

Activities and Milestones

To facilitate the development of the Carters Creek watershed TMDL I-Plan, two general stakeholder meetings were held in April and August of 2010. From these meetings, a Coordination Committee was formed. This Committee consists of critical watershed stakeholders and is considered the local decision making body for the development of the I-Plan. The Coordination Committee felt it pertinent to form work groups to determine appropriate management and control measures as appropriate for each work group's respective area of interest. The work groups formed are: Natural Resources, Planning and Development, Stormwater and Transportation, and Wastewater. Collectively, the Coordination Committee and the work groups have held about 20 meetings to date in the development of this I-Plan.

Each work group developed detailed, consensus-based action plans that considered bacteria loading sources in the watershed. The management measures contained in this I-Plan are the combined products of the four work groups. Individual work group reports can be found on the Carters Creek website at: <http://cartersandburton.tamu.edu/>.

Management Measures and Control Actions

The Carters Creek watershed I-Plan includes six stakeholder-developed management measures and two control actions.

Management Measures

1. *Coordinate and expand existing water quality monitoring in the watershed and conduct a watershed bacteria source survey.*

2. *Determine feasibility of modifying tax valuation requirements for agricultural lands and quantify expected water quality impacts of modifications and impacts of transitioning from agriculture to wildlife valuations.*
3. *Work to improve OSSF identification, inspection, pre-installation planning, education, operation, maintenance and tracking to ensure proper system functioning.*
4. *Implement SSO initiatives as appropriate across the watershed.*
5. *Implement voluntary BMPs on agricultural or undeveloped properties.*
6. *Continue existing efforts and work to establish new mechanisms that encourage and promote future development and redevelopment that will mitigate adverse water quality impacts in the watershed.*

Control Actions

1. *Implement entity-specific MS4 Phase II SWMPs throughout the watershed.*
2. *Monitor WWTF effluent* E. coli *concentrations according to permit requirements.*

Management Measure 1.0

Coordinate and expand existing water quality monitoring in the watershed and conduct watershed bacteria source survey.

The purpose of this management measure is to develop a more refined understanding of the spatial and temporal dynamics of *E. coli* loading in the Carters Creek watershed. The water quality impairments in Carters and Burton Creeks are based on quarterly data collected at 4 sampling locations (TCEQ Stations 11783, 11784, 11785, 11795) (Millican, 2011). To accurately identify and address the sources of water quality impairments in the Carters Creek watershed, an intensified monitoring campaign is needed.

With the exception of station 11795, monitoring has been reduced to station 11785 on Carters Creek since 2007. Monitoring at station 11795 resumed in 2011 and will continue through 2012 on a quarterly basis. The two large WWTFs do monitor and self-report their effluent for *E. coli;* however, this data is not used for water body assessment.

This effort will begin with coordinating the monitoring that already exists in the watershed. Brazos River Authority (BRA), City of Bryan (COB), and City of College Station (COCS) personnel will develop a sampling schedule and communication structure to coordinate with each other about needed changes to the sampling schedule. This coordination will ensure that instream water quality monitoring and WWTF self-reported data are collected on the same dates at approximately the same time. This approach will ensure a level of consistency in the data that will make them comparable.

Expanding the monitoring in the watershed is a primary goal of all four work groups. Quarterly monitoring collected at one site is not sufficient to accurately

determine the quality of a water body, nor is it sufficient to aid watershed managers in identifying and addressing instream water quality. The data used in the development of the TMDL indicated that elevated *E. coli* levels exist under all flow conditions at each of the four monitored sites, which does not help to identify critical areas of need in the watershed. An expanded monitoring network that collects data at strategic locations on a refined time scale will aid entities involved in the management of their watershed in identifying where problem areas for *E. coli* loading may be and when they are most problematic.

Monitoring is needed in the watershed to accomplish two primary goals:

1) better define where problem loading areas are in the watershed
2) monitor long-term trends in water quality following BMP implementation

Further evaluation of potential sources of pollution in the watershed is also needed. Piecemeal information exists across the watershed regarding potential sources of pollution in the watershed. A physical survey of the stream network in the watershed will be conducted and paired with a GIS source survey to further understand potential sources of *E. coli* loading in the watershed.

To partially fulfill these needs, TWRI has worked with local watershed stakeholders to facilitate development of a proposal that defines desired water quality monitoring goals, objectives, tasks, and expected outcomes of a special monitoring and source assessment project. Funding has been sought from the TCEQ's Nonpoint Source Program through the annual 319(h) Grant funding program to implement this measure.

In this proposal, monitoring is planned to occur at 16 locations. Six of these sites will be monitored every other week for two years to provide additional data for the TCEQ's SWQMIS database for use in future water body assessments and establishing a baseline water quality prior to BMP implementation. The other 10 sites will be monitored monthly to provide supplemental data collected by volunteer monitors organized through the Texas Stream Team that will illustrate spatial variations in water quality, thus helping to illustrate where *E. coli* loading is most problematic in the watershed.

Two of the monitoring sites within these groups overlap with each other to illustrate the quality/usefulness of volunteer data collected. Two stations will also be equipped with automated stormwater sampling equipment to illustrate hydrological variations on instream water quality and better illustrate when elevated *E. coli* loadings occur in relation to rain events.

Data produced through this project will provide needed water quality data to watershed stakeholders thus aiding them in better managing their local water

resources and in illustrating future improvements in water quality. The proposal also includes a watershed source survey that will further understanding of *E. coli* pollutant loading impacting the stream network in the watershed by conducting physical observations along the length of the creek and its tributaries.

A comprehensive watershed GIS survey will also be conducted to provide a better understanding of pollutant sources in the watershed. Specific details of the monitoring will be available in the project's work plan and quality assurance project plan (QAPP).

TWRI will manage the project and coordinate its execution, ensuring that water quality data are collected as defined in the project work plan and QAPP. Data will be reported to the TCEQ for inclusion in their surface water quality monitoring information system (SWQMIS) for use in future water body assessments. TWRI will facilitate necessary reporting and accounting functions as well.

Additional monitoring needs identified in the future will be conducted contingent upon the receipt of funding specifically for additional water quality monitoring.

Responsible Parties and Funding

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

- BRA – Clean Rivers Program
- COB
- COCS
- Texas AgriLife Research
- TCEQ –CWA §319(h) Nonpoint Source Grant Program funding
- TCEQ – Regional Office
- TCEQ – Clean Rivers Program
- TWRI
- Watershed volunteers

BRA will continue Clean Rivers Program (CRP) monitoring in the watershed and will coordinate efforts with other monitoring entities in the watershed.

COB will coordinate monitoring of its WWTFs with other monitoring in the watershed. Support of monitoring efforts will also be provided.

COCS will coordinate monitoring of its WWTFs with other monitoring in the watershed. Support of monitoring efforts will also be provided.

Texas AgriLife Research will provide data collection and analysis support as needed for special water quality monitoring projects in the watershed.

A proposal for grant funding to conduct an enhanced spatial and temporal monitoring project was submitted by TWRI to the TCEQ during the FY 2012 319 (h) Grant request for grant applications and was approved.

TCEQ – Regional Office will continue to support monitoring efforts in the watershed through their involvement in coordinated monitoring efforts.

TCEQ – Clean Rivers Program will continue to support monitoring in the Carters Creek watershed through BRA.

TWRI will assist in coordinating monitoring efforts in the watershed, will assist watershed stakeholders in the development of the monitoring proposal, and will manage the project and ensure that it is completed as described.

Watershed volunteers will be organized when funds have been secured to conduct supplemental monitoring in the watershed. This monitoring will provide additional insight into the extent and potential sources of the water quality impairment and will aid in targeting future BMP implementation.

Measurable Milestones

The measureable milestones are as follows.

Year 1:

- TWRI will facilitate the establishment of appropriate contracts between the TCEQ and entities receiving funding to conduct watershed monitoring.
- TWRI will organize monitoring efforts and develop the project QAPP.
- The TCEQ and BRA continue CRP monitoring efforts in the watershed.

Year 2:

- Monitoring and assessment will begin and continue throughout the year.
- The TCEQ and BRA continue CRP monitoring efforts in the watershed.

Year 3:

- Monitoring will continue through the year and conclude.
- Data assessment will commence
- Areas of the watershed will be identified where future implementation efforts will be targeted.
- Reporting will begin.
- The TCEQ and BRA continue CRP monitoring efforts in the watershed.

Year 4:

- Reporting requirements will be met.
- Reports will be submitted to local stakeholders and TCEQ for review that illustrate the current state of water quality in the Carters Creek watershed and establish a good baseline of data for assessing BMP effectiveness.
- The TCEQ and BRA continue CRP monitoring efforts in the watershed.

Year 5:

- Upon completion of monitoring and assessment, responsible parties as appropriate will use monitoring and source assessment results to collectively plan targeted BMP implementation.
- The TCEQ and BRA continue CRP monitoring efforts in the watershed.

Table 4. Summary of Management Measure 1: Watershed Monitoring and Assessment

Causes and Sources: General nonpoint and point sources

Key Element (1), Management Measure: *Coordinate and expand existing water quality monitoring in the watershed*

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
Monitoring will aid in setting a baseline for quantifying future load reductions from BMPs.	**Technical**: for development and management of the grant to conduct expanded watershed monitoring.	Make presentations on preliminary data and findings. Provide water quality data to BRA for inclusion in the basin highlights report.	**Year 1**: – Establish contracts, procure supplies, develop QAPP, and initiate monitoring. – Continue CRP.	– Funding is being sought. – Contracts established. – QAPP developed. – Monitoring initiated.	Data collected as planned, and submitted to TCEQ.	N/A	- **TCEQ NPS Program**: Funding. - **TWRI**: project management, reporting, data collection.
	Technical: to complete monitoring outlined in proposed special project. Texas A&M students will provide this assistance.	Prepare final report detailing project findings and highlighting recommendations for targeting future BMP implementation.	**Year 2**: – Continue water quality monitoring and water body reconnaissance surveys. – Continue CRP.	– Continued monitoring as scheduled. – Completion of watershed reconnaissance survey.			- **Texas AgriLife Research**: data analysis and collection. - **BRA/TCEQ RO & CRP**: continue existing CRP monitoring.
	Financial: to support expanded monitoring, assessment, and analysis of watershed *E. coli* distribution, sources, and concentration.	Train volunteers to enhance volunteer monitoring in the watershed.	**Year 3**: – Complete monitoring, data assessments, and report development. – Deliver information on findings to stakeholders. – Continue CRP.	– Completion of monitoring. – Completion of data assessment. – Reports developed. – Data submitted to TCEQ for future water body assessment.			- **Cities of Bryan and College Station**: data collection, analysis.
	Financial: Non-federal matching funds will be obtained in forms such as personnel and volunteer time.	Develop informational news releases highlighting local water quality.	**Year 4 & 5**: – Complete reporting requirements and use findings to direct future BMP implementation. – Continue CRP.	Determinations made on BMP implementation.			– **All**: plan targeted BMP implementation.

Management Measure 2.0

Determine feasibility of modifying tax valuation requirements for agricultural lands and quantify expected water quality impacts of modifications and impacts of transitioning from agriculture to wildlife valuations.

The purpose of this management measure is to determine if there are any water quality benefits to be gained through the modification of current agricultural use valuation requirements imposed by the local tax assessor's office. For smaller properties, overgrazing by livestock may be a function of animal numbers being housed on a property to maintain county requirements for tax valuation purposes instead of more appropriate BMPs.

To determine if water quality improvements might be achieved, discussions will be initiated with the Brazos County Appraisal District (BCAD) office to evaluate the requirements of a property receiving an agricultural use valuation. U.S. Department of Agriculture–Natural Resources Conservation Service (NRCS) and Texas AgriLife Extension Service personnel will compare currently used requirements of BCAD to applicable NRCS recommendations for selected conditions within Brazos County and will make suggestions to the BCAD for modifying tax requirements as appropriate. Additionally, using mailings from the BCAD as a vehicle to get educational materials to selected landowners will be explored.

Wildlife use valuation is another option that can be used by landowners who do not wish to engage in agricultural practices yet still maintain their tax valuation levels on par with agricultural levels. More information on this management option can be found on the Texas Parks and Wildlife Department (TPWD) website at: <www.tpwd.state.tx.us/landwater/land/private/agricultural_land/>. The potential differences in *E. coli* loading for a conversion from agricultural to wildlife tax valuation are not well known, but changes in sources and quantities of bacteria loading may occur.

A research project was recommended as a feasible mechanism for determining what the associated costs and water quality impacts may be from a conversion from agriculture valuation to wildlife valuation. Funding will be sought to support a graduate student in conducting a research project to assess these impacts.

Responsible Parties and Funding

Each entity listed below will only be responsible for undertaking efforts to identify areas where improvements can be made. Graduate student support is the only additional funding needed to complete this management measure.

- BCAD
- Brazos County Soil and Water Conservation District (SWCD) #450
- NRCS - Brazos County Field Office
- Texas AgriLife Extension Service
- Texas A&M – Agricultural Economics Department
- TWRI

BCAD will be asked to participate in discussions on making improvements to the requirements for agricultural land valuations for taxing purposes.

Brazos County SWCD #450 will participate in discussions with the BCAD to improve agricultural land-valuation tax requirements such that water quality improvement can be realized.

Brazos County NRCS will participate in discussions on making improvements to requirements for agricultural land valuations for taxing purposes with the BCAD and will provide technical basis for these discussions. NRCS will work with BCAD to develop an improved set of requirements if improvements are deemed feasible.

Texas AgriLife Extension Service will participate in discussions to make improvements to the requirements for agricultural land valuations for taxing purposes. Texas AgriLife Extension Service will also provide educational materials as appropriate and funding allows for mailings and other educational opportunities.

The Department of Agricultural Economics at Texas A&M and others as appropriate will work to secure funding to conduct a research project that quantifies changes in landowner behavior when land is transitioned from agricultural uses to wildlife uses. Behavioral impacts of agricultural tax valuation requirements could also be evaluated.

TWRI will assist in efforts to secure funding for Texas A&M – Agricultural Economics Department to conduct their assessment.

Measurable Milestones

The measureable milestones are as follows.

Year 1:

- Completed discussions by NRCS, SWCD, and the Texas AgriLife Extension Service with the BCAD to evaluate agriculture valuation requirements for areas where modifications can be made to improve water quality.
- If feasible, work will begin to modify requirements for agricultural tax valuations.

- Discussions completed with Appraisal District on the ability to send educational materials to landowners receiving agricultural and wildlife valuations along with annual tax statements from the Appraisal District.
- Begin seeking funding to assess water quality impacts resulting from a shift from agricultural land uses to wildlife land uses.

Year 2:

- Contingent upon receipt of funding, work will begin on assessing potential water quality changes because of shifting properties from agricultural tax valuations to wildlife tax valuations.
- Based upon outcomes of discussions with BCAD, continue work to modify requirements for agricultural tax valuations.
- Begin sending educational materials to landowners with agricultural or wildlife tax valuations through the BCAD.

Year 3:

- Contingent upon previous years' activities, continue effort to quantify water quality impacts from transitioning land uses from agricultural to wildlife.
- If allowable, continue disseminating educational material to landowners through BCAD mailings.

Year 4:

- Complete efforts to quantify water quality impacts from transitioning land uses from agricultural to wildlife if funding secured.
- Results of work presented to watershed stakeholders and the TCEQ as well as published for widespread use.
- If allowable, continue disseminating educational material to landowners through BCAD mailings.

Year 5:

- If allowable, continue disseminating educational material to landowners through BCAD mailings.

Table 5. Summary of Management Measure 2: Possible Tax Valuation Modification

Causes and Sources: Livestock and wildlife nonpoint sources

Key Element (1), Management Measure: *Determine the water quality impacts of (1) modifications to tax valuation requirements for agricultural lands and (2) of transitioning from agriculture to wildlife valuations*

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
Cannot be quantified until levels of change are determined.	**Technical**: Support of NRCS, SWCD, and Texas AgriLife Extension Service personnel for discussions on tax requirement modifications.	Discussions will include educating the Tax Assessor's office as necessary on the need for tax requirement modifications.	**Year 1**: – Discuss tax modifications and use of Appraisal District mailing for educational material dissemination. – Seek funds for land use change assessment.	– Funding source identified/secured. – Tax requirement discussions complete. – Educational material dissemination discussed.	– Feasible tax requirement modifications identified. – Funding secured.	Documentation of progress indicators achieved.	– **NRCS**: technical assistance. – **AgriLife Extension**: technical assistance.
	Financial: No financial support is needed to discuss tax modifications. Should educational material dissemination be allowed, existing funds will be used to the extent possible.	Selected, existing educational materials will be used in mailings if allowed.	**Year 2**: – Continue to discuss tax modifications. – Disseminate educational materials. – If funded, initiate land use change assessment.	– Complete tax requirement modifications if feasible. – Disseminate educational materials. – If funded, land use change assessment initiated.	Number of educational materials disseminated.	Monitoring designed to establish baseline and identify problem areas.	**SWCD**: support need for tax requirement modifications.
	Technical: A student trained in water resource economics to carry out the agricultural to wildlife use assessment.	Project reports will illustrate water quality impacts because of land use transition.	**Year 3**: – Continue dissemination of educational materials. – If funded, continue land use change assessment.	– Continued dissemination of educational materials. – Continuation of land use change assessment.	Land use change assessment finalized.		**Texas A&M Ag Economics**: land use change assessment if funded.

Table 5, continued
Possible Tax Valuation Modification

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
	Financial: For the student to conduct assessment; roughly estimated at $2,500/month for time and supplies for 2 years.	Publications will be developed for wide dissemination of project findings.	**Year 4**: – Continue disseminating educational materials. – If funded, complete land use change assessment and distribute results.	– Continued dissemination of educational materials. – Completed land use change assessment and dissemination of results.			**TWRI**: help seek funding for land use change assessment.
			Year 5: – Complete tax requirement modifications if feasible. – Continue dissemination of educational materials.	– Continued dissemination of educational materials.			

Management Measure 3.0

Work to improve OSSF identification, inspection, pre-installation planning, education, operation, maintenance and tracking to ensure proper system functioning.

The purpose of this management measure is to improve the identification, inspection, pre-installation planning, education, operation, maintenance, and tracking of all OSSFs in the watershed to minimize the potential negative water quality impacts from malfunctioning systems.

Identifying all OSSFs in the Carters Creek watershed is the first step in this process. Tracking OSSF locations, age, and type is a current practice employed in Brazos County; however, systems installed prior to 1978 were not well documented or not documented at all. Systems of this age or older have an increased likelihood of failure and as such identifying the location of these systems will aid in reducing potential *E. coli* loading to the Carters Creek watershed. The initial step in this process will be to collect geographic information system (GIS) information on known OSSFs in the watershed as well as the known sewerage system extent. From there, dwellings and other facilities not served by known systems will be identified. As OSSFs are identified, they will be tracked using GIS to document pertinent information related to the installation, operation, maintenance, and performance history of the system.

Inspecting all septic systems in the watershed is also a goal of this management measure. Aerobic OSSFs installed in the county are currently required by county ordinance to be inspected triennially by a licensed service provider to ensure that systems are properly operating and that adequate maintenance is being performed. No such inspection requirement exists for conventional OSSFs. A new or amended ordinance will be required to enact this requirement.

Knowledge and understanding of operation and maintenance requirements for OSSFs (aerobic and conventional) is viewed as being generally deficient throughout the watershed and is especially deficient for new homeowners who purchase a home with a previously existing OSSF. Improved mechanisms are needed and will be explored to provide education and outreach (E&O) materials to homeowners on the proper operation and maintenance of an OSSF and its importance in preserving local environmental quality.

Pre-installation planning for new OSSF construction will also be evaluated. Current OSSF sizing and spray field sizing is based purely on the number of rooms in a house and/or its total square footage. These sizing requirements will be evaluated to determine if a better metric is available to more appropriately size OSSFs.

To aid in accomplishing some of these goals, TWRI worked with watershed stakeholders to develop and submit a project proposal that, if funded, will identify potential OSSFs in the watershed and assign a potential pollution contribution risk to each system using a GIS methodology. The proposed work will also provide needed OSSF education and outreach to local watershed stakeholders. Specific details of the GIS identification and prioritization methodology will be available in the project's work plan and quality assurance project plan (QAPP) assuming there is sufficient funding. Funding has been sought from the TCEQ's Nonpoint Source Program through the annual 319(h) Grant funding program to implement this measure.

Responsible Parties and Funding

Each entity listed below will only be responsible for undertaking efforts to identify areas where improvements can be made. No expense of resources is currently associated with activities described in this management measure.

- Brazos County GIS Coordinator
- Brazos County Health Department
- COB
- COCS
- Texas AgriLife Extension Service
- TWRI

Brazos County Health Department (BCHD) personnel will be responsible for the bulk of the activities associated with this management measure. They have the authority and jurisdiction over OSSFs in the county and as such will be responsible for deciding upon changes to these authorities and implementing them.

COB and COCS will assist in efforts to identify all OSSFs in the watershed by providing GIS support through providing information about locations of known OSSF and wastewater conveyance systems within each city.

The Texas AgriLife Extension Service will assist as needed in the development and delivery of E&O materials to OSSF owners in the watershed.

TWRI will provide needed technical assistance to administer project funding if received; will develop and employ the GIS identification and ranking methodology and will coordinate OSSF E&O programming with Texas AgriLife Extension Service.

Measurable Milestones

The measureable milestones are as follows.

Year 1:

- BCHD will continue to ensure that required OSSF inspections are completed, and will develop a mechanism to verify that OSSF inspections occur as documented.
- BCHD and others as appropriate will evaluate ways in which E&O material delivery to homeowners with OSSFs can be improved, and will develop a strategy for implementing the approach.
- COB and COCS will transfer GIS information as needed to BCHD for use in OSSF identification efforts.
- OSSF identification and documentation will begin as funding and personnel time exists.

Year 2:

- BCHD will continue to identify OSSFs in the watershed as funding and personnel time exists.
- BCHD will evaluate changes to new OSSF sizing requirements and make a recommendation on modifications to the existing requirements.
- BCHD and others, as appropriate, will deliver E&O materials to OSSF system owners.
- Contingent upon support of local government leaders, BCHD will work to amend county ordinances to establish inspection requirements on all OSSFs.

Years 3 and beyond:

- BCHD will complete OSSF identification in the watershed and will continually add new OSSF data to a GIS of watershed OSSFs.
- Following amendment of OSSF inspection ordinance, BCHD will begin implementing new inspection policy.
- BCHD and others, as appropriate, will deliver E&O materials to OSSF system owners.

Table 6. Summary of Management Measure 3: OSSF Education, Inspection, Operation, Maintenance, and Tracking

Causes and Sources: Nonpoint sources from OSSFs

Key Element (1), Management Measure: *Work to improve OSSF identification, inspection, pre-installation planning, education, operation, maintenance, and tracking to ensure proper system functioning*

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators to Measure Progress	(8) Monitoring Component	(9) Responsible Entity
$2.67x10^{10}$ cfu/day Estimated using an equation from EPA's 2001 *Protocol for Developing Pathogen TMDLs*. Appendix B provides additional calculation information.	**Technical**: BCHD will provide needed technical assistance for most items. Texas AgriLife Extension Service can provide educational assistance as needed. Cities of Bryan & College Station provide GIS support.	BCHD and others as appropriate will evaluate E&O mechanisms for delivering information to OSSF owners.	**Year 1**: — Begin identifying OSSFs in watershed. — Coordinate GIS information. — Evaluate E&O delivery mechanisms. — Ensure OSSF inspections occur as required.	– GIS layers coordinated with BCHD, cities of Bryan and College Station. – E&O delivery mechanisms identified and put into use. – OSSF inspections continue as required.	– GIS completed. – All OSSFs identified.	— Documentation of progress indicators achieved.	– **BCHD**: technical assistance, lead entity on all items.
	Financial: Financial assistance is being sought to provide additional man power to identify and prioritize potential OSSFs in the watershed and provide needed E&O.	BCHD and others will distribute materials to OSSF owners.	**Year 2**: – Continue OSSF identification. – Evaluate changes to OSSF sizing. – Deliver E&O materials. – Amend ordinances as support of local government leaders exists.	– OSSFs in watershed identified. – Ordinance amendment requiring inspection of all OSSFs. – OSSF sizing requirements evaluated and amended.	– All OSSFs inspected. – E&O items delivered.	– BRA's CRP monitoring @ TCEQ station 11785.	– **Texas AgriLife Extension**: technical assistance for E&O. – **TWRI**: assistance in developing/administering proposal, conducting GIS based OSSF assessment.

Table 6, continued
OSSF Education, Inspection, Operation, Maintenance, and Training

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators to Measure Progress	(8) Monitoring Component	(9) Responsible Entity
	Potential Financial: Funding support to correct identified OSSF malfunctions may be needed and will be determined after systems are identified and inspected.	As OSSFs are identified, E&O materials will be delivered.	**Year 3 and beyond**: – Continue and complete OSSF identification. – Continually add new OSSF info to watershed GIS. – Following ordinance amendment, begin implementing inspection policy. – Continue delivery of E&O materials as needed.		– Ordinance amendments complete.	– Monitoring designed to establish baseline and identify problem areas.	– **COB & COCS**: technical assistance and GIS support as needed; cities provide info to the county.
		Workshops will be planned and provided to OSSF owners, inspectors, service providers and others (if needed).					– **BC GIS Coordinator**: update and maintain GIS layer of OSSFs county-wide.

Management Measure 4.0

Implement sanitary sewer overflow (SSO) initiatives as appropriate across the watershed.

The purpose of this management measure is to continue the implementation of the SSO initiatives in the watershed, thus minimizing the impacts of raw sewage being spilled in the watershed due to failures in the wastewater delivery system.

COB currently has a SSO initiative in place; COCS is in the process of establishing their SSO initiative that is similar in nature to the COB's. These initiatives include a host of activities that each city will carry out in efforts to reduce the number of SSOs that occur within their respective service areas, including portions of the Carters Creek watershed. Within the SSO initiatives, the cities will conduct routine sewer pipe inspections, using inflow and infiltration studies to prioritize needed system repairs and/or replacements; additionally, manholes will undergo visual inspections to prioritize needed repairs. Tracking SSOs using GIS and documenting the source of the SSO will also serve to prioritize future repairs. Repairs and replacements are tracked annually.

Implementing the SSO initiative complements the implementation of the COB and COCS Phase II MS4 permits. Identification of illicit discharges to the MS4 system overlaps with identifying SSOs in some cases, and as a result, can lead to better identification and quantification of these events.

Responsible Parties and Funding

Entities listed below will only be responsible for undertaking efforts within its specific jurisdiction. Expenses associated with this management measure are built into annual operating budgets, and may vary annually. Amounts of work accomplished each year are dependent upon annual approved budgets.

- COB
- COCS

COB will be responsible for continuing implementation of its SSO initiative and seeking funding to be allocated to accomplish needed objectives.

COCS will be responsible for establishing its SSO initiative, establishing funding for this initiative, and implementing the outlined objectives.

Measurable Milestones

The measureable milestones are as follows.

Year 1:

- COB will continue to implement the components of its SSO initiative and track SSO events, repairs, and replacements.
- COCS will work to establish its SSO initiative and begin to implement it once funded.

Year 2 and beyond:

- COB and COCS will continue to implement their SSO initiatives and track SSO events, repairs, and replacements.

Table 7. Summary of Management Measure 4: SSO Initiative

Causes and Sources: Point and nonpoint sources from SSOs

Key Element (1), Management Measure: *Implement sanitary sewer overflow (SSO) initiatives as appropriate across the watershed.*

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators to Measure Progress	(8) Monitoring Component	(9) Responsible Entity
1.72×10^{10} cfu/day Estimated using an equation from EPA's 2001 *Protocol for Developing Pathogen TMDLs*. Appendix B provides additional calculation information.	**Technical**: The cities of Bryan and College Station retain needed technical capabilities on staff to accomplish the goals of their SSO initiatives.	Bryan and College Station disseminate E&O materials to sewerage customers to aid in reducing SSOs (Fats, Oils, & Grease education for example).	**Year 1**: – COB continues implementing SSO initiative as planned. – COCS establish SSO initiative and begin implementation. – Track SSO events, repairs, and replacements annually in GIS. – Conduct E&O to minimize future SSOs.	– GIS layers illustrating SSO events, repairs, and replacements made.	– SSO initiatives funded. – SSO initiative objectives met.	Documentation of progress indicators achieved.	**COB**: implement and fund its SSO initiative.
	Financial: Financial support is currently set aside for these efforts through annually approved budgets by each respective city.	Participating in E&O events such as the local Earth Day celebration, and other media is an avenue of dissemination.	**Year 2 and beyond**: – COB and COCS continue implementing SSO initiative as planned. – Track SSO events, repairs, and replacements annually in GIS. – Conduct E&O to minimize future SSOs.	– Number of E&O disseminations/ views/events.	– # of feet of pipe replace annually. – # of SSO events declining.	BRA's CRP monitoring @ TCEQ station 11785.	**COCS**: establish, implement, and fund its SSO initiative.
	Financial: Should the need for capital improvement projects arise, additional financial resources may be needed and will be sought as needed.	Websites, brochures, PSAs, water plan tours.				Monitoring designed to establish baseline and identify problem areas.	

Management Measure 5.0

Voluntary BMP implementation on agricultural or undeveloped properties.

The purpose of this management measure is to mitigate potential *E. coli* loadings derived from agricultural lands by targeting education and outreach to watershed landowners that illustrate water quality benefits of appropriately planned BMP implementation on areas within priority areas of the watershed. These efforts will further show landowners how water quality improvements can be achieved while still meeting their individual land management goals.

Despite the rapid expansion of the urbanized areas in and around Bryan and College Station, agricultural uses still make up a sizable portion of the land use in the eastern portion of the Carters Creek watershed. According to the BCAD, 9,775 acres of the watershed are classified as agricultural lands for taxing purposes. This accounts for approximately 27 percent of the total watershed area.

Properly planned implementation of BMPs in targeted areas of a watershed has proven to have positive impacts on water quality while simultaneously improving animal health/performance and profit margins for livestock producers (Redmon et al., 2011), and can be effective in the Carters Creek watershed as well. Through the development of water quality management plans (WQMPs), site-specific plans are developed and approved by SWCDs to meet landowner goals while improving water quality management.

Rather than take a blanket approach to implementing BMPs on all agriculturally designated lands in the watershed, a targeted approach is recommended as a way to identify those areas that have the highest likelihood for contributing fecal material to the creek. A ranking system will be developed and based largely on the following criteria, in decreasing order of significance:

- Proximity to the main channel of Carters Creek
- Proximity to 3rd order streams or higher
- Active use of the property
  - Grazed – top priority
  - Un-grazed – not a priority
- Pasture type
  - Managed pasture – top priority
  - Unimproved pasture / rangeland – low priority
- Size of the property
  - > 50 acres - top priority
  - < 50 and > 25 acres - second priority
  - < 25 acres - lowest priority

- Likelihood of near future development

This ranking system will not be used to designate where actual BMP implementation will occur. Instead, this ranking system will simply prioritize what properties will likely yield the best possibilities for improving water quality as a result of BMP implementation. Using property rankings, education and outreach will be targeted to landowners such that they are informed of the water quality benefits that can be realized through the proper environmental stewardship, management planning, and implementation of BMPs focused on improving water quality while simultaneously meeting landowner usage goals. Natural resource management professionals will apply this ranking system, and will use their best professional judgments in final prioritization. Implementation will take place on a solely voluntary basis.

It should be noted that land development pressure will likely limit the adoption of BMP implementation in some areas of the watershed. Some properties on the fringe of existing developed areas that are currently used for livestock grazing are actively being marketed for development and an ensuing use change.

Bacteria contributions from wildlife sources can also be mitigated through implementing appropriate BMPs and/or habitat management practices that can promote the use of areas away from the riparian corridor by wildlife species present in the watershed. Technical assistance can be provided to landowners by Texas Parks and Wildlife Department (TPWD) such that individual landowner management goals are met while simultaneously improving wildlife habitat/availability and promoting natural resource conservation.

Feral hogs have also been identified as contributors to the bacteria load in the watershed. Feral hogs are an invasive species that is known to inhabit white-tailed deer range and habitats (Taylor, 1991). Specific watershed population estimates are not available but can be extrapolated to range from approximately 237 up to 509 animals based on published density estimates presented in Mellish et al. (2011) and Wagner & Moench (2009) respectively. Given the low number of hogs and the urbanizing nature of this watershed, education and outreach is seen as the most appropriate mechanism for managing feral hog populations and bacteria contributions to the watershed.

Texas State Soil and Water Conservation Board

The Texas State Soil and Water Conservation Board (TSSWCB) is the lead agency in Texas responsible for planning, implementing, and managing programs and practices for preventing and abating agricultural and silvicultural (forestry-related) nonpoint source pollution (Texas Agriculture Code Section 201.026). In accordance with this responsibility, the TSSWCB administers a certified WQMP Program that provides, through local SWCDs, for the development, implementa-

tion, and monitoring of individual WQMPs for agricultural and silvicultural lands. Each WQMP is developed, maintained, and implemented under rules and criteria adopted by the TSSWCB. A WQMP achieves a level of pollution prevention or abatement consistent with the state's water quality standards.

A WQMP is a site-specific plan designed to assist landowners in managing nonpoint source pollution from agricultural and silvicultural activities. WQMPs are traditional conservation plans based on the criteria outlined in the NRCS Field Office Technical Guide (FOTG). The FOTG is the best available technology and is tailored to meet local needs. A WQMP includes appropriate land treatment practices, production practices, management measures, technologies, or combinations thereof. WQMPs are developed in cooperation with the landowner with assistance from the NRCS and approved by the local SWCD and are certified by the TSSWCB. This approach to preventing and abating nonpoint source pollution uses a voluntary approach while affording the landowner a mechanism for compliance with the state's water quality standards.

The TSSWCB regularly performs status reviews on WQMPs to ensure that the producer is implementing the measures prescribed in the WQMP. The TSSWCB administers technical and cost-share assistance programs to assist producers in implementing their WQMPs. The TSSWCB uses both state general revenue and federal grants to fund the WQMP Program.

Several essential practices from the NRCS FOTG included in a WQMP are of specific applicability to the bacteria reduction goals of this TMDL and I-Plan. A grazing management system is a vital component of a WQMP for livestock operations.

Grazing management examines the intensity, frequency, duration and season of grazing to promote ecologically and economically stable relationships between livestock and forage species. The distribution of grazing animals is managed to maintain adequate and desired vegetative cover, including on sensitive areas like riparian corridors. Livestock distribution is managed through cross-fencing, alternate water sources, supplemental feed placement, and shade or cover manipulation. The expected forage quality, quantity, and species are analyzed to plan for an appropriate forage-animal balance. Grazing management systems plan for potential contingencies such as severe drought, wildfires, or flooding in order to protect the resource, protect grazing animals, and reduce economic risk.

The TSSWCB, in collaboration with NRCS and the Brazos County SWCD #450, will continue to provide technical assistance to landowners in developing and implementing WQMPs. The TSSWCB will develop WQMPs on 100% of the livestock operations in the Carters Creek watershed who request planning assistance

through the SWCD. The TSSWCB will annually perform status reviews on at least 50% of all WQMPs in the Carters Creek watershed.

Since the beginning of the TSSWCB WQMP Program in 1995, financial incentive funds (state general revenue) have been allocated to SWCDs in priority areas across the state and obligated by the SWCDs to individual producers. A lesser amount of funding is reserved by the TSSWCB for individual producers and SWCDs not in priority areas. Neither the Brazos County SWCD #450 nor Carters Creek is in a priority area. Livestock producers in the Carters Creek watershed seeking financial assistance from the TSSWCB to implement specific BMPs prescribed in a WQMP may request funding through the statewide, non-priority area allocation.

U.S. Department of Agriculture Natural Resources Conservation Service

The NRCS is a federal agency that works hand-in-hand with Texans to improve and protect their soil, water, and other natural resources. For decades, private landowners have voluntarily worked with NRCS specialists to prevent erosion, improve water quality, and promote sustainable agriculture.

The NRCS provides conservation planning and technical assistance to landowners, groups, and units of government to develop and implement conservation plans that protect, conserve, and enhance their natural resources. When providing assistance, NRCS focuses on the sound use and management of soil, water, air, plant, and animal resources. NRCS helps customers manage their resources in a way that prevents resource degradation, ensures sustainability, allows for productivity, and respects the customers' needs. Conservation planning can make improvements to livestock operations, crop production, soil quality, water quality, pastureland, forestland, and wildlife habitats. The NRCS also integrates ecological and economic considerations in order to address private and public concerns.

The NRCS administers numerous Farm Bill Programs authorized by the U.S. Congress that provide financial assistance for many conservation activities:

- Conservation Innovation Grants (CIG)
- Conservation Stewardship Program (CSP)
- Environmental Quality Incentives Program (EQIP)
- Agricultural Water Enhancement Program (AWEP)
- Farm and Ranch Lands Protection Program (FRPP)
- Grassland Reserve Program (GRP)
- Wetlands Reserve Program (WRP)
- Wildlife Habitat Incentives Program (WHIP)

- Conservation Reserve Program (CRP) administered by USDA Farm Service Agency

EQIP and other programs were reauthorized in the federal Food, Conservation, and Energy Act of 2008 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. People who are engaged in livestock or agricultural production on eligible land may participate in EQIP. EQIP offers financial and technical assistance to eligible participants for installation or implementation of structural and management practices on eligible agricultural land.

EQIP also provides financial assistance to implement conservation practices. EQIP activities are carried out according to a plan of operations developed in conjunction with the producer that identifies the appropriate conservation practice(s) to address resource concerns. All practices are subject to NRCS technical standards described in the FOTG and adapted for local conditions. Local SWCDs approve these plans.

Local Work Groups provide recommendations to USDA-NRCS on allocating EQIP county base funds and on resource concerns for other USDA Farm Bill programs. Carters Creek watershed stakeholders are encouraged to participate in the Local Work Group in order to promote the goals of this I-Plan Management Measure as compatible with the resource concerns and conservation priorities for EQIP.

Soil and Water Conservation Districts

An SWCD, like a county or school district, is a subdivision of state government. SWCDs are administered by a board of five directors who are elected by their fellow landowners. There are 216 individual SWCDs organized in Texas. Through decades old agreements, SWCDs offer agricultural landowners and operators technical assistance through a partnership with the NRCS and the TSSWCB. It is through this conservation partnership that local SWCDs are able to furnish technical assistance to farmers and ranchers in the preparation of a complete soil and water conservation plan to meet each land unit's specific capabilities, and needs. The Carters Creek watershed is wholly within the Brazos County SWCD #450.

Texas Parks and Wildlife Private Lands Services

TPWD Private Lands Services is a program to provide practical information for private landowners on ways to manage wildlife resources consistent with other land use goals, to ensure plant and animal diversity, to provide aesthetic and economic benefits, and to conserve soil, water, and related natural resources. To participate, landowners may request assistance by contacting the TPWD district

serving their county <www.tpwd.state.tx.us/landwater/land/technical_guidance/biologists/>.

TPWD cost share programs available to private landowners in the Carters Creek watershed include the Landowner Incentive Program (LIP) and the Pastures for Upland Birds program. Each assists landowners to manage their properties in a way that benefits wildlife while supporting landowner goals. To learn more about TPWD's programs or request assistances from a TPWD biologist, visit the website: <www.tpwd.state.tx.us/landwater/land/private/lip/>, which explains the types of projects funded by LIP. Once the property's potential has been determined, a biologist will provide recommendations and, if requested, help the landowner develop a written wildlife management plan. The local Brazos County wildlife biologist can be reached at 979-845-5798.

Texas AgriLife Extension Service

AgriLife Extension, an agency of The Texas A&M University System, serves Texans through community-based education and outreach. With the mission of improving the lives of people, businesses, and communities across Texas and beyond through high-quality, relevant education, AgriLife Extension custom-designs and delivers its programs in focused areas of the state. These programs are based on local needs and supported by sound science. Extension education encompasses areas of agriculture and natural resources, community economic development, family and consumer sciences, and youth development programs such as 4-H (Texas AgriLife Extension Service, 2011).

Using TSSWCB CWA §319(h) nonpoint source grant funding, Texas AgriLife Extension Service and the Texas Water Resources Institute are developing a suite of curricula under the *Lone Star Healthy Streams* program. These will focus on providing needed information to producers on methods to improve the management of grazing cattle, horses, and feral hogs such that bacterial loading from these sources can be effectively reduced. Once developed, these educational programs will be delivered statewide and will promote the adoption of BMPs, as well as participation in federal and state cost-share programs.

Responsible Parties

Entities listed below will only be responsible for providing technical assistance and aiding landowners in identifying available financial assistance.

- Governmental Agencies
  - Brazos County SWCD #450
  - TPWD
  - TSSWCB
  - USDA NRCS

- Local Landowners
- Texas AgriLife Extension Service

Governmental agencies will work with landowners to voluntarily implement BMPs on their properties to mitigate potential impacts from livestock and wildlife. In doing this, agencies will first make pointed efforts to notify producers of program availability and respective financial assistance available through these programs. Technical assistance will be provided at the request of local landowners through identified programs based on individual landowner management goals. When available, financial assistance opportunities will be promoted to local landowners and assistance will be provided to landowners aiding them in applying for available funds.

The TSSWCB and NRCS will continue to provide appropriate levels of financial assistance to agricultural producers that will facilitate the implementation of BMPs and WQMPs in the Carters Creek watershed, as described in this management measure. As was previously discussed, the land use dynamics are rapidly changing in the Carters Creek watershed shifting from an agricultural landscape to urban development. As such, the TSSWCB expects the demand for financial assistance to implement WQMPs to be very low and, therefore does not anticipate establishing a priority area for Carters Creek.

The TSSWCB expects that existing levels of financial assistance funding reserved for statewide, non-priority area use will be sufficient, depending on continued appropriations from the Texas Legislature, to satisfy demand and need for financial assistance in Carters Creek. NRCS expects that existing levels of financial assistance available through multiple Farm Bill programs will be sufficient, depending on continued appropriations from the U.S. Congress, to satisfy demand and need in Carters Creek.

Local landowners will be responsible for volunteering to receive technical assistance to improve management on their properties. In doing so, landowners must agree to and fulfill the terms and conditions of an individual program.

The TSSWCB and AgriLife Extension anticipate receiving grant funding to deliver the Lone Star Healthy Streams curricula (grazing cattle, horses, feral hogs) to landowners statewide, including program delivery targeted to Carters Creek.

Measurable Milestones

The measureable milestones are as follows.

Year 1:

- Natural resource managers will develop a property prioritization system to identify properties where voluntary BMP implementation will likely have the greatest affect on mitigating water quality.
- Contact information for each identified property will be compiled.
- The need for watershed-specific education will be evaluated and a listing of E&O needs will be developed.

Year 2:

- Appropriate natural resource managers will make contact with individual landowners of priority 1 properties via existing direct mailings notifying them of technical and financial assistance program availability and explaining the significance of their participation.
- Agencies, as appropriate, will begin working directly with private landowners at their request to develop property-specific management plans and begin implementing designated BMPs.
- E&O delivered as needed.

Year 3:

- Appropriate natural resource managers will make contact with individual landowners of second priority properties via direct mailings notifying them of technical and financial assistance program availability and explaining the significance of their participation.
- Agencies, as appropriate, will continue working directly with private landowners at their request to develop property-specific management plans and begin implementing designated BMPs.
- E&O delivered as needed.

Year 4:

- Appropriate natural resource managers will make contact with individual landowners of third priority properties via direct mailings notifying them of technical and financial assistance program availability and explaining the significance of their participation.
- Agencies, as appropriate, will continue working directly with private landowners at their request to develop property-specific management plans and begin implementing designated BMPs.
- E&O delivered as needed.

Year 5:

- Appropriate natural resource managers will make contact with individual landowners of priority properties not already participating in technical or financial assistance programs via direct mailings notifying them of their availability and explaining the significance of their participation.
- Agencies, as appropriate, will continue working directly with private landowners at their request to develop property-specific management plans and begin implementing designated BMPs.
- E&O delivered as needed.

Table 8. Summary of Management Measure 5: Voluntary Agricultural BMPs

Causes and Sources: Nonpoint sources from agricultural and wildlife land uses

Key Element (1), Management Measure: *Voluntary BMP implementation on private properties*

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
Specific reduction not defined. Load reduction equation developed based on site-specific scenarios and BMP implementation.	**Technical**: Agency support will provide needed technical assistance as requested by local landowners and dependent upon their management goals.	Existing E&O efforts will be continued including direct mailing, newsletters, newspaper articles, and event participation.	**Year 1**: – Property prioritization developed and completed. – Contact information compiled. – E&O needs assessed.	– Development of priority ranking system. – Identification of priority landowners. – Compilation of landowner contact info.	– # of acres under management plans. – # and type of BMPs documented.	Tracking of properties under management plans.	**Agencies** (TPWD, TSSWCB, NRCS, Brazos Co. SWCD #450) provide technical & financial assistance as available.
Equation derived using modified equation from EPA's 2001 *Protocol for Developing Pathogen TMDLs*.	**Financial**: Financial support for technical assistance is currently available through a variety of programs and is available through a competitive process.	Need assessed for watershed-specific E&O; recommendations made accordingly.	**Year 2**: – Contact made with priority 1 landowners. – Begin working with landowners as appropriate. – Deliver E&O as appropriate.	– Documentation of landowner contacts. – Documentation of landowner participation.	– # of livestock/ wildlife impacted by BMPs.	Tracking # and types of BMPs implemented.	**Private Landowners** volunteer to participate in programs.
Appendix B provides additional calculation information.	**Financial**: Special project funding is currently available for the delivery of some E&O activities in/near the watershed.	In/near watershed programming delivered (e.g., Lone Star Healthy Streams).	**Year 3**: – Contact made with priority 2 landowners. – Continue working with landowners as appropriate. – Deliver E&O as appropriate.	– E&O needs assessed and prioritized. – E&O delivery documented.		Monitoring designed to establish baseline and identify problem areas.	**Texas AgriLife Research** delivers E&O as needed.

Table 8, continued
Voluntary Agricultural BMPs

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
	Financial: The watershed does not lie within any current special priority areas for funding consideration; this may reduce the likelihood of securing program funds.	Informational websites publicized, publications highlighted, workshops delivered.	**Year 4 and beyond**: – Contact made with priority 3 landowners. – Continue working with landowners as appropriate. – Deliver E&O as appropriate.			BRA's CRP monitoring @ TCEQ station 11785.	

Management Measure 6.0

Continue existing efforts and work to establish new mechanisms that encourage and promote future development and redevelopment that will mitigate adverse water quality impacts in the watershed.

The purpose of this management measure is to continue existing efforts and work toward establishing new mechanisms that will be used to encourage and promote future development and redevelopment such that negative impacts on water quality are minimized.

Development and redevelopment occur in the watershed on a continual basis with the bulk of new development occurring near the riparian areas along Carters Creek and redevelopment occurring in the older urban areas. While change is inevitable, taking appropriate actions before and during the planning phase of a development project can lessen the impacts of these changes and is the goal of this management measure. Implementing and promoting mechanisms such as existing ordinance amendments, new ordinance development, establishing recognition programs for exceptional work in environmental stewardship, and continuing to protect riparian areas (existing green spaces near creeks) from future development will all work toward minimizing adverse water quality.

Development is a critical driver of local economies. Regardless of this situation, existing ordinances regulating development will be evaluated for areas where improvements can be made to mitigate adverse water quality impacts. New ordinances or other mechanisms may also be considered for use in enhancing water quality control requirements. These could include increasing or adding requirements for stream buffers, water quality and erosion control measures, wastewater line locations, wetland mitigation, and others.

An informed and involved community also plays a role in achieving long-term improvements in water quality. Building upon existing efforts in the watershed to involve and inform citizens of local water quality issues as well as raise their awareness of how their actions impact the watershed will aid in getting this message across. Local stream clean-ups present an excellent opportunity for giving people a first-hand look at local water bodies and present an opportunity for delivery of E&O content and materials. Developing an "Environmental Stewardship Awards" program is another way to inform the public of good practices and reward those businesses who implement these practices.

Educating local public officials is also a high priority E&O activity. Educational needs will be prioritized and workshops/meetings will be targeted to educate local public officials and elected leaders about general water quality issues such as watershed functions; the local bacteria impairment; the importance and benefits

of riparian restoration; watershed protection; various control measures; and the implications of poor water quality.

In support of implementing the Carters Creek TMDL, a Texas Watershed Steward workshop was held March 2011 in College Station. Sponsored by the TSSWCB, Texas AgriLife Extension Service, TWRI, the City of College Station, and other partners, this workshop discussed what it is to be a watershed steward, sources of water pollution, managing urban and rural lands using BMPs, and how to get involved in protecting and enhancing their community water resources. There were nearly 40 participants including concerned citizens, landowners, local businesses, and professionals in a variety of fields. The Texas Watershed Steward Program was developed by AgriLife Extension through CWA 319(h) nonpoint source grants from the TSSWCB. More information about the Texas Watershed Steward Program is available at <http://tws.tamu.edu>.

Responsible Parties

Entities listed below will be responsible for providing technical assistance and working to evaluate needs for establishing mechanisms that will be used to encourage and promote future development and redevelopment that reduces adverse water quality impacts.

- Brazos County
- COB
- COCS

Developing new or amending existing ordinances depends largely on public perception. Without public or political support, it is unlikely that new or amended ordinances will pass. As a result, changes to ordinances or development of new ordinances will be timed accordingly.

Brazos County will be responsible for implementing ordinances that are applicable to unincorporated areas of the county, and will participate in determining the feasibility of a local environmental awards program, and educational needs. Brazos County will also participate in programming for expanding local knowledge on water quality issues.

COB will be responsible for planning future development in the COB and amending or developing ordinances to direct future development or re-development. COB will also participate in determining the feasibility of a local environmental awards program, determining educational needs, and developing or delivering E&O activities as needed with other participating entities.

COCS will be responsible for planning future development in the COCS, amending or developing ordinances to direct future development or redevelopment, will

participate in determining the feasibility of a local environmental awards program, educational needs and will participate in, develop or deliver E&O activities as needed with other participating entities. COCS will also continue its 'Greenways' program to protect critical riparian areas from future development pending funding and land availability.

Measurable Milestones

The measureable milestones are as follows.

Year 1:

- Assess the feasibility of and make a determination regarding the establishment of a local awards program that recognizes the activities of developers and other businesses that excel in environmental stewardship and protecting or improving local water quality.
- As needed in support of entity-specific MS4 Phase II SWMPs, respective entities will work to amend or develop ordinances to better protect instream water quality.
- Continue existing efforts to protect riparian areas as funds and support of local government leaders allow.
- Determine educational needs, establish plan for their delivery, and deliver events according to plan.
- Conduct local involvement efforts such as stream cleanups as needed.

Year 2 and beyond:

- If deemed feasible, establish local environmental awards program.
- Respective entities will work to amend or develop ordinances to better protect instream water quality in support of entity specific MS4 Phase II SWMPs.
- Continuation of existing efforts to protect riparian areas will occur as funds and support of local government leaders allow.
- Continued implementation of educational events as planned.

Table 9. Summary of Management Measure 6: Development and Redevelopment Mitigation

Causes and Sources: Nonpoint sources from development/redevelopment related land use changes

Key Element (1), Management Measure: *Continue existing, and work to establish, mechanisms that encourage and promote future development and redevelopment that will mitigate adverse water quality impacts in the watershed*

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
Specific load reduction not defined Impacts from ordinance modification/development cannot be quantified until the action is complete.	**Technical**: Entity personnel will supply needed technical support for evaluating award program, amending/ developing new ordinances, and pursuing additional riparian area protection.	Host workshops as needed to educate elected and local officials on general water quality topics.	**Year 1**: – Complete evaluation of awards program feasibility and make a determination. – Begin to amend existing or develop new ordinances in support of entity specific SWMPs. – Continue riparian area protection as funding allows.	– Awards program evaluation complete. – Documented # of amended or new ordinances developed in support of SWMPs.	# of acres under riparian protection.	GIS tracking riparian protection areas, e.g., conservation easements, greenways, parks.	**Brazos County** – Ordinances in unincorporated areas of the county. – Participating in assessment of local awards program. – Planning/ delivery/ participation in E&O activities.
A hypothetical load reduction equation was developed for riparian area protection and illustrates potential reductions per acre of land protected based on local conditions.	**Financial**: Assistance will be needed for the procurement of riparian areas in the near future as the current economy has resulted in much reduced operating budgets.	Conduct community involvement activities and incorporate E&O as appropriate (stream cleans, etc.).	**Year 2 and beyond**: – If feasible, establish local environmental awards program. – Continue as needed to amend existing or draft new ordinances in support of entity specific SWMPs. – Continue riparian area protection as funding allows.	Documented # of acres of land in riparian areas protected as funding allows.	Maintenance or improvement seen in *E. coli* concentrations in selected stream reaches.	BRA's CRP monitoring @ TCEQ station 11785.	**COB** – Ordinances in the city's jurisdiction. – Participating in assessment of local awards program. – Planning/ delivery/ participation in E&O activities. – GIS tracking of entity specific items.

Table 9, continued
Development and Redevelopment Mitigation

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
Equation derived using modified equation from EPA's 2001 *Protocol for Developing Pathogen TMDLs.* Appendix B provides additional calculation information.	**Financial**: Assistance may be needed to operate an awards program and will likely weigh heavily on the decision to implement such a program.	Coordinate staff education efforts between entities to maximize educational opportunities for local staff members.		– E&O delivery documented.		Monitoring designed to establish water quality baseline and identify problem areas of bacteria contribution.	**COCS** – Ordinances in the city's jurisdiction. – Participating in assessment of local awards program, planning/ delivery/ participation in E&O activities. – Continuing Greenways program as funding and local/ political support allows. – GIS tracking of entity specific items.
		Informational websites publicized, publications highlighted, workshops delivered.					

Control Action 1.0

Implement entity-specific MS4 Phase II SWMPs throughout the watershed.

Through this control action, responsible entities will continue to implement actions outlined in their entity specific MS4 Phase II SWMPs. The development and implementation of MS4 permits in Brazos County is a recent occurrence as illustrated in Table 10.

Table 10. MS4 Phase II SWMPs Partially within the Carters Creek Watershed

Entity Name	Permit Number	Permit Effective Date
Brazos County MS4	TXR040172	May 1, 2009
City of Bryan MS4	TXR040336	June 23, 2009
City of College Station MS4	TXR040008	December 1, 2010
Texas A&M University MS4	TXR040237	March 12, 2009
Texas Department of Transportation Bryan District MS4	TXR040181	May 1, 2009

Each of the entities listed above is responsible for the items included in their specific permits only. Annual reports are submitted to the TCEQ and document implementation progress and compliance with permit requirements. The TCEQ is responsible for enforcing permit compliance.

Because these MS4 permits are relatively new, some BMPs within designated Minimum Control Measures (MCMs) defined in individual MS4 permits have yet to be implemented. Further, quantifiable instream water quality impacts have yet to be realized from the BMPs that have been implemented and are likely masked by other watershed influences. Improvements in current water quality levels are expected from BMPs that are awaiting implementation. General MCMs included in these SWMPs are public education, public participation and involvement, illicit discharge detection and elimination, construction site runoff control, stormwater management in new construction and redevelopment, and pollution prevention and good housekeeping.

Adaptive management is a critical part of the SWMP process and will be critical to the long-term success of protecting and restoring water quality in the Carters Creek watershed. Each of the listed MS4 Phase II SWMPs is a five-year permit that will be revised and reapproved in cooperation with each entity and the TCEQ. This will allow each SWMP to be tailored to maximize mitigation of stormwater based on lessons learned in the previous five-year period.

In an effort to coordinate and support the implementation of MS4 MCMs, the entities listed have formed a group named Brazos Clean Water. This group meets roughly quarterly to plan and coordinate E&O efforts delivered throughout the county and watershed.

Responsible Parties

Entities listed below will be responsible for implementing only items set forth in their own MS4 Phase II SWMPs. Coordination and collaboration between entities in the application of these SWMPs is encouraged; however, despite collaboration, each entity remains solely responsible for implementing its own SWMP.

- Brazos County
- COB
- COCS
- Texas A&M University
- Texas Department of Transportation (TxDOT) Bryan District
- TCEQ

Brazos County will be responsible for implementing its currently active MS4 Phase II SWMP, completing annual reporting requirements, working with the TCEQ to revise and renew its permit, and collaborating with other MS4 entities as needed. The County will continue participation in Brazos Clean Water.

The COB will be responsible for implementing its currently active MS4 Phase II SWMP, completing annual reporting requirements, working with the TCEQ to revise and renew its permit, and collaborating with other MS4 entities as needed. The COB will continue participation in Brazos Clean Water.

The COCS will be responsible for implementing its currently active MS4 Phase II SWMP, completing annual reporting requirements, working with the TCEQ to revise and renew its permit, and collaborating with other MS4 entities as needed. The COCS will continue participation in Brazos Clean Water.

Texas A&M University will be responsible for implementing its currently active MS4 Phase II SWMP, completing annual reporting requirements, working with the TCEQ to revise and renew its permit, and collaborating with other MS4 entities as needed. Texas A&M will continue participation in Brazos Clean Water.

The TxDOT Bryan District will be responsible for implementing its currently active MS4 Phase II SWMP, completing annual reporting requirements, working with the TCEQ to revise and renew its permit, and collaborating with other MS4 entities as needed. TxDOT Bryan District will continue participation in Brazos Clean Water.

The TCEQ is responsible for MS4 permit compliance and enforcement.

Measurable Milestones

The measureable milestones are as follows.

All Years:

Measureable milestones for MS4s are entity-specific, and are reported individually to the TCEQ in each MS4 entity's annual report.

Table11. Summary Control Action 1: Individual MS4 Phase II SWMPs

Causes and Sources: Nonpoint sources from stormwater

Key Element (1), Control Action: *Implement entity-specific MS4 Phase II SWMPs throughout the watershed*

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
Specific load reduction not defined Impacts from individual SWMPs are different and difficult to quantify.	**Technical**: Each individual MS4 entity will supply needed technical support for implementing its respective SWMPs.	Continue coordination of E&O delivery through Brazos Clean Water.	**Year 1**: – Continue participation in the Brazos Clean Water and implement MCMs and BMPs according to individual MS4 Phase II SWMPs.	Annual reports compiled and submitted to TCEQ.	Permit compliance by all MS4 entities.	BRA's CRP monitoring @ TCEQ station 11785.	**Brazos County** – Implementing its SWMP. – Completing annual SWMP report. – Revising and keeping its MS4 permit current. – Coordinating with other MS4 entities.
	Financial: Each individual MS4 entity will supply or identify needed financial support for implementing their respective SWMPs.	Utility bill inserts, flyers, brochures, websites, PSAs, display booths at local events Public presentations as described in individual MS4 permits (topics may include proper pet waste management, appropriate lawn care practices, impacts of stormwater, rainwater harvesting, and others).		# of BMPs implemented by each MS4 entity and documented in annual reports.	Maintenance or improvement seen in *E. coli* concentrations in selected stream reaches.	Monitoring designed to establish baseline and identify problem areas.	**COB** – Implementing its SWMP. – Completing annual SWMP report. – Revising and keeping its MS4 permit current. – Coordinating with other MS4 entities.
				E&O delivery documented in annual reports.			**COCS** – Implementing its SWMP. – Completing annual SWMP report. – Revising and keeping its MS4 permit current. – Coordinating with other MS4 entities.

Table 11, continued
Individual MS4 Phase II SWMPs

(2) Potential Load Reduction	(3) Technical and Financial Assis-tance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
							Texas A&M – Implementing its SWMP. – Completing annual SWMP report. – Revising and keeping its MS4 permit current. – Coordinating with other MS4 entities.
							TxDOT Bryan District – Implementing its SWMP. – Completing annual SWMP report. – Revising and keeping its MS4 permit current. – Coordinating with other MS4 entities.
							TCEQ – Ensuring permit compli-ance & enforcement.

Control Action 2.0

Continue monitoring WWTF effluent E. coli *levels according to individual permit requirements.*

In November 2009, the TCEQ commissioners approved Rule Project No. 2009-005-309-PR. This rule requires the addition of bacteria limits for either *E. coli* in fresh water discharges or Enterococci in saltwater discharges to all TPDES domestic permits during their next permit amendment or revision. This rule is defined in Title 30 Administrative Code Chapter 309 and the frequency of testing required is defined in Chapter 319. Through this control action, responsible entities will continue to monitor *E. coli* concentrations in WWTF effluent as required by individual WWTF permits and any subsequent permit amendments or revisions. Currently, five permitted WWTFs exist in the Carters Creek watershed and two of those are required to monitor *E. coli* levels in their effluent. The other three will be required to monitor for *E. coli* upon renewal of (or amendment to) their permits.

Section 303(d)(1)(C) of the Clean Water Act requires that an MOS be included in all TMDLs. Applying this in the Carters Creek watershed will result in 5 percent reductions in allowable *E. coli* discharge limits as described in individual TPDES permits. The allowable daily average for *E. coli* will be reduced from 126 cfu/100mL down to 120 cfu/100mL. Changes will occur following the approval of the TMDL and during the next amendment or revision to an individual permit.

Table 12. Permitted WWTFs in the Carters Creek Watershed

Entity Name	Permit Number	*E. coli* Monitoring	Permit Effective Date
Burton Creek WWTF	WQ0010426 / TX0022616	Yes	7/17/2009
Carters Creek WWTF	WQ0010024 / TX0047163	Yes	7/29/2009
Carter Lake WWTF	WQ0013153 / TX0098663	No	12/22/2009
Glen Oaks WWTF	WQ0012296 / TX0085456	No	9/11/2009
Texas A&M Central Utility	WQ0004002 / TX0002747	No	6/30/2009

Each of the entities listed above is responsible for adhering to the requirements of their specific permits only. The terms and conditions in each individual permit are agreed upon by both the TCEQ and the permittee. Each permit specifically outlines the effluent constituents that require monitoring as well as the monitoring and reporting frequency to which the permittee must adhere. The TCEQ

reviews and documents compliance with individual permits. WWTF permits are issued on every five years and must be renewed by the permittee.

Responsible Parties

Entities listed below will be responsible for complying with the specific requirements listed within their individual permits.

- COB
- COCS
- Glen Oaks WWTF Owner/Operator
- Texas A&M
- TCEQ

COB will be responsible for operating the Burton Creek WWTF in accordance with permit requirements.

COCS will be responsible for operating the Carters Creek and Carter Lake WWTFs in accordance with permit requirements.

The owner and operator of the Glen Oaks WWTF will be responsible for operating the Glen Oaks WWTF in accordance with permit requirements.

Texas A&M will be responsible for operating the Texas A&M Central Utility in accordance with permit requirements.

The TCEQ is responsible for permit compliance and enforcement.

Measurable Milestones

The measureable milestones are as follows.

All Years:

Owners and operators of each permitted discharger will operate their own permitted systems in accordance and in compliance with their individual permits.

Table 13. Summary of Control Action 2: Continued Monitoring WWTF Effluent *E. coli* Levels according to Individual Permit Requirements

Causes and Sources: WWTF effluent

Key Element (1), Control Action: *Continue monitoring WWTF effluent E. coli levels according to individual permit requirements*

(2) Potential Load Reduction	(3) Technical and Financial Assistance Needed	(4) Education Component	(5) Schedule of Implementation	(6) Interim, Measurable Milestones	(7) Indicators of Progress	(8) Monitoring Component	(9) Responsible Entity
No immediate load reduction expected. If recurring problems identified, load reduction may be realized.	**Technical**: Each entity has technical assistance required or will acquire technical assistance as needed.	WWTF tours are provided upon request to the general public and highlight the overall operation and maintenance, functioning and impacts of the systems; presentations are also made to groups (school classes, career fairs, etc.) explaining operations and environmental implications of proper WWTF operation.	**All years**: Each entity will: – Operate their permitted discharges in accordance with their individual permits. – Report *E. coli* levels in effluent as required by permit.	*E. coli* concentrations in effluent reported as required through discharge monitoring report.	Permitted discharges operated according to permits.	-BRA's CRP monitoring @ TCEQ station 11785.	COB responsible for operating Burton Creek WWTF.
	Financial: Each entity currently has needed financial resources. If additional financial resources are needed, they will be acquired.					Monitoring designed to establish baseline and identify problem areas.	COCS responsible for operating Carters Creek and Carter Lake WWTFs.
							Owner/operator of Glen Oaks WWTF operates WWTF.
							Texas A&M responsible for operating the Texas A&M Central Utility.
							TCEQ responsible for permit compliance and enforcement.

Sustainability

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

The 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 effect an improvement in water quality.

Water Quality Indicators

Water quality monitoring staff of the BRA will monitor the status of water quality during implementation and additional funding will be sought to conduct supplemental monitoring in the watershed at currently undefined locations. The following summary describes routine water-quality monitoring activities in the Carters Creek watershed. The BRA monitors in Carters Creek. The TCEQ is conducting a short-term monitoring project in County Club Branch. Monitoring is no longer conducted in Burton Creek due to resource constraints. The purpose of this monitoring is to collect *E. coli* data to determine water quality standards attainment in the Carters Creek watershed.

Carters Creek (1209C): Site 11785, Carters Creek at Bird Pond Road, is located in the downstream portion of the watershed and is east of the COCS. This site is monitored quarterly by BRA and is both a current and historic water quality site with *E. coli* data dating back to 2001.

Site 11784, Carters Creek at Highway 30, is located at the approximate mid-point of Carters Creek, downstream of the COB and mostly upstream of the COCS. This historic site is no longer monitored. BRA collected quarterly *E. coli* data at this site from 2001 to 2007.

Country Club Branch (1209D): Site 11795, Country Club Branch at Duncan St., is located between Fin Feather Lake and Country Club Lake within the Bur-

ton Creek subwatershed. This site is currently being monitored quarterly under a special study by the TCEQ Region 10 Office. Historic *E. coli* data exists back to 1997; however, only 12 data points exist between 1997 and 2010. Monitoring is scheduled to end at this site in August 2012.

Burton Creek (1209L): Station 11783, Burton Creek Downstream of WWTF, is located just upstream of the Highway 6 crossing and immediately upstream of Burton Creek's confluence with Carters Creek. This is a historic data site and *E. coli* data were collected at this site by BRA from 2001 to 2007. This site is no longer monitored.

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 actions which may not be working, and make any changes that may be necessary to get the plan back on target. Schedules of implementation activities and milestones for this I-Plan are included in Appendix A.

Communication Strategy

Communication is necessary to ensure stakeholders understand the I-Plan and its progress in restoring water quality conditions. The TCEQ will disseminate the information derived from tracking I-Plan activities to all interested parties, organizations, and individuals.

The TCEQ will report results and evaluations from implementation tracking to stakeholders as needed. The TMDL Program will summarize all actions taken to address the impairment and will report trends observed in the water quality data collected to track the progress of implementation as needed. Responsible parties are committed to providing appropriate information to the TCEQ to update these progress assessments and communicating information at annual meetings.

In accordance with the Clean Water Act §319, the state must annually report to USEPA on success in achieving the goals and objectives of the *Texas Nonpoint Source Management Program*, including progress in implementing the NPS portion of TMDLs. The TCEQ and TSSWCB jointly publish *Managing Nonpoint Source Water Pollution in Texas: Annual Report*, which highlights the state's efforts during each fiscal year to collect data, assess water quality, implement projects that reduce or prevent NPS pollution, and educate and involve the public to improve the quality of water resources. Information derived from tracking and review activities of the *Carters Creek Surface Water Quality and Pollution Source Assessment* will be reported in each annual report. Previously published

annual reports are available at <www.tceq.texas.gov/waterquality/nonpoint-source/mgmt-plan/annual-reports.html>.

The TCEQ will participate in annual meetings for up to the next five years to support stakeholders in evaluating their progress. Stakeholders will continue to take part in annual meetings over the five-year period to evaluate implementation efforts. At the completion of the scheduled I-Plan activities, stakeholders will assemble and evaluate the actions, overall impacts, and results of their implementation efforts.

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Appendix A.
I-Plan Matrix

Table A-1. Watershed Monitoring and Assessment — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1			
	TWRI, AgriLife Research, Brazos County, COB, COCS, Texas A&M TxDOT	Develop watershed monitoring and reconnaissance proposal.	– Proposal developed. – Proposal submitted to prospective funding agency.
	TWRI	Organize and implement volunteer water quality monitoring effort dependent upon receipt of grant funding.	– Volunteers organized. – Volunteers trained. – - volunteer monitoring initiated.
	TWRI	Maintain Carters Creek Water Quality website.	– Website updated as needed.
	TWRI, subcontractors as appropriate	When funded, organize and establish contracts for watershed monitoring, initiate watershed monitoring and reconnaissance project.	– Project funded. – Contracts established. – Project initiated.
	TWRI, AgriLife Research, COB, COCS, Texas A&M	Develop project QAPP.	– QAPP developed. – QAPP approved.
2			
	TWRI, subcontractors as appropriate	Continue watershed monitoring and reconnaissance project.	– Project reporting completed as planned. – Watershed reconnaissance completed. – Water quality monitoring underway.
	Volunteers	Continue volunteer water quality monitoring.	– Water quality data collected and submitted.
	TWRI, subcontractors as appropriate	Conduct public meetings to describe monitoring efforts and how the data will be used.	– # of meetings held. – # of invited presentations given. – # of people in attendance at meetings.
	TWRI	Maintain Carters Creek Water Quality website.	– Website updated as needed.
	TWRI, AgriLife Research	Revise project QAPP.	– QAPP revised. – QAPP revision approved.
3			
	TWRI, subcontractors as appropriate	Depending on project start time, either conclude or near completion of watershed monitoring and reconnaissance project.	– Project completed/nearing completion. – Project reporting completed as planned. – Water quality monitoring results summarized and reported. – Water quality data submitted to TCEQ for SWQMIS inclusion.

Table A-1, continued
Monitoring and Assessment Schedule

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
	TWRI, subcontractors as appropriate	Present project findings to watershed stakeholders.	– # of public meetings conducted. – # of participants in public meetings.
	TWRI	Maintain Carters Creek Water Quality website.	– Website updated as needed.
4			
	TWRI, subcontractors as appropriate	If needed, conclude watershed monitoring and reconnaissance project.	– Project completed/nearing completion. – Project reporting completed as planned. – Water quality monitoring results summarized and reported. – Water quality data submitted to TCEQ for SWQMIS inclusion.
	TWRI	Maintain Carters Creek Water Quality website.	- Website updated as needed.
	TWRI, subcontractors as appropriate	Present project findings to watershed stakeholders.	– # of public meetings conducted. – # of participants in public meetings.
5			
	Brazos County, COB, COCS, Texas A&M, TxDOT	Upon completion of water quality monitoring and reconnaissance project, use data in directing future BMP implementation.	– Targeted BMP implementation plan based on watershed monitoring project findings.
	TWRI	Maintain Carters Creek Water Quality website.	– Website updated as needed.

Table A-2. Tax Valuation Amendments — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1			
	Brazos County NRCS, Brazos County SWCD, AgriLife Extension	Hold discussions with Brazos County Appraisal District on modifying requirements for Ag tax valuations.	– Discussions initiated. – Outcomes of discussions determined and next steps identified.
	Brazos County NRCS, Brazos County SWCD, AgriLife Extension	Discuss using Brazos County Appraisal District mailings as educational material outlet.	– Discussions initiated. – Outcomes of discussions determined and next steps identified.
	Brazos County NRCS, AgriLife Extension	If permissible, provide educational materials to Brazos County Appraisal District for mailing.	– Documentation of educational materials mailed. – # of materials mailed.
	Texas A&M Ag Economics & TWRI	Develop proposal and seek funds for work to define potential water quality changes because of land-use change from Ag to Wildlife uses.	– Funding sources identified. – Funding applications submitted.
2			
	Brazos County NRCS, Brazos County SWCD, AgriLife Extension	If amenable, work with Brazos County Appraisal District on modifying requirements for Ag tax valuations.	– If amenable, modified requirements for receiving Ag valuation for property taxes.
	Brazos County NRCS, AgriLife Extension	If permissible, provide educational materials to Brazos County Appraisal District for mailing.	– Documentation of educational materials mailed. – # of materials mailed.
	Texas A&M Ag Economics & TWRI	When funded, initiate work to define potential water quality changes as a result of land-use change from Ag to Wildlife uses.	– Assessment initiated.
3			
	Brazos County NRCS, Brazos County SWCD, AgriLife Extension	If permissible, continue to provide educational materials to Brazos County Appraisal District for mailing.	– Documentation of educational materials mailed. – # of materials mailed.
	Texas A&M Ag Economics & TWRI	If funded, continue work to define potential water quality changes because of land-use change from Ag to Wildlife uses.	– Develop project reports summarizing findings.
4			
	Brazos County NRCS, Brazos County SWCD, AgriLife Extension	If permissible, continue to provide educational materials to Brazos County Appraisal District for mailing.	– Documentation of educational materials mailed. – # of materials mailed.

Table A-2, continued
Tax Valuation Amendments Schedule

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
	Texas A&M Ag Economics & TWRI	If funded, complete work to define potential water quality changes because of land-use change from Ag to Wildlife uses.	– Publish reports on project findings. – Disseminate reports to stakeholders and public.
5			
	Brazos County NRCS, AgriLife Extension	If permissible, continue to provide educational materials to Brazos County Appraisal District for mailing.	– Documentation of educational materials mailed. – # of materials mailed.

Table A-3 OSSF Education, Inspection, Operation, Maintenance, and Tracking — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1			
	BCHD, COB, COCS	Begin identifying all OSSFs in watershed (cities responsible for OSSFs in city only).	– GIS info coordinated between entities. – Develop approach for identifying undocumented OSSFs. – # of OSSFs identified an added to database.
	BCHD, AgriLife Extension	Evaluate mechanisms for better delivering E&O to OSSF owners.	– Improved E&O mechanisms identified.
	BCHD COB & COCS in City bounds	Continue monitoring OSSF inspections as required by county ordinance.	– Document inspection follow ups. – # of inspections finding improperly operating OSSFs.
	BCHD, AgriLife Extension	Deliver OSSF E&O as needed through identified mechanisms.	– # of E&O materials delivered. – # of OSSF owners contacted thru E&O efforts.
2			
	BCHD, COB, COCS	Continue efforts to identify all OSSFs in watershed (cities responsible for in city OSSFs only).	– GIS info coordinated between entities. – # of OSSFs identified an added to database.
	BCHD	Evaluate need for modifying OSSF sizing requirements.	– Finding on needed modifications.
	BCHD	If evaluation recommends modifications, begin process to amend ordinances to modify sizing requirements as support of local government leaders exists.	– Modified ordinances developed and put in place.
	BCHD	Continue monitoring OSSF inspections as required by county ordinance.	– Document inspection follow ups. – # of inspections finding improperly operating OSSFs.
	BCHD, AgriLife Extension	Deliver OSSF E&O as needed through identified mechanisms.	– # of E&O materials delivered. – # of OSSF owners contacted thru E&O efforts.
3			
	BCHD	Continue efforts to identify all OSSFs in watershed (cities responsible for in city OSSFs only).	– GIS info coordinated between entities. – # of OSSFs identified an added to database.
	BCHD	Evaluate need to establish ordinance requiring a minimum annual inspection of all OSSFs.	– Finding on need for new/amended ordinance.

Table A-3, continued
OSSF Education, Inspection, Operation, Maintenance, and Tracking

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
3 cont.	BCHD	If evaluation recommends modifications, begin process to amend ordinances to modify sizing requirements as support of local government leaders exists.	– Modified ordinances developed and put in place.
	BCHD	Continue monitoring OSSF inspections as required by county ordinance.	– Document inspection follow ups. – # of inspections finding improperly operating OSSFs.
	BCHD, AgriLife Extension	Deliver OSSF E&O as needed through identified mechanisms.	– # of E&O materials delivered. – # of OSSF owners contacted thru E&O efforts.
4			
	BCHD	Complete efforts to identify all OSSFs in watershed; add new OSSFs to database as constructed.	– GIS info coordinated between entities. – # of OSSFs identified an added to database.
	BCHD	Following amendment/establishment of ordinance requiring inspections on all OSSFs, begin notifying all OSSF owners of inspection requirements.	– E&O delivery of new ordinance and impacts to OSSF owners.
	BCHD	Implement OSSF sizing requirements following ordinance amendment.	– OSSF sizing requirements modified in ordinance.
	BCHD	Continue monitoring OSSF inspections as required by county ordinance.	– Document inspection follow ups. – # of inspections finding improperly operating OSSFs.
	BCHD, AgriLife Extension	Deliver OSSF E&O as needed through identified mechanisms.	– # of E&O materials delivered. – # of OSSF owners contacted thru E&O efforts.
5			
	BCHD	Add new OSSFs to database as constructed.	– GIS info coordinated between entities. – # of OSSFs identified an added to database.
	BCHD	Implement new inspection ordinance requiring all OSSFs to be inspected.	– Document inspection follow ups. – # of inspections finding improperly operating OSSFs.
	BCHD	Implement OSSF sizing requirements following ordinance amendment.	– OSSF sizing requirements modified in ordinance.
	BCHD, AgriLife Extension	Deliver OSSF E&O as needed through identified mechanisms.	– # of E&O materials delivered. – # of OSSF owners contacted thru E&O efforts.

Table A-4 SSO Initiative Implementation — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1			
	COB	Continue implementing SSO initiative as planned and funding allows.	– Inflow and infiltration studies completed to target repairs. – # SSO incidents tracked; cause and source identified. – # of repairs documented and tracked. – GIS of SSO initiative actions.
	COCS	Complete development of SSO initiative.	– SSO initiative developed and completed.
	COB & COCS	Disseminate E&O materials to sewerage system customers in efforts to minimize future SSO events.	– # of E&O materials disseminated. – # of customers reached by E&O material delivery.
2			
	COB	Continue implementing SSO initiative as planned and funding allows.	– Inflow and infiltration studies completed to target repairs. – # SSO incidents tracked; cause and source identified. – # of repairs documented and tracked. – GIS of SSO initiative actions.
	COCS	Begin implementing SSO initiative as planned and funding allows.	– Inflow and infiltration studies completed to target repairs. – # SSO incidents tracked; cause and source identified. – # of repairs documented and tracked. – GIS of SSO initiative actions.
	COB & COCS	- disseminate E&O materials to sewerage system customers in efforts to minimize future SSO events.	– # of E&O materials disseminated. – # of customers reached by E&O material delivery.
3 and beyond			
	COB & COCS	Continue implementing SSO initiative as planned and funding allows.	– Inflow and infiltration studies completed to target repairs – # SSO incidents tracked; cause and source identified – # of repairs documented and tracked – GIS of SSO initiative actions
	COB & COCS	Disseminate E&O materials to sewerage system customers in efforts to minimize future SSO events.	– # of E&O materials disseminated. – # of customers reached by E&O material delivery.

Table A-5 Voluntary Agricultural BMPs — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1			
	Brazos County NRCS	Complete landowner identification of all properties actively used in agricultural use (used to deliver E&O materials by NRCS/SWCD personnel only).	– Contact information for all property owners compiled.
	Brazos County NRCS, Brazos County SWCD, TPWD, TSSWCB	Develop and apply property prioritization matrix to rank properties for voluntary BMP implementation targeting.	– Developed property ranking matrix. – Rankings applied to properties in watershed.
	Brazos County NRCS, AgriLife Extension	E&O needs assessed, recommendations made, and begin implementing.	– Determination of E&O strategy. – # of E&O materials disseminated. – # of landowners reached through E&O efforts.
2			
	Brazos County NRCS	Make contact with priority 1 landowners informing them about availability voluntary BMP implementation assistance program and need for participation.	– Contacts documented.
	Brazos County NRCS, other agencies as appropriate	Begin working with willing landowners to develop and implement property-specific plans to improve water quality.	– # of landowners willing to participate. – # of plans developed. – # and type of BMPs implemented.
	Brazos County NRCS, AgriLife Extension	Continue delivering E&O as appropriate.	– # of E&O materials disseminated. – # of E& O events held. – # of landowners reached through E&O efforts.
3			
	Brazos County NRCS	Make contact with priority 2 landowners informing them about availability of voluntary BMP implementation assistance program and need for participation.	– Contacts documented.
	Brazos County NRCS, other agencies as appropriate	Continue working with willing landowners to develop and implement property-specific plans to improve water quality.	– # of landowners willing to participate. – # of plans developed. – # and type of BMPs implemented.
	Brazos County NRCS, AgriLife Extension	Continue delivering E&O as appropriate.	– # of E&O materials disseminated. – # of landowners reached through E&O efforts.

Table A-5, continued
Voluntary Agricultural BMPs

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
4			
	Brazos County NRCS	Make contact with priority 3 landowners informing them about availability of voluntary BMP implementation assistance program and need for participation.	– Contacts documented.
	Brazos County NRCS, other agencies as appropriate	Continue working with willing landowners to develop and implement property-specific plans to improve water quality.	– # of landowners willing to participate. – # of plans developed. – # and type of BMPs implemented.
	Brazos County NRCS, AgriLife Extension	Continue delivering E&O as appropriate.	– # of E&O materials disseminated. – # of landowners reached through E&O efforts.
5			
	Brazos County NRCS	Make second contact with selected landowners informing them about availability of voluntary BMP implementation assistance program and need for participation.	– Contacts documented.
	Brazos County NRCS, other agencies as appropriate	Continue working with willing landowners to develop and implement property-specific plans to improve water quality.	– # of landowners willing to participate. – # of plans developed. – # and type of BMPs implemented.
	Brazos County NRCS, AgriLife Extension	Continue delivering E&O as appropriate.	– # of E&O materials disseminated. – # of landowners reached through E&O efforts.

Table A-6. Development/Redevelopment Water Quality Mitigation — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1			
	Brazos County, COB, COCS, Texas A&M, TxDOT	Evaluate the feasibility of developing an awards program to recognize good actors in selected sectors (construction, developers, landscapers, etc.).	– Determination made on feasibility of awards program.
	Brazos County, COB, COCS, Texas A&M	Work to deliver needed education and outreach programming to local elected and municipal officials and other decision makers.	– Documentation of the number and types of education and outreach events held.
	Brazos County, COB, COCS, Texas A&M	Explore need to review and amend existing ordinances in support of entity specific SWMPs.	– Documentation of reviews and/or amendments of existing ordinances.
	Brazos County, COB, COCS, Texas A&M	Amend ordinances or rules as applicable in support of entity specific SWMPs as needed.	– Documentation of ordinance or rule modifications in support of SWMPs.
	COCS	Continue riparian area protection through 'Greenways' program as funds and support of local government leaders allow; expand information delivery on riparian area protection benefits.	– # of acres tracked that are considered or are enrolled in 'Greenways' program – Documentation on riparian area protection
	Brazos County, COB, COCS, Texas A&M, TxDOT	Coordinate E&O outreach efforts for entity employees, local and elected officials.	– Documentation of coordinated E&O activities held jointly between entities.
2 and beyond			
	Brazos County, COB, COCS, Texas A&M, TxDOT	If feasible, establish an awards program to recognize good actors in selected sectors (construction, developers, landscapers, etc.).	– Documentation of awards given annually. – Winners publicly announced via available information outlets.
	Brazos County, COB, COCS, Texas A&M	Continue as needed to amend ordinances or rules as applicable in support of entity specific SWMPs.	– Documentation of ordinance or rule modifications in support of SWMPs.
	COCS	Continue riparian area protection through 'Greenways' program as funds and support of local government leaders allow.	– # of acres tracked that are considered or are enrolled in 'Greenways' program.
	Brazos County, COB, COCS, Texas A&M, TxDOT	Coordinate E&O outreach efforts for entity employees, local and elected officials.	– Documentation of coordinated E&O activities held jointly between entities.

Table A-7. Individual MS4 Phase II SWMPs — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
All			
	Brazos County, COB, COCS, Texas A&M, TxDOT	Implement MCMs and BMPs according to individual entity MS4 Phase II SWMPs.	– Annual reports to TCEQ documenting progress in implementing MCMs and BMPs.
	Brazos County, COB, COCS, Texas A&M, TxDOT	Continue participating in Brazos Clean Water to coordinate and plan E&O efforts.	– Actions of meetings documented and brazoscleanwater.org updated.
	Brazos County, COB, COCS, Texas A&M, TxDOT	Delivery of E&O materials to target audiences as needed.	– Documentation of E&O efforts. – # of E&O materials delivered. – # of people/households reached through E&O efforts.

Table A-8. Continue Monitoring WWTF Effluent *E.coli* Levels according to Individual Permit Requirements – Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
All			
	COB, COCS, Glen Oaks WWTF, Texas A&M	Operate permitted discharges as described in each entity specific TPDES permit.	– Permit adhered to annually.
	COB, COCS, Glen Oaks WWTF, Texas A&M	Report *E. coli* concentrations in discharge effluent as required by entity specific TPDES permits.	– *E. coli* data reported to TCEQ in Discharge Monitoring Reports.

Appendix B.
Load Reduction Estimates

Management Measure 3.0: Load Reduction Estimate

OSSF Identification

As reported in the *Technical Support Document for Bacteria TMDLs, Carters Creek Watershed (Segments 1209D, 1209 L, & 1209C)*, the Brazos County Health Department indicated that 455 OSSFs are known to exist within the Carters Creek watershed. Of these, 98 percent were thought to be aerobic and are required to be inspected three times annually under a service contract; the other 2 percent (or 9 systems) are conventional OSSFs. Soils in Brazos County are not conducive to conventional OSSFs, and almost all new OSSFs are aerobic systems due to the elevated potential for failure in conventional systems. Using their best professional judgment, the Wastewater Work Group estimated that approximately 50 percent of conventional OSSFs may be failing, or a total of 5 systems. Additionally, it is also assumed that as many as 5 percent of aerobic OSSFs may be experiencing operational problems at any one time and thus could be considered to be malfunctioning. Using the equations presented below, estimated load reductions can be developed for identifying and repairing failing septic systems in the watershed and addressing operational malfunctions of aerobic OSSFs.

Conventional OSSFs

$$5\ failing\ septic\ systems * 10^6 \frac{fecal\ coliforms}{100\ mL} * .63 * \frac{70\frac{gallons}{person}}{day} * 3785.2\frac{mL}{gallon} * 2.52\frac{persons}{household} = 2.10x10^{11}\frac{cfu}{day}$$

In this equation, the inputs are as follows:

- 5 OSSFs are considered failing in the watershed (Work Group determination; roughly 50% of current known number of conventional OSSFs in watershed due to soils and conventional OSSF age; further supported by Reed, Stowe and Yanke 2001 findings that soil and system age are major factors in system malfunctions)
- $10^6 \frac{cfu}{100mL}$ = fecal coliform concentration rate in onsite sewage facility effluent as reported by Metcalf & Eddy, 1991; Canter & Knox, 1985; Cogger & Carlile, 1984
- .63 = conversion factor to convert between fecal coliform and *E. coli* derived by dividing the current *E. coli* standard of 126 cfu/100mL by the previously used fecal coliform standard of 200 cfu/100mL

- $3785.2\frac{ml}{gallon}$ = number of milliliters in a gallon
- 70 gallons per person per day is estimated discharge in OSSFs as reported by Horsley & Witten, 1996
- 2.52 persons per household is the US Census Bureau's Brazos County estimate for 2009

Assumptions made include:

- Identifying these failing septic systems and working with their owners to correct these problems is achievable
- Colony Forming Units (CFUs) of *E. coli* and Most Probably Number (MPN) of *E. coli* are considered as equals and are used inter-changeably

Using these assumptions, an average daily load reduction of $2.10x10^{11}\frac{cfu}{day}$ can be achieved by repairing these systems. This calculation is easily scalable to account for other failing or malfunctioning OSSFs.

Aerobic OSSFs

$$22\ failing\ septic\ systems * 10^6\frac{fecal\ coliforms}{100\ mL} * .63 * \frac{70\frac{gallons}{person}}{day} * 3785.2\frac{mL}{gallon} * 2.52\frac{persons}{household} = 9.25x10^{11}\frac{cfu}{day}$$

In this equation, the inputs are as follows:

- 22 OSSFs are considered malfunctioning in the watershed (Work Group determination; roughly 5% of current known number of aerobic OSSFs in watershed due to improper operation of systems. The county requires three system inspections annually thus minimizing this number.)
- $10^6\frac{cfu}{100mL}$ = fecal coliform concentration rate in onsite sewage facility effluent as reported by Metcalf & Eddy, 1991; Canter & Knox, 1985; Cogger & Carlile, 1984 (assumed that effluent from malfunctioning aerobic OSSFs is similar in quality to conventional OSSF effluent
- .63 = conversion factor to convert between fecal coliform and *E. coli* derived by dividing the current *E. coli* standard of 126 cfu/100mL by the previously used fecal coliform standard of 200 cfu/100mL
- $3785.2\frac{ml}{gallon}$ = number of milliliters in a gallon
- 70 gallons per person per day is estimated discharge in OSSFs as reported by Horsley & Witten, 1996

- 2.52 persons per household is the US Census Bureau's Brazos County estimate for 2009

Assumptions made include:

- Identifying these malfunctioning septic systems and working with their owners to correct these problems is achievable
- Colony Forming Units (CFUs) of *E. coli* and Most Probably Number (MPN) of *E. coli* are considered as equals and are used inter-changeably

Using these assumptions, an average daily load reduction of $9.25x10^{11}\,\frac{cfu}{day}$ can be achieved by repairing these systems. This calculation is easily scalable to account for other failing or malfunctioning OSSFs.

Management Measure 4.0: Load Reduction Estimate

SSO Initiative Implementation

In the *Technical Support Document for Bacteria TMDLs, Carters Creek Watershed (Segments 1209D, 1209L & 1209C)*, sanitary sewer overflows (SSOs) were identified as one contributor of *E. coli* into the storm sewer system. Stormwater managers actively identifying these SSOs and subsequently working with wastewater collection system personnel to rectify these problems is one management measure that will produce a quantifiable *E. coli* load reduction. Using the SSO information presented in the *Technical Support Document for Bacteria TMDLs, Carters Creek Watershed (Segments 1209D, 1209L & 1209C)* and published literature values identified below, the following equation was derived to estimate an estimated load reduction for reducing the average number of SSO events by half.

$$.132\,\frac{SSOs}{day} * 8748\,\frac{gallons}{SSO} * \frac{10^7 cfu}{100mL} * .63 * 3785.2\,\frac{ml}{gallon} = 2.75x10^{12}\,\frac{cfu}{day}$$

In this equation, the inputs are as follows:

- $.132\,\frac{SSOs}{day}$ = 248 SSOs recorded over a 1,884 day period
- $8748\,\frac{gallons}{SSO}$ = 248 SSOs totaling 2,169,622 gallons of sewage
- $10^7\,\frac{cfu}{100mL}$ = fecal coliform concentration rate in raw sewage as reported by Metcalf & Eddy, 1991

- .63 = conversion factor to convert between fecal coliform and *E. coli* derived by dividing the current *E. coli* standard of 126 cfu/100mL by the previously used fecal coliform standard of 200 cfu/100mL
- $3785.2 \frac{ml}{gallon}$ = number of milliliters in a gallon

Assumptions made include:

- Goal of SSO initiatives are zero SSOs. While SSOs will likely occur as failures cannot be planned, the estimated load reduction is based on zero SSOs occurring.
- Colony Forming Units (CFUs) of *E. coli* and Most Probably Number (MPN) of *E. coli* are considered as equals and are used inter-changeably

Assuming that this level of load reduction can be achieved by reducing the average number of SSO occurrences by half and that the average SSO volume remains about the same, the average daily load in Carters Creek as measured at Station 11785 under very high flow conditions will be reduced from $1.6895 * 10^{13} \frac{MPN}{day}$ to $1.4141 * 10^{13} \frac{MPN}{day}$.

Management Measure 5.0: Load Reduction Estimate

Potential load reductions that could be achieved by implementing practices through the TSSWCB WQMP Program will depend specifically on the particular BMP implemented by each individual landowner and the number of livestock in each landowner's operation. BMPs that have been included in EQIP or WQMP programs, that have been documented to measurably reduce the amount of fecal bacteria loading from cattle, and that can be employed in the Carters Creek watershed include exclusionary fencing, filter strips, prescribed grazing, stream crossings, and alternate or additional watering facilities. Fencing, prescribed grazing, and water development are the three most likely practices to be implemented.

These BMPs have been the subject of various research efforts and estimated bacteria reduction efficiencies have been established for these practices through these studies. Table B-1 lists the individual practice, the range of bacteria removal efficiency and the midpoint of the efficiency range as described in the literature. While research conducted in these works was not conducted in the Carters Creek watershed, or in Texas in most cases, these studies do illustrate the abilities of these practices to reduce bacteria contributions from livestock. Without watershed-specific BMP efficiency evaluations, using the midpoint of the effectiveness ranges should be a safe assumption for predicting potential load reductions that

could be realized through voluntary BMP implementation; however, using the lowest effectiveness rate will likely give a more dependable prediction for load reductions.

One challenge that will be experienced in the Carters Creek watershed when working with landowners to use these programs will be pressure from land development. As the population of the Bryan and College Station area continues to grow, increasing demands for currently undeveloped lands in the watershed will persist. Many of the rural areas that are currently used for agricultural purposes on the fringes of the urbanized area are being shopped for development opportunities and this trend will likely continue into the future. As a result, landowners who feel that they will sell their property soon may be apprehensive to implement conservation practices through the EQIP or WQMP programs due to requirements to maintain practices over a designated period. As a result, potential load reductions realized from implementation of this management measure may be minimal.

Table B-1. Livestock BMP Fecal Coliform Removal Efficiencies

Management Practice	Effectiveness: Low Rate	Effectiveness: High Rate	Effectiveness: Mid-point
Fencing to Limit Creek Access 1	30%	94%	62%
Filter Strips 2	30%	100%	65%
Prescribed Grazing 3	42%	66%	54%
Stream Crossing 4	44%	52%	48%
Watering Facility 5	51%	94%	72.5%

1 Brenner 1996, Cook 1998, Hagedorn et al. 1999, Line 2002, Line 2003, Lombardo et al. 2000, Meals 2001, Meals 2004

2 Casteel et al. 2005, Cook 1998, Coyne et al. 1995, Fajardo et al. 2001, Goel et al. 2004, Larsen et al. 1994, Lewis et al. 2010, Mankin & Okoren 2003, Roodsari et al. 2005, Stuntebeck & Bannerman 1998, Sullivan 2007, Tate 2006, Young 1980

3 Tate et al. 2004, USEPA 2010

4 Inamdar et al. 2002, Meals 2001

5 Byers et al. 2005, Hagedorn et al. 1999, Sheffield et al. 1997, Wagner 2011

To calculate potential load reductions for each of these five BMPs, a generic equation has been developed based upon the number of animal units, average fecal material production rates of beef cattle, the average *E. coli* content of beef cattle manure and the selected BMP effectiveness rate as listed above in Table 2. This generic form of equation based on animal units was chosen because an accurate

estimation of BMP implementation cannot be clearly defined. Since BMP implementation is strictly voluntary, no firm number of BMPs that will be installed can be established. The number of cattle or animal units in an operation that voluntarily implements some of these BMPs can also not be determined prior to the actual implementation. As a result, basing the equation on the number of animal units can serve as a starting point for making estimations of potential load reductions that could be realized by implementing each practice.

$$Potential\ Load\ Reduction = \#\ of\ AUs * \frac{37{,}195\frac{g}{day}}{AU} * 7.97x10^5 * BMP\ Effectivness\ Rate$$

In this equation, inputs are as follows:

- AU = animal unit defined as 1,000 pounds of animal weight (i.e. a 1,400lb cow = 1.4 AU)
- 37,195 $\frac{g}{day}$ = the average fecal production rate of beef cattle as reported by Metcalf & Eddy, 1991 and referenced in Wagner and Moench, 2009.
- 7.97x10^5 = the average *E. coli* production per gram of beef cattle fecal matter as reported in unpublished data from pastured cattle in the Cedar Creek watershed, Brazos County, Texas (Karthikeyan, 2011).
- BMP Effectiveness rate = midpoint of BMP efficiencies as illustrated in Table B-1.

Management Measure 6.0: Load Reduction Estimate

Riparian Area Protection

Using information similar to that used in the Gilleland Creek TMDL I-Plan, the following equation can be used to estimate a projected *E. coli* load reduction per acre.

$$\#\ of\ acres * 2\frac{tons}{acre}\ soil\ savings * 2000\frac{lbs}{ton} * 453.6\frac{g}{lb} * 1000\ cfu\ \frac{fecal\ coliform}{g\ of\ sediment} * .63\ \frac{E.coli}{\text{fecal coliform}} = estimated\ load\ reduction$$

The inputs to this equation are as follows:

- 2 tons/acre soil savings based on 40% reduction in sediment loss as a result of riparian area protection.
- 2,000 lbs/ton is the number of pounds in 1 ton
- 453.6 is the number of grams in 1 pound
- 1,000 cfu fecal coliform/ gram of sediment
- .63 = conversion factor to convert between fecal coliform and *E. coli* derived by dividing the current *E. coli* standard of 126 cfu/100mL by the previously used fecal coliform standard of 200 cfu/100mL

Assumptions made include:

- Colony Forming Units (CFUs) of *E. coli* and Most Probably Number (MPN) of *E. coli* are considered as equals and are used inter-changeably
- According to NRCS Web Soil Survey, the Sandow Loam dominates the flood plain in the Carters Creek watershed and has an average annual soil loss of 5 tons/acre; therefore a 40% reduction in sediment loss reduces sediment loading to the creeks by 2 tons/acre
- Sediment contains 1,000 cfu of fecal coliform per gram. Number is based on the approximate mid-point of a data set collected in Arkansas (HDR 2003).

Using a hypothetical 100 acre area of the watershed as having Riparian Area Protection applied, an estimated *E. coli* load reduction of $1.14 * 10^{11} \frac{MPN}{day}$ could be expected.