Texas State Soil and Water Conservation Board
Total Maximum Daily Load Program
FY 2009 Project 09-55 Workplan

TMDL PROJECT SUMMARY PAGE			
Title of Project	Modeling Support and Bacterial Source Tracking for Big Cypress Creek Bacteria Assessment [Short Title: Big Cypress Creek Modeling and BST]		
Project Goals/Objectives	To provide stakeholders and agencies with sufficient information to address bacteria impairments on Big Cypress Creek and tributaries (Hart and Tankersley Creeks) between Lake O' the Pines and Lake Bob Sandlin through verification of use attainment, revision of water quality standards and/or designated uses, or development of a WPP or TMDL by 1) conducting bacterial source tracking, 2) developing a comprehensive GIS inventory and conducting a watershed source survey, and 3) analyzing data using Load Duration Curves and spatially explicit modeling.		
Project Tasks	1) Project Administration; 2) Quality Assurance; 3) Bacterial Source Tracking; 4) Data Analysis and Watershed Modeling		
Measures of Success	1) Decision-making for watershed planning activities, including BST, LDC analysis, and spatially explicit modeling, is founded on local stakeholder input. 2) BST, LDC analysis, and spatially explicit modeling in the study area are conducted using data of known and acceptable quality. 3) Bacteria loads are estimated for each of the three segments in the study area through the development of LDCs. 4) Bacteria loads are estimated from various contributing sources and critical loading areas within the watersheds are identified based on SELECT model output and BST.		
Project Type	Implementation ( ); Education ( ); Planning ( ); Assessment (X)		
Status of Waterbody on 2008 Texas Water Quality Inventory and 303(d) List	Segment ID: 0404 Big Cypress Creek below Lake Bob Sandlin 0404B Tankersley Creek 0404C Hart Creek	Parameter: bacteria bacteria bacteria	Category: 5a 5a 5a
Project Location (Statewide or Watershed and County)	Big Cypress Creek and Tributaries (Hart and Tankersley Creeks) between Lake O' the Pines and Lake Bob Sandlin in Titus, Camp, Upshur and Morris Counties		
Key Project Activities	Hire Staff (X); Surface Water Quality Monitoring ( ); Technical Assistance ( ); Education ( ); Implementation ( ); BMP Effectiveness Monitoring ( ); Demonstration ( ); Planning ( ); Modeling (X); Bacterial Source Tracking (X); Other ( )		
NPS Management Program Elements	• Element One (STG 1B; STG 1C; STG 1D; STG 2A; STG 3B; STG 3D) • Element Two • Element Five		
Project Costs	$ 173,422 (TSSWCB TMDL GR)		
Project Management	• Texas A&M AgriLife – Texas Water Resources Institute • Texas AgriLife Research – Department of Soil and Crop Sciences • Texas AgriLife Research – Department of Biological and Agricultural Engineering		
Project Period	June 1, 2009 – July 31, 2011		

Part I – Applicant Information

Applicant							
Project Lead	B.L. Harris						
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Project Co-Lead	R. Karthikeyan						
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Project Co-Lead	Terry Gentry, Ph.D.						
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Project Partners	
Names	Roles & Responsibilities
Texas State Soil and Water Conservation Board (TSSWCB)	Provide state oversight and management of all project activities and ensure coordination of activities with related projects and TCEQ.
Northeast Texas Municipal Water District (NETMWD)	Conduct water quality monitoring through TSSWCB project 09-54.
Texas AgriLife Research – Department of Biological and Agricultural Engineering (BAEN)	Develop GIS inventory and perform LDC analysis and spatially explicit modeling.
Texas AgriLife Research – Department of Soil and Crop Sciences – Soil and Aquatic Microbiology Laboratory (SAML)	Conduct Bacterial Source Tracking.
Texas A&M University – Spatial Sciences Laboratory (SSL)	Classify land use through TSSWCB project 08-52.
Texas AgriLife Research – Texas Water Resources Institute (TWRI)	Coordinate and manage all work described in Tasks. Develop QAPP.
Sulphur-Cypress Soil and Water Conservation District and Upshur-Gregg Soil and Water Conservation District (SWCDs 419 & 417)	Collaborate as critical local stakeholders and play a lead role in communicating with other local stakeholders.

Part II – Project Information

Watershed Information

Watershed Name	Hydrologic Unit Code (8 Digit)	Segment ID	305(b) Category	Size (Acres)
Big Cypress Creek and Tributaries (Hart and Tankersley Creeks) between Lake O' the Pines and Lake Bob Sandlin	11140305	0404 0404B 0404C	5a 5a 5a	284,487

Water Quality Impairment

Describe all known causes of water quality impairments from any of the following sources: 2008 Texas Water Quality Inventory and 303(d) List, or Other Documented Sources (i.e., Clean Rivers Program Basin Summary or Basin Highlights Reports).

2008 TWQI & 303(d) List

0404 non-supporting recreation use for bacteria geomean and bacteria single sample, upper 18 miles; source unknown, industrial point source discharge

0404B non-supporting recreation use for bacteria geomean and bacteria single sample, lower 8 miles below Tankersley Lake; source unknown, unrestricted cattle access, septic systems, industrial point source discharge, natural sources

0404C non-supporting recreation use for bacteria geomean and bacteria single sample, entire waterbody; municipal point source discharges, industrial point source discharge

2008 NETMWD Clean Rivers Program Basin Highlights Report

This segment [0404]…has the most intensive agricultural and urban development in the Cypress Creek Basin. Vegetation within this area ranges from areas cleared for agriculture to dense forests. The floodplain…is heavily wooded and contains widespread-forested wetlands. Nearby uplands are used for livestock grazing and hay production. Urban concentrations are highest in this segment… A majority of the intensive poultry operations within the Cypress Basin are located in this area.

2005 NETMWD Clean Rivers Program Tankersley Creek Bacterial Source Tracking Special Study

…all stations except the two Tankersley Lake stations…and the uppermost stream station…exhibited geometric mean[s]…that exceed the…criterion. …the highest *E. coli* abundances occur during and immediately after rainfall… However, …substantial bacterial levels…[are] present at some locations when there was no recent surface runoff. The extensive shoreline development fringing Tankersley Lake has had little apparent impact on bacterial water quality there. The widespread and common exceedance of the criteria…throughout the lower reach of Tankersley Creek…represents at least a potential impairment of that use. These streams are too small for water skiing, boating and swimming, the channels tend to be deeply and sharply incised in the landscape, with large amounts of woody debris and turbid water; not attractive recreational qualities. …a land use/cover map of the Tankersley Creek watershed, show[s]…the overwhelming dominance…by pastureland and the rural residential areas… Those areas…may be important sources of bacterial contamination from the high densities of livestock (e.g., horses, goats, fowl) observed there, and from on-site treatment facilities. Further characterization of…bacterial sources will require the use of specific source tracking methodologies. A *Bacteroides-Prevotella*, or other assay that distinguishes between human and other animal sources would be useful in this case…

2003 NETMWD Clean Rivers Program Tankersley Creek Indicator Bacteria Special Study

Evaluation of the combined results…indicate that these bacteria are consistently present at levels above the single value criterion…within 1-2 days of significant local rainfall. Of the streams sampled…, only Big Cypress Creek could be considered large enough to support contact recreation, but accessibility is limited and the aesthetic aspects of this stream (steep banks, muddy water, abundant woody debris, snakes) do not make it particularly attractive for such uses. However, in spite of their small size and relatively unattractive character,

the suburban nature of Tankersley and Hart Creeks suggests that some level of exposure, especially among children, may be occurring. Although the spatial distribution and correlation of *E. coli* abundance with rainfall indicates an important non-point source component, dry and wet weather results considered together suggest that bacterial contamination may be resulting from continuing sources, particularly in Tankersley Creek, which exhibits the largest bacterial abundances observed…at all conditions. …possible sources include overflowing septic systems, the dumping of animal waste into catchment basins, sanitary and combined sewer overflows, wastewater, illicit connections to the storm drain system, and sewage sludge disposal.

Project Goals

To provide stakeholders and agencies with sufficient information to address bacteria impairments on Big Cypress Creek and tributaries (Hart and Tankersley Creeks) between Lake O' the Pines and Lake Bob Sandlin through verification of use attainment, revision of water quality standards and/or designated uses, or development of a WPP or TMDL by 1) conducting bacterial source tracking, 2) developing a comprehensive GIS inventory and conducting a watershed source survey, and 3) analyzing data using Load Duration Curves and spatially explicit modeling.

2005 Texas Nonpoint Source Management Program References (Expand from Summary Page)

- Element 1 – Explicit short-…term goals, objectives and strategies that protect surface…water.
  - Short-Term Goal One – Data Collection and Assessment – Objective B – Ensure that…procedures meet quality assurance requirements…
  - Short-Term Goal One – Data Collection and Assessment – Objective C – Conduct special studies to determine sources of NPS pollution and gain information to target TMDL activities and BMP implementation.
  - Short-Term Goal One – Data Collection and Assessment – Objective D – Develop…TMDLs, I-Plans and WPPs to maintain and restore water quality in waterbodies…impacted by NPS pollution.
  - Short-Term Goal Two – Implementation – Objective A – …determine priority areas and develop…strategies to address NPS pollution in those areas.
  - Short-Term Goal Three – Education – Objective B – Administer programs to educate citizens about water quality and their potential role in causing NPS pollution.
  - Short-Term Goal Three – Education – Objective D – Conduct outreach…to facilitate broader participation and partnerships…[to] enable stakeholders…to participate in decision-making and provide a more complete understanding of water quality issues and how they relate to each citizen.
- Element 2 – Working partnerships…[with] appropriate state,…regional, and local entities, private sector groups, and federal agencies.
- Element 5 – The State…identifies waters…impaired by NPS pollution and…establishes a process to progressively address these…waters by conducting more detailed watershed assessments…

Measures of Success

- Decision-making for watershed planning activities, including BST, LDC analysis, and spatially explicit modeling, is founded on local stakeholder input.
- BST, LDC analysis, and spatially explicit modeling in the study area are conducted using data of known and acceptable quality.
- Bacteria loads are estimated for each of the three segments in the study area through the development of LDCs.
- Bacteria loads are estimated from various contributing sources and critical loading areas within the watersheds are identified based on SELECT model output and BST.

Project Narrative

Problem/Need Statement

Big Cypress Creek (and its tributaries) are located in the Cypress Creek Basin. The headwaters of Big Cypress Creek originate in southeast Hopkins County. From there, Big Cypress Creek flows east into Lake Cypress Springs and then into Lake Bob Sandlin in Franklin County. After leaving Lake Bob Sandlin, Big Cypress Creek, which forms the county line between Titus and Camp Counties, flows southeast to Lake O' the Pines and then finally to Caddo Lake before entering Louisiana. The watershed is characterized by gently rolling wooded hills and broad, frequently flooded, densely vegetated stream bottoms. Post oak savannah is predominant in the western portion of the basin, while pineywoods are common in the eastern portion.

The Big Cypress Creek watershed, between Lake Bob Sandlin and Lake O' the Pines, encompasses approximately 445 square miles in Camp, Morris, Titus and Upshur Counties. In 1996, Big Cypress Creek (Segment 0404) was placed on the *Texas 303(d) List* for having bacteria levels that exceed water quality standards. In 2000, Tankersley Creek (Segment 0404B) was placed on the *303(d) List* for bacteria, and in 2006, Hart Creek (Segment 0404C) was placed on the *303(d) List* for bacteria. Other tributaries to Big Cypress Creek are not currently impaired for bacteria, but they are likely contributing some degree of bacteria loading to the impaired reaches of Big Cypress Creek.

The focus of this project will be on bacterial water quality issues in Segments 0404, 0404B, and 0404C. Additionally, Segment 0404 is the contributing watershed to Lake O' the Pines (Segment 0403) and is covered by *One Total Maximum Daily Load for Dissolved Oxygen in Lake O' the Pines (Segment 0403)*. The TMDL was adopted by the TCEQ on April 12, 2006, approved by the TSSWCB on March 23, 2006 and approved by the EPA on June 7, 2006. The TMDL determined that low dissolved oxygen concentrations in the reservoir are due to high rates of photosynthesis and respiration in aquatic vegetation and that phosphorus is the limiting nutrient during the critical conditions. The TMDL determined that a 56% reduction in total phosphorus loading is needed to restore water quality. An Implementation Plan (I-Plan) was developed to reduce phosphorus loadings from the contributing watershed. Implementation strategies were identified for point source dischargers (total phosphorus effluent limits), animal feeding operations (BMPs to reduce runoff of sediment and nutrients from poultry litter application sites and dairies), forestry operations (BMPs to reduce runoff of sediment and nutrients), and other sources (on-site sewage facilities, boat sewage disposal, sites permitted for land application of domestic sewage sludge). On July 9, 2008, the TCEQ approved the *I-Plan for One TMDL for Dissolved Oxygen in Lake O' the Pines*. The TSSWCB approved the I-Plan on July 17, 2008. It is anticipated that many of the implementation strategies designed to reduce phosphorus loadings will also have a positive impact on reducing bacteria loadings to Big Cypress Creek.

Through the Lake O' the Pines TMDL process, watershed stakeholders have become extremely familiar with water quality rules and regulations, as well as, approaches to watershed planning. As such, local stakeholders have already expressed interest in taking an active role in addressing the bacteria impairments.

Land use in the watershed is predominantly cropland and pasture (about 48%) and forest (about 40%). During periods of rainfall, which averages approximately 46 inches annually, bacteria originating from aquatic birds and mammals, livestock, inadequately treated sewage, and/or failing septic systems may be washed into the streams and have the potential to impede recreational use of the waterbodies. Bacterial indicators, such as *E. coli*, may remain in the streams at levels exceeding established criteria and can be measured well after a rain event has occurred. These microorganisms are normally found in wastes of warm-blooded animals and are generally not harmful to human health, but may indicate the presence of pathogens that can cause disease.

Lake O' the Pines and other waterbodies in its watershed are extremely important to the surrounding region. Lake O' the Pines provides drinking water for 7 cities and towns, numerous rural water districts, and several steel manufacturing and electric generating companies. In addition, the City of Longview (population 70,000) will be using the lake as a drinking water source in the near future. The lake is an important resource to the timber industry and to agricultural enterprises such as the poultry industry, dairies, cow/calf operations, and for irrigation. Recreation and tourism are significant sources of income for residents of the watershed. Boating and fishing for trophy bass, catfish, and crappie lure large numbers of recreational users to the watershed each year.

The TCEQ and the TSSWCB established a joint, technical Task Force on Bacteria TMDLs in September 2006 charged with making recommendations on cost-effective and time-efficient bacteria TMDL development methodologies. The Task Force recommended the use of a three-tier approach that is designed to be scientifically credible and accountable to watershed stakeholders. The tiers move through increasingly aggressive levels of data collection and analysis in order to achieve stakeholder consensus on needed load reductions and strategies to achieve those reductions. In June 2007, the TCEQ and the TSSWCB adopted the principles and general process recommended by the Task Force and directed agency staff to incorporate the principles of the recommendations into an updated joint-agency TMDL guidance document.

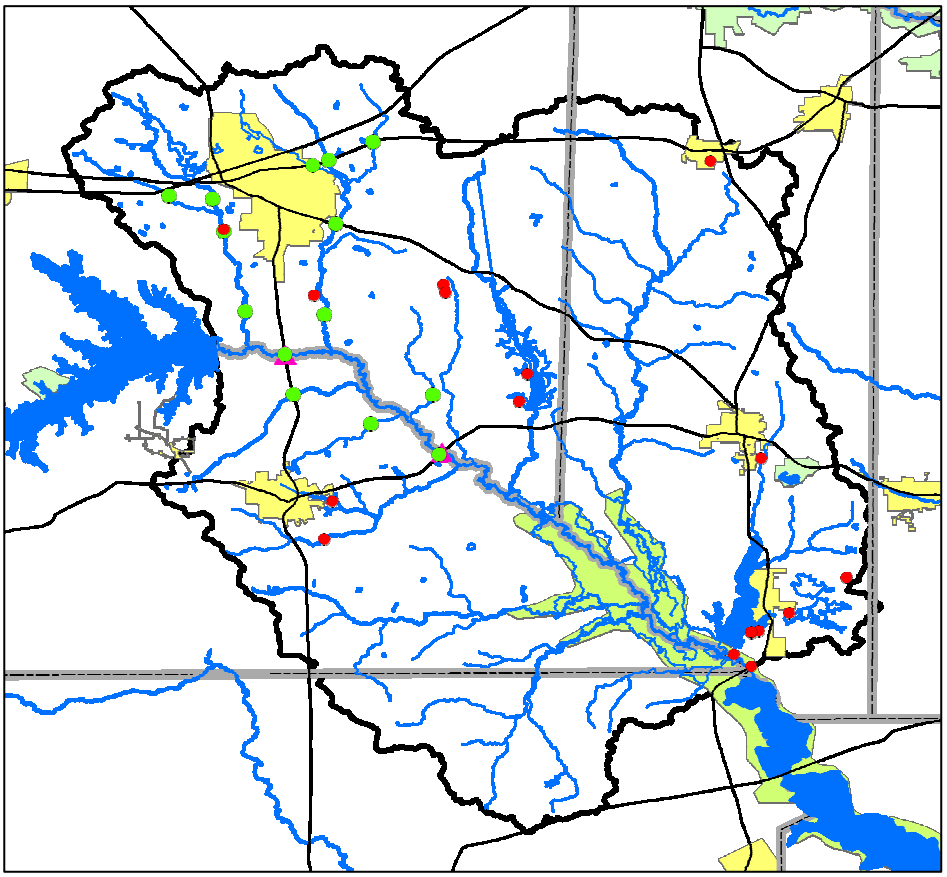
Major revisions to the Texas Surface Water Quality Standards are being drafted by TCEQ, including the establishment of numeric nutrient criteria for reservoirs and modifications to contact recreation use and bacteria criteria. As part of this process, TCEQ is developing procedures for conducting recreational Use Attainability Analyses (UAAs). In order for a new category of recreational use or a different bacteria water quality standard to be applied to a waterbody, a recreational UAA will need to be conducted. TCEQ and TSSWCB have collaborated on developing a list of priority waterbodies for collecting information needed for recreational UAAs. Segments in this project's study area are on that list.

In accordance with the *Memorandum of Agreement Between the TCEQ and the TSSWCB Regarding TMDLs, Implementation Plans, and Watershed Protection Plans*, the TSSWCB has agreed to take the lead role in addressing the bacteria impairments in the study area. Through this and associated projects, the TSSWCB and NETMWD will work with local stakeholders to progress through the data collection and analysis components of the first two tiers of the Task Force recommended three-tier approach. The goal is to remove the waterbodies in the study area from the *303(d) List*; however, the mechanism is not predetermined. At the end of this two-year assessment project, possible outcomes include: 1) waterbodies are achieving current water quality standards, 2) waterbodies are achieving revised water quality standards, based on TCEQ triennial review process, 3) adequate data exists to support a UAA to change water quality standards, 4) adequate data exists to develop a Watershed Protection Plan, or 5) adequate data exists to develop a TMDL and I-Plan for TCEQ adoption.

Project Narrative

General Project Description

In order to communicate project goals, activities, results and accomplishments to affected parties, TWRI, SAML, and BAEN will participate in public stakeholder meetings as needed. At a minimum, public stakeholder meetings shall consist of an organizational/kick-off meeting, a source survey design meeting, a meeting presenting results from initial data analysis and the GIS inventory, a Texas Watershed Steward Program workshop, two project update meetings during the middle of the project, a meeting presenting data analysis results, and a meeting presenting final technical reports.



TWRI will develop and disseminate educational materials to watershed stakeholders, including, but not limited to, flyers, brochures, letters, and news releases. BAEN, SAML, and NETMWD, shall contribute content matter for educational materials as appropriate. TWRI will develop, host and maintain an internet webpage for the dissemination of project information. BAEN, SAML, and NETMWD, shall contribute content matter for the webpage as appropriate.

BAEN will develop a comprehensive GIS inventory for the study area, with assistance from NETMWD through TSSWCB project 09-54 *Assessment of Contact Recreation Use Impairments and Watershed Planning for Big Cypress Creek and Tributaries (Hart and Tankersley Creeks)*.

TSSWCB, in cooperation with SSL, will provide BAEN a current land use classification, based on 2004-2006 imagery, for the study area through TSSWCB project 08-52 *Classification of Current Land Use/Land Cover for Certain Watersheds Where TMDLs or WPPs Are In Development*.

In order to apply knowledge gained through TSSWCB project 07-06, *Fate and Transport of E. coli in Rural Texas Landscapes and Streams*, BAEN will assist NETMWD in designing a watershed source survey, to be conducted through TSSWCB project 09-54, that better characterizes the possible sources of bacteria loadings in the study area. SAML will also assist NETMWD in designing the watershed source survey.

To provide sufficient water quality data to characterize bacteria loadings in the study area, NETMWD, through TSSWCB project 09-54, will conduct routine ambient monitoring, effluent monitoring, and biased-flow monitoring under high flow (storm event influenced) conditions.

TWRI will develop a Quality Assurance Project Plan (QAPP) to ensure data of known and acceptable quality are generated and used in this project. The QAPP shall be consistent with the *TSSWCB Environmental Data Quality Management Plan*.

To determine bacteria load reductions needed to achieve water quality standards, BAEN, with assistance from NETMWD, will conduct a Load Duration Curve (LDC) analysis of all historic and existing water quality monitoring

data from the study area. LDCs will be developed for at least one critical index site per segment. LDCs shall be consistent with 1) EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs*, 2) EPA's *Options for Expressing Daily Loads in TMDLs*, and 3) EPA's *Development of Duration-Curve Based Methods for Quantifying Variability and Change in Watershed Hydrology and Water Quality*. Then, using water quality monitoring data collected by NETMWD through TSSWCB project 09-54, BAEN will refine the developed LDCs.

To estimate loadings from various sources and to identify critical loading areas within the watersheds, BAEN, again with assistance from NETMWD, will conduct watershed modeling for the study area. Utilizing information from the GIS inventory, watershed source survey, and water quality monitoring, and in combination with the LDCs, BAEN will develop a spatially explicit or mass balance model, such as SELECT, for the study area.

To assess and identify different sources contributing to bacteria loadings, SAML will conduct Bacterial Source Tracking (BST) in the study area. SAML will conduct library-independent BST utilizing the *Bacteroidales* PCR genetic test for human, ruminant, horse, and swine markers. Additionally, SAML will conduct limited library-dependent BST and analyze *E. coli* isolates utilizing the ERIC-PCR and RiboPrinting combination method. This will serve to confirm that the sources of *E. coli* and *Bacteroidales* are comparable and assess the spatial and temporal adequacy of the Texas Known Source Library. The Texas Known Source Library may need to be supplemented with known fecal samples from the study area. NETMWD will provide SAML a subset of water samples collected through TSSWCB project 09-54 for BST. Additionally, NETMWD will collect known fecal samples, if needed. Results from the watershed source survey, to be conducted by NETMWD, will be used by SAML to make appropriate adjustments to the BST sampling design and to assess the adequacy of the Texas Known Source Library. SAML will work with BAEN to integrate BST results into the model, to the extent possible, and address and reconcile discrepancies between BST and modeling results.

Tasks, Objectives and Schedules				
Task 1	Project Administration			
Costs	$ 16,446			
Objective	To effectively administer, coordinate, and monitor all work performed under this project including technical and financial supervision and preparation of status reports.			
Subtask 1.1	TWRI will prepare electronic quarterly progress reports (QPRs) for submission to the TSSWCB. QPRs shall document all activities performed within a quarter and shall be submitted by the 15th of December, March, June and September. QPRs shall be posted to the project website and provided to all project partners.			
	Start Date	Month 1	Completion Date	Month 26
Subtask 1.2	TWRI will perform accounting functions for project funds and will submit appropriate Reimbursement Forms to TSSWCB at least quarterly.			
	Start Date	Month 1	Completion Date	Month 26
Subtask 1.3	TWRI will host, and BAEN and SAML will participate in, coordination meetings, conference calls, or TTVN meetings with TSSWCB, and any project partners as appropriate, at least quarterly to discuss project activities, project schedule, communication needs, deliverables and other requirements. Coordination with NETMWD through TSSWCB project 09-54, *Assessment of Contact Recreation Use Impairments and Watershed Planning for Big Cypress Creek and Tributaries (Hart and Tankersley Creek)*, will be especially critical to achieve project goals.			
	Start Date	Month 1	Completion Date	Month 26
Subtask 1.4	In order to communicate project goals, activities, results and accomplishments to affected parties, TWRI, BAEN, and SAML will participate in public stakeholder meetings as needed. At a minimum, public stakeholder meetings shall consist of an organizational/kick-off meeting (month 3), a source survey design meeting (month 4), a meeting presenting results from initial LDCs and the GIS inventory (month 6), Texas Watershed Steward Program workshop (month 9), two project update meetings (months 12 and 18), a meeting presenting data analysis results (month 21), and a meeting presenting final technical reports (month 24).			
	Start Date	Month 1	Completion Date	Month 26

Subtask 1.5	TWRI will develop and disseminate educational materials to watershed stakeholders, including, but not limited to, flyers, brochures, letters, and news releases. BAEN, SAML, and NETMWD (through TSSWCB project 09-54), shall contribute content matter for educational materials as appropriate.			
	Start Date	Month 1	Completion Date	Month 26
Subtask 1.6	TWRI will develop (Months 1-3), host and maintain (Months 4-24) an internet webpage for the dissemination of project information. BAEN, SAML, and NETMWD (through TSSWCB project 09-54), shall contribute content matter for the webpage as appropriate.			
	Start Date	Month 1	Completion Date	Month 26
Deliverables	• Quarterly Progress Reports in electronic format • Reimbursement Forms and necessary supporting documentation, in either electronic or hard copy format • Educational materials, as developed and disseminated • Project webpage			

Tasks, Objectives and Schedules				
Task 2	Quality Assurance			
Costs	$ 5,000			
Objective	To develop and implement data quality objectives (DQOs) and quality assurance/control (QA/QC) activities to ensure data of known and acceptable quality are generated through this project.			
Subtask 2.1	TWRI will develop a QAPP for activities in Tasks 3 and 4 consistent with the most recent versions of *EPA Requirements for Quality Assurance Project Plans (QA/R-5)* and the *TSSWCB Environmental Data Quality Management Plan.*			
	Start Date	Month 1	Completion Date	Month 2
Subtask 2.2	TWRI will submit revisions and necessary amendments to the QAPP as needed.			
	Start Date	Month 3	Completion Date	Month 26
Deliverables	• QAPP for Tasks 3 and 4 approved by TSSWCB in both electronic and hard copy formats • Approved revisions and amendments to QAPP, as needed • Data of known and acceptable quality as reported through Tasks 3 and 4			

Tasks, Objectives and Schedules				
Task 3	Bacterial Source Tracking			
Costs	$ 82,116			
Objective	To conduct Bacterial Source Tracking to assess and identify different sources contributing to bacteria loadings.			
Subtask 3.1	SAML will conduct library-independent BST on 50-100 water samples per segment utilizing the *Bacteroidales* PCR genetic test for human, ruminant, horse, and swine markers. The number of samples may be adjusted depending on the size of each watershed in the study area and the complexity of sources as identified in the source survey (Subtask 3.4). Budgeted number of samples is 75 from each of Hart and Tankersley Creeks and 100 from Big Cypress Creek (main stem) for a total of 250. Specific genetic markers for various animal sources are continually being developed by the scientific community and as new markers are identified, they should be included in this analysis, as the budget allows. Water samples for this subtask shall be a subset of those collected by NETMWD through TSSWCB project 09-54.			
	Start Date	Month 3	Completion Date	Month 21
Subtask 3.2	SAML will conduct limited library-dependent BST and analyze *E. coli* isolates from 50-100 water samples (1 isolate per water sample) from across the study area utilizing the ERIC-PCR and RiboPrinting combination method. Budgeted number of samples is 100. This will serve to 1) confirm that the sources of *E. coli* and *Bacteroidales* are comparable and 2) assess the spatial and temporal adequacy of the Texas Known Source Library. Water samples for this subtask shall be a subset of those collected by NETMWD through TSSWCB project 09-54.			

	Start Date	Month 3	Completion Date	Month 24
Subtask 3.3	The Texas Known Source Library may need to be supplemented with known fecal samples from the study area. SAML will add up to 30 known source fecal samples (1-2 isolates per fecal sample) to the Texas Known Source Library. Fecal samples will be added to the BST library utilizing the ERIC-PCR and RiboPrinting combination method. Samples for this subtask shall be collected by NETMWD through TSSWCB project 09-54.			
	Start Date	Month 3	Completion Date	Month 24
Subtask 3.4	SAML will assist NETMWD in designing a watershed source survey (also known as a sanitary survey), to be conducted through TSSWCB project 09-54, that better characterizes possible sources of bacteria loadings in the study area. Results from the source survey will be used by SAML to make appropriate adjustments to the BST sampling design and assess the adequacy of the Texas Known Source Library.			
	Start Date	Month 1	Completion Date	Month 15
Subtask 3.5	BAEN will conduct watershed modeling for the study area (Task 4). SAML will work with BAEN to 1) integrate BST results into the model, to the extent possible, and 2) address and reconcile discrepancies between BST and modeling results.			
	Start Date	Month 7	Completion Date	Month 24
Deliverables	• Technical Report detailing the results of Bacterial Source Tracking			

Tasks, Objectives and Schedules				
Task 4:	Data Analysis and Watershed Modeling			
Costs:	$ 69,860			
Objective:	To develop a comprehensive GIS inventory for the study area and to assess the possible sources of bacteria loadings by conducting a watershed source survey. To analyze and interpret data using Load Duration Curves and spatially explicit modeling to determine bacteria load reductions needed to achieve water quality standards and estimate loadings from various sources.			
Subtask 4.1:	BAEN will develop a comprehensive GIS inventory for the study area, with assistance from NETMWD through TSSWCB project 09-54. Data layers will be collected by NETMWD and/or BAEN and should include the most recent information available on land use, elevation, soils, stream networks, reservoirs, roads, public parklands, municipalities and satellite imagery or aerial photography. Locations of SWQM stations, USGS gages, public access points to the waterbodies, floodwater-retarding structures, wetlands, TPDES permittees (including WWTFs, CAFOs and MS4s), and subdivisions should also be included. Sites permitted for land application of sewage sludge and septage should be included. Locations of possible bacteria sources, identified in the source survey, should be incorporated. The cumulative impact of TSSWCB-certified WQMPs on the management of agricultural and silvicultural lands should be documented. BAEN will incorporate these data into a GIS, create maps for stakeholder meetings and utilize this information for watershed modeling (Subtask 4.6).			
	Start Date:	Month 1	Completion Date:	Month 26
Subtask 4.2:	TSSWCB, in coordination with SSL, will provide BAEN a current land use classification for the study area through TSSWCB project 08-52, *Classification of Current Land Use/Land Cover for Certain Watersheds Where TMDLs or WPPs Are In Development*.			
	Start Date:	Month 1	Completion Date:	Month 3
Subtask 4.3:	In order to apply knowledge gained through TSSWCB project 07-06, *Fate and Transport of E. coli in Rural Texas Landscapes and Streams*, BAEN will assist NETMWD in designing a watershed source survey, to be conducted through TSSWCB project 09-54, that better characterizes the possible sources of bacteria loadings in the study area.			
	Start Date:	Month 1	Completion Date:	Month 25

Subtask 4.4:	BAEN, with assistance from NETMWD through TSSWCB project 09-54, will conduct a LDC analysis of all historic and existing water quality monitoring data from the study area. LDCs will be developed for one critical index site per segment (0404, 0404B, 0404C). LDCs shall be consistent with 1) EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs*, 2) EPA's *Options for Expressing Daily Loads in TMDLs*, and 3) EPA's *Development of Duration-Curve Based Methods for Quantifying Variability and Change in Watershed Hydrology and Water Quality*. Initial LDC development will be completed using available USGS gage flow data and SWAT generated flow data as utilized in the development of the Lake O' the Pines TMDL.			
	Start Date:	Month 3	Completion Date:	Month 6
Subtask 4.5:	Using water quality monitoring data collected by NETMWD through TSSWCB project 09-54, BAEN, with assistance from NETMWD, will refine LDCs developed in subtask 4.4. LDCs will be used to determine bacteria load reductions needed to achieve water quality standards.			
	Start Date:	Month 7	Completion Date:	Month 26
Subtask 4.6	BAEN, with assistance from NETMWD through TSSWCB project 09-54, will conduct watershed modeling for the study area. Utilizing information from the GIS inventory (Subtask 4.1), the source survey (Subtask 4.3), and water quality monitoring (TSSWCB project 09-54), and in combination with LDCs from Subtasks 4.4-4.5, BAEN will develop a spatially explicit or mass balance model, such as SELECT, for the study area. Modeling will be conducted on the entire Big Cypress Creek watershed between Lake O' the Pines and Lake Bob Sandlin; model output subsets highlighting the individual impacts of Hart and Tankersley Creeks will also be provided. Modeling will be used to estimate loadings from various sources and to identify critical loading areas within the watersheds.			
	Start Date:	Month 7	Completion Date:	Month 26
Deliverables	• Technical Report detailing the characteristics of the study area as represented in the comprehensive GIS inventory • Draft Technical Report detailing preliminary LDC analysis • Technical Report detailing final LDC analysis • Technical Report describing watershed modeling results			

Part III – Financial Information

Budget Summary	
Category	**Costs**
Personnel	$ 87,892
Fringe Benefits	$ 20,367
Travel	$ 4,390
Equipment	$ 0
Supplies	$ 36,140
Contractual	$ 0
Construction	$ 0
Other	$ 2,013
Total Direct Costs	$ 150,802
Indirect Costs (≤15%)	$ 22,620
Total Project Costs	$ 173,422

Budget Justification		
Category	**Costs**	**Justification**
Personnel	$ 87,892	• BAEN – Research Scientist (1 mo/yr in yrs 1 & 2) and a Graduate Research Associate (6 mo in yr 1 & 3.25 mo in yr 2) • SAML –Postdoctoral Associate (6 mo in yr 1 and 1.625 mo in yr 2). Additional support provided for through TSSWCB project 08-51, *Increased Analytical Infrastructure and Further Development of a Statewide Bacterial Source Tracking Library at Texas AgriLife Research – College Station*. • TWRI – Project Manager (1 mo/yr in yrs 1 & 2)
Fringe Benefits	$ 20,367	Calculated at 17.6% of salary, plus $471/mo (pro-rated) for medical insurance for everyone except BAEN Graduate Research Associate (10.1% of salary plus $190/mo (pro-rated) for medical insurance). Additional support for SAML provided for through TSSWCB project 08-51.
Travel	$ 4,390	For ~8 overnight trips to watershed for participation in stakeholder meetings; includes mileage, lodging and per diem
Equipment	$ 0	
Supplies	$ 36,140	• BAEN – Costs of miscellaneous supplies including GIS plotting, software, etc. ($2,000) • SAML – Costs of media, reagents, and other consumables for culturing of *E. coli* are estimated at $15/water sample (3 dilutions per sample at $5/dilution) for 100 samples and $25/fecal sample (5 dilutions per sample at $5/dilution) for 30 samples. Total of 130 samples. ($2,250). Costs of media, reagents, and other consumables for ERIC-PCR and RiboPrinting combination are estimated at $5/isolate for isolation and confirmation, $8/isolate for ERIC-PCR, and $40/isolate for RiboPrinting of 130 isolates ($6,890). Costs of media, reagents, and other consumables for *Bacteroidales* PCR are estimated at $100/sample for 250 samples ($25,000). Total of $34,140
Contractual	$ 0	
Construction	$ 0	
Other	$ 2,013	printing and mailing ($2,013)
Indirect	$ 22,620	15% of Total Direct Costs
SOURCE	TSSWCB will provide $173,422 in non-federal funds sourced from state appropriations (FY2009 General Revenue) through a TMDL Program Grant to the Texas Water Resources Institute.	