Modeling Support
for Little Brazos River Tributaries Bacteria Assessment
(Project # 08-55)

Revision No. 1

prepared by

Texas AgriLife Research

Texas Water Resources Institute

and the

Texas A&M University Dept. of Biological and Agricultural Engineering

Funding Source:

Texas State Soil and Water Conservation Board
Total Maximum Daily Load Program Project

Effective Period: June 2008 to May 2010

Questions concerning this quality assurance project plan should be directed to:

Lucas Gregory, TWRI Quality Assurance Officer

lfgregory@ag.tamu.edu

-or-

Dr. R. Karthikeyan, Assistant Professor, Department of Biological and Agricultural Engineering

Texas A&M University

306A Scoates Hall

2117 TAMU

College Station, TX 77843-2117

Section A2: Table of Contents

Section: Title **Page**

List of Tables

List of Figures

List of Acronyms and Abbreviations

BAEN	Department of Biological and Agricultural Enginnering
BRA	Brazos River Authority
CAFO	confined animal feeding operation
CAR	corrective action report
CBMS	computer based mapping system
CWA	Clean Water Act
DEM	digital elevation model
DQO	data quality objectives
EPA	United States Environmental Protection Agency
GIS	geographic information system
MS4	municipal separate storm sewer system
LDC	load duration curve
NLCD	national land cover data set
QA	quality assurance
QAPP	quality assurance project plan
QAO	Quality Assurance Officer
QC	quality control
QPR	quarterly progress report
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SOP	standard operating procedures
SSL	Spatial Sciences Laboratory
SSURGO	soil survey geographic
SWQM	surface water quality monitoring
TAMU	Texas A&M University; College Station Campus
TCEQ	Texas Commission on Environmental Quality
TMDL	total maximum daily load
TPDES	Texas pollution discharge elimination system
TSSWCB	Texas State Soil and Water Conservation Board
TWRI	Texas Water Resources Institute
USGS	United States Geological Survey
WQMP	water quality management plan
WWTF	wastewater treatment facility

Section A3: Distribution List

Organizations, and individuals within, which will receive copies of the approved QAPP and any subsequent revisions include:

- Texas State Soil and Water Conservation Board (TSSWCB)

  Name: Loren Henley
  Title: TSSWCB Project Manager

  Name: Donna Long
  Title: TSSWCB Quality Assurance Officer

- Texas Water Resources Institute (TWRI)

  Name: Bill Harris
  Title: TWRI Associate Director, Project Lead

  Name: Lucas Gregory
  Title: TWRI Quality Assurance Officer

  Name: Allen Berthold
  Title: TWRI Project Manager

- Texas A&M University—Department of Biological and Agricultural Engineering (BAEN)

  Name: R. Karthikeyan
  Title: Assistant Professor; Project Co-Leader

Section A4: Project/Task Organization

The following is a list of individuals and organizations participating in the project with their specific roles and responsibilities:

TSSWCB –Texas State Soil and Water Conservation Board, Temple, Texas. Provides project overview at the State level.

Loren Henley, TSSWCB Project Manager

Maintains a thorough knowledge of work activities, commitments, deliverables, and time frames associated with the project. Develops lines of communication and working relationships between, TWRI, TAMU-BAEN, and TSSWCB. Tracks deliverables to ensure that the tasks are completed as specified in the contract. Responsible for ensuring that the project deliverables are submitted on time and are of acceptable quality and quantity to achieve project objectives. Participates in the development, approval, implementation, and maintenance of the QAPP. Assists the TSSWCB QAO in technical review of the QAPP. Responsible for verifying that the QAPP is followed by TWRI and TAMU-BAEN. Notifies the TSSWCB QAO of particular circumstances that may adversely affect the quality of outputs derived from the model. Enforces corrective action.

Donna Long; TSSWCB Quality Assurance Officer

Reviews and approves QAPP and any amendments or revisions and ensures distribution of approved/revised QAPPs to TSSWCB participants. Responsible for verifying that the QAPP is followed by project participants. Monitors implementation of corrective actions. Coordinates or conducts audits of field and laboratory systems and procedures. Determines that the project meets the requirements for planning, quality assessment (QA), quality control (QC), and reporting under the TSSWCB Total Maximum Daily Load Program.

TWRI - Texas Water Resources Institute (TWRI), College Station, Texas. Responsible for development of data quality objectives (DQOs) and a QAPP.

Bill Harris, Project Lead

The TWRI Project Lead is responsible for ensuring that tasks and other requirements in the contract are executed on time and with the QA/QC requirements in the system as defined by the contract and in the project QAPP; assessing the quality of subcontractor/participant work; and submitting accurate and timely deliverables to the TSSWCB Project Manager.

Lucas Gregory, Quality Assurance Officer

Responsible for determining that the QAPP meets the requirements for planning, quality control, and quality assessment. Conducts audits of field and laboratory

systems and procedures. Responsible for maintaining the official, approved QAPP, as well as conducting Quality Assurance audits in conjunction with TSSWCB personnel.

Allen Berthold, Project Manager

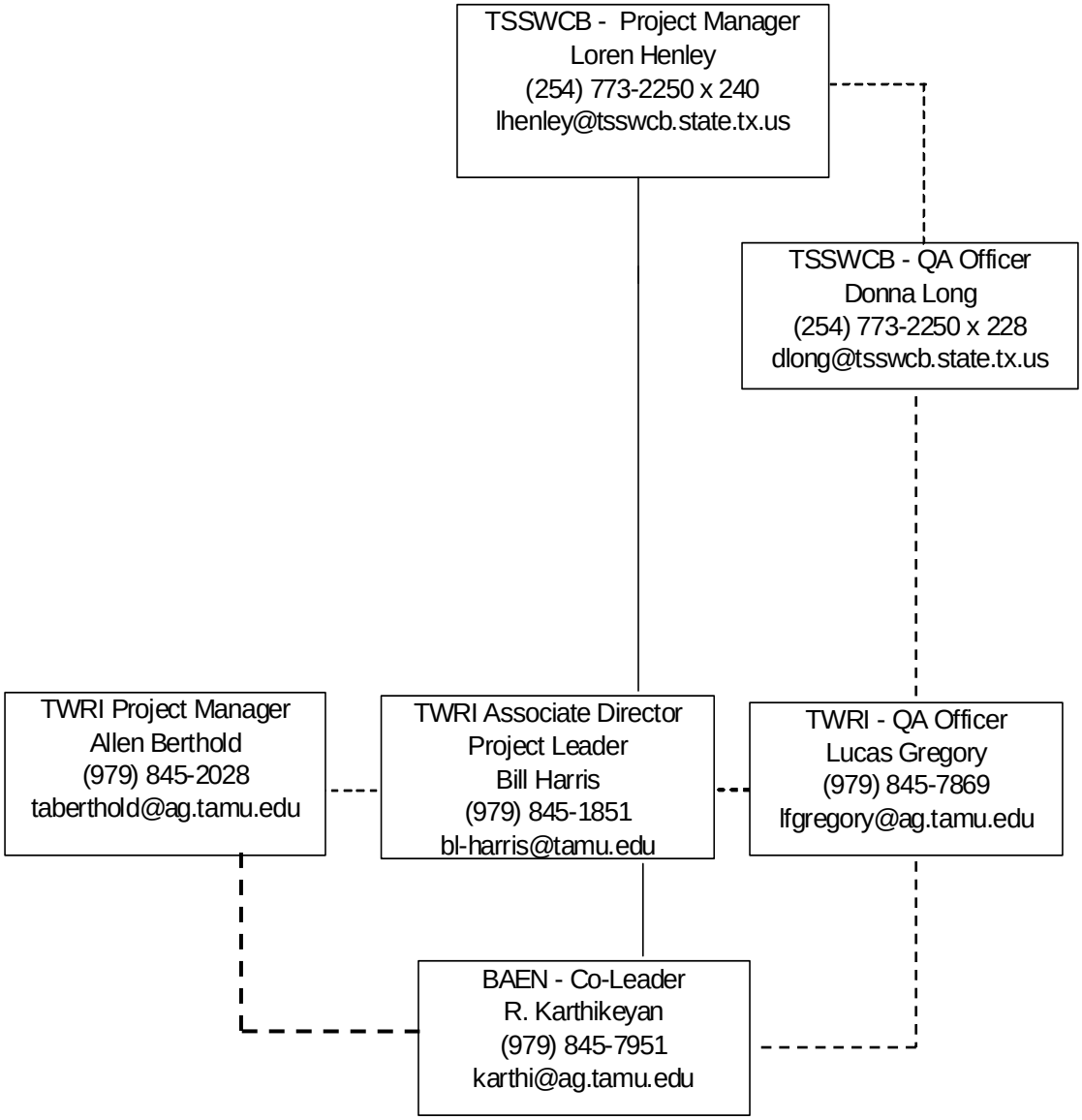
Responsible for ensuring the timely completion of project deliverables, fiscal oversight and project reporting.

BAEN – Department of Biological and Agricultural Engineering, Texas A&M University, College Station, Texas. Responsible for modeling activities associated with the Spatially Explicit Load Enrichment Calibration Tool (SELECT) and Load Duration Curve (LDC) development.

R. Karthikeyan, Assistant Professor, Biological and Agricultural Engineering

Responsible for performing LDC analysis and SELECT modeling. Responsible for assisting in the development of a GIS inventory of the selected project watersheds and designing the watershed source survey.

Figure A4-1. Project Organization Chart
Dashed lines indicate communication only



Section A5: Problem Definition/Background

The central watershed of the Brazos River consists of one classified water body, the Brazos River above Navasota River (Segment 1242), and a number of unclassified waterbodies on tributary systems. This segment extends from the Lake Brazos Dam in Waco 183 miles downstream to its confluence with the Navasota River southeast of College Station and its watershed encompasses approximately 2,705 mi^2. With the exception of the Waco and Bryan/College Station urban areas, land use in the watershed is generally agricultural with a few large industrial facilities and quarries.

In 2002, a water quality data analysis determined that eight unclassified water bodies within the central watershed had bacteria concentrations that exceed state water quality standards for contact recreation. As a result, these waterbodies were placed on the *Texas §303(d) List of Impaired Waters*. Three additional unclassified segments were added to the *2006 §303(d) List* bringing the total number of water quality impairments (bacteria) on segment 1242 to eleven.

Of those waterbodies impaired for bacteria, five are located within a very close proximity of each other in Robertson County and share similar land use and water quality characteristics. In addition, they are all tributaries to the Little Brazos River (Segment 1242E). The five waterbodies in this project's study area are Campbells Creek (Segment 1242I), Mud Creek (Segment 1242K), Pin Oak Creek (Segment 1242L), Spring Creek (Segment 1242M), and Walnut Creek (Segment 1242O). The study area encompasses 327 mi^2, almost entirely within Robertson County. The land use in the area is primarily agricultural (range and pasture land with mixed areas of cultivated cropland) with several small communities.

The *2006 §303(d) List* identifies all five segments in the study area as Category 5c, meaning that the waterbody does not meet applicable water quality standards for one or more designated uses by one or more pollutants and that additional data and information will be collected before a TMDL is scheduled.

The Texas Commission Environmental on Environmental Quality (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.

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 for the five segments in the study area. Through this and associated projects, the TSSWCB, TWRI and BAEN 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.

Section A6: Project Goals and Task Description

The goals of this project are to assess contact recreation use impairments and support watershed planning/TMDL development efforts for five tributaries of the Little Brazos River by developing a comprehensive GIS inventory and conducting a watershed source survey, and analyzing water quality data using Load Duration Curves (LDC) and spatially explicit modeling.

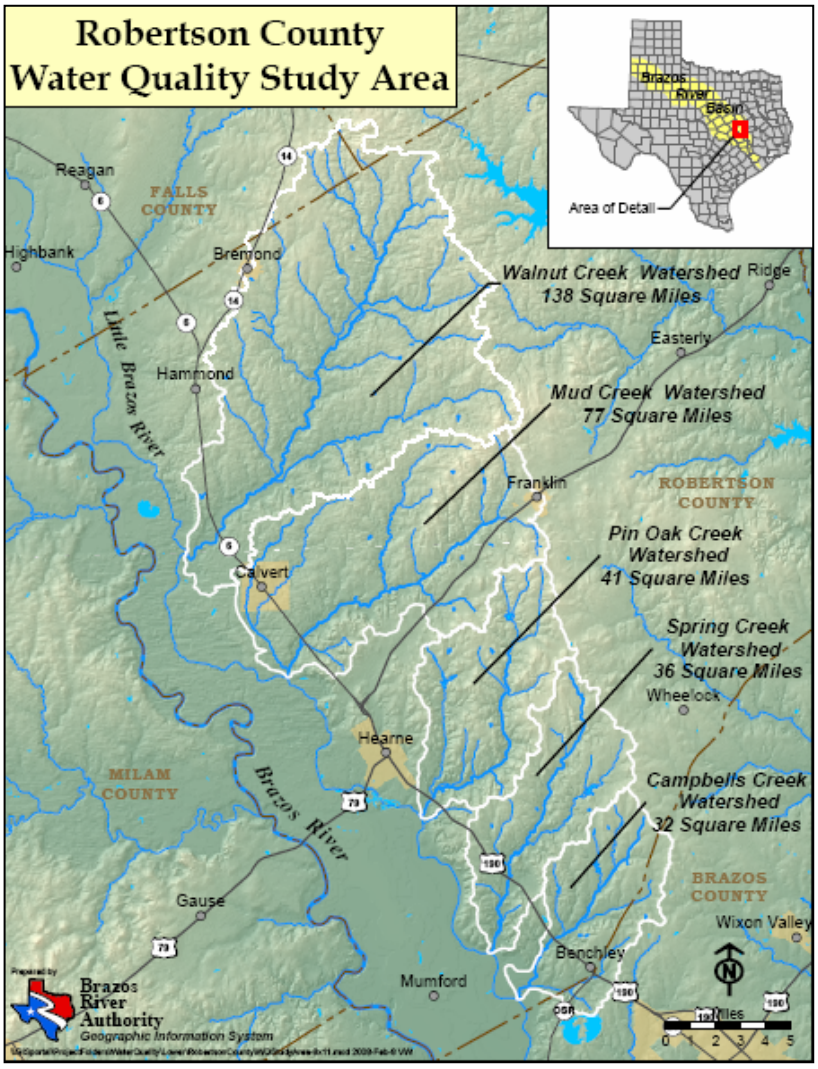


Figure A6-1. Walnut Creek, Mud Creek, Pin Oak Creek, Spring Creek and Campbells Creek Watersheds.

Task 1: Project Administration

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 provided to all project partners. (Start Date: Month 1; Completion Date: Month 24)

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 24)

Subtask 1.3: TWRI and BAEN will participate in coordination meetings or conference calls 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 TSSWCB project 08-54, *Assessment of Contact Recreation Use Impairments and Watershed Planning for Five Tributaries of the Little Brazos River*, will be especially critical to achieve project goals. (Start Date: Month 1; Completion Date: Month 24)

Subtask 1.4: In order to communicate project goals, activities, results and accomplishments to affected parties, TWRI and BAEN will participate in public stakeholder meetings coordinated and hosted by the Brazos River Authority (BRA) as needed. At a minimum, public stakeholder meetings shall consist of an organizational/kick-off meeting (month 3), a source survey design meeting (Subtask 3.3) (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 24)

Deliverables

- Quarterly Progress Reports in electronic format
- Reimbursement Forms in either electronic or hard copy format

Task 2. Quality Assurance

Objective: To develop and implement DQOs and quality assurance/quality 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 Task 3 consistent with *EPA Requirements for Quality Assurance Project Plans (QA/R-5)* (May 2006) and the *TSSWCB Environmental Data Quality Management Plan* (August 2007). (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 24)

Deliverables

- QAPP for Task 3 approved by TSSWCB in both electronic and hard copy formats
- Approved revisions and amendments to QAPP

Task 3: Data Analysis and Watershed Modeling

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 3.1: BAEN will cooperate with BRA to develop a comprehensive GIS inventory for the study area through TSSWCB project 08-54. Data should include the most recent information available on land use, elevation, soils, stream networks, reservoirs, roads, municipalities and satellite imagery or aerial photography. Locations of surface water quality monitoring (SWQM) stations, United States Geological Survey (USGS) gages, public access points to the waterbodies, floodwater-retarding structures, wetlands, Texas pollutant discharge elimination system (TPDES) permittees (including wastewater treatment facilities (WWTFs), confined animal feeding operations (CAFOs) and municipal separate storm sewer systems (MS4s)), and subdivisions should also be included. Locations of possible bacteria sources, identified in the source survey (Subtask 3.3), should be incorporated. The cumulative impact of TSSWCB-certified WQMPs on the management of agricultural and silvicultural lands should be documented. (Start Date: Month 1; Completion Date: Month 3)

Subtask 3.2: TSSWCB, in coordination with the Spatial Sciences Laboratory (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 3.3: 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 BRA in designing a watershed source survey, to be conducted through TSSWCB project 08-54, that better characterizes the possible sources of bacteria loadings in the study area. (Start Date: Month 1; Completion Date: Month 4)

Subtask 3.4: BAEN, with assistance from BRA through TSSWCB project 08-54, will conduct a LDC analysis of all historic and existing bacteria (*E. coli*) 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 both EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs* and EPA's *Options for Expressing Daily Loads in TMDLs*. (Start Date: Month 1; Completion Date: Month 6)

Subtask 3.5: Using water quality monitoring data collected by BRA through TSSWCB project 08-54, BAEN, with assistance from BRA, will refine LDCs developed in subtask 3.4. LDCs will be used to determine bacteria load reductions needed to achieve water quality standards. (Start Date: Month 7; Completion Date: Month 21)

Subtask 3.6: BAEN, with assistance from BRA through TSSWCB project 08-54, will conduct watershed modeling for the study area. Utilizing information from the GIS inventory (Subtask 3.1), the source survey (Subtask 3.3), and water quality monitoring (TSSWCB project 08-54), and in combination with LDCs from Subtasks 3.4-3.5, BAEN will develop a spatially explicit potential bacterial load estimation using SELECT for each of the five watersheds in the study area. 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 21)

Deliverables

- Draft Technical Report detailing preliminary LDC analysis
- Technical Report detailing final LDC analysis
- Technical Report describing watershed modeling results

The purpose of this QAPP is to clearly delineate the QA policy, management structure, and procedures, which will be used to implement the QA requirements necessary to developing a comprehensive GIS inventory and conducting a watershed source survey, and analyzing data using Load Duration Curves and spatially explicit modeling under subtasks 3.1-3.6.

Table A6-1. Project Plan Milestones

Task	Project Milestones	Agency	Start	End
1.1	TWRI will prepare electronic quarterly progress reports 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 provided to all project partners.	TWRI	June 08	May 10
1.2	TWRI will perform accounting functions for project funds and will submit appropriate Reimbursement Forms to TSSWCB at least quarterly.	TWRI	June 08	May 10
1.3	TWRI and BAEN will participate in coordination meetings or conference calls 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 TSSWCB project 08-54, *Assessment of Contact Recreation Use Impairments and Watershed Planning for Five Tributaries of the Little Brazos River*, will be especially critical to achieve project goals.	TWRI	June 08	May 10
1.4	In order to communicate project goals, activities, results and accomplishments to affected parties, TWRI and BAEN 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 (Subtask 3.3) (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).	TWRI	June 08	May 10
2.1	TWRI will develop a QAPP for activities in Task 3 consistent with *EPA Requirements for Quality Assurance Project Plans (QA/R-5)* (May 2006) and the *TSSWCB Environmental Data Quality Management Plan* (August 2007).	TWRI	June 08	July 08
2.2	TWRI will submit revisions and necessary amendments to the QAPP as needed.	TWRI	Aug 08	May 10
3.1	BAEN will cooperate with BRA to develop a comprehensive GIS inventory for the study area through TSSWCB project 08-54. Data should include the most recent information available on land use, elevation, soils, stream networks, reservoirs, roads, 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. Locations of possible bacteria sources, identified in the source survey (Subtask 3.3), should be incorporated. The cumulative impact of TSSWCB-certified WQMPs on the management of agricultural and silvicultural lands should be documented.	BAEN	June 08	Aug 08
3.2	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*.	BAEN	June 08	Aug 08
3.3	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 BRA in designing a watershed source survey, to be conducted through TSSWCB project 08-54, that better characterizes the possible sources of bacteria loadings in the study area.	BAEN	June 08	Sept 08

Task	Project Milestones	Agency	Start	End
3.4	BAEN, with assistance from BRA through TSSWCB project 08-54, will conduct a 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 both EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs* and EPA's *Options for Expressing Daily Loads in TMDLs*.	BAEN	Aug 08	Nov 08
3.5	Using water quality monitoring data collected by BRA through TSSWCB project 08-54, BAEN, with assistance from BRA, will refine LDCs developed in subtask 3.4. LDCs will be used to determine bacteria load reductions needed to achieve water quality standards.	BAEN	Dec 08	Feb 10
3.6	BAEN, with assistance from BRA through TSSWCB project 08-54, will conduct watershed modeling for the study area. Utilizing information from the GIS inventory (Subtask 3.1), the source survey (Subtask 3.3), and water quality monitoring (TSSWCB project 08-54), and in combination with LDCs from Subtasks 3.4-3.5, BAEN will develop a spatially explicit load estimation using SELECT for each of the five watersheds in the study area. Modeling will be used to estimate loadings from various sources and to identify critical loading areas within the watersheds.	BAEN	Dec 08	Feb 10

Model descriptions

Statistical Models

- Spatially Explicit Load Enrichment Calculation Tool (SELECT)
- Load duration curve

Spatially Explicit Load Enrichment Calculation Tool (SELECT)

The Center for TMDL and Watershed Studies at Virginia Tech has been involved in TMDL development for bacteria impairments. The Center personnel developed a systematic process for source characterization that includes the following steps:

- inventorying bacterial sources (including livestock, wildlife, humans, and pets);
- distributing estimated loads to the land as a function of land use and source type; and
- generating bacterial load input parameters for watershed-scale simulation models.

This process provides a consistent approach that is necessary to develop comprehensive bacteria TMDLs. The Center personnel developed a software tool, the Bacteria Source Load Calculator (BSLC), to assist with the bacterial source characterization process and to automate the creation of input files for water quality modeling (Zeckoski, et al., 2005). But BSLC does not spatially reference the sources. A spatially-explicit tool, Spatially Explicit Load Enrichment Calculation Tool (SELECT) is being developed by Spatial Sciences Laboratory and Biological and Agricultural Engineering, TAMU to calculate contaminant-loads resulting from various sources within a watershed. SELECT spatially references the sources, and is being developed under ArcGIS 9 environment. SELECT will calculate and allocate pathogen loading to a stream from various sources within a watershed. All loads will

be spatially referenced. In order to allocate the *E. coli* load throughout the five selected watershed, estimations of the source contributions will be made. This in turn allows the sources and locations to be ranked according to their potential contribution for each watershed. The populations of agricultural animals, wildlife, and domestic pets will be calculated and distributed throughout each watershed according to appropriate land use. Furthermore, point sources such as Waste Water Treatment Plants will be identified and their contribution quantified based on flow and outflow concentration. Septic system contribution will also be estimated based on criteria including distance to a stream, soil type, failure rate, and age of system. Once the watershed profile is developed for each potential source, the information can be aggregated to the sub-watershed level to identify the top contributing areas in each of the five selected watersheds.

Load duration Curve

This is a simple and an effective first-step methodology to obtain data-based TMDLs (Cleland, 2003; Stiles, 2001). A duration curve is a graph that illustrates the percentage of time during which a given parameter's value is equaled or exceeded. For example, a flow duration curve (FDC) (Figure A6-2) uses the hydrograph of the observed stream flows to calculate and depict the percentage of time the flows are equaled or exceeded.

A load duration curve (LDC) (Figure A6-3), which is related to the FDC, shows the corresponding relationship between the contaminant loadings and stream flow conditions at the monitoring site. In this manner, it assists in determining patterns in pollution loading (point sources, non point sources, erosion, etc.) depending on the streamflow conditions. Based on the observed patterns, specific restoration plans can be implemented that target a particular kind of pollutant source. For example, if the pollutant loads exceed the allowable loads (see Figure A6-3) for low stream flow regimes, then the point sources such as waste water treatment plants and direct deposition sources (wildlife, livestock) should be targeted for the restoration plans. Another main advantage of the LDC method is that it can also be used to evaluate the current impairment as some percent of samples which exceed the standard, and therefore it allows for the rapid development of TMDLs (Stiles, 2001).

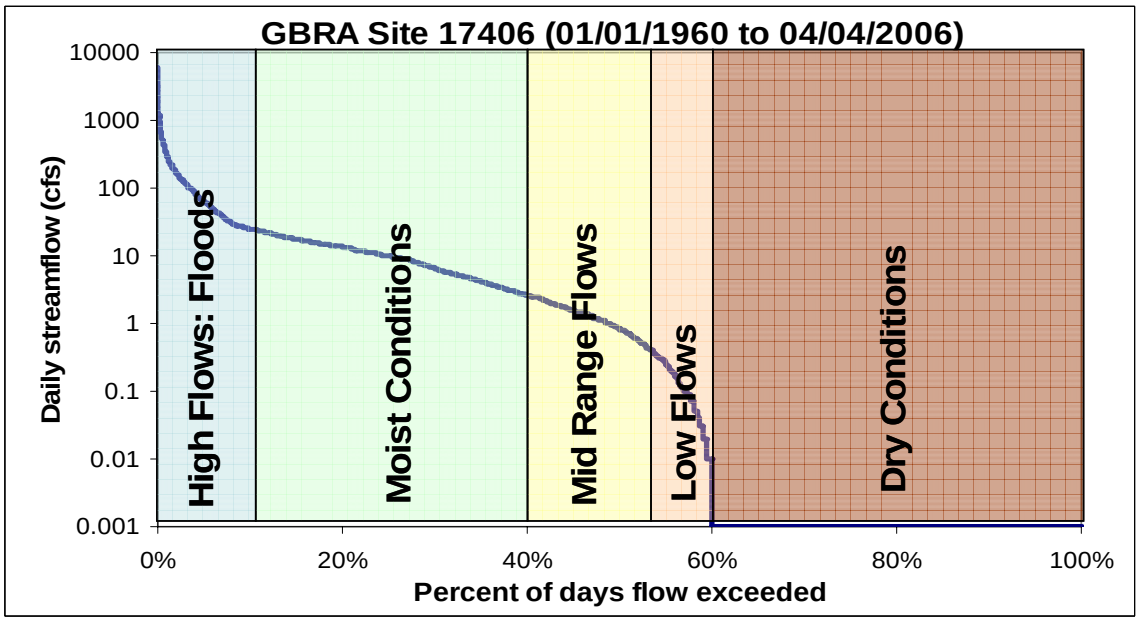


Figure A6-2 Flow Duration Curve (FDC) for streamflow conditions at GBRA monitoring station 17406 on Plum Creek, near Uhland, TX. The flow data at 17406 was obtained from the nearest USGS gage station 8172400, after adjusting for subwatershed aerial contribution during runoff events.

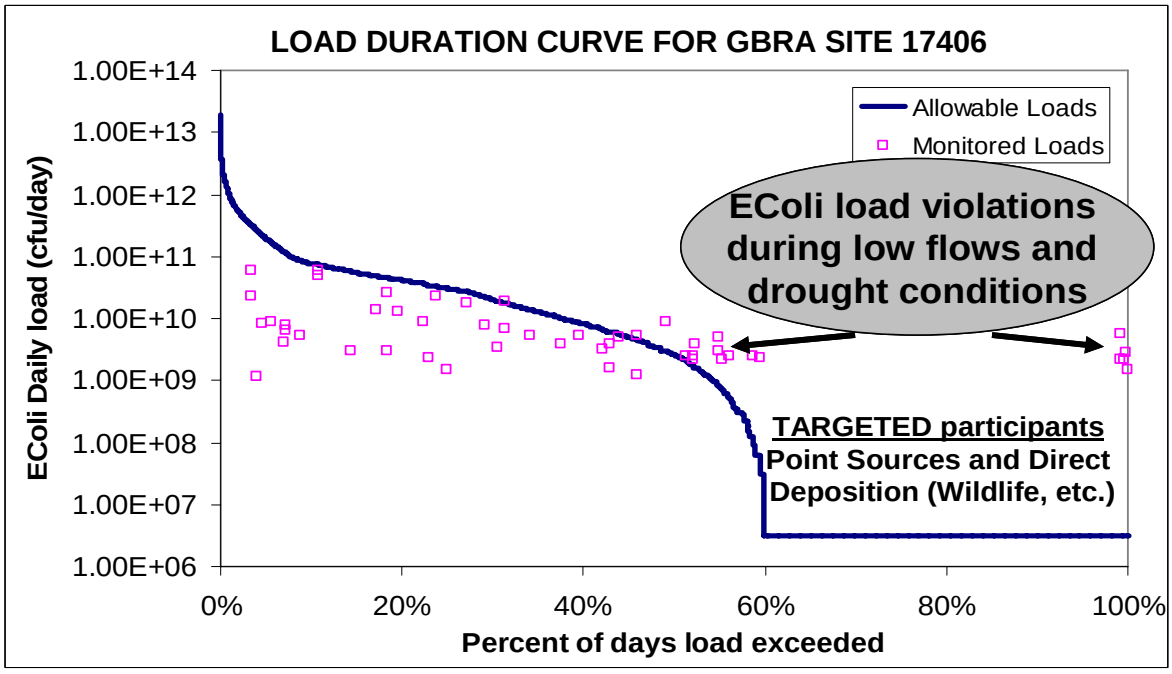


Figure A6-3 Load Duration Curve for *E. coli* at GBRA monitoring station 17406 on Plum Creek, near Uhland, TX. The flow data at 17406 was obtained from the nearest USGS gage station 8172400, after adjusting for subwatershed aerial contribution during runoff events.

Section A7: Quality Objectives and Criteria for Model Inputs / Outputs

Faculty in the Department of Biological and Agricultural Engineering at TAMU will conduct a phased modeling effort to develop pollutant source and loading information and estimates of needed. The objectives of the water quality modeling for this project are as follows:

1) Develop and obtain approval for a QAPP
2) Conduct efforts in conjunction with BRA to develop a comprehensive GIS inventory for the study area through TSSWCB project 08-54, *Assessment of Contact Recreation Use Impairments and Watershed Planning for Five Tributaries of the Little Brazos River*.
3) Conduct efforts in conjunction with BRA to design a watershed source survey, to be conducted through TSSWCB project 08-54, that better characterizes the possible sources of bacteria loadings in the study area.
4) Spatially characterize and rank sources of bacteria and within the watershed using SELECT, a spatially-explicit Geographic Information System (GIS) methodology. Divide the area into sub-watersheds and identify, quantify and rank pollutant loads from various sources, i.e. agriculture, urban/human, wildlife, and other sources for each of the five watersheds in the study area.
5) Develop two Load Duration Curves (LDC) to analyze the temporal trends in the observed water quantity and quality data for each of the watersheds. The first set of LDCs will be developed using currently existing data available from BRA; the second set of LDCs will be developed using data collected by BRA under TSSWCB project 08-54. Obtain an interpolated model to simulate the trends of the monitored data. Evaluate the violations and the required load-reductions for different flow-rate regimes (low, medium, and high flow) using LDC and interpolated model.

SELECT – this approach is being developed by SSL and Biological and Agricultural Engineering. It is similar to BSCL (Zeckoski, et al. 2005) in TMDL development. High quality spatial data (Landuse data developed under TSSWCB Project 08-52, SSURGO soils data, NHD, etc) will be processed and utilized in SELECT approach. Distributions for input parameters for SELECT will be created based on literature values and expert knowledge.

LDC – this approach has been utilized in several TMDL projects as an initial screening-tool to evaluate the actual temporal load trends in streams (Cleland, 2003; Stiles, 2001). In cases of violations, it is necessary to determine the required load-reduction in that region near the monitoring station. The load-reductions should be calculated for all flow-regimes of the stream. In order to do this continuous monitoring data will be simulated using the actual monitoring data by regression methods. Uncertainty of the model will be estimated via residual error analysis. The straight line passing through residual error plot should have a slope of zero.

Section A8: Special Training Requirements/Certification

All personnel involved in model calibration, validation, and development will have the appropriate education and training required to adequately perform their duties. No special certifications are required.

Section A9: Documentation and Records

All records, including modeler's notebooks and electronic files, will be archived by BAEN for at least five years. These records will document model testing, calibration, and evaluation and will include documentation of written rationale for selection of models, record of code verification (hand-calculation checks, comparison to other models), source of historical data, and source of new theory, calibration and sensitivity analyses results, and documentation of adjustments to parameter values due to calibration. Electronic data on the UNIX drive and the network server are backed up daily to a tape drive. In the event of a catastrophic systems failure, the tapes can be used to restore the data in less than one day's time. Data generated on the day of the failure may be lost, but can be reproduced from raw data in most cases.

TWRI's QAO will produce an annual quality assurance/quality control report, which will be kept on file at TWRI with copies distributed to individuals listed in section A3. Any items or areas identified as potential problems and any variations or supplements to QAPP procedures noted in the quality assurance/quality control report will be made known to pertinent project personnel and included in an update or amendment to the QAPP.

Quarterly progress reports disseminated to the individuals listed in section A3 will note activities conducted in connection with the water quality modeling project, items or areas identified as potential problems, and any variations or supplements to the QAPP. Final reports on the SELECT modeling analysis and the LDC analysis will be developed. Outcomes will be submitted to the established stakeholder group and utilized in future TMDL development.

Corrective Action Reports (CARs) will be utilized when necessary (Appendix A). CARs will be maintained in an accessible location for reference at TWRI and will be disseminated to the individuals listed in section A3. CARs resulting in any changes or variations from the QAPP will be made known to pertinent project personnel and documented in updates or amendments to the QAPP.

Section B1: Sampling Process Design (Experimental Design)

Not relevant.

Section B2: Sampling Method Requirements

Not relevant.

Section B3: Sample Handling and Custody Requirements

Not relevant.

Section B4: Analytical Methods

Not relevant.

Section B5: Quality Control Requirements

Not relevant.

Section B6: Equipment Testing, Inspection, & Maintenance Requirements

Not relevant.

Section B7: Instrument Calibration and Frequency

Not Relevant.

Section B8: Inspection/Acceptance Requirements for Supplies and Consumables

Not relevant.

Section B9: Data Acquisition Requirements (Non-direct Measurements)

The BRA is a partner in the Clean Rivers Program for the state of Texas. As such, they collect data on a regular basis for routine water quality assessment as part of the state's mandate for Clean Water Act (CWA) §305(b) – Water Quality Inventory Report. These data also are used by Texas for consideration of water bodies to be added to their list of impaired water body segments, as described in CWA §303(d). Additional data obtained from the TCEQ are from the SWQMIS database.

All data used in the modeling procedures for this project are collected in accordance with approved quality assurance measures under the state's Clean Rivers Program, TCEQ, Texas Water Development Board, USDA, National Weather Service, or USGS. Future data collection carried out by BRA and supported by TSSWCB's TMDL Program funding (TSSWCB Project 08-54) will be incorporated into the modeling process as the data become available. Those data will be collected under a separate QAPP for TSSWCB Project 08-54.

GIS data to be used are 2004 and 2005 NAIP (National Agricultural Imagery Program) aerial photos, SSURGO (Soil Survey Geographic) and CBMS (Computer Based Mapping System) soils, USGS NLCD (National Land Cover Dataset) landuse, National Hydrography Dataset (NHD), Census data (2000), Agricultural Census data from USDA-NASS (2002), and the USGS 30-meter resolution digital elevation model (DEM). Depending on the availability of the GIS layers from different data sources, efforts will be made to update the spatial data to the most recent year.

Because most historical data is of known and acceptable quality and were collected and analyzed in a manner comparable and consistent with needs for this project, no limitations will be placed on their use, except where known deviations have occurred.

Section B10: Data Management

Systems Design

BAEN uses laptop personal computers and desktop personal computers. The computers run Windows XP or Vista operating system. Softwares include Microsoft® Word, Microsoft® Excel, Microsoft® Access, and a Statistical Analysis System database management system run through Windows XP operating system. All GIS analysis will be performed using ArcGIS 9x.

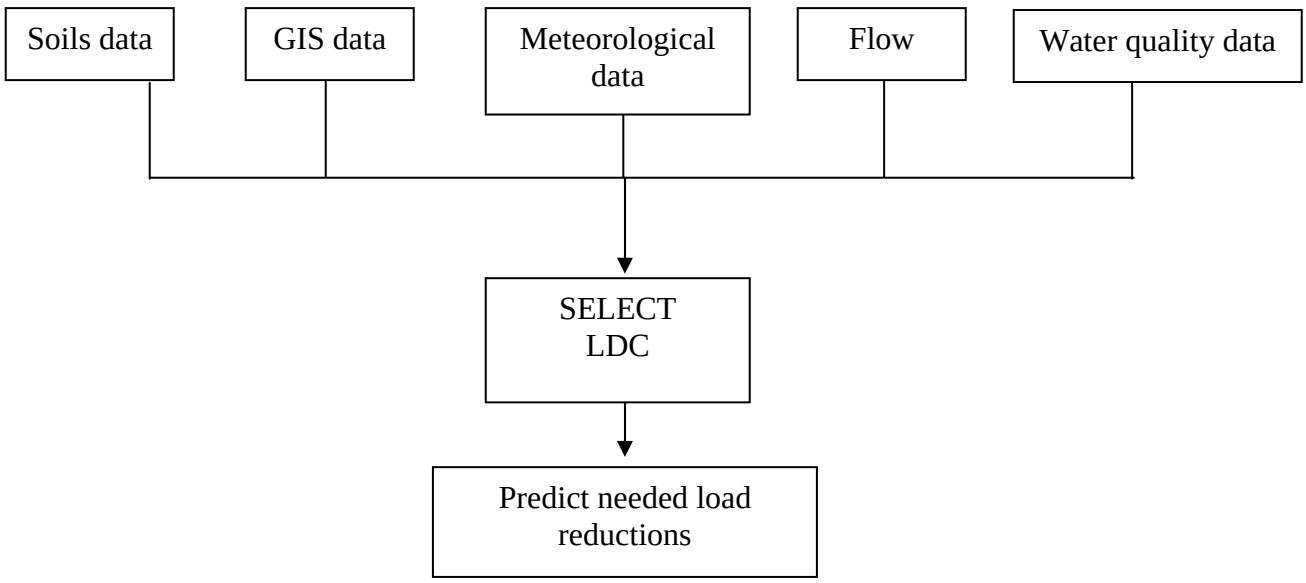
Backup and Disaster Recovery

The personal computer drives are backed up on a weekly basis to a tape drive and on a monthly basis to an external hard drive for storage in a secure secondary location. In the event of a catastrophic systems failure, the tapes can be used to restore the data in less than one day's time. Data generated on the day of the failure may be lost, but can be reproduced from raw data in most cases.

Archives and Data Retention

Original data recorded on paper files are stored for at least five years. Data in electronic format are stored on tape drives in a climate controlled, fire-resistant storage area on either the Texas A&M University campus.

Figure B10-1. Information Dissemination Diagram



Section C1: Assessments and Response Actions

Table C1.1 presents the types of assessments and response actions for activities applicable to the QAPP.

Table C1.1 Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party(ies)	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	TWRI, BAEN	Monitoring of the project status and records to ensure requirements are being fulfilled. Monitoring and review of performance and data quality.	Report to project lead in Quarterly Report
Technical Systems Audit	Minimum of one during the course of this project.	TSSWCB QAO	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP. Facility review and data management as they relate to the project.	30 days to respond in writing to the TSSWCB QAO to address corrective actions

In addition to those listed above, the following assessment and response actions will be applied to modeling activities. As described in Section B9 (Non-direct Measurements), modeling staff will evaluate data to be used in calibration and as model input according to criteria discussed in Section A7 (Quality Objectives and Criteria for Model Inputs/Outputs Data) and will follow-up with the various data sources on any concerns that may arise.

The model calibration procedure is discussed in Section D2 (Validation and Verification Methods), and criteria for acceptable outcomes are provided in Section A7 (Quality Objectives and Criteria for Model Inputs/Outputs).

Results will be reported to the project QAO in the format provided in Section A9. If agreement is not achieved between the calibration standards and the predictive values, corrective action will be taken by the Project Manager to assure that the correct files are read appropriately and the test is repeated to document compliance. Corrective action is required to ensure that conditions adverse to quality data are identified promptly and corrected as soon as possible. Corrective actions include identification of root causes of problems and successful correction of identified problem. CARs (Appendix A) will be filled out to document the problems and the remedial action taken. Copies of CARs will be included with the TWRI's annual Quality Assurance report. The Quality Assurance report will discuss any problems encountered and solutions made. These QA reports are the responsibility of the QAO and the Project Manager and will be disseminated to individuals listed in section A3. If the predicted value cannot be brought within calibration standards, the QAO will work with TSSWCB to arrive at an agreeable compromise.

Software requirements, software design, or code are examined to detect faults, programming errors, violations of development standards, or other problems. All errors found are recorded at the time of inspection, with later verification that all errors found have been successfully corrected. Software used to compute model predictions are tested to assess its performance relative to specific response times, computer processing usage, run time, convergence to solution, stability of the solution algorithms, the absence of terminal failures, and other quantitative aspects of computer operation.

Checks are made to ensure that the computer code for each module is computing module outputs accurately and within any specific time constraints. The full model framework is tested as the ultimate level of integration testing to verify that all project-specific requirements have been implemented as intended. All testing performed on the original version of the module or linked modules is repeated to detect new “bugs” introduced by changes made in the code to correct a model.

Section C2: Reports to Management

Quarterly progress reports developed by the Project Manager will note activities conducted in connection with the water quality modeling project, items or areas identified as potential problems, and any variations or supplements to the QAPP. CAR forms will be utilized when necessary (Appendix A). CARs will be maintained in an accessible location for reference at TWRI and disseminated to individuals listed in section A3. CARs that result in any changes or variations from the QAPP will be made known to pertinent project personnel and documented in an update or amendment to the QAPP.

If the procedures and guidelines established in this QAPP are not successful, corrective action is required to ensure that conditions adverse to quality data are identified promptly and corrected as soon as possible. Corrective actions include identification of root causes of problems and successful correction of identified problem. CARs will be filled out to document the problems and the remedial action taken. Copies of CARs will be included with the TWRI's annual Quality Assurance report. The Quality Assurance report will discuss any problems encountered and solutions made. These QA reports are the responsibility of the QAO and the Project Manager and will be disseminated to individuals listed in section A3.

Section D1: Data Review, Validation and Verification

All data obtained will be reviewed, validated, and verified against the data quality objects outlined in Section A7, "Quality Objectives and Criteria for Model Inputs / Outputs." Only those data that are supported by appropriate quality control will be considered acceptable for use.

The procedures for verification and validation are described in Section D2, below. The TAMU Biological and Agricultural Engineering Project Co-Leader is responsible for ensuring that data are properly reviewed, verified, and submitted in the required format for the project database. Finally, the TWRI QAO is responsible for validating that all data collected meet the DQOs of the project and are suitable for reporting.

Section D2: Validation Methods

There is no validation and calibration for the SELECT model or LDC as they are data processors.

Section D3: Reconciliation with User Requirements

The modeling framework developed for this project will be used to evaluate water quality issues in the five tributaries of the Little Brazos River Watershed. It will provide information pertaining to watershed characteristics and to the prediction of possible pollution, the sources of this pollution and will provide critical information to assist in identifying management practices to prevent pollution loading in area streams. This, in turn, will be useful for later TMDL development.

The final data will be reviewed to ensure that it meets the requirements as described in this QAPP. CARs will be initiated in cases where invalid or incorrect data have been detected. Data that have been reviewed, verified, and validated will be summarized for their ability to meet the DQOs of the project and the informational needs of water quality agency decision-makers. These summaries, along with a description of any limitations on data use, will be included in the final report.

References

Cleland, B. 2003. TMDL Development from the "bottom up" – Part III: Duration Curves and wet-weather assessments. America's Clean Water Foundation, Washington, DC.

Stiles, T.C., 2001. A simple method to define bacteria TMDLs in Kansas. KS Dept. of Health and Environment. Topeka, KS. http://www.wef.org/pdffiles/TMDL/Stiles.pdf (last accessed, 9/12/2006).

Zeckoski, R.W., B.L. Benham, S.B. Shan, M.L. Wolfe, K.M. Brannan, M. Al-Smadi, T.A. Dillaha, S. Mostaghimi, and C.D. Heatwole, 2005. BSLC: A tool for bacteria source characterization for watershed management. Transactions of ASAE, 21(5): 879-889.

Corrective Action Report
SOP-QA-001
CAR #:_____

Date:_____ Area/Location:_____

Reported by:_____ Activity:_____

State the nature of the problem, nonconformance or out-of-control situation:
_____
_____
_____
_____
_____

Possible causes:
_____
_____
_____

Recommended Corrective Actions:
_____
_____
_____

CAR routed to:_____
Received by:_____

Corrective Actions taken:
_____
_____
_____
_____

Has problem been corrected?: YES NO

Immediate Supervisor:_____

Program Manager:_____

TWRI Quality Assurance Officer:_____

TSSWCB Quality Assurance Officer:_____