

**Assessment of Springtime Contributions of Nutrients and Bacteria
to the North Bosque River Watershed
(Project 04-12)**

**Revision No. 1
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**Clean Water Act Section 319(h)
Nonpoint Source Pollution Control Program Project
in cooperation with
Texas State Soil and Water Conservation Board
and
U.S. Environmental Protection Agency**

Effective Period: April 2008-August 2008

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A1 APPROVAL PAGE

Title: Assessment of Springtime Contributions of Nutrients and Bacteria to the North Bosque River Watershed (Project 04-12)

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LIST OF ACRONYMS

AWRL	Ambient Water Reporting Limit
BMP	Best Management Practice
CAR	Corrective Action Report
COC	Chain-of-Custody
CWA	Clean Water Act
DOC	Demonstration of Capability
DQO	Data Quality Objective
EPA	US Environmental Protection Agency
FY	Fiscal Year
GM	General Maintenance
LCS	Laboratory Control Sample (formerly Laboratory Control Standard)
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
LOD	Limit of Detection (formerly Method Detection Limit or MDL)
LOQ	Limit of Quantitation (formerly Reporting Limit)
MDL	Method Detection Limit
MS	Matrix Spike
NPS	Nonpoint Source
NRCS	USDA Natural Resources Conservation Service
NWS	National Weather Service
PM	Project Manager
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAM	Quality Assurance Manual
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RL	Reporting Limit
SOP	Standard Operating Procedure
SWCD	Soil and Water Conservation District
SWQM	Surface Water Quality Monitoring
TIAER	Texas Institute for Applied Environmental Research
TMDL	Total Maximum Daily Load
TCEQ	Texas Commission on Environmental Quality
TSSWCB	Texas State Soil and Water Conservation Board
USGS	United States Geological Survey
WQMP	Water Quality Management Plan

A3 DISTRIBUTION LIST

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The TIAER will provide copies of this project plan and any amendments or appendices of this plan to each person on this list. The TIAER will document distribution of the plan and any amendments and appendices, maintain this documentation as part of the project's quality assurance records, and will be available for review.

A4 PROJECT/TASK ORGANIZATION

Description of Responsibilities

TSSWCB

Loren Henley

TSSWCB Project Manager

Maintains a thorough knowledge of work activities, commitments, deliverables, and time frames associated with project. Develops lines of communication and working relationships between TIAER, TSSWCB, and EPA. Tracks deliverables to ensure that 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 the TIAER. Notifies the TSSWCB QAO of particular circumstances that may adversely affect the quality of data derived from the collection and analysis of samples. 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 and USEPA participants. Responsible for verifying that the QAPP is followed by project participants. Determines that the project meets the requirements for planning, quality assessment (QA), quality control (QC), and reporting under the CWA Section 319 program. Monitors implementation of corrective actions. Coordinates or conducts audits of field and laboratory systems and procedures.

TIAER

Anne McFarland

TIAER Project Manager

Responsible for ensuring tasks and other requirements in the contract are executed on time and are of acceptable quality. Monitors and assesses the quality of work. Coordinates attendance at conference calls, training, meetings, and related project activities with TSSWCB. Responsible for writing and maintaining the QAPP in cooperation with the TIAER QAO. Responsible for verifying the QAPP is followed and the project is producing data of known and acceptable quality. Notifies the TSSWCB project manager of particular circumstances that may adversely affect the quality of data derived from the collection and analysis of samples. Enforces corrective action. Responsible for developing and providing TSSWCB with project final report.

Nancy Easterling

TIAER Quality Assurance Officer

Responsible for coordinating development and implementation of the QA program. Participates in the planning, development, approval, implementation, and maintenance of the QAPP. Responsible for maintaining records of QAPP distribution, including appendices and amendments. Responsible for identifying, receiving, and maintaining project quality assurance records. Responsible for coordinating with the TSSWCB QAO to resolve QA-related issues. Notifies the TIAER Project Manager and TSSWCB Project Manager of particular circumstances that may adversely affect the quality of data. Responsible for validation and verification of all data collected according to Table A7.1 and QC specifications and acquired data procedures after each task is performed. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Develops, facilitates, and conducts monitoring systems audits.

Tim Jones

TIAER Field Supervisor

Responsible for supervising all aspects of the sampling and measurement of surface waters and other parameters in the field. Responsible for the acquisition of water samples and field data measurements in a timely manner that meet the quality objectives specified in Section A7 (Table A7.1), as well as the requirements of Sections B1 through B8. Responsible for field scheduling, staffing, and ensuring that staff are appropriately trained as specified in Sections A6 and A8.

Mark Murphy

Laboratory Manager

Responsible for supervision of laboratory personnel involved in generating analytical data for this project. Responsible for ensuring that laboratory personnel involved in generating analytical data have adequate training and a thorough knowledge of the QAPP and all SOPs specific to the analyses or task performed and/or supervised. Responsible for oversight of all operations, ensuring that all QA/QC requirements are met, and documentation related to the analysis is completely and accurately reported. Enforces corrective action, as required. Develops and facilitates monitoring systems audits.

Dianne Swanson

Laboratory QAO

Monitors the implementation of the QAM and the QAPP within the laboratory to ensure complete compliance with QA objectives as defined by the contract and in the QAPP. Conducts internal audits to identify potential problems and ensure compliance with written SOPs. Responsible for supervising and verifying all aspects of the QA/QC in the laboratory. Performs validation and verification of data before data are evaluated to assess project objectives. Insures that all QA reviews are conducted in a timely manner from real-time review at the bench during analysis to final pass-off of data to the QA officer. Conducts laboratory inspections.

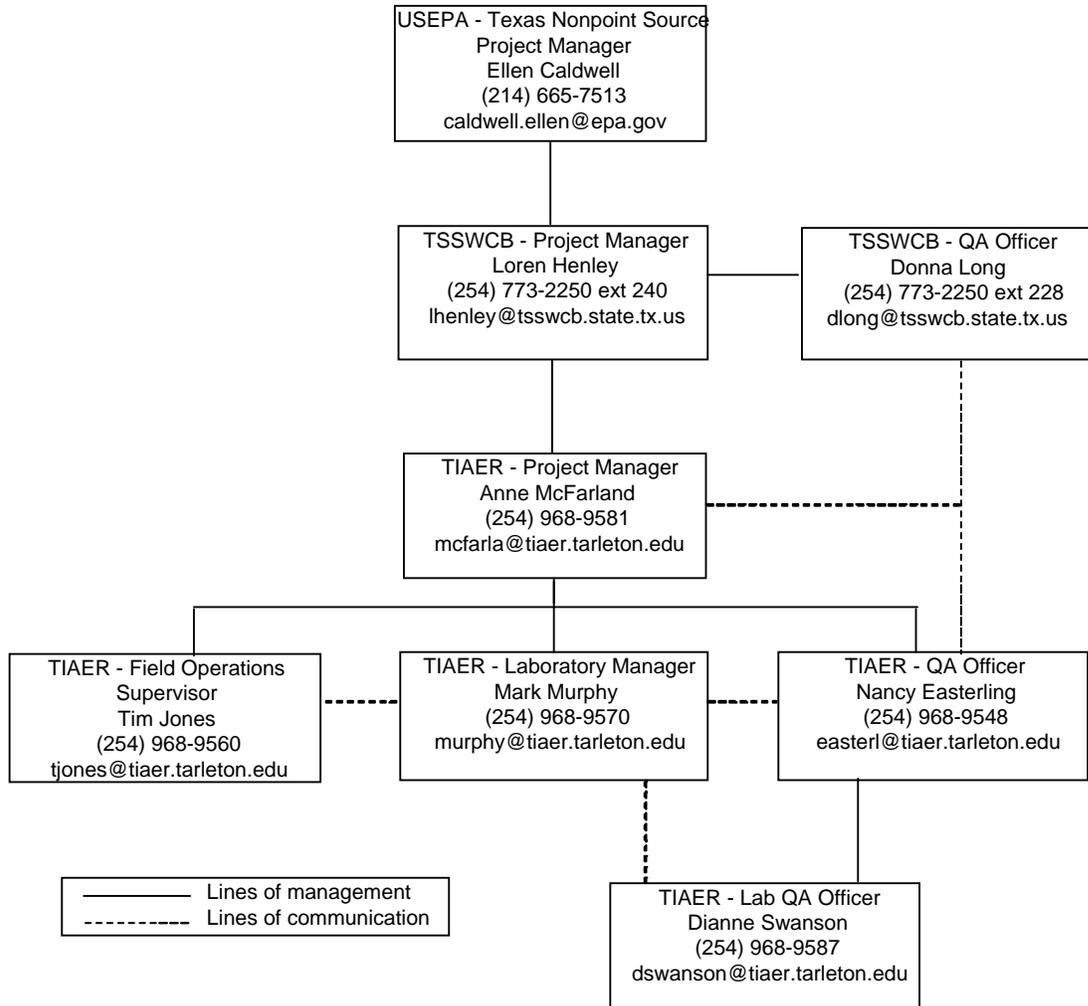
U.S. EPA Region 6

Ellen Caldwell EPA Project Officer

Responsible for managing the CWA Section 319 funded grant on the behalf on EPA. Assists the TSSWCB in approving projects that are consistent with the management goals designated under the State's NPS management plan and meet federal guidance. Coordinates the review of project work plans, QAPPs, draft deliverables, and works with the TSSWCB in making these items approvable. Meets with the State at least semi-annually to evaluate the progress of each project and when conditions permit, participate in a site visit on the project. Fosters communication within EPA by updating management and others, both verbally and in writing, on the progress of the State's program and on other issues as they arise. Assists the regional NPS coordinator in tracking a State's annual progress in its management of the NPS program. Assists in grant close-out procedures ensuring all deliverables have been satisfied prior to closing a grant.

PROJECT ORGANIZATION CHART

Figure A4.1. Project Organization Chart - Lines of Communication.



A5 PROBLEM DEFINITION/BACKGROUND

The North Bosque River watershed encompasses approximately 3,140 square kilometers (1,210 square miles) in north central Texas and includes two classified stream segments (1226 and 1255). The 1996 State of Texas Water Quality Inventory indicated that nonpoint source loadings associated with elevated nutrient and fecal coliform levels were the most serious threat to meeting designated uses within segments 1226 and 1225. In 1998, segments 1226 and 1255 were included in the Clean Water Act Section 303(d) list for Texas as impaired water bodies and scheduled for development of total maximum daily loads (TMDLs). These two segments were listed under narrative water quality criteria related to nutrients and aquatic plant growth with concentrated animal feeding operations identified as the major nonpoint source of nutrients. In February 2001, the Texas Commission on Environmental Quality (TCEQ) adopted a TMDL for soluble reactive phosphorus in segments 1226 and 1255 that was approved by EPA in December 2001. This TMDL requires about a 50 percent reduction in loading and concentration of soluble reactive phosphorus, depending on the location along the river. Soluble reactive phosphorus was identified as the nutrient limiting algal growth in the North Bosque River, and, thus, a reduction in soluble reactive phosphorus should reduce algal abundance in the North Bosque River. The 2004 Texas Water Quality Inventory assessment prepared by the TCEQ pursuant to the Clean Water Act Section 305(b) continues to indicate impairments associated with bacteria and concerns associated with nutrient enrichment and algal growth on stream segments in the North Bosque River watershed. Although the TMDL process did not directly consider bacteria with regard to supporting the use of contact recreation, many of the control practices for phosphorus outlined in the Implementation Plan should also help reduce bacterial loadings to the North Bosque River.

The basis for this project is to provide assessment activities in the North Bosque River watershed to support the Texas State Soil and Water Conservation Board (TSSWCB) and local Soil and Water Conservation Districts (SWCDs) in efforts to reduce agricultural nonpoint source (NPS) pollution loadings. This project represents a continuation of an effort outlined in the TMDL Implementation Plan using a microwatershed approach to target water quality monitoring and agricultural producer assistance to help reduce phosphorus loadings to the North Bosque River. This specific effort focuses on monitoring microwatersheds to target areas needing BMP implementation associated with springtime manure and fertilizer applications. Manure and fertilizer are often applied in the spring to provide nutrients for crop growth and development.

A6 PROJECT/TASK DESCRIPTION

The primary focus of this 319(h) project is to assess the preexisting and post-TMDL implementation effects at the microwatershed level. A secondary focus is to provide TSSWCB and local SWCDs with support in targeting areas needing water quality improvement.

In this project, TIAER will provide continued assessment activities at 18 microwatershed sites within the North Bosque River (Figure 1). The monitoring effort will be a continuation of a current 319 project (FY01-17, Extending TMDL Efforts in the North Bosque River Watershed) that ends in March 2008. The proposed project will extend monitoring of microwatershed sites through at least June 2008 to allow monitoring of spring and early summer nonpoint source contributions. The report for this project will focus specifically on improvements in water quality associated with spring and early summer runoff events pre- and post-TMDL implementation, while the focus of FY01-17 report will more broadly assess step-trends in water quality using year-round base and storm event data.

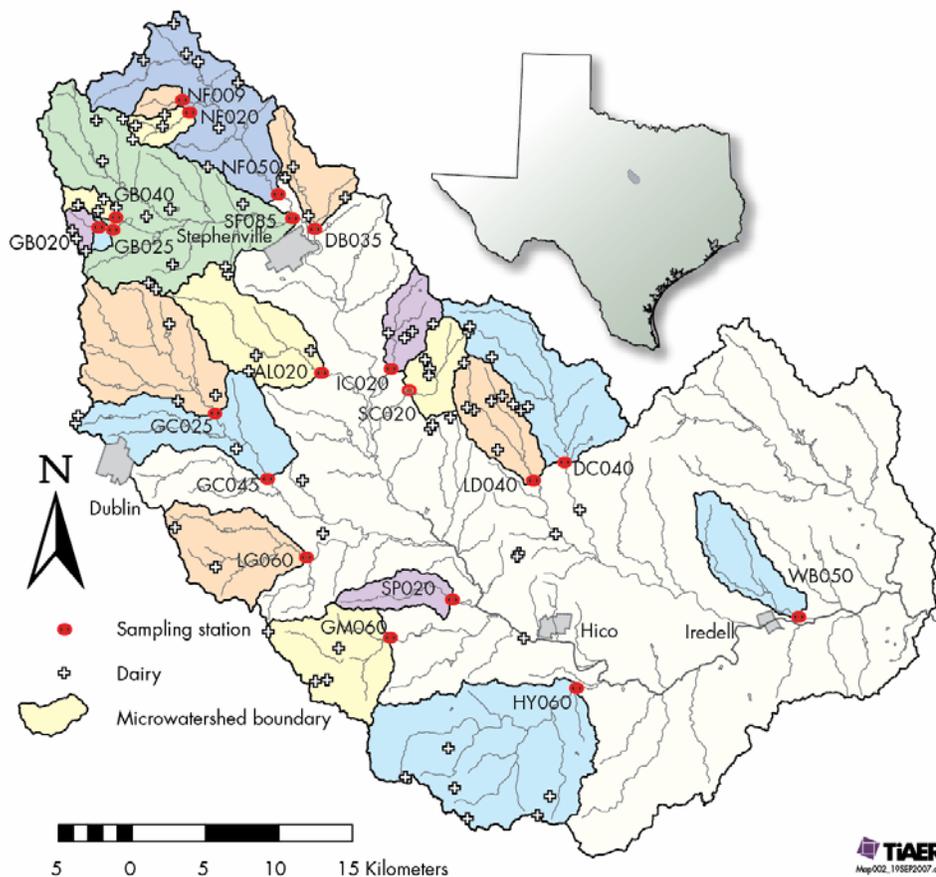


Figure 1. Location of project sampling sites. Sites GB025 and GB040 are included in the map but are no longer viable sampling locations but are included for reference.

Of note, the location of sampling sites under 01-17 has changed slightly from what was presented in the work plan for this current project (Appendix A). Sampling locations as currently under project 01-17 are indicated in Figure 1. The change from the original work plan for 04-12 is that sites GB025 and GB040 are no longer viable sampling locations. Sites GC045 and WB050 have been added to the monitoring network for project 01-17, and we plan to continue monitoring at GC045 and WB050 under the current project.

The monitoring effort will make use of numerous automated sampling systems in TIAER's possession that will be made available to this project. Historical or nondirect data obtained from other projects with approved EPA or the State of Texas QAPPs will also be used to supplement this project. The data collected for this project will be used to determine the reduction of NPS pollution associated with post-TMDL implementation efforts and provide data to inform TSSWCB of areas where focused reduction efforts are most needed.

Project-related tasks and schedule of deliverables are defined in Table A6.1.

Table A6.1. Schedule of Milestones.

Task	Project Milestones	Start	End
1	Quarterly Progress Reports	Aug. 25, 2004	Aug. 31, 2008
2	Approved QAPP	Dec. 1, 2007	March 31, 2008
3	QAPP Amendments	Apr. 1, 2008	Jun. 30, 2008
3	Monitoring Activities	Apr. 1, 2008	Jun. 30, 2008
4	Final Assessment Report	Jun. 1, 2008	Aug. 31, 2008

Constraints in meeting this work schedule include timely approval of the QAPP and unexpected extreme variability in weather conditions that preclude sampling. See Section B1 for sampling design and monitoring pertaining to this QAPP.

Revisions to the QAPP

Until the work described is completed, this QAPP shall be revised as necessary and reissued annually on the anniversary date, or revised and reissued within 120 days of significant changes, whichever is sooner. If the entire QAPP is current and valid, the document may be reissued by certifying that the plan is current and including a new copy of the signed approval page. The approved version of the QAPP shall remain in effect until revised versions have been approved, only if the revised version is submitted for approval before the approved version expires.

Expedited Changes

Expedited changes to the QAPP should be approved before implementation to reflect changes in project organization, tasks, schedules, objectives, and methods, address deficiencies and non-

conformance, improve operational efficiency and accommodate unique or unanticipated circumstances. Requests for expedited changes are directed from the TIAER Project Manager to the TSSWCB Project Manager in writing. They are effective immediately upon approval by the TSSWCB Project Manager and Quality Assurance Officer, or their designees, and the EPA Project Manager.

Justifications, summaries, and details of expedited changes to the QAPP will be documented and distributed to all persons on the QAPP distribution list under the direction of the TIAER QAO. Expedited changes will be reviewed, approved, and incorporated into a revised QAPP during the annual revision process or within 120 days of the initial approval in cases of significant changes.

A7 QUALITY OBJECTIVES AND CRITERIA

The primary goal of this project is to obtain necessary water quality and streamflow data to allow assessment of the effectiveness of various best management practices (BMPs) and nutrient control activities that are either ongoing or scheduled for implementation in the North Bosque River watershed. A secondary goal is to help target areas where further assistance from TSSWCB might be needed to help meet TMDL reductions. A statistical analysis including non-direct and direct data will be used to determine significant ($\alpha = 0.10$) step trends using a before and after design at sites with long-term historical data as outlined in Section B9. At sites with shorter timeframes of monitoring, comparisons will be made to similar watersheds using a paired watershed analysis or other techniques, as determined appropriate, to relate watershed BMPs to improvements in water quality. Statistical evaluations will focus on orthophosphate-P as the primary parameter associated with the North Bosque River TMDLs. Statistical analyses will also be conducted on other consequential parameters, such as nitrogen forms, bacteria and suspended solids, to ensure that BMPs are not causing an unexpected increase in other pollutants. Non-direct data measurements are discussed in Section B9. Monitoring efforts and direct data collection will be conducted by TIAER. Quantitative and qualitative information regarding measurement of direct data needed to assess instream water quality improvements are provided below in Table A7.1.

Table A7.1 - Measurement Performance Specifications

Parameter	Units	Matrix	Method ^{1,2}	Parameter Code	AWRL	Limit of Quantitation (LOQ)	Recovery at LOQ Ck Std. (%)	Precision ³ LCS/LCSD (% RPD)	Bias (% Recovery of LCS)	Completeness (%)
Field Parameters										
pH	pH/ units	water	EPA 150.1 and TCEQ SOP, V1	00400	NA ⁴	NA	NA	NA	NA	90
DO, dissolved oxygen	mg/L	water	EPA 360.1 and TCEQ SOP, V1	00300	NA ⁴	NA	NA	NA	NA	90
Conductivity	µS/cm	water	EPA 120.1 and TCEQ SOP, V1	00094	NA ⁴	NA	NA	NA	NA	90
Temperature	°C	water	EPA 170.1 and TCEQ SOP V1	00010	NA ⁴	NA	NA	NA	NA	90
Flow	cfs	water	TCEQ SOP V1	00061	NA ⁴	NA	NA	NA	NA	90
Days since last precipitation	Days	water	TCEQ SOP V1	72053	NA ⁴	NA	NA	NA	NA	90
Flow severity	1 no flow, 2 low, 3 normal, 4 flood, 5 high, 6 dry	water	TCEQ SOP V1	01351	NA ⁴	NA	NA	NA	NA	90
Flow measurement method	1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler	water	TCEQ SOP V1	89835	NA ⁴	NA	NA	NA	NA	90

IParameter	Units	Matrix	Method ^{1,2}	Parameter Code	AWRL	Limit of Quantitation (LOQ)	Recovery at LOQ Ck Std. (%)	Precision ³ LCS/LCSD (% RPD)	Bias (% Recovery of LCS)	Completeness (%)
Laboratory Parameters										
TSS, total suspended solids	mg/L	water	EPA 160.2	00530	4	4	NA ⁵	20	80-120	90
NH ₃ -N, Ammonia-N, dissolved	mg/L	water	EPA 350.1, modified ⁶	00608	0.1	0.1	70-130	20	2 ₈₀₋₁₂₀	90
NO ₂ -N+NO ₃ -N, Nitrate/nitrite-N, dissolved	mg/L	water	EPA 353.2	00631	0.05	0.05	70-130	20	3 ₈₀₋₁₂₀	90
TKN, Total Kjeldahl Nitrogen	mg/L	water	EPA 351.2, modified ⁷	00625	0.20	0.20	70-130	20	80-120	90
PO ₄ -P, O-phosphate-P, field filtered <15 min.	mg/L	water	EPA 365.2	00671	0.04	0.005	70-130	20	80-120	90
PO ₄ -P, O-phosphate-P, Lab-filtered >15 min.	mg/L	water	EPA 365.2	70507	0.04	0.005	70-130	20	4 ₈₀₋₁₂₀	90
TP, Total phosphorus	mg/L	water	EPA 365.4, modified ⁷	00665	0.06	0.06	70-130	20	80-120	90
<i>E. coli</i> , IDEXX Colilert	MPN/100 mL	water	SM 9223-B Colilert	31699	1	1	NA	0.5 ⁸	NA	90

Footnotes:

- ¹ In case of equipment malfunction and resulting holding time issues, alternate back-up analytical methods include the following: EPA 350.2 for NH₃-N; EPA 351.1-4 (modified as per footnote 5) for TKN; EPA 300.0, EPA 352.1, EPA 353.1-3, and EPA 354.1 for NO₂-N+NO₃-N; EPA 300.0 and EPA 365.2 for PO₄-P, EPA 365.4 (modified as per footnote 6) for total P, and SM-9222D for *E. coli*. If an alternate method is necessitated, all QC, AWRLs, recovery, precision, and bias limits will be followed.
- ² For methods requiring filtration and/or acidification, samples collected by automated sampler will be filtered and acidified in the laboratory after aliquots have been composited. Additionally, if grab samples have too much sediment for field filtration, the samples will be filtered and acidified as soon as possible in the laboratory. Orthophosphate aliquots are not acidified.
- ³ Precision will be assessed using sample and sample duplicates, where a LCS is not appropriate. Precision results will not be used as acceptance criteria if values are below the practical quantitation limit.
- ⁴ Reporting to be consistent with TCEQ SWQM guidance and based on measurement capability.
- ⁵ Verification at the AWRL is not required for TSS.
- ⁶ Modification to the ammonia nitrogen procedure includes not distilling samples as per the original EPA 350.1 method. Comparison testing was conducted between distilled ammonia samples and samples that were not distilled. Results of the comparison will be made available to TSSWCB upon request.
- ⁷ Modification of the TKN method involves using copper sulfate as the catalyst instead of mercuric sulfate. A memorandum dated May 21, 1999, was sent from William Telliard, Director of EPA's Analytical Methods Staff, stating that EPA believes that it is acceptable to make the substitution as long as all method specified performance are met. Modification of the total phosphorus method involves using copper sulfate as the catalyst instead of mercuric sulfate. Documentation of TIAER's ability to achieve acceptable performance using the modification is kept by the TIAER analytical laboratory.
- ⁸ Based on range statistic as described in Standard Methods, 18th Edition, Section 9020-B, "QA/QC - Intralaboratory QC Guidelines." This criterion applies to bacteriological duplicates with concentrations >20 MPN/100 mL, which is the lower limit for acceptable counts, according to Standard Methods.

References for Table A7.1:

United States Environmental Protection Agency (USEPA) "Methods for Chemical Analysis of Water and Wastes," Manual #EPA-600/4-79-020.
American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF), "Standard Methods for the Examination of Water and Wastewater," 18th Edition, 1992.
TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, 2003 (RG-415).

Limit of Quantitation

The ambient water reporting limit (AWRL) set by TCEQ establishes the reporting specification at or below which data for a parameter will be reported for comparison with Texas Water Quality Standards. The AWRLs specified in Table A7.1 for each analyte should yield data acceptable for routine monitoring. The AWRL will be used as the limit of quantitation (LOQ) for all constituents but PO₄-P. A lower LOQ for PO₄-P will be used to keep in line with requirements of other projects within the Bosque River watershed and for comparison with historical monitoring data. The laboratory will meet two requirements in order to report meaningful results in evaluating the project's objectives:

- The laboratory's reporting limit for each analyte will be at or below the AWRL.
- The laboratory will demonstrate and document on an ongoing basis the laboratory's ability to quantitate at its reporting limits.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria are provided in Section B5.

Precision

Precision is a statistical measure of the variability of a measurement when a collection or an analysis is repeated and includes components of random error. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Laboratory precision is assessed by comparing replicate analyses of laboratory control standards in the sample matrix (e.g., deionized water) or sample/duplicate pairs in the case of bacterial analysis. Precision results are plotted on quality control charts that are based on historical data and used during evaluation of analytical performance. Performance specifications for laboratory control standard/laboratory control standard duplicate pairs are defined in Table A7.1. Field splits are used to assess the variability of sample handling, preservation, and storage, as well as the analytical process, and are prepared by splitting samples in the field. Control limits for field splits are defined in Section B5.

Bias

Bias is a statistical measurement of correctness and includes multiple components of systematic error. A measurement is considered unbiased when the value reported does not differ from the true value. Bias is verified through the analysis of laboratory control standards prepared with verified and known amounts of analytes and by calculating percent recovery. Results are plotted on quality control charts and used during evaluation of analytical performance. Project control limits for laboratory control standards are specified in Table. A7.1.

Representativeness

The data collected as routine grabs and storm samples will be considered representative of the target population or phenomenon to be studied. The representativeness of the data is dependent

on 1) the sampling locations, 2) the flow regime during sample collection 3) the number of years sampling is performed, and 4) the sampling procedures. Site selection and sampling of pertinent media (i.e., water) and use of only approved analytical methods will assure that the measurement data represent the population being studied at the site. Although data may be collected during varying regimes of weather and flow, data collection will be targeted toward both ambient conditions and storm events, representing water quality at high and low flow conditions. The goal for meeting total representation of the water body will be tempered by the funding available.

Comparability

Confidence in the comparability of data sets for this project is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP. Comparability is also guaranteed by reporting data in standard units, by using accepted rules for rounding figures, and by reporting data in a standard format as specified in Section B10 on Data Management.

Completeness

The completeness of the data is basically a relationship of how much of the data is available for use compared to the total potential data. Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, insufficient sample volume, broken or lost samples, etc. is to be expected. Therefore, it will be a general goal of the project that 90% data completion is achieved.

A8 SPECIAL TRAINING/CERTIFICATION

Staff responsible for operating the automated samplers and flow loggers will be trained by senior TIAER staff members who have experience operating the equipment. A training record will be completed to document the training of each staff member who operates the automated samplers and flow loggers.

Field personnel will receive training in proper sampling and field measurements. Before actual sampling or field analysis occurs, they will demonstrate to the QA officer or designee, their ability to properly operate the automated samplers and multisondes and retrieve the samples. The QA officer or designee will sign off each field staff in the field training logbook.

Laboratory analysts have a combination of experience, education, and training to demonstrate knowledge of their function. To perform analyses for the TCEQ, laboratory analysts will have a demonstration of capability (DOC) on record for each test that the analyst performs. The initial DOC should be performed prior to analyzing samples and annually thereafter. For cases in which analysts have been analyzing samples prior to an official certification of capability being generated, a certification statement is made part of the training record to document the analyst's initial on the job training. Annual DOCs are a part of analyst training thereafter.

A9 DOCUMENTS AND RECORDS

Hard copies of all field data sheets, general maintenance (GM) records, chain of custody forms (COCs), laboratory data entry sheets, field data entry sheets, calibration logs, and corrective action reports (CARs) will be archived by TIAER for at least five years. In addition, TIAER will archive electronic forms of all project data for at least five years. Examples are presented of GM and field data sheets in Appendix B, a COC form in Appendix C, and a CAR form in Appendix D.

Quarterly progress reports will be produced electronically for the TSSWCB and will note activities conducted in connection with audits of the water quality monitoring program, items or areas identified as potential problems, and any variations or supplements to the QAPP. CARs will be utilized when necessary (Appendix D). CARs will be maintained in an accessible location for reference at TIAER. 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, when appropriate.

Individuals listed in Section A3 at TIAER will be notified of approval of the most current copy of the QAPP by the TIAER project manager. The TIAER project manager will make available to the department secretary the most recent version of the QAPP. Current copies of the QAPP will be kept on file for all individuals on the TIAER distribution list to be signed out in the QAPP logbook kept by the department secretary.

The final project report will be produced electronically and as a hard copy and all files used to produce the final report will be saved electronically by TIAER for at least five years.

As an electronic data protection strategy, TIAER utilizes Double Take software to mirror the Primary Aberdeen 1.2TB file server TIAER5A located in Hydrology 2nd floor (* RAID 5 fault tolerant) that will be mirrored to a secondary Aberdeen Abernas211 file server TIAER5B located in Davis Hall 4th floor (* RAID 5 fault tolerant). This provides instant fault recovery rollover capability in the event of hardware failure. TIAER also exercises complete backup of its Primary server to LTO-3 Quantum ValueLoader on a weekly basis, coupled with daily incremental backups. This provides a third level of fault tolerance in the event that both the primary and secondary servers are disabled. TIAER will maintain all cyclic back up tapes for 26 weeks prior to reuse saving the 1st tape in the series indefinitely to preserve an historical snapshot. This will facilitate recovery of data lost due to human error. Backup tapes are stored in a secure area on the Tarleton State University campus and are checked periodically to ensure viability. If necessary, disaster recovery can also be accomplished by manually re-entering the data.

The documents and records that describe, specify, report, or certify activities are listed in Table A9.1.

Table A9.1 Project Documents and Records

Document/Record	Location	Retention (yrs)	Format
QAPPs, amendments and appendices	TIAER QAO Offices	5 years	Paper
QAPP, distribution documentation	TIAER QAO Offices	5 years	Paper
Field training records	TIAER Field Offices	5 years	Paper
Field notebooks or data sheets (see Appendix B for examples of field data sheets)	TIAER Field Offices	5 years	Paper
Field equipment calibration/maintenance logs	TIAER Field Offices	5 years	Paper
Field instrument printouts	TIAER Field Offices	5 years	Paper
Field SOPs	TIAER Field Offices	5 years	Paper
Chain of custody records (see Appendix C for example)	TIAER Data Management Offices	5 years	Paper
Laboratory Quality Manuals	TIAER Laboratory	5 years	Paper
Laboratory training records	TIAER Laboratory	5 years	Paper
Laboratory SOPs	TIAER Laboratory	5 years	Paper
Laboratory instrument printouts	TIAER Laboratory or Offsite Storage	5 years	Paper
Laboratory data reports/results	TIAER Laboratory or Offsite Storage	5 years	Paper/LIMS electronic
Laboratory equipment maintenance logs	TIAER Laboratory or Offsite Storage	5 years	Paper
Laboratory calibration records	TIAER Laboratory or Offsite Storage	5 years	LIMS electronic
Corrective Action Documentation (see Appendix D for example)	TIAER QAO Office	5 years	Electronic/ Paper

Laboratory Documentation

The laboratory will document sample results clearly and accurately. Information about each sample will include the following to aid in interpretation and validation of data:

- A clear identification of samples analyzed for the project including station information
- Date and time of sample collection
- Identification of preservation and analysis methods used
- Sample results, units of measurement, and sample matrix
- Information on QC failures or deviations from requirements that may affect the quality of results or is necessary for verification and validation of data

B1 SAMPLING PROCESS DESIGN

The sample design rationale for the study is based on the intent to assess reductions in levels of phosphorus and other constituents at microwatershed sites in the North Bosque River following implementation of BMPs in the watershed. Monitoring sites are specified in Table B1.1 and locations are shown in the map in Figure A6.1. Sampling sites were selected to represent a range of land management practices within the watershed and were based on past monitoring by TIAER. The sampling program is designed to characterize water quality of both base flow and storm events at smaller, tributary stream sites. Smaller stream sites were chosen, because it is anticipated that changes in water quality will occur more quickly in these smaller watersheds than in larger watershed areas and that changes observed can be more readily related to changes in land management. Because nonpoint source runoff is rainfall driven, storm monitoring is very important. Storm samples will be collected throughout the extent of each event and aggregated to obtain an event mean concentration. The current project represents a continuation of an earlier CWA Section 319(h) project¹ using a microwatershed approach to evaluate reductions in phosphorus loadings and to target areas where producer assistance may be needed. Continued monitoring of these sites was desired to better assess changes in water quality associated with springtime management efforts.

A paired watershed² or before/after³ design will be used to demonstrate the effectiveness of implemented WQMPs. Both designs require a period of pre-BMP data to be used as a baseline, and then a period of time to collect samples following BMP implementation. Hence, water quality data collected pre-and post implementation of the TMDL will be compared to demonstrate the effectiveness of BMPs in reducing nutrient NPS pollution. Historical data, as defined in Section B9, will be used to supplement pre-BMP data collected during this project for the pre- and post-BMP comparisons. Sampling at tributary sites is completely weather-dependent so the number of runoff events sampled during the pre- and post-BMP portion of the project will vary. Although the number of samples pre and post-BMP will vary and the number of samples per site will vary, enough storm samples should be collected given the timeframe of the project to adequately evaluate project objectives.

Other sources of variability that will need to be considered in evaluating the water quality data are variability in the land use and management of each microwatershed. While the specific timing of management activities in each watershed are not known, seasonality will be considered to determine if there is a time of year when higher runoff concentrations occur. Land use information about each microwatershed, such as the number of dairy operations and levels of participation in the manure composting program, will also be related to microwatershed water quality.

¹ Project 01-17, Extending TMDL Efforts in the North Bosque River Watershed.

² Spooner, et al. 1985. Appropriate Designs for Documenting Water Quality Improvements from Agricultural NPS Control Programs, pp. 30-34 EPA 440/5-85-001.

³ Grabow, et al., 1999. Detecting Water Quality Changes Before and After BMP Implementation: Use of SAS for Statistical Analysis. NWQEP Notes, No. 93.

Table B1.1 Monitoring Sites and Monitoring Frequencies

CR = County Road; FM = Farm to Market Road; SH = State Highway

Station ID – TIAER/ TCEQ	Site Description	Latitude Longitude (Datum NAD27)	Start Date	End Date ¹	Sample Matrix	Sampling Frequency (per month)	
						Routine ²	Wet- Weather ³
AL020 17604	Alarm Creek at FM 914	32°08'34"N 98°11'37"W	01April08	30Jun08	Water	biweekly	TBD ⁴
DB035 17603	Dry Branch near FM 8	32°13'53"N 98°11'53"W	01April08	30Jun08	Water	biweekly	TBD
DC040 17607	Duffau Creek at FM 2481	32°05'11"N 98°01'08"W	01April08	30Jun08	Water	biweekly	TBD
GB020 17214	Unnamed tributary to Goose Branch between CR 541 and CR 297	32°13'59"N 98°21'15"W	01April08	30Jun08	Water	biweekly	TBD
GC025 TBD	Green Creek downstream of FM 847	32° 07' 06"N 98° 16' 16"W	01April08	30Jun08	Water	biweekly	TBD
GC045 17609	Green Creek upstream of SH 6	32°04'40"N 98°13'60"W	01April08	30Jun08	Water	biweekly	TBD
GM060 17610	Gilmore Creek at bend of CR 293	31°58'46"N 98°08'44"W	01April08	30Jun08	Water	biweekly	TBD
HY060 17611	Honey Creek at FM 1602	31°56'54"N 98°00'40"W	01April08	30Jun08	Water	biweekly	TBD
IC020 17235	Indian Creek downstream of US 281	32°08'34"N 98°08'37"W	01April08	30Jun08	Water	biweekly	TBD
LD040 17608	Little Duffau Creek at FM 1824	32°04'32"N 98°02'29"W	01April08	30Jun08	Water	biweekly	TBD
LG060 17606	Little Green Creek at FM 914	32°01'46"N 98°12'20"W	01April08	30Jun08	Water	biweekly	TBD
NF009 17223	Unnamed tributary of Scarborough Creek at CR 423	32°18'39"N 98°17'36"W	01April08	30Jun08	Water	biweekly	TBD
NF020 17222	North Fork North Bosque River Scarborough Creek at CR 423	32°18'12"N 98°17'16"W	01April08	30Jun08	Water	biweekly	TBD
NF050 17413	North Fork of North Bosque River at SH 108	32°15'10"N 98°13'27"W	01April08	30Jun08	Water	biweekly	TBD
SC020 17240	Sims Creek upstream of US 281	32°07'54"N 98°07'50"W	01April08	30Jun08	Water	biweekly	TBD
SF085 17602	South Fork of North Bosque River at SH 108	32°14'16"N 98°12'50"W	01April08	30Jun08	Water	biweekly	TBD
SP020 17242	Spring Creek at CR 271	32°00'09"N 98°06'02"W	01April08	30Jun08	Water	biweekly	TBD
WB050 TBD	Walker Branch at FM927	31° 59' 32"N 97° 51' 04"W	01April08	30Jun08	Water	biweekly	TBD

¹ If funding allows and depending on weather conditions (e.g., fewer than expected samples are collected in the spring due to unusually dry conditions), monitoring may be continued beyond the current end date.

² Routine samples are scheduled for collection every other week, so two to three routine samples may be collected in a given month. Samples will not be collected if flow is not present.

³ A maximum of 195 wet-weather samples are budgeted for the project based on historical runoff data. The actual number of wet-weather samples collected will depend on weather conditions during the project.

⁴ TBD indicates to be determined. Because wet-weather sampling is rainfall dependent the frequency of sampling cannot be predetermined. Also, TCEQ station identifications do not currently exist for sites GC025 and WB050.

A before/after⁴ design will be used to demonstrate the effectiveness of implemented WQMPs. This design requires a period of pre-BMP data to be used as a baseline, and then a period of time to collect samples following BMP implementation. Hence, water quality data collected pre- and post-implementation of WQMPs will be compared to demonstrate the effectiveness of BMPs in reducing nutrient NPS pollution. Historical data, as defined in Section B9, will be used to supplement post-BMP data collected during this project for the pre- and post-BMP comparisons. Storm sampling at stream sites is completely weather-dependent, so the number of runoff events sampled during the pre- and post-BMP portion of the project will vary. Although the number of samples pre- and post-BMP will vary and the number of samples per site will vary, enough storm samples should be collected given the timeframe of the project to adequately evaluate project objectives.

Other sources of variability that will need to be considered in evaluating the water quality data are variability in the land use and management of each watershed. While the specific timing of management activities in each watershed is not known, seasonality will be considered to determine if there is a time of year when higher runoff concentrations occur. Land use information about each watershed, such as the types of crops grown and estimates of fertilizer usage, will also be related to stream water quality.

Routine instream water quality samples will be collected from project sampling stations on a bi-weekly basis, when flow is present. Field measurements of dissolved oxygen, water temperature, specific conductance, and pH will occur with all grab sampling. All water samples will be analyzed for TSS and the nutrients described in Table A7.1. In addition, routine grab samples will be analyzed for *E. coli*. The analytical results will be evaluated against comparable historical stream data to determine if there is an improvement in water quality. Field data and water samples will be collected using procedures detailed in the TCEQ guidance document Surface Water Quality Monitoring Procedures, Volume 1 (RG-415). Table B1.1 lists monitoring stations and frequency of routine sample collection at monitoring sites.

In order to assess water quality of elevated flows due to storm events, ISCO automated water samplers will be used to obtain water samples during storm events for nutrient and TSS analyses. *E. coli* will not be analyzed with wet-weather samples from automated samplers due to difficulties in maintaining a sterile environment for sampling with the automated equipment. Automated samplers will be located at all project sites. Each wet-weather monitoring station will have an ISCO automated sampler with 24 one-liter bottles, a bubbler flow meter, and a housing unit. The automated sampler will be programmed to take liter samples, starting when a significant rise in water level occurs above the bubbler. After the initial sample, samples will be collected sequentially. The general collection sequence may vary by site, but will be structured for more frequent collection early in the storm event (when changes in water quality are most anticipated) with increased time between bottles as the runoff event continues. Sampling will continue until water level drops below the initiation level or it is determined that streamflow is no longer predominately representative of stormwater runoff. Initiation and termination levels

⁴ Grabow, et al., 1999. Detecting Water Quality Changes Before and After BMP Implementation: Use of SAS for Statistical Analysis. NWQEP Notes, No. 93.

may be adjusted during the project, depending on changing conditions. Adjustments to this sampling regime may become necessary due to the unique responsiveness of each site and storm event and needs to collect representative storm samples within project budget limitations. All wet-weather samples will be composited and analyzed for nutrient forms and total suspended solids.

The water level data recorded by the flow meter as well as the sampler partition indication of the time each sequential sample was collected will be down-loaded when storm samples are retrieved, so the storm hydrograph can be used to flow-weight samples in the lab. Flow rates will be determined according to specific level to flow rate relationships at each site. Stormwater samples will be retrieved within 36 hours, except on weekends. If storm samplers are initiated on weekends, storm samples will be retrieved as soon as possible on Monday morning. If a storm was initiated during the week and continues through the weekend, storm samples will be retrieved throughout the weekend. Sample bottles will be collected, iced, transported to the TIAER laboratory, and composited, based on a flow-weighting program developed by TIAER using a maximum of 36 hours between the first and last bottle in a composite sample. Wet weather samples will be retrieved from automated sampling stations on all week days except Thanksgiving, Christmas, and Easter.

Project funds were budgeted for the collection and analysis of a maximum of 195 wet weather samples for all sampling sites based on historical data. Due to the unpredictable nature of wet weather monitoring, TIAER is not able to guarantee a set number of wet weather samples from each station. If stream conditions such as resulting from appreciably greater than average rainfall result in the likelihood of more samples than budgeted, corrective measures, such as discarding samples from small runoff events, will be implemented to reduce sample load and yet provide representative sampling over the duration of the project sampling period. Efforts will be made to make sure storm samples are representative of NPS conditions throughout the monitoring period to best meet project objectives.

If for some reason, wet-weather samples cannot be collected by the automated sampler at a station (e.g., distributor arm jam, sedimentation over intake line, flooding), a storm grab, if possible, will be collected by the field crew when the sampler is checked for storm samples. If a sampler is inoperative for an extended period of time during elevated flows, daily storm grabs will be collected until the sampler is fixed, assuming a grab sample can safely be collected and the site is not in backwater.

During times of sub-freezing weather (e.g., daily high temperatures below freezing or forecast in the 20s or below overnight), it may be necessary to turn off samplers and flow meters to protect the equipment. The sampling lines have been insulated, but there are still incidences when the lines can freeze. The primary concern is that when water levels are low, the bubbler line can freeze over, inhibiting the ability of the bubbler to force air from the line. This may result in the flow meter's air pump running constantly, burning up the motor. If it becomes this cold, it is likely the surface of these stream stations will freeze, prohibiting the collection of a grab sample as well. Samplers will be restarted as soon as the weather allows.

Because sterile conditions are needed for collecting bacteria samples, collecting bacteria samples with the automated samplers would be impractical. Storm bacteria samples will be collected as manual grab samples using the same protocols outlined for routine grab samples for *E. coli*. Samples will be collected once per day during elevated flows with sampling continuing at least one day after flow levels have receded (assuming flow is still occurring) to evaluate changes in *E. coli* concentrations with changes in flow. Elevated flows will be defined by a rise in the water level of about 1.5 inches, which is also the rise used to trigger automated samplers for storm sampling. To accommodate lab and field staff due to the relatively short holding times associated with bacteria samples (8 hours), storm sampling of bacteria will occur only during the standard work week (Monday – Friday) and not on weekends. Modifications to the sampling regime for storm bacteria samples may also occur to accommodate available incubator and laboratory space, if an extended wet-weather period is encountered.

B2 SAMPLING METHODS

Field Sampling Procedures

Routine sample collection will follow field sampling procedures documented in the TCEQ Surface Water Quality Monitoring Procedures Manual (most recent addition). Container types, expected sample volumes, preservation requirements, and holding time requirements are specified in Table B2.1 for routine samples.

Table B2.1 Sample Storage, Preservation and Handling Requirements for Routine Samples

Parameter	Matrix	Container	Field Preservation ^a	Expected Sample Volume	Holding Time
Nitrite+nitrate-Nitrogen	Water	Pre-cleaned plastic	Filter within 15 minutes; pH<2 with H ₂ SO ₄ ; cool to 4°C	60 mL ^b	28 days
Total Phosphorus	Water	Pre-cleaned plastic	pH<2 with H ₂ SO ₄ ; cool to 4°C	250 mL ^c	28 days
Total Kjeldahl Nitrogen	Water	Pre-cleaned plastic	pH<2 with H ₂ SO ₄ ; cool to 4°C	250 mL ^c	28 days
Total Suspended Solids	Water	Pre-cleaned plastic	Cool to 4°C	500 mL	7 days
Ammonia Nitrogen	Water	Pre-cleaned plastic	Filter within 15 minutes; pH<2 with H ₂ SO ₄ ; cool to 4°C	60 mL ^b	28 days
Orthophosphate-Phosphorus	Water	Pre-cleaned plastic	Filter within 15 minutes; cool to 4°C	50 mL	48 hours
<i>E. coli</i>	Water	Sterile plastic	Add sodium thiosulfate; cool to 4°C	250 mL	8 hours

^a If samples have too much sediment for field filtration, they may be filtered and acidified in the laboratory. All samples will be transported on ice and temperatures will be checked upon receipt.

^b The same 60 mL is used for the analysis of nitrite+nitrate-nitrogen and ammonia-nitrogen.

^c The same 250 mL is used for the analysis of total phosphorus and total Kjeldahl nitrogen.

Routine samples for nutrients and TSS are collected in a liter plastic bottle. Aliquots for analytes requiring filtration and/or acidification will be taken from this bottle, after it has been agitated thoroughly to ensure total mixing of sediments that may have settled. Project samples that require field filtration are filtered in the field using a 0.45-micron filter generally in a 50 CC or larger syringe. An aliquot for NO₂-N+NO₃-N and NH₃-N is filtered and transferred to an acidified 60-mL plastic bottle, labeled as indicated above, capped, and shaken to disperse the acid in the sample. A filtered aliquot for PO₄-P is iced and submitted to the lab in the syringe, which is labeled in the same way as sample bottles. An aliquot for TP and TKN is poured from the liter bottle into a labeled and acidified 250-mL plastic bottle, which is capped and shaken to disperse the acid. The remaining sample in the liter bottle is submitted for TSS analysis.

Bacteria samples are collected in sterile, disposable plastic 250 ml bottles that have been factory autoclaved and sealed and include an addition of 10 percent sodium thiosulfate to minimize the

impact of potential chlorine residuals. Bacteria samples are labeled as outlined above, iced immediately in the field, and transported to the laboratory.

All automated samplers for wet-weather sampling will consist of an ISCO 4230 or 3230 bubbler-type flow meter and an ISCO 6712 or 3700 sampler, both enclosed in a sheet metal shelter. Of note, TIAER maintains older ISCO equipment as backup equipment for use if malfunctions occur and temporary replacement of equipment is needed. Automated storm samples are collected in one-liter plastic bottles throughout the hydrograph. When retrieved, each bottle is labeled with site name and bottle number. Samples are transported on ice to the lab. At the lab, storm samples are flow-weight composited using a TIAER computer program that correlates collection time with estimated flow, which is calculated using downloaded level data and the site's rating curve. Samples are filtered and acidified after being composited and divided into analyte aliquots. Container types, field preservation, expected sample volumes, and holding time requirements are specified in Table B2.2 for wet-weather samples. Assuming the composite sample is a full liter, an aliquot of 250 mL would be obtained for analysis of TKN and total P, an aliquot of 100 mL for NH₃-N and NO₂-N+NO₃-N, 150 mL for PO₄-P, and 500 mL for TSS.

Table B2.2 Sample Storage, Preservation and Handling Requirements for Automated Wet-Weather Samples

Parameter	Matrix	Container	Field Preservation ^a	Expected Sample Volume	Holding Time
Nitrite+nitrate-Nitrogen	Water	Pre-cleaned plastic	Cool to 4°C	100 mL ^b	28 days
Total Phosphorus	Water	Pre-cleaned plastic	Cool to 4°C	250 mL ^c	28 days
Total Kjeldahl Nitrogen	Water	Pre-cleaned plastic	Cool to 4°C	250 mL ^c	28 days
Total Suspended Solids	Water	Pre-cleaned plastic	Cool to 4°C	500 mL	7 days
Ammonia Nitrogen	Water	Pre-cleaned plastic	Cool to 4°C	100 mL ^b	28 days
Orthophosphate-Phosphorus	Water	Pre-cleaned plastic	Cool to 4°C	150 mL	48 hours

^a Automated samples are composited, then filtered and acidified, as necessary, in the laboratory. All samples will be transported on ice and temperatures will be checked upon receipt.

^b The same 100 mL is used for the analysis of nitrite+nitrate-nitrogen and ammonia-nitrogen.

^c The same 250 mL is used for the analysis of total phosphorus and total Kjeldahl nitrogen.

Sample Containers

Sample containers are reusable plastic bottles, except for sterile bacteria containers and syringes used in the field for filtering, which are disposable containers. Reusable containers are thoroughly cleaned upon receipt before initial use and after each use, if reused. Reusable containers are cleaned by washing them in hot, soapy (non-phosphate) water. Containers are then rinsed first in warm tap water, then with 1 N hot HCl, and finally rinsed at least three times in type II ASTM (American Society for Testing and Materials) water, i.e., water with conductivity of less than 1 microsiemen per centimeter (µS/cm). Containers are then placed on a

rack to dry. The following TIAER SOP contains the specific steps used for container cleaning and is available for review upon request:

SOP-I-116 Preparation of Labware (includes sampling bottles and equipment used in field operations)

TIAER's tracking system to detect contamination resulting from the washing procedure is based on method blank numbers, which are date stamped numbers assigned at the time of analysis. One method blank is evaluated with each preparation batch of 20 samples or less by analyzing deionized water in the same manner as environmental samples. Each lot of sterile, disposal bacteria container is also tested for sterility as part of the bacterial analyses QC. If any measured concentration is greater than the LOQ, the method blank fails and is reanalyzed. If the method blank fails a second time, data are flagged for review by the PM and QAO. Sources of contamination are remediated, if found. Corrective action documentation is maintained for all method blanks that exceed the LOQ.

Processes to Prevent Contamination

Procedures in the TCEQ Surface Water Quality Monitoring Procedures outline the necessary steps to prevent contamination of samples. These include direct collection into sample containers, when possible, and use of pre-cleaned sample containers.

For wet-weather samples collected with automated samplers, the sampler back-flushes the collection line before pulling each sample. As part of monthly maintenance, the steel strainer and bubbler lines are cleaned of debris or anything that might inhibit correct operation of the sampling equipment. The strainer is cleaned with a wire brush to remove rust and possible algae growth. The bubbler line is also cleaned with a wire brush and a piece of wire is used to clean the inside of the bubbler line of any sand, silt or algae. Each sampler is manually enabled to determine if the sampler would respond to a storm event. As part of quarterly maintenance, the line for sample collection is cleaned using 1 N HCl. After washing the line with acid, the line is triple rinsed with deionized water.

Documentation of Field Sampling Activities

Field sampling activities are documented on Field Data Sheets for routine samples and on General Maintenance Sheets for automated wet-weather samples. Both types of field data sheets are included in Appendix B. For all routine visits, station ID, location, sampling time, sampling date, sampling depth, and sample collector's name/signature are recorded. Preservatives added to routine samples are indicated by the test group code marked on the COC and sample container in which it is delivered to the laboratory. Values for all measured field parameters (water temperature, pH, dissolved oxygen and conductivity) are recorded electronically by the data sonde and are also written on the field data sheet.

Recording Data

For the purposes of this section and subsequent sections, all field and laboratory personnel follow the basic rules for recording information as documented below:

1. Legible writing in indelible ink with no modifications, write-overs or cross-outs;
2. Correction of errors with a single line followed by an initial and date;
3. Close-out on incomplete pages with an initialed and dated diagonal line.

Deficiencies, Nonconformances and Corrective Action Related to Sampling Requirements

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render data unacceptable or indeterminate. Deficiencies related to sampling method requirements include, but are not limited to, such things as sample container, volume, and preservation variations, improper/inadequate storage temperature, holding-time exceedances, and sample site adjustments.

Deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via Corrective Action Report (CAR) to the pertinent field or laboratory supervisor. The supervisor will forward the CAR to the QAO. If the situation requires an immediate decision concerning data quality or quantity, the TIAER Project Manager will be notified within 24 hours. The TIAER Project Manager will notify the TIAER QAO of the potential nonconformance. The TIAER QAO will record and track the CAR to document the deficiency.

The TIAER QAO, in consultation as appropriate with the TIAER Project Manager (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the TIAER Project Manager in consultation with TIAER QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a Corrective Action Report, which is retained by the TIAER QAO.

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency; action(s) prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and, the means by which completion of each corrective action will be documented. The TSSWCB will be notified of excursions that affect data quality with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to the TSSWCB immediately.

B3 SAMPLE HANDLING AND CUSTODY

Chain-of-Custody

Water quality data are generated in the field and the TIAER analytical laboratory. A chain of custody (COC) form is used to record sample identification parameters and to document the submission of samples from the field staff to the analytical laboratory staff. Each COC has space to record data for at least 10 separate samples. An example of the COC is found in Appendix C. For samples collected by automated samplers that will be composited, a computer printout for each site showing aliquot volumes should be attached to the COC. For grab samples, a field data sheet for each site is attached to the COC. COCs and accompanying data sheets are kept in three-ring binders in TIAER offices for at least five years.

The field staff member submitting the sample transfers possession of samples to a laboratory staff member or alerts a laboratory staff member and leaves the sample containers, COCs and other paperwork in a secured area. The field staff member and the laboratory staff member both sign and date the COC. A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The COC form is used to document sample handling during transfer from the field to the laboratory. For this project, there will be no subcontract laboratories. All lab work will be performed by TIAER. The following information concerning the sample is recorded on the COC form (See Appendix C).

1. Date and time of collection
2. Site identification
3. Sample matrix, indicated by test group code
4. Number of containers and container type ID designation
5. Preservative used or if the sample was filtered, indicated by test group code
6. Sample composite information (bottle numbers and ending time)
8. Analyses required, indicated by test group code
9. Name of collector
10. Custody transfer signatures and dates and time of transfer
11. Name of laboratory admitting the sample

Sample Labeling

Water samples are labeled on the container with an indelible marker. Label information from the field crew includes:

1. Station identification
2. Time of sampling (or bottle number for composited samples)
3. Date of sampling
4. Preservation (if applicable)

These unique identifiers on the sample container can be matched with data on Chain of Custody forms that are submitted to the laboratory generally the same day as samples are collected.

Laboratory personnel then add information on container type ID designation, test group code, and sample number with log in of each sample, so it is clearly indicated what analytes need to be analyzed from each container.

The field staff member documents on a field data sheet the station, date, time, location, and sample type and pertinent comments. These identifying data are copied in ink onto a COC. A unique sample identification number is assigned to water samples at the TIAER office and written in indelible ink on the sample container and on the COC. This sample identification number, time, date and station location serves to match the sample with the data on the COC.

Sample Handling

All samples are collected according to TCEQ SWQM procedures. All water samples are iced in the field and submitted to the laboratory on ice the same day they are collected in the field or retrieved from an automated sampler.

After samples are received at the laboratory, they are inventoried against the accompanying COC. Any discrepancies are noted at that time, remediated if possible, and the COC is signed for acceptance of custody. Sample numbers are then be assigned and samples are checked for preservation (as allowed by the specific analytical procedure). Samples are then filtered or pretreated as necessary and placed in a refrigerated cooler dedicated to sample storage, where required.

The laboratory manager has the responsibility to ensure that all holding times are met (see Tables B2.1 and B2.2). Any problems will be documented with a corrective action report.

Deficiencies, Nonconformances and Corrective Action Related to Chain-of-Custody

Deficiencies are defined as unauthorized deviation from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render the data unacceptable or indeterminate. Deficiencies related to chain-of-custody include but are not limited to delays in transfer, resulting in holding time violations; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc.

Deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via Corrective Action Report (CAR) to the pertinent field or laboratory supervisor. The supervisor will forward the CAR to the QAO. If the situation requires an immediate decision concerning data quality or quantity, the TIAER Project Manager will be notified within 24 hours. The TIAER Project Manager will notify the TIAER QAO of the potential nonconformance. The TIAER QAO will record and track the CAR to document the deficiency.

The TIAER QAO, in consultation as appropriate with the TIAER Project Manager (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed.

If it is determined that a nonconformance does exist, the TIAER Project Manager in consultation with TIAER QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a Corrective Action Report, which is retained by the TIAER QAO.

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency; action(s) prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and, the means by which completion of each corrective action will be documented. The TSSWCB will be notified of excursions that affect data quality with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to TSSWCB immediately.

B4 ANALYTICAL METHODS

Dissolved oxygen, water temperature, conductivity and pH of water at sampling sites for this project will be measured *in-situ* using YSI multiprobe field sampling equipment. The remainder of the parameters will be analyzed by TIAER at Tarleton State University in Stephenville, Texas. A listing of analytical methods and equipment is provided in Table B4-1. Standard operating procedures have been established for all procedures undertaken by TIAER staff that concerns water quality monitoring and analysis, and copies of the SOPs are available upon request.

In the event of a failure in the analytical system, the Project Manager will be notified. The Laboratory Manager, Quality Assurance Officer, and Project Manager will then determine if the existing sample integrity is intact, if re-sampling can and should be done, or if data should be omitted.

Table B4.1. Laboratory and Field Analytical Methods and Equipment

Parameter	Method ¹	Equipment Used
Laboratory Parameters		
Ammonia Nitrogen	EPA 350.1 ¹	Perstorp or Lachat QuickChem Autoanalyzer
Nitrite-Nitrogen+Nitrate Nitrogen	EPA 353.2	Perstorp or Lachat QuickChem Autoanalyzer
Total Kjeldahl Nitrogen	EPA 351.2 ¹	Perstorp or Lachat QuickChem Autoanalyzer w/ Tecator block digester
Orthophosphate Phosphorus	EPA 365.2	Beckman DU 64 or DU-640 Spectrophotometer
Total Phosphorus	EPA 365.4 ¹	Perstorp or Lachat QuickChem Autoanalyzer w/ Tecator block digester
Total Suspended Solids	EPA 160.2	Sartorius AC210P analytical balance, oven
<i>Escherichia coli</i>	SM 9223-B Colilert	Incubator, IDEXX Quantitray sealer
Field Parameters		
Dissolved Oxygen	EPA 360.1	YSI Multiprobe
Potential Hydrogen	EPA 150.1	YSI Multiprobe
Specific Conductance	EPA 120.1	YSI Multiprobe
Water Temperature	EPA 170.1	YSI Multiprobe
Flow	TCEQ SWQM	Global Water FlowProbe, Pygmy Flow Meter, Price Flow Meter, SonTek FlowTracker, or RDI- Acoustic Doppler Current Profiler

¹ Some methods are modified by TIAER as outlined in Table A7.1.

EPA = Methods for Chemical Analysis of Water and Wastes, March 1983

SM = Standard Methods for Examination of Water and Wastewater, 18th and 20th editions

TCEQ SWQM = Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures, Volume 1 (RG-415)

After samples have been analyzed and results reviewed by the laboratory manager, any remaining sample material will be disposed of appropriately per the analyte's SOP. The goal of TIAER's laboratory is to analyze all samples within the holding time indicated in Tables B2.1 and B2.2.

The analytical methods, associated matrices, and performing laboratories are listed in Table A7.1 of Section A7. Laboratories collecting data under this QAPP are compliant with NELAC Standards. The TIAER laboratory was granted NELAC accreditation as of January 2008 via TCEQ. Copies of laboratory SOPs are available for review by the TSSWCB. Laboratory SOPs are consistent with EPA requirements as specified in the method.

Standards Traceability

All standards used in the laboratory are traceable to verified and known amounts of analytes. Standards preparation is fully documented and maintained in a standards log book. The use of standards and reagents are documented when used in preparation and analytical logs. Each documentation includes traceability to purchased stocks, reference to the method of preparation, including concentration, amount used and lot number, date prepared, expiration date and preparer's initials or signature. The reagent bottle is labeled with concentration, date of preparation, expiration date, storage requirements, safety considerations, and a unique identifier that traces the reagent to the standards log book entry.

Analytical Method Modification

Only data generated using approved analytical methodologies as specified in this QAPP will be used as direct data for this project. Requests for method modifications will be documented and submitted for approval to the TSSWCB. Work using modified methods will begin only after the modified procedures have been approved.

Deficiencies, Nonconformances and Corrective Action Related to Analytical Methods

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render the data unacceptable or indeterminate. Deficiencies related to field and laboratory measurement systems include but are not limited to instrument malfunctions, blank contamination, quality control sample failures, etc.

Deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via Corrective Action Report (CAR) to the pertinent field or laboratory supervisor. The supervisor will forward the CAR to the QAO. If the situation requires an immediate decision concerning data quality or quantity, the TIAER Project Manager will be notified within 24 hours. The TIAER Project Manager will notify the TIAER QAO of the potential nonconformance. The TIAER QAO will record and track the CAR to document the deficiency.

The TIAER QAO, in consultation as appropriate with the TIAER Project Manager (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the TIAER Project Manager in consultation with TIAER QAO will determine the disposition of the nonconforming activity or item and

necessary corrective action(s); results will be documented by completion of a Corrective Action Report, which is retained by the TIAER QAO.

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency; action(s) prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and, the means by which completion of each corrective action will be documented. The TSSWCB will be notified of excursions that affect data quality with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to TSSWCB immediately.

B5 QUALITY CONTROL

Sampling Quality Control Requirements and Acceptability Criteria

Field Split - A field split is a single sample subdivided by field staff immediately following collection and submitted to the laboratory as two separately identified samples. This requirement applies to composited grab samples as well as single grab samples, but not to automated samples or bacteria samples. Field splits will be collected on a 10% basis for instream routine samples. The precision of field split results is calculated by relative percent difference (RPD) using the following equation:

$$RPD = (X_1 - X_2) / ((X_1 + X_2) / 2)$$

A 30% RPD criteria will be used to screen field split results as a possible indicator of excessive variability in the sample handling and analytical system. If it is determined that elevated quantities of analyte (i.e., > 5 times the RL) were measured and analytical variability can be eliminated as a factor, then variability in field split results will be used to trigger discussions with field staff to ensure samples are being handled in the field correctly. Some individual sample results may be invalidated based on the examination of all extenuating information. The information derived from field splits is generally considered to be event specific and would not normally be used to determine the validity of an entire batch; however, some batches of samples may be invalidated depending on the situation. Professional judgment during data validation will be relied upon to interpret the results and take appropriate action. Deficiencies will be addressed as specified in this section under Deficiencies, Nonconformances, and Correction Action related to Quality Control.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria

Method Specific QC requirements – QC samples, other than those specified later this section, are run (e.g., sample duplicates, surrogates, internal standards, continuing calibration samples, interference check samples, positive control, negative control, and media blank) as specified in the methods. The requirements for these samples, their acceptance criteria or instructions for establishing criteria, and corrective actions are method-specific.

Detailed laboratory QC requirements and corrective action procedures are contained within the individual laboratory quality assurance manuals (QAMs). The minimum requirements that all participants abide by are stated below.

Limit of Quantitation (LOQ) – The laboratory will analyze a calibration standard (if applicable) at the LOQ on each day project samples are analyzed. Calibrations including the standard at the LOQ will meet the calibration requirements of the analytical method or corrective action will be implemented.

LOQ Check Standard – An LOQ check standard consists of a sample matrix (e.g., deionized water, sand, commercially available tissue) free from the analytes of interest spiked with verified

known amounts of analytes or a material containing known and verified amounts of analytes. It is used to establish intra-laboratory bias to assess the performance of the measurement system at the lower limits of analysis. The LOQ check standard is spiked into the sample matrix at a level less than or near the LOQ for each analyte for each batch of samples that are run.

The LOQ check standard is carried through the complete preparation and analytical process. LOQ Check Standards are run at a rate of one per preparation batch. A preparation batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

The percent recovery of the LOQ check standard is calculated using the following equation in which %R is percent recovery, SR is the sample result, and SA is the reference concentration for the check standard:

$$\%R = SR/SA * 100$$

Measurement performance specifications are used to determine the acceptability of LOQ Check Standard analyses as specified in Table A7.1.

As noted above, the LOQ check standard will be used for information in determining the performance of the measurement system at the lower limits of analysis and not as a sole criterion for determining overall data acceptability for a batch.

Laboratory Control Sample (LCS) - An LCS consists of a sample matrix (e.g., deionized water, sand, commercially available tissue) free from the analytes of interest spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is used to establish intra-laboratory bias to assess the performance of the measurement system. The LCS is spiked into the sample matrix at a level less than or near the mid point of the calibration for each analyte. In cases of test methods with very long lists of analytes, LCSs are prepared with all the target analytes and not just a representative number, except in cases of organic analytes with multipeak responses.

The LCS is carried through the complete preparation and analytical process. LCSs are run at a rate of one per preparation batch. A preparation batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Results of LCSs are calculated by percent recovery (%R), which is defined as 100 times the measured concentration, divided by the true concentration of the spiked sample.

The following formula is used to calculate percent recovery, where %R is percent recovery; SR is the measured result; and SA is the true result:

$$\%R = SR/SA * 100$$

Measurement performance specifications are used to determine the acceptability of LCS analyses as specified in Table A7.1.

Laboratory Duplicates – A laboratory duplicate is prepared by taking aliquots of a sample from the same container under laboratory conditions and processed and analyzed independently. A laboratory control sample duplicate (LCSD) is prepared in the laboratory by splitting aliquots of an LCS. Both samples are carried through the entire preparation and analytical process. LCSDs are used to assess precision and are performed at a rate of one per preparation batch. A preparation batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

For most parameters, precision is calculated by the relative percent difference (RPD) of LCS duplicate results as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, X_1 and X_2 , the RPD is calculated from the following equation:

$$RPD = (X_1 - X_2) / \{(X_1 + X_2) / 2\} * 100$$

A bacteriological duplicate is considered to be a special type of laboratory duplicate and applies when bacteriological samples are run in the field as well as in the lab. Bacteriological duplicate analyses are performed on samples from the sample bottle on a 10% basis. Results of bacteriological duplicates are evaluated by calculating the logarithm of each result and determining the range of each pair.

Measurement performance specifications are used to determine the acceptability of duplicate analyses-as specified in Table A7.1. The specifications for bacteriological duplicates in Table A7.1 apply to samples with concentrations > 20 org./100mL.

Matrix spike (MS) –Matrix spikes are prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Percent recovery of the known concentration of added analyte is used to assess accuracy of the analytical process. The spiking occurs prior to sample preparation and analysis. Spiked samples are routinely prepared and analyzed at a rate of 10% of samples processed, or one per quality control batch whichever is greater. A quality control batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 10 environmental samples. The information from these controls is sample/matrix specific and is not used to determine the validity of the entire batch. The MS is spiked at a level less than or equal to the midpoint of the calibration or analysis range for each analyte. Percent recovery (%R) is defined as 100 times the observed concentration, minus the sample concentration, divided by the true concentration of the spike.

The results from matrix spikes are primarily designed to assess the validity of analytical results in a given matrix and are expressed as percent recovery (%R). The laboratory shall document the calculation for %R. The percent recovery of the matrix spike is calculated using the following equation in which %R is percent recovery, SSR is the observed spiked sample concentration, SR is the sample result, and SA is the reference concentration of the spike added:

$$\%R = (SSR - SR)/SA * 100$$

Measurement performance specifications for matrix spikes are not specified in this document.

The results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine the internal criteria and document the method used to establish the limits. For matrix spike results outside established criteria, corrective action shall be documented or the data reported with appropriate data qualifying codes.

Method blank –A method blank is a sample of matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as the samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. The method blank is carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination from the analytical process. The analysis of method blanks should yield values less than the LOQ. For very high-level analyses, the blank value should be less than 5% of the lowest value of the batch, or corrective action will be implemented.

Deficiencies, Nonconformances and Corrective Action Related to Quality Control

Deficiencies are defined as unauthorized deviation from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render the data unacceptable or indeterminate. Deficiencies related to Quality Control include but are not limited to quality control sample failures.

Deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via Corrective Action Report (CAR) to the pertinent field or laboratory supervisor. The supervisor will forward the CAR to the QAO. If the situation requires an immediate decision concerning data quality or quantity, the TIAER Project Manager will be notified within 24 hours. The TIAER Project Manager will notify the TIAER QAO of the potential nonconformance. The TIAER QAO will record and track the CAR to document the deficiency.

The TIAER QAO, in consultation as appropriate with the TIAER Project Manager (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the TIAER Project Manager in consultation

with TIAER QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a Corrective Action Report, which is retained by the TIAER QAO.

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency; action(s) prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and, the means by which completion of each corrective action will be documented. The TSSWCB will be notified of excursions that affect data quality with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to the TSSWCB immediately.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

Automated sampler testing and maintenance requirements are outlined in the following SOPs, which are available upon request for review:

- TIAER SOP-F-112 Programming Automated Samplers
- TIAER SOP-F-114 Downloading Automated Sampling Sites

All automated sampling equipment (ISCO samplers and flow meters) will be inspected biweekly and serviced as needed by the field crew with a report going to the field supervisor. A general maintenance (GM) sheet will be filled out for each sampling site during each GM inspection (Appendix B). The GM sheet contains a checklist for all equipment and routine maintenance activities. Any equipment that needs attention will be serviced during the GM inspection. Backup equipment will be maintained by TIAER so that failing equipment can be replaced as soon as possible. As part of monthly maintenance, sites are manually enabled to make sure the sampler will pull a sample under wet-weather conditions. Any deficiencies will be noted on the GM sheet as well as corrective actions. If during general maintenance, it is found that sample integrity may be in question, a CAR will be filled out for the samples impacted.

Maintenance requirements for YSI multiprobes are detailed in the TCEQ Surface Water Quality Monitoring Procedures. Maintenance requirements for velocity measurement equipment follow manufacturer guidelines. Sampling equipment is inspected and tested upon receipt and is assured appropriate for use. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within laboratory quality assurance manual (QAM) and are inspected by appropriate laboratory personnel under the supervision of the laboratory manager. Testing and maintenance records are maintained and are available for inspection by the TSSWCB. Instruments requiring daily or in-use testing include, but are not limited to, water baths, ovens, autoclaves, incubators, refrigerators, and laboratory-pure water. Critical spare parts for essential equipment are maintained to prevent downtime. Maintenance records are available for inspection by the TSSWCB. Any deficiencies will be noted and how these deficiencies were resolved as part of routine maintenance records. If during routine maintenance of laboratory equipment, it is found that sample integrity may be in question, a CAR will be filled out for the samples impacted.

B7 INSTRUMENT CALIBRATION AND FREQUENCY

Calibration requirements for automated monitoring equipment are outlined in the following SOPs, which are available upon request for review:

- TIAER SOP-F-112 Programming Automated Samplers
- TIAER SOP-F-114 Downloading Automated Sampling Sites

Calibration requirements for other field equipment are contained in the TCEQ Surface Water Quality Monitoring Procedures. Post-calibration error limits will be adhered to. Data not meeting post-error limit requirements invalidates associated data collected subsequent to the pre-calibration and will not be used for evaluation of project objectives.

Detailed laboratory calibrations are contained within the laboratory SOPs. The laboratory SOPs identify all tools, gauges, instruments, and other sampling, measuring, and test equipment used for data collection activities affecting quality that must be controlled and, at specified periods, calibrated to maintain bias within specified limits. Calibration records are maintained, are traceable to the instrument, and are available for inspection by the TSSWCB. Equipment requiring periodic calibrations include, but are not limited to, thermometers, pH meters, balances, incubators, and analytical instruments.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Chemicals for analysis are tested by the supplier and meet or exceed ACS certification, where applicable.

All supplies and consumables received by the TIAER chemistry laboratory are inspected upon receipt for damage, missing parts, expiration date, and storage and handling requirements by appropriate laboratory personnel. Labels on reagents, chemicals, and standards are examined to ensure they are of appropriate quality, initialed by staff member and marked with receipt date. Volumetric glassware is inspected to ensure class "A" classification, where required.

B9 NON-DIRECT MEASUREMENTS

TIAER has collected data from project sites, beginning as early as 1992, under a variety of quality assurance project plans. These QAPPs include the following:

1. Data collected by TIAER in the Upper North Bosque River Watershed under the USEPA-sponsored Livestock and the Environment: A National Pilot Project (NPP). The QAPP is the TIAER document entitled Quality Assurance Project Plan for the National Pilot Project (1993), that encompasses data collected from June 1, 1992 through August 31, 1995. Data that may be used from this project includes water quality, rainfall, and water level (streamflow) information.
2. Data collected by the Brazos River Authority and TIAER, as a subcontractor, under the TCEQ Clean Rivers Program. The QAPP is the BRA document entitled Quality Assurance Project Plan for the Bosque River Watershed Pilot Project (1995) which encompasses data collected from October 1, 1995 through May 31, 1996. Data that may be used from this project includes water quality, rainfall and water level (streamflow) information.
3. Data collected by TIAER under the USDA Lake Waco-Bosque River Initiative. The QAPPs are TIAER documents entitled Quality Assurance Project Plan for the Lake Waco-Bosque River Initiative (1996, 1997-99, 1999-2000, 2000-2003, and 2003 - 2005) which encompass data collected from September 1, 1996 through September 1, 2005. A QAPP for data collected from September 2005 and continuing through August 2006 was approved by TCEQ and is entitled United States Department of Agriculture Bosque River Initiative Quality Assurance Project Plan, Revision 6. Data that may be used from this project includes water quality, rainfall and water level (streamflow) information.
4. Data collected by TIAER under the Clean Water Act Section 319(h) Nonpoint Source Pollution Control Program the following projects:
 - “Technical and Financial Assistance to Dairy Producers and Landowners of the North Bosque River Watershed within the Cross Timbers Soil and Water Conservation District” (01-13)
 - “Technical and Financial Assistance to Dairy Producers and Landowners of the North Bosque River Watershed within the Upper Leon Soil and Water Conservation District” (01-14)

These projects include data collected from March 2002 through March 2006 under a TSSWCB and EPA approved QAPP. Data that may be used from these projects include water quality and water level (streamflow) information.

5. Data collected by TIAER under Clean Water Act Section 319(h) Nonpoint Source Pollution Control Program project funded through TCEQ entitled “North Bosque River Effectiveness Monitoring.” This project will include water quality and flow data collected at mainstem and major tributary sites along the North Bosque River. Monitoring started February 1, 2006 and should continue through August 31, 2008 under a TCEQ and EPA approved QAPP. Data that may be used from this project includes water quality and water level (streamflow) information.

6. Data collected by TIAER under Clean Water Act Section 319(h) Nonpoint Source Pollution Control Program project funded through TSSWCB entitled "Extending TMDL Efforts in the North Bosque River Watershed." This project includes data collected from April 2006 through March 2008 under a TSSWCB and EPA approved QAPP. Data that may be used from these projects include water quality and water level (streamflow) information.

The water quality data associated with the projects listed above were collected and analyzed using similar assessment objectives, sampling techniques, laboratory protocols and data validation procedures as the current project. One known deviation is in the measurement of bacteria. Prior to 2000 fecal coliform rather than *Escherichia coli* was monitored at stream sites. From November 2000 through March 2004 both *E. coli* and fecal coliform were evaluated to allow comparison of these two types of bacteria data. This period of overlap will be used to determine if fecal coliform can be adjusted to comparable *E. coli* values using accepted statistical methods for comparing different analytical methods. In addition, *E. coli* analysis used a membrane filtration technique prior to April 2004, after which the IDEXX Colilert method was used.

Another known deviation is in the reporting limits used for various parameters. Prior to January 2004, TIAER used method detection limits rather than AWRLs as the reporting limit. Non-direct data will be adjusted as appropriate for each constituent prior to statistical evaluation to make sure that these differences in reporting limits do not cause an indication of false trends in the data assessment. The overall project objective is to use non-direct data from these previous projects with direct data collected under the current project to evaluate changes in water quality over time. Because most historical data were collected and analyzed in a manner comparable to the data collected under this project, no limitations will be placed on their use, except where known deviations have occurred as outlined above.

In addition, flow data from the United States Geological Service (USGS) may be used to help determine flows and loadings along the mainstem of the North Bosque River. The USGS maintains a high flow gauging station near site 11961 at Hico, Texas (gage # 08094800), and records flows at all levels at gauging stations #0809500 (near Clifton and site 11956) and # 08095200 (near Valley Mills and site 11954). TIAER will use USGS stream flow and/or rating curve data for sites 11961, 11954, and 11956, since these stations are either in close proximity to a USGS gauge or have established relationships with a proximate USGS gauge.

Supplemental precipitation data have been and will be obtained from the National Weather Service (NWS) observers in Dublin, Huckabay, Hico, Chalk Mountain, Cranfills Gap, Meridian, Morgan Mill, and Stephenville. Data from additional NWS observer sites may also be considered within or near the borders of the North Bosque River watershed. These precipitation data will be used to augment data obtained from TIAER's network of precipitation gages. TIAER currently maintains a network of at least seven precipitation gage sites in the upper portion of the North Bosque River watershed and historically has had a more expanded network (see Jones, 2004).

B10 DATA MANAGEMENT

In dealing with data management, preparation and control procedures for TIAER standard operating procedures (SOPs) are outlined in SOP-A-101. Laboratory document and data control is addressed in TIAER SOP-A-102. Control of field data sheets is addressed in TIAER SOP-F-100. These SOPs are available for review upon request.

Data Management Process

Water quality samples are collected and transferred from the field to the laboratory for analyses as described in Section B3 using a COC form (Appendix C) following procedures in TIAER SOP-Q-110, Sample Receipt and Log In. A unique sample identification number is given to each sample at log in. Identifying sample information and comments are manually entered into the initial database queue. Laboratory measurement results are entered into a secondary database queue, either automatically or manually, depending on the instrument. Following laboratory data verification and validation, the data are transferred from the secondary queue database to the master queue within the TIAER LIMS. At this point, any additional manually generated field data or comments are added to the LIMS database by the field crew and validated by a separate individual. Data from TIAER's LIMS are then uploaded to a SAS software database, which is used for statistical evaluation of the data to evaluate project objectives. Procedures and personnel involved in data entry and review are outlined in TIAER SOP-Q-104, Data Entry and Review. The SAS water quality database is the final depository for TIAER water quality data for use and storage for all projects, including the non-direct water quality data outlined in Section B9 analyzed by TIAER for other projects.

Field parameters collected with the YSI multprobe (pH, water temperature, conductivity, and dissolved oxygen) are automatically downloaded from the instrument and imported into an EXCEL spreadsheet. Printouts of the sonde data are compared with manually entered data on the field data sheets for validation. The electronic sonde data are then exported to a SAS database and automatically merged with the SAS database containing the LIMS data by site, date, and time and again reviewed by field crew personnel to make sure the data merge occurred correctly.

Other ISCO data, such as water level and sample partition information, are downloaded when storm samples are collected for use in flow weight compositing using field laptop computers or modems, where phone lines are available. The field crew maintains hard copies of the sample partition data for storm events. The electronic stage and sample partition data are transferred to a desktop computer in the TIAER laboratory Annex.

For storm samples that will be flow composited, a computer program has been developed by TIAER that correlates five-minute flow data with sample collection times in order to flow-weight composite a group of samples into one. When storm samples are to be composited, a Flowlink program is run which extracts the stream level and sample bottle data and writes this information to an ASCII text file. The ASCII file is imported into a SAS program that generates a report for flow-compositing of samples based on TIAER SOP-Q-112, Sample Compositing. The results inform the laboratory staff how many milliliters of liquid from each sample bottle to use in creating a composite one-liter sample. For composited samples, field personnel record the date and time of the first and last sample bottles on the COC. The bottle numbers to be used are also recorded in the comment section of the COC.

Flow data for archival purposes is routinely downloaded every two weeks whether wet-weather has occurred or not and stored in a SAS or WISKI database for review. Records of site visits to download the flow meters are kept on the GM sheets (Appendix B). Of note, TIAER obtained the WISKI software package from the Kisters Corporation in December 2005. Stream level data are reviewed in WISKI by appropriate field staff and then transferred back to SAS for storage. The SAS water level and flow databases act as the final depository TIAER data for use and storage for all projects, including the non-direct flow data outlined in Section B9 collected under other TIAER projects. Water level and flow data obtained from the USGS as outlined in Section B9 will also be transferred to a SAS database for final storage and usage.

Chain of Custody Forms

A chain of custody (COC) form is used to record water sample identification parameters and to document the submission of samples from the field staff to the analytical laboratory staff (Appendix C). Each COC has space to record data for numerous separate samples. All entries onto the COC forms will either be typed or completed in ink, with any changes made by crossing out the original entry, which should still be legible, and initialing and dating the new entry. COCs are kept in three-ring binders in the TIAER office for at least five years.

Data Verification/Validation

The control mechanisms for detecting and correcting errors and for preventing loss of data during data reduction, data reporting, and data entry are contained in Sections D1, D2, and D3.

Data Handling

Data are entered into a LIMS based on Microsoft Access software, then transferred to a SAS database. Data integrity is maintained by the implementation of password protections that control access to the database and by limiting update rights to a select user group. No data from external sources are maintained in the database. The database administrator is responsible for assigning user rights and assuring database integrity.

Hardware and Software Requirements

Hardware configurations are sufficient to run Microsoft Access and SAS software in a networked environment. Specific hardware need to be configured to run WISKI and FLOWLINK software, but not necessarily in a networked environment. TIAER information resources staff are responsible for assuring that hardware configurations meet the requirements for running current and future data management/database software as well as providing technical support. Software development of the LIMS and SAS applications are based on user requests and are tested for reliability prior to implementation.

As an electronic data protection strategy, TIAER utilizes Double Take software to mirror the Primary Aberdeen 1.2TB file server TIAER5A located in Hydrology 2nd floor (* RAID 5 fault tolerant) that will be mirrored to a secondary Aberdeen Abernas211 file server TIAER5B located

in Davis Hall 4th floor (* RAID 5 fault tolerant). This provides instant fault recovery rollover capability in the event of hardware failure. TIAER also exercises complete backup of its Primary server to LTO-3 Quantum ValueLoader on a weekly basis, coupled with daily incremental backups. This provides a third level of fault tolerance in the event that both the primary and secondary server are disabled. TIAER will maintain all cyclic back up tapes for 26 weeks prior to reuse saving the 1st tape in the series indefinitely to preserve an historical snapshot. This will facilitate recovery of data lost due to human error. Backup tapes are stored in a secure area on the Tarleton State University campus and are checked periodically to ensure viability. If necessary, disaster recovery can also be accomplished by manually re-entering the data.

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following table presents the types of assessments and response actions for data collection activities applicable to this project (Table C1.1).

Table C1.1 Assessments and Response Requirements

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	TIAER Project Manager	Monitoring of the project status and records to ensure requirements are being fulfilled	Report to TSSWCB in Quarterly Report
Monitoring Systems Audit of TIAER	Dates to be determined by TSSWCB (minimum of one per life of project)	TSSWCB QAO	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP. Field sampling, handling and measurement; facility review; and data management as they relate to the NPS Project	30 days to respond in writing to the TSSWCB to address corrective actions
Laboratory Inspection	Dates to be determined by TSSWCB (minimum of one per life of project)	TSSWCB QAO	Analytical and quality control procedures employed at the TIAER laboratory	30 days to respond in writing to TSSWCB to address corrective actions
Laboratory Management Review	Annually	TIAER QAO	Conduct management reviews of the laboratory's quality system to ensure its effectiveness	Not applicable
Laboratory Internal Audits	Annually	TIAER Laboratory QAO	Conduct internal audits of the quality system to verify that activities comply with the quality system Standard	30 days to respond in writing to Lab QAO to address corrective actions
Site Visit	Dates to be determined by TSSWCB (minimum of one per each fiscal year during life of project)	TSSWCB PM	Status of activities. Overall compliance with work plan and QAPP	As needed

Corrective Action

The TIAER Project Manager is responsible for implementing and tracking corrective action resulting from audit findings outlined in any internal or external audit report. The TIAER QAO will maintain records of audit findings and corrective actions. Internal audit reports will be made available to the TSSWCB upon request. External audits conducted by the TSSWCB will include corrective action reports of any findings directly to the TSSWCB.

C2 REPORTS TO MANAGEMENT

Reports to TSSWCB Project Management

Quarterly Progress Report - Summarizes TIAER's activities for each task; reports problems, delays, and corrective actions; and outlines the status of each task's deliverables. Report written by the TIAER project manager.

Monitoring System Audit Response - TIAER will respond in writing to the TSSWCB within 30 days upon receipt of a monitoring system audit report to address corrective actions. Response written by the TIAER QA officer.

Laboratory System Audit Response - TIAER will respond in writing to the TSSWCB within 30 days upon receipt of a laboratory system audit report to address corrective actions. Response written by the TIAER's laboratory QAO.

Final Project Report - Summarizes TIAER's activities for the entire project period including a description and documentation of major project activities; evaluation of project results and environmental benefits; and a conclusion. Report written by or under the guidance of the TIAER project manager with assistance from other staff members.

D1 DATA REVIEW, VERIFICATION, AND VALIDATION

For the purposes of this document, data verification is a systematic process for evaluating performance and compliance of a set of data to ascertain its completeness, correctness, and consistency using the methods and criteria defined in the QAPP. Validation means those processes taken independently of the data-generation processes to evaluate the technical usability of the verified data with respect to the planned objectives or intention of the project. Additionally, validation can provide a level of overall confidence in the reporting of the data based on the methods used.

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives listed in Section A7. Only those data that are supported by appropriate quality control data and meet the measurement performance specification defined for this project will be considered acceptable and used in the project.

The procedures for verification and validation of data are described in Section D2. The TIAER Field Supervisor is responsible for ensuring that field data are properly reviewed and verified for integrity. The Laboratory Manager is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and accuracy, and reviewed for integrity. The TIAER QAO and PM will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to the project database. The TIAER Laboratory QAO is responsible for validating a minimum of 10% of the data produced in each task. Finally, the TIAER Project Manager, with the concurrence of the TIAER QAO, is responsible for validating that all data collected and analyzed meet the objectives of the project.

All field and laboratory will be reviewed and verified for integrity and continuity, reasonableness, and conformance to project requirements, and then validated against the project objectives and measurement performance specifications which are listed in Section A7. Data that are supported by appropriate quality control data and meet the measurement performance specifications defined for this project will be considered acceptable will be used in evaluating project objectives for the final report.

D2 VERIFICATION AND VALIDATION METHODS

All data will be verified to ensure they are representative of the samples analyzed and locations where measurements were made, and that the data and associated quality control data conform to project specifications. The staff and management of the respective field, laboratory, and data management tasks are responsible for the integrity, validation and verification of the data each task generates or handles throughout each process (Table D2.1). The field and laboratory tasks ensure the verification of raw data, electronically generated data, and data on chain-of-custody forms and hard copy output from instruments.

Verification, validation and integrity review of laboratory data will be performed using self-assessments and peer review, as appropriate to the project task, followed by technical review by the manager of the task. The data to be verified are evaluated against project performance specifications (Section A7) and are checked for errors, especially errors in transcription, calculations, and data input. If a question arises or an error is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues that can be corrected are corrected and documented electronically or by initialing and dating the associated paperwork. If an issue cannot be corrected, the task manager consults with higher level project management to establish the appropriate course of action, or the data associated with the issue are rejected.

The TIAER Project Manager and QAO are each responsible for validating that the verified data are scientifically valid, defensible, of known precision, accuracy, integrity, meet the data quality objectives of the project, and are reportable to TSSWCB. One element of the validation process involves evaluating the data again for anomalies. The manager of the task associated with the suspected data errors or anomalous data must address these issues before data validation can be completed.

A second element of the validation process is consideration of any findings identified during a laboratory or monitoring systems audit conducted by the TSSWCB QAO. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. Finally, the TIAER Project Manager, with the concurrence of the TIAER QAO, validates that the data meet the data quality objectives of the project and are suitable for meeting project objectives for the TSSWCB.

Table D2.1: Data Review Tasks

Field Data Review	Responsibility
Field data reviewed for conformance with data collection, sample handling and chain of custody, analytical and QC requirements	TIAER Field Supervisor
Post-calibrations checked to ensure compliance with error limits	TIAER Field Supervisor
Field data calculated, reduced, and transcribed correctly	TIAER Field Supervisor
Laboratory Data Review	
Laboratory data reviewed for conformance with data collection, sample handling and chain of custody, analytical and QC requirements to include documentation, holding times, sample receipt, sample preparation, sample analysis, project and program QC results, and reporting	TIAER Laboratory Manager
Laboratory data calculated, reduced, and transcribed correctly	TIAER Laboratory Manager
Reporting limits consistent with requirements for Ambient Water Reporting Limits.	TIAER Laboratory Manager
Analytical data documentation evaluated for consistency, reasonableness and/or improper practices	TIAER Laboratory Manager
Analytical QC information evaluated to determine impact on individual analyses	TIAER Laboratory Manager
All laboratory samples analyzed for all parameters	TIAER Laboratory Manager
Data Set Review	
Data reported has all required information as described in Section A9 of the QAPP	TIAER QAO
Confirmation that field and lab data have been reviewed	TIAER QAO
Data set (to include field and laboratory data) evaluated for reasonableness and if corollary data agree	TIAER PM
Outliers confirmed and documented	TIAER QAO and PM
Field QC acceptable (e.g., field splits)	TIAER QAO
Sampling and analytical data gaps checked and documented	TIAER QAO and PM
Verification and validation confirmed. Data meets conditions of end use and are reportable	TIAER PM

D3 RECONCILIATION WITH USER REQUIREMENTS

Data produced in this project, and data collected under other TIAER projects or by other organizations (e.g., USGS and NWS), will be analyzed and reconciled with project data quality requirements. Data meeting project requirements will be used by the TSSWCB to determine reductions in nonpoint source loadings, specifically those associated with soluble reactive phosphorus related to the North Bosque River TMDL and Implementation Plan, and to aid in targeting locations where further reduction efforts are needed. Data that do not meet project requirements will not be used.

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Appendix A. Work Plan

Assessment of Springtime Contributions of Nutrients and Bacteria to the North Bosque River Watershed (Formerly Little Wichita River Watershed Protection Plan) FY04 CWA Section 319(h)

WORK PLAN 04-12

Amendment to Scope of Work with 1-yr No Cost Extension – revised 9 February 2007
August 25, 2004 – August 31, 2008 (former end date Aug. 31, 2007)

Problem/Need Statement:

The North Bosque River watershed encompasses approximately 3,140 square kilometers (1,210 square miles) in north central Texas and includes two classified stream segments (1226 and 1255; Figure 1). The 1996 State of Texas Water Quality Inventory indicated that nonpoint source loadings associated with elevated nutrient and fecal coliform levels were the most serious threat to meeting designated uses within segments 1226 and 1225. In 1998, segments 1226 and 1255 were included in the Clean Water Act Section 303(d) list for Texas as impaired water bodies and scheduled for development of total maximum daily loads (TMDLs). These two segments were listed under narrative water quality criteria related to nutrients and aquatic plant growth with concentrated animal feeding operations identified as the major nonpoint source of nutrients. In February 2001, the Texas Commission on Environmental Quality (TCEQ) adopted a TMDL for soluble reactive phosphorus in segments 1226 and 1255 that was approved by EPA in December 2001. This TMDL requires about a 50 percent reduction in loading and concentration of soluble reactive phosphorus, depending on the location along the river. Soluble reactive phosphorus was identified as the nutrient limiting algal growth in the North Bosque River, and, thus, a reduction in soluble reactive phosphorus should reduce algal abundance in the North Bosque River. The 2004 Texas Water Quality Inventory assessment prepared by the TCEQ pursuant to the Clean Water Act Section 305(b) continues to indicate impairments associated with bacteria and concerns associated with nutrient enrichment and algal growth on stream segments in the North Bosque River watershed. Although the TMDL process did not directly consider bacteria with regard to supporting the use of contact recreation, many of the control practices for phosphorus outlined in the Implementation Plan should also help reduce bacterial loadings to the North Bosque River.

The basis for this project is to provide assessment activities in the North Bosque River watershed to support the Texas State Soil and Water Conservation Board (TSSWCB) and local Soil and Water Conservation Districts (SWCDs) in efforts to reduce agricultural nonpoint source (NPS) pollution loadings. This project represents a continuation of an effort outlined in the TMDL Implementation Plan using a microwatershed approach to target water quality monitoring and agricultural producer assistance to help reduce phosphorus loadings to the North Bosque River. This specific effort focuses on monitoring microwatersheds to target areas needing BMP implementation associated with springtime manure and fertilizer applications. Manure and fertilizer are often applied in the spring to provide nutrients for crop growth and development.

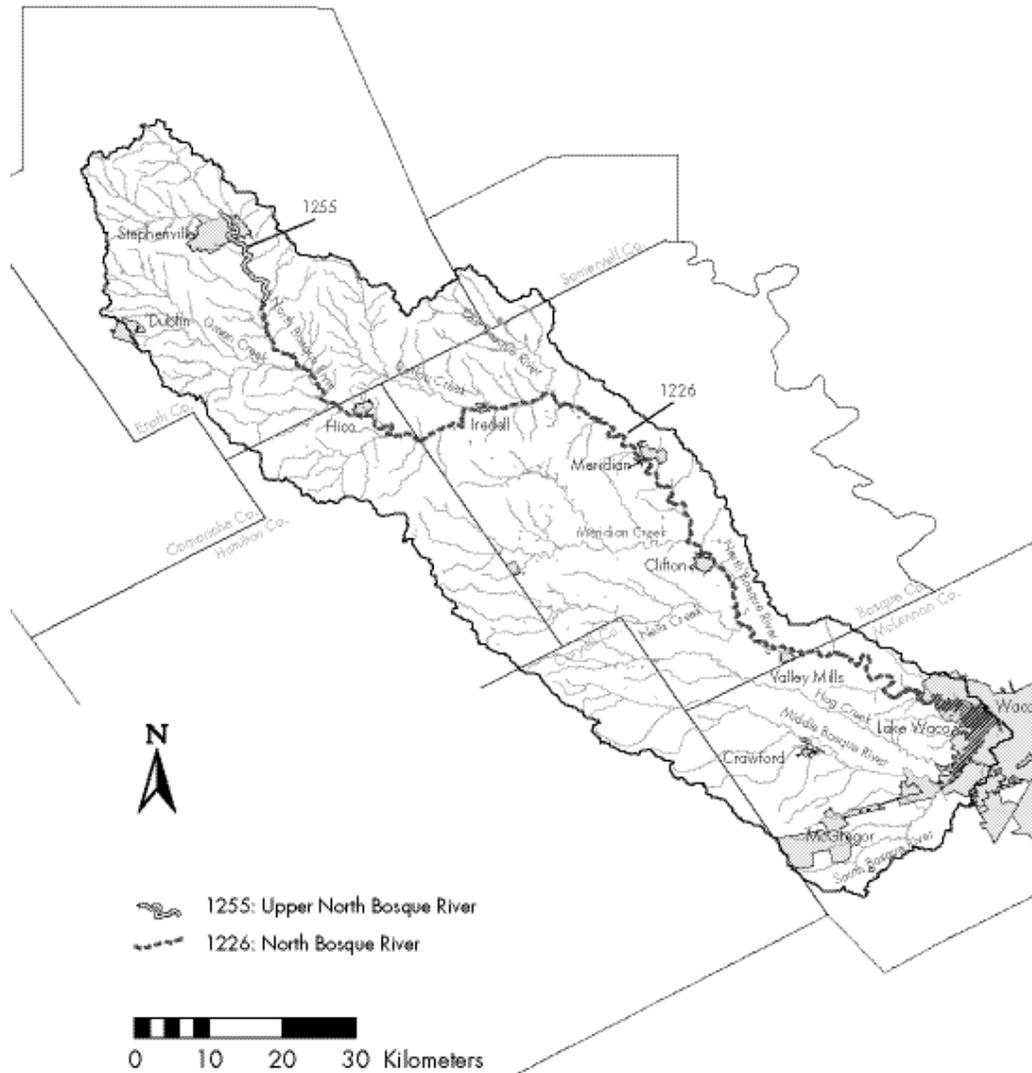


Figure 1. Classified stream segments along the North Bosque River.

Within the upper portion of the North Bosque River watershed, where most of the dairy operations are located, spring and early summer rains can be quite heavy and intense contributing potentially large amounts of runoff from agricultural fields to streams and tributaries. Historically, the month with the greatest rainfall is May (Figure 2). Fertilizer application (either as manure or commercial) is generally recommended in April or May in the North Bosque River watershed depending on the crop being grown. To evaluate improvements associated with Implementation Plan practices, such as nutrient management of manure and fertilizer, focused monitoring and assessment efforts are needed of springtime contributions of nutrients and bacteria.

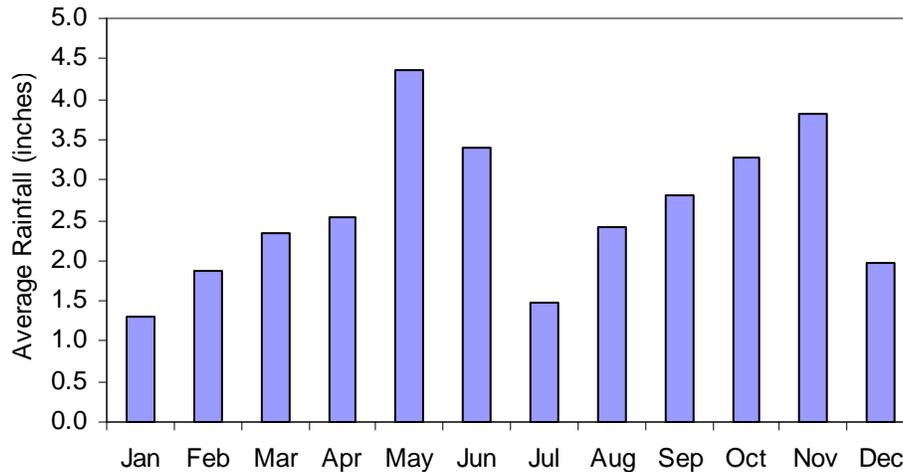


Figure 2. Long-term average monthly rainfall (1971-2000) for Stephenville, Texas (Source: National Weather Service).

General Project Description:

The primary focus of this 319(h) project is to assess the preexisting and post-TMDL implementation effects at the microwatershed level. A secondary focus is to provide TSSWCB and local SWCDs with support in targeting areas needing water quality improvement.

In this project, TIAER will provide continued assessment activities at 18 microwatershed sites within the North Bosque River (Figure 3). The monitoring effort will be a continuation of a current 319 project (FY01-17, Extending TMDL Efforts in the North Bosque River Watershed) that ends in March 2008. The proposed project will extend monitoring of microwatershed sites through June 2008 to allow monitoring of spring and early summer nonpoint source contributions. The report for this project will focus specifically on improvements in water quality associated with spring and early summer runoff events pre- and post-TMDL implementation, while the focus of FY01-17 report will more broadly assess step-trends in water quality using year-round base and storm event data.

The monitoring effort will make use of numerous automated sampling systems in TIAER's possession that will be made available to this project. Historical or nondirect data obtained from other projects with approved EPA or the State of Texas QAPPs will also be used to supplement this project. The data collected for this project will be used to determine the reduction of NPS pollution associated with post-TMDL implementation efforts and provide data to inform TSSWCB of areas where focused reduction efforts are most needed.

These 18 microwatersheds represent a variety of land uses within the watershed and provide focused monitoring in the upper portion of the North Bosque River watershed where most dairy operations are located (Table 1). Most of these stream sites have been monitored since April or May 2001, although some sites have a monitoring history extending back to 1991 (Table 2). The historical water quality data available at these sites has been collected by TIAER and will be made available as non-direct data to this project for use in the assessment of water quality improvements.

Figure 3. Location of microwatershed sampling sites within the upper portion of the North Bosque River watershed.

Table 1. Estimated land use and drainage area above sampling sites.

TIAER Site ID	Wood & Range (%)	Pasture (%)	Cropland (%)	Dairy Waste App. Fields (%) ^a	Urban (%)	Other (%)	Total Area (Hectares)
AL020	57.6	23.0	7.4	11.4	0.7	0.0	4,720
DB035	46.2	24.1	12.8	14.0	2.3	0.6	2,130
DC040	72.5	4.8	7.1	14.9	0.6	0.0	6,250
GB020	40.6	17.7	0.6	40.6	0.6	0.0	440
GB025	29.5	13.5	0.6	55.9	0.5	0.0	660
GB040	21.1	42.8	4.9	30.2	0.7	0.1	540
GC045	61.5	22.2	8.4	6.4	0.9	0.5	11,900
GM060	78.1	13.3	2.8	5.7	0.1	0.0	4,410
HY060	71.7	12.9	12.3	2.9	0.1	0.1	11,800
IC020	64.9	16.8	6.1	11.8	0.3	0.0	1,740
LD040	59.3	5.4	5.5	29.6	0.1	0.1	2,960
LG060	66.2	16.7	9.4	7.1	0.1	0.5	4,260
NF009 ^b	58.4	27.2	11.4	2.7	0.2	0.0	520
NF020	29.7	14.2	3.3	52.6	0.1	0.1	800
NF050	45.6	34.1	8.3	11.2	0.3	0.6	8,370
SC020	68.7	9.4	1.4	20.0	0.1	0.4	1,900
SF085	50.6	26.5	5.6	14.3	2.2	0.7	12,900
SP020 ^c	82.6	12.0	5.2	0.0	0.1	0.1	1,560

^a Information on dairy waste application fields within microwatersheds was obtained from dairy permits and dairy waste management plans on record with the TCEQ as of May 2000.

^b Site NF009 represents a microwatershed stream site with minimal impact from dairies but with impact from other agricultural practices for comparison.

^c Site SP020 represents a least impacted or reference microwatershed stream site for comparison as a control.

Table 2. Location and sampling history of monitoring sites.

TIAER Site ID	TCEQ ID	Watershed and General Location	Date of First Grab Sample	Date of First Automatic Storm Sample
AL020	17604	Alarm Creek at FM 914	14-May-01	5-Sep-01
DB035	17603	Dry Branch near FM 8	2-Apr-02	5-Feb-02
DC040	17607	Duffau Creek at FM 2481	16-Apr-01	7-May-01
GB020	17214	Unnamed tributary to Goose Branch between CR 541 and CR 297	11-May-95	5-May-95
GB025	17213	Unnamed tributary to Goose Branch near end of CR 297	12-Feb-97	19-May-97
GB040	17215	Goose Branch downstream of FM 8	12-Feb-97	6-Feb-97
GC045	17609	Green Creek upstream of SH 6	16-Apr-01	26-May-01
GM060	17610	Gilmore Creek at bend of CR 293	5-Feb-01	31-Aug-01
HY060	17611	Honey Creek at FM 1602	16-Apr-01	4-May-01
IC020	17235	Indian Creek downstream of US 281	8-Jun-94	18-Oct-93 ^a
LD040	17608	Little Duffau Creek at FM 1824	14-May-01	31-Aug-01
LG060	17606	Little Green Creek at FM 914	14-May-01	14-Jul-01
NF009	17223	Unnamed tributary of Scarborough Creek at CR 423	18-Apr-91	16-May-92 ^b
NF020	17222	North Fork North Bosque River Scarborough Creek at CR 423	30-Oct-91	19-May-92
NF050	17413	North Fork of North Bosque River at SH 108	4-Apr-91	7-Jun-91 ^c
SC020	17240	Sims Creek upstream of US 281	21-Sep-94	17-Jan-95 ^a
SF085	17602	South Fork of North Bosque River at SH 108	30-Apr-01	26-May-01
SP020	17242	Spring Creek at CR 271	8-Jun-94	20-Oct-93 ^a

^a Storm sampling suspended from March 3, 1998 to May 3, 2001 at IC020 and SP020 and from March 3, 1998 through May 12, 2001 at SC020.

^b Storm sampling at NF009 was suspended from March 25, 1998 through June 12, 1998.

^c Storm sampling at NF050 was suspended from February 9, 1997 through May 4, 2001.

The monitoring activities of this project will consist of automated stormwater sampling, some grab storm sampling, biweekly (once every two weeks) ambient grab sampling, and continuous streamflow measurements. Field measurements of dissolved oxygen, water temperature, specific conductance, and pH will occur with all grab sampling. Stormwater samples from automated samplers will be retrieved on a daily basis and flow composited into a single sample. All biweekly grab and automated storm samples will be analyzed for various nutrient forms (i.e., total phosphorus, dissolved orthophosphate phosphorus [frequently referred to as soluble reactive phosphorus], total Kjeldahl nitrogen, dissolved ammonia, dissolved nitrite plus nitrate), and total suspended sediments (TSS). The nitrogen forms are included in the laboratory analyses to provide a more complete indication of macronutrient conditions in the watershed, to evaluate whether agricultural BMPs are reducing both nutrients (nitrogen and phosphorus), and to ensure that efforts to reduce one nutrient is not inadvertently increasing another. In addition, grab samples will be collected and analyzed for *E. coli* as part of routine monitoring and during elevated flows associated with storm events to evaluate bacteria concentrations.

Project staff will also maintain equipment to record continuous water level information and take required measurements to maintain and update, as needed, existing stage-discharge relationships (rating curves) at all stations. Historical data obtained from the microwatershed monitoring will be used to establish baseline nutrient and bacteria concentrations within these smaller streams and tributaries that contribute flow to 303(d) listed classified segments within the watershed. As implementation of BMPs progress, the direct microwatershed monitoring associated with this project will more effectively measure the success of agricultural BMPs by removing the cumulative effect of urban NPS pollution and wastewater treatment plant contributions associated with stream sites along the main stem of the North Bosque River.

Tasks, Objectives, Schedules, and Estimated Costs:

Task 1: Project Administration

Costs: Federal \$3,544; Non-Federal \$2,363; Total \$5,906

Objective: To effectively coordinate and monitor all work performed under this contract including technical and financial supervision, preparation of status reports, and maintenance of project files and data. Progress reports shall document all activities performed within a quarter. Quarterly reports will be initiated in January 2008 for the revised project. Prior to December 2007, no activity is planned. As of January 2008, quarterly reports will be due by the 15th of January, April, and July 2008 based on Federal fiscal quarters (Oct.-Dec., Jan.-Mar., Apr.-Jun., and Jul.-Sep.). The final project report due in August 2008 will act as the final progress report for the project.

Task 1.1: TIAER will submit quarterly Progress Reports, which will include the status of deliverables for each objective and a narrative description of the progress on each task.

Task 1.2.: TIAER will submit appropriate Reimbursement Forms.

Deliverables

- Quarterly progress reports due to TSSWCB 15th day following the end of the Federal fiscal quarters (October-December; January-March; April-June; July-September).
- Quarterly reimbursement statements and necessary documentation based on Federal fiscal quarters.

Task 2: Quality Assurance

Costs: Federal \$1,772; Non-Federal \$1,181; Total \$2,953

Objective: To develop Data Quality Objectives (DQO), a Quality Assurance Project Plan (QAPP), and provide amendments to the QAPP, as needed. An annual revision to the QAPP will not be needed, since monitoring under this project will occur for less than a year. Because this project is an extension of a previous 319(h) project with an approved QAPP, the previous QAPP will be modified and used for this project with the goal of having it approved by April 1, 2008, so sampling may continue seamlessly between projects without a gap in time. The previous project ends March 31, 2008.

Task 2.1: Develop data quality objectives and submit a draft Quality Assurance Project Plan for review by the TSSWCB and EPA at least two months prior to the initiation of the project.

Task 2.2: Revise QAPP for approval by the TSSWCB and EPA and finalize by April 1, 2008.

Task 2.3: Provide amendments of the QAPP, as necessary, to the TSSWCB and EPA.

Deliverables

- Approved QAPP
- Approved amendments to QAPP

Task 3: Data Collection

Costs: Federal \$58,717; Non-Federal \$39,145; Total \$97,862

Objective: To perform routine grab and storm assessment activities at stream sampling sites including collection of flow and associated measurements for maintaining stage-discharge relationships. Direct sampling under this project is planned to start in April 1, 2008, assuming an approved QAPP is in place, and continue until June 30, 2008.

Task 3.1: TIAER will perform routine biweekly grab sampling at all 18 stream sites (Figure 1). Water quality samples will be collected only if water is flowing. If water is not flowing when biweekly sampling is scheduled, a water quality sample will not be collected, but it will be documented that the stream is pooled or dry. Routine grab samples will be analyzed for nutrient forms, and TSS. In addition, field constituents of dissolved oxygen, pH, conductivity, and water temperature will be recorded at the time grab samples are collected. Based on a historical review, these sites are generally dry or not flowing about 40 percent of the time when visited for routine grab sampling. Based on this information, a maximum of 60 grab samples over the three months of sampling were budgeted for the project. If stream conditions during the project lead to the potential for more samples than the maximum anticipated for routine grab samples, modifications to the sampling design will occur. These modifications may include reducing the number biweekly sampling events or reducing the number of sites sampled during a biweekly event to reduce sample load while maintaining representative sampling to meet project objectives.

Task 3.2: TIAER will maintain and operate automated samplers and water-level recorders at all 18 stream sites. Automated samplers will be set to activate sampling upon a small rise in water level and collect individual samples at sequential time intervals. At each stream site, individual

stormwater samples will be collected daily and flow composited into one sample that will be analyzed for nutrient forms and TSS. Due to the unpredictable nature of wet weather monitoring, TIAER is not able to guarantee a set number of wet weather samples from each station. Based on historical data the project is budgeted to collect and analyze a maximum of 195 storm samples. If stream conditions such as those resulting from appreciably greater than average rainfall result in more samples than budgeted, corrective measures, such as discarding samples from small runoff events, will be implemented to reduce sample load while maintaining representative sampling over the duration of the project.

Task 3.3: Stage-discharge relationships will be maintained and updated, as necessary, for all stream sites. This will include taking flow measurements and re-surveying stream cross-sections, if apparent changes have occurred.

Task 3.4: TIAER will conduct routine general maintenance of all automated sampling and water level equipment to help ensure that these instruments will operate properly during storm water conditions.

Task 3.5: TIAER will collect grab samples for analysis of *E. coli* as part of routine biweekly sampling and during elevated flows associated with storm events. Storm samples for *E. coli* will be collected once per day during elevated flows with sampling continuing at least one day after flow levels have receded (assuming flow is still occurring) to evaluate changes in *E. coli* concentrations with changes in flow. To accommodate lab and field staff due to the relatively short holding times associated with bacteria samples (8 hours), storm sampling of bacteria will occur only during the standard work week (Monday – Friday) and not on weekends. Modifications to this sampling regime may also occur to accommodate available incubator and laboratory space, if an extended wet-weather period is encountered. A maximum of 60 routine and 195 storm grab samples will be analyzed for *E. coli*. If wet-weather conditions lead to the potential for more samples than the budgeted maximum, modifications to the sampling design, such as reducing the number of sites or the number of events analyzed will be taken to reduce sample load while maintaining representative sampling to meet project objectives.

Deliverables

- A water quality data summary for each site will be submitted to the TSSWCB as part of TIAER's semiannual water quality report of assessment activities in the Bosque River watershed.

Task 4. Assessment

Costs: Federal \$26,057; Non-Federal \$17,371; Total \$43,428

Objective: Develop a report assessing the impact of post-TMDL implementation activities on stream water quality focusing on springtime contributions.

Task 4.1: During the last few months of the project, TIAER will develop a final project report that will evaluate the success of post-TMDL implementation activities on water quality at microwatershed stream sites. A draft of this report will be submitted to the TSSWCB for review at the end of the project. All TSSWCB comments will be considered and addressed before finalizing the report.

Deliverables

- Draft and final project report.

Project Management:

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Assessment of Springtime Contributions to the North Bosque River Watershed
Schedule of Milestones
August 25, 2004 – August 31, 2008

Task	Project Milestones	Start	End
1	Quarterly Progress Reports	Aug. 25, 2004	Aug. 31, 2008
2	Approved QAPP	Dec. 1, 2007	March 31, 2008
3	QAPP Amendments	Apr. 1, 2008	Jun. 30, 2008
3	Monitoring Activities	Apr. 1, 2008	Jun. 30, 2008
4	Final Assessment Report	Jun. 1, 2008	Aug. 31, 2008

Appendix B. Example Field Data Sheets

General Maintenance

SITE _____ DATE _____ TIME (CST) _____ INITIALS _____

Level _____ Enable _____ callout _____
 Battery ___% New En/Dis _____

Desiccants: OK Changed
 Bottles: Full of Clean Needs _____ Added

Flowmeter SPA652 4230 3230

Sampler :
 Display _____ Reset to SI Yes No
 Reset arm to bottle 1 Yes
 Checked distributor arm nut

Time interval: Uniform NonUniform Reset start time Yes Time _____
 NonUniform Reset start time No

Sampling interval: Time Flow
 Line: OK Clear Damaged Silted/Clogged
 Purged Acid Washed Test sample collected (monthly)
 Position in arm OK Reset

Pump tubing Current counts _____ Alarm counts _____
 Changed Reversed Checked all connections
 Reset counter # counts _____ Restart sampler YES

Bubbler: XS OK Silted Scoured Requires new survey
 Line OK Clear Damaged Requires new survey

TB Rain Gauge: Clear Cleaned Weekly inches recorded _____
 Checked operation Number of tips _____

QA rain gauge: Clear Cleaned Weekly inches collected _____

Downloaded: Sampler Flowmeter Met Viewed graph

Color Code: _____

Bottles used for composite: _____

Samples Missed: Yes No CAR number _____

Comments:

**Field Data Sheet
 Streams**

(Working draft: 27Oct05)

Site: TIAER	Flowmeter level in ft. (bl sites)	Time:	Investigators:
TCEQ		Color Code:	Project:
Date:		Location: <i>run glide</i>	Observations (select from below): Wind intensity Dir.(opt.)
Air Temp:		<i>riffle pool</i>	Present Weather

Hydrological Parameters

Total Depth: _____ ft.

Sample #	Sample Depth (ft)	Place Sonde Readings Here					Flow Sev. (select from below)
		Temp C	Cond us	DO %Sat	DO mg/L	pH	
	*						
	1.00 **						
	record depth	* If total depth is <1.5 ft. collect at 1/3 total dep ** If total depth >1.5 ft. collect at 1 ft.					
		Bacteria Sample - sterilized bottle					
		Chlorophyl Sample - dark bottle					
		Filtered NO2NO3N, NH3N - acidified					
		TKN, TP acidified					
		Filtered OPO4 (FPO4)					
		Field Split of Sample _____ Nutrient Fecal Chl					

Estimated Flow Severity 1. no flow 2. low 3. normal 5. high 4. flood 6. dry

Wind intensity 1. Calm 2. Slight 3. Moderate 4. Strong

Present Weather 1. Clear 2. Pt. Cloudy 3. Cloudy 4. Rain

Last Significant Rainfall (in days) <1 (w/in 24 hrs) 1 2 3 4 5 6 7 >7 (over a week) _____

Hi/Lo Drop DO Atm % Start Atm % End DO ch pH mv

Datasonde used: _____

Comments:

Unusual Observations: (dBase info) _____

General Observations: _____

Field Calib.	Time	Temp	Actual	Initial	mg/L	%	DO ch	gain
Baro.		Table DO	x %Atm					

Appendix D. Example Corrective Action Report (CAR)

Corrective Action Report

SOP-Q-105

CAR #: 08-003

Report Initiation Date _____ Report By: _____ Procedure or QC Typ _____

Deviation: _____

Analyte: _____

Affected Sample #s: _____

Sampling Station: _____

Project(s): _____

Attached Documentation:

- COC
- FDS
- FlowLink
- Flow8
- GM
- Log Book
- QC Sheet
- Memo
- Other

Details of the problem, nonconformance or out-of-control situation:

Possible Causes:

Corrective Actions Taken:

Corrective Actions Suggested:

CAR routed to: _____ Date: _____

Supervisor: Tier 1 (does not affect final data integrity) Tier 2 (data accepted but flag required) Tier 3 (possibly affects final data integrity)

Corrective actions taken for specific incident: _____

Corrective actions taken to prevent recurrences: _____

Corrective actions to be taken: _____

Responsible Party: _____ Proposed completion date: _____

Effect on data quality: _____

Responsible Supervisor: _____ Date: _____

Concurrence:

Program/Project Manager: _____ Date: _____
(Tier 3 CARs only)

Quality Assurance Officer: _____ Date: _____