Bryan W. Shaw, Ph.D., *Chairman*
Carlos Rubinstein, *Commissioner*
Toby Baker, *Commissioner*
Zak Covar, *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

August 20, 2012

Anne McFarland
Texas Institute for Applied Environmental Research
Tarleton State University
201 St. Felix Street
Stephenville, Texas 76401

Re: Evaluating Effectiveness of Implementation Activities within the north Bosque River Watershed Quality Assurance Project Plan (QAPP)

Approved: August 20, 2012 (Next update due August 20, 2013)
QAPP Revision Date: July 5, 2012

Dear Dr. McFarland:

The above named QAPP has been approved. The original document and signature pages are enclosed as documentation of approval.

In accordance with the terms of the QAPP, **please ensure that copies of this document and any subsequent amendments are distributed to each sub-tier participant as noted in Section A3 of the QAPP.** This approval letter must be available for review during a monitoring systems audit.

Should you have questions, please contact me at (512) 239-0425.

Sincerely,

Kyle Girten
Quality Assurance Specialist

enclosure

cc: Sharon Coleman, Senior Quality Assurance Specialist, MC 165
Tim Cawthon, Project Manager, MC 203

Evaluating Effectiveness of Implementation Activities within the North Bosque River Watershed
Quality Assurance Project Plan

Texas Institute for Applied Environmental Research
Stephenville, Texas 76402

Funding Source:

Nonpoint Source Program CWA §319(h)
Prepared in cooperation with the Texas Commission on Environmental Quality
and the U.S. Environmental Protection Agency
Federal ID #905011

Effective Period: One year from date of final approval

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

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Research Scientist
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Stephenville, Texas 76402
(254) 968-9581
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A1 APPROVAL PAGE

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ)

Field Operations Support Division

Stephen Stubbs 8-20-12
Stephen Stubbs, TCEQ Quality Assurance (QA) Manager — Date

8/20/12
Kyle Girten, Lead Nonpoint Source (NPS) QA Specialist, Quality Assurance Team — Date

Water Quality Planning Division

8/7/12
Kerry Niemann, Team Leader Nonpoint Source Program — Date

8/9/12
Nancy Ragland, Team Lead Data Management and Analysis — Date

Anjusheema Chalise 8/07/2012
Anju Chalise, NPS QA Specialist Nonpoint Source Program — Date

Tim Cawthon 8/3/12
Tim Cawthon, Project Manager Nonpoint Source Program — Date

TEXAS INSTITUTE FOR APPLIED ENVIRONMENTAL RESEARCH (TIAER)

12 July 2012
Anne McFarland, Project Manager Date

12 July 2012
Nancy Easterling, QA Officer Date

TIAER Laboratory

7/16/12
Mark Murphy, Laboratory Manager Date
and Laboratory QA Officer

The TIAER will secure written documentation from additional project participants (e.g., subcontractors, laboratories) stating the organization's awareness of and commitment to requirements contained in this quality assurance project plan and any amendments or revisions of this plan. The TIAER will maintain this documentation as part of the project's quality assurance records. This documentation will be available for review. Copies of this documentation will also be submitted as deliverables to the TCEQ NPS Project Manager within 30 days of final TCEQ approval of the Quality Assurance Project Plan (QAPP). (See sample letter in Attachment 1 of this document.)

TRINITY RIVER AUTHORITY (TRA) CENTRAL REGIONAL WASTEWATER SYSTEM (CRWS) LABORATORY

Craig Harvey 7/20/12
Craig Harvey Date
Laboratory Division Chief

Cathy Sieger 7/21/12
Cathy Henderson-Sieger Date
Quality Assurance Coordinator

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A3 DISTRIBUTION LIST

The Lead NPS QA Specialist will provide original versions of this project plan and any amendments or revisions of this plan to the TCEQ NPS Project Manager and the TIAER Project Manager. The TCEQ NPS Project Manager will provide copies to the TCEQ Data Management and Analysis Team Leader and EPA Project Officer within two weeks of approval. The TCEQ NPS Project Manager will document receipt of the plan and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review.

Texas Commission on Environmental Quality
P.O. Box 13087 Austin, Texas 78711-3087

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Quality Assurance Team
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State/Tribal Section
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Dallas, TX 75202-2733
Leslie Rauscher, Project Officer
(214) 665-2773

The TIAER will provide copies of this project plan and any amendments or revisions of this plan to each project participant defined in the list below. The TIAER will document receipt of the plan by each participant and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review.

Texas Institute for Applied Environmental Research
P.O. Box 0410, Tarleton State University, Stephenville, Texas 76402

Anne McFarland, Project Manager
(254)-968-9581

Nancy Easterling, Quality Assurance Officer
(254)-968-9548

Mark Murphy, Laboratory Manager and Laboratory Quality Assurance Officer
(254) 968-9570

Jeff Stroebel, Project Field Operations Supervisor
(254) 968-9556

Trinity River Authority CRWS Laboratory
6500 West Singleton, Dallas Texas 7512

Craig Harvey, Laboratory Division Chief
(972) 263-2251

Cathy Henderson-Sieger, Quality Assurance Coordinator
(972) 263-2251

List of Acronyms

ACS	American Chemical Society
AFO	Animal Feeding Operation
ASTM	American Society for Testing and Materials
AWRL	Ambient Water Reporting Limit
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
CAP	Corrective Action Plan
CAR	Corrective Action Report
CMIP	Composted Manure Incentive Project
CNMP	Comprehensive Nutrient Management Plan
COC	Chain of Custody
CRWS	Central Regional Wastewater System
CWA	Clean Water Act
DMES	Dairy Manure Export Support
DMP	Data Management Plan
DMRG	Data Management Reference Guide
DM&A	Data Management and Analysis
DOC	Demonstration of Capability
DOQ	Digital Orthophoto Quadrangles
DQO	Data Quality Objective
EPA	Environmental Protection Agency
GIS	Geographic Information System
GM	General Maintenance
GPS	Global Positioning System
ISCO	ISCO equipment by Teledyne ISCO Inc., Lincoln, Nebraska
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
LOD	Limit of Detection
LOQ	Limit of Quantitation
MS	Matrix Spike
NELAC	National Environmental Laboratory Accreditation Conference

NELAP	National Environmental Laboratory Accreditation Program
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
PM	Project Manager
PO	Project Officer
QA/QC	Quality Assurance/Quality Control
QAM	Quality Assurance Manual
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Specialist
QMP	Quality Management Plan
RPD	Relative Percent Difference
SAS	SAS database and statistical software by SAS Institute Inc., Cary, North Carolina
SLOC	Station Location
SOP	Standard Operating Procedure
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TIAER	Texas Institute for Applied Environmental Research
TIGER	Topologically Integrated Geographic Endcoding and Referencing system
TMDL	Total Maximum Daily Load
TRA	Trinity River Authority
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
USGS	United States Geological Survey
WAF	Waste Application Field
WISKI	Water Management Information System by Kisters North America, Inc., Citrus Heights, California
WQI	Water Quality Inventory
YSI	YSI equipment by YSI Inc., Yellow Springs, Ohio

A4 PROJECT/TASK ORGANIZATION

TCEQ

Field Operations Support Division

Kyle Girten
Lead NPS QA Specialist (QAS)
Assists the TCEQ Project Manager in QA related issues. Serves on planning team for NPS projects. Participates in the planning, development, approval, implementation, and maintenance of the QAPP. Determines conformance with program quality system requirements. Coordinates or performs audits, as deemed necessary and using a wide variety of assessment guidelines and tools. Concurs with proposed corrective actions and verifications. Monitors corrective action. Provides technical expertise and/or consultation on quality services. Provides a point of contact at the TCEQ to resolve QA issues. Recommends to TCEQ management that work be stopped in order to safe guard project and programmatic objectives, worker safety, public health, or environmental protection.

Water Quality Planning Division

Kerry Niemann, Team Leader
NPS Program
Responsible for management and oversight of the TCEQ NPS Program. Oversees the development of QA guidance for the NPS program to be sure it is within pertinent frameworks of the TCEQ. Monitors the effectiveness of the program quality system. Reviews and approves all NPS projects, internal QA audits, corrective actions, reports, work plans, and contracts. Enforces corrective action, as required. Ensures NPS personnel are fully trained and adequately staffed.

Tim Cawthon
TCEQ NPS Project Manager
Maintains a thorough knowledge of work activities, commitments, deliverables, and time frames associated with projects. Develops lines of communication and working relationships between the contractor, the TCEQ, and the 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. Serves on planning team for NPS projects. Participates in the development, approval, implementation, and maintenance of the QAPP. Assists the TCEQ QAS in technical review of the QAPP. Responsible for verifying that the QAPP is followed by the contractor. Notifies the TCEQ QAS of particular circumstances which may adversely affect the quality of data derived from the collection and analysis of samples. Enforces corrective action.

Anju Chalise
NPS Quality Assurance Specialist
Assists Lead QAS with NPS QA management. Serves as liaison between NPS management and Agency QA management. Responsible for NPS guidance development related to program quality assurance. Serves on planning team for NPS projects. Participates in the development, approval, implementation, and maintenance of the QAPP.

Rebecca Ross
NPS Data Manager
Responsible for coordination and tracking of NPS data sets from initial submittal through NPS Project Manager review and approval. Ensures that data are reported following instructions in the Surface Water Quality Monitoring Data Management Reference Guide (January 2010, or most current version). Runs automated data validation checks in Surface Water Quality Monitoring Information System (SWQMIS) and coordinates data verification and error correction with NPS Project Managers' data review. Generates SWQMIS summary reports to assist NPS Project Managers' data reviews. Provides training and guidance to NPS and Planning Agencies on technical data issues. Reviews QAPPs for valid stream monitoring stations. Checks validity of parameter codes, submitting entity code(s), collecting entity code(s), and monitoring type code(s). Develops and maintains data management-related standard operating procedures for NPS data management. Serves on planning team for NPS projects.

TEXAS INSTITUTE FOR APPLIED ENVIRONMENTAL RESEARCH

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 the TCEQ. Responsible for writing and verifying the QAPP is followed and the project is producing data of known and acceptable quality. Ensures adequate training and supervision of all monitoring and data collection activities. Complies with corrective action requirements. Responsible for acquisition and verification of non-direct data as outlined in Section B10 used to meet project objectives and transfer, as appropriate, of specified non-direct data to TCEQ Project Manager.

Nancy Easterling
TIAER QAO
Responsible for coordinating development and implementation of the QA program. Responsible for reviewing and maintaining the QAPP. Responsible for maintaining records of QAPP distribution, including appendices and amendments. Responsible for maintaining written records of sub-tier commitment to requirements specified in this QAPP. Responsible for identifying, receiving, and maintaining project quality assurance records. Responsible for coordinating with the TCEQ QAS to resolve QA- related issues. Notifies the TIAER Project Manager and TCEQ Project Manager of particular circumstances which may adversely affect the quality of data.

Responsible for validation and verification of all data collected and analyzed according with Table A7.1 specifications. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Conducts laboratory inspections. Develops, facilitates, and conducts monitoring systems audits.

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.

Mark Murphy
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 the report is sent to the TCEQ. 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.

Nancy Easterling
TIAER Project Data Manager
Responsible for the acquisition, verification, and transfer of direct monitoring data collected under this QAPP to the TCEQ as appropriate for SWQMIS. Oversees data management for the study. Performs data quality assurances prior to transfer of data to TCEQ. Responsible for transferring data to the TCEQ in the Event/Result file format specified in the DMRG. Ensures data are submitted according to workplan specifications. Provides the point of contact for the TCEQ Data Manager to resolve issues related to the SWQMIS data.

Jeff Stroebel
TIAER Project Field Operations 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 is appropriately trained as specified in Sections A6 and A8.

TRINITY RIVER AUTHORITY CRWS LABORATORY

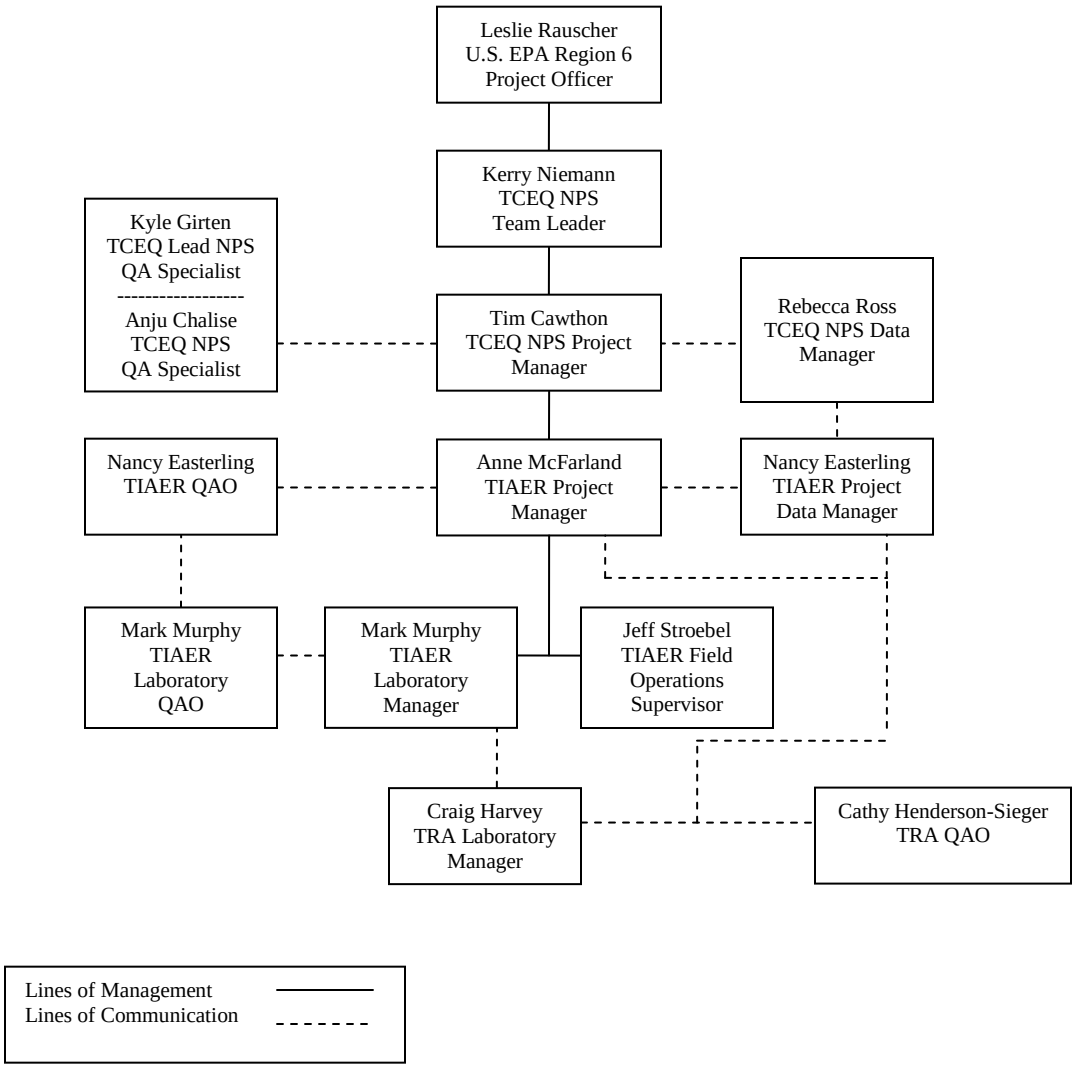
Craig Harvey
Laboratory Division Chief
Responsible for supervision of laboratory personnel involved in generating analytical data for this project. Responsible for ensuring that laboratory personnel involved in generating analytical data have adequate training and a thorough knowledge of the QAPP and 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.

Cathy Henderson-Sieger
Quality Assurance Coordinator
Responsible for making sure QA/QC requirements of this QAPP are met for data generated by the TRA. Responsible for coordinating with the TIAER QAO to resolve QA-related issues. Notifies the TIAER Project Manager of particular circumstances that may adversely affect the quality of data.

U.S. EPA Region 6

Leslie Rauscher
EPA Project Officer
Responsible for managing the CWA Section 319 funded grant on the behalf on EPA. Assists the TCEQ 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 workplans, draft deliverables, and works with the State 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.

Figure A4.1. Organization Chart - Lines of Communication



A5 PROBLEM DEFINITION/BACKGROUND

The North Bosque River watershed is located in central Texas and covers about 780,000 acres draining into Lake Waco (see area location and site map, Appendix A). Excessive nutrients, elevated chlorophyll-a concentrations, and indicator bacteria levels exceeding established criterion have been a concern in the watershed for over a decade. The TCEQ approved two TMDLs for phosphorus in the North Bosque River for Segments 1226 and 1255 on February 9, 2001, which were subsequently submitted to and approved by the United States Environmental Protection Agency (EPA). The Implementation Plan for the two North Bosque River segments was approved by TCEQ in late 2002 and the Texas State Soil & Water Conservation Board (TSSWCB) in early 2003. Bacteria concerns continue in Segment 1255, which has resulted in that segment's listing on both the draft 2002 and 2004 State of Texas 303(d) lists. The two TMDLs and subsequent Implementation Plan focus on contaminants originating from municipal wastewater treatment plants, animal feeding operations (AFOs) including concentrated animal feeding operations (CAFOs) and animal waste application fields (WAFs).

In the approved Implementation Plan a number of efforts are presented to reduce phosphorus levels in the North Bosque River watershed. The four basic elements of phosphorus control identified in the plan are:

- Establishing phosphorus application rates on dairy waste application fields.
- Reducing phosphorus diets for dairy cows to decrease phosphorus content of dairy waste.
- Removing approximately half of the dairy-generated manure from the North Bosque River watershed for use or disposal outside the watershed.
- Setting effluent limits on phosphorus for municipal wastewater treatment plants.

The TSSWCB and the TCEQ implemented complementing programs that resulted in the collection of dairy manure and export of compost from the watershed. The TSSWCB Dairy Manure Export Support (DMES) program provided financial incentives to commercial manure haulers for the transport of raw manure from dairy farms to commercial composting projects. The complementing TCEQ Composted Manure Incentive Project (CMIP) provided oversight of commercial compost facilities and provides rebates to Texas State agencies that use the manure compost. Through August 31, 2006, about 650,000 tons of raw manure has been taken to composting facilities.

The TSSWCB Comprehensive Nutrient Management Plan (CNMP) Program was initiated in response to the Implementation Plan recommendation that dairy producers voluntarily implement CNMPs. The TCEQ has adopted a rule requiring permitted dairies in the North Bosque River watershed to implement TSSWCB-certified CNMPs by December 31, 2006.

All municipal wastewater treatment plants have been required, with their permit renewals, to monitor effluent total phosphorus. The cities of Clifton and Stephenville have phosphorus limits imposed that necessitate advanced treatment processes. In late 2005, the Stephenville facility

implemented measures to meet a daily average discharge limit of 1 mg/L total phosphorus, and Clifton is presently operating under a phosphorus limit of 7 pounds per day.

There is a need for continued sampling of the parameters of concern in the North Bosque River watershed to determine whether water pollution reduction measures are having a beneficial effect and to substantiate the cause of observed reductions.

The purpose of this QAPP is to clearly delineate the TIAER's QA policy, management structure, and procedures which will be used to implement the QA requirements necessary to verify and validate the surface water quality data collected. The QAPP is reviewed by the TCEQ to help ensure that data generated for the purposes described above are scientifically valid and legally defensible. This process will ensure that data collected under this QAPP and submitted to SWQMIS have been collected and managed in a way that guarantees its reliability and therefore can be used for the purpose(s) included in this QAPP.

A6 PROJECT/TASK DESCRIPTION

This project provides assessment activities for the North Bosque River watershed, which includes the collection and analysis of streamflow and water quality data to determine the large-scale effectiveness of best management practices (BMPs) to reduce NPS derived phosphorus. A secondary benefit of the assessment will be the evaluation of any changes to bacteria (*E. coli*) concentrations that occur as a result of BMP implementation. The monitoring activities will focus on existing stations at which temporally intensive data collection has occurred for approximately 10 years (Appendix A). The monitoring stations include

- The five North Bosque River index stations (TCEQ stations 11954, 11956, 11963, 17226, and 18003) specified in the phosphorus TMDLs and Implementation Plan,
- North Bosque River at Hico, TCEQ station 11961, located in a long reach of river where index stations are absent,
- TCEQ station 13486, which is located at TCEQ's real-time monitoring station on Green Creek, and
- TCEQ station 11826, located on Neils Creek, which is a reference or least disturbed stream for the Central Oklahoma-Texas Plains ecoregion.

The monitoring activities of this project will consist of automated stormwater sampling, biweekly (once every two weeks) ambient grab sampling, and continuous streamflow measurement at most stream stations. Streamflow measurement data associated with biweekly grab samples will be submitted to TCEQ. Both stormwater and routine sampling are included to allow evaluation of nonpoint source loadings as well as ambient stream concentrations.

Field measurements of dissolved oxygen, water temperature, specific conductance, and pH will occur with all routine grab sampling. Stormwater samples will be retrieved within 36 hours and flow composited into a single sample, except on weekends. If storm samplers are initiated on

weekends, storm samples will be collected as soon as possible on Monday morning. All water 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. In addition, routine grab samples on streams will be analyzed biweekly for chlorophyll a, monthly for *E. coli*, and quarterly for chloride and sulfate. Of note, dissolved forms of nitrite plus nitrate-nitrogen and ammonia-nitrogen will be used for routine grabs for consistency with historical data, although if routine grabs cannot be field filtered, then total forms of nitrite plus nitrate-nitrogen and ammonia-nitrogen will be analyzed. 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, and to ensure that efforts to reduce one nutrient are not inadvertently increasing another. Chlorophyll a is measured as an indication of suspended algal concentrations. Reductions in chlorophyll a concentrations are the ultimate goal of the Implementation Plan.

Stormwater sampling will occur at each stream station except TCEQ station 18003, where automated sampling is not presently feasible due to difficult and limited stream access at this location. To flow-weight storm samples, water level records will be maintained at each storm sampling station and integrated with an existing stage-discharge relationship. For stations 11963, 11826, 13486, and 17226, project staff will take the required data for maintaining and updating existing stage-discharge (rating curve) relationships. In addition, for stations 11954, 11956, and 11961, streamflow and/or rating curve data from the U.S. Geological Survey (USGS) will be used, since these stations are either in close proximity to a USGS gauge or have established relationships with a proximate USGS gauge.

As a separate task, TIAER will develop a spatial update of information regarding the location and distribution of AFOs and CAFOs within the North Bosque River watershed and associated WAFs using an ArcView Geographic Information System (GIS) platform. This GIS update of CAFO and AFO land management activities will be based on existing GIS data layers of land use/land cover, WAFs, and dairy locations developed under a previous TCEQ project, *Monitoring to Support North Bosque River Model Refinement*, conducted by TIAER. These existing GIS layers are reflective of watershed conditions in early 2000s. Updates to CAFO information will be based on a review of TCEQ permit files, while AFO information will be obtained from available records with the TCEQ, the TSSWCB, and other sources, such as milk production records. Details regarding acquired or non-direct data are addressed in Section B9.

As major project deliverables, TIAER will develop annually two interim and a final assessment report. These assessment reports will each evaluate an additional year's worth of data. The data assessment will involve trend analyses of historical water quality data at all stations and interpretation of these analyses in terms of BMP activities and related information acquired through the GIS task (e.g., changes in distribution and size of dairies and changes in land area used for WAF). The trend analyses will use state-of-the-art statistical procedures that allow correction for seasonality and streamflow variability. The assessment reports will also evaluate

the data against the phosphorus reduction goals specified in the approved TMDLs. All historical water quality and flow data to be used in these analyses were collected and analyzed by TIAER under project specific QAPPs listed in Section B9 on non-direct measurements.

This project lead entity will be TIAER at Tarleton State University. Because this project's activities entail only assessment and data analyses, TIAER will perform almost all required project activities. TIAER staff will develop a project specific QAPP, maintain automated stormwater and water level stations, collect stormwater and grab samples, provide analysis of water samples, conduct the analyses of the water quality data, and develop the interim and final assessment reports. All water quality analyses except Cl and SO_4 will be conducted by the TIAER lab. Water analyses for Cl and SO_4 will be analyzed by the TRA lab. TIAER will develop the QAPP in accordance with the guidelines found in EPA/QA R5 and pertinent TCEQ guidance and templates. TIAER resources and staff will be used to maintain necessary water quality and streamflow databases.

Information on acquired data is addressed in Section B9 of this document.

See Appendix B for the project-related work plan tasks related to data collection and schedule of deliverables for a description of work defined in this QAPP.

See Section B1 for monitoring to be conducted under this QAPP.

Revisions to the QAPP

Until the work described is completed, this QAPP shall be reissued annually on the anniversary date, or revised and reissued prior to any significant changes being made in activities, whichever is sooner. Reissuances and annual updates must be submitted to the TCEQ for approval at least 90 days before the last approved version has expired. If the QAPP expires, the QAPP is no longer in effect and the work covered by the QAPP must be halted. If the entire QAPP is current, valid, and accurately reflects the project goals and the organization's policy, the annual re-issuance may be done by a certification that the plan is current. This can be accomplished by submitting a cover letter stating the status of the QAPP and a copy of new, signed approval pages for the QAPP. If the QAPP needs to be updated to incorporate amendments made earlier in the year or to incorporate new changes, a full annual update is required. This is accomplished by submitting a cover letter, a document detailing changes made, and a full copy of the updated QAPP (including signature pages).

Amendments

Amendments to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives, and methods; address deficiencies and nonconformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for amendments are directed from the TIAER Project Manager to the TCEQ Project Manager in writing using the QAPP Amendment shell. The changes are effective immediately upon

approval by the TCEQ NPS Project Manager and Quality Assurance Specialist, or their designees, and the EPA Project Officer (if necessary).

Amendments to the QAPP and the reasons for the changes will be documented, and revised pages will be forwarded-to all persons on the QAPP distribution list as outlined in Section A3. Amendments shall 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 goal of this project is to obtain necessary water quality and streamflow data to allow assessment of the effectiveness of various BMPs and nutrient control activities that are either ongoing or scheduled for implementation in the North Bosque River watershed. A Kendall's tau test, as described by Reckhow et al. (1993) and applied to the North Bosque watershed by McFarland and Millican (2010), will be used to evaluate water quality data for trends. This trend analysis will include use of non-direct and direct data from 1993 through 2013 focusing on orthophosphate-P and chlorophyll-a as the primary parameters associated with the North Bosque River TMDLs. Trend analysis will include adjustments for flow conditions as recommended by Helsel and Hirsch (1992) as well as adjustment for left-censored data (data below the reporting limit). Potential increasing or decreasing trends will be related to watershed BMPs based on documented land-management changes. Trend analysis will also be conducted on other 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. Measurement performance specifications regarding measurement of direct data needed to assess instream water quality improvements are provided below in Table A7.1. Only data collected that have a valid TCEQ parameter code assigned in Table A7.1 are stored in SWQMIS. Any parameter listed in Table A7.1 that does not have a valid TCEQ parameter code assigned will not be stored in SWQMIS.

Table A7.1 Measurement Performance Specifications for Instream Monitoring

Parameter	Units	Method [1]	Parameter Code	AWRL	Limit of Quantitation (LOQ)	Recovery at LOQ (%)	Precision LCS/LCSD (%RPD)	Recovery of LCS	Complete-ness (%)	Respon-sible Entity
pH	pH/ units	EPA 150.1 & TCEQ SOP	00400	NA	NA	NA	NA	NA	90	TIAER Field
DO, dissolved oxygen	mg/L	EPA 360.1 & TCEQ SOP	00300	NA	NA	NA	NA	NA	90	TIAER Field
Specific Conductance	µS/cm	EPA 120.1 & TCEQ SOP	00094	NA	NA	NA	NA	NA	90	TIAER Field
Temperature	ºC	EPA 170.1 & TCEQ SOP	00010	NA	NA	NA	NA	NA	90	TIAER Field
Flow	cfs	TCEQ SOP	00061	NA	NA	NA	NA	NA	90	TIAER Field
Flow Measurement Method	1-gage 2-electric 3-mechnical 4-weir/flume 5-doppler	TCEQ SOP	89835	NA	NA	NA	NA	NA	NA	TIAER Field
Days since last precipitation	days	TCEQ SOP	72053	NA	NA	NA	NA	NA	90	TIAER Field
Flow severity	1 no flow, 2-low, 3-normal, 4-flood, 5-high, 6-dry	TCEQ SOP	01351	NA	NA	NA	NA	NA	90	TIAER Field
NO_2-N+NO_3-N, Nitrate/nitrite-N, dissolved	mg/L	SM online 4500-NO3-F	00631	0.05	0.05	70-130%	20	80-120%	90	TIAER Lab
NO_2-N+NO_3-N, Nitrate/nitrite-N, total (acidified field, lab filtered) [2]	mg/L	SM online 4500-NO3-F	00630	0.05	0.05	70-130%	20	80-120%	90	TIAER Lab
TP, Total Phosphorus	mg/L	EPA 365.4, modified [3]	00665	0.06	0.06	70-130%	20	80-120%	90	TIAER Lab
TKN, Total Kjeldahl Nitrogen	mg/L	SM 4500-NH3G, modified [3]	00625	0.20	0.20	70-130%	20	80-120%	90	TIAER Lab
Residue, total nonfiltrable (also referred to as TSS, Total Suspended Solids)	mg/L	SM 2540 D	00530	4	4	NA [4]	20	80-120%	90	TIAER Lab
OPO_4-P, Orthophosphate-P, dissolved, field filtered	mg/L	SM online 4500P-E	00671	0.01[5]	0.005	70-130%	20	80-120%	90	TIAER Lab
OPO_4-P, Orthophosphate-P, dissolved, lab filtered	mg/L	SM online 4500-P E	70507	0.01[5]	0.005	70-130%	20	80-120%	90	TIAER Lab
NH_3-N, Ammonia-N, dissolved	mg/L	SM online 4500-NH3 G [5]	00608	0.1	0.06	70-130%	20	80-120%	90	TIAER Lab
NH_3-N, Ammonia-N, total (acidified field, lab filtered) [2]	mg/L	SM online 4500-NH3 G [5]	00610	0.1	0.06	70-130%	20	80-120%	90	TIAER Lab
Chlorophyll-a	µg/L	SM online 10200-H [6]	32211	3	3	70-130%	20	80-120%	90	TIAER Lab

Parameter	Units	Method [1]	Parameter Code	AWRL	Limit of Quantitation (LOQ)	Recovery at LOQ (%)	Precision LCS/LCSD (%RPD)	Recovery of LCS	Complete-ness (%)	Respon-sible Entity
E. coli, IDEXX	MPN/100 mL	IDEXX Colilert ®[7]	31699	1	1	NA	0.5 [8]	NA	90	TIAER Lab
Holding time, E. coli, IDEXX Colilert [7]	hours	IDEXX Colilert ®	31704	NA	NA	NA	NA	NA	NA	TIAER Lab
Cl, Chloride	mg/L	EPA 300.0	00940	5	2	70-130%	20	80-120	90	TRA Lab
SO_4, Sulfate	mg/L	EPA 300.0	00945	5	2	70-130%	20	80-120	90	TRA Lab

Footnotes:

1. 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.
2. Total forms of NO_2-N+NO_3-N and NH_3-N are analyzed only if routine grabs cannot be field filtered; otherwise, dissolved forms of these parameters are analyzed for consistency with historical data.
3. 40 CFR 136 now allows for the substitution of copper in place of mercury as a digestion catalyst in this method. The preparation step of SM 4500 N-org is shared for TP and TKN.
4. Verification at the LOQ is not required for TSS.
5. Modification will be the use of the original EPA 350.1 method by not distilling the samples. TCEQ will be presented with the results of a comparison testing upon request.
6. In addition to following SM 10200-H, the SOP for chlorophyll-a will include quality control information similar to that outlined in TCEQ's chlorophyll SOP for the Clean Rivers Program.
7. *E. coli* samples analyzed by these methods should always be processed as soon as possible and within 8 hours. When transport conditions necessitate delays in delivery longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 48 hours. Only when the holding time is extended beyond the normal 8 hours will the holding time parameter (31704) be reported for data submittals to SWQMIS.
8. Based on range statistic as described in Standard Methods, online Edition, Section 9020-B, "QA/QC - Intralaboratory QC Guidelines." This criterion applies to bacteriological duplicates with concentrations >10 MPN/100 mL, which is the lower limit for acceptable counts, according to Standard Methods. Precision will be assessed using sample and sample duplicates for bacteria samples.

References:

EPA, *Methods for Chemical Analysis of Water and Wastewater*, Manual #EPA-600/4-79-020.

American Public Health Association, American Water Works Association and Water Environment Federation, *Standard Methods for the Examination of Water and Waste Water*, latest online edition.

TCEQ, *Surface Water Quality Monitoring Procedures*, Volume 1 (latest edition).

Helsel, D.R., and R.M. Hirsch. 1992. Statistical Methods in Water Resources. Elsevier Science B.V., Amsterdam, The Netherlands.

McFarland, A., and J. Millican. 2010. Assessment of Water Quality Trends for the North Bosque River through 2009. TR1002, Final Project Report to the Nonpoint Source Protection Program CWA 319(h), Texas Commission on Environmental Quality, Austin, Texas.

Reckhow, K.H., K. Kepford, and W.W. Hicks. 1993. Methods for the analysis of lake water quality trends. United States Environmental Protection Agency, Office of Water, Washington, D.C., EPA 841-R-93-003.

Reporting Limits

The Ambient Water Reporting Limit (AWRL) value for each analyte of interest is specified in Table A7.1. These values represent the highest concentration or quantity of a target variable that can be used as a reporting limit by the laboratory unless laboratory capabilities prohibit attaining an AWRL. AWRLs are program defined, and achieving them allows data to be evaluated

against established freshwater criteria. The AWRLs in Tables A7.1 must be achieved to yield data acceptable for TCEQ water quality assessments.

The limit of quantitation (LOQ) is the lowest concentration or quantity of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. Analytical results shall be reported down to the laboratory's LOQ (i.e., the laboratory's LOQ for a given parameter is its reporting limit).

The following requirements must be met in order to report results to the under this QAPP:

- The laboratory's LOQ for each analyte must be equal to or less than the AWRL as a matter of routine practice.
- The laboratory must demonstrate its ability to achieve its LOQ for each analyte by analyzing an LOQ check standard (see Section B5) with each preparation batch of samples. Control limits for LOQ check standards are found in Table A7.1.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria are provided in Section B5. In the few instances where a laboratory cannot achieve the AWRL (i.e., the laboratory's LOQ is greater than the AWRL), the data for those parameters will be used for screening purposes to determine if further sampling is warranted.

Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. It is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions, and is an indication of random error.

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.

Laboratory precision is assessed by comparing replicate analyses of laboratory control samples in the sample matrix or sample/duplicate pairs in the case of bacterial analysis. Precision results are compared against measurement performance specifications and used during evaluation of analytical performance. Program-defined measurement performance specifications for precision are defined in Table A7.1.

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 samples (LCS) and LOQ

Check Standards prepared in the sample matrix with verified and known amounts of analytes and by calculating percent recovery. Results are compared against measurement performance specification and used during evaluation of analytical performance. Project performance specifications for laboratory control standards are specified in Table A7.1.

Representativeness

The data collected for both objectives 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 measurement data represent the population being studied at the site.

Project funds were budgeted to collect and analyze 252 wet weather samples per year, which should allow monitoring of at least half of all storm events under average rainfall conditions for the watershed. 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, but will aim to collect as many as possible given the limitations of weather and project funding. To accommodate the analysis of a limited number of wet-weather samples, storm monitoring protocols are to sample only selected rather than all events, e.g., during extended periods of wet-weather activation levels for automated samplers may be raised to avoid monitoring and analysis of relatively small events, while during dry conditions, activation levels may be lowered. This means that the size of events monitored may vary with season. Fairly small events may be monitored during drier summer months, while events of the same size might be excluded from monitoring during wetter spring months. To spread monitoring throughout the project to allow a representative monitoring of storms throughout each year for trend analysis, an attempt will be made to monitor one or two events per month at each station, weather permitting. Because the project extends over three years, the data collection effort will involve multiple seasons over enough time to account for extended periods without rainfall.

Instream monitoring is designed to spatially represent water quality in the North Bosque River watershed. Data collection will be targeted toward both ambient conditions and storm events, representing water quality at high and low flow conditions. The data will be compared to historical data associated with both low and high flow conditions. The goal for meeting total representation of the monitoring will be tempered by the availability of time and funding.

Completeness

The completeness of the data is basically a relationship of how much of the data is available for use compared to total planned to be collected. 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(s) that 90% data completion is achieved.

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 and in TCEQ SOPs. 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 the Data Management Plan.

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.

While all sampling stations for this project already have TCEQ Station Location (SLOC) identification numbers, TIAER has personnel on staff certified with TCEQ for the collection of global positioning (GPS) data, and these staff members will maintain their certification throughout the project.

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 automatic samplers and multisondes and retrieve the samples. The QA officer or designee will sign off each field staff in the field training logbook which will be retained in the personnel file and will be available during a monitoring systems audit.

Laboratory analysts have a combination of experience, education, and training to demonstrate a 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. The certifications statement is retained in the personnel file and will be available during audits. Annual DOCs are a part of analyst training thereafter.

The TIAER and TRA laboratories are NELAP accredited through TCEQ for the parameters outlined for analysis in Table A7.1.

A9 DOCUMENTS AND RECORDS

Laboratory Test Reports

Test/data reports from the laboratory will document results clearly and accurately. Routine data reports should be consistent with the NELAC standards (Section 5.5.10) and include the following information necessary for interpretation and validation of data:

- Sample results
- Units of measurement
- Sample matrix
- Station information
- Date and time of sample collection
- Identification of test method
- Sample depth
- Holding time for *E. coli* analysis, IDEXX Colilert method, if necessary
- LOQ and LOD
- A certification that the test results comply with all requirements of NELAC or reasons and/or justification if they do not

Electronic Data

Monitoring data with appropriate parameter codes (see Table A7.1) will be submitted to the TCEQ semiannually as outlined in the project work plan under Task 4.6 for SWQMIS. All data will be submitted in the event/result format specified in the TCEQ Data Management Reference Guide (DMRG; January 2010 or most recent version) for upload to SWQMIS. The Data Summary contained in Appendix C of this document will be submitted with the data. The routine stream data will be loaded to SWQMIS under monitoring type RT. The monitoring type for wet weather data will be listed as AF for biased flow collected by an automated sampling device. Under some conditions, wet-weather samples may be collected as a manual grab sample if there are problems with the automated sampler and will be listed as BF for biased flow. TIAER will check with the TCEQ project manager prior to submitting any data to make sure the appropriate codes are implemented. Data collection sites for this project have been assigned a SWQMIS Station Identification Number by TCEQ.

Submitting Entity, Collecting Entity, and Monitoring Type will reflect the project organization of reporting the data, who will be collecting the data, and data collection targeted toward NPS data as follows:

Sample Description	Tag Prefix	Submitting Entity	Collecting Entity	Monitoring Type
Routine stream grab samples	TA	TIAER (TA)	TIAER (TA)	RT
Wet-weather stream samples collected with automated sampler	TA	TIAER (TA)	TIAER (TA)	AF
Wet-weather stream samples collected manually	TA	TIAER (TA)	TIAER (TA)	BF

Records and Documents Retention Requirements

Document/Record	Location	Retention	Form
QAPP, amendments, and appendices	TIAER	5 years	Paper
QAPP distribution documentation	TIAER	5 years	Paper
Training records	TIAER/TRA	5 years	Paper
Field notebooks or field data sheets	TIAER	5 years	Paper
Field equipment calibration/maintenance	TIAER	5 years	Paper
Field instrument printouts	TIAER	5 years	Paper
Chain of custody records	TIAER	5 years	Paper
Field SOPs	TIAER	5 years	Paper
Laboratory QA manuals	Lab	5 years	Paper
Laboratory SOPs	Lab	5 years	Paper
Laboratory procedures	Lab	5 years	Paper
Instrument raw data files	Lab	5 years	Electronic
Instrument readings/printouts	Lab	5 years	Paper
Laboratory data reports/results	Lab	5 years	Paper
Laboratory equipment maintenance logs	Lab	5 years	Paper
Laboratory calibration records	Lab	5 years	Electronic
Corrective action documentation	TIAER/TRA	5 years	Electronic/Paper

B1 SAMPLING PROCESS DESIGN (EXPERIMENTAL DESIGN)

The sample design rationale for the study is based on the intent to assess reduction in levels of phosphorus and other constituents 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 Appendix A. The monitoring activities focus on existing sampling stations at which temporally intensive data collection has occurred for approximately ten years. Five of the stations are index stations located along the North Bosque River, one station is located in a long reach of the North Bosque where index stations are absent, one station is located at TCEQ's real-time monitoring station on a major tributary to the North Bosque River, and one station is a located on a least disturbed reference stream that is a tributary to the North Bosque River.

Routine instream water quality samples will be collected from the project sampling stations on a biweekly basis, when flow is present. Field measurements of dissolved oxygen, water temperature, specific conductance, and pH will occur with all grab sampling. Flow measurement data (from TIAER and USGS gage measurement stations) associated with routine grab sample collection and field measurements will be submitted to TCEQ. Of note, flow will not be routinely measured or reported for Station 18003, because the location is not conducive to installment of a gaging station and access makes the location difficult to obtain routine flow measurements. All water 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. In addition, routine grab samples on streams will be analyzed for chlorophyll-a, and on a monthly basis stream samples will be analyzed for *E. coli*, and on a quarterly basis for chloride and sulfate. If routine grab samples cannot be field filtered (e.g., due to excessive sample turbidity), the ammonia and nitrite plus nitrate nitrogen aliquots will be analyzed as total ammonia and total nitrite plus nitrate nitrogen rather than dissolved and the orthophosphate aliquot will be noted as lab filtered using the appropriate parameter code. The analytical results will be evaluated against comparable historical stream data to determine if there is an improvement in water quality. Field data and 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.

Monitoring stations with automatic samplers and flow meters are installed at designated stations along the mainstem of the North Bosque River and two tributaries to ensure that reliable and representative sampling of wet weather events is achieved both up and down gradient. Automated samplers are located at all project stations except 18003 (BO083). Table B1.2 provides the monitoring stations, measured parameters, and estimated frequency of wet weather sample collection.

Each wet-weather monitoring station will have an ISCO (Teledyne ISCO Inc., Lincoln, Nebraska) automatic sampler with 24 1-liter bottles, a bubbler flow meter, and a housing unit. The bubbler flow meter will measure the flow level and a computer program at TIAER will calculate flow rates according to the known level to flow rate relationship of the primary device. The flow meter will be programmed to log stream level data every five minutes and to trigger the automatic sampler to start sampling at a given stream level.

The automatic sampler will be programmed to take liter samples, starting when the level is elevated by a set amount based on the conditions of the site and previous wet or dry weather conditions. After the initial sample, samples will be collected as follows: one sample each at one-, two-, and three-hour intervals. Subsequent samples will be collected at four-hour intervals. Sampling will continue until the flow level drops below the initiation level or it is determined that the hydrograph has leveled off and streamflow is no longer predominately representative of stormwater runoff. Initiation and termination levels may be adjusted during the project,

depending on changing conditions. 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.

Table B1.1 Monitoring Sites and Monitoring Frequencies for Routine Sampling

Station ID - TCEQ TIAER	Site Description	Latitude Longitude	Start Date	End Date	Sample Matrix	Routine Monitoring Frequencies (per year)					
						TSS & Sonde	Nut-rients	*E. coli*	Chla	Cl & SO_4	Comments
11826 NC060	Neils Creek at SH 6 near Clifton	31.693453 -97.535316	01Sep 2011	31Aug 2014	water	26	26	12	26	4	Least disturbed stream site
11954 BO095	North Bosque River at River Rd.	31.678612 -97.507225	01Sep 2011	31Aug 2014	water	26	26	12	26	4	North Bosque River index station
11956 BO090	North Bosque River at FM 219	31.785915 -97.567528	01Sep 2011	31Aug 2014	water	26	26	12	26	4	Index station on North Bosque River above Clifton WWTP
11961 BO070	North Bosque River at US 281 near Hico	31.977222 -98.035004	01Sep 2011	31Aug 2014	water	26	26	12	26	4	Above Hico WWTP discharge at Hico City Park
11963 BO040	North Bosque River at CR 454	32.193104 -98.184021	01Sep 2011	31Aug 2014	water	26	26	12	26	4	Index station below Stephenville WWTP
13486 GC100	Green Creek at Erath CR 269	32.036762 -98.126213	01Sep 2011	31Aug 2014	water	26	26	12	26	4	Co-located with TCEQ real time monitoring station on tributary of North Bosque R.
17226 BO020	North Bosque River at FM 8	32.235001 -98.203888	01Sep 2011	31Aug 2014	water	26	26	12	26	4	Below confluence of North and South Forks of N. Bosque
18003 BO083	North Bosque River at CR 2371	31.990278 -97.757866	01Sep 2011	31Aug 2014	water	26	26	12	26	4	Index station on North Bosque; not automated

Stormwater samples will be retrieved within 36 hours, except on weekends. If storm samplers are initiated on weekends, storm samples will be collected as soon as possible on Monday morning. 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.

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.

Table B1.2 Monitoring Sites and Monitoring Frequencies for Wet Weather Sampling

Station ID - TCEQ TIAER	Site Description	Latitude Longitude	Start Date	End Date	Sample Matrix	Estimated Wet Weather Monitoring Frequencies (per year)[1]		
						TSS	Nutrients	Comments
11826 NC060	Neils Creek at SH 6 near Clifton	31.693453 -97.535316	01Sep 2011	31Aug 2014	water	20	20	Estimated # of flow-weight composited wet-weather samples.
11954 BO095	North Bosque River at River Rd.	31.678612 -97.507225	01Sep 2011	31Aug 2014	water	35	35	Estimated # of flow-weight composited wet-weather samples.
11956 BO090	North Bosque River at FM 219	31.785915 -97.567528	01Sep 2011	31Aug 2014	water	35	35	Estimated # of flow-weight composited wet-weather samples.
11961 BO070	North Bosque River at US 281 near Hico	31.977222 -98.035004	01Sep 2011	31Aug 2014	water	35	35	Estimated # of flow-weight composited wet-weather samples.
11963 BO040	North Bosque River at CR 454	32.193104 -98.184021	01Sep 2011	31Aug 2014	water	35	35	Estimated # of flow-weight composited wet-weather samples.
13486 GC100	Green Creek at Erath CR 269	32.036762 -98.126213	01Sep 2011	31Aug 2014	water	20	20	Estimated # of flow-weight composited wet-weather samples.
17226 BO020	North Bosque River at FM 8	32.235001 -98.203888	01Sep 2011	31Aug 2014	water	35	35	Estimated # of flow-weight composited wet-weather samples.

[1] The overall project total for storm samples on average should not exceed 252 per year.

Wet weather samples will be made from aliquots collected over a maximum 36-hour period and composited based on the amount of flow associated with the time period represented by each aliquot. Sample aliquots will be transported on ice to the laboratory. Samples will be filtered and preserved only after the aliquots have been composited. Each wet weather sample will be analyzed for orthophosphate phosphorus, total Kjeldahl nitrogen, dissolved ammonia, dissolved nitrite plus nitrate, total phosphorus, and total suspended sediments. Field parameters are not measured for wet weather samples.

Based on the work plan, project funds were budgeted for collection and analysis of 252 wet weather samples per year, which should allow monitoring of at least half of all storm events under average rainfall conditions for the watershed. 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. Therefore, estimated numbers of wet weather samples indicated in Table B1.2 serve only as a guideline. The project will collect and analyze a maximum of 252 storm samples per year. Efforts will be made to make sure storm samples are representative of NPS conditions throughout the monitoring period to best meet project objectives.

To accommodate the analysis of a limited number of wet-weather samples, storm monitoring protocols are to sample only selected rather than all events, e.g., activation levels for automated samplers may be raised to avoid monitoring and analysis of relatively small events. To spread monitoring throughout the project period to allow a more thorough evaluation of water quality trends, an attempt will be made to monitor one or two events per month at each station. Depending on weather conditions, the size of events monitored may vary greatly, e.g., during the

drier summer months, smaller events may be monitored than during the wetter spring months. Any changes in monitoring protocols will be determined by the TIAER project manager in consultation with the TCEQ project manager.

B2 SAMPLING METHODS

Sample Containers

Most sample containers are reusable plastic bottles, except for sterile bacteria containers and syringes, which are disposable containers. Syringes, which are sometimes used for field filtering, are acid washed upon receipt but only used once and then disposed. 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. Containers are then placed on a rack to dry. The TIAER SOP-I-116 “Preparation of Labware” contains specific steps used for cleaning sampling containers and equipment used in field operations and is available for review upon request.

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 containers 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, the data are flagged for review by the Project Manager and QAO. Sources of contamination are investigated and remediated, if found. Corrective action documentation is maintained for all method blanks that exceed the LOQ.

Aliquots for Cl and SO_4 analysis will be prepared by the TIAER laboratory and shipped to TRA in plastic containers and shipped on ice.

Field Sampling Procedures

SOPs for the automated flow meter and automated sampler data collection are available from TIAER upon request and include the following:

SOP-F-103 Rev. 2, Flow Measurements and Estimates
SOP-F-110 Rev. 2, Flowmeter Initialization
SOP-F-111 Rev. 2, Programming Flowmeter Equipment
SOP-F-112 Rev. 2, Programming Automated Samplers
SOP-F-114 Rev. 2, Downloading Automated Sampling Sites

Appendix D contains the following SOP:

SOP-F-115 Rev. 3, General Maintenance of Automated Sampling Sites

Within SOP-F-115 are covered the testing, calibration and maintenance requirements for the automated sampler. Maintenance requirements are also referenced in the ISCO Portable Water Sampler Instruction Manual and Flowmeter Equipment and Instruction Manual.

Routine sample collection will follow the field sampling procedures for conventional and microbiological parameters documented in the TCEQ Surface Water Quality Monitoring Procedures Manual (most recent edition). The container types, preservation requirements, minimum sample volumes requested by the lab, and holding time requirements are specified in Table B2.1 for routine samples and in Table B2.2 for automated samples.

Table B2.1 Sampling and Handling Procedures for Routine Stream Samples

Parameter	Matrix	Sample Type	Container	Field Preservation[1]	Sample Volume	Holding Time
Nitrite + nitrate-Nitrogen	water	Grab	Pre-cleaned plastic	Filter within 15 minutes, pH<2 with H_2SO_4, cool to 4ºC	60 mL[2]	28 days
Total Phosphorus-P	water	Grab	Pre-cleaned plastic	pH<2 with H_2SO_4, cool to 4ºC	250 mL[3]	28 days
Total Kjeldahl Nitrogen	water	Grab	Pre-cleaned plastic	pH<2 with H_2SO_4, cool to 4ºC	250 mL[3]	28 days
Total Suspended Solids	water	Grab	Pre-cleaned plastic	Cool to 4ºC	1000 mL	7 days
Ammonia Nitrogen	water	Grab	Pre-cleaned plastic	Filter within 15 minutes, pH<2 with H_2SO_4, cool to 4ºC	60 mL[2]	28 days
Orthophosphate-P	water	Grab	Pre-cleaned plastic	Filter within 15 minutes, cool to 4ºC	50 mL	48 hours
E. coli	water	Grab	Sterile plastic	Add sodium thiosulfate, cool to 4ºC	250 mL	8 hours[4]
Chlorophyll-a	water	Grab	Amber plastic	Dark, cool 4ºC before filtration; dark, 0ºC after filtration	1000 mL	Filter within 48 hrs; frozen filters up to 28 days
Chloride	water	Grab	Pre-cleaned plastic	Cool to 4ºC	100 mL	28 days
Sulfate	water	Grab	Pre-cleaned plastic	Cool to 4ºC	100 mL	28 days

[1] If samples have too much sediment for field filtration (as indicated by actual efforts to filter, direct observation or if routine sampling occurs within 72 hrs of elevated flows associated with storm runoff), samples, if required, may be acidified in the field and filtered in the laboratory. All samples will be transported on ice and temperatures will be checked upon receipt.
[2] The same 60 mL is used for the analysis of nitrite+nitrate-nitrogen and ammonia-nitrogen.
[3] The same 250 mL is used of the analysis of total phosphorus and total Kjeldahl nitrogen.
[4] If holding time for *E. coli* is over 8 hours, the holding time will be documented using the holding time parameter code 31704.

Table B2.2 Sampling and Handling Procedures for Wet-Weather Automated Samples

Parameter	Matrix	Sample Type	Container	Field Preservation[1]	Sample Volume[2]	Holding Time[5]
Nitrite+nitrate-N	water	Automated composite	Pre-cleaned plastic	Cool to 4ºC	100 mL[3]	28 days
Total Phosphorus-P	water	Automated composite	Pre-cleaned plastic	Cool to 4ºC	250 mL[4]	28 days
Total Kjeldahl Nitrogen	water	Automated composite	Pre-cleaned plastic	Cool to 4ºC	250 mL[4]	28 days
Total Suspended Solids	water	Automated composite	Pre-cleaned plastic	Cool to 4ºC	500 mL[6]	7 days
Ammonia Nitrogen	water	Automated composite	Pre-cleaned plastic	Cool to 4ºC	100 mL[3]	28 days
Orthophosphate-P	water	Automated composite	Pre-cleaned plastic	Cool to 4ºC	150 mL	48 hours

[1] 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.
[2] Samples are collected in 1-L bottles by the automated sampler and multiple bottles are composted into a single 1-L bottle for use by the lab to prepare aliquots for parameter analyses.
[3] The same 100 mL is used for the analysis of nitrite+nitrate-nitrogen and ammonia-nitrogen.
[4] The same 250 mL is used of the analysis of total phosphorus and total Kjeldahl nitrogen.
[5] Holding times for composited samples begin when the last aliquot is collected.
[6] If needed on cleaner samples with low TSS concentrations, the lab will work with bottles to obtain more volume to meet method requirements. For storm samples, this is expected to occur on very rare occasions.

Processes to Prevent Cross Contamination

Procedures outlined in the TCEQ Surface Water Quality Procedures outline the necessary steps to prevent cross-contamination of samples. These include such things as direct collection into sample containers and the use of pre-cleaned sample containers.

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 E. For all routine visits, station ID, location, sampling time, sampling date, sampling depth, and sample collector's name/signature are recorded. Routine grab samples are not collected when no streamflow is present. During periods of no streamflow a flow severity of either No Flow (1) or Dry (6) is recorded and reported. In addition, when pooled conditions exist, an Instantaneous Flow for parameter 00061 will be reported as 0. When the stream is dry no record is reported for parameter 00061.

Preservatives added to routine samples are indicated by the test group code marked on the Chain of Custody (COC) and on the sample container delivered to the laboratory. Values for all measured field parameters are recorded electronically by the data sonde and are also written on the field data sheet. Detailed observational data for routine samples are recorded on the field data sheets, including unusual water appearance, weather, observed biological activity, stream uses, unusual odors, specific sample information, missing parameters, days since last significant rainfall, and flow severity.

Recording Data

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

1. Legible writing in indelible, waterproof 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-outs on incomplete pages with an initialed and dated diagonal line.

Sampling Method Requirement or Sampling Process Design Deficiencies and Corrective Action

Examples of sampling method requirement or sample design deficiencies include but are not limited to such things as inadequate sample volume due to spillage or container leaks, failure to preserve samples appropriately, contamination of a sample bottle during collection, storage temperature and holding time exceedance, sampling at the wrong site, etc. Any deviations from the QAPP and appropriate sampling procedures may invalidate resulting data and may require corrective action. Corrective action may include for samples to be discarded and re-collected. It is the responsibility of the TIAER Project Manager, in consultation with the TIAER QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the NPS Project Manager both verbally and in writing in the project progress reports and by completion of a corrective action plan (CAP) form.

Only data collected directly under this QAPP is submitted to the SWQMIS database with the exception of acquired USGS flow data for routine grab samples as outlined in the SWQM manual. Because storm samples will be composited over time representing varying flow conditions, flow data associated with storm water samples will not be submitted to TCEQ and will not be loaded into the SWQMIS database.

The definition of and process for handling deficiencies and corrective actions are defined in Section C1.

B3 SAMPLE HANDLING AND CUSTODY

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 COC forms that are submitted daily to the laboratory. 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 on a hardcopy COC or typed onto a computer generated 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 data on the COC.

Sample Collection and Handling

All samples are collected according to procedures as outlined in the SWQM Procedures Manual, Vol. 1. All water samples are iced in the field and submitted to the laboratory on ice the same day they are collected in the field, whenever possible. If circumstances delay the submission of bacteria samples, they will be held on ice until submission to the laboratory. As noted in Table A7.1, when transport conditions necessitate delays in delivery of *E. coli* samples longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 48 hours.

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 glass filter generally using a filtration flask and pump or in a 50 CC or larger syringe. An aliquot for NO_2-N+NO_3-N and NH_3-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. If needed, a fresh filter is used to obtain an aliquot for OPO_4-P, which is iced and submitted to the lab in a bottle or 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 and a separate liter bottle are submitted for TSS analysis. When Cl and SO_4 analyses are required an additional amount of at least 200 mL is collected in a liter plastic bottle. Chlorophyll-a samples are collected in an amber plastic liter bottle.

Bacteria samples are collected in sterile plastic 250 mL bottles that have been factory autoclaved and sealed with autoclave tape 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 samples for bacteria will be screened in the laboratory for presence of chlorine residual.

Automated storm samples are collected in one liter plastic bottles throughout the hydrograph. They are retrieved within at least 36 hours after sampler initiation, except on weekends. If storm samplers are initiated on weekends, storm samples are collected as soon as possible on Monday morning. Each bottle is labeled with site name and bottle number. Storm samples are iced during transport to the laboratory, where they are flow-weight composited into a single 1-L bottle using TIAER computer program that correlates collection time with 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.

Aliquots for Cl and SO_4 analysis will be prepared by the TIAER laboratory and shipped to TRA in plastic containers and shipped on ice.

Chain-of -Custody

A 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. A copy of the TIAER COC is found in Appendix F. 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 the TIAER office for at least five years.

The field staff member submitting the sample transfers possession of the 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 and among subcontract laboratories. For this project, all lab work will be performed by TIAER, except Cl and SO_4 analyses that will be performed by the TRA. The following information concerning the sample is recorded on the TIAER COC form (See Appendix F).

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

A COC provided by TRA will be used for transfer of sample aliquots for Cl and SO_4 analyses from the TIAER lab to the TRA lab.

Sample Tracking Procedure Deficiencies and Corrective Action

All deficiencies associated with chain-of-custody procedures as described in this QAPP are immediately reported to the TIAER Project Manager. These include such items as delays in transfer, resulting in holding time violations; violations of sample preservation requirements; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc. The TIAER Project Manager in consultation with the TIAER QAO will determine if the procedural violation may have compromised the validity of the resulting data. Any failures that have reasonable potential to compromise data validity will invalidate data and, if possible, the sampling event should be repeated. The resolution of the situation will be reported to the TCEQ NPS Project Manager in the project progress report. Corrective Action Plans will be prepared by the TIAER QAO and submitted to TCEQ NPS Project Manager along with project progress report.

The definition of and process for handling deficiencies, nonconformances, and corrective action are defined in Section C1.

B4 ANALYTICAL METHODS

The analytical methods are listed in Table A7.1 of Section A7. Laboratories collecting data under this QAPP are compliant with the NELAC Standards. The TIAER and TRA laboratories are both NELAC accredited via TCEQ for the parameters to be evaluated under this QAPP.

Copies of laboratory SOPs are retained by TIAER and TRA and are available for review by the TCEQ. Laboratory SOPs are consistent with EPA requirements as specified in the method.

Standards Traceability

All standards used by the laboratory chemists and field technician 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 the concentration, amount used and lot number, the 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.

Alternative Methodologies

Only data generated using TCEQ-approved analytical methodologies as specified in this QAPP will be submitted to the TCEQ. Requests for method modifications will be documented on form TCEQ-10364, the TCEQ Application for Analytical Method Modification, and submitted for approval to the TCEQ Quality Assurance Section. Work will only begin after the modified procedures have been approved.

Analytical Method Deficiencies and Corrective Actions

Deficiencies in field and laboratory measurement systems involve, but are not limited to such things as instrument malfunctions, failures in calibration, blank contamination, quality control samples outside QAPP defined limits, etc. In many cases, the field technician or lab analyst will be able to correct the problem. If the problem is resolvable by the field technician or lab analyst, then they will document the problem on the field data sheet or laboratory record and complete the analysis. If the problem is not resolvable, then it is conveyed to the TIAER Laboratory Manager or Field Supervisor, who will make the determination and notify the TIAER QAO. If the analytical system failure may compromise the sample results, the resulting data will not be reported to the TCEQ. The nature and disposition of the problem is reported on the data report which is sent to the TIAER Project Manager. The TIAER Project Manager will include this information in the CAP form to submit with the Progress Report, which is sent to the TCEQ NPS Project Manager.

The definition of and process for handling deficiencies, nonconformances, and corrective action are defined in Section C1.

The TCEQ has determined that analyses associated with the qualifier codes, such as holding time exceedance, sample received unpreserved, or estimated value, may have unacceptable measurement uncertainty associated with them. This will immediately disqualify analyses from submittal to SWQMIS. Therefore, data with these types of problems should not be reported to the TCEQ. Additionally, any data collected or analyzed by means other than those stated in the QAPP, or data suspect for any reason should not be submitted for loading and storage in SWQMIS.

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 routine grab samples. The

precision of field split results is calculated by relative percent difference (RPD) using the following equation:

$$RPD = |(X1-X2)/\{(X1+X2)/2\}*100|$$

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 constituent (i.e., >5 x LOQ) were measured and analytical variability can be eliminated as a factor, then variability in field split results will primarily be used as a trigger for discussion with field staff to ensure samples are being handled in the field correctly. Some individual sample results or batches of samples 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. The qualification (i.e., invalidation) of data will be documented on the Data Review Checklist and Summary. Deficiencies will be addressed as specified in this section under Quality Control or Acceptability Requirement Deficiencies and Corrective Actions.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria

Batch – A batch is defined as environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 25 hours. An analytical batch is composed of prepared environmental samples (extract, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

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 over all 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 > 10 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. Method blanks are performed at a rate of once per preparation batch. 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.

Quality Control or Acceptability Requirement Deficiencies and Corrective Actions

Sampling QC excursions are evaluated by the TIAER Project Manager, in consultation with the TIAER QAO. In that differences in sample results are used to assess the entire sampling process, including environmental variability, the arbitrary rejection of results based on pre-

determined limits is not practical. Therefore, the professional judgment of the TIAER Project Manager and QAO will be relied upon in evaluating results with regard to use of data in meeting overall project objectives of assessing trends over time. Rejecting sample results based on wide variability is a possibility.

With regard to evaluating data acceptability in data transfers to TCEQ for SWQMIS, discrepancies in quality control will be noted within the Comments of the Data Review Checklist and Summary (Appendix C) and data will be rejected or submitted with appropriate flags (as per the SWQM Data Management Reference Guide (most recent version)) based on review of specific circumstances with the TCEQ Project Manager. An example of data with failing QC that may be flagged and submitted would be if the LOQ check standard fails. Discrepancies regarding the LOQ check standard and the extent of the discrepancy would be described in the data summary and the data result would have a flag of "D" (data did not pass all QC criteria). Laboratory measurement quality control discrepancies, such as field split excursions and blank contamination, will be noted in the CAP submitted with the quarterly Progress Report to the TCEQ Project Manager.

Laboratory measurement quality control failures are evaluated by the laboratory staff. The disposition of such failures and the nature and disposition of the problem is reported to the TIAER Laboratory QAO and Manager. The Laboratory QAO and/or Manager will discuss with the TIAER Project Manager and QAO issues regarding data acceptability associated with laboratory quality control failures. If applicable, the TIAER Project Manager will include this information in the CAP and submit with the Progress Report, which is sent to the TCEQ NPS Project Manager.

The definition of and process for handling deficiencies, nonconformances, and corrective action are defined in Section C1.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

Automated sampler testing and maintenance requirements are contained with Appendix D of this document as outlined in SOP-F-115 Rev. 2, General Maintenance of Automated Sampling Sites.

All instream sampling equipment testing and maintenance requirements are detailed in the TCEQ *Surface Water Quality Monitoring Procedures, Volume 1*. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained by the TIAER Field Supervisor.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are described in laboratory QAM(s). Testing and maintenance records are available for inspection by TCEQ. Instruments requiring daily or in-use testing may 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 TCEQ.

B7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Calibration requirements for automated monitoring equipment are outlined in TIAER SOP-F-115 Rev. 2, General Maintenance of Automated Sampling Sites, in Appendix D of this document.

Instream field equipment calibration requirements are contained in the TCEQ Surface Water Quality Monitoring Procedures Manual. Post calibration error limits and the disposition resulting from error are adhered to. Data not meeting post-error limit requirements invalidates associated data collected subsequent to the pre-calibration and are not submitted to the TCEQ.

Detailed laboratory calibrations are contained within the SOPs. Individual 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 and are available for inspection by the TCEQ. Instruments requiring periodic calibration include, but are not limited to, thermometers, pH meters, balances, incubators, and analytical instruments. Calibration records are available to the TCEQ for review.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Chemicals for analysis are tested by the supplier and meet or exceed American Chemical Society (ACS) certification, where applicable.

B9 NON-DIRECT MEASUREMENTS

Only data collected directly under this QAPP with appropriate parameter codes (see Table A7.1) will be submitted to the SWQMIS database with the exception of acquired USGS flow data for routine grab samples as outlined in the SWQM manual. The project will not submit any acquired or non-direct measurement data to SWQMIS that has been or is going to be collected under another QAPP. Non-direct water quality, rainfall, and flow data that may be included in the statistical evaluation of project objectives include data collected by TIAER, beginning as early as 1992, under a variety of QAPPs. These QAPPs include the following:

1. Data collected by TIAER in the Upper North Bosque River Watershed under the EPA-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), which 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 North Bosque River Watershed Water Quality Assessment Clean Water Act 319(h) project with QAPPs approved by the TCEQ and EPA Region 6 under EPA Grant #99614611-0. This 319 project encompasses data collected from February 2006 through August 2010. Data that may be used from this project includes water quality and water level (streamflow) information.

5. Data collected by TIAER under the North Bosque River Watershed Water Quality Assessment project through the TCEQ, Surface Water Quality Monitoring Program under Contract No. 582-6-70859 as Work Order No. 34. This SWQM project encompasses data collected from September 2010 through August 2011. Data that may be used from this project includes water quality and water level (streamflow) information.

External data will be used to determine flow at some of sampling sites. The United States Geological Service (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.

The water quality data associated with the projects above were collected and analyzed using similar assessment objectives, sampling techniques, laboratory protocols, and data validation procedures as the current project. One known area of 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. 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, such as with changes in parameters and methods for bacteria and differences in the approach over time to reporting limits.

For the third task of the study TIAER will acquire information regarding AFOs and CAFOs from available records at the Stephenville and Austin TCEQ offices, the TSSWCB, and other sources, such as milk production records from the Department of State Health Services, Texas Department of Health, Division of Milk and Milk Products. These data will be stored in spreadsheet formats and, as appropriate, GIS formats. These records will be used to help define the location of AFOs and CAFOs in the watershed, permitted head size (if applicable), operating head size, and location and size of WAFs. Information directly available from approved permit applications or TCEQ inspection records will be considered accurate for use without further verification. Data from other sources will be verified prior to use by confirmation from State agencies or through direct visual observation of the location of AFO and CAFO operations.

If specific records are not available, estimates will be made concerning known operations through either direct contact with operators, drive-by surveys, or other methods as needed. If after checking with available government sources the size of an AFO must be estimated, the maximum number prior to needing a permit will be used and the needed area for waste application estimated assuming the maximum head number. The WAF area will also then be estimated based on this maximum head number. It is important to account for all the operations in the watershed because of their nutrient and bacteria contributions to the North Bosque watershed. The AFO and CAFO data collected by TIAER will not be submitted to the SWQMIS database.

Locations of WAFs associated with CAFOs and AFOs will be mapped using ArcGIS. Each WAF GIS feature will be linked to its corresponding record in the spreadsheet. The locations will be mapped using spatial coordinates obtained from the available permit records aided with the use of aerial imagery (digital orthophoto quadrangles, DOQs) from the USGS, road files from the Topologically Integrated Geographic Endcoding and Referencing system (TIGER) of the U.S. Census Bureau, and stream files from the USGS National Hydrograph Dataset stream layer. The Texas Natural Resources Information System (TNRIS) and TCEQ GIS dataset resources may also be used with respect to possible road, stream, and topographic GIS layers. Because these datasets are from state and nationally recognized and accepted sources or have already been validated (e.g., through the TCEQ permit review process or other projects), they will be accepted without any further validation and without any limitations.

When updating existing GIS data layers with WAFs, CAFO, or AFO operations defined as no longer in business, the update will define the associated WAFs as “historical” within the GIS

layers. The older GIS layer of WAFs was developed under the TCEQ project, Monitoring to Support North Bosque River Model Refinement, and represents conditions in the North Bosque watershed as of 2005. As part of this project, a land use/land cover layer was also developed by the Spatial Science Laboratory in College Station, Texas. Development of both the WAF and land use/land cover layers was covered in the project QAPP and details of their development are outlined in the Chapter 2 of the project report, *Sampling History Report, Final Project Report for Monitoring to Support North Bosque River Model Refinement*, Chapter 2: Geographic Information System Layers and Associated Metadata. Because these layers were previously reviewed and accepted by TCEQ, they will be accepted as is without further validation or any limitations. Updated maps of the locations of AFOs and CAFOs and active and historical WAFs within the watershed will be submitted to TCEQ on an annual basis and all associated GIS and spreadsheet data will be submitted to TCEQ as part of the final project report.

B10 DATA MANAGEMENT

Personnel

Section A4 lists responsibilities and lines of communication for data management personnel.

Data Path

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 F) 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 Laboratory Information Management System (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 (SAS Inc., Cary, North Carolina) database, which is used for statistical evaluation of the data to accomplish project objectives. Procedures and personnel involved in data entry and review are outlined in TIAER SOP-Q-104, Data Entry and Review.

Field parameters collected with the YSI (YSI Inc., Yellow Springs, Ohio) mulitprobe (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, which is 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.

Stream water level data collected using ISCO flowmeters are downloaded to a computer about once every two weeks either remotely via phone modems or directly using field laptop

computers. Data from these computer files are then transferred and stored in a SAS database and transferred to a WISKI (Water Management Information System by Kisters North America, Inc., Citrus Heights, California) database for review. Records of site visits to download the flow meters are kept on the General Maintenance (GM) sheets (Appendix E). Stream level data are reviewed in WISKI by appropriate field staff and then transferred back to SAS for storage and for use in statistical data evaluations.

Following data verification and validation, data appropriate for SWQMIS are exported from the appropriate database to pipe-delimited text files in format for reporting to the TCEQ.

Semiannually, as outlined in the project work plan, project water quality data are reviewed by the TIAER Project Data Manager for completeness and anomalies and prepared in a pipe-delimited format for reporting in TCEQ format as described in the SWQM DMRG (January 2010 or the latest version). Data for SWQMIS along with the Data Summary Form are reviewed by the TIAER Project Manager, and then these data are transferred to TCEQ Project Manager along with the Data Summary Form (Appendix C) for loading to SWQMIS.

The TRA Laboratory performs NELAP-accredited analyses for some project samples. The TRA Laboratory mails or emails copies of the analytical results, including associated QC results, to the TIAER Laboratory Manager. The Laboratory Manager logs in receipt of the data report and sends it to the TIAER Project Manager, who forwards it to the TIAER QAO. The TIAER QAO reviews the report to ensure all QC data have passed and analytical results are reasonable, and then checks for results that exceed the TCEQ maximum for the parameter, which would need TRA Laboratory verification. A designee of the QAO, typically a student worker, enters the analytical results into an Excel spreadsheet, which is reviewed by the TIAER QAO to ensure the tag ID and analytical value match the original data report. The electronic TRA data are then matched by Tag ID with an Excel spreadsheet containing TIAER sample data. The TRA data are added to the TIAER spreadsheet and formatted according to SWQMIS requirements. During completion of the Data Summary for the data submission, the comment column of each sample with TRA data is reviewed to ensure it notes that data were analyzed by the TRA Laboratory.

See Appendix G for a flow chart of the Data Management Process for water quality data.

Record-keeping and Data Storage

TIAER record-keeping and document control procedures are contained in the TIAER Quality Assurance Manual and this QAPP. Original field and laboratory data sheets are stored in the TIAER offices, laboratory, and storage facilities in accordance with the record-retention schedule in Section A9. As an electronic data protection strategy, TIAER utilizes Double Take software to mirror the Primary Aberdeen 1.2TB file server (raid 5 fault tolerant) that will be mirrored to a secondary Aberdeen Abernas211 file server (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 backup tapes for 26 weeks prior to reuse saving the 1st tape in the series indefinitely to preserve a historical snapshot. This will facilitate recovery of data lost due to human error. Backup tapes are stored in a secure area on the Tarleton University campus and are checked periodically to ensure viability. If necessary, disaster recovery will be accomplished by information resources staff using the backup database and by manually re-entering any data input after the timing of the last backup.

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.

Forms and Checklists

See Appendix E for the Field Data Sheets.
See Appendix C for the Data Review Checklist and Summary.

Data Handling

Data are entered into a LIMS system based on Microsoft Access software, then transferred to a SAS database. Data integrity is maintained by the implementation of password protections which control access to these databases and by limiting update rights to a select user group. No data from external sources are maintained in the LIMS or SAS water quality database as transferred from the LIMS. 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 is also configured to run WISKI and Isco Flowlink software for continuous stage data and ArcView software for GIS data, but not necessarily in a networked environment. TIAER information resources staff is 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.

Information Resource Management Requirements

Data will be managed in accordance with the TCEQ Surface Water Quality Monitoring Data Management Reference Guide. Global Positioning System (GPS) equipment may be used as a

component of the information required by the Station Location (SLOC) request process for creating the certified positional data that will ultimately be entered into the TCEQ's SWQMIS database. Any Positional data obtained by TIAER using a Global Positioning System will follow the TCEQ's OPP 8.11 and 8.12 policy regarding the collection and management of positional data.

Positional data entered into SWQMIS will be collected by a GPS certified individual with an agency approved GPS device to ensure that the agency receives reliable and accurate positional data. Certification can be obtained in any of three ways: completing a TCEQ training class, completing a suitable training class offered by an outside vendor, or by providing documentation of sufficient GPS expertise and experience. Contractors must agree to adhere to relevant TCEQ policies when entering GPS-collected data.

In lieu of entering certified GPS coordinates, positional data may be acquired with a GPS and verified with photo interpolation using a certified source, such as Google Earth or Google Map. The verified coordinates and map interface can then be used to develop a new Station location.

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following table presents types of assessment and response activities associated with data collection activities for the project.

Table C1.1 Assessment and Response Actions

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 TCEQ in Quarterly Report
Technical Systems Audit	Dates to be determined by TCEQ	TCEQ Project Manager and Project QA Specialist	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 TCEQ to address corrective actions
Laboratory Inspection	Based on work plan and/or TIAER discretion	TIAER Laboratory QAO	Analytical and quality control procedures at the laboratory and contract laboratory[1]	30 days to respond in writing to Lab QAO to address corrective actions
Monitoring Systems Audit	Based on work plan and/or TIAER discretion	TIAER 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 TIAER QAO to address corrective actions
Site Visit	Dates to be determined by TCEQ	TCEQ Project Manager	Status of activities. Overall compliance with work plan and QAPP	As needed

[1] TIAER considers the NELAP certification of the TRA lab and the participation of the TRA lab in the CRP as sufficient evidence of their analytical and quality control for the quarterly analysis of chloride and sulfate samples and does not plan to conduct laboratory inspections of the TRA laboratory.

Corrective Action Process for Deficiencies

Deficiencies are any deviation from the QAPP, SWQM Procedures Manual, SOPs, or Data Management Reference Guide. Deficiencies may invalidate resulting data and may require corrective action. Corrective action may include for samples to be discarded and re-collected. Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff. It is the responsibility of the TIAER Project Manager, in consultation with the TIAER QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the NPS Project Manager both verbally and in writing in the project progress reports and by completion of a corrective action plan (CAP).

At TIAER, deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via Corrective Action Reports (CARs) to the cognizant field or laboratory supervisor (Appendix H). 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. TCEQ will be notified of CARs that affect data quality with quarterly progress reports via the CAP form (Appendix I). In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to TCEQ immediately both verbally and in writing.

Corrective Action

CAPs should:

- Identify the problem, nonconformity, or undesirable situation
- Identify immediate remedial actions if possible

- Identify the underlying cause(s) of the problem
- Identify whether the problem is likely to recur, or occur in other areas
- Evaluate the need for Corrective Action
- Use problem-solving techniques to verify causes, determine solution, and develop an action plan
- Identify personnel responsible for action
- Establish timelines and provide a schedule
- Document the corrective action

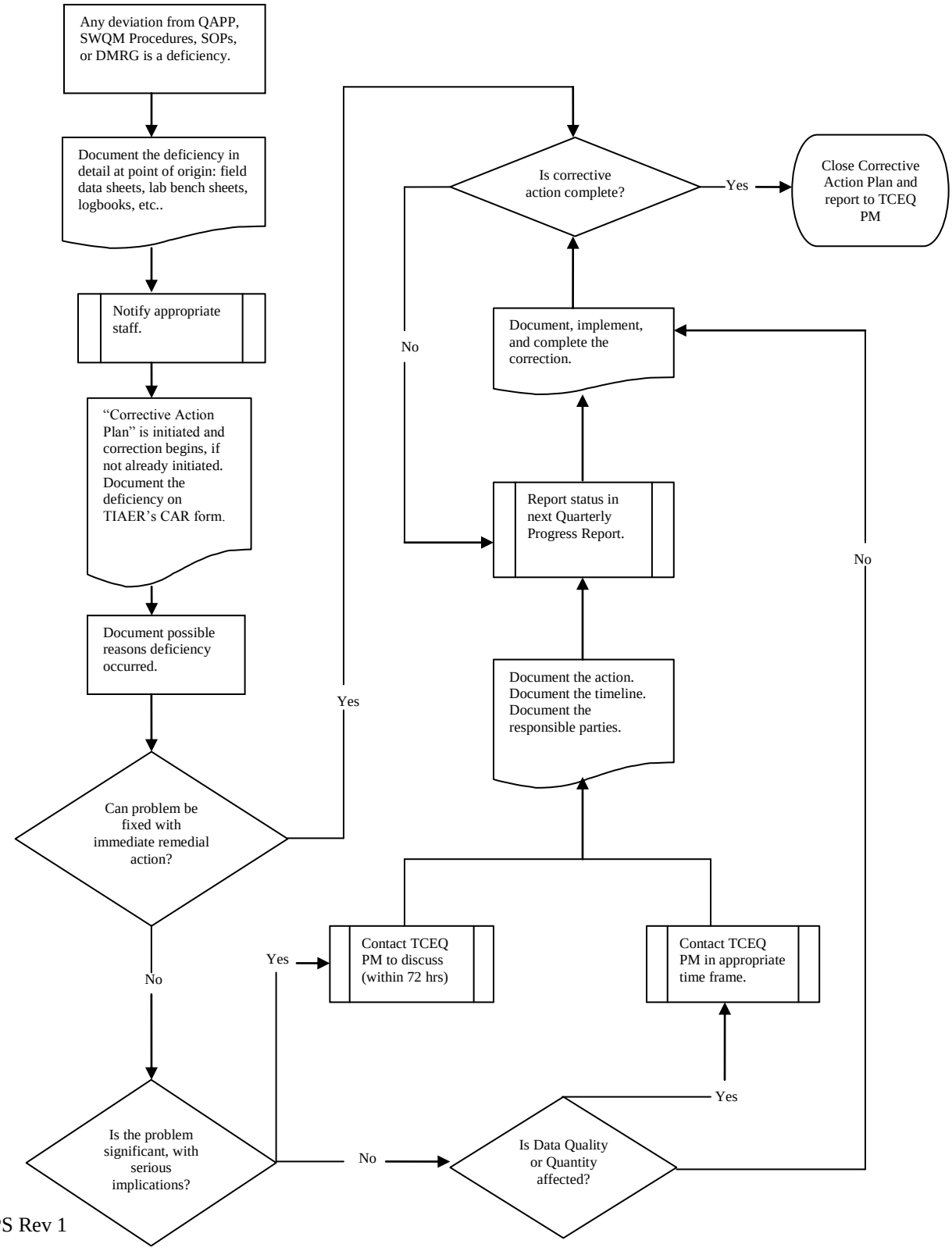
To facilitate the process a flow chart has been developed (see figure C1.1: Corrective Action Process for Deficiencies).

Status of CAPs will be documented on the Corrective Action Status Table (See Appendix J) and included with Quarterly Progress Reports. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TCEQ immediately.

The TIAER Project Manager is responsible for implementing and tracking corrective actions. Corrective action plans will be documented on the Corrective Action Plan Form (See Appendix I) and submitted, when complete, to the TCEQ Project Manager. Records of audit findings and corrective actions are maintained by both the TCEQ and the TIAER QAO. Audit reports and corrective action documentation will be submitted to the TCEQ with the Quarterly Progress Report.

If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work are specified in the TCEQ QMP and in agreements in contracts between participating organizations.

Figure C1.1 Corrective Action Process for Deficiencies



C2 REPORTS TO MANAGEMENT

Reports to TCEQ Project Management

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

Technical System Audit Response - The TIAER will respond in writing to the TCEQ within 30 days upon receipt of a technical system audit report to address corrective actions.

Interim Project Reports – Includes a map of CAFOs and AFOs and annual interim report updating the assessment of water quality trends through the most recent calendar year.

Final Project Report - Includes all GIS data layers and spreadsheet information along with a map of all mapped CAFOs and AFOs and final project report updating the assessment of water quality trends through the most recent calendar year.

Reports to TIAER Project Management

CARs are the primary mechanism for communicating significant QA issues to management. In addition, the TIAER PM routinely interacts with the field crew supervisor and lab manager in coordinating sampling and with regard to any issues that arise with sample collection or analysis. Project staff at TIAER are also queried with regard to progress on project deliverables and any problems or issues concerning project activities by the TIAER PM in preparing quarterly progress reports.

Reports by TCEQ Project Management

Contractor Evaluation - The Contractor participates in a Contractor Evaluation by the TCEQ annually for compliance with administrative and programmatic standards. Results of the evaluation are submitted to the TCEQ Financial Administration Division, Procurement and Contracts Section.

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/reported to the TCEQ for loading into SWQMIS.

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 Project Data Manager will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to be loaded into SWQMIS. 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 to be reported meet the objectives of the project and are suitable for reporting to TCEQ.

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.

Table D2.1: Data Verification Procedures

Data to be Verified	Field Task	Laboratory Task	TIAER Project Manager & Data Manager Task
Sample documentation complete; samples labeled, sites identified	x	x	
Field QC samples collected for all analytes as prescribed in the TCEQ *SWQM Procedures Manual*	x		
Standards and reagents traceable	x	x	
Chain of custody complete/acceptable	x	x	
Sample preservation and handling acceptable	x	x	
Holding times not exceeded	x	x	
Collection, preparation, and analysis consistent with SOPs and QAPP	x	x	x
Field documentation (e.g., biological, stream habitat) complete	x		
Instrument calibration data complete	x	x	
Bacteriological records complete	x	x	
QC samples analyzed at required frequency	x	x	x
QC results meet performance and program specifications	x	x	x
Analytical sensitivity (Minimum Analytical Levels/Ambient Water Reporting Limits) consistent with QAPP		x	x
Results, calculations, transcriptions checked	x	x	
Laboratory bench-level review performed		x	
All laboratory samples analyzed for all parameters		x	
Corollary data agree	x	x	x
Nonconforming activities documented	x	x	x
Outliers confirmed and documented; reasonableness check performed			x
Dates formatted correctly			x
Depth reported correctly			x
TAG IDs correct			x
TCEQ ID number assigned			x
Valid parameter codes			x
Codes for submitting entity(ies), collecting entity(ies), and monitoring type(s) used correctly			x
Time based on 24-hour clock			x
Absence of transcription error confirmed	x	x	x
Absence of electronic errors confirmed	x	x	x
Sampling and analytical data gaps checked (e.g., all sites for which data are reported are on the coordinated monitoring schedule)			x
Field QC results attached to data review checklist (?)			x
Verified data log submitted (?)			x
10% of data manually reviewed			x

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 TCEQ. One element of the validation process involves evaluating the data again for anomalies. Any suspected errors or anomalous data must be addressed by the manager of the task associated with the data, before data validation can be completed.

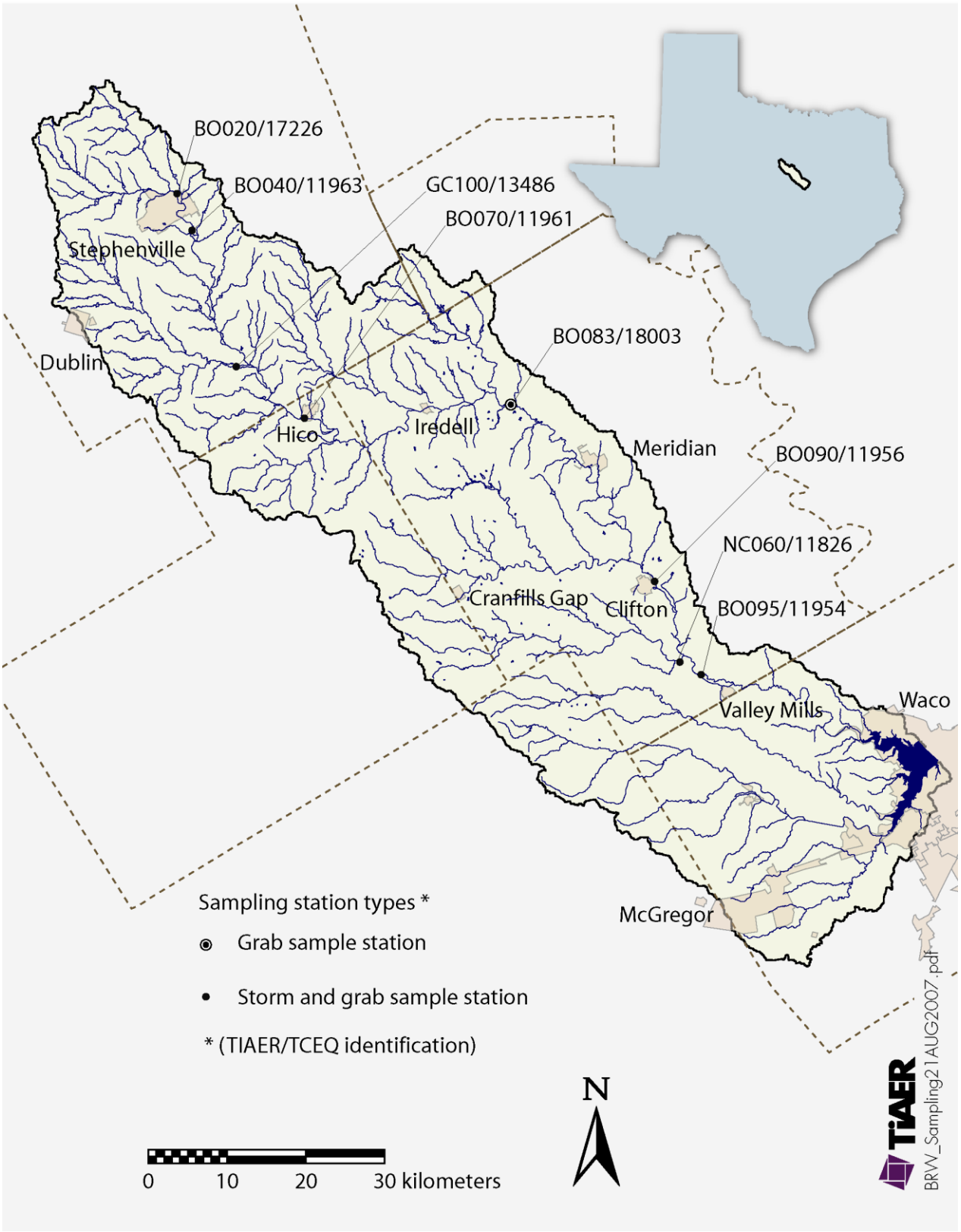
A second element of the validation process is consideration of any findings identified during the technical systems audit conducted by the TCEQ QAS assigned to the project. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data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

D3 RECONCILIATION WITH USER REQUIREMENTS

Data collected from this project will be analyzed by TIAER and TCEQ to report the measured reductions in phosphorus loadings. Instream monitoring data that do not meet project requirements will not be used in the project or submitted to the TCEQ for storage in SWQMIS.

Data requirements may differ with regard to use for the project in evaluating trends over time versus data requirements for storage in SWQMIS, e.g., data may require flagging for storage in SWQMIS that may be deemed appropriate by the TIAER Project Manager for use in trend analysis without further flagging. A general discussion of data acceptability is presented in Section B2 under Quality Control or Acceptability Requirement Deficiencies and Corrective Actions.

Appendix A. Area Location Map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Stephenville
Dublin
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Hico
Iredell
Meridian
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Cranfills Gap
Clifton
BO095/11954
Valley Mills
Waco
McGregor
Sampling station types *
Grab sample station
Storm and grab sample station
* (TIAER/TCEQ identification)
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10
20
30 kilometers
TIAER
BRW_Sampling21AUG2007.pdf

Appendix B. Work Plan

Task 3:	**Inventory of Abatement Activities Associated with AFO and CAFOs**
Objective:	To provide a spatial update of land management practices associated with WAFs within the North Bosque River watershed for AFOs and CAFOs.
Subtask 3.1:	**Review of CAFO Permit Information** – In the first year of the project, CAFO permit information available from TCEQ will be reviewed. CAFOs and associated WAFs will be defined in GIS layers, and information regarding operation type (e.g., dairy, calf raising, beef feedlot or auction barn), crop type and dominant type of waste applied (liquid or solid) will be reported in table format.
Subtask 3.2:	**Review of AFO Information** – In the first year of the project, AFO information will be obtained from available records with TCEQ, TSSWCB or other sources, such as milk production records. If specific records are not available, estimates will be made concerning known operations through either direct contact with operators, drive-by surveys or other methods as needed. AFOs and associated WAFs will be defined in GIS layers, and information regarding operation type, crop type and dominant type of waste applied will be reported in table format.
Subtask 3.3:	**Identification of Historical WAFs** – Using past GIS data layers defining WAFs, CAFO or AFO operations defined as no longer in business during the update will have their WAFs defined as historical within the GIS layers.
Subtask 3.4	**Annual Updates of CAFO and AFO Information** – Following completion of the initial GIS layers and associated spreadsheets, inspection information from the Stephenville TCEQ office and other available information will be reviewed on an annual basis to track items for each operation, such as actual versus permitted cow numbers, whether operations are still in business and enforcement issues. Information on permitted CAFOs should be readily available via TCEQ records, while specific information on AFOs (non-permitted facilities) may need to be estimated indirectly. Disclosure of AFO information is limited, even those with WQMP through the TSSWCB, so indirect means, such as querying inspection reports produced by the Texas Department of State Health Services, will be utilized. The available information will be provided in an updated spreadsheet and, as appropriate, updated within the GIS layers.
Subtask 3.5	**Annual Data and Map Submittals** – TIAER will send the TCEQ Project Manager the GIS layers and associated spreadsheets with the final report. Digital maps of the watershed showing the created GIS layers will be sent with both interim reports and the final report.
Deliverables	• GIS Layers and Spreadsheets (Submitted with Final Report) • Annual Map Submittals

Task 4:	**Surface Water Quality Monitoring and Data Management**
Objective:	To collect water quality data (routine ambient and storm event) for effectiveness monitoring of TMDL implementation activities in the North Bosque River watershed.

Subtask 4.1:	**Biweekly Routine Monitoring** – TIAER will collect biweekly near-surface grab samples at eight stream stations. Field measurements will include dissolved oxygen, specific conductance, water temperature and pH. Routine grab samples will be analyzed in TIAER's NELAP-accredited lab for nutrient forms (total phosphorus, dissolved orthophosphate phosphorus [also referred to as soluble reactive phosphorus], total Kjeldahl nitrogen, dissolved ammonia and dissolved nitrite plus nitrate) and TSS. Streamflow will be measured in association with biweekly monitoring through direct field measurements or through gaging station data, at all stations but 18003. Station 18003 is not suitable for a flow gaging station due to an inability to obtainstream access through private land. While routine grab samples may be obtained off the bridge crossing at station 18003, the height of the bridge above the water makes it difficult to obtain accurate flow measurements with most readily available equipment.
Subtask 4.2:	**Monthly Bacteria Monitoring** – TIAER will collect monthly near-surface grab samples at eight stream stations for analysis of E. coli in TIAER's NELAP-accredited lab.
Subtask 4.3:	**Quarterly Routine Monitoring** – TIAER will collect quarterly near surface grab samples at eight stream stations for analysis of chloride and sulfate. TIAER will subcontract analysis to the Trinity River Authority lab, which is NELAP accredited for these constituents.
Subtask 4.4:	**Biased Flow Monitoring** – TIAER will maintain and operate automated samplers and water-level recorders at seven stream stations to conduct biased flow monitoring during elevated flows associated with storm events. Streamflow data will be generated from the water-level data using site specific state-discharge relationships. The integration of the continuous streamflow data with the stormwater quality data will allow calculation of nutrient loadings associated with storm events. The automated samplers will be operated to activate upon a designated rise in water level and will collect discrete samples at set time intervals during selected storm events. Groups of individual storm samples will be collected on about a daily basis and flow composited by station into one sample for analysis of nutrients (total phosphorus, dissolved orthophosphate phosphorus, total Kjeldahl nitrogen, dissolved ammonia and dissolved nitrite plus nitrate) 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 monitoring efforts, budgeted sampling will only allow for about half of all storm events under average rainfall conditions to be monitored. Efforts will be made to sample storm events that are representative of conditions during the monitoring period to meet project objectives.

Subtask 4.5:	**Continuous Streamflow Monitoring and Maintenance of Rating Curves** – Water-level recorders that record continuously at about 5-minute intervals will be maintained at seven of the stream stations. Stage-discharge relationships will be maintained and updated at all seven automated sampling stations. This effort will include updating cross-sectional surveys at each station and, as necessary, obtaining additional water level and streamflow measurements under various hydrologic conditions to refine existing rating curves. At stations 11961, 11956 and 11954 on the North Bosque River, continuous streamflow and/or rating curve data from nearby USGS gages will also be used. The integration of the stage-discharge relationship with the stage data at each station will allow the calculation of instantaneous flows in association with grab samples and the amount of stream discharge over time for determination of constituent loadings.
Subtask 4.6:	**Data Maintenance and Submittals** – TIAER will maintain a database to house the data collected for this project. TIAER will review, verify and validate water quality monitoring data before they are submitted to the TCEQ. Water quality data (routine and biased flow) will be submitted to the TCEQ in accordance with specification in the QAPP on a semi-annual basis. Unless otherwise indicated in the QAPP, these data will be submitted in a form consistent with TCEQ formatting requirements for upload into the Surface Water Quality Monitoring Information System (SWQMIS).
Deliverables	• Semi-Annual Data Submission

Task 5:	**Data Post-Processing and Evaluation**
Objective:	To provide post-processing of water quality data for an assessment of water quality trends and an evaluation of the effectiveness of the NPS control measures associated with I-Plan activities in the North Bosque River watershed focusing on AFOs and CAFOs in support of interim and final project reports within Task 6.
Subtask 5.1:	**Data Post-Processing for Interim Annual Reports** – Post-processing of water quality data for trends analysis will be performed annually on datasets from the eight monitoring stations on pertinent water quality parameters (e.g., phosphorus, nitrogen, chlorophyll-a, TSS and *E. coli*) for historical and project data collected through the end of the previous calendar year. Summaries of this post-processed data will be included in the interim project reports developed under Subtask 6.1. Trend analysis will be conducted separately on grab sample and storm event data. Data post-processing for storm events will include calculation of event mean concentrations and review of storm hydrographs. Exploratory data analysis will also be used in post-processing steps for evaluation of data distributions, the need for data transformations, management of censored values, seasonality and identification of potential outliers. Datasets will be flow or storm volume adjusted, as appropriate, prior to trend analysis, and trend analysis will be conducted using appropriate statistics, such as the Kendall's tau or seasonal Kendall's tau. Other statistical tools may be applied in the post-processing of data as deemed appropriate in meeting project objectives.

Subtask 5.2:	**Data Post-Processing for Final Water Quality Assessment Report** – TIAER will conduct a final data evaluation including all historical data and project data through December 31, 2013 evaluating trends and building on findings provided by previous interim evaluations under Task 5.1. A final summary of the post-processed data will be included in the final project report under Task 6.2.
Deliverables	• Summaries of post-processed data provided in interim and final project reports through Task 6.

Task 6:	**Reporting of I-Plan Effectiveness**
Objective:	To provide annual assessment reports on water quality trends evaluating the effectiveness of the NPS control measures associated with I-Plan activities in the North Bosque River watershed focusing on AFOs and CAFOs.
Subtask 6.1:	**Interim Annual Reports** – TIAER will develop two interim annual reports; one in FY 2012 and the other in FY 2013 using post-processed data from Task 5. Draft interim annual reports will be due to TCEQ by June 30 each fiscal year. The final interim annual reports will be due 15 days after receipt of final comments from TCEQ.
Subtask 6.2:	**Final Water Quality Assessment Report** – TIAER will develop a final report that includes all historical data and project data through December 31, 2013 evaluating trends and building on findings provided in the interim reports. The final report will relate information compiled on the spatial distribution of CAFO and AFO activities within the watershed to changes in surface water quality. It will also link information from a related TSSWCB CWA §319(h) microwatershed monitoring project to main stem and major tributary water quality data collected for this project. The final report will provide TCEQ with an evaluation of effectiveness of source controls defined in Phase I of the I-Plan on attaining water quality goals along the North Bosque River. The draft final report will be due to TCEQ by June 30, 2014. The final report will be due 15 days after receipt of final comments from TCEQ.
Deliverables	• Draft and Final Interim Reports • Draft and Final Assessment Report • With TCEQ approval, dissemination of interim and final reports to watershed stakeholders through posting on TIAER website

Appendix C. Data Review Checklist and Summary

NPS DATA REVIEW CHECKLIST AND SUMMARY
A completed checklist must accompany all data sets submitted to the TCEQ by the Contractor.

QAPP Title: _____

Effective Date of QAPP: _____

Data Format and Structure		**Y, N, or NA**
A.	Are there any duplicate *Tag Id* numbers in the Events file?	
B.	Do the *Tag* prefixes correctly represent the entity providing the data?	
C.	Have any *Tag Id* numbers been used in previous data submissions?	
D.	Are TCEQ station location (SLOC) numbers assigned?	
E.	Are sampling *Dates* in the correct format, MM/DD/YYYY with leading zeros?	
F.	Are the sampling *Times* based on the 24 hour clock (e.g. 13:04) with leading zeros?	
G.	Is the *Comment* field filled in where appropriate (e.g. unusual occurrence, sampling problems, unrepresentative of ambient water quality)?	
H.	*Submitting Entity, Collecting Entity, and Monitoring Type* codes used correctly?	
I.	Are the sampling dates in the *Results* file the same as the one in the *Events* file for each Tag Id?	
J.	Are values represented by a valid parameter code with the correct units?	
K.	Are there any duplicate parameter codes for the same *Tag Id*?	
L.	Are there any invalid symbols in the *Greater Than/Less Than* (*GT/LT*) field?	
M.	Are there any *Tag Ids* in the *Results* file that are not in the *Events* file or vice versa?	
Data Quality Review		**Y, N, or N/A**
A.	Are all the "less-than" values reported at the LOQ? **If no, explain on next page**.	
B.	Have the outliers been verified and a "1" placed in the *Verify_flg* field?	
C.	Have checks on correctness of analysis or data reasonableness been performed? e.g.: Is ortho-phosphorus less than total phosphorus? Are dissolved metal concentrations less than or equal to total metals?	
D.	Have at least 10% of the data in the data set been reviewed against field and laboratory data sheets?	
E.	Are all parameter codes in the data set listed in the QAPP?	
F.	Are all stations in the data set listed in the QAPP?	
Documentation Review		**Y, N, or N/A**
A.	Are blank results acceptable as specified in the QAPP?	
B.	Were control charts used to determine the acceptability of field duplicates?	
C.	Was documentation of any unusual occurrences that may affect water quality included in the *Event* table's *Comments* field?	
D.	Were there any failures in sampling methods and/or deviations from sample design requirements that resulted in unreportable data? **If yes, explain on next page**.	
E.	Were there any failures in field and/or laboratory measurement systems that were not resolvable and resulted in unreportable data? **If yes, explain on next page.**	
F.	Was the laboratory's NELAC Accreditation current for analyses conducted?	

Data Set Information

Data Source:

Date Submitted:

Tag_ID Range:

Date Range:

Comments:

Please explain in the space below any data discrepancies discovered during data review including:

- Inconsistencies with AWRL specifications or LOQs
- Failures in sampling methods and/or laboratory procedures that resulted in data that could not be reported to the TCEQ
- Include completed Corrective Action Reports with the applicable Progress Report

_____
_____
_____
_____
_____
_____
_____
_____

□ I certify that all data in this data set meets the requirements specified in Texas Water Code Chapter 5, Subchapter R (TWC §5.801 et seq) and Title 30 Texas Administrative Code Chapter 25, Subchapters A & B.

□ This data set has been reviewed using the Data Review Checklist.

TIAER's Project Data Manager:

Date:

Appendix D. Automated Sampler Testing, Maintenance and Calibration Requirements

SOP-F-115 Rev. 2, General Maintenance of Automated Sampling Sites

SOP-F-115

General Maintenance of Automated Sampling Sites

Revision 3

Automated Sampler Supervisor	05 Apr 11 Date
Nancy Easterling Quality Assurance Officer	05 April 2011 Date

Texas Institute for Applied Environmental Research

Effective Period: 05 April 2011 to 04 April 2012

1.0 Applicability

This procedure applies to all field equipment used to monitor non-point source pollution at automated sampling sites utilized at the Texas Institute for Applied Environmental Research (TIAER), Tarleton State University, Stephenville, Texas.

2.0 Purpose

The purpose of this procedure is to provide written documentation of the methods and procedures used by TIAER field personnel to maintain all field equipment. Maintaining equipment in good working order is essential for production of high quality data in the field.

3.0 Definitions

3.1 Maintenance - functions or actions required to ensure the proper working order of a piece of equipment. These actions include, but are not limited to, cleaning, minor repairs, changes of tubing, periodic calibration, checks for damaged or worn components, changes of consumable materials and protective measures.

3.2 Field Notebook - notebook of general maintenance sheets used specifically to record field activities, measurements, observations and notes.

3.3 Flowmeter - ISCO 3230 and 4230 Flowmeter - a scientific instrument designed to monitor the level of water in a stream, pipe or other system. The bubbler system, used by this particular flowmeter to measure level, detects changes in the level of the flow stream by measuring the amount of air pressure required to force an air bubble from the end of a submerged tube. As the liquid level in the flow stream increases, the amount of air pressure required to force the bubble from the tube also increases.

3.4 Automated Sampler – ISCO 3700 and 6712 Portable Samplers - a scientific instrument used to collect water samples based on time or flow conditions, depending on the program of the instrument. The sampler retrieves samples based on automation, not human actions.

4.0 Equipment, Calibration & Maintenance

4.1 ISCO Model 3700 Portable Sampler

4.1.1 Calibration - See SOP F-112 Programming Portable Samplers and *ISCO 3700 Portable Water Sampler Instruction Manual*.

4.1.2 Maintenance - maintenance of the flow meter is described in further detail in section 5 of this manual.

4.2 ISCO Model 6712 Portable Sampler

4.2.1 Calibration - See SOP F-112 Programming Portable Samplers and *ISCO 6712 Portable Water Sampler Instruction Manual*.

4.2.2 Maintenance - maintenance of the flow meter is described in further detail in section 5 of this manual.

4.3 ISCO Model 3230 Flowmeter

4.3.1 Calibration - See SOP F-111 Programming Flowmeter Equipment and *Instruction Manual Model 3230 Flowmeter*.

4.3.2 Maintenance - maintenance of the flowmeter is described in further detail in section 5 of this manual.

4.4 ISCO Model 4230 Flowmeter

4.4.1 Calibration - See SOP F-111 Programming Flowmeter Equipment and *Instruction Manual Model 4230 Flowmeter*.

4.4.2 Maintenance - maintenance of the flowmeter is described in further detail in section 5 of this manual.

5.0 Procedure

Maintenance of all field equipment is performed on bi-weekly, quarterly, and/or annual time schedules. A general maintenance field data sheet (see attached) must be filled out each time a site is visited. Maintenance for each schedule is as follows:

5.1 Bi-Weekly Maintenance

5.1.1 Using a general maintenance field data sheet, write down the site name, current date, your initials and central standard time. Continue to fill in all blanks on the data sheet as follows:

5.1.2 Using a battery tester, check the percent charge or voltage of the 12 volt deep cycle marine battery. If the percent charge is less than 50% or 12 volts, replace the battery with a fully charged battery. Record the percent charge or voltage on the data sheet.

5.1.3 Observe the tubes of desiccant on the side or top of the flowmeter. They should be a shade of blue. If not, they need to be replaced with new ones. In addition, the internal square desiccant should also be checked and replaced if necessary. Record the condition of the desiccants on the data sheet. *Note: Currently the dessicants are changed out every two weeks during the downloading of the flowmeter.*

- Record the current level reading displayed on the view screen of the flowmeter.
- Press the "go to program step" button on the flowmeter. Press 6 for 4230 flowmeters and then press the enter (green) button until the display reads "enter level at which to enable sampler" and record the level displayed. This level is project specific and may vary within the project. The various activation and enable levels are emailed to field staff for documentation.
- To change the "enable" level, press exit program.
- Now press the "go to program step" button. Press 6 and the enter button until the display reads "enter level at which to enable sampler". Enter the appropriate level. Press the enter button 4 times, then press the exit program button.
- Check to make sure the automatic water sampler is full of clean sample bottles. If the sampler is not full, please fill with clean bottles.

- Look at the display panel of the sampler. Record what is displayed on the screen. Press the display status button of the sampler and press the enter key one time to review the results program. Using the arrow key, toggle over until the word "results" is flashing and press the enter key. Keep pressing the "enter" key until the display reads "SAMPLER INHIBITED", and note if any water samples were collected. If water samples were collected, use the sample retrieval sheet to record the sample data.
- Record the type of flowmeter installed at the sampling site, either SPA 652 or 4230.
- Note the condition of the suction and bubbler lines.
- If the sampling site contains a tipping bucket rain gage, check the funnel to ensure it is not clogged. Also check the QA rain gage for any rain measurement and record on the data sheet.
- If the site contains a staff gage, please note the depth measurement of the gage on the data sheet.
- Finally, the flowmeters at the automated sampling sites are downloaded with a laptop computer every two weeks. The collected data is transferred to a database and reviewed for potential errors. If the site is downloaded, please record on the general maintenance sheet which computer was used to download the flowmeter.

5.2 Quarterly Maintenance

The following procedures are performed at each of the automated water sampling sites on a quarterly basis. The procedures performed are recorded on the general maintenance data sheets along with any additional comments regarding the status of the sampling site.

- The fluid levels in the batteries used to power the samplers and flowmeters are checked to monitor the water usage of the battery. If water levels are low in the battery, water is added to the battery to ensure that the battery maintains a full charge. In addition, if any corrosion is noted on the battery posts, the posts are cleaned using a wire brush and sprayed with a battery corrosion protectant.
- The 1/8 inch polyethylene bubbler lines, used by the flowmeters to measure the depth of the water in the stream, are calibrated for accuracy using a staff gauge. If the display level on the flowmeter and measured level are different, the flowmeter level is adjusted accordingly and the change is noted on the general maintenance sheet.
- At each automated sampling site, the sampler is enabled through the flowmeter and a sample is drawn into a 1000 mL graduated cylinder to check calibration of the sampler. If the collected volume is not exactly 1000 mL, the sampler is calibrated using the “calibrate sampler” function. Enabling the sampler also checks the ability of the flowmeter and sampler to respond during a storm event.
- The stainless steel strainer and bubbler lines are cleaned of debris or anything which might inhibit the correct operation of the sampling equipment. The strainer is cleaned using 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.

- If the site contains a tipping bucket rain gage, a test is performed to ensure a proper response from the rain gage. The rain gage is manually tipped five or ten times. After tipping the gage, a report is printed on the flow meter to make sure the rain was recorded in the rain partition. The number of tips is recorded on the general maintenance sheet and is taken out of the rainfall database.

5.3 Yearly Maintenance

The following procedures are performed at each sampling site once a year. Each of the procedures is recorded on the standard general maintenance sheet or on a sheet of paper to be filed.

- The cross section of each sampling stations is surveyed to record any changes in the shape of the channel. The survey is performed at the same location each time using a level and rod. Reading are taken at 1 foot increments and all the surveys at each site are tied together using a common bench mark.
- The suction line at each site is cleaned using 1 N hydrochloric acid. After washing the line with acid, the line is triple rinsed with deionized water.
- Stations may be surveyed more frequently if large rainfall events have caused significant changes to the stream channel.

6.0 Quality Control & Safety Aspects

6.1 All aspects of this procedure shall conform to the criteria established in SOP-S-102 "Field Safety"

6.2 The general maintenance sheets shall remain in a notebook controlled by the Automated Sampling Supervisor.

6.3 No maintenance, adjustment or repair shall be performed on any field instrument without consultation with the Automated Sampling Supervisor.

7.0 References

7.1 ISCO, Inc., 1992. Flowlink Instruction Manual, 1992.

7.2 ISCO, Inc., 1990. Instruction Manual Model 3230 Flow Meter, 1990.

7.3 ISCO, Inc., 1992. 3700 Portable Sampler Instruction Manual, 1992.

8.0 Attachments

8.1 Example of General Maintenance Sheet

Appendix E. Examples of Field Data Sheets

General Maintenance
Field Data Sheet (Streams)

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

Hydrological Parameters

Total Depth: _____ft.

Sample #	Sample Depth (ft)	***Place Sonde Readings Here***						
		Temp C	Cond us	DO %Sat	DO mg/L	pH		Flow Sev. (select from below)
	*							
	1.00 **							
	record depth	* If total depth is <1.5 ft. collect at 1/3 total dept** 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						

Estiimated 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** **%** **ch** **gain**

Baro. **Table DO** **x %Atm**

Appendix F. Example of Chain-of-Custody Form

TIAER ***Chain of Custody / Sample Information Form*** **Page __ of __** Field data or attachments? (Y/N) Y

Client or Project Manager: Larry Hauck | Client phone: | Sampler(s) and Delivery information: T. Jones/ J. Stroebel/ A. Martinez | 0-6ºC temp. Therm. used: T-

TIAER Project Code	TIAER Lab Sample Number	TIAER Test Group Code	Sample Date(s) (mm/dd/yy)	Sample Time(s) (hh:mm) CST for TIAER	Client Sample or Site ID	Sample Type	Matrix	Preservative	Preservative and Container types/ number	Comments (if applicable): Flow Weighted data start/end date/time:	bottle numbers:	Other notes (special turnaround times requested may incur premium charges):	Composite only- last bottle collection date/time:	pH <2 check	temp check	Disposed
TNT-Hill		H-1			10668	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			82002	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			10684	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			10686	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			20657	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			10669	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			20660	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			10673	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			10673	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
TNT-Hill		H-1			82703	G	L	I	A-4, B, D-2, C	N/A	N/A	N/A	3 -250ml A, 1- 250ml D for TRA			
-----	-----	-----	-----	-----	-----	--	-----	-----	-----	---	-----	----------	-----	--	--	--

Relinquished by:	Date/Time: CST DST	Received by:	Date/Time: CST DST
Relinquished by:	Date/Time: CST DST	Received by:	Date/Time: CST DST

Sample Types: **G**=Grab, **SG**=Storm Grab, **S**=Sequential, **T**=Time based comp., **F**=Flow based comp., **M**=Multisonde, **O**=other | **Matrix:** **L**=Liquid (nonpotable water), **S**=Solid or chemical | Form review initials/ date

Preservative/container codes: **A**= plastic unfiltered (**uf**) unacidified (**ua**), **B**= dark plastic **uf/ua**, **C**= field filtered **ua** plastic, **D**=acidified **uf** plastic, **E**= acidified filtered plastic, **F**=filter, **G**=glass **ua/uf**, **H**=dark glass **uf**, **J**=glass acidified **uf**, **O**=other (describe), **S**=sterile plastic **ua/uf**, V=VOA vial **uf**, W= plastic bag **ua/uf.** I=Ice, HS=Sulfuric acid, HN=Nitric acid | Data entry: | Field review:

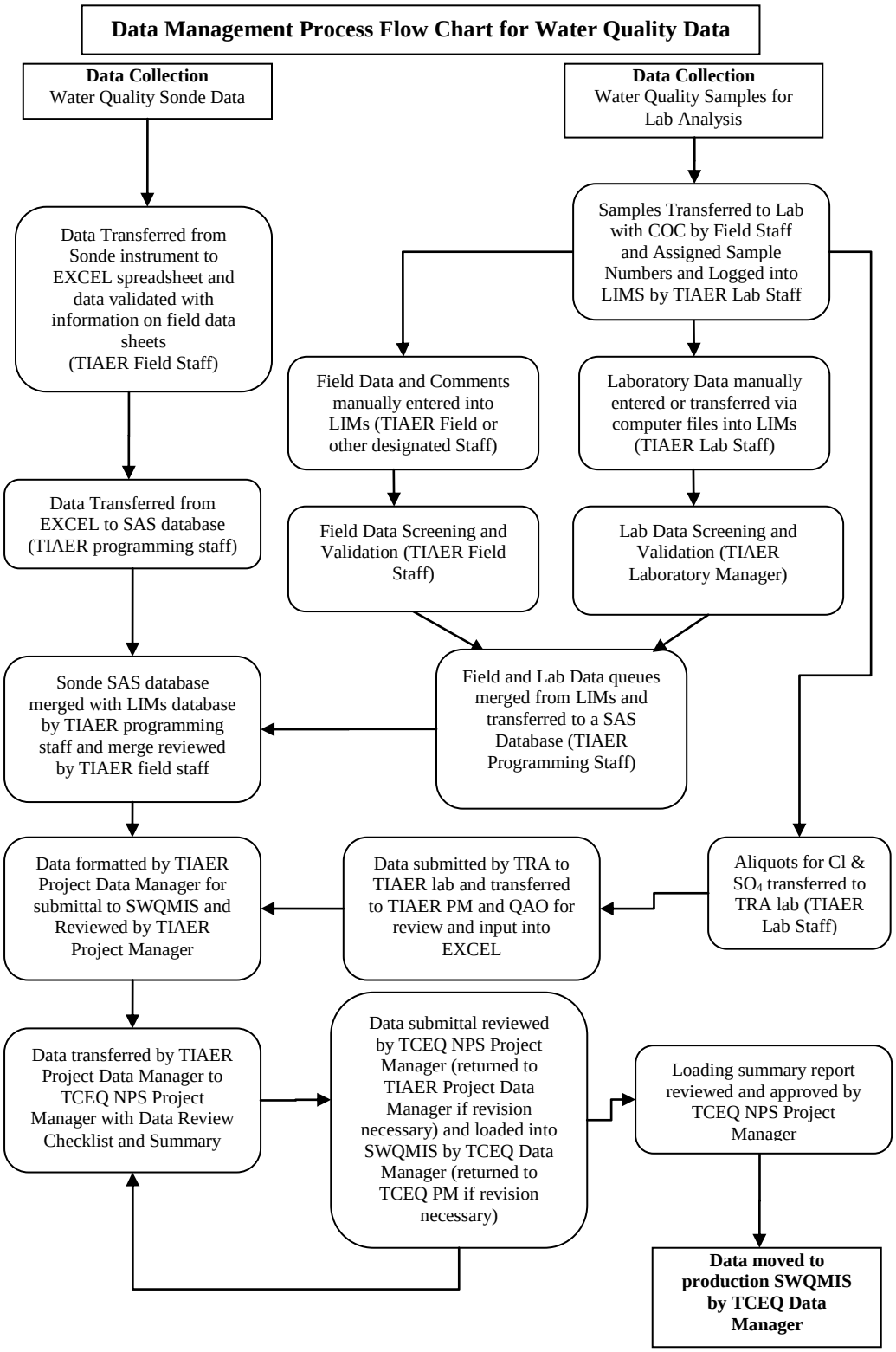
Each preservative/container code represents one container ID. If more than one container is submitted for a code, enter the number of each beside the code.

Texas Institute for Applied Environmental Research
Box T-0410, Stephenville, TX 76402, Tarleton State University 254-968-9570, 968-9560

Lab review: **Q-110-1, rev. 6 mm 11/2/09**

Sample Acceptance Policy: TIAER retains the right to refuse acceptance of any sample and return any and all portions of samples to the client. Samples submitted with little holding time remaining may not be analyzed in time to meet project requirements. Samples should have at least 50% of holding time remaining when submitted. Unless otherwise agreed upon in writing, Client should submit samples collected and preserved in accordance with 40 CFR 136, the 2003 NELAC Standard, or other regulatory requirement stated by the Client's project. TIAER Lab shall not be responsible for data accuracy on samples improperly collected, preserved or submitted. Samples not appropriately collected, preserved or submitted may be accepted and analyzed by the TIAER Lab at the request of the Client. Unless previously arranged, normal sample acceptance hours without premium fees are Monday-Friday, 0800-1600, exclusive of official Tarleton holidays . Samples submitted outside of the normal hours may be processed at a premium surcharge. By signing to relinquish the sample(s) above, the Client or Client's representative hereby agrees to this policy & conforms to Contract or Cooperative Agreement between Client and TIAER.

Appendix G. Data Management Flow Chart


Data Management Process Flow Chart for Water Quality Data
Data Collection
Water Quality Sonde Data
Data Collection
Water Quality Samples for Lab Analysis
Data Transferred from Sonde instrument to EXCEL spreadsheet and data validated with information on field data sheets (TIAER Field Staff)
Samples Transferred to Lab with COC by Field Staff and Assigned Sample Numbers and Logged into LIMS by TIAER Lab Staff
Field Data and Comments manually entered into LIMs (TIAER Field or other designated Staff)
Laboratory Data manually entered or transferred via computer files into LIMs (TIAER Lab Staff)
Data Transferred from EXCEL to SAS database (TIAER programming staff)
Field Data Screening and Validation (TIAER Field Staff)
Lab Data Screening and Validation (TIAER Laboratory Manager)
Sonde SAS database merged with LIMs database by TIAER programming staff and merge reviewed by TIAER field staff
Field and Lab Data queues merged from LIMs and transferred to a SAS Database (TIAER Programming Staff)
Data formatted by TIAER Project Data Manager for submittal to SWQMIS and Reviewed by TIAER Project Manager
Data submitted by TRA to TIAER lab and transferred to TIAER PM and QAO for review and input into EXCEL
Aliquots for Cl & SO4 transferred to TRA lab (TIAER Lab Staff)
Data transferred by TIAER Project Data Manager to TCEQ NPS Project Manager with Data Review Checklist and Summary
Data submittal reviewed by TCEQ NPS Project Manager (returned to TIAER Project Data Manager if revision necessary) and loaded into SWQMIS by TCEQ Data Manager (returned to TCEQ PM if revision necessary)
Loading summary report reviewed and approved by TCEQ NPS Project Manager
Data moved to production SWQMIS by TCEQ Data Manager

Appendix H: Example of TIAER Corrective Action Report

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:** _____

Q-105-1, Rev. 3

Appendix I: Corrective Action Plan Form

Corrective Action Plan
Issued by:_____ Date Issued_____ Report No._____
Description of deficiency
Root Cause of deficiency
Programmatic Impact of deficiency
Does the seriousness of the deficiency require immediate reporting to the TCEQ? If so, when was it?
Corrective Action to address the deficiency and prevent its recurrence
Proposed Completion Date for Each Action
Individual(s) Responsible for Each Action
Method of Verification
Date Corrective Action Plan Closed?

Appendix J: Corrective Action Status Table

Corrective Action Status Table

Corrective Action #	Date Issued	Description of Deficiency	Action Taken	Date Closed

ATTACHMENT 1
Example Letter to Document Adherence to the QAPP

TO: (name)
(organization)

FROM: (name)
(organization)

RE: TIAER, Evaluating Effectiveness of Implementation Activities within the North Bosque River Watershed QAPP

Please sign and return this form by (date) to:

(address)

I acknowledge receipt of the "Evaluating Effectiveness of Implementation Activities within the North Bosque River Watershed QAPP, Revision Date". I understand that the document describes quality assurance, quality control, data management and reporting, and other technical activities that must be implemented to ensure the results of work performed will satisfy stated performance criteria.

My signature on this document signifies that I have read and approved the document contents. Furthermore, I will ensure that all staff members participating in activities covered under this QAPP will be required to familiarize themselves with the document contents and adhere to the contents as well.

_____

Signature Date

Copies of the signed forms should be sent by the Contractor to the TCEQ NPS Project Manager within 60 days of TCEQ approval of the QAPP.