Onion Creek Recharge Project
Quality Assurance Project Plan

Barton Springs/Edwards Aquifer
Conservation District
Austin, Texas 78748

Effective Period: September 12, 2012 – September 12, 2013

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

Brian A. Smith
Barton Springs/ Edwards Aquifer Conservation District
Aquifer Science Team Leader
1124 Regal Row
Austin, TX 78748
512-282-8441
brians@bseacd.org

This page intentionally left blank

A1 Approval Page

Barton Springs/Edwards Aquifer Conservation District

Brian A. Smith	8/29/12	Brian Hunt	8/29/12
Brian A. Smith, Project Manager	Date	Brian Hunt, QA Officer	Date

LCRA Environmental Laboratory Services

Alicia Gill	9/12/12	Hollis Pantalion	9/11/12
Alicia Gill, Laboratory Manager	Date	Hollis Pantalion, Laboratory QA Officer	Date

Barton Springs/Edwards Aquifer Conservation District 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. BSEACD will maintain this documentation as part of the project's quality assurance records. This documentation will be available for review.

A2 Table of Contents

A1 Approval Sheets 2
A2 Table of Contents 3
A3 Distribution List 4
List of Acronyms 5
A4 Project/Task Organization 7
Figure A4.1 - Organization Chart 9
A5 Problem Definition/Background 10
A6 Project/Task Description 11
A7 Quality Objectives and Criteria 12
Table A7.1 Measurement Performance Specifications for Continuous Instream Monitoring and Stormwater Monitoring 13
Table A7.2 DQOs for Continuous Water-Quality Monitoring Sondes (Multi-Probes) 14
Table A7.3 MQOs for 500 KHz Acoustic Doppler Current Profiler (ADCP) Flow Meters 14
A8 Special Training/Certification 17
A9 Documents and Records 18
B1 Sampling Process Design (Experimental Design) 21
Table B1.1 Monitoring Sites 23
B2 Sampling Methods 24
Table B2.1 Methods and Equipment for Continuous Water-Quality Monitoring 25
Table B2.2 Stormwater Monitoring 25
B3 Sampling Handling and Custody 27
B4 Analytical Methods 29
B5 Quality Control 31
B6 Instrument/Equipment Testing, Inspection and Maintenance 35
B7 Instrument/Equipment Calibration and Frequency 35
B8 Inspection/Acceptance of Supplies and Consumables 36
B9 Non-direct Measurement 37
B10 Data Management 37
Table B10.1 SWQMIS Parameters 39
C1 Assessments and Response Actions 41
Table C1.1 Assessments and Response Actions 43
C2 Reports to Management 44
D1 Data Review, Verification, and Validation 44
D2 Verification and Validation Methods 45
D3 Reconciliation with User Requirements 45
Appendix A. Area Location Map 46
Appendix B. Data Summary 48
Appendix C. Manufacturer’s Operator Manuals 50
Appendix D. Field Data Reporting Form 53
Appendix E. Chain-of-Custody Form 55
Appendix F. Automated Sampler Testing with Maintenance and Calibration Requirements 57
Appendix G. Standard Operating Procedures for the In-Situ Troll 9500 SOP BSEACD-001 59

A3 Distribution List

BSEACD will provide copies of this project plan, and any amendments or revisions of this plan, to each project participant defined in the list below. BSEACD 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 Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

Chuck Dvorsky, CWQMN Network Coordinator
(512) 239-5550

Barton Springs/Edwards Aquifer Conservation District
1124 Regal Row
Austin, TX 78748

Brian A. Smith, Project Manager
(512) 282-8441

Brian Hunt, Quality Assurance Officer
(512) 282-8441

LCRA Environmental Laboratory Services
3505 Montopolis
Austin, TX 78744

Alicia Gill, Laboratory Manager
(512) 356-6022

Hollis Pantalion, Laboratory Quality Assurance Officer
(512) 356-6022

List of Acronyms

AWRL	Ambient Water Reporting Limit
BMP	Best Management Practice
BSEACD	Barton Springs/Edwards Aquifer Conservation District
CAMS	Continuous Ambient Monitoring Station
CAR	Corrective Action Report
COC	Chain of Custody
CRP	Clean Rivers Program
CVS	Calibration Verification Sample
CWA	Clean Water Act
CWQMN	Continuous Water Quality Monitoring Network
DOC	Demonstration of Capability
DMP	Data Management Plan
DMRG	Data Management Reference Guide
DQO	Data Quality Objective
EPA	Environmental Protection Agency
GIS	Geographic Information System
LCS	Laboratory Control Sample (formerly Laboratory Control Standard)
LCSD	Laboratory Control Sample Duplicate (formerly Laboratory Control Standard Duplicate)
LOD	Limit of Detection
LOQ	Limit of Quantitation (formerly reporting limit)
MOM	Manufacturer’s Operator Manuals
NCR	Nonconformance Report
NELAC	National Environmental Laboratory Accreditation Conference
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NTU	Nephelometric Turbidity Units
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
SLOC	Station Location Form
SOP	Standard Operating Procedure
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TSS	Total Suspended Solids
TSWQS	Texas Surface Water Quality Standards
WQI	Water Quality Inventory

A4 Project/Task Organization

TCEQ

Water Quality Planning Division

Chuck Dvorsky
CWQMN Network Coordinator

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

Barton Springs/Edwards Aquifer Conservation District (BSEACD)

Brian Smith
BSEACD 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 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.

Brian Hunt
BSEACD QAO
Responsible for coordinating development and implementation of the QA program. Responsible for writing 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 BSEACD 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 according to Section D2 procedures and acquired data procedures after each task is performed. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Conducts laboratory inspections. Develops, facilitates, and conducts monitoring systems audits.

Kendall Bell-Enders
BSEACD Data Manager
Responsible for the acquisition, verification, and transfer of data to the TCEQ. 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 acceptable format. Ensures data are submitted according to workplan specifications. Provides the point of contact for the TCEQ Data Manager to resolve issues related to the data.

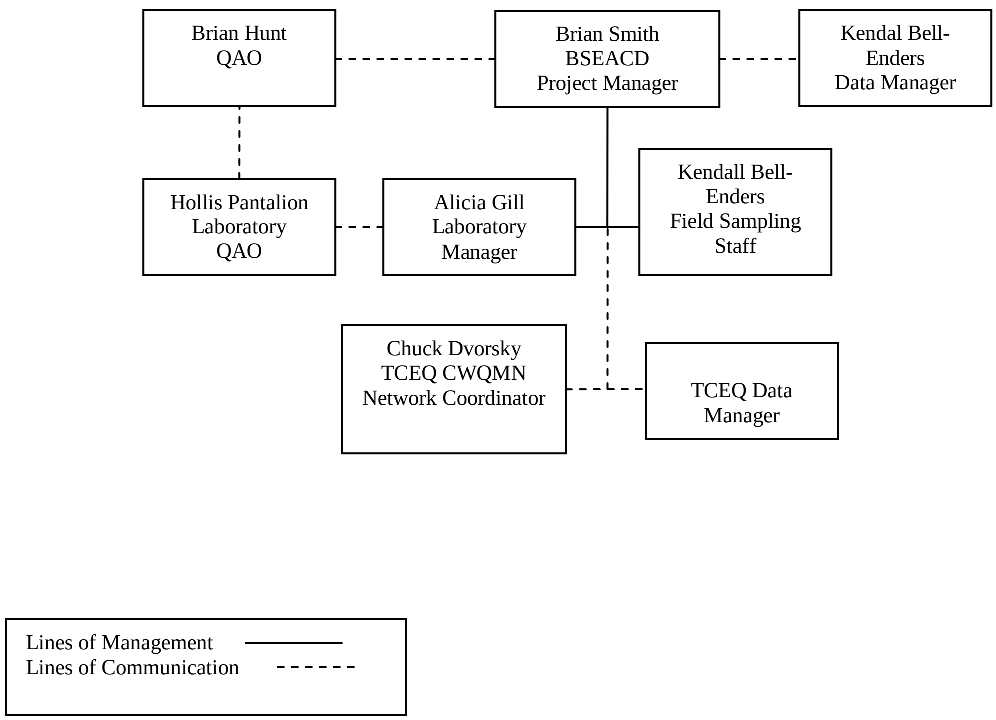
Brian Hunt
BSEACD Field Supervisor
Responsible for supervising all aspects of the sampling and measurement of surface waters and other parameters in the field. Responsible for the acquisition of water samples and field data measurements in a timely manner that meet the quality objectives specified in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

LCRA Environmental Laboratory Services

Alicia Gill 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 actions, as required. Develops and facilitates monitoring systems audits.

Hollis Pantalion
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 BSEACD. 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.

Figure A4.1. Organization Chart - Lines of Communication



A5 Problem Definition/Background

The Edwards Aquifer, located in south-central Texas, is one of the most prolific karst aquifers in the United States and is an important groundwater resource for municipal, industrial, domestic, agricultural, recreational, and ecological needs. The aquifer extends about 270 miles from the Rio Grande River along the Mexico/United States border at Del Rio, east to San Antonio, then northeast through Austin to Salado. Hydrologic divides separate the Edwards Aquifer into three major segments: the San Antonio, Barton Springs, and Northern segments and numerous subsections.

The Barton Springs segment of the Edwards Aquifer is the focus of this project (Appendix A, Location Map). Approximately 60,000 people depend on water from the Barton Springs aquifer as their sole source of drinking water, and the various spring outlets at Barton Springs are the only known habitats for the endangered Barton Springs salamander.

Up to 85 percent of recharge to the aquifer is derived from streams originating on the contributing zone, located up gradient and west of the recharge zone. Water flowing onto the recharge zone sinks into numerous caves, sinkholes, and fractures recharging the aquifer. Groundwater then moves northeast toward wells and Barton Springs. Onion Creek contributes about one third of all recharge, with most of that recharge occurring within several discrete recharge features within the creek bottom (Appendix A).

EPA identifies karst aquifers as one of the most vulnerable to pollution because of their rapid groundwater velocities and limited ability to filter contaminants. Numerous tracer tests have been performed on the Barton Springs aquifer demonstrating that rapid groundwater flow occurs in an integrated network of conduits discharging at wells and springs. A portion of this groundwater flows from the conduits into the diffuse matrix of the aquifer building up storage in the aquifer. Water from storage flows diffusely to wells or back into the conduit network. This dual flow system results in the potential for contamination to rapidly impact wells and springs, as well as slowly accumulate and move within the matrix of the aquifer.

The TCEQ lists the Barton Springs aquifer on a list of impaired groundwater resources. Onion Creek is listed on the 303(d) list of impaired streams. Increases in sediment, bacteria, and other contaminants in groundwater as a result of storm-flow events in the Barton Springs aquifer have been documented by analysis of water samples from monitor and water-supply wells.

To reduce the amount of sediment and other storm-related contaminants entering one of these recharge features, an automated control system has been designed and installed at the BMP that was previously constructed over Antioch Cave on Onion Creek. Two valves on the BMP controls flow into the cave.

During periods of storm water flow in the creek, valves will be closed to prevent entry of sediment-laden water into the recharge feature. Continuous water quality monitoring network (CWQMN) systems have been installed at the Antioch site and at the low water dam site within the Onion Creek Management Area, which will monitor turbidity and other parameters in water flowing in the creek. When turbidity reaches a level indicative of storm-water flow, 100 Nephelometric Turbidity Units (NTU), the valve on the Antioch BMP will be automatically closed. When turbidity drops to a level consistent with no storm-water flow, 50 NTU, the valve will be opened, allowing better quality water to enter the aquifer. Operation of these systems will decrease the amount of sediment and other storm-water related contaminants entering the aquifer. This will improve the quality of water in the aquifer that thousands of users rely upon and that the endangered salamanders need for survival.

To monitor the influence of recharge via Antioch Cave on the Edwards Aquifer, a multiport monitor well was installed near Antioch Cave as part of the 319h grant project. The movement of non-point source pollution in the various units of the Edwards Aquifer will be monitored in this well when recharge from Onion Creek is taking place in Antioch Cave.

A6 Project/Task Description

CWQMN Sites

The two CWQMN systems installed in the Onion Creek watershed monitor water quality at two locations, one in the upper portion of the recharge zone, and the second at the lower portion of the recharge zone within the Barton Springs segment of the Edwards Aquifer (Barton Springs aquifer).

This project's goal is to improve water quality in the Barton Springs aquifer by facilitating timely and efficient responses to recharge events by continuously monitoring water quality in the Onion Creek Watershed and excluding "first flush" flows of contaminated storm water into a recharge feature on Onion Creek. This is accomplished using a BMP with a valve that automatically opens when a storm water pulse has passed to allow recharge of clean surface water into the aquifer. The valve is triggered based on CWQMN data from the site. The valve closes when turbidity is determined to be high, currently at 100 NTU. The valve reopens when turbidity lowers to acceptable concentrations of 50 NTU.

Two CWQMN sites have been installed on Onion Creek, one at the Antioch BMP location and the second 8 miles upstream of Antioch at the Onion Creek Management Area low water dam. Each CWQMN site in the Onion Creek Watershed analyzes ambient water for DO, turbidity, temperature, and conductivity. Continuous water-quality monitoring is conducted in accordance with TCEQ's established CWQMN quality assurance project plan (QAPP). Data are transmitted to TCEQ electronically and uploaded into the LEADS system.

Surface Water Sampling

Water samples from the Antioch BMP on Onion Creek are collected by using an automatic sampler during occasional storm flow events. Manual (grab) samples are collected when possible for base flow samples between storm events.

Samples are analyzed for TSS, TDS, turbidity, nitrate and nitrite as N, and total phosphate. An automated sampler collects samples when triggered by a storm event. Water-quality data are used to determine the amount of pollutant loads (nitrate/nitrite, phosphorus, and sediment) that are prevented from entering the aquifer by operation of the Antioch BMP. This is accomplished by first calculating the amount of contaminants in Onion Creek during the storm pulse and then calculating the amount of water not entering the aquifer when the valve is closed. This volume is determined by taking the flow rate of water entering the BMP when the valve is first opened following a storm event multiplied by the length of time the valve was closed. The masses of nitrate/nitrite, phosphorous, and sediment prevented from entering the aquifer are calculated with the following formula:

$$Q * C_{N,P,S} * T = M_{N,P,S}$$

where

Q = Rate of flow into Antioch BMP when valve is first opened following storm pulse

$C_{N,P,S}$ = Concentration of N (nitrate/nitrite), P (phosphorous), or S (sediment) during storm pulse

T = Duration of time that valve on BMP was closed

$M_{N,P,S}$ = Mass of contaminant prevented from entering aquifer

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 revised as necessary and reissued annually on the anniversary date, or revised and reissued within 120 days of significant changes, whichever is sooner. The most recently approved QAPPs shall remain in effect until revisions have been fully approved; reissuances (i.e., annual updates) must be submitted to the TCEQ for approval before the last version has expired. If the entire QAPP is current, valid, and accurately reflects the project goals and organization's policy, the annual reissuance 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.

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 BSEACD 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.

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 by the BSEACD QAO. 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 objectives of the data collection efforts of this project are as follows:

Continuous water quality monitoring is conducted to operate a valve over a recharge feature for the Barton Springs segment of the Edwards Aquifer. Continuous water quality monitoring also obtains information about water quality in Onion Creek and water quality entering the aquifer. CWQMN data are telemetered to TCEQ and uploaded into the LEADS system.

Data from automatic samplers are used to calculate the pollutant loads associated with stormwater runoff events in Onion Creek.

Manual grab samples are collected to determine the amount of sediment and contaminants that enter the aquifer through Antioch Cave when the valve is open. These values will be compared to values for storm flow when the valve on the Antioch BMP is closed. Such a comparison gives us a better understanding of the quality of water entering the aquifer along Onion Creek. With that knowledge, we can better understand non-point source pollution in the Onion Creek watershed. Grab samples, that are representative of base flow conditions, are collected following occasional sampled storm events. These sampling events occur only when BSEACD staff and resources are available.

The Onion Creek Recharge Project employs only methods and techniques which have been determined to produce measurement data of a known and verifiable quality and which are sufficient to meet the objectives of the project.

Measurement Quality Objectives (MQOs) and Data Quality Objectives (DQOs) to support the Continuous Water Quality Monitoring Network (CWQMN) objectives are specified in Tables A7.2 and A7.3, respectively. Data Quality Objectives for automatic sampling data are in table A7.1. The quality control (QC) program has been developed with these objectives in mind. Methods used for water-quality measurements in the CWQMN are based on *Standard Methods used for the Examination of Water and Wastewater*, 20th Edition, 1998 unless otherwise specified.

Table A7.1 Measurement Performance Specifications for Automatic and Manual (Grab Sample) Monitoring

PARAMETER	UNITS	MATRIX	METHOD	PARAMETER CODE	AWRL	Limit of Quantitation (LOQ)	Recovery at LOQ (%)	PRECISION (RPD of LCS/LCSD)	BIAS %Rec. of LCS	Completeness (%)	Field / Lab
Specific Conductivity	uS/cm	water	SM 2510B and TCEQ SOP	00095	NA	NA	NA	NA	NA	90	Lab
Nitrate/Nitrite – N	mg/l	water	SM4500 NO3-H	00630	.05	0.02	70-130	20	80-120	90	Lab
Total Phosphorus	mg/L	water	EPA 365.4	00665	.06	0.02	70-130	20	80-120	90	Lab
TSS_SM	mg/L	water	SM 2540 D	00530	4	1	NA	20	80-120	90	Lab
TDS_SM	mg/l	water	SM 2540 C	70300	10	10	NA	20	80-120	90	Lab
TURB_W Turbidity	NTU	water	SM 2130 B	82079	NA	NA	NA	NA	NA	90	Lab

References: *US 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*, 20th Ed., Texas Commission on Environmental Quality *Surface Water Quality Monitoring Procedures*, Volume 1.

** Based on range statistic as described in Standard Methods, 21st Edition, Section 9020-B, Quality Assurance/Quality Control – Intralaboratory Quality Control Guidelines. This criterion applies to bacteriological duplicates with concentrations >10 MPN/100mL or > 10 org./100 mL.

Table A7.2 DQOs for Continuous Water-Quality Monitoring Sondes (Multi-Probes)

Parameter	LEADS Parameter Code	Units	Measurement Equipment	Method	Calibration Verification Sample Acceptance Limit (CVS)
pH*	10400	pH /units	In-Situ TROLL 9500	Glass electrode, Standard Method 4500-H+B	± 0.50 pH unit*
DO*	10300	mg/L	In-Situ TROLL 9500	Polarographic & Galvanic membrane electrode, Standard Method 4500-O-G	% Saturation ≤ 6.0%* ± 0.50 mg/L*
DO*	10300	mg/L	In-Situ TROLL 9500	Optical (luminescence quenching) ASTM D888-05 **	% Saturation ≤ 6.0%* ± 0.50 mg/L*
SC*	10095	μS/cm	In-Situ TROLL 9500	Conductivity cell, Standard Method 2510B	5.0% RPE*
Temperature*	10010	EC	Thermistor	Standard Method 2550 B	± 0.50 ºC*
Depth	NA	Feet @ 30psi	In-Situ TROLL 9500	NA	NA
Turbidity	10104	NTU	In-Situ TROLL 9500	EPA 170.1	± 3.0 FNU/NTU or ± 5%

*Parameters and CVS acceptance criteria for use in the Clean Water Act 305(b) Inventory and 303(d) Lists per SWQM DQOs.
**Method not based on *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998. EPA Region 6 has approved Optical DO methods for use in the CWQMN.
***LEADS reports turbidity measurements in NTUs.
ºC = degrees centigrade
NA = Not Applicable

Table A7.3 MQOs for 500 KHz Acoustic Doppler Current Profiler (ADCP) Flow Meters

Parameter	SOP	Flow Meter	Units	Method	Range[1]	Range[2]	Resolution	Accuracy
Volumetric Flow Rate Water Velocity	00094	Shallow Water (Intermittent Streams)	CFS	Doppler Ultrasonic, frequency 500kHz	0.033 to 5.0 ft	-5 to 20 ft/s	+0.01 ft + 0.1 ft/s	TBD

1- vertical beam
2- water velocity
CFS = cubic feet per second
TBD = To be determined. This information will be provided in an amendment to the QAPP.

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 (e.g. deionized water, sand, commercially available tissue). 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 determined through the analysis of laboratory control samples and LOQ Check Standards prepared with verified and known amounts of all target analytes in the sample matrix (e.g. deionized water, sand, commercially available tissue) and by calculating percent recovery. Results are compared against measurement performance specifications and used during evaluation of analytical performance. Program-defined measurement performance specifications for bias are specified in Table A7.1.

Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, a process condition, or an environmental condition. The data will be considered representative of the target population or phenomenon to be studied. Site selection, the appropriate sampling regime, the sampling of all pertinent media according to TCEQ SOPs, and use of only approved analytical methods will assure that the measurement data represents the conditions at the site. Continuous data collected for water-quality assessment are considered to be spatially and temporally representative of the full range of water quality conditions over time. Continuous water-quality data are collected on a routine frequency and are separated by even time intervals. Depending on data storage capabilities, readings will be made between every 1 to 10 minutes. The intent of the stormwater sampling component is to define the water-quality profile(s) of stormwater events within the Onion Creek watershed with the parameters listed in Table A7.1. Stormwater samples will be collected by an automatic sampling device for the duration of the stormwater event. For a single stormwater event within the Onion Creek watershed, four to seven samples will accurately represent the over-all water quality of that storm event. Although data may be collected during varying regimes of weather and flow, the continuous water-quality data sets will not be biased toward unusual conditions of flow, runoff, or season. Stormwater samples will be representative of water quality during storm events or of base-flow (non-storm) conditions. The goal for meeting total representation of Onion Creek will be tempered by the potential funding for complete representativeness.

Completeness

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

Comparability

Confidence in the comparability of routine data sets for this project and for water quality assessments 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 Section B10.

Limit of Quantitation

AWRLs (Table A7.1 and A7.2) are used in this project as the *limit of quantitation* specification, so the Water Quality Standards can be used as the benchmarks to compare data against. Laboratory *limits of quantitation* (Table A7.1 and A7.2) must be at or below the AWRL for each applicable parameter.

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

Analytical Quantitation

To demonstrate the ability to recover at the limit of quantitation, the laboratory will analyze an LOQ check standard on each day samples are run.

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

DQOs for CWQMN

The MQOs and DQOs to support the CWQMN objectives are specified in Tables A7.2 and A7.3. The DQOs for CWQMN DO, SC, pH, and temperature data that can be used in the CWA 305(b) and CWA 303(d) List are specified in Tables A7.2 and A7.3. The QC program has been developed with these objectives in mind. Methods used for water quality measurements in the CWQMN are based on *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998 unless otherwise noted.

A7.1 CWQMN Turbidity Measurements

A variety of measurement techniques can be used to measure turbidity. Data from differing instrumentation and sample matrixes can be highly variable. The only approved EPA method for turbidity is EPA Method 180.1. EPA Method 180.1 utilizes a white or broadband light source. Data produced by this method are reported as Nephelometric Turbidity Units (NTU). EPA Method 180.1 is a laboratory method.

Currently, the CWQMN utilizes International Organization for Standards (ISO) Method 7027 for turbidity (for more details see section B4). CWQMN turbidity data is not usable for regulatory purposes. The CWQMN uses NTUs to report turbidity data collected by the ISO Method 7027 until the appropriate SWQMIS/Parameter code can be identified.

A7.2 Representativeness

By design, the CWQMN measures water quality in greater temporal detail and resolution than is possible with grab samples or short term deployments of monitoring instrumentation. In general, monitoring locations are chosen based on the location being representative of the water body. Ideally, for rivers and streams, the sample collection or *in situ* measurement location should be in the centroid of flow. Centroid is defined as the midpoint of Texas Commission on Environmental Quality Section A7 Continuous Water Quality Monitoring Network Quality Assurance Project Plan Revision of March 2012 that portion of stream width which contains 50 percent of the total flow. However, it is recognized that locating the sample collection or *in situ* measurement location in the centroid of flow is not always possible. If possible, monitoring locations should not be located in backwater or eddies.

A7.3 Comparability

CWQMN water quality measurements are based on *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998, unless otherwise noted. Comparability is also achieved by using SOPs, reporting data in standard units by using accepted rules for significant figures, and by reporting data in standard formats.

A7.4 Bias, Precision, CVS, DQOs, and MQOs

Determining and calculating bias and precision for the purposes of this quality assurance project plan is discussed in Section B5.

A7.5 Completeness

A general requirement for data completeness has been set at 75 percent return. Periods of no flow or dry conditions necessitate shutdown of some instrumentation and these times are not considered in the goal for data completeness. Calculation method for data completeness is discussed in Section C1. Requirements for data completeness for use in the CWA 305(b) and 303(d) Lists are discussed in Section D2.

A8 Special Training/Certification

Staff responsible for operating the automated samplers and flow meters will undergo a training session by the project equipment vendor.

Field personnel will receive training in proper sampling and field analysis. Before actual sampling or field analysis occurs, they will demonstrate to the QA officer (in the field), their ability to properly operate the automatic samplers and retrieve the samples. The QA officer will sign off each field staff in their field logbooks.

BSEACD and subcontractors must ensure that laboratories analyzing samples under this QAPP meet the requirements contained in Section 5.4.4 of the NELAC standards (concerning Review of Requests, Tenders and Contracts).

The following is from Section A8 of the CWQMN QAPP (TCEQ March 2012):

> The TCEQ has an extensive base of professional and skilled employees to enable it to successfully complete the projected tasks and activities associated with this network. Currently, most training is conducted informally on an as-needed-basis by project leads, project participants, vendors, and TCEQ. Data validation training is provided to network participants who validate the data they collect.
>
> When developing new instrumentation, sampling techniques or applications training may be limited to vendor support or what is learned during method development. Expertise and SOPs are derived from this developmental process.
>
> Available approved SOPs shall be used by employees, cooperators and contractors, who audit, calibrate, operate sampling and analytical instrumentation, or validate network data.
> Instrument manuals are available for reference.

All TCEQ personnel associated with the project have detailed functional job descriptions describing the requirements for their positions. All formal training is documented by the administrative staff.

According to the TCEQ *Quality Management Plan*, training requirements for contract staff shall be stated in contract specifications if contracted work is part of the project.

A9 Documents and Records

See Section B10, below, for electronic management of Continuous Water Quality Monitoring Network Data.

The District will follow and adhere to the following from the CWQMN QAPP:

> Each site operator is expected to maintain records that include sufficient information to reconstruct each final reported measurement from the variables originally gathered in the measurement process. This includes, but is not limited to, information (raw data, electronic files, and/or hard copy printouts) related to sample collection, measurement instrument calibration, QC checks of sampling or measurement equipment, "as collected" measurement values, an audit trail for any modifications made to the "as collected" measurement values and traceability documentation for reference standards.
>
> Difficulties encountered during sampling or analysis is documented in operator logs to clearly indicate the affected measurements.

A9.1 Documentation of Procedures and Objectives

The following documents are available for the project team, either in the BSEACD office or on line:

1. Published guidance (*Code of Federal Regulations {CFR}* EPA, and EPA *Quality Assurance Handbook*)
2. CWQMN Project Plan
3. Method specific SOPs
4. Instrument manufacturer's technical support manuals
5. *TCEQ Quality Management Plan, SOPs, and the CWQMN QAPP*
6. *TCEQ SWQM Procedures, Volume 1*

A9.2 Record Keeping

CWQMN written records are kept for five years. Electronic records are kept indefinitely or for the life of a project. Please see Table A9.1 for type of record and location.

Table A9.1
CWQMN Record Locations

Record	Location
Sampling Information	TCEQ Website
Instrument calibration and calibration verification data forms	TCEQ Regional offices/Cooperators/Contractors
Instrument and equipment logbooks	Should be located with instrumentation if possible
LEADS electronic Operator logs Validator logs and Calibration Verifications	CFEP
Validators notes	Data validators office
CWQMN Project Plans	SWQM Central Office
Finding Summary Reports	SWQM Central Office
Technical systems audit and performance evaluation audit	SWQM Central Office

CFEP=Comms Front-End Processor computer located at TCEQ headquarters in Austin, TX

A9.3 Data Reporting

CWQMN environmental data is stored electronically in the MeteoStar/LEADS System. Once testing is complete, all validated CWQMN data will be loaded into the SWQMIS data base. See Section B10 and Section D for more details.

A9.4 Documentation Control Plan

This section describes the procedure and responsibilities for document control used by the TCEQ CWQMN Project for environmental sample collection and analysis.

All SOPs must have a document title, a unique document control number, a revision number, approval signatures, and effective date. The official copy of this document is the hard copy document with the original signatures. SOPs are formally reviewed and re-signed once every two years. SOPs will stay in effect until superseded by a later version or the project is completed. Copies of the official documents shall be clearly identified as such.

The administrative staff is responsible for obtaining and providing the document control number, maintaining the official copy, controlling and documenting access to the documents, maintaining an electronic version of the current copy of the QAPP. PDFs of the QAPP, SOPs and Project Plans are available via the internet at: (www.texaswaterdata.org)

It is the responsibility of each CWQMN participant to ensure they are properly following the most current revision of these documents. The Water Quality Planning Monitoring & Assessment Section Manager, CWQMN Program Manager, and QC Officer are responsible for approving new SOPs and SOP revisions. The QC officer is responsible for changes to the SOPs.

All logbooks containing data or sample information are uniquely identified with a Texas Commission on Environmental Quality Section A9 Continuous Water Quality Monitoring Network Quality Assurance Project Plan logbook number. Each site operator has the responsibility of maintaining the logbooks for a minimum of five years or until all sample information contained within is no longer required to be kept.

Analytical data records are stored on site for a minimum of five years, unless otherwise required by a project or regulation. Indelible ink will be used for all hand-written documents. Changes made to hand written documents must be done by using a single line to strike-out the text. The changes are then initialized and dated.

Laboratory Test Reports

Test/data reports from the laboratory must document the test results clearly and accurately. Routine data reports will be consistent with the NELAC standards (Section 5.10.2) and include the information necessary for the interpretation and validation of data. The requirements for reporting data and the procedures are provided below.

- Report title
- Name and address of laboratory
- Name and address of client and project name
- Sample results
- Units of measurement
- Sample matrix
- Dry weight or wet weight (as applicable)
- Station information
- Date and time of collection
- LOQ and LOD (formerly referred to as the reporting limit and the method detection limit, respectively), and qualification of results outside the working range (if applicable)
- An explanation of failed QC and any non-standard conditions that may have affected quality
- A signature and title of laboratory director or designee

Electronic Data

Only CWQMN data will be reported electronically to TCEQ. Data will be submitted to the TCEQ in the format specified by the TCEQ Project Manger. The Data Summary as contained in Appendix B of this document will be submitted with the data.

In-situ water quality and water level measurements are logged once every 15 minutes by the data logger. The data is then transmitted to the MeteoStar/LEADS system in Austin, Texas where the data is ingested, archived, and posted to the appropriate TCEQ internet site.

A station location request (SLOC) will be submitted to the TCEQ Project Manager for each sampling site to obtain a station identification number.

Records and Documents Retention Requirements

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

B1 Sampling Process Design (Experimental Design)

B1.1 Sample Design Rationale

CWQMN

Data collected by the CWQMN system at the Antioch site is used to trigger the opening and closing of the valve on the Antioch BMP. As a storm pulse is recognized by high turbidity readings on the CWQMN instruments, a signal is sent automatically to the valve control mechanism for the valve to close. As turbidity readings drop below a pre-set level that indicates approach to base flow conditions, the valve is opened to allow the cleaner water in Onion Creek to recharge the aquifer. Data collected by the CWQMN system at the Onion Creek Management Area CWQMN site (CAMS 0727) will be used to monitor the amount of nonpoint source pollution in this portion of Onion Creek and to compare to the amount of nonpoint source pollution at the Antioch site. This comparison will provide an indication of where these pollutants are coming from within the Onion Creek watershed.

Automatic Sampling (Stormwater)

The sample design rationale for stormwater sampling for this study is based on the intent to quantify the amount of sediment and other contaminants that are prevented from entering the Edwards Aquifer by the automated operation of an existing BMP situated over Antioch Cave (CAMS 0770). Monitoring sites are specified in Table B1.1. Since the valves on the BMP are closed during periods of high storm flow, the amount of sediment and other contaminants in the surface water during this period needs to be determined. The stormwater sampling program focuses on the collection of samples that represent the highest amount of flow from a given storm and the collection of samples as the storm pulse subsides to develop a water-quality profile of the stormwater event. For each sampled storm event, representative samples will be collected to define contamination loading along the hydrograph. The first sampling event is a first order look at the contaminant loading as a function of the hydrograph by collecting in general, one to three samples near the maximum stream flow, one or two samples will be collected as the storm pulse is rapidly subsiding, and another one or two samples will be collected when turbidity levels of the water are close to stabilizing. The following sampling events will focus primarily on collecting more samples for the contaminant peak and the recession. It is estimated that the number of days between peak flow and the time at which sediment load and turbidity have decreased to the point that the valve on the BMP should be opened could vary between 2 to 10 days. The sampling schedule will be set to cover this amount of time initially. As data are collected from the first storm events, the sampling schedule will be refined.

An ISCO 3700 series automatic sampler and an ISCO 4230 bubbler flow meter were installed at Antioch. The bubbler flow meter measures the water level (stage) in Onion Creek at the Antioch BMP. The flow meter is programmed to log water level every 5 minutes to trigger the automatic sampler to start sampling and could be used to pace the sample intervals based on water level. The sampler and flow meter has been placed at such a distance and elevation from the BMP so that the sampler pump will be capable of delivering samples to the bottles in the sampler. Because that location might not be above the maximum flood stage for that section of Onion Creek, there is a possibility that the sampler could be inundated under extremely high flood conditions. If that occurs, the sampler will be inspected and repaired or replaced if necessary.

The automatic sampler has been programmed to collect samples starting when the increase in water level indicates that the beginning of storm flow has reached Antioch. The amount of rise in water level has been set at 1 ft, but that might be changed in the future if a lesser or greater value is more representative of storm flow. During a storm event, samples are collected every 15 minutes to 6 hours depending on the anticipated duration of the storm flow. Sampling will continue until the water level drops below 75 percent of the peak flow compared to flow at the start of sampling, or until 10 days after start of sampling, whichever comes first. The cutoff for sample collection will also be evaluated periodically. The cutoff point is likely to vary considerably for each storm event.

Each sample will be acidified as appropriate, iced and transported to the laboratory where they will be stored at $< 6\ ^{0}$ C prior to analysis.

Grab Samples (Base Flow)

Either before a predicted storm event, or well after a storm event, District staff will manually collect an instream sample (grab sample) that will be representative of base flow conditions in Onion Creek. Grab samples will be handled and analyzed as described above for automatic samples. Base flow conditions need to be determined to better understand conditions during storm events. To the extent practicable, grab samples will be collected following each sampled storm event. Possible exceptions will be for back-to-back storm events for which there will be insufficient time to coordinate sampling.

Monitoring and Support Equipment

In addition to the sampling equipment mentioned above, the Antioch site includes the following equipment:

In-Situ Troll 9500 water-quality probe (temperature, conductivity, DO, turbidity, pressure)
Zeno data logger
Enfora modem and cellular telephone

ISCO 2150 flow meter with area velocity/pressure
Air compressor and tank

This equipment is part of TCEQ's Continuous Water Quality Monitoring Network (CWQMN). The equipment that was installed near the Antioch BMP are the Troll 9500 and Isco flow meter. An equipment box was installed above flood stage to house the Zeno data logger, modem, communications equipment, air compressor and tank. Cables to connect the data logger to the probes are run through a PVC conduit that is buried in a trench for a portion of the distance between the BMP and the equipment shed.

Data collected with the above equipment (temperature, conductivity, DO, turbidity, pressure, and stream flow) is telemetered to the TCEQ LEADS System with a cellular telephone.

The following equipment was installed at the Onion Creek Management Area CWQMN site (CAMS 0727) as described above for the Antioch site:

In-Situ Troll 9500 multi-parameter water quality probe (temperature, conductivity, DO, turbidity, pressure)
Zeno data logger
Enfora modem and cellular telephone

Table B1.1 Monitoring Sites

TCEQ Station ID	Site Description	Latitude Longitude	Start Date	End Date	Sample Matrix	Monitoring Frequencies (per year)		
						Total Suspended Solids	Nutrients	Comments
CAMS 0770	Antioch Cave BMP	30 04 35.10 97 51 51.52	15 days from QAPP approval	May 31, 2013	water	2 to 4	2 to 4	3 to 5 sampling events will be tied to rainfall, stage to discharge relationship,
CAMS 0727	Onion Creek Management Area (OCMA – Low Water Dam)	30 03 18.22 97 58 11.49	15 days from QAPP approval	May 31, 2013	water			CWQMN only
Pending*	Multiport monitor well at Antioch	30 04 32.74 97 51 32.74	15 days from QAPP approval	May 31, 2013	water	1 sample from each Edwards monitoring zone	1 sample from each Edwards monitoring zone	

**SLOC numbers have been requested.*

B1.2 Monitoring Station Design

Monitoring and/or support equipment are installed in weather-tight enclosures or climate controlled trailers containing a data logger, modem, telemetry equipment, and various other support equipment.

Multiprobe Sondes

Multiprobes are typically deployed in a four inch diameter poly vinyl chloride (PVC) tube that extends into the water body via a support structure. The lower three feet of the PVC tube is perforated to allow water flow across the sensors. These types of installations usually utilize a weather-tight aluminum “Traffic Box” containing a Zeno data logger, wireless cellular modem or Geostationary Operational Environmental Satellite (GOES) communications equipment, and a deep cycle battery. Solar panels can be installed for battery charging purposes. If wireless cellular service is available at the monitoring site a wireless modem is used to transmit data to TCEQ. In remote areas, equipment can be installed that will relay data using GOES.

B2 Sampling Methods

Continuous Monitoring Auto Analyzers collect and measure discrete water samples. Sondes or Multiprobes measure water quality parameters *in situ*. Data from CWQMN sites are collected and stored in a data logger via communication cables. The data are transmitted via telephone land line, wireless modem, or Geostationary Operational Environmental Satellite GOES to the TCEQ MeteoStar/LEADS system in Austin, Texas, where the data are ingested and archived. Averaged data are then posted to the appropriate TCEQ internet site. Table B2.1 describes equipment, sampling method, and telemetry method for specific CWQMN sites.

Field Sampling Procedures

Manufacturer’s Operator Manuals (MOM) for the automated flow meter, multi-parameter probe, and automated sampler data collection are attached in Appendix C of this document.

Storm-water 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 addition).

The sample volumes, container types, minimum sample volume, preservation requirements, and holding time requirements are specified in Table B2.2.

Table B2.1 Methods and Equipment for Continuous Water-Quality Monitoring

River Basin	Station Location	MeteoStar /LEADS Data Averaging Time	Sampling Method	Measurement Equipment	Telemetry	Station Parameters
Colorado	Antioch Cave BMP	5 minute	Sonde: In situ	Troll 9500 Isco 2150	Wireless Modem	Surface Temperature Surface SC Surface DO Surface Turbidity Stream Stage
Colorado	Sky Ranch Onion Creek Management Area (OCMA – Low Water Dam)	5 minute	Sonde: In-situ	Troll 9500	Wireless Modem	Surface Temperature Surface SC Surface DO Surface Turbidity Stream Stage

Table B2.2 Stormwater and Base Flow Monitoring

Parameter	Matrix	Sample Type	Container	Preservation	Sample Volume	Holding Time
Total Dissolved Solids	Water	Grab	500 mL HDPE	Ice, <6 °C not frozen	500 mL	7 days
Nitrite+nitrate-N	water	Grab	250 mL HDPE	Ice, <6 °C not frozen, H2SO4, pH<2	250 mL	28 days
Total Phosphorus-P	water	Grab	250 mL HDPE	Ice, <6 °C not frozen, H2SO4, pH<2	250 mL	28 days
Total Suspended Solids	water	Grab	1000 mL HDPE	Ice, <6 °C not frozen	1000 mL	7 days
Turbidity	water	Grab	500 mL HDPE	Ice, <6 °C not frozen	250 mL	48 hours

Processes to Prevent Cross Contamination

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

Documentation of Field Sampling Activities

Field sampling activities are documented on the Field Data Reporting Form as presented in Appendix D. For all visits, station ID, location, sampling time, sampling date, sampling depth, preservatives added to samples, and sample collector's name/signature are recorded. Values for all measured field parameters collected from the sonde are recorded. Detailed observational data are recorded including water appearance, weather, unusual odors, specific sample information, missing parameters, 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. Changes should be made by crossing out original entries with a single line, entering the changes, and initialing and dating the corrections.
3. Close-outs on incomplete pages with an initialed and dated diagonal line.

Deficiencies, Nonconformances and Corrective Action Related to Sampling Requirements

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

Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff and reported to the cognizant field or laboratory supervisor who will notify the BSEACD Project Manager. The BSEACD Project Manager will notify the BSEACD QAO of the potential nonconformance within 24 hours. The BSEACD QAO will initiate a Nonconformance Report (NCR) to document the deficiency.

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

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency; action(s) to 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. CARs will be 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 both verbally and in writing.

B3 Sampling Handling and Custody

See Section B10, below, for electronic managing of Continuous Water Quality Monitoring Network data. Water quality is measured *in situ* for the sonde instrumentation.

Sample Labeling

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

1. Site identification
2. Date and time of collection
3. Preservative added, if applicable
4. Sample type (i.e., analysis(es)) to be performed

Sample Handling

The following sampling and related equipment will be required for each sampling event:

- Sample bottles for the required analyses, duplicates, field blanks, etc.
- ISCO samplers
- De-ionized water
- Ice chest
- Ice
- Field data sheets and/or field log book
- Chain-of-custody forms
- Sample labels

Immediately after filling, sample bottles will be dried and labeled.
Sample-bottle labels that are adhesive backed and capable of being attached directly to the sample containers will be used. The following information will be entered on the sample label as a minimum:

Date
Time
Location
Sample type
Sampler name
Sample identification (ID) number
Preservative (if necessary)

Other information may be entered on the sample label if space permits. However, any information entered on the label will not obscure the required information. Sample labels will be either be preprinted and filled out or may be written directly on sample bottles / containers with waterproof ink.

Sample Tracking

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis.

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 contractors. The following information concerning the sample is recorded on the COC form (See Appendix E).

1. Date and time of collection
2. Site identification
3. Sample matrix
4. Number of containers
5. Preservative used
6. Was the sample filtered?
7. Analyses required
8. Name of collector
9. Custody transfer signatures and dates and time of transfer

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

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

Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff and reported to the cognizant field or laboratory supervisor who will notify the BSEACD Project Manager. The BSEACD Project Manager will notify the BSEACD QAO of the potential nonconformance within 24 hours. The BSEACD QAO will initiate a Nonconformance Report (NCR) to document the deficiency.

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

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency; action(s) to 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. CARs will be 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 both verbally and in writing.

B4 Analytical Methods

Water quality measurement methods used by the CWQMN are based on the *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998, unless otherwise noted. Data comparability is achieved by following approved standardized analytical methods and operating procedures. Methods must be documented to minimize variation in procedures and results. Method-specific SOPs are used to document exact procedures necessary to perform the method or operate a specific instrument or apparatus.

CWQMN method summaries are presented in Section A7. These tables include methods, analytical techniques, performance and criteria.

Analytical system corrective actions are addressed in Section C1 of this quality assurance project plan.

CWQMN Turbidity Measurements

Continuous water quality monitoring network turbidity measurement methods are not based on *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998. Turbidity measurements are made using a near infrared (780 – 900 nanometers) or monochrome light source with 90 degree detection angle, one detector (ISO Method 7027). ISO Method designates measurement units for this method as Formazin Nephelometric Units (FNU).

New Technology and Methodology

The CWQMN develops new sampling and measurement technology. Consequently, method performance determination, MQOs, and SOP development, can take place after sampling and/or measurement equipment has been deployed for testing purposes. The project leads and the Ambient Monitoring Section are responsible for developing new sampling and measurement technology.

New (and non-published) method performance is evaluated and documented. Method performance for new methods is assessed for qualitative and quantitative bias, precision, sensitivity, sampling and/or analytical system contribution, comparability, and stability by:

- Determining instrument linear range.
- Defining instrument working range using a multipoint calibration curve for each target analyte or physical water parameter.
- Demonstrating contamination potential from sampling and preparation procedures by analyzing blanks.
- Demonstrating calibration bias and accuracy by analyzing second source standards.
- Demonstrating measurement precision by analyzing second source standards multiple times.
- Demonstrating a measured sample is representative (i.e., measured at correct point in water column etc.).

- Determining method detection limits according to *40 CFR Part 136,* Appendix B (see Section B5).
- Determining digestion or converter efficiencies, when applicable.
- Determining known or suspected limitations.
- Comparing results obtained with new sampling or measurement technology with grab sampling results.

Method performance results are compiled by TCEQ personnel and the data are reviewed by the SWQM team leader, Network Coordinator, and QC support staff. TCEQ management evaluates available resources when planning expansion of the network.

The analytical methods are listed in Table A7.1 of Section A7. Laboratories collecting data under this QAPP are compliant with the NELAC Standards.

Copies of laboratory SOPs are retained by BSEACD 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 in the field and laboratory are traceable to certified reference materials. Standards and reagent preparation is fully documented and maintained in a standards log book. Each documentation includes information concerning the standard or reagent identification, starting materials, including concentration, amount used and lot number; date prepared, expiration date and preparer=s initials/signature. The bottle is labeled in a way that will trace the standard or reagent back to preparation. Standards or reagents used are documented each day samples are prepared or analyzed.

Deficiencies, Nonconformances and Corrective Action Related to Analytical Method

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

Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff and reported to the cognizant field or laboratory supervisor who will notify the BSEACD Project Manager. The BSEACD Project Manager will notify the BSEACD QAO of the potential nonconformance within 24 hours. The BSEACD QAO will initiate a Nonconformance Report (NCR) to document the deficiency.

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

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency; action(s) to 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. CARs will be 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 both verbally and in writing.

B5 Quality Control

For a QA/QC program to be successful, it is essential that specific controls be established and maintained throughout the measurement process. QC includes technical activities that measure the attributes and performance of the sampling and analysis process against defined standards to verify that they meet the needs of the project. Data quality is assessed, controlled, and measured by using SOPs, QC samples, and audits. Specific QC samples and procedures shall be described in instrument specific SOPs.

Using a variety of control samples, a determination is made as to whether the method and instrument performance are operating within acceptable limits. Control standards are used to check instrument calibration and bias, blank(s) are used to assess contamination, and duplicates are used to measure precision.

Control samples are fortified samples or blanks that are used as indicators of method and/or analytical system performance. Each analytical method SOP specifies the necessary control sample, frequency and performance criteria. Listed below is a synopsis of selected control samples and the information that can be derived from each sample.

• Duplicate samples or analyses provide an indication of system or method precision.
• Blank samples or analyses may provide an indication of positive interferences.
• Fortified sample analyses provide information on analytical bias and instrument response. If fortified samples are prepared and analyzed in duplicate, information on precision is also provided.

Program-defined measurement performance specifications are specified in Tables A7.1-3.

Sonde (Multiprobe) Temperature Sensor Checks

After every deployment period, network multi-probe temperature sensors are checked against National Institute of Standards and Technology (NIST)-traceable thermometers and thermistors. The multi-probe measured temperature must be within ± 0.50 º C of the NIST thermometer. If the multi-probe temperature sensor does not meet the ± 0.50 º C criterion, the corresponding DO and SC data are invalidated.

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 according to procedures specified in the SWQM Procedures. Split samples are preserved, handled, shipped, and analyzed identically and are used to assess variability in all of these processes. Field splits apply to conventional samples only. One field split will be taken for every 10 sample.

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

$$RPD = (X1-X2)/((X1+X2)/2))$$

A 30% RPD criteria will be used to screen field split results as a possible indicator of excessive variability in the sample handling and analytical system. If it is determined that elevated quantities of analyte (i.e., > 5 times the RL) were measured and analytical variability can be eliminated as a factor, than 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 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 Summary. Deficiencies will be addressed as specified in this section under Deficiencies, Nonconformances, and Correction Action related to Quality Control.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria

<u>Method Specific QC requirements</u> – 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 manuals (QMs). The minimum requirements that all participants abide by are stated below.

<u>LOQ Check Standard</u> – 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 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 analytical batch. A 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.

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 midpoint 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 analytical batch. A 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 batch. A 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:

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

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.

Laboratory equipment blank - Laboratory equipment blanks are prepared at the laboratory where collection materials for metals sampling equipment are cleaned between uses. These blanks document that the materials provided by the laboratory are free of contamination. The QC check is performed before the metals sampling equipment is sent to the field. The analysis of laboratory equipment blanks should yield values less than the LOQ. Otherwise, the equipment should not be used.

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 batch whichever is greater. A 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 information from these controls is sample/matrix specific and is not used to determine the validity of the entire batch. The MS is spiked at a level less than or equal to the midpoint of the calibration or analysis range for each analyte. Percent recovery (%R) is defined as 100 times the observed concentration, minus the sample concentration, divided by the true concentration of the spike.

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

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

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

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

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

Deficiencies, Nonconformances and Corrective Action Related to Quality Control

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

Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff and reported to the cognizant field or laboratory supervisor who will notify the BSEACD Project Manager. The BSEACD Project Manager will notify the BSEACD QAO of the potential nonconformance within 24 hours. The BSEACD QAO will initiate a Nonconformance Report (NCR) to document the deficiency.

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

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency; action(s) to 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. CARs will be 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 both verbally and in writing.

B6 Instrument/Equipment Testing, Inspection and Maintenance

All instream sampling equipment testing and maintenance requirements are detailed in the TCEQ Surface Water Quality Monitoring Procedures. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained by the BSEACD Field Supervisor. Automated sampler testing and maintenance requirements are contained with Appendix F of this document.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within laboratory QAM(s). Testing and maintenance records are maintained and are available for inspection by the 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 the TCEQ.

B7 Instrument/Equipment Calibration and Frequency

Before sample analysis, calibration standards are analyzed to establish instrument response, linearity, and sensitivity. Instrument calibration is performed using calibration standards spanning the expected sample concentrations. Concentrations or constituents are calculated using multipoint or single-point calibration responses.

Standards

Calibration, CVS, and LCS shall be NIST - traceable standards or prepared from NIST - traceable materials. Class “A” glassware and NIST traceable weights shall be used when making SC, pH, polymer

B or formazin standards (turbidity standards), ammonia-nitrogen, nitrate-nitrogen, phosphate-phosphorus, and TP LCS standards.

Instrument Calibrations

Multipoint and single-point calibrations are performed whenever: (1) the instrument response has drifted so that the CVSs or other quality control checks do not meet established acceptance criteria; (2) or, instrumentation is calibrated at routine frequencies; (3) or, prior to *in situ* field deployment.

Water Quality Calibration Verification Samples

Instrument calibration is periodically assessed using CVSs. These standards are analyzed to determine if bio-fouling and/or instrument drift has caused the sensor to exceed method specific criteria. The CVS is prepared from the same standard used to generate the initial calibration curve.

Data generated from the CVS is compared to method specific acceptance criteria. When results are outside of the performance criteria (see Section A7), the assignable cause is determined and corrected before sample analysis continues. Any major procedural, hardware, or software maintenance or changes require that the system be checked for calibration drift before sample analysis.

Sonde (Multiprobe) Temperature Checks

After every deployment period, network multi-probe temperature sensors are checked against NIST-traceable thermometers and thermistors. The TCEQ site operators have been issued spirit filled thermometers. These thermometers are calibrated annually by TCEQ against a mercury filled NIST-calibrated (sevenpoint) thermometer. The TCEQ's NIST-calibrated (seven-point) thermometer has been deemed valid for five-years between NIST traceable seven point re-calibrations.

Site operators who are cooperators are issued mercury filled NIST-calibrated (ice point) thermometers. The TCEQ has deemed the calibration for these types of thermometers valid for five- years. When the calibration expires the thermometers will be re-calibrated using a NIST traceable ice-point standard.

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. Calibration requirements for the automated monitoring equipment (In-Situ Troll 9500) are included in Appendix G of this document.

Detailed laboratory calibrations are contained within the QAM(s).

B8 Inspection/Acceptance of Supplies and Consumables

The TCEQ procures, stores, and dispenses various spare parts, equipment, consumable items, and other items to CWQMN TCEQ staff and Cooperators. New batches of supplies are tested before use to verify that they function properly and are not contaminated. The laboratory QAM provides additional details on acceptance requirements for laboratory supplies and consumables.

B9 Non-direct Measurements

This quality assurance project plan does not include the use of routine data obtained from non-direct measurement sources.

B10 Data Management

Water quality data, sample depth data, water level data and operator logs are sent to TCEQ by wireless cellular modem.

Cellular and standard phone line data (and operator logs) are transferred to the TCEQ Headquarters (Austin, Texas) Comms Front-End Processor (CFEP) computer through Regional Hub (Hewlett Packard 712/60) computers that automatically download data from a Zeno data logger every 15 minutes. The data are secured from tampering or corruption over the carrier line through an unlisted telephone number, pass code protection, and error checking protocol.

Measurement instrumentation is connected to the data logger systems. The data logger systems records the analog output voltage of each instrument once every 15 minutes, digitizes it, and stores the data sequentially as five-minute averages into a record. A record consists of sequential fields of data for as many channels as are activated for each monitoring station.

If the telemetry method fails at a given site, the data loggers are capable of recording and storing data until (number of parameter dependent) the data are overwritten with newly generated data. Once communications are re-established the data are automatically downloaded to the CFEP computer. The site operator should check the operational status of the station every business day via the TCEQ website. If communication problems are detected, the site operator needs to initiate corrective action in a timely manner or data can be lost. The site operator should alert TCEQ staff to initiate corrective action. Once TCEQ staff has been notified, TCEQ will ensure that corrective action was taken and that the action was effective.

The MeteoStar/LEADS processing program checks for correct date, time, sampling site number, and proper formatting of raw data fields. For the water quality parameters it then calculates five-minute and hourly averages, converting voltages to engineering units. The data are stored in a temporary disk file. The BSEACD data validators work from this file through their personal computer on a graphical interface. Data validators obtain Sonde QC information from the MeteoStar/LEADS operator log from the RHONE Calibration Verification page, which is typically entered by the site operators and cooperators/contractors. TCEQ site operators (with agency computers) access the MeteoStar/LEADS TCEQ RHONE web page operator log at http://rhone/to enter operator logs. Site cooperators/contractors who have obtained authorization can access the MeteoStar/LEADS TCEQ web page operator log via the Virtual Private Network to enter operator logs. Operator log entries into LEADS can be made on a secure external website at http://tceqwatercal.ipsmtx.com/.

The data validators periodically download Aqualab Analyzer QC data via telephone modem. The sonde and Aqualab Analyzer QC results are used in the data validation process. The data maintained on the CFEP are accessible through Internet web page reports.

After data validation, the data are coded in the file. The coded data in this file are considered “validated data” and are archived on optical disk indefinitely.

SWQMIS Data Base

A data loader is being tested that will load validated CWQMN data into the SWQMIS data base for long term storage and management. The dataset of record will be considered the SWQMIS dataset. Once complete, database system users will have the ability to:

- Run database reports on the CWQMN data (see the *SWQMIS User's Guide, 2007* for a description of available reports). The report query builder allows users to specify criteria of records to include, specify how the information is sorted in the report, and select the format for the report output. Report output can easily be imported into other applications for further data analysis.
- Report CWQMN data to EPA for the inclusion in the Storage and Retrieval (STORET) data warehouse
- Visualize, using ArcIMS map features of SWQMIS, CWQMN station locations
- Access the CWQMN QAPP associated with each real-time data result
- See the history of any changes made to CWQMN data once it is stored in SWQMIS.

Only validated CWQMN parameters will be stored in the SWQMIS data base. Calculated parameters such as total dissolved solids and salinity will not be stored in the SWQMIS. Additionally, water level and sample depth parameters will not be stored in SWQMIS.

See Table B10.1 for a complete list of CWQMN parameters that will be stored in SWQMIS. The table also contains a crosswalk of parameters codes from LEADS to SWQMIS.

Table B10.1
SWQMIS Parameters

Parameter	LEADS Parameter Code	SWQMIS Parameter Code	Units
Temperature	10010	00010	ºC
Specific Conductance	10095	00094	µS/cm
Dissolved Oxygen	10300	00300	mg/L
Dissolved Oxygen, Percent Saturation	10301	00301	%
pH	10400	00400	pH units
Ammonia-Nitrogen	10107	13851	mg/L
Nitrate-Nitrogen	10101	13852	mg/L
Total Reactive Phosphorus	10105	17527	mg/L
Total Phosphorus	10110	17528	mg/L
Turbidity	10104	13854	NTU
USGS Gage Height		00065	Feet
USGS Water Flow Rate		00061	CFS

CFS = Cubic feet per second mg/L = milligrams/Liter µS/cm = micro Siemens / cubic centimeter NTU = nephelometric turbidity unit EC = Degrees Centigrade
Revision No. 3 Page 3 of 4 Texas Commission on Environmental Quality Section B10 Continuous Water Quality Monitoring Network Quality Assurance Project Plan (March 2012)

Data Users

Data stored in the MeteoSTar/Leads system may be provided to internal users (TCEQ data analyst, etc.) by email, on disk, on printouts, or through TCEQ web page reports. Other internal customers have read-only access. Public requests for CWQMN data, as well as MeteoStar/LEADS data, are made through the Data Management & Analysis Team. Non-validated data may be released to the public with disclaimers regarding the validity of the data.

B10.1 Data Reporting

Data collected in the CWQMN are internally hosted on the Meteostar/LEADS TCEQ RHONE data server. Internal and external reports and summaries are compiled from data hosted on this server.

Data are reported internally on the RHONE Daily Reporting Page at various frequencies, which are dependent upon project monitoring instrumentation. Data collected with multiprobes and level sensors every 15 minutes are reported in the SWQM Daily Report in the 15-minute increment of their collection. Data collected by Aqualab Auto-analyzers in one or six hour frequencies are reported in the SWQM Daily Report in 15-minute increments, with values updated in the hour of their collection. Data collected with Floating Vertical Profilers every hour are reported in the Profiler Daily Printout in the hour and depth of their collection. Internal summary reports are available for all CWQMN data.

Hourly data summary reports are externally available on the TCEQ-hosted website (www.texaswaterdata.org) for all stations in the network except Floating Vertical Profilers. Profile data are not available externally, but are available upon request. See Section B10 Data Users for specific information regarding data requests. Raw data, reported with the time of collection, are not available for external reporting.

Data Path

Samples are collected and are transferred to the laboratory for analyses as described in Sections B1 and B2. Analytical data will be sent electronically via email from the laboratory to BSEACD. Sampling information (e.g. site location, date, time, sampling depth, etc.) is used to generate a unique sampling event in an interim database built on an autogenerated alphanumeric key field. Measurement results from both the field data sheets and laboratory data sheets are manually entered into the interim database for their corresponding event. Customized data entry forms facilitate accurate data entry. Following data verification and validation, the data are exported in a format specified by the TCEQ project Manager.

Record-keeping and Data Storage

BSEACD recordkeeping and document control procedures are contained in the water quality sampling and laboratory standard operating procedures (SOPs) and this QAPP. Original field sheets and copies of the LCRA-Environmental Laboratory Services Final Analytical Reports are stored in the BSEACD offices in accordance with the record-retention schedule in Section A9. One copy of the database is backed up each Friday on magnetic tape and is stored off-site. If necessary, disaster recovery will be accomplished by information resources staff using the backup database.

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 D for the Field Data Reporting Form. See Appendix E for the Chain-of-Custody Form.

Data Handling

Data are processed using the Microsoft Access 2000 suite of tools and applications. Data integrity is maintained by the implementation of password protections which control access to the database and by limiting update rights to a select user group. No data from external sources are maintained in the database. The database administrator is responsible for assigning user rights and assuring database integrity.

Hardware and Software Requirements

Hardware configurations are sufficient to run Microsoft Access 2000 under the Windows NT operating system in a networked environment. Information resources staff are responsible for assuring hardware configurations meet the requirements for running current and future data management/database software as well as providing technical support. Software development and database administration are also the responsibility of the information resources department. Information resources develops applications based on user requests and assures full system compatibility prior to implementation.

Information Resource Management Requirements

BSEACD information technology (IT) policy is contained in IT SOPs which are available for review at BSEACD offices.

C1 Assessment and Response Actions

The management of the TCEQ advocates and encourages a "continuous improvement" philosophy in personnel development and work processes. Each employee is responsible for implementing and evaluating the effectiveness of quality improvement activities with which he/she is involved. Fostering a "no-fault" attitude to encourage the identification of opportunities for improvement so they can be brought to the forefront and addressed accordingly is recognized to be a critical factor in a continuous improvement environment. Review of process performance is done on a continuous basis. This section addresses the assessment and response actions for the CWQMN.

Based on audit reports the network coordinator may recommend to the division director and project leads to stop work if necessary in order to safeguard programmatic objectives, worker safety, public health, or environmental protection.

Data Completeness Assessment

Please see calculation below for how data completeness is calculated. Sites in the CWQMN may be located in intermittent streams. Needless to say, suspension of water monitoring can occur in times of drought. Data completeness reports will be generated and distributed quarterly.

Data completeness is calculated as follows for stream sites:

$$\% \text{ Completeness} = \frac{\text{Number of valid measurements during stream flow} \times 100}{\text{Total possible measurements} - \text{Total possible measurements during no stream flow}}$$

Corrective Action

Corrective action is an essential part of any quality system and involves those procedures and actions taken to correct situations causing data quality to fall below established expectations. The need for corrective actions will be minimized by the implementation of applicable quality management plans, QAPP, and the application of statistical QC to establish appropriate performance specifications limits for measurement activities. When problems are identified at a monitoring site, the site operator shall initiate corrective action as soon as possible. Corrective action is accomplished at the lowest level and shall be documented in the MeteoStar/LEADS operator log. For complex problems that cannot be readily resolved, the individual discovering the problem notifies the appropriate project lead for resolution. If the problem cannot be resolved by the project lead, the network coordinator is notified and coordinates a resolution to the problem with the appropriate CWQMN personnel. For complex problems, verbal and written communication between the affected parties is started and continues until the issue is resolved.

It is expected that any individual in the CWQMN program who discovers a problem will initiate corrective action appropriate to the situation. A formal corrective action plan for negative audit findings and non conformances will be developed.

Audit Reports

An audit report is generated for each CWQMN audit. The recipient of the audit report is the CWQMN coordinator. Each audit report is individually numbered, dated, and identifies the auditor, auditee, and nonconformity (findings and observations). The audit report may suggest recommended corrective action to nonconformities.

If an audit report contains findings a written response to the findings from the network coordinator is required within thirty days with proposed corrective action or action to be taken. The written response is used to track and verify the proposed corrective action initiated by the finding. If a finding or proposed corrective action is disputed and cannot be readily resolved, the recommendation is pushed to successively higher management levels for resolution. The network coordinator is responsible for managing this process. Corrective actions can be verified during following inspections.

Response actions to project assessments are presented in Table C1.1, including the scope of the action.

Table C1.1 Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	BSEACD Project Manager	Monitoring of the project status and records to ensure requirements are being fulfilled.	Report to TCEQ in Quarterly Report
Laboratory Inspections	Dates to be determined by the TCEQ lab inspector	TCEQ Lab Inspector	Analytical and quality control procedures employed at the laboratory and the contract laboratory	30 days to respond in writing to the TCEQ to address corrective actions
Monitoring Systems Audit	Dates to be determined by TCEQ	TCEQ QAS	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 discretion of BSEACD	BSEACD QAO	Analytical and quality control procedures employed at the laboratory and the contract laboratory	30 days to respond in writing to the BSEACD QAO to address corrective actions
Monitoring Systems Audit	Based on work plan and or discretion of BSEACD	BSEACD QAO	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP. Field sampling, handling and measurement; facility review; and data management as they relate to the NPS Project	30 days to respond in writing to the BSEACD QAO to address corrective actions
Site Visit	Dates to be determined by TCEQ	TCEQ PM	Status of activities. Overall compliance with work plan and QAPP	As needed

Corrective Action

The BSEACD Project Manager is responsible for implementing and tracking corrective action procedures as a result of audit findings. Records of audit findings and corrective actions are maintained by both the TCEQ PM and the BSEACD QAO.

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

C2 Reports to Management

Reports to TCEQ Project Management

Monitoring Systems Audit Report and Response - Following any audit performed by the Basin Planning Agency, a report of findings, recommendations and response is sent to the TCEQ in the quarterly progress report.

Monitoring System Audit Response - BSEACD will respond in writing to the TCEQ within 30 upon receipt of a monitoring system audit report to address corrective actions.

Monitoring Report**-** Provides data collected for the project and a summary of the data.

Reports to BSEACD Project Management

All laboratory analytical reports and applicable QA/QC data related to field and laboratory analysis will be collected and archived by the BSEACD and LCRA ELS.

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 which are listed in Section A7. Only those data which are supported by appropriate quality control data and meet the measurement performance specification defined for this project will be considered acceptable and used in the project.

The procedures for verification and validation of data are described in Section D2, below. The BSEACD Field Supervisor is responsible for ensuring that field data are properly reviewed and verified for integrity. The Laboratory Supervisor is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and bias, and reviewed for integrity. The BSEACD Data Manager will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to the project database. The BSEACD QAO is responsible for validating a minimum of 10% of the data produced in each task. Finally, the BSEACD Project Manager, with the concurrence of the BSEACD 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. 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 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 which can be corrected are corrected and documented electronically or by initialing and dating the associated paperwork. If an issue cannot be corrected, the task manager consults with higher level project management to establish the appropriate course of action, or the data associated with the issue are rejected.

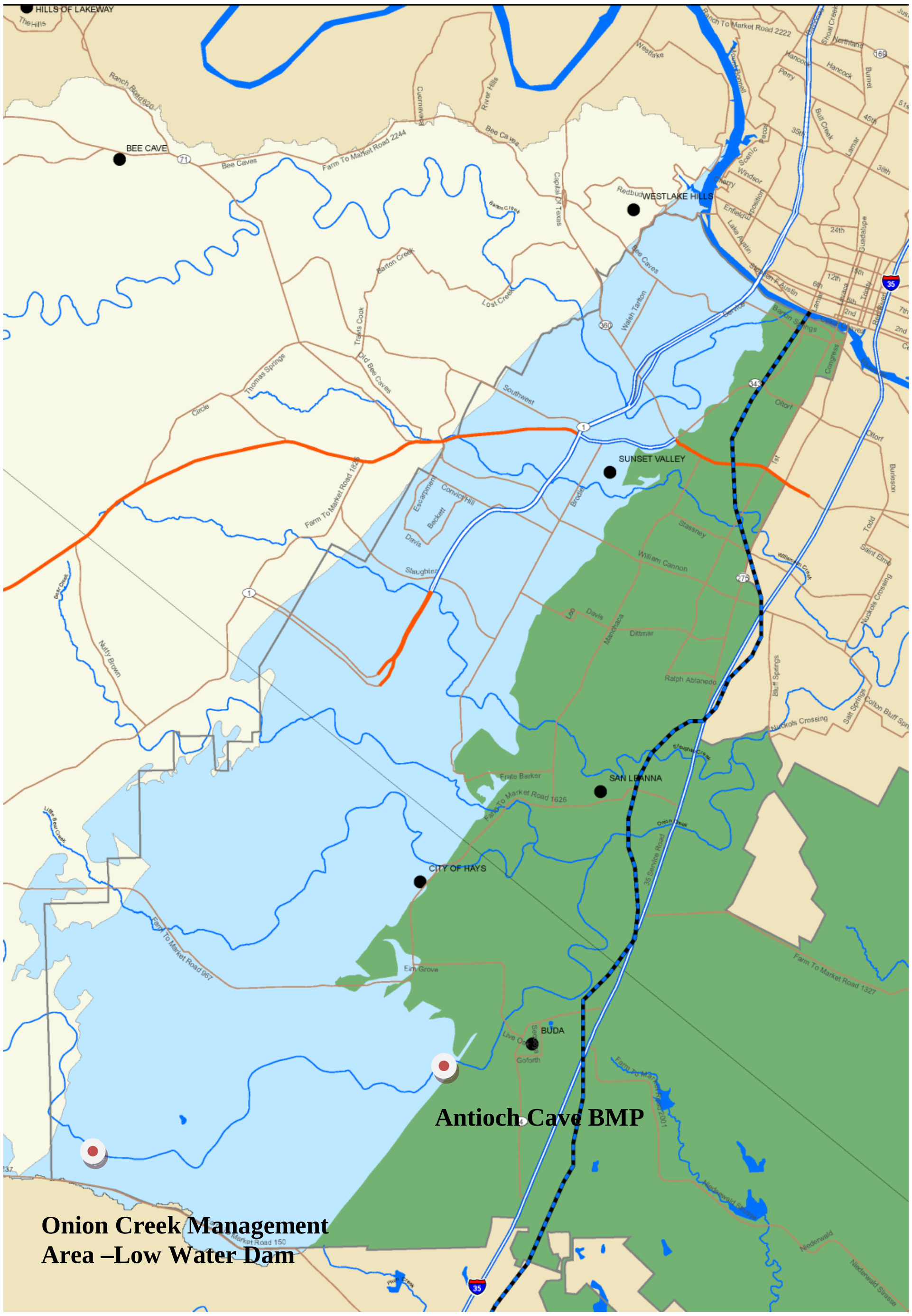
The BSEACD Project Manager and QAO are each responsible for validating that the verified data are scientifically valid, defensible, of known precision, bias, integrity, meet the data quality objectives of the project, and are reportable to TCEQ. One element of the validation process involves evaluating 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 monitoring 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 BSEACD 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 the BSEACD to report the performance of the BMP and the measured reductions in NPS loadings. The percentage of pollutant removal achieved as a result of the storm water ponds performance will be one of several criteria examined by BSEACD in the design and sizing of similar BMPs to be constructed in other segments of Onion Creek. Neither BMP nor instream monitoring data that do not meet requirements will not be used in the project or submitted to the SWQMIS.

Appendix A. Area Location Map


HILLS OF LAKEWAY
BEE CAVE
WESTLAKE HILLS
SUNSET VALLEY
SAN LEANNA
CITY OF HAYS
BUDA
Antioch Cave BMP
Onion Creek Management
Area –Low Water Dam

Appendix B. Data Summary

NPS DATA SUMMARY

A completed checklist must accompany all data sets submitted to the TCEQ by the Contractor.

Data Quality Review

A. Are all the "less-than" values reported at or below the specified reporting limit? ____________
B. Have checks on correctness of analysis or data reasonableness performed? ____________
e.g.: Is ortho-phosphorus less than total phosphorus? ____________
Are dissolved metal concentrations less than or equal to total metals? ____________
C. Have at least 10% of the data in the data set been reviewed against the field and laboratory data sheets? ____________
D. Are all *Storetcodes* in the data set listed in the QAPP? ____________
E. Are all *StationIds* in the data set listed in the QAPP? ____________

Documentation Review

A. Are blank results acceptable as specified in the QAPP? ____________
B. Was documentation of any unusual occurrences that may affect water quality included in the *Event* table's *Comments* field? ____________
C. 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.
D. Were there any failures in field and laboratory measurement systems that were not resolvable and resulted in unreportable data? If yes, explain on next page.

Describe any data reporting inconsistencies with performance specifications. Explain failures in sampling methods and field and laboratory measurement systems that resulted in data that could not be reported to the TCEQ. (attach another page if necessary):

Date Submitted to TCEQ: ______________________________________

TAG Series: ______________________________________

Date Range: ______________________________________

Data Source: ______________________________________

Comments (attach file if necessary): ______________________________________
____
____
____
____

Contractor's Signature: ______________________________________

Date: ______________________________________

Appendix C. Manufacturer's Operator Manuals

In-Situ Inc.

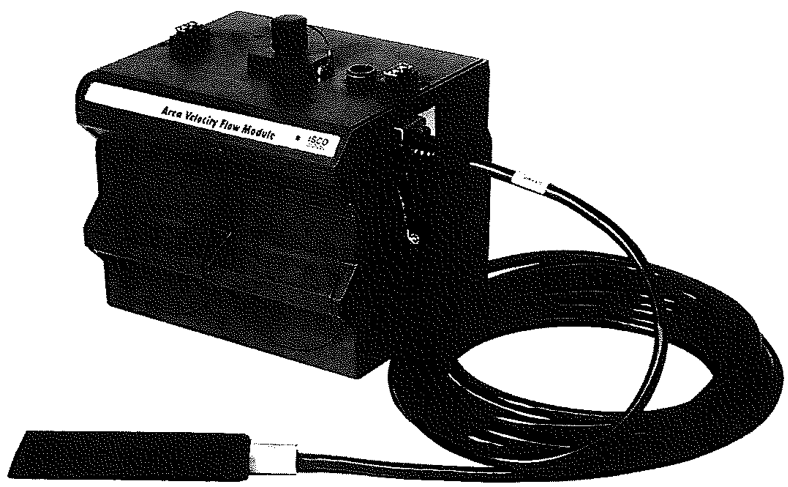
Multi-Parameter
Water Quality TROLL®

Multi-Parameter TROLL 9500

WQP-100
OPERATOR'S MANUAL

2150 Area Velocity Flow Module and Sensor

Installation and Operation Guide



TELEDYNE ISCO
A Teledyne Technologies Company

Part #60-2003-092 of Assembly #60-2004-038

Revision K, January 2005

Appendix D. Field Data Reporting Form

Onion Creek Recharge Project
Water Quality Data Sheet

Event Data

Station ID	______
Location	______
Sampling Date(s)	______
Sampling Time	______
Sampler's Name	______
Sampling Depth	______
Isco Serial #	______

Continuous Water Quality Data

Specific Conductance	______
Temperature	______
Dissolved Oxygen	______
Turbidity	______
Flow (ft^3/sec)	______
Velocity (ft/sec)	______
Missing Parameters	______

Detailed Observations

Flow Severity	______
Water Apperance	______
Unusual Odors	______

Specific Sample Information

Number of Sample Bottles	______
Sampling Duration	______
Sampling Interval	______
Preservatives added to samples	______

Isco Sample Bottle #	Date / Time	Submit to Lab	Isco Sample Bottle #	Date / Time	Submit to Lab
Bottle # 1			Bottle # 13		
Bottle # 2			Bottle # 14		
Bottle # 3			Bottle # 15		
Bottle # 4			Bottle # 16		
Bottle # 5			Bottle # 17		
Bottle # 6			Bottle # 18		
Bottle # 7			Bottle # 19		
Bottle # 8			Bottle # 20		
Bottle # 9			Bottle # 21		
Bottle # 10			Bottle # 22		
Bottle # 11			Bottle # 23		
Bottle # 12			Bottle # 24		

Appendix E. Chain-of-Custody Form

Environmental Laboratory Services
The Solution Lab

LCRA ENVIRONMENTAL LABORATORY SERVICES (ELS)
CHAIN OF CUSTODY RECORD

NOTE: Relinquishing sample(s) to ELS obligates the submitter to all Standard Terms and Conditions stated on the back of this form.

Target Due Date: ____________
Work Order No.: ____________
COC No.: ____________
Page _____ of _________

Results To: ____________ (NAME, ADDRESS, CITY, STATE, ZIP) Sampled By: ____________
Bill To: ____________ (NAME, ADDRESS, CITY, STATE, ZIP) PO No.: ____________
Phone No.: __________ Fax No.: ____________ Method of Transport: ____________ TAT Requested: ________ Working days E-mail: ____________
Relinquished By: _________ Date: _____ Time: _____ Received By: ________ Date: ______ Time: _____ Relinquished By: _________ Date: ______ Time: _____

Report Requirements	Regulatory Requirements	Received at ELS By: ________ Date: ____ Time: _____	ELS Mgmt. Approval for RUSH:
☐ Hardcopy ☐ E-mail ☐ Fax ☐ EDD (Generic)	☐ None ☐ NELAP ☐ ____________	☐ Received on Ice Temp: ______ °C Login Review: ____________ Date: ____________	Surcharge for RUSH: _______%

ELS ID:	SAMPLE DESCRIPTION Custody Seals (circle): Cooler Bottles None	MATRIX	SAMPLE COLLECTION DATE	SAMPLE COLLECTION TIME	CONTAINERS NUMBER	CONTAINERS SIZE	CONTAINERS TYPE	ANALYSIS REQUESTED - Place an "x" in the box below to indicate request.								PRESERVATIVES	pH

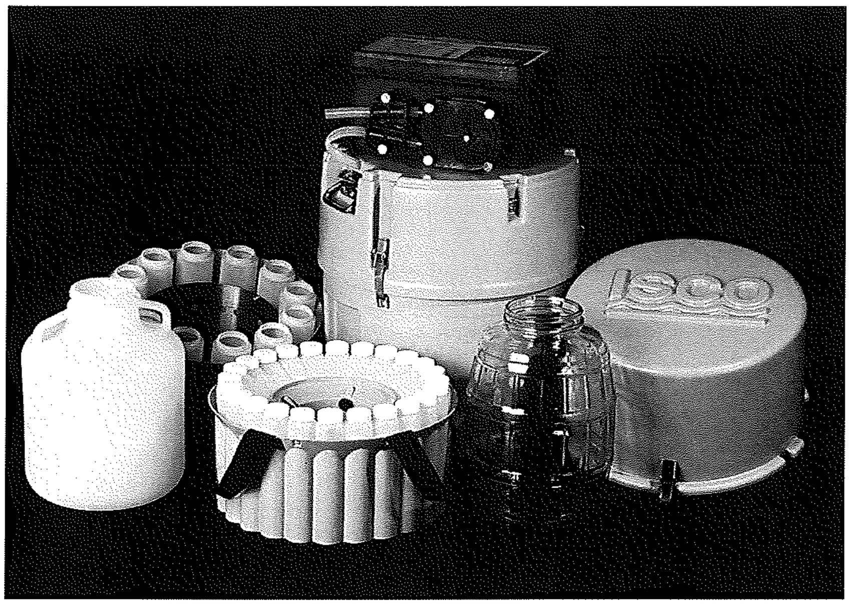
Special Instructions: ____________
ELS Comments: ____________

White - ELS Pink - Customer http://els.lcra.org • 3505 Montopolis • Austin, Texas • 78744-1417 • (512) 356-6022 • Fax (512) 356-6021 • 1-800-776-5272, Ext. 6022 Form 1156 Rev. 7/08

Appendix F. Automated Sampler Testing with Maintenance and Calibration Requirements

3700 Portable Samplers

Installation and Operation Guide



TELEDYNE ISCO
A Teledyne Technologies Company

Part #60-3703-267 of Assembly #60-3704-101

Revision EE, March 20, 2007

Appendix G. Standard Operating Procedures for the In-Situ Troll 9500 SOP BSEACD-001

Analysis of Dissolved Oxygen (DO), Specific Conductance (SC), pH, Temperature, and Turbidity in Ambient Surface Water Using the In-Situ Inc. Multi-Parameter Water Quality TROLL 9500

Standard Operating Procedure (SOP) BSEACD-001
Title: Analysis of Dissolved Oxygen (DO), Specific Conductance (SC), pH, Temperature, and Turbidity in Ambient Surface Water Using the In-Situ Inc. Multi-Parameter Water Quality TROLL 9500
Team Leader:________________________________ Date:________________________ Quality Control Review:______________________ Date:_________________________ Section Manager:_____________________________ Date:_________________________ Effective Date:_______________________________

1.0 Purpose

This document describes the analytical procedures for continuous automated analysis of DO, SC, pH, Temperature and Turbidity in ambient surface water using the In-Situ Inc. Multi-Parameter Water Quality TROLL 9500.

2.0 Scope and Applicability

2.1 This procedure is intended for use in the Onion Creek Recharge Project.

2.2 Due to the extended length of time that TROLLs are deployed the data can be used to establish baseline conditions, identify trends, and characterize pollution events and seasonal variations in water quality.

2.3 SC, DO, pH, and Temperature data meeting Surface Water Quality Monitoring Data (SWQM) Quality Objective Criteria (DQOs) may be used for the Federal Clean water Act Sections 305(b) Report and 303(d) lists.

2.4 TROLL Turbidity measurements can be used for data validation purposes. The working range of the sensors is listed below.

Parameter	Working Range	Reported Accuracy
DO (optical, RDO)	0-20 milligrams/Liter (mg/L)	+/-0.2 milligrams/Liter (mg/L)
SC (low range sensor)	5-20,000 micro Siemens/cubic centimeter (u*S*/cm)	+/-2 micro Siemens/cubic centimeter (u*S*/cm) or 0.5% (whichever is greater)
pH	0-12 pH Standard Units	+/-0.1 pH Standard Units
Temperature	-5 to 50 Degrees Celsius (OC)	+/-0.1 (OC)
Turbidity (Nephelometer, 90_o light scattering, 870 nm LED, solid state)	0-2000 Nepholometric Turbidity Units (NTU)	+/-3 Nepholometric Turbidity Units (NTU) or +/-5% (whichever is greater)

3.0 Method Summary

3.1 The TROLL is deployed in the water body of interest, or ambient surface water is pumped through a flow cell near the water body of interest, and DO, SC, pH, Temperature and Turbidity are measured in situ.

3.2 The DO is measured with an optical sensor that uses the principle of "dynamic luminescence quenching". With this principle, "lumiphore" molecules fluoresce when excited by light of a specific wavelength. The oxygen molecules present act to quench this fluorescence. The "lumiphores" in the sensor are embedded in a gas-permeable sensing foil in a replaceable cap. The sensor optics includes a lens, blue LED with filter, red LED with filter and a photodetector. When the blue LED emits light, the sensing foil emits red photons; the presence of oxygen in the foil causes a reduction in red light detected by the photodiode. The phase difference between the blue excitation light and the returned red light is measured and the result is used to compute dissolved oxygen. This method measures the "phase" (or delay) of the returned signal and is thus based on the "lifetime" rather than the "intensity" of the luminescence. The RDO optical dissolved oxygen sensor does not consume oxygen does not consume oxygen and thus it does not require flow past the sensor for measurement of DO. The RDO sensor does not require conditioning before use or frequent calibration.

3.3 The Electrical Conductivity (EC) sensor is a flow cell with four electrodes. The four electrodes consist of two drive electrodes and two sensing electrodes. Conductivity/specific resistance is measured through an

3.4 The pH sensor uses a potentiometric method to measure the pH of the solution. The pH sensor consists of a pH-sensitive glass whose voltage is proportional to the hydrogen ion concentration. A second sensor (electrode) serves as a reference, which supplies a constant stable output. Electrical contact is made with the solution using a saturated potassium chloride (KCl) solution. The electrode behavior is described by the Nernst equation: $E_m = E_o + (2.3\ RT/nF) \log [H+]$ where E_m is the potential from the pH electrode, Eo is related to the potential of the reference electrode, R is the Gas Law constant, F is Faraday's constant, T is the Temperature in Kelvin, n is the ionic charge (+1 for Hydrogen) and [H+] is the hydrogen ion concentration in moles/L. The MP TROLL 9500 reads the signal from the pH electrode, the reference electrode and the temperature and then calculates the pH using the Nernst equation.

3.5 Surface water Temperature is measured by a platinum resistance thermometer

3.6 The turbidity sensor is an electronic Nephelometer, which compares the intensity of light scattered by the ambient water with the intensity of the light scattered by a standard reference suspension. The higher the intensity of scattered light, as measured in Nephelometric Turbidity Units (NTUs), the higher the turbidity. The turbidity sensor consists of a matched solid-state photodiode detector/emitter pair positioned at right angles. The light source is an infrared LED, optimized for operation at 870 nanometers (nm) with a photodiode detector. The sensor uses a detection angle of 90 degrees and a light wavelength of 860 nm. The sensor uses active modulation for ambient light rejection.

3.7 The pressure transducer senses changes in pressure, measured in force per square unit of surface area, exerted by a column of water or other fluid. With a vented or "gauged" pressure sensor, a vent tube in the cable applies atmospheric pressure to the back of the strain gauge. The basic unit for vented measurements is psig (pounds per square inch "gauge"), measured with respect to atmospheric pressure. PGIS sensors exclude the atmospheric or barometric pressure component.

4.0 Limitations

4.1 Do, EC, pH and Turbidity sensors can become fouled due to bacteria, algae and chemical deposits. In some water bodies (or due to seasonal variation in water quality) sensor fouling can occur rapidly, decreasing deployment periods. Some In-Situ MP TROLL 9500s are equipped with a mechanical wiper brush that cleans turbidity sensor tips. This capability can increase deployment periods in some water quality conditions.

4.2 In rivers that have high sediment loading, sensors can periodically become covered with sediment.

4.3 Electrolytic conductivity increases with temperature. Significant errors can result from inaccurate temperature measurements.

4.4 The glass pH electrode is relatively free from interference from color, turbidity, colloidal matter, oxidants, reductants, or highly salinity, except for sodium error at pH>10. pH measurements are affected by temperature and can cause long term drift. The pH electrode can only accurately measure up to 12 standard units.

4.5 Expired standards should not be used.

5.0 Safety

This procedure includes processes that can be hazardous. Therefore, before attempting this process, review the TCEQ Chemical Hygiene Plan for proper equipment and procedures necessary for the safe completion of this procedure. Operators must read and be familiar with the Material safety Data Sheets for all reagents listed in section 6.0 of this document. Lab Coasts, safety glasses with side shields and/or splash goggles, and chemical resistant gloves should be worn when handling harmful chemicals. Some of these chemicals have the potential to be skin and eye irritants.

6.0 Equipment and Reagents

6.1 Equipment

6.1.1 In-Situ Multi Parameter TROLL 9500 with EC, RDO, pH, Pressure, Temperature, and Turbidity Sensors.

6.1.2 RS232 Connection Cable

6.1.3 Personal Computer

6.1.4 Instrument Logbook

6.1.5 Calibration Forms

6.1.6 Calibration Cup

6.1.7 Ring Stand and Clamp

6.1.8 Thermistor or Thermometer traceable to National Institute of Standards and Technology (NIST) with a 0.1^{o}C tolerance.

6.1.9 100 ml volumetric flask

6.1.10 100-1000 ml pipette

6.1.11 100-1000 ml pipette tips

Optional Equipment

6.1.12 Peristaltic Pump

6.1.13 TROLL 9500 Flow Cell

6.2 Standards and Reagents (All reagents/chemicals must be AR grade)

6.2.1 pH 7.00 +/-0.01 S.U. @ 25^{o}C Buffer (ACS traceable reagent grade Dibasic Sodium Phosphate Na2HPO4 – Monobasic Potassium Phosphate KH2PO4 Buffer)

6.2.2 pH 10.00 +/-0.02 @ 25^{o}C Buffer (ACS traceable reagent grade Potassium Carbonate K2CO3 – Potassium Borate K[B5O6(OH)4] – Potassium Hydroxide KOH Buffer)

6.2.3 12890 micromhos/cm @ 25 ^{o}C Conductivity/TDS Standard (ACS traceable reagent grade Potassium Chloride KCl in reagent grade deionized water H2O

6.2.4 10, 100, 1000 NTU Polymer Turbidity Standard for In-Situ (Styrene Divinylbenzene Copolymer beads, deionized water, trace sodium azide (0.01%, added as preservative)

6.2.5 Deionized (DI) Type I water

6.2.6 0 mg/L Dissolved Oxygen/Zero Oxygen Standard (ACS Reagent Grade Sodium Sulfite, trace Cobalt Chloride)

7.0 Procedure

Before water quality is monitored, the sensors are calibrated and quality control (QC) samples are analyzed at a minimum of once a month (30days). The station's water quality parameters are monitored by the site operator, remotely, or with weekly data downloads to a laptop computer, to evaluate operational status of the station.

7.1 Monitoring

The TROLL measures ambient surface water while in situ. The TROLL can be deployed in poly vinyl chloride (PVC) tubing that is attached to a support structure. Alternatively, the TROLL can be placed in an enclosure near the edge of the stream bank and water can be pumped up to a flow cell which covers the sensors.

7.1.1 The TROLL should be deployed in a representative section of the water body. When monitoring rivers and streams, the TROLL should be located as close as possible to the centroid of flow. Centroid is defined as the midpoint of that portion of stream or river width which contains 50 percent of the total flow.

7.1.1.1 Alternatively, if water is pumped through a flow cell containing the TROLL sensors then the inlet hose should be place near the centroid of flow in the stream.

7.1.2 Sensors should be positioned at approximately one foot (0.3 m) of water depth. Areas of excessive vegetation, turbulence, or silt should be avoided.

7.1.2.1 Alternatively, if an inlet hose is used to pump water up to the flow cell containing the instrument sensors, the inlet hose should be attached to the top of a weight, at a fixed position above the bottom of the stream.

7.1.3 Drill holes in the PVC to allow for an exchange of water into the tubing.

7.1.4 Adjust the TROLL periodically due to fluctuations in water levels of the water body.

7.2 Station Monitoring

The site operator should monitor water quality and other parameters daily to ensure the station is operational.

7.2.1 Every business day, the site operator will monitor (via TCEQ website http://www.texaswaterdata.org) and screen EC, DO, pH, Temperature, and Turbidity measurements for anomalies. If problems are identified, a site visit may be needed to correct any problems.

7.2.2 If online data are not available, the sire operator shall visit the site once per week.

7.3 DO, EC, pH, and Turbidity Sensor Calibration Verification Samples (CVS) and Temperature QC.

EC, DO, and pH CVSs are analyzed and the sensors are re-calibrated at a minimum of once every month. Turbidity CVSs are analyzed at a minimum of once every month, but the Turbidity sensor is only recalibrated if the CVS check standard shows more than a +/-5.0 % recovery difference from the nominal. More frequent sensor re-calibrations may be needed in high fouling environments. The site operator will need to determine sensor re-calibration frequency for their water body. Temperature and pressure sensors are checked monthly. Note: The TCEQ Surface Water Quality Monitoring Program has used the phrase “Post-Calibration” to describe QC samples used to assess analytical drift from previous sensor calibrations. For the purposes of this document, CVS is used in place of “Post-Calibration”.

7.3.1 EC, DO, pH and Turbidity CVS are analyzed at a minimum of once every month (or more frequently), before the TROLL EC, DO, pH and Turbidity sensors are re-calibrated.

7.3.1.1 A check of a CVS standard can be made by connecting to the TROLL with the Win-Situ software and a laptop PC and selecting the TROLL in the Navigation tree.

7.3.1.2 The TROLL is washed with tap water and deionized water and shaken to remove the water.

7.3.1.3 The TROLL sensor is placed into the applicable CVS standard.

7.3.1.4 Select one of the appropriate parameter in the Win-Situ display and Tap the “Read” button in the navigation window. Multiple parameters can be selected and read at the same time by holding down the control key on the keyboard while selecting parameters. The Temperature parameter should be read alongside all of the other CVS readings.

7.3.1.5 Record the CVS reading and temperature for each parameter in the calibration logbook.

7.3.2 The Temperature sensor should be checked against an NIST traceable thermometer at the same time that CVS samples are analyzed. If the sensor does not meet the acceptance criteria listed in Table 9-1, the temperature data must be invalidated back to the last temperature check. For further details, see Section 9.0.

7.3.3 The pressure sensor should also be checked at the same time that CVS samples are analyzed. The vented or “gauged” pressure transducer should be verified in open air, where it should read zero plus or minus the acceptable electronic drift offset from zero.

7.3.4 If barometric pressure for DO calibrations is determined by barometer, the accuracy of the barometer will need to be checked once a year.

7.4 EC, DO, pH and Turbidity Sensor Calibration

DO, EC, and pH calibrations are performed at least once a month, prior to TROLL deployment, and after the monthly EC, DO, pH and turbidity CVSs have been analyzed. A Turbidity sensor calibration is performed if the Turbidity CVS recovery is reported at +/-5.0% of the known value of the standard, otherwise maintaining factory calibration is recommended. After the EC, DO, pH and Turbidity sensor calibrations, calibration parameters/constants are recorded in the instrument logbook.

- Note: Perform calibrations and analyze EC, DO, pH and Turbidity CVSs as close to 25.0°C as possible in a temperature controlled environment.
- Note: Perform the EC calibration before the calibration of the pH sensor.
- Barometric pressure measurements for DO calibrations can be obtained at the National Weather Service.
- Allow the TROLL and calibration standards time to equilibrate (a minimum of 2 minutes) before calibration(s) or initial readings.
- Secure the TROLL in a vertical orientation (by length).
- Before calibration, make sure plugs are installed in empty sensor ports.
- Ensure that all sensors are immersed in the applicable calibration standard before calibration.
- Use a small amount tap water and deionized water to pre-rinse the sensors between each sensor calibration.
- Have several clean absorbent paper towels. Shake the excess rinse water off the TROLL between sensor calibrations. This will reduce carry –over contamination of calibration solutions.
- Connect the TROLL to a laptop computer with a standard RS232 Serial Port.
- Open the Win-Situ 4.0 software on a laptop computer.
- Manually connect to the TROLL by selecting the appropriate COM port in the Win-Situ software and mouse-clicking the “Find” button.

7.4.1 Single-Point EC Calibration

The calibration of the EC sensor consists of a single-point calibration with a 12890 micromhos/cm Conductivity Standard. A high-value standard is recommended because it has the ability to remain stable over longer periods of time. The conductivity calibration curve is linear over the whole range of the sensor, making it unnecessary to calibrate with a standard concentration closer to the expected conductivity of the water body. During the calibration, the In-Situ TROLL will measure the temperature of the standard and automatically calculate the (non-normalized) conductivity of the standard.

7.4.1.1 Rinse the EC sensor with tap water followed by deionized water.

7.4.1.2 Shake the probe to remove the rinse water from the sensor.

7.4.1.3 Pour the calibration standard into a beaker and insert the MP TROLL 9500 Turbidity sensor into the solution.

7.4.1.4 Connect the MP TROLL 9500 to a PC and establish a connection with the Win-Situ 4 software.

7.4.1.5 Select the MP TROLL 9500 in the Navigation tree.

7.4.1.6 Select conductivity in the Parameters list. The sensor serial number and recent calibration information is shown.

7.4.1.7 Select Calibrate

7.4.1.8 Select the "Other" row under the Calibration setup screen and type 12890 into the space provided. The number typed is the conductivity of the calibration solution.

7.4.1.9 Select the "Next" button

7.4.1.10 Select the "Run" button.

7.4.1.11 Wait for the word "Stable" to appear on the calibration screen at which point the display screen will automatically advance.

7.4.1.12 A final screen will appear containing the conductivity cell constant for this calibration. Record this value in the calibration logbook and press the "Finish" button on the display.

7.4.1.13 Record the Temperature during calibration, the Sensor Reading in ohms and the Sensor Deviation in the calibration logbook.

7.4.2 Two-Point pH Calibration

The pH calibration requires two pH buffer solutions (pH 4.00 and 7.00 or pH 7.00 and 10.00). Choose the solutions that bracket the expected pH range of the water body.

7.4.2.1 Rinse the pH sensor with tap water followed by deionized water.

7.4.2.2 Shake the probe to remove the rinse water from the sensor.

7.4.2.3 Pour the first calibration standard into a beaker and insert the MP TROLL 9500 Turbidity sensor into the solution.

7.4.2.4 Connect the MP TROLL 9500 to a PC and establish a connection with the Win-Situ 4 software.

7.4.2.5 Select the MP TROLL 9500 in the Navigation tree.

7.4.2.6 Select pH in the Parameters list. The sensor serial number and recent calibration information is shown.

7.4.2.7 Select Calibrate to launch the pH Calibration Wizard.

7.4.2.8 Change the number of calibration points to 2 in the drop down menu.

7.4.2.9 Select the values of the two calibration points that will be used in the drop down menus.

7.4.2.10 Select “Next” to continue.

7.4.2.11 Select “Run.” The screen will automatically advance when the word “Stable” is displayed under the stabilization readings column.

7.4.2.12 Remove the pH sensor from the first calibration solution and wash it with tap water and deionized water.

7.4.2.13 Place the sensor into a beaker containing the second calibration solution. Select “Run” to begin the stabilization process.

7.4.2.14 The word “Stable” will appear and automatically advance the screen.

7.4.2.15 Record the pH slope and offset milli-volts (mV) for the pH 7.00 and pH 10.00 solutions in the calibration logbook and press “Finish” to apply the calculated calibration.

7.4.3 DO Calibration

The DO sensor is calibrated in water that is 100 % saturated with air. An oxygen bubbler is placed into beaker of tap water and allowed to run for at least 5 minutes prior to the calibration procedure. However, after replacing the DO sensor caps a two point calibration (100% and 0%) is recommended. It’s important to note that the DO calibration procedure is very sensitive to changes in temperature; therefore it should be done in an area protected from direct sunlight and away from ventilation ducts.

7.4.3.1 Rinse the RDO sensor with tap water followed by deionized water.

7.4.3.2 Shake the probe to remove the rinse water from the sensor.

7.4.3.3 If necessary, utilize a lens wipe to clean the sensor lens.

7.4.3.4 Submerge the RDO sensor in a beaker of tap water aerated with a bubbler. Ensure that the sensor is completely submerged and the sensor cap is not directly in the bubble stream. The bubbler is allowed to run for 5 to 10 minutes before continuing.

7.4.3.5 Connect the TROLL 9500 to a PC and establish a connection with the Win-Situ 4 software.

7.4.3.6 Select the TROLL 9500 in the Navigation tree on the display screen. The software will automatically detect and display the installed sensors.

7.4.3.7 Select Rugged Dissolved Oxygen in the Parameters list. Information on the RDO sensor is shown, including its serial number (SN).

7.4.3.8 Select Calibrate

7.4.3.9 A screen will ask if the barometric pressure settings should be edited at this time. Since the Troll 9500 is usually on a vented cable and will take measurements using a vented cable, click “No”. For instances when the device is calibrated using a vented cable but will take measurements using a non-vented cable, click “Yes”. On the next screen, check the box indicating a non-vented cable for measurements but vented cable for calibration/programming.

7.4.3.10 Select the “Calibrate” option on the next screen. Press the “Run” button on the screen.

7.4.3.11 When the Temperature and Dissolved Oxygen readings have stabilized; the screen will show the word “Stable” in the status row. Record these values in the calibration logbook and select the “Next” button two times to use the factory calibrated 0% saturation value. If conducting a Zero Oxygen Point calibration, select “Next” once to display Zero Oxygen Point Screen.

7.4.3.11.1 Immerse the DO sensor in an oxygen depleted medium of Sodium sulfite (Na2SO3) solution.

7.4.3.11.2 When ready to take calibration point, click Run in Zero Oxygen Point screen. Wait for readings to stabilize.

7.4.3.11.3 Select “Next” to finalize the calibration.

7.4.3.12 The final calibration screen for a 1-point calibration at saturation will be displayed on the screen. Press “Finish” to apply the calibration.

7.4.4 Turbidity Sensor Calibration

The Turbidity Sensor is factory calibrated over its full range, 0 to 2000 NTU, using polymer standards; however instrument drift can occur over extended periods of deployment. A turbidity sensor calibration will only need to be performed when the turbidity calibration verification standard (CVS) from the previous deployment falls outside of the accepted quality control criteria. The CVS should always read between +/- 5.0 % or 3 NTU of the stated value of the standard; if the CVS is beyond this acceptable Percent Recovery criteria it is recommended to reset default coefficients and restore factory accuracy.

7.4.4.1 Resetting Default Coefficients:

The sensor’s factory calibration may be reset back to factory defaults at any time. As long as there is no contamination on the optical windows, this will restore the factory accuracy (+/- 5% or 2 NTU).

7.4.4.12 Establish a connection to the instrument in Win-Situ 4.

7.4.4.13 Select Turbidity in the Parameters list and click calibrate.

7.4.4.14 In the first screen, select Use Default Coefficients, then Next.

7.4.4.15 In the final screen, click Finish to restore the sensor’s factory calibration coefficients.

If the Percent Recovery does not meet the acceptable criteria after resetting default coefficients, it is then necessary to conduct a three point calibrations with an instrument specific polymer standard calibration (0 NTU, 10 NTU, 100 NTU).

7.4.4.16 Rinse the Turbidity sensor with tap water followed by deionized water.

7.4.4.17 Shake the probe to remove the rinse water from the sensor.

7.4.4.18 Pour the calibration standard into an opaque beaker (to reduce stray-light scatter) and insert the MP TROLL 9500 Turbidity sensor into the solution.

7.4.4.19 The windows of the turbidity sensor should be submersed at least 0.25” deep in the solution.

7.4.4.20 If no wiper blade is present on the sensor, gently agitate the instrument to dispel any air bubbles.

7.4.4.21 Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4. Select the MP TROLL 9500 in the navigation tree. This will display the installed sensors (including the Turbidity sensor).

7.4.4.22 Click to select Turbidity in the Parameters list. The sensor serial number (S/N) and recent calibration information is displayed.

7.4.4.23 Select Calibrate. The turbidity calibration wizard will start automatically.

7.4.4.24 Select the Standard Calibration Option.

7.4.4.25 Select the Next button to continue.

7.4.4.26 Change the number of calibration points to 4 from the drop down menu.

7.4.4.27 Select the values of the three turbidity calibration solutions in the drop down menus for each point (Cal 1 = 0 NTU, Cal2 = 10 NTU, Cal3 = 100 NTU).

7.4.4.28 The first calibration point will always be 0 NTU and will be calibrated with Type I Deionized water.

7.4.4.29 Press the Next Button to continue.

7.4.4.30 The value of the first calibration standard will be shown on the screen. Immerse the Turbidity sensor in the first calibration standard and press the "Run" button to calibrate the first calibration point. The "Accept" button becomes available when nominal stability is achieved. Continue to wait for the instrument to display the word "Stable" and automatically advance the screen to the next calibration point.

7.4.4.31 Discard the previous solution, rinse the beaker and the front end of the instrument with tap water and deionized water, then refill the beaker with the second calibration standard.

7.4.4.32 Select the "Run" button to calibrate the next calibration point. Wait for the screen to show "Stable" and automatically advance to the next calibration point.

7.4.4.33 Repeat steps 7.4.4.31-7.4.4.32 for the final two calibration points.

7.4.4.34 The final screen will show the sensor slope and offset calculated during the calibration process. A slope and offset value will also be shown for each point in used in the calibration. Record these values in the Calibration Logbook.

7.4.4.35 Select the "Finish" button on the display to program the sensor with the calculated calibration coefficients.

8.0 Calculations

8.1 Seal Level Corrected Barometric Pressure Uncorrected to Actual Barometric Pressure

This equation is used to uncorrected sea level corrected barometric to actual barometric pressure. Local barometric pressure obtained from the National Weather Service is corrected to sea level and is usually reported in inches of Hg (inches HG x 2.54 = mm Hg).

ABP = CBP – (2.5 mm Hg)(A/100)

Where:

ABP = Actual Barometric Pressure in mm Hg.
CBP = Barometric Pressure corrected to sea level in mm Hg.
A – local altitude in feet above mean sea level.
2.5 mm Hg = constant.

8.2 Sample Conductivity

Electrical Conductivity is reported as SC using Equation 8.2.1

8.2.1 SC is actual conductivity corrected to 25^{o}C:

SC = (AC)/(1 + 0.0191 x (t-25.0))

Where:

AC = non-standardized conductivity in uS/cm.
t = the solution temperature in degrees Celsius.

8.2.2 To determine un-normalized (raw) conductivity standard EC concentration from normalized Raw EC = normalized EC in uS/cm (1 + 0.0191 (temp measured – 25)).

8.3 QC calculations

8.3.1 Recovery (percent recovery) = $\dfrac{\text{X1 X 100}}{\text{X2}}$

Where:

X1 = measured CVS concentration
X2 = theoretical (known) CVS concentration

9.0 QC Samples

Note: Analyze EC, DO, pH and Turbidity CVSs as close to 25.0^{o}C as possible.

QC samples are used to ensure that acceptable data quality is maintained throughout the process and to help assess data validation. The QC samples analyzed for this method are performed on a monthly basis, or more frequently as determined by the site operator. Any deviation from the procedure documented in the SOP, including any QC samples which do not meet the frequency requirement or acceptance criteria, need to be documented in the operators log. The log entry should contain a description of the exception, the cause (if possible), the affected data, and the impact on data. Any affected data should be qualified accordingly. Note: A failing CVS can be followed by a single replicate analysis to determine if there is a systematic problem. If the reanalysis meets all acceptance criteria, the system may be deemed as providing acceptable data. Conducting multiple analyses to single passing QC samples when no corrective action as a result of an assignable cause or instrument maintenance is performed is not acceptable. In other words, if the original QC sample or its rerun passes, then the failing QC analysis is considered to be an anomaly, its results are not used for data assessment.

EC QC Samples

9.1 An EC CVS is analyzed at a minimum of once monthly (before calibration of the EC sensor) to assess analytical drift from the previous calibration. The CVS should be the same standard used to generate the initial single-point calibration.

9.2 The CVS Calibration solution is introduced using a beaker or Cal Cup. Rinse the sensor with Tap water followed by DI Water and shake off the water before introducing the CVS. The Percent Recovery of the CVS should be 5.0%. If the CVS does not meet acceptance criteria, the previous month’s EC (back to the last EC calibration) data should be invalidated. Note: a failing CVS could be the result of an aged EC CVS standard. If CVS failed, re-analyze the CVS using a fresh EC standard. CVS results should be entered into the operator log and instrument logbook.

DO QC Samples

The Amount of DO in a sample is pressure and temperature dependent.

9.3 A DO CVS is analyzed a minimum of once monthly (before calibration of the DO sensor) to assess analytical drift from the previous calibration. The CVS consists of percent saturation in air-saturated water using procedures in Section 7.4.3.

9.4 This reading should be within +/-6.0 % saturation of 100 %.

9.5 If the CVS does not meet acceptance criteria the previous month’s DO (back to the last passing CVS or DO calibration) data should be invalidated. CVS results should be entered in the operator log. The results should also be logged in the Instrument Logbook and/or recorded in the Calibration Logbook.

pH QC Samples

9.6 A pH CVS is analyzed a minimum of once monthly (before calibration of the pH sensor) to assess analytical drift from the previous calibration. The CVS consists of pH buffer solution of 4.00 or 10.00 pH units and a 7.00 buffer solution. The pH buffer solutions are introduced using the Calibration cup or a glass beaker. Note: Rinse the sensor with DI water and shake off DI water before introducing the CVS. The CVS is prepared from different standards than the ones used to generate the initial calibration curve. The CVS should be within 0.50 pH units. Note: a failing CVS could be the result of an aged pH CVS standard. If CVS has failed, re-analyze the CVS using a fresh EC standard. If the CVS does not meet acceptance criteria, the previous month's pH (back to the last pH calibration) data should be invalidated. CVS results should be entered into the operator log. The results should also be logged in the instrument logbook and/or recorded in the Calibration Logbook.

Temperature QC

9.7 Once every quarter (3 months), check the accuracy of the TROLL temperature sensor with a NIST traceable thermometer or thermistor. Fill a container with tap water and immerse the TROLL sensors into the water. Place the thermometer or thermistor thermocouple next to the TROLL temperature sensor and allow both temperature measuring devices time to stabilize. The TROLL Temperature measurement should be within 0.5^{o}C of the NIST traceable thermometer or thermistor. If the TROLL temperature accuracy is not within acceptance criteria with the NIST traceable thermometer or thermistor the temperature data collected prior to the last NIST check should be invalidated. If it is determined that the TROLL's temperature sensor does not meet acceptance criteria, the sensor needs to be sent back to the factory for repairs/calibration. The temperature check should be entered into the operator log. The results should also be logged in the instrument logbook and/or recorded in the Calibration Worksheet.

Pressure QC

9.8 Once a month, check the accuracy of the vented or "gauged" pressure transducer in open air. The sensor should read zero plus or minus the acceptable electronic drift offset, as shown in table below.

Sensor Range	Accuracy (% full scale)	Acceptable offset from zero
15 psig	+/- 0.05% FS	+/- 0.0075 psig
30 psig	+/- 0.05% FS	+/- 0.015 psig
100 psig	+/- 0.05% FS	+/- 0.05 psig
300 psig	+/- 0.05% FS	+/- 0.15 psig

If the reading deviates from zero by more than the specified amounts, factory calibration is recommended. Zeroing the pressure sensor is not recommended and should be used with caution.

Turbidity QC Samples

9.9 A Turbidity CVS is analyzed at a minimum of once monthly to assess analytical drift from the previous calibration. The CVS should be a different standard than the one used to generate the initial 3 point calibration. A high-value standard (1000 NTU) is suggested for the CVS; it decreases measurement errors related to stray-light scatter associated with low-value standards.

9.10 The CVS polymer solution is introduced using an opaque beaker or Cal Cup. Rinse the sensor with Tap water followed by DI Water and shake off the water before introducing the CVS. The Percent Recovery of the CVS should be +/-5.0% or +/-3 NTU of the theoretical value. If the CVS does not meet acceptance criteria, the previous month's Turbidity (back to the last Turbidity calibration) data should be invalidated. Note: a failing CVS could be the result of an aged Turbidity CVS standard. If CVS failed, re-analyze the CVS using a fresh Turbidity standard. Any bio-fouling on the optical port should be wiped off with a lens wipe and the CVS should be reanalyzed to determine if the calibration has drifted or if the CVS failed due to instrument fouling. CVS results should be entered into the operator log and instrument logbook.

Table 9-1

QC Check	Purpose	Frequency	Acceptance Criteria	Response Action
Single-Point EC Calibration	To establish slope used for quantitation	A minimum of once monthly or after failing CVS	Stable Concentration level is detected	1. Analyze standard again 2. Perform corrective action as necessary 3. Re-calibrate
Single-Point DO Calibration	To establish slope used for quantitation	A minimum of once monthly or after failing CVS	Stable Concentration level is detected	1.Analyze standard again 2. Perform corrective action as necessary 3. Re-calibrate
Two-Point pH Calibration	To establish slope used for quantitation	A minimum of once monthly or after failing CVS	Stable Concentration level is detected	1. Analyze standard again 2. Perform corrective

				action as necessary 3. Re-calibrate
QC Check	Purpose	Frequency	Acceptance Criteria	Response Action
Four-Point Turbidity Calibration (Formazin polymer standards)	To establish slope used for quantitation	Only after an unexplainable failing CVS	Stable Concentration level is detected	1. Analyze standard again 2. Perform corrective action as necessary 3. Re-calibrate
DO CVS (Percent Saturation in Air-Saturated Water)	To assess sensor drift	Before Sensor re-calibration. A minimum of once a month	+/-6.0 % Saturation	1. Re-Analyze CVS 2. If still failing perform corrective action and/or recalibrate 3. Invalidate data accordingly
1000 uS/cm EC CVS	To assess sensor drift	Before Sensor re-calibration. A minimum of once a month	+/-5.0 % REC	1. Re-Analyze CVS 2. If still failing perform corrective action and/or recalibrate 3. Invalidate data accordingly
7.00 and 10.00 pH CVS	To assess sensor drift	Before Sensor re-calibration. A minimum of once a month	+/-0.5 SU	1. Re-Analyze CVS 2. If still failing perform corrective action and/or recalibrate 3. Invalidate data accordingly
20 NTU Turbidity CVS	To assess sensor drift	Before Sensor re-calibration. A minimum of once a month	+/-3 NTU	1. Re-Analyze CVS 2. If still failing perform corrective action and/or recalibrate 3. Invalidate data accordingly
Temperature QC Check of Tap Water against NIST Traceable Thermometer	To assess sensor drift	A minimum of once every quarter	+/-0.5 degrees Celsius	1. Re-Analyze temperature reading 2. If still failing, send to manufacturer for repairs 3. Invalidate data accordingly

10.0 Definitions

10.1 CVS -Calibration Verification Sample

10.2 uS/cm = micro Siemens per centimeter (unit of electrical conductance)

10.3 DO= Dissolved Oxygen

10.4 NTU = Nephelometric Turbidity Units (unit of turbidity)

10.5 mg/l – milligrams per liter (unit of concentration)

10.6 SU – Standard Units (units of pH measurement)

11.0 References

In-Situ Inc. Multi-Parameter TROLL 9500, WQP-100, Operator's Manual
Surface Water Quality Monitoring Procedures Manual, Volume I
Continuous Water Quality Monitoring Network Quality Assurance Project Plan, March 2012

12.0 Pollution Prevention and Waste Management

Supervisors, sampling personnel, and laboratory analysts should identify and implement innovative and cost saving water reduction procedures as part of the method development, review, and revision of standard operating procedures. Wastes that result from these procedures are managed and disposed of in accordance with appropriate state and federal regulations.

The Reagents, washes, standards, and waste associated with this procedure do not require special disposal. Before disposing waste into a municipal sewer system check with respective municipal sewer system on what concentration levels are allowed to be put into their system.

13.0 Shorthand Procedure

- Setup Procedures (Section 7.1 and 7.3).
- Calibrate EC, DO, and pH sensors once a month at a minimum.
- Deploy TROLL
- Monitoring and Sensor Verification (Section 7.2 and 7.4).
- Monitor TROLLS weekly via the internet if online data is available.
- Analyze EC, DO, pH and Turbidity CVSs once a month.
- Check TROLL temperature sensors every 3 months with an NIST traceable thermometer.