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Rev. 1

Quality Assurance Project Plan for Continuous Water Quality Monitoring on the Arroyo Colorado at Rio Hondo, Texas



Water Quality Planning Division

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Quality Assurance Project Plan for Continuous Water Quality Monitoring on the Arroyo Colorado, Rio Hondo, Texas

Prepared by:
United States Geological Survey Texas Water Science Center &
Texas Commission on Environmental Quality's Water Quality Planning Division

June 2014



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A1.1 Preface

Continuous Water Quality Monitoring of the Arroyo Colorado Quality Assurance Project Plan

Collaborative Agreement Number: 582-14-40842

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A1.2 Approval Page

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A1.2 Approval Page (continued)

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A1.2 Approval Page (continued)

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Carly Vaughn

Date

The TCEQ will secure written documentation from each sub-tier project participant (e.g., subcontractors, organizations operating sites, laboratories) stating the organization's commitment to requirements contained in this quality assurance project plan and any amendments. The TCEQ will maintain this documentation as part of the project's quality assurance records, and will ensure this documentation is available for review.

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A2.3 Guidelines and Procedures

The USGS has been contracted by TCEQ to collect, validate, and report water quality and gage height monitoring data from the Arroyo Colorado at FM 160, Rio Hondo, TX (See Table A5.1) following USGS guidelines and procedures. The USGS documents and internet addresses of USGS documents are listed below.

The project's Quality Assurance Project Plan will be available at: (www.texaswaterdata.org).

USGS – *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting TM1D3*.
<http://pubs.usgs.gov/tm/2006/tm1D3/>.

Once developed, a USGS project-specific Arroyo Colorado Standard Operating Procedures (SOP) will be available at (www.texaswaterdata.org).

User's Manual for the National Water Information System of The U.S. Geological Survey Automated Data Processing System (ADAPS).
<http://pubs.usgs.gov/of/2003/ofr03123/>

National Field Manual. Techniques of Water-Resources Investigations Book 9.
<http://water.usgs.gov/owq/FieldManual/>

USGS Texas Water Science Center QAPPs are available upon request.

Quality-Assurance Plan for Water Quality Activities in the Texas Water Science Center.

Texas Water Science Center Surface-Water Quality-Assurance Plan.

A3 Distribution List

**United States Fish and Wildlife Service
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Corpus Christi, TX 78412

The Texas Commission on Environmental Quality will provide copies of this Quality Assurance Project Plan and any amendments or appendices of this plan to each person on this list and to each sub-tier project participant, e.g., subcontractors, organizations operating sites, laboratories. The TCEQ will document distribution of the plan and any amendments and appendices, maintain this documentation as part of the project's quality assurance records, and will ensure this documentation is available for review.

A4 Project/Task Organization

This QAPP is specific to the activities of the USGS Arroyo Colorado Monitoring project. The organization of the Arroyo Colorado project is shown in Figure A4.1. The interrelationships and responsibilities of the participants in these projects are listed below:

A4.1 Project Sponsor, Coastal Resources Program, Texas General Land Office (Carly Vaughn)

Sets the preliminary objectives for the project

- Allocates adequate resources to ensure completion of the project in compliance with the stated objectives.

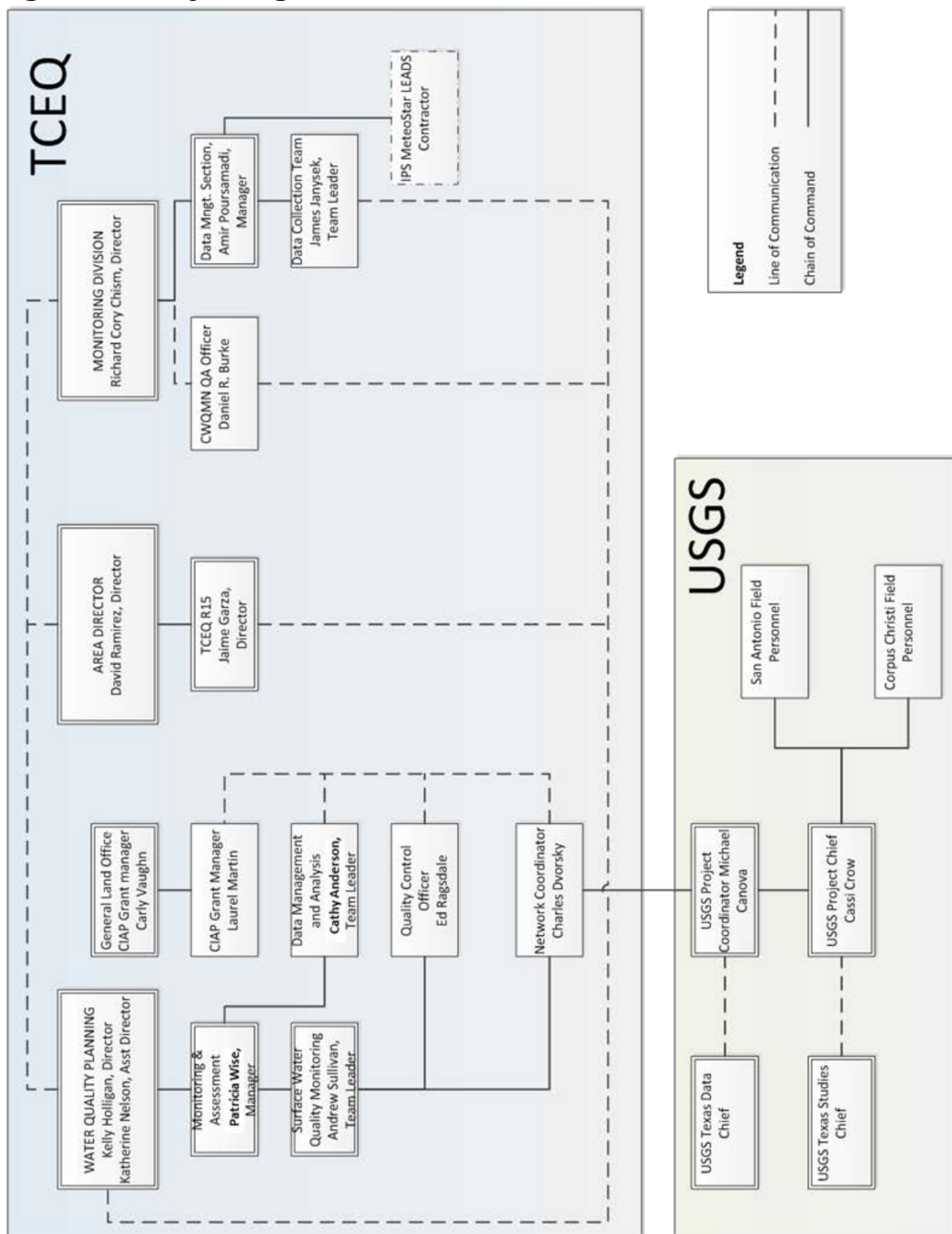
A4.2 CWQMN Network Coordinator, Monitoring and Assessment Section, Water Quality Planning Division, (Chuck Dvorsky)

- TCEQ Arroyo Colorado Project Manager.
- Coordinates the identification of representative project site with input from interested parties.
- Coordinates and facilitates development of site-specific Data Quality Objectives (DQOs) or Monitoring Quality Objectives (MQOs). Approves sampling sites after consultation with TCEQ staff and stakeholders.
- Completes Site Initiation Forms for new sites.
- Advises network participants about known data and/or project limitations.
- Assists USGS QC officers in developing and revising SOPs.
- Assists USGS QC officers in conducting audits and implementing corrective actions.
- Receives and maintains USGS contract assessment records.
- Develops and coordinates contracts and intergovernmental agreements.

A4.3 CWQMN Program Manager, Monitoring and Assessment Section, Water Quality Planning Division, (Andrew Sullivan)

- Communicates to management the status, recommended changes, and goals of the project.
- Maintains a thorough knowledge of project work activities, commitments, deliverables, and time frames.
- Advises management about objectives, timetables, tasks, and coordination not being met.
- Maintains oversight of contracts and intergovernmental agreements.
- Maintains oversight of various budgets associated with grants and state funding.

Figure A4.1 Project Organizational Chart



A4.4 USGS Project Manager (Cassi Crow)

- Responsible for implementing and monitoring project requirements in contract, QAPPs, SOPs, and QAPP amendments and appendices.
- Ensures QAPP requirements are followed by project participants and that the project is producing data of known quality.
- Ensures USGS personnel are trained, and qualified to perform contracted work.
- Ensures that project managers and/or QA Specialists are notified of deficiencies and corrective actions, and that issues are resolved.
- Responsible for ensuring collected data are acceptable for reporting to the TCEQ.
- Responsible for writing and maintaining the QAPP and monitoring its implementation.
- Responsible for maintaining records of QAPP distribution, including appendices and amendments.

A4.5 USGS Quality Assurance Officer (Michael Canova)

- Responsible for coordinating the implementation of the QA program.
- Responsible for identifying, receiving, and maintaining project quality assurance records.
- Responsible for coordinating with the TCEQ Project Manager and QA staff to resolve QA-related issues.
- Notifies the USGS Project Manager of particular circumstances which may adversely affect the quality of data.
- Coordinates and monitors deficiencies, and corrective actions.
- Maintains records of data verification and validation.
- Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques.
- Ensures that monitoring systems audits on project participants are conducted to determine compliance with project and program specifications, reviews written reports, and follows through on findings.

A4.6 USGS Project QC Officer (Michael Canova)

- Responsible for annual Arroyo Colorado Project QAPP revisions.
- Provides QC oversight for Arroyo Colorado Project activities.
- Assists USGS Project Manager in developing and implementing quality systems.
- Develops various processes to help ensure quality objectives are achieved
- Advises program managers and data users about known Arroyo Colorado Project data and/or project limitations.
- Conducts on-going informal data reviews.
- Researches measurement equipment technical specifications and test equipment if possible.

- Lead for developing, coordinating, writing, and revising Arroyo Colorado Project SOPs.
- Investigate Arroyo Colorado Project measurement anomalies.
- Develops, prepares, conducts, and distributes performance and technical systems/audits/inspections of Arroyo Colorado Project.
- Evaluates proposed corrective actions and verifications.
- Concurs with proposed corrective actions and verifications.
- Responsible for determining if responses to audit findings are acceptable or not.
- Maintains files for performance and technical systems/audits.
- Assesses the effectiveness of program quality systems.
- Monitors the implementation of corrective actions.

A4.7 USGS Station Operators (Jaime Ingold and Michael Willis)

- Design and deploy monitoring station.
- Provide overall support for the operation and maintenance of station.
- Operate and maintain monitoring sites and sampling equipment according to current QAPPs and SOPs.
- Perform QC checks on monitoring, sampling equipment according to current QAPPs and SOPs.
- Review QC data and ensure quality data is being generated.
- Provides station data to TCEQ via file transfer protocol.
- Train operators and cooperators on monitoring equipment and QC procedures.
- Assist auditors with performance evaluations and technical systems audits.
- Participate in the development of SOPs for instrumentation.
- Perform preventative maintenance on monitoring equipment.
- Assist in the development of DQOs or MQOs.

A4.8 TCEQ CWQMN QA Officer (Daniel Burke)

- Provides oversight of all QA activities.
- Participates in the development and approval, and implementation of written QA standards.
- Determines conformance with TCEQ quality system requirements.
- Assists program and project managers in developing and implementing quality systems.
- Receives and reviews assessment records.
- Provides technical expertise and/or consultation on quality services.
- Participates in data quality assessments.
- Monitors the status of corrective actions.
- Identifies positive and adverse trends in the program quality system.
- Serves as quality system representative.
- Participates in planning meetings as needed.

- Recommends to program managers and division directors, and through them to deputy directors, that work be stopped when necessary to safeguard programmatic objectives, worker safety, public health, or environmental protection.

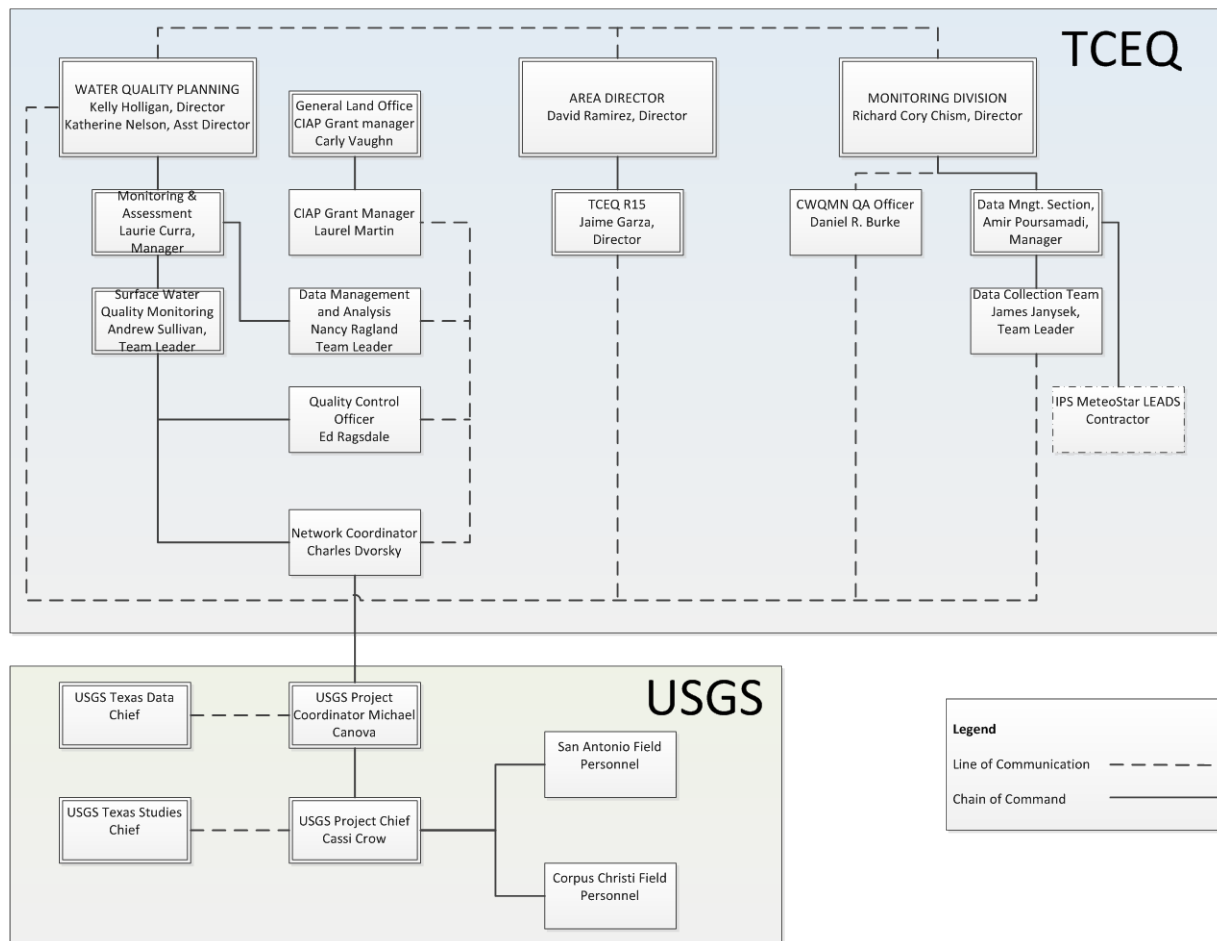
A4.9 TCEQ CWQMN QC Officer (Edward Ragsdale)

- Assists project managers in developing and implementing project quality systems via the Quality Assurance Project Plan.
- Reviews project's Quality Assurance Project Plan
- Conducts informal station operation, technical systems evaluations, and data reviews.
- May conduct performance and technical systems audits of the data projects collection and data validation and processing.
- Advises project managers about known project limitations.
- Responsible for determining if responses to audit findings are acceptable or not.
- Maintains files for performance and technical systems/audits.

A4.10 Monitoring Division, Office of Compliance and Enforcement

- Coordinates activities related to the LEADS for water monitoring.
- Facilitate ingest of CWQMN data via file transfer protocol.
- Maintains the repository and the internal/external LEADS-based web. This includes Monitoring Division RHONE web pages with water data reports, water data status pages, and online network documentation.

Figure A4.1 Project Organizational Chart



A5 Project Definition/Background

The Arroyo Colorado is an ancient distributary channel of the Rio Grande that flows through Hidalgo, Cameron and Willacy Counties in Deep South Texas. In addition to providing flood control, navigation and conveyance of irrigation return flows, wastewater and storm water, the Arroyo Colorado is a major source of fresh water to the Lower Laguna Madre. One hundred and twenty years of intense agricultural production and rapid urbanization over the past twenty years have resulted in increased nutrients, suspended sediment and total dissolved solids in the Arroyo Colorado. A significant portion of the contributions of these constituents are from Nonpoint Sources (NPS) of pollution.

Arroyo Colorado Stream Segment 2201 is listed on the 2012 Texas' Clean Water Act (CWA) 303 (d) list for impaired waters due to depressed Dissolved oxygen (DO) and bacteria. The water body has been listed for these parameters since 1996. The water body is also on the 303 (d) lists due to elevated levels of mercury, polychlorinated biphenyls, and DDE in fish tissue. Arroyo Colorado Stream Segment 2201 delineates the tidal reach of the Arroyo Colorado. The channel has been modified in this reach for navigation purposes.

In January 2007, the Arroyo Colorado Watershed Partnership developed "A Watershed Protection Plan for the Arroyo Colorado," also known as the Arroyo Colorado Watershed Protection Plan (ACWPP). The ACWPP addresses urban and agricultural point and nonpoint sources of pollution entering the Arroyo Colorado. A top priority goal for the ACWPP is an intensive water quality monitoring effort to assess the effectiveness of the pollution mitigation measures included in the plan. Dissolved Oxygen (DO) is a key parameter for assessing effectiveness of the pollution mitigation measures.

A continuous water quality monitoring station will be installed by USGS in stream Segment 2201 (CAMS 730). The station will be located on the FM 106 Bridge that spans the Arroyo Colorado at Rio Hondo, Texas. The station will provide multi-probe DO, specific conductance (SC), and temperature, vertical profile measurements. The station will also measure stream gage height. Continuous water quality vertical profile measurements are needed to provide information about dynamic salt water wedges associated with tidal streams. These wedges can force freshwater to the near surface and create anoxic conditions near the bottom. These layers can also become mixed. The data will be used by Texas Institute of Applied Environmental Research (TIAER) to calibrate a DO model and use the model to assess improvement in DO associated with the ACWPP reducing point and NPS pollution. The data and modeling results will also be used for public education and outreach.

There have been two previous attempts by TCEQ and USGS to collect continuous water quality data at this location. Multi-probe data collection problems occurred during both efforts due to extreme multi-probe sensor marine bio-fouling at the near-surface and hydrogen sulfide corrosion of the multi-probes at the near-bottom. As a result, both of these monitoring efforts were suspended. The current effort will include continuous monitoring vertical profiling engineering strategies in conjunction with advances in multi-probe copper-alloy sensor components. These strategies are discussed in Section B1.

A5.1 Project Objectives and Location

River Basin	Seg. No.	CAMS	Station Location	Objective	Station Parameters
Nueces - Rio Grande Coastal Basin	2201	730	Arroyo Colorado at FM 106, Rio Hondo, TX	Support the Arroyo Colorado Watershed Protection Plan by providing the data necessary to address the data limitations and information gaps. Data may be used to model hydrodynamics and DO dynamics in the impaired portion of the tidal segment and for public education and outreach for the Arroyo Colorado Watershed Protection Plan	Temperature Specific Conductance Dissolved Oxygen Gage Height

A6 Project/Task Description

In April 2014, the USGS installed a vertical profiler and station support equipment on the FM 106 Bridge that spans the Arroyo Colorado at Rio Hondo, Texas (Figure 1). The USGS will be responsible for vertical profiling method development, station operation, maintenance, data validation, data processing, and data delivery to TCEQ. The USGS will also produce an SOP describing vertical profiler and multiprobe operations for the station. The SOP may also describe any station-specific deviations, modifications, or interpretations of USGS TM1D3 procedures.

Due to technical challenges associated with vertical profiling a tidal channel, the USGS and TCEQ staff met on-site with the manufacturer of the profiler in May of 2014. The goal of the meeting was to develop a method for vertical profiling the channel. Method development includes writing a computer program for the vertical profiler. For more details on the method development see Section B2.

The station will be operated on a test basis before official data collection begins. The test phase serves the purpose of allowing USGS to work out any station, equipment, or data collection issues and develop the Arroyo SOP. Before official data collection begins, the USGS will prepare an Arroyo Colorado Continuous Water Quality Monitoring SOP. The initial SOP (before official data collection begins) will focus on profiler operation and data collection. As the project progresses, the SOP may be modified to include any unforeseen data collection problems and detail any modifications or interpretations of TM1D3. The SOP may be updated (with TCEQ's concurrence) at any time on an as needed basis. The final SOP will be submitted as an appendix to the Arroyo Colorado Continuous Water Quality Monitoring Project Final Report.

After the test period/method development, the station is scheduled to collect data through January 31, 2016. Data will be telemetered from the station's data logger by wireless internet protocol modem, loaded to the USGS National Water Information System (NWIS) database, and then uploaded to the TCEQ Leading Environmental Analysis Display System (LEADS) ingest and display database. The data will be archived

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 nonconformance; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for amendments are directed from the contractor Project Manager to the TCEQ Project Manager in writing using the QAPP Amendment shell. The changes are effective immediately upon approval by the TCEQ Project Manager and Quality Assurance Specialist.

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 USGS Quality Assurance Officer. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process. Amendments to the QAPP may also be submitted at any time during the course of the project when changes to the project methods, procedures, or instrumentation warrant an amendment.

A7 Quality Objectives and Criteria

A7.1 Multiprobe Quality Objectives and Criteria

Water quality monitoring activities on the Arroyo Colorado will be performed in accordance to: USGS – *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting TM1D3*.

Generally stated, multiprobe fouling and sensor electronic drift measurements are used to apply prorated data corrections over deployment periods. Multiprobe fouling and sensor drift measurements are also used to rate data quality (Table A7.1.1). TCEQ has a “Fair” (Table A7.1.1 USGS data ratings) or better data acceptance requirement for this project and a target data return of 75%. Generally, if collected data do not meet “Fair” criteria; the USGS does not report the data to TCEQ. The USGS station-specific Arroyo SOP will detail any deviations or modifications to TM1D3 with regards to assessing data quality and assigning data quality ratings to collected data.

Table A7.1.

Ratings of Accuracy

Parameter	Ratings of accuracy (based on combined fouling and calibration drift corrections applied to the record)			
	Excellent	Good	Fair	Poor
Temperature	$\leq \pm 0.2^{\circ}\text{C}$	$> \pm 0.2\text{-}0.5^{\circ}\text{C}$	$> \pm 0.5\text{-}0.8^{\circ}\text{C}$	$> \pm 0.8^{\circ}\text{C}$
Specific Conductance	$\leq \pm 3\%$	$> \pm 3\text{-}10\%$	$> \pm 10\text{-}15\%$	$> \pm 15\%$
Dissolved Oxygen	$\leq \pm 0.3\text{ mg/l}$ or $\leq \pm 5\%$, whichever is greater	$> \pm 0.3\text{-}0.5\text{ mg/l}$ or $> \pm 5\text{-}10\%$, whichever is greater	$> \pm 0.5\text{-}0.8\text{ mg/l}$ or $> \pm 10\text{-}15\%$, whichever is greater	$> \pm 0.8\text{ mg/l}$ or $> \pm 15\%$, whichever is greater

$^{\circ}\text{C}$ = degrees centigrade
 mg/l = milligrams per liter

The accuracy of the OTT PLS is $\leq \pm 0.1\%$ of full scale (manufacturer instrument specifications http://s.campbellsci.com/documents/ca/manuals/pls_man.pdf).

A7.2 Water Level, Multiprobe Sample Depth, and Multiprobe Parking Depth Quality Objectives

Water level measurements collected by a vented YSI 600 XL reference sonde in conjunction with the multiprobe sonde depth measurements and the profiler control unit will be used to determine multiprobe vertical profile parking depths through the water column. In order to characterize water quality through the water column, parking depths must be discrete and equally distributed through the water column and each parking depth is at a consistent depth from the bottom of the channel. Equally distributed means parking depths for a given profile must be representative of water quality through the water column.

A7.3 Representativeness

By design, a continuous water-quality monitor measures water quality in greater temporal detail and resolution than is possible with grab samples or short term deployments of monitoring instrumentation. Water-quality data will be collected at equally distributed discrete points through the water column.

A7.4 Multiprobe Comparability

Continuous water-quality monitor measurements are based on *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998, unless otherwise noted. As previously discussed in Section A7.1, data collected for the Arroyo Colorado are corrected based on multiprobe fouling and drift measurement results. Comparability is also achieved by adapting methodology as documented in the Arroyo SOP, reporting data in standard units by using accepted rules for significant figures, and by reporting data in standard formats.

A7.5 Multiprobe Bias

Potential measurement bias includes multi-probe sensor / deployment tube fouling.

A7.6 Multiprobe Data Completeness

Data completeness is discussed in Section C1.

A8 Special Training/Certification

The USGS has an extensive base of professional and skilled employees to enable it to successfully complete the projected tasks and activities associated with this project. All personnel associated with the project have detailed functional job descriptions describing the requirements for their positions.

USGS staff attends a comprehensive course on continuous water quality monitoring data collection, quality control, data validation, and data processing.

The project will utilize a vertical profiler. The vertical profiler and measurement equipment vendor met with project personnel on May 27-28, 2014. The hands-on training session was conducted on-site to complete the initial setup of the equipment and train staff in programming the equipment. Since this will be a new monitoring application (vertical profiling in a tidal stream), training on this particular application will be limited to vendor support and what is learned during method development. Expertise and SOPs are derived from this developmental process.

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

The QAPP, SOPs, and Audit Reports are filed and maintained by USGS. Measurement data and other site information can be found on TCEQ's CWQMN website and the USGS NWISWeb website. Instrument calibration and calibration verification forms, instrument logbooks, and certificate of analysis are filed and maintained by site operators.

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 analyses are documented in USGS Station Analysis Notes and Monthly Progress Reports.

A9.1 Documentation of Procedures and Objectives

1. Published guidance (Code of Federal Regulations EPA, and EPA Quality Assurance Handbook)

2. USGS Monthly Progress Reports
3. Instrument manufacturer's technical support manuals
4. *United States Geological Survey* – Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting TM1D3
5. USGS/TCEQ - Standard Operating Procedure for the Monitoring of Continuous Water-quality Data of the Arroyo Colorado

A9.2 Record Keeping

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

Table A9.2

Record Location

Record	Location
Sampling Information	TCEQ Website / USGS Offices
Certificate of Analysis Conductivity standards	USGS Offices
Instrument and equipment logbooks	Should be located with instrumentation if possible / USGS Offices
Station Analysis Notes	USGS data Base
Monthly Progress Reports	USGS & TCEQ
Standard Operating Procedures	www.texaswaterdata.org & USGS Offices
Technical systems and performance evaluation	USGS Texas Water Science Center and TCEQ

A9.3 Data Reporting

Environmental data are stored electronically in the National Water Information System. Selected validated data will be loaded into the LEADS database.

A9.4 Documentation Control Plan

All SOPs must have a document title, a revision number, approval signatures, and effective date. SOPs are formally reviewed and re-signed on an as needed basis. 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 current QAPP and official SOPs are available via the internet at: (www.texaswaterdata.org).

It is the responsibility of each project participant to ensure they are properly following the most current revision of these documents.

Standard Operating Procedure Approval Signatures

The USGS site specific water quality profiler SOP will be signed by the USGS Project Manager, the USGS QA/QC Officer, and the TCEQ Project Manager.

Instrument-Specific Logbooks

Each site operator has the responsibility of maintaining instrument-specific logbooks for a minimum of 5 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 5 years, unless otherwise required by a project or regulation.

Hand Written Documents

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 initialed and dated.

B1 Sampling Process Design

B1.1 Station Design

Section A5 describes the project's experimental design and explains the project's data collection design. For a more detailed description of how the data will be collected, see Section B2.

B2 Sampling Methods

B2.1 Monitoring Methods & Equipment

The vertical profiler is attached to the right pier bumper on the upstream side of the CR 106 Bridge at the Rio Hondo. The profiler will automatically raise and lower the multiprobe through the water column. The profiler will park the multiprobe at equally distributed discrete points in the water column and the station's data logger will record instantaneous DO, SC, temperature, and depth measurements. These data are transmitted by cell phone modem to the USGS National Water Information System, and then delivered to MeteoStar/LEADS system in Austin, Texas where the discrete data are stored. Data are averaged into one-hour averages and displayed on the external TCEQ web pages and on an external USGS web display (NWIS Web).

Tidal Channel Vertical Profiling Method Development

The following describes the initial method for collecting the project's vertical profile data. As mentioned in Section A6, the station will be operated on a test basis before official data collection begins. During this test period, the USGS may modify the method as needed. Before official data collection begins, the USGS will produce a final SOP (Arroyo SOP) describing vertical profiler and multiprobe operations for the station.

Initial Planned Method

Along with the profiler's reference sonde (YSI 600XL), an additional vented water-level sensor (OTT PLS) is attached to the bridge pier bumper at a fixed point. The OTT PLS sensor will be used to measure the total depth/water level of the water column and reported separately. The profiler is programmed to use the water level measurements from the YSI

600XL reference sonde to determine the depths of each of the multiprobe measurement sets collected for a given tidal water level. The multiprobe's depth sensor will work with the YSI 600XL reference sonde to govern where the multiprobe will park before taking a measurement in the profile. It is expected a single profile may contain four to eight discrete parking points depending on the water level during the profile.

Profiles will initially be conducted hourly but the frequency of profiles may be adjusted over the course of the project.

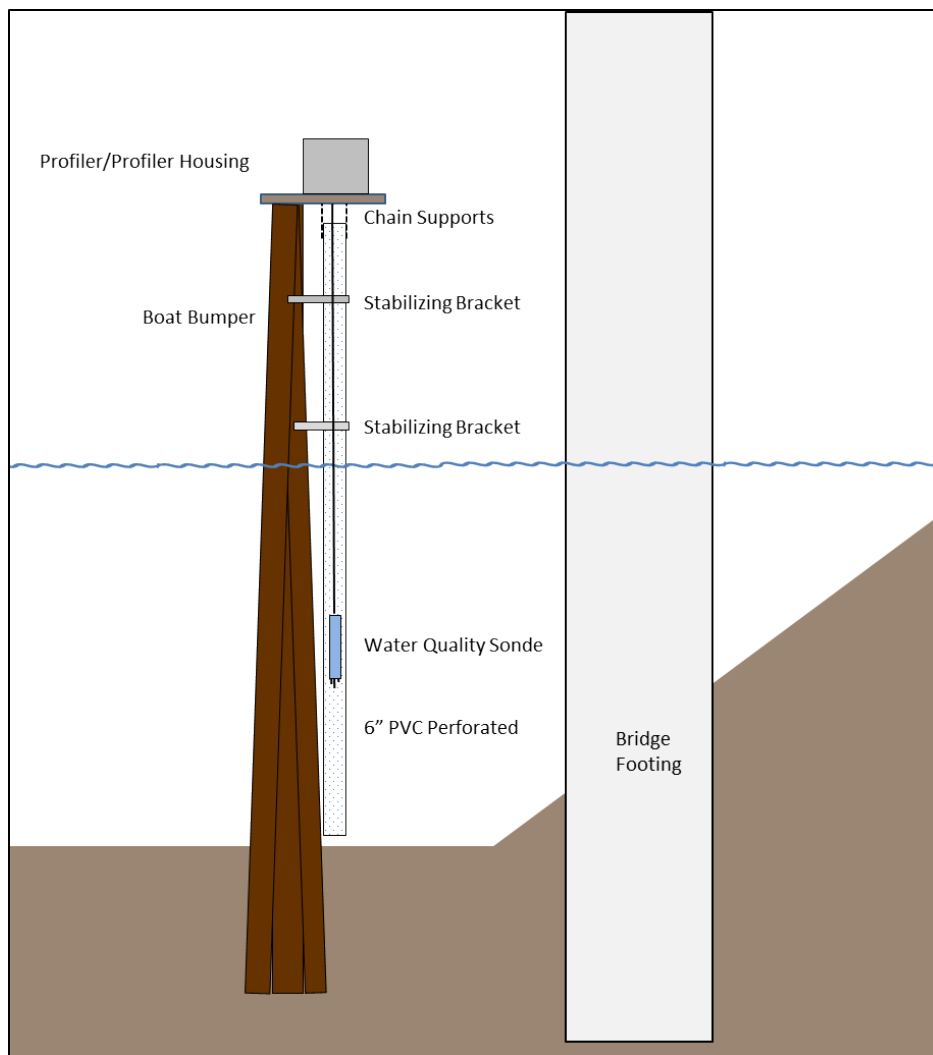
Multiprobe Deployment

The multiprobe will be deployed in a 6" PVC vertical deployment tube that extends to the bottom of the stream channel (see Figure B2.1). The deployment tube contains evenly spaced one-inch holes for the entire length of the tube at and below the high tide of record.

As part routine station service events, the deployment tube will either be cleaned of bio-fouling on-site or the deployed tube will be replaced with a pre-cleaned deployment tube.

To combat sensor bio-fouling copper multiprobe sensor guards will be used and copper tape will be installed on the sensor bodies. In between profiles, the multiprobe will be parked at the near bottom in anoxic conditions.

Figure B2.1
Multi-probe Installation



B2.2 Sampling/Measurement System Corrective Action

Corrective action measures will be taken to ensure the DQOs and MQOs are attained. The site operators are responsible for monitoring the performance of the measurement and support equipment and identifying problems or potential problems. It is expected that any individual who discovers a problem will initiate corrective action appropriate to the situation.

Corrective action is accomplished at the lowest level and shall be documented in the Monthly Progress Report. The USGS QC Officer, USGS Project Manager, and TCEQ Network Coordinator must be notified of any proposed corrective action that can affect data quality and/or protocols. When problems are identified that cannot be resolved by the site operator, the site operator notifies the USGS Project Manager that is responsible for

coordination with appropriate personnel to resolve the problem. The project lead reports the problem and necessary corrective action to the network coordinator.

The Project Manager is responsible for coordinating the necessary supply and parts shipments to the site operator. When necessary specialized personnel may be required to travel to the site to repair or replace support equipment that cannot be repaired or replaced by the site operators. Monitoring equipment that cannot be repaired by staff is sent to the manufacturer for repair.

The Arroyo Colorado site is located in the best possible location to monitor environmental conditions while being protected from flooding, storms, hurricanes, vandalism, and barge traffic. While all measures will be employed to protect the equipment and preserve data it is accepted that the support systems and components will need periodic replacement and repair possibly resulting in downtime.

B3 Sample Handling and Custody

See Section B10 for electronic management of data. Water quality is measured *in situ* for the multiprobe instrumentation. Samples are not generated as part of this project.

B4 Analytical Methods

Water quality measurement methods used are based on the *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998, unless otherwise noted.

Gage height measurement methods are documented in Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter 8.

Section A7 summarizes and quality objectives. Project measurement equipment and analytical methods are listed in Tables B4.1, and B4.2.

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

Table B4.1

Multiprobe Analytical Methods

Parameter	LEADS Parameter Code	USGS Parmameter Code	Units	Measurement Equipment	Method
DO*	10300	00300	mg/L	YSI 6-Series	Optical (luminescence quenching) ASTM D888-05 *
SC	10095	00095	µS/cm	YSI 6-Series	Conductivity cell, Standard Method 2510B
Temperature	10010	00010	°C	Thermistor	Standard Method 2550 B
Sample Depth	10078	00003 or 00098	Feet or Meters	YSI 6-Series	Pressure Transducer
Gage Height	10078	00065	Feet or meters	OTT PLS	Vented Pressure Transducer

*Method not based on *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998. U. S. Environmental Protection Agency (EPA) Region 6 has approved Optical DO methods for use in the CWQMN.

°C = degrees centigrade

µS/cm = micro siemens per centimeter

ASTM = American Society for Testing and Materials

DO = dissolved oxygen

USGS = United States Geological Survey

LEADS = Leading Environmental Analysis and Display System

YSI = Yellow Springs Instrument

Gage Height Measurement Methods

A vented OTT PLS pressure transducer will be used to measure the water level at the site. The sample depth will be measured by an additional depth sensor installed in the YSI 6920 V2. The water quality measurements (DO, SC, and Temperature) will be associated with a sample depth from the bottom of the channel. The number of equally spaced sampling intervals will be determined by the profiler software using water level measurements collected by the profiling system's YSI 600 XL reference sonde.

Table B4.2

Water Level and Sample Depth Analytical Methods

Instrument/Parameter	LEADS Parameter Code	USGS Paramter Code	Units	Range	Method
Vented YSI 600XL pressure transducer / Gage Height	10078	00065	Feet	Model Dependent	Vented Pressure Transducer
Vented OTT PLS pressure transducer / Gage Height	10078	00065	Feet	Model Dependent	Vented Pressure Transducer
YSI 6920 V2 / Sample Depth	10078	00003	Feet	Model Dependent	Pressure Transducer

LEADS = Leading Environmental Analysis and Display System

B5 Quality Control (QC)

Quality Control 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. Audits can also be used to assess data quality. Project measurement quality objectives are specified in Section A7.

B5.1 Multiprobe Quality Control

Multi-probe data quality is measured, assessed, and controlled, according to procedures and criteria found in: USGS – *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting TM1D3*. The Arroyo SOP will detail any station-specific QC modifications or deviations from USGS TM1D3. This SOP will be developed during the testing phase of the project and may be updated on an as needed basis during the data collection phase of the project. See Section A6.

Table B5.1.

CAMS Designations and SOPs

CAMS	Site Designation	Measurement Equipment	SOP
730	USGS	YSI 6920 V2	<p>USGS – <i>Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting TM1D3</i>. http://pubs.usgs.gov/tm/2006/tm1D3/.</p> <p>USGS Arroyo Colorado Standard Operating Procedure</p>

B5.2 Water Level Quality Control

Water level data quality is measured, assessed, and controlled, according to procedures and criteria found in: USGS – *Discharge Measurements at Gaging Stations: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter 8*. The Arroyo Colorado SOP will detail any station-specific QC modifications or deviations from the USGS procedures. This SOP will be developed during the testing phase of the project and may be updated on an as needed basis during the data collection phase of the project. See Section A6.

Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter 8. The Arroyo Colorado SOP will detail any station-specific QC modifications or deviations from the USGS procedures. This SOP will be

developed during the testing phase of the project and may be updated on an as needed basis during the data collection phase of the project. See Section A6.

B6 Instrument/Equipment Testing, Inspection and Maintenance

Instrumentation and equipment for the Arroyo Colorado Project are provided by TCEQ. Instrument maintenance activities are documented in equipment dedicated logbooks. Logbook, field sheet, and validation records contain information on periodic routine maintenance, symptoms, troubleshooting effort descriptions, results and follow-up observations. Records should include the date, time, and the name or initials of the site operator performing the maintenance. These records are vital tools in historic instrument performance and are an aid to future troubleshooting.

Multiprobes

Currently, the instruments' operation manuals are being used as guidance for maintenance activities.

Multiprobe Optical DO Membranes (YSI)

Optical dissolved oxygen membranes will be replaced at least annual. Optical dissolved oxygen membranes may be replaced more frequently if necessary to achieve project data quality objectives.

B7 Instrument Calibration and Frequency

Standards

Conductivity standards shall be National Institute of Standards and Technology (NIST) - traceable standards or prepared from NIST - traceable materials. Multi-probe conductivity standards are purchased through the USGS National Field Supply Store. Expired standards cannot be used. DO will be calibrated in an air-saturated water bath and pre-made zero DO standards for checks will be purchased.

USGS Multi-probe DO, SC, and Depth Sensor Calibration and Calibration Drift Checks

Multi-probe DO and conductivity sensor will be calibrated at a minimum of once a month. Multi-probe calibrations and calibration drift checks will be analyzed in a temperature controlled environment. The monitors will be maintained and calibrated according to the USGS TM1D3 "Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Operation, Record Computation, and Data" (Wagner and others, 2006).

Multi-probe DO Calibrations and Calibration Drift Checks

1. Multi-probe calibrations and calibration drift checks will occur in air saturated water.
2. The project will employ single-point DO calibrations. DO will be calibrated to 100% saturation using an air-saturated water bath, and a zero DO check will be

performed using a sodium-sulfite solution, in the laboratory prior to each deployment.

3. Monitors will be calibrated in a USGS laboratory. Each USGS laboratory has a dedicated barometer that is checked against an NIST-certified barometer annually.
4. If an optical DO membrane's protective black coating is worn off by more than 25%, the membrane must be replaced prior to calibration.
5. USGS personnel will ensure that the optical DO membranes have the correct calibration and temperature coefficients by checking the documentation sent by the manufacturer with any new membrane. Coefficients must be changed any time a membrane is replaced. New sensors will be checked to ensure they are properly pre-programmed by the manufacturer prior to calibration and deployment.
6. Optical DO gains must be between 0.85 – 1.15 after calibration. If not, corrective action must be performed before sensor can be used to collect project data.

Multi-probe Conductivity Calibrations and Calibration Drift Checks

1. The range of specific conductance at the site is approximately 5,000 -50,000 uS/cm based on past data collected at the site. The conductivity sensors will be calibrated to a conductivity value of 10,000 uS/cm and multi-point calibration drift checks will be done using specific conductance values of 1,000 uS/cm and 50,000 uS/cm.
2. Conductivity cell constants must be between $5 \pm .45$ after calibration. If not, corrective action must be performed before sensor can be used to collect project data.

Multi-probe Depth Sensor Calibrations

YSI Multi-probe depth sensors are non-vented sensors. Consequently, these sensors will be calibrated (zeroed) at the station just prior to deployment.

Vented Water Level Sensor Calibrations

The YSI 600 XL reference sonde will be calibrated by zeroing the sensor in air at the site during every visit prior to deployment of the sonde. Desiccant will be replaced every visit. Zinc anodes will be used to protect the bulkhead and cable connectors from corrosion.

Gage height measured by an OTT PLS will be checked against and corrected to an outside gage (staff plate) during each visit.

Multi-probe Temperature Checks

After every deployment period, multi-probe temperature sensors are checked against NIST-traceable thermometers and thermistors at a single point. The accuracy of the thermistors is ± 0.2 °C. Temperature checks are conducted in a vessel of water and not in a circulated water bath. Thermistors that exceed a 0.5 °C difference from the NIST traceable thermistor or thermometer will be replaced.

B8 Inspection/Acceptance of Supplies and Consumables

B8.1 Spare Parts

Multiprobe replacement sondes, sensors, and profiler parts will be supplied by TCEQ.

Standards and Reagents

Conductivity standards will be purchased through the USGS National Field Supply Store.

B9 Non-Direct Measurements

This QAPP does not include the use of routine data obtained from non-direct measurement sources.

B10 Data Management

Water quality data, sample depth data, and water level project data will be sent by wireless cell phone modem to transfer data from the station to the USGS NWIS database. Provisional data will then be uploaded to the TCEQ LEADS ingest and display database.

USGS submits formatted continuous water quality and gage height data hourly to TCEQ using an automated script that extracts the data from the USGS database (NWIS), formats it and sends the data to a FTP site. Two data sets are regularly delivered to TCEQ. USGS uses an automated water quality data ingest system that retrieves, formats, and scans incoming data for errors. When USGS transmits this data to TCEQ, it is “provisional.” This provisional data is coded as parameter occurrence code (POC) 1 and is subject to change as the data is validated by USGS. The data transmission is received by TCEQ and loaded into the LEADS database.

NWIS requires the correct date, time, sampling site number, and proper formatting of raw data fields. USGS data validators work on Edited Unit Values through their personal computer on a graphical interface. Data validators obtain sonde QC information from the field sheets and spreadsheets maintained by field personnel.

Within 150 days of data collection, USGS staff will review the data and compute unit values based on the fouling and drift documented at the time the sensors are retrieved from the deployment site. When USGS has completed their review and the results approved by USGS management, the data is transmitted to TCEQ by FTP with the data coded as POC 3 indicating that the data has been validated. This process retains the provisional data (POC 2) and the validated computed unit values (POC 3) in the LEADS database

The USGS reviews data prior to the publication of their annual water year report. If problems with data are identified as part of this review, the USGS may re-submit data to TCEQ. Data submitted as the result of changes for the annual water year report will be submitted by FTP flagged as POC4.

C1 Assessments and Response Actions

USGS, at its discretion or upon request by TCEQ, may conduct audit(s) of the Arroyo Colorado Project. USGS will conduct such audits under USGS audit procedures. USGS will submit the resulting audit reports to TCEQ for concurrence.

Each audit report submitted to TCEQ will be individually numbered, dated, and identifies the auditor, auditee, and nonconformity (findings and observations). The audit report may suggest recommended corrective action to findings.

Participant-Initiated Corrective Action

It is expected that any individual who discovers a problem will initiate corrective action appropriate to the situation. Corrective action is accomplished at the lowest level and shall be documented in the field sheets and Monthly Progress Reports. The Project Lead must be notified of any proposed corrective action that can affect data quality and/or protocols.

Data Completeness Assessments

The Arroyo Colorado Project has a general data completeness requirement of 75% data return. Data completeness is defined as data meeting QC performance criteria described in Sections A7 and B5.

The following is the calculation used to determine data completeness:

$$\text{Percent Completeness} = \frac{\text{Number of Valid Measurements}}{\text{Total Scheduled Measurements}} \times 100$$

Data Completeness Reports

Periodically, USGS provides TCEQ data completeness reports for TCEQ/USGS contract sites. As part of the contract, a data completeness requirement of 75% data return meeting at least a USGS “fair” data rating was established.

C2 Reports to Management

Reports are distributed according to the TCEQ *Quality Management Plan*.

USGS Water Quality and Water Level Data

The USGS must notify TCEQ Network Coordinator in writing if any USGS collected data that has been subsequently identified by USGS and/or TCEQ as not meeting USGS/TCEQ quality objectives or criteria.

USGS will provide TCEQ with a report providing the following information when any USGS validated data does not meet quality objectives or criteria:

- Specific data not meeting quality objectives or criteria.
- The quality objective or criteria not met.
- An explanation of impact to data.
- Corrective action

USGS Monthly Progress Reports

The USGS submits a monthly progress report to the TCEQ Network Coordinator. These reports document activities from the first day of the subject month to the last day of the subject month and are due on the 15th of the subsequent month. Each monthly report details each service event, fouling and drift measurements, issues encountered and the resolution of the issues

USGS Final Report

The USGS will submit a Final Report within 10 working days of the close of the project documenting the issues encountered and the resolution of the issues, observations, and recommendations concerning collection of vertical water quality profile data for the Arroyo Colorado Project station and other vertical water quality profiling stations.

D1 Data Review, Verifications, and Validation

Project data will be reviewed, validated, and processed according to procedures and guidance found in: USGS – *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting TM1D3*. <http://pubs.usgs.gov/tm/2006/tm1D3/>. Project measurement quality objectives are specified in Section A7.

The station will be operated on a test basis before official data collection, data validation, and data processing begins. During this time, the USGS will produce the Arroyo Colorado SOP. The SOP may describe any station-specific deviations, modifications, or interpretations of USGS TM1D3 data validation and data processing procedures. Before official data collection begins, the USGS will produce a final Arroyo SOP. Due to unforeseen data collection problems that may arise during the data collection phase of project, this SOP may be updated (with TCEQ's concurrence) at any time on an as needed basis.

D2 Verification and Validation Methods

Project data will be verified and validated according to procedures and guidance found in: USGS – *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting TM1D3*. <http://pubs.usgs.gov/tm/2006/tm1D3/>.

D3 Reconciliation with User Requirements

Problems with potential limitations of the data are handled at three different levels:

1. At the time of audit of the monitoring stations or by the site operators, who have prime responsibility for routine calibrations, maintenance, and analysis of quality control samples;
2. Data validators who review verify and validate station data; and
3. By users of the data.

Issues are reconciled at the lowest level and at the earliest time possible. The mechanisms for communication between the producers and the users of the data are telephone, e-mail, and the operator's log.

The auditors, validators, site operators, project leads, and managers are empowered to review and question any part of the measurement process and may initiate data reviews and corrective actions to bring the process back into compliance.

To assess the quality of the data produced during the monitoring efforts, the precision, accuracy, and completeness will be assessed in comparison to the quality objectives and measurement quality objectives as discussed in Section A7.