RECLAMATION
Managing Water in the West

Discharge of Non-Project Water into the Tehama Colusa Canal

Quality Assurance Project Plan

U.S. Bureau of Reclamation, Mid-Pacific Region
Environmental Monitoring Branch, MP-157

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Discharge of Non-Project Water into the Tehama Colusa Canal – Supplemental Drought Conditions

Quality Assurance Project Plan

Environmental Monitoring Team Project Manager — Date: 2-16-18

Quality Assurance Team Project Manager — Date: 2/16/18

Data Management Team Project Manager — Date: 2/16/18

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Project Management

I. Project/Task Organization

Personnel from the Environmental Monitoring Branch (EMB) in the Mid-Pacific Region of the U.S. Bureau of Reclamation will maintain and review this quality assurance project plan (QAPP). Additionally, personnel from the EMB will collect the samples, incorporate external quality assurance samples, validate the analytical data, write a quality assurance summary report, enter data into the EMB database, and generate a data assessment. Individuals from the EMB responsible for these tasks are:

Stuart Angerer, 916-978-5046	Environmental Monitoring Chief
Victor Stokmanis, 916-978-5285	Quality Assurance Specialist
Rosa Heredia, 916-978-5284	Database Entry
Nathan Hawley, 530-243-7234	Basic Laboratory
Regina Wixon, 605-692-7325	South Dakota Ag Labs

II. Problem Definition/Background

The Tehama-Colusa Canal Authority (TCCA) is a Joint Powers Authority comprised of 17 Central Valley Project water contractors. The service area spans four counties (Tehama, Glenn, Colusa, and Yolo) along the west side of the Sacramento Valley, providing irrigation water to farmers growing a variety of permanent and annual crops. TCCA operates and maintains the 140 mile Tehama-Colusa and Corning canals irrigation water supply system. The service area is approximately 150,000 acres, producing over $250 million in crops per year, and contributing $1 billion to the regional economy annually.

The Bureau of Reclamation, in accordance with the Warren Act of 1911, has allowed the introduction of Non-Project water into the Tehama Colusa Canal (TCC) to supplement the drought-diminished CVP supply.

To address the environmental commitments identified in Section 2.2.1 of EA 13-03, this supplemental QAPP incorporates new water quality criteria for determining the eligibility of groundwater to be discharged to and conveyed in the Canals in. The criteria are based on agricultural standards with aquatic life standards added for a few constituents where agricultural standards were not available.

New Warren Act Contracts are being negotiated that would allow the introduction of groundwater from wells (Non-Project water) into the canal. Wells sampled under this project plan will be assessed to meet the criteria outlined in this plan. The project described is this Quality Assurance Project Plan (QAPP) will ensure that water quality monitoring data is reliable, accurate, and timely, all of which are

necessary to confirm whether or not the conveyance of Non-Project water will affect the quality of CVP water in the canal.

Criteria selected for assessing water quality was generated based on the designation of beneficial uses of the water in the canal for agricultural purposes.

III. Project/Task Description

The overall goal of this program is to monitor the quality of Non-Project well water entering the TCC. General tasks for this program are listed below:

1. Collect water samples from the wells.
2. Measure and record the EC, pH, and temperature of well water at times of sample collection
3. Analyze chemical characteristics of field and quality assurance samples via contract laboratories
4. Reviews verified analytical results and compare them to the water quality standards.

IV. Quality Objectives and Criteria

Table 1 - Water Quality Standards

Constituent	Limit
Aluminum	20,000
Arsenic	2,000
Beryllium	500
Boron	2,000
Cadmium	500
Chloride	355 mg/L
Chromium III	1,000
Cobalt	5,000
Copper	5,000
Fluoride	15,000
Iron	20,000
Lead	10,000
Manganese	10,000
Mercury	0.77
Molybdenum	50
Nickel	2,000
pH	4.5 - 9.0
Silver	0.71
Sodium Absorption Ratio	9

Specific Conductance	3,000 µS/cm
Total Dissolved Solids	2,000 mg/L
Zinc	10,000

Units, where applicable, are µg/L unless otherwise specified.

Table 2. – Data Quality Objectives (Analytical Laboratory)

Required Reporting Limits

Parameters	Reporting Limit (ug/L)*	Laboratory
Aluminum	5	Basic
Arsenic	0.5	Basic
Beryllium	0.5	Basic
Boron	25	Basic
Cadmium	0.2	Basic
Calcium	1000	Basic
Chloride	1000	Basic
Chromium	0.5	Basic
Cobalt	0.5	Basic
Copper	0.5	Basic
Fluoride	100	Basic
Iron	50	Basic

Parameters	Reporting Limit (ug/L)*	Laboratory
Lead	0.5	Basic
Magnesium	1000	Basic
Manganese	0.5	Basic
Mercury	0.1	Basic
Molybdenum	0.5	Basic
Nickel	0.5	Basic
SAR	calculated	Basic
Silver	0.2	Basic
Sodium	1000	Basic
TDS	6,000	Basic
Zinc	2	Basic

Table 3. Quality Assurance Acceptance Criteria

Result or Spike Value	Precision	Accuracy	Contamination
≥ 5 x RL	≤ 20% RPD	80%-120% Recovery	≤ 2 x RL, or ≤ 10% of the lowest production sample result
< 5 x RL	± 1 x RL	± 1 x RL	

Table 4. – Data Quality Objectives (Field Instruments)

Parameter	Method/range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Completeness
pH	pH meter	pH units	2.0	0.1 unit	± 0.2 units	± 0.2 units	80%
Conductivity	conductivity meter	µS/cm	10	10 µS/cm	± 10%	± 10%	80%

V. Special Training/Certifications

No special training or certifications are required for this investigation.

VI. Documentation and Records

Field Logbook

Field logbooks are carried in the field and entries are made by field personnel at the time of sample collection. Logbook entries document the following information:

- Project name
- Site name
- Sample collection date
- Start and end times for sample collection
- Weather/sampling conditions
- QA samples collected
- Sample IDs
- Sampling methods
- Decontamination
- Parameters and matrices collected
- Field measurements
- Water clarity
- Unusual conditions that might affect the samples

After entering the required information, logbook entries are signed by all field personnel. The logbook is then securely stored in the EMB office.

Field Sheet

Field sheets provide duplicate documentation of essential sampling information. Field sheets document the following information:

- Project name
- Sampler name
- Sample IDs
- Sample collection date
- Site name
- Field measurements

- QA type
- Parameters and matrices collected

Field sheets are filed in the EMB office and are used by database personnel to make entries into the Environmental Monitoring database. When older than two years, field sheets are stored at the EMB's El Camino Plaza facility.

Instrument Calibration Sheet

The instrument calibration sheet documents the information from an initial calibration, performed prior to instrument use, and information from a verification check, performed after all sampling for that day is completed. Information documented on the instrument calibration sheet should include:

- Project name(s)
- Date
- Time(s)
- Field sampler's name
- Instrument type
- Instrument number
- Standard value
- Initial value
- Adjusted value
- Post value

The instrument calibration sheets are filed in the EMB office.

Chain of Custody

Chain of Custody forms (COCs) document the custody of samples from the time samples are collected to the time they are delivered to the laboratory. EMB personnel initiate COC documentation while in the field. Information recorded on the COC include:

- Project name
- Project manager
- Title and signature of sample collector
- Name of the designated analytical laboratory
- List of sample IDs
- Date and time samples were collected
- Sample matrix type
- Number of containers per sample ID
- Analyses requested
- Point of contact phone number

- Date, time, and signatures of all parties responsible for receiving and relinquishing the samples from the time of collection to the time of delivery to the laboratory

Signed COCs accompany all samples to the laboratory. A copy of the COC is returned to the EMB by the laboratory, and then filed with the field sheets in the EMB office. After two years, COCs are transferred to the EMB's El Camino Plaza facility for long term storage.

Spike Book

The QA Specialist is responsible for documenting the necessary information pertaining to the QA samples in the spike book. A spike book is a bound notebook that contains spike worksheets. Information documented on the spike worksheet can include:

- Project and site names
- Sample collection date(s)
- Batch identification number
- Range of sample ID numbers assigned to the batch of samples
- Range of laboratory ID numbers assigned to the batch of samples
- Types of QA samples incorporated and spike/reference concentrations
- Field IDs that correspond to the QA samples
- Lot numbers of reference materials used
- Historical background levels for parameters
- Dated initials of QA personnel incorporating the QA samples

Spike books are stored in the EMB office when not in use.

Analytical Report

The laboratory generates the analytical report. The analytical report documents the analytical results for each parameter analyzed on each sample submitted. The analytical report generally includes the case narrative, analytical results, reporting limits for parameters, methods used to analyze the sample, dates samples were collected, prepared, and analyzed, and the laboratory's quality control (QC) results.

Following QA review and entry of the analytical results into the database, reports are stored with the field sheets and COCs at the EMB office. After two years, storage is transferred to the EMB's El Camino Plaza facility.

Data Assessment / Data Tables

Database personnel will generate tables from the EMB database. The Project Manager will use the tables to produce an assessment report for the well sites.

Quality Assurance Summary Report

The QA Officer will generate a QA summary report that discusses the results of the external QA samples, the results of the laboratory's QC samples, completeness, sample holding times, and circumstances that may affect data quality. The QA summary report will accompany the data tables and assessment report.

Data Generation and Acquisition

VII. Sampling Process Design

The experimental design for this project is intended to obtain a representative sample of groundwater at each pump / well . Analysis of these samples will determine whether or not the ground water is of sufficient quality to support agriculture as a beneficial use

Sampling under this project plan is expected to occur on an "as needed basis".

VIII. Sampling Methods

At each pump / well, samples are collected from the discharge point. The well is to be turned on and allowed to run until three well casing volumes are discharged; the sample is then collected directly into the sample bottles or into a precleaned churn splitter. For QA sites, the sample is initially collected into a churn splitter, mixed thoroughly (churn moved up and down 10 times), and then split up to three ways into the sample bottles. The churn splitter and all sample bottles without chemical preservation must be rinsed three times with the site water prior to being filled. In addition, the churn splitter must be rinsed three times with DI water after use at a site. After collection, the samples are placed on (blue) ice in a cooler and transported to the EMB's El Camino Plaza facility or shipped directly from the field to the contract laboratory (short hold time constituents). At the EMB's El Camino Plaza facility, the samples are stored at 4°C in refrigerators.

Physical measurements will be collected in the field per EMB's SOPs. Physical measurements will include pH and E.C.

IX. Sample Handling and Custody

EMB personnel collect samples into appropriate, pre-preserved containers (Table 5). Samples are placed on blue ice and stored in coolers during collection and while in transit. Upon arrival to the EMB's El Camino Plaza facility, the samples are refrigerated and custody is relinquished to the QA Specialist via COC(s).

As detailed in section XI, the QA Specialist will incorporate blind QA samples. Following QA sample incorporation, the QA Specialist will relinquish the samples to the laboratories using COC, pack the samples on blue ice in cooler(s), and then ship the samples and COC in the cooler(s) to the project laboratories (Table 1). The laboratories then document receiving the samples on the COC with the date of receipt and a signature.

Samples are collected using appropriate parameter bottles, processed, and shipped to the laboratories in a timely manner to ensure all holding times are met (Table 5). The laboratories must have adequate time to prepare and analyze the samples within the parameter's holding time.

Table 5 - Required Bottle Sizes, Sample Preservation, and Sample Hold Times

Constituent	Bottle / Preservative	Hold Time
Metals Al, As, Be, B, Ca, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mg, Mn, Mo, Ni, Ag, Na, Zn	HDPE 500 ml / HNO3	6 months for all metals except Hg; Hg 28 days
Chloride, Fluoride, TDS	HDPE 1000 ml / none	7 days TDS; 28 days for chloride and fluoride

Calcium and Magnesium added for hardness calculation

X. Analytical Methods

Table 6 – Analytical Methods

Parameter	Method
Aluminum	**EPA 200.8**
Arsenic	**EPA 200.8**
Beryllium	**EPA 200.8**
Boron	**EPA 200.7**
Cadmium	**EPA 200.8**
Calcium	**EPA 200.7**
Chloride	**EPA 300.0**
Chromium	**EPA 200.8**
Cobalt	**EPA 200.8**
Copper	**EPA 200.8**
Fluoride	**EPA 300.0**
Iron	**EPA 200.7**
Lead	**EPA 200.8**
Magnesium	**EPA 200.7**
Manganese	**EPA 200.8**
Mercury	**EPA 245.1**
Molybdenum	**EPA 200.8**
Nickel	**EPA 200.8**
SAR	**calculated**
Silver	**EPA 200.8**
Sodium	**EPA 200.7**
TDS	**SM 2540 C,E**
Zinc	**EPA 200.8**

XI. Quality Control

Quality Control procedures and protocols are fully outlined in the Environmental Monitoring Branch's Standard Operating Procedures for Quality Assurance, May 2009 document. Following is a brief summary of the QA activities that pertain to this project.

External Quality Assurance Samples

Blind, external QA samples are incorporated into sample batches that are submitted to the laboratory for inorganic, gross alpha and microbiological parameters. The QA samples assess the laboratory's ability to prepare and analyze samples with an acceptable level of precision and accuracy without introducing contamination to the sample. If any of the inorganic or radiochemical external QA samples do not meet the criteria stated in Table 3, the samples are reanalyzed. If the laboratory is unable to confirm the original result upon reanalysis, a bracket of samples or the entire batch of samples are submitted for reanalysis. Due to the nature of the samples, microbiological samples cannot be reanalyzed. External QA samples are described below.

Accuracy

Matrix spike/reference samples are incorporated to assess accuracy. They are incorporated at a rate of 10% of the production samples. If less than 10 production samples are collected, at least one spike or reference sample is incorporated. Spike accuracy is assessed using percent recovery:

$$PR = \frac{(S - R)}{A}(100)$$

PR	=	Percent Recovery
S	=	Spiked Sample Result
R	=	Background Sample Result
A	=	Amount of Spike Added

The PR for a reference sample is calculated as follows:

$$PR = \left(\frac{F}{MPVorMPN}\right)(100)$$

PR = Percent Recovery
F = Reference Sample Result
MPV = Most Probable Value
MPN = Most Probable Number

Precision

Duplicate samples are incorporated to assess precision. They are incorporated at a rate of 10% of the production samples. If less than 10 production samples are collected, at least one duplicate sample is incorporated. Precision is assessed using relative percent difference (RPD):

$$RPD = \frac{|R - D|}{\left((R + D)/2\right)}(100)$$

RPD = Relative Percent Difference
R = Regular Sample Result
D = Duplicate Sample Result

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Contamination

DI water blank samples are incorporated to assess laboratory contamination. They are incorporated at a rate of 5% of the production samples. If less than 20 production samples are collected, at least one blank sample is incorporated.

Laboratory Quality Control Samples

The laboratory incorporates QC samples at the frequencies specified in the analytical method and their laboratory SOP for the method. The results of the QC samples are assessed based on the acceptance criteria in the analytical method and the laboratory SOP for the method. If any laboratory QC samples do not meet the established acceptance criteria, the laboratory follows the corrective action protocols detailed in the analytical method or the laboratory SOP for the method.

Holding Times

The date of the sample preparation/analysis is compared to the date the sample was collected to ensure the sample was prepared and analyzed within the holding time. If the holding times are exceeded, the Program Manager determines if re-sampling is required. If re-sampling is not required, the QA Officer qualifies the data as necessary. Applicable hold times are listed in Table 5.

Completeness

If the completeness criterion is not met, then appropriate re-sampling will occur. Completeness is determined by calculating the following:

$$\%completeness = \left(\frac{V}{n}\right)(100)$$

V = Number of Valid Results
n = Total Number of Results

XII. Instrument/Equipment Testing, Calibration, Inspection, and Maintenance

Field

Portable (hand held) instruments are calibrated according to manufacturer's protocol. For each sampling episode (whether taking place in one day, or over a number of days), instruments are calibrated every day and within four hours of taking the first measurement. Calibrations are verified with calibration standards within four hours of recording the last measurement of the day. All calibration information is recorded on a calibration sheet.

Laboratory

Maintenance procedures for instruments used by the contract laboratories for this project are detailed in the contract laboratory's QA manual. All instrument maintenance is documented in logbooks. Instrument calibration procedures are specified in the analytical methods for each parameter.

XIII. Inspection/Acceptance for Supplies and Consumables

Pre-preserved, certified clean bottles (sample collection), certified calibration standards (preparation of project-specific spike solutions), and certified reference materials are ordered from outside vendors. All bottles and reagents are inspected prior to use. If any damage or contamination is suspected, packages are not accepted.

Spike solutions used to prepare the matrix spikes have been certified by the EMB to be within 90%-110% of the expected parameter value prior to use.

Field calibration references are certified.

XIV. Data Management

The alpha-numeric field sample identification (ID) assigned for this project is TCC_W [*number*]. Numbers are assigned sequentially, beginning with 001.

Database personnel enter field measurements and laboratory data into the Environmental Monitoring Database. By entering QA specific data from the Environmental Monitoring Database into Microsoft Excel tables, the QA Officer will generate the QA summary report. Prior to releasing data or reports from the Environmental Monitoring Database, data entries are secondarily reviewed.

All data are entered into the Environmental Monitoring Database in accordance with EMB's Data Management Team (DMT) SOP. As a QC check, all data entered is secondarily reviewed by an additional DMT member and initialed. After all data has been entered into the database, the data is signed and filed in project binders. Project binders are locked in a file cabinet in the EMB office and must be signed out when removed.

Assessment and Oversight

XV. Assessments and Response Actions

EMB's Quality Assurance Team (QAT) performs laboratory, field, and documentation audits.

Laboratory

The three-tier audit consists of reviewing the laboratory's QA Manual, reviewing the laboratory's performance evaluation (PE) sample results, and conducting an intensive, on-site, system audit of the laboratory. The laboratory's expertise in conducting analyses, their capability of generating valid data, their ability to effectively support the data, and the integrity of their QA/QC practices are assessed during the on-site audit. Laboratory audits are conducted every three years. The audit reports are issued to the laboratory. The laboratory then issues a response with corrective actions to the EMB. At that time, the QAT determines whether or not to approve the laboratory for use and contacts the laboratory with their decision.

Field

The field audit consists of reviewing the SOP, submitting PE samples and reviewing the results, and accompanying the field sampler during the sample collection process. The QAT assesses the field sampler's expertise in collecting representative samples. Field audits are conducted every two years. The field audit reports are sent to the field sampler and to the field sampler's Supervisor. The Supervisor is responsible for issuing corrective actions.

Documentation

The yearly documentation audits are performed on a percentage of field logbook entries along with the corresponding field sheets and field instrument calibration sheets. The QAT assesses if documentation is

adequate, if all entries have been recorded, and whether or not the work was performed in accordance with the EMB's documentation protocol.

XVI. Reports to Management

Following secondary review by DMT members, data and QA summary reports are submitted to the EMT for assessment.

Data Validation and Usability

XVII. Data Review, Verification, and Validation

If all external QA samples and laboratory QC samples meet the acceptance criteria and all samples are analyzed within the holding time, all data is accepted as valid.

If a result is confirmed after reanalysis, the result is accepted as valid.

Data may be qualified if results demonstrate unacceptable QA, if the laboratory QC sample results are unacceptable, or if the holding times were exceeded.

Based on the qualification, the data assessor (Project Manager) determines the usability of the data.

XVIII. Verification and Validation Methods

The QA Officer validates the data by following the guidelines in the EMB's *SOPs for Quality Assurance* document, dated May 2009. Validation consists of reviewing the results of external quality assurance samples and laboratory quality control results. Holding times and completeness will also be assessed.

If any of the external QA sample results for inorganic parameters do not meet the acceptance criteria stated in Table 3, the samples are submitted for reanalysis. If the laboratory confirms the original result, the original data is accepted based on the laboratory demonstrating that sample preparation and instrumentation was run properly on the initial analysis. If the original result cannot be confirmed, the laboratory must then analyze a bracket of samples or the entire batch of samples an additional time for the parameter. The bracket of samples or the entire batch of samples that has been analyzed an additional time is then evaluated for the parameter to see if the results meet the acceptance criteria in Table 3. Professional judgment is used to decide which set of data to accept and whether or not the data should be qualified if both sets of data demonstrate unacceptable external QA sample results.

XIX. Reconciliation with User Requirements

Any qualified results will be identified to the data entry staff (DMT) by completing the Qualified Results form per EMB protocol. Additionally, if results are qualified, the result will be marked with a footnote on the data table submitted to the data assessor (Project Manager); the footnote will detail the qualification.

XX. References

Marshack, J.B., 2008, A compilation of water quality goals: Sacramento, Calif.,California Regional Water Quality Control Board
http://www.waterboards.ca.gov:8080/WaterQualityGoals