

Final

GUIDELINES FOR ACCEPTING WATER INTO THE FRIANT-KERN CANAL

Final Environmental Impact Report

Prepared for



July 2023



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Prepared for
Friant Water Authority

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CHAPTER 1

Introduction

1.1 Introduction

The Friant Water Authority (Friant), a joint powers authority, has been working with Friant Division long-term contractors (Friant Contractors) and the United States Department of the Interior, Bureau of Reclamation (Reclamation) to develop the proposed *Guidelines for Accepting Water into the Friant-Kern Canal* (proposed Guidelines) to ensure that the quality of water conveyed through the Friant-Kern Canal is protected for sustained domestic and agricultural use.

The proposed Guidelines would be applicable to all Non-Millerton water (water from sources other than Millerton Lake) introduced to or diverted from the Friant-Kern Canal including but not limited to: groundwater pump-ins, surface water diversions and pump-ins, recaptured and recirculated San Joaquin River Restoration Program Restoration Flows, and water introduced at the Friant-Kern Canal–Cross Valley Canal (CVC) intertie and delivered via reverse flow on the Friant-Kern Canal. The proposed Guidelines define the water quality thresholds and required “leave behind” water associated with introduced Non-Millerton water and corresponding water quality, as well as the methodologies and tools for monitoring and forecasting water quality in the Friant-Kern Canal. The proposed Guidelines describe the Friant review process for applications to Reclamation to introduce Non-Millerton water into the Friant-Kern Canal; implementation procedures; and the responsibilities of water contractors and other parties authorized to introduce or receive Non-Millerton water into or from the Friant-Kern Canal (referred to collectively as “Contractors”).

Implementation of the proposed Guidelines would not result in Friant making any physical modifications to the Friant-Kern Canal; however, in response to the proposed Guidelines, Contractors may need to take certain actions to ensure that a proposed introduction of Non-Millerton water meets the water quality thresholds of the Guidelines. These actions may include blending of water, changes to the timing of the introduction or discharge of Non-Millerton water, use of alternative water supplies, or construction and operation of small water treatment facilities at the source of the pump-in. In addition, Friant or Contractors may need to construct and/or maintain facilities for monitoring and forecasting water quality (e.g., water quality monitoring stations).

Pursuant to the California Environmental Quality Act (CEQA), Friant is the lead agency and prepared a Draft Environmental Impact Report (EIR) to analyze potentially significant impacts that could result from implementation of the proposed Guidelines. This document is the Final EIR for the proposed Guidelines. The Final EIR has been prepared in accordance with the CEQA and together with the Draft EIR (and appendices) constitutes the EIR for the proposed Guidelines.

1.2 Environmental Review and Approval Process

1.2.1 Notice of Preparation and Public Scoping Period

Friant issued a notice of preparation (NOP) on Tuesday, December 6, 2022, to satisfy the requirements of CEQA and CEQA Guidelines Section 15082 (State Clearinghouse #2022120093). The purpose of the NOP is twofold: (1) to notify the public, responsible agencies, trustee agencies, the Governor’s Office of Planning and Research, potentially affected public agencies, involved federal agencies, and tribes regarding Friant’s intent to prepare an EIR for the proposed Guidelines; and (2) to solicit input from the public and those agencies as to the scope and content of the environmental information to be included in the Draft EIR.

The issuance of the NOP began the 30-day public comment period, which closed at 5 p.m. on Monday, January 9, 2023. In accordance with Public Resources Code (PRC) Section 21080.4(a) and CEQA Guidelines Section 15082(b), each responsible agency, trustee agency, and involved federal agency was requested to provide, in writing, the scope and content of the environmental information to be included in the Draft EIR related to its area of statutory responsibility. The NOP was also sent to public agencies, organizations, and individuals that requested receipt of Friant’s public notices, to invite them to provide input. The NOP and the current draft of the *Guidelines for Accepting Water into the Friant-Kern Canal* were also made available for review on Friant’s website at the following locations:

NOP: https://friantwater.org/s/Friant_WQ_Guidelines_NOP_120622.pdf

Proposed Guidelines: <https://friantwater.org/public-notice>

The NOP and the proposed Guidelines were also made available for review at the Friant Water Authority office at 854 N. Harvard Avenue, Lindsay, CA 93247.

A virtual public meeting was held during the 30-day NOP review period to solicit comments on the scope and content of the Draft EIR, and to provide information to the public, including a description of the proposed Guidelines. The meeting was held at 3:00 p.m. on Tuesday, December 13, 2022, via the Zoom web conference application. Written comments were accepted throughout the 30-day public NOP comment period and at the scoping meeting; verbal comments were recorded at the scoping meeting. Written comments were accepted via both U.S. Mail and email. One comment letter was received and is included in **Appendix A, Notice of Preparation**, of the Draft EIR which includes the NOP and the comment letter.

1.2.2 Notification of California Native American Tribes

Assembly Bill (AB) 52 requires lead agencies to notify California Native American tribes that are traditionally and culturally affiliated with the geographic area of an individual restoration project, if they have requested notice of projects proposed in that area. No California Native American Tribes have reached out to Friant to be consulted with on Friant projects as per PRC Sections 21080.3.1, 21080.3.2, and 21082.3. Therefore, no tribal consultation efforts outside of the Native American Heritage Commission (NAHC) correspondence were conducted.

1.2.3 Draft EIR

The Draft EIR was made available to federal, state, and local agencies and interested organizations and individuals to review and comment on the adequacy of the analysis. The Draft EIR circulated for 45-days beginning Friday May 12, 2023, and ending at 5:00 p.m. on Monday June 26, 2023. Comments were addressed to:

Friant Water Authority
c/o Ian Buck-Macleod
854 N. Harvard Avenue
Lindsay, CA 93247
ibuckmacleod@friantwater.org

A Notice of Availability (NOA) for the Draft EIR was made available at the Fresno, Kern and Tulare County Clerks offices and published in The Fresno Bee and The Bakersfield Californian on Friday May 12, 2023. The Draft EIR was also available for review on Friant's website: <https://friantwater.org/public-notice>, and at the Friant Water Authority office at 854 N. Harvard Avenue, Lindsay, CA 93247.

During the 45-day review period, a virtual public meeting was held on Tuesday May 30, 2023 at 3:00 p.m. via the Zoom web conference application. Information about the Draft EIR public meeting can be found on Friant's website: <https://friantwater.org/public-notice>. No comments were received at the public meeting. In addition, no comments were received on the Draft EIR by the close of the 45-day public comment period.

1.3 Requirements for EIR Certification and Guidelines Approval Process

Before Friant makes a decision with regard to the proposed Guidelines, CEQA Guidelines Section 15090(a) requires that Friant first certify that the EIR has been completed in compliance with CEQA, that Friant has reviewed and considered the information in the EIR, and that the EIR reflects the independent judgment and analysis of Friant.

In the event Friant approves the proposed Guidelines, CEQA requires that it file a Notice of Determination (NOD) and adopt appropriate findings as set forth in CEQA Guidelines Section 15091. Under CEQA Guidelines Section 15092, a lead agency may only approve or carry out a project subject to an EIR if it determines that: (1) that project will not have a significant effect, or (2) that the agency has eliminated or substantially lessened all significant effects on the environment where feasible and any remaining significant effects on the environment that are found to be unavoidable are acceptable due to overriding considerations. This EIR may also be used by Contractors, as responsible agencies under CEQA, in their discretionary approval processes within their jurisdictions to meet their obligations under CEQA.

1.4 Organization and Format of this Document

This Final EIR is organized as follows:

- **Chapter 1, *Introduction*:** This chapter states the purpose and use of this Final EIR, explains the purpose of the Draft EIR and the Final EIR, and provides an overview of the environmental review process for the EIR.
- **Guidelines for Accepting Water into the Friant-Kern Canal:** The final Guidelines are included as **Appendix A** to this Final EIR.
- **Mitigation Monitoring and Reporting Program:** As part of the approval process, Friant prepared a Mitigation Monitoring and Reporting Program (MMRP), as required by PRC Section 21081.6 and Section 15097 of the CEQA, for mitigation measures recommended in the Draft EIR. The MMRP is included as **Appendix B** to this Final EIR.

Appendix A
**Guidelines for Accepting Water
into the Friant-Kern Canal**



Guidelines for Accepting Water into the Friant-Kern Canal

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Guidelines for Accepting Water into the Friant-Kern Canal

Overview

These Guidelines apply to all water introduced into the Friant-Kern Canal (“**FKC**”) other than directly from Millerton Lake to the headworks of the FKC (collectively, “**Non-Millerton water**”).

These Guidelines describe the Friant Water Authority’s (“**FWA**”) application review process, implementation procedures, and the responsibilities of water contractors and other parties authorized to introduce or receive Non-Millerton water into or from the FKC (collectively, “**Contractors**”). These Guidelines define the water quality thresholds and the required mitigation associated with introduced Non-Millerton water and corresponding water quality, as well as the methodologies and tools for monitoring and forecasting water quality in the FKC. These Guidelines are intended to ensure that water quality is protected for sustained domestic and agricultural use.

These Guidelines are applicable to all Non-Millerton water introduced or diverted into the FKC including but not limited to:

- Groundwater pump-ins (e.g., groundwater wells or previously banked water)
- Surface water diversions and pump-ins
- Recaptured and recirculated San Joaquin River Restoration Program Restoration Flows
- Water introduced at the FKC-Cross Valley Canal (“**CVC**”) intertie and delivered via reverse flow on the FKC

A Water Quality Advisory Committee composed of Friant Division long-term contractors (“**Friant Contractors**”) involved in either introducing or receiving Non-Millerton water to or from the FKC has been established to provide recommendations to FWA on operations and monitoring requirements of the FKC. The Water Quality Advisory Committee will operate under an established charter (see Attachment A). The Water Quality Advisory Committee will appoint a Monitoring Subcommittee to assist FWA in the implementation of the Guidelines.

These Guidelines are subject to review and modification by FWA if any of the following conditions occurs:

- A future regulatory cost or equivalent fee is imposed on Friant Contractors and a portion of such fee can reasonably be attributed to the incremental difference of water quality conditions in the FKC.
- When Friant Division Class 1 contract allocation is less than or equal to 25 percent, the Water Quality Advisory Committee will convene as outlined in Attachment A. In these years, mitigation will be accounted for as presented in these Guidelines, but will be deferred to a mutually agreed to later date unless those responsible for the put and take mutually agree to put and take the

mitigation in the critical year. All monitoring requirements will remain as presented in these Guidelines.

- There is a significant, regulatory change or scientifically based justification and three out of the following five Friant Contractors agree and work with the Water Quality Advisory Committee to recommend a change: (1) Arvin-Edison Water Storage District, (2) Shafter Wasco Irrigation District, (3) Delano-Earlimart Irrigation District, (4) South San Joaquin Municipal Utility District, and (5) Kern-Tulare Water District.

The Bureau of Reclamation (**Reclamation**) may also propose and/or require modifications to these Guidelines in coordination with FWA and reserves the right to implement additional water quality requirements as needed to protect water quality within the FKC. FWA will provide written notice of any proposed modification that are relevant to these Guidelines to all Contractors prior to adoption and implementation.

A. General Requirements for Discharge of Water into the Friant-Kern Canal

1. Guidelines Compliance Determination

A Contractor wishing to discharge Non-Millerton water into the FKC must, concurrent with its application for a contract or other applicable approval from Reclamation in such form and contents as may be required by Reclamation, obtain a determination from FWA as to compliance with the Guidelines or demonstrate to FWA and Reclamation that the proposed discharge will be subject to comparable and adequate alternative water quality mitigation measures. The application will not be approved until FWA has provided its determination that the applicant is compliant with the Guidelines or the provision of alternative mitigation measures is adequately demonstrated and incorporated into the proposed discharge project. Figure 1 shows the concurrent process that a Contractor must pursue to obtain these approvals. The Contractor will be responsible for securing all other requisite Federal, State or local permits.

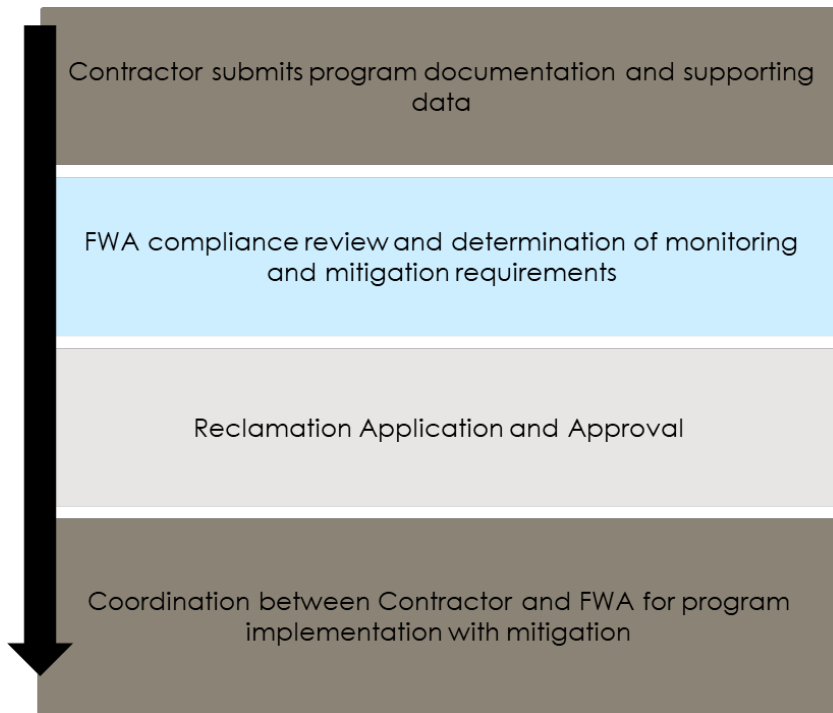


Figure 1. Approval Process Diagram

2. Discharge Facility Approval

The approvals for the erection and maintenance of each discharge facility into the FKC must be approved and documented in the manner required by Reclamation, in coordination with FWA.

3. Other Discharge and Conveyance Requirements

The discharge of Non-Millerton water into the FKC may not in any way limit the ability of either FWA or Reclamation to operate and maintain the FKC for its intended purpose nor may it adversely impact existing water delivery contracts or any other water supply or delivery agreements. The discharge of Non-Millerton water into the FKC will be permissible only when there is capacity in the system as determined by FWA and/or Reclamation.

B. Water Quality Monitoring and Reporting Requirements

1. General Discharge Approval Requirements

Each source of Non-Millerton water discharged into the FKC must be correctly sampled, completely analyzed, and approved by FWA and Reclamation prior to introduction into the FKC. The Contractor must pay the cost of collection and analyses of the water required under these Guidelines. Other costs associated with the implementation of these Guidelines to be paid by the Contractors are described in Section E below.

2. Water Quality Monitoring and Management

The monitoring program requirements are detailed below. In addition, the requirements are summarized in a single table in Attachment B.

(a) Monitoring Requirements for Discharged Water

Prior to introduction to the FKC, all Non-Millerton water discharged into the FKC must be tested at the source (i.e., grab samples at each pump location for groundwater pump-ins or in-prism (i.e., in-situ) grab samples for water being introduced via other conveyances) and sampled by an appropriate party every three years for the complete list of water quality constituents listed in the then current version of Table 1. In addition, all Non-Millerton water discharged into the FKC must be tested and sampled by an appropriate party annually for the short list of water quality constituents listed in Table 4. The analytical laboratory must be a facility with Environmental Laboratory Accreditation Program (ELAP) certification. The laboratory analytical report and summary of water quality analytical results must be reported to FWA and Reclamation's **Contracting Officer** (i.e., the Area Manager for the South-Central California Area Office) for review. All monitoring requirements are summarized in Attachment B.

If analytical results show an exceedance of 80% of the threshold for any water quality constituents, defined in Table 4, discharged Non-Millerton water will be tested weekly for the targeted constituents of concern until four consecutive grab samples show consistent water quality results. The appropriateness of the threshold buffer (i.e., 80% of the threshold) will be evaluated by the Water Quality Advisory Committee.

If the water quality analytical results show exceedance of any constituent above its threshold in Table 1, 3 or 4 (i.e., not the threshold buffer but the threshold itself), at the discretion of Reclamation such water may not be allowed to be introduced into the FKC. FWA will evaluate monitoring requirements on a case-by-case basis and may impose additional requirements including but not limited to monitoring of the discharge source and downstream in prism quality at the cost of the Contractor.

(b) In-Prism Water Quality Monitoring

FWA will cause to be implemented continuous, real-time monitoring of in-prism water quality conditions in the FKC. Conductivity meters (or sondes) will measure and record real-time in-prism electrical conductivity ("EC"), measured as microsiemens per centimeter ($\mu\text{S}/\text{cm}$), every 15 minutes at the FKC check structures and corresponding mileposts shown in Table 2. Collected EC data will be uploaded to FWA's Intellisite Operation System (IOS) in real-time. These continuous, in-prism measurements of EC will provide real-time data on incremental water quality changes and mixing in the canal and will assist in water quality threshold management.

If the Friant Water Quality Model forecasts an in-prism exceedance of 80% of the threshold for any water quality constituents, defined in Table 4, water samples from the FKC will be collected each week by appropriate FWA staff until the sampled concentrations, supported through Friant Water Quality Model forecasted simulations, show four consecutive weeks below the 80% threshold. Each weekly collection will consist of one sample from each downstream check structure shown in Table 2 and where water quality changes are expected, plus one duplicate sample. FWA will deliver the samples to a laboratory

with ELAP certification. FWA expenses for all water quality monitoring and sampling are subject to reimbursement from Contractors through fees and charges. As was the case for the discharged water, the appropriateness of the threshold buffer will be evaluated by the Water Quality Advisory Committee.

Additional water quality sampling and analysis will be performed during specific FKC operations. FWA will cause to be measured EC using hand-held conductivity meters as needed, such as during:

- servicing of real-time monitoring equipment;
- unexpected real-time monitoring equipment outages;
- confirmation of real-time monitoring equipment measurements; and,
- targeted in-prism measurements.

(c) CVC In-Prism Water Quality Monitoring

Upon initiation of reverse-flow, pump-back activities and/or if it is anticipated that operations within the CVC will significantly change mixed water quality conditions (i.e., influence from California Aqueduct, Kern River, Kern Fan), grab samples will be collected by FWA within the CVC near the FKC/CVC Intertie, and provided to a third-party laboratory with ELAP certification for testing of water quality constituents listed in Table 1. In addition, during reverse-flow pump-back operations, weekly water quality sampling will be performed within the CVC near the FKC/CVC Intertie. Grab samples will be collected by FWA and provided to a third-party, ELAP certified laboratory for testing. At a minimum, grab samples collected during reverse-flow pump-back operations will be analyzed for the short list of water quality constituents listed in Table 4.

The Water Quality Advisory Committee will evaluate water quality monitoring, sampling, and analysis requirements on a regular basis and provide recommendations for modification of the described requirements.

(d) In-Prism Water Quality Management

FKC in prism water quality will be managed per the following thresholds. If the below thresholds are exceeded, systematic cessation of pump-in or pump-back operations will occur.

1. Title 22. The Domestic Water Quality and Monitoring Regulations specified by the State of California Health and Safety Code (Sections 116270-116755), and Title 22 of the California Code of Regulations (Sections 6440 et seq.), as amended. In prism water quality constituent concentrations may not exceed the Maximum Contaminant Level (**MCL**) as defined in Table 1, except those constituents listed in Table 3 and Table 4. Current State of California requirements at the time of sampling will prevail over those in the accepted version of this document if MCLs in Table 1 are changed in the future.
2. Water quality thresholds defined in Table 3. Water quality thresholds are representative of constituent thresholds of sensitive crops; leaching requirements; and crop thresholds for regulated

deficit irrigation practices that occur during almond hull split from July 1 through August 31; and flexible thresholds in the second half of the contract year, from September 1 through February 28, depending on observed water quality in the first portion of the contract year.

- i. Table 3 presents alternative water quality thresholds for Period 3 (September 1 – February 28) that are dependent on the measured water quality during Period 1 (March 1 – June 30). If the measured average chloride concentration for Period 1 exceeds 70 milligrams per liter (mg/L), the chloride threshold remains at 102 mg/L for Period 3a. If the measured average chloride concentrations for Period 1 are less than or equal to 70 mg/L, the allowable chloride concentration increases from 102 mg/L to 123 mg/L for Period 3b.
- ii. It is estimated that an average of one week is required for in-prism water quality to turnover. Prior to the onset of the defined hull split period requirements (July 1), current FKC operations and water quality conditions will be evaluated to determine if this one-week period should be adjusted.

If water quality thresholds are exceeded, or based on modeling appear likely to be imminently exceeded, or operations in the FKC need to change per Guidelines requirements, FWA will immediately notify the Water Quality Advisory Committee, which must convene a meeting of the Monitoring Subcommittee within three days of receiving notification from FWA. The Monitoring Subcommittee and FWA will review operations and water quality data and will seek consensus on determining the best management actions to improve water quality; provided, however, the final operational decision will be made by FWA. In addition, the Monitoring Subcommittee will seek 1:1, unleveraged, and cost-neutral exchanges to limit potential Project water impacts. Notwithstanding the foregoing, FWA retains the right to determine and take immediate management actions with respect to groundwater pump-ins in accordance with the applicable approvals, but will work in good faith with the Water Quality Advisory Committee and Monitoring Subcommittee to evaluate options. If required, management actions including any reductions or cessation of pump-in volume must occur within three days of the meeting between FWA and the Monitoring Subcommittee. FWA will order any reduction in pump-in volume in order of greatest mass loading. Finally, the Monitoring Subcommittee will set an appropriate review period to assess if implemented management actions are working and, if not, will agree to reconvene to discuss additional actions necessary to improve water quality.

(e) Uncontrolled Season

Non-Millerton water may not be introduced to the FKC during the Friant Division uncontrolled season as declared by Reclamation unless:

- Deliveries are necessary due to FKC capacity constraints, and if the Non-Millerton water delivered from the CVC remains below the Shafter Check, or
- The Non-Millerton water is below the determined baseline EC threshold of 200 $\mu\text{S}/\text{cm}$ and, therefore, does not require mitigation.
- Introduction of Non-Millerton water does not impact Friant Division flood operations.

3. Water Quality Mitigation

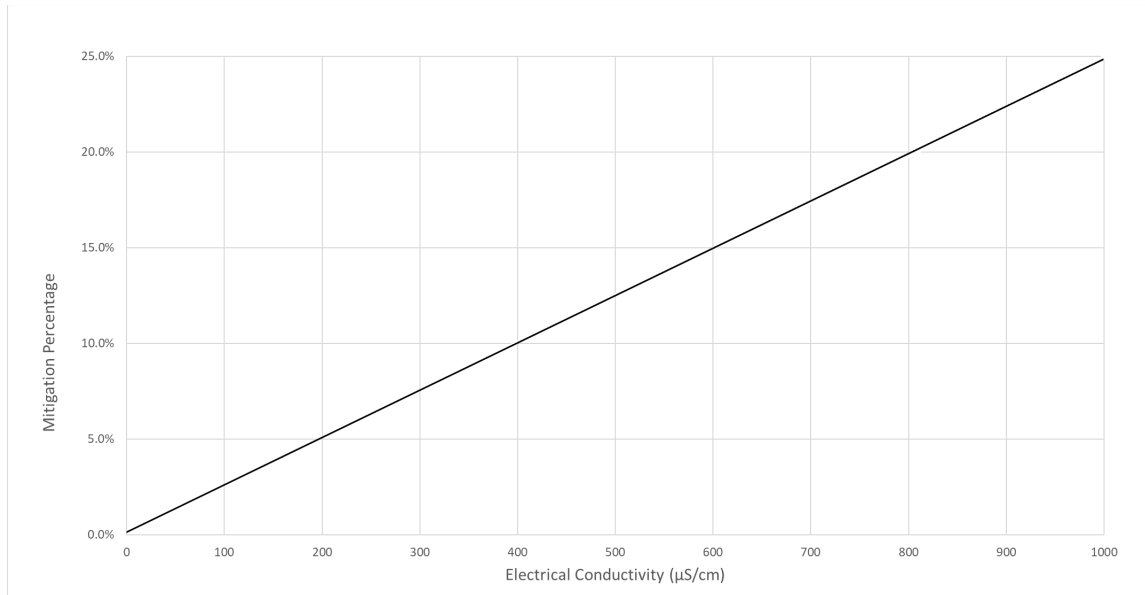
Mitigation for impacted water quality is quantified through use of the Water Quality Mitigation Ledger (“**Ledger**”). The Ledger tracks and accounts for all inflows into and diversions from the FKC in order to determine appropriate mitigation for impacted water quality (attributable to the introduced Non-Millerton water or “**Put**”¹). The volume of additional surface water needed for mitigation, expressed as a percentage of the introduced water, or Put, is determined using an established mitigation rating curve. The mitigation rating curve is based on (1) constituent concentrations, and (2) agronomic principles that focus on leaching requirements to prevent constituent accumulation in the rootzone and resulting impacts on crops. This approach aims to balance concerns related to long-term groundwater quality with a multi-layered assessment of agronomic impacts as a durable solution. The process for developing the agronomic impacts evaluation and mitigation rating curve can be found in *Attachment C– Agronomic Impacts and Mitigation*.

The Ledger quantifies mitigation for Friant Contractors that have an expectation to receive water consistent with quality conditions of Millerton Lake. Specifically, mitigation applies to the “**Take**” (or delivery) of Friant Division Class 1, Class 2, Recovered Water Account (RWA [Paragraph 16b]), and Unreleased Restoration Flows supplies. Friant Contractors and/or other Contractors, including but not limited to third parties, whose supplies are not delivered to the headworks of the FKC are not eligible to receive mitigation.

Mitigation percentage is based on the EC of the Put above the established baseline. The established baseline is based on assumptions of current, minimum leaching practices by water users, or growers, in the region. Consistent with good agricultural practices, it is assumed that growers are currently applying at least a five percent (5%) leaching fraction. Under the mitigation rating curve shown in Figure 2, this corresponds to an approximate EC of 200 $\mu\text{S}/\text{cm}$. It is assumed that growers are already managing the effects of applied water quality conditions up to 200 $\mu\text{S}/\text{cm}$ of EC, and mitigation is only required for water quality conditions with incremental EC that exceed the baseline EC threshold of 200 $\mu\text{S}/\text{cm}$. Note that the mitigation rating curve extends beyond the maximum EC and mitigation percentage shown in Figure 2 (i.e., at 1,000 $\mu\text{S}/\text{cm}$ and 25%) at the same slope of 5% mitigation per 200 $\mu\text{S}/\text{cm}$ of EC.

A mitigation volume is calculated based on the Put volume and corresponding mitigation percentage. Mitigation volumes for each Put are distributed to each Friant Contractor receiving an eligible Take, or “**Taker**,” downstream based on the volumetric proportion of the Take on a weekly basis. Mitigation occurs in real time by the Contractor and offsets a like volume of each Taker’s supply at the end of a reporting period. Additional mitigation is not required to account for the water quality conditions of the mitigation volumes. Water quality conditions and flows are tracked daily. The ledger and required mitigation volumes are balanced weekly and reported and transferred monthly. Accounting and reporting are detailed in *Attachment D – Standard Operating Procedures*.

¹ Existing FKC inlet drains are exempt from providing mitigation.



Key:

$\mu\text{S/cm}$ = microsiemens per centimeter ($1 \mu\text{S/cm} = 1 \mu\text{mhos/cm} = 1/1,000 \text{ dS/m}$)

Figure 2. Proposed Mitigation Rating Curve Based on Boron Sensitivity and Normalized to Electrical Conductivity

4. Critical Year Management

When Friant Division Class 1 contract allocation is less than or equal to 25 percent, the Water Quality Advisory Committee will convene as outlined in Attachment A. In these years, mitigation will be accounted for as presented in these Guidelines, but will be deferred to a mutually agreed later date unless those responsible for the Put and Take mutually agree to put and take the mitigation in the critical year. All monitoring requirements will remain as presented in these Guidelines.

C. Resolution of Disputes

In the event a Contractor is dissatisfied with the application or interpretation of these Guidelines by FWA staff or consultants, the following dispute resolution procedures will apply:

1. A Contractor may request FWA refer the dispute to Reclamation's Contracting Officer's Representative for initial review. FWA will prepare and deliver a written summary of the dispute for Reclamation's Contracting Officer's Representative, who will then confer with the parties and issue an advisory opinion regarding the dispute in a timely manner.
2. In addition to or in lieu of the meet and confer process with Reclamation's Contracting Officer's Representative above, a Contractor may submit a written appeal to be heard by the FWA Board of Directors. The written appeal must be submitted to the office of the Chief Executive Officer, who will then place the dispute on the agenda of the Board of Directors for a hearing at a board meeting no later than 60 days from the date of receipt. The decision of the Board of Directors will be final and FWA and the other party(ies) must promptly comply with such decision until the same is stayed, reversed, or modified by a decision of a court of competent jurisdiction.

The Cooperative Agreement between the Contractors and FWA provides additional dispute resolution procedures. In the event of any conflict between the dispute resolution procedures in these Guidelines and the Cooperative Agreement, the provisions in the Cooperative Agreement will control.

D. Water Quality Forecasting and Communications

1. Friant-Kern Canal Water Quality Model

Water quality monitoring and collection of water quality data will be evaluated using the FKC Water Quality Model, a volumetric mass-balance model of the entire FKC. The FKC Water Quality Model will serve as a predictive, water quality forecast tool to assist Friant Contractors and FWA in making real-time operation decisions. The weekly application of this model will require compilation of surface water quality data collected, as described above, as well as forecasts of water orders and periodic model updates.

2. Water quality reporting and communications

IOS will report real-time, continuous FKC in-prism EC measurements. In addition, FWA will cause to be provided a weekly summary report to Friant Contractors and Reclamation on:

- FKC current and forecasted operations;
- FKC current in-prism monitoring and forecasted water quality conditions; and,
- Pertinent pump-in programs' operations and water quality conditions.

E. Implementation Responsibilities and Costs

FWA will be responsible for the following actions:

- Maintain and calibrate conductivity meters
- Perform water quality sampling during pump-in operations
- Coordinate laboratory water quality testing
- Coordinate with Contractors on water quality data monitoring and analysis
- Manage in-prism water quality and manage operations database
- Perform weekly water quality reporting and forecasting using FKC Water Quality Model
- Perform weekly analysis to determine mitigation and distribution to respective Friant Contractors or any other Contractor party(ies) using the FKC Water Quality Mitigation Ledger
- Coordinate with Reclamation's SCCAO on water quality reporting, mitigation, and contractual requirements

- Coordinate and facilitate the work of Water Quality Advisory Committee and the Monitoring Subcommittee.

Costs for implementation and administration of these Guidelines will be initially paid out of the FWA Operation, Maintenance, and Replacement (OM&R) budget, and subsequently will be reimbursed by Contractors. The Contractor will pay a dollar per acre-foot (\$/acre-foot) surcharge (“**Guidelines Surcharge**”) for introduced Non-Millerton water, that will be credited to the FWA OM&R budget. The Guidelines Surcharge will be adopted by the FWA Board of Directors and will be based on an estimate of total annual costs divided by average annual deliveries of pump-in programs into the FKC. The Guidelines Surcharge will be applied to all introduced Non-Millerton water even if mitigation is not required

Annual costs and deliveries will be reassessed every year and compared to estimates provided in Attachment E to determine if any adjustments are required to the Guidelines Surcharge.

Definitions

Contractors: Water contractors and other parties authorized to introduce or receive Non-Millerton water into or from the FKC.

Contracting Officer: The Area Manager of Reclamation's South-Central California Area Office.

Cooperative Agreement: The agreement between FWA and the participating Contractors regarding the establishment, implementation and management of these Guidelines.

CVC: Cross Valley Canal

EC: Salinity measured as electrical conductivity

ELAP: Environmental Laboratory Accreditation Program

Friant Contractors: Friant Division contractors with long-term contracts with Reclamation.

FWA: Friant Water Authority, a California joint powers agency.

Guidelines Surcharge: The surcharge imposed by FWA on Contractors on a per acre feet basis for Non-Millerton water introduced into the FKC to cover the costs of implementing the Guidelines.

IOS: Intellisite Operation System

Ledger: The Water Quality Mitigation Ledger that tracks and accounts for all inflows into and diversions from the FKC in order to determine appropriate mitigation for impacted water quality attributable to the introduced Non-Millerton water.

Maximum Contaminant Level (MCL): Usually reported in milligrams per liter (parts per million) or micrograms per liter (parts per billion).

Non-Millerton water: All water introduced into the Friant-Kern Canal other than directly from Millerton Lake to the headworks of the FKC.

OM&R: Operation, Maintenance and Replacement.

Put: The introduction of Non-Millerton water into the FKC.

Project: The Friant Division of the Central Valley Project, specifically the Friant-Kern Canal.

Reclamation: U.S. Department of the Interior, Bureau of Reclamation.

SCCAO: Reclamation's South-Central California Area Office.

Take: The delivery of Friant Division Class 1, Class 2, Recovered Water Account (RWA [Paragraph 16b]), and Unreleased Restoration Flows supplies.

Taker: A Friant Contractor receiving an eligible Take.

Title 22: The Domestic Water Quality and Monitoring Regulations specified by the State of California Health and Safety Code (Sections 116270-116755), and California Code of Regulations (Sections 6440 et seq.), as amended.

Tables

Table 1. Water Quality Constituents

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The non-Project water discharged into Federal Facilities must comply with the California Drinking Water standards (Title 22)² listed in Table 1. However, selenium thresholds cannot exceed 2 micrograms per liter as defined in Table 4.

Table 1 Title 22 Water Quality Standards

Constituent	Units	MCL	Detection Limit for Reporting	CAS Registry Number	Recommended Analytical Method
Primary					
Aluminum	mg/L	1 ⁽¹⁾	0.05 ⁽²⁾	7429-90-5	EPA 200.7
Antimony	mg/L	0.006 ⁽¹⁾	0.006 ⁽²⁾	7440-36-0	EPA 200.8
Arsenic	mg/L	0.010 ⁽¹⁾	0.002 ⁽²⁾	7440-38-2	EPA 200.8
Asbestos	MFL	7 ⁽¹⁾	0.2 MFL>10µm ⁽²⁾	1332-21-4	EPA 100.2
Barium	mg/L	1 ⁽¹⁾	0.1 ⁽²⁾	7440-39-3	EPA 200.7
Beryllium	mg/L	0.004 ⁽¹⁾	0.001 ⁽²⁾	7440-41-7	EPA 200.7
Cadmium	mg/L	0.005 ⁽¹⁾	0.001 ⁽²⁾	7440-43-9	EPA 200.7
Chromium, total	mg/L	0.05 ⁽¹⁾	0.01 ⁽²⁾	7440-47-3	EPA 200.7
Copper	mg/L	1.3	0.050 ⁽²⁾	7440-50-8	EPA 200.7
Cyanide	mg/L	0.15 ⁽¹⁾	0.1 ⁽²⁾	57-12-5	EPA 335.2
Fluoride	mg/L	2.0 ⁽¹⁾	0.1 ⁽²⁾	16984-48-8	EPA 300.1
Hexavalent Chromium	mg/L	0.010 ⁽¹⁾	0.001 ⁽²⁾	18540-29-9	EPA 218.7
Lead	mg/L	0.015 ⁽⁹⁾	0.005 ⁽²⁾	7439-92-1	EPA 200.8
Mercury	mg/L	0.002 ⁽¹⁾	0.001 ⁽²⁾	7439-97-6	EPA 245.1
Nickel	mg/L	0.1 ⁽¹⁾	0.01 ⁽²⁾	7440-02-0	EPA 200.7
Nitrate (as nitrogen)	mg/L	10 ⁽¹⁾	0.4 ⁽²⁾	7727-37-9	EPA 300.1
Nitrate + Nitrite (sum as nitrogen)	mg/L	10 ⁽¹⁾		14797-55-8	EPA 353.2
Nitrite (as nitrogen)	mg/L	1 ⁽¹⁾	0.4 ⁽²⁾	14797-65-0	EPA 300.1
Perchlorate	mg/L	0.006 ⁽¹⁾	0.004 ⁽²⁾	14797-73-0	EPA 314/331/332
Selenium	mg/L	0.002 ⁽¹⁰⁾	0.001	7782-49-2	EPA 200.8
Thallium	mg/L	0.002 ⁽¹⁾	0.001 ⁽²⁾	7440-28-0	EPA 200.8
Thiobencarb	mg/L	0.07		28249-77-6	EPA 527
Secondary					
Aluminum	mg/L	0.2 ⁽⁶⁾		7429-90-5	EPA 200.7
Chloride	mg/L	500 ⁽⁷⁾		16887-00-6	EPA 300.1
Color	units	15 ⁽⁶⁾			EPA 110
Copper	mg/L	1.0 ⁽⁶⁾	0.050 ⁽⁸⁾	7440-50-8	EPA 200.7
Iron	mg/L	0.3 ⁽⁶⁾		7439-89-6	EPA 200.7
Manganese	mg/L	0.05 ⁽⁶⁾		7439-96-5	EPA 200.7
Methyl-tert-butyl ether (MTBE)	mg/L	0.005 ⁽⁶⁾		1634-04-4	EPA 502.2/524.2
Odor -threshold	units	3 ⁽⁶⁾			SM 2150B
Silver	mg/L	0.1 ⁽⁶⁾		7440-22-4	EPA 200.7
Specific Conductance	µS/cm	1,600 ⁽⁷⁾			SM 2510 B

² California Code of Regulations, Title 22. The Domestic Water Quality and Monitoring Regulations specified by the State of California Health and Safety Code (Sections 4010 4037), and Administrative Code (Sections 64401 et seq.), as amended
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dw_regulations_2019_03_28.pdf

Constituent	Units	MCL	Detection Limit for Reporting	CAS Registry Number	Recommended Analytical Method
Sulfate	mg/L	500 ⁽⁷⁾		14808-79-8	EPA 300.1
Thiobencarb	mg/L	0.001 ⁽⁶⁾		28249-77-6	EPA 527
Total Dissolved Solids	mg/L	1,000 ⁽⁷⁾			SM 2540 C
Turbidity	units	5 ⁽⁶⁾			EPA 190.1/SM2130B
Zinc	mg/L	5.0 ⁽⁶⁾		7440-66-6	EPA 200.7
Other Required Analyses					
Boron	mg/L	2.0 ⁽¹³⁾		7440-42-8	EPA 200.7
Molybdenum	mg/L	0.01 ⁽¹¹⁾		7439-98-7	EPA 200.7
Sodium	mg/L	200 ⁽¹²⁾		7440-23-5	EPA 200.7
Radioactivity					
Gross alpha*	pCi/L	15 ⁽³⁾			SM 7110C
Organic Chemicals					
<i>(a) Volatile Organic Chemicals (VOCs)</i>					
Benzene	mg/L	0.001 ⁽⁴⁾	0.0005 ⁽⁵⁾	71-43-2	EPA 502.2/524.2
Carbon Tetrachloride	mg/L	0.0005 ⁽⁴⁾	0.0005 ⁽⁵⁾	56-23-5	EPA 502.2/524.2
1,2-Dichlorobenzene.	mg/L	0.6 ⁽⁴⁾	0.0005 ⁽⁵⁾	95-50-1	EPA 502.2/524.2
1,4-Dichlorobenzene.	mg/L	0.005 ⁽⁴⁾	0.0005 ⁽⁵⁾	106-46-7	EPA 502.2/524.2
1,1-Dichloroethane	mg/L	0.005 ⁽⁴⁾	0.0005 ⁽⁵⁾	75-34-3	EPA 502.2/524.2
1,2-Dichloroethane	mg/L	0.0005 ⁽⁴⁾	0.0005 ⁽⁵⁾	107-06-2	EPA 502.2/524.2
1,1-Dichloroethylene	mg/L	0.006 ⁽⁴⁾	0.0005 ⁽⁵⁾	75-35-4	EPA 502.2/524.2
cis-1,2-Dichloroethylene	mg/L	0.006 ⁽⁴⁾	0.0005 ⁽⁵⁾	156-59-2	EPA 502.2/524.2
trans-1,2-Dichloroethylene	mg/L	0.01 ⁽⁴⁾	0.0005 ⁽⁵⁾	156-60-5	EPA 502.2/524.2
Dichloromethane.	mg/L	0.005 ⁽⁴⁾	0.0005 ⁽⁵⁾	75-09-2	EPA 502.2/524.2
1,2-Dichloropropane.	mg/L	0.005 ⁽⁴⁾	0.0005 ⁽⁵⁾	78-87-5	EPA 502.2/524.2
1,3-Dichloropropene.	mg/L	0.0005 ⁽⁴⁾	0.0005 ⁽⁵⁾	542-75-6	EPA 502.2/524.2
Ethylbenzene.	mg/L	0.3 ⁽⁴⁾	0.0005 ⁽⁵⁾	100-41-4	EPA 502.2/524.2
Methyl-tert-butyl ether	mg/L	0.013 ⁽⁴⁾	0.003 ⁽⁵⁾	1634-04-4	EPA 502.2/524.2
Monochlorobenzene	mg/L	0.07 ⁽⁴⁾	0.0005 ⁽⁵⁾	108-90-7	EPA 502.2/524.2
Styrene.	mg/L	0.1 ⁽⁴⁾	0.0005 ⁽⁵⁾	100-42-5	EPA 502.2/524.2
1,1,2,2-Tetrachloroethane	mg/L	0.001 ⁽⁴⁾	0.0005 ⁽⁵⁾	79-34-5	EPA 502.2/524.2
Tetrachloroethylene (PCE)	mg/L	0.005 ⁽⁴⁾	0.0005 ⁽⁵⁾	127-18-4	EPA 502.2/524.2
Toluene	mg/L	0.15 ⁽⁴⁾	0.0005 ⁽⁵⁾	108-88-3	EPA 502.2/524.2
1,2,4-Trichlorobenzene	mg/L	0.005 ⁽⁴⁾	0.0005 ⁽⁵⁾	120-82-1	EPA 502.2/524.2
1,1,1-Trichloroethane	mg/L	0.200 ⁽⁴⁾	0.0005 ⁽⁵⁾	71-55-6	EPA 502.2/524.2
1,1,2-Trichloroethane	mg/L	0.005 ⁽⁴⁾	0.0005 ⁽⁵⁾	79-00-5	EPA 502.2/524.2
Trichloroethylene (TCE)	mg/L	0.005 ⁽⁴⁾	0.0005 ⁽⁵⁾	79-01-6	EPA 502.2/524.2
Trichlorofluoromethane	mg/L	0.15 ⁽⁴⁾	0.005 ⁽⁵⁾	75-69-4	EPA 502.2/524.2
1,1,2-Trichloro-1,2,2-Trifluoroethane	mg/L	1.2 ⁽⁴⁾	0.01 ⁽⁵⁾	76-13-1	SM 6200B
Vinyl Chloride	mg/L	0.0005 ⁽⁴⁾	0.0005 ⁽⁵⁾	75-01-4	EPA 502.2/524.2
Xylenes	mg/L	1.750* ⁽⁴⁾	0.0005 ⁽⁵⁾	1330-20-7	EPA 502.2/524.2
<i>(b) Non-Volatile Synthetic Organic Chemicals (SOCs)</i>					
Alachlor	mg/L	0.002 ⁽⁴⁾	0.001 ⁽⁵⁾	15972-60-8	EPA 505/507/508
Atrazine	mg/L	0.001 ⁽⁴⁾	0.0005 ⁽⁵⁾	1912-24-9	EPA 505/507/508
Bentazon	mg/L	0.018 ⁽⁴⁾	0.002 ⁽⁵⁾	25057-89-0	EPA 515.1
Benzo(a)pyrene	mg/L	0.0002 ⁽⁴⁾	0.0001 ⁽⁵⁾	50-32-8	EPA 525.2
Carbofuran	mg/L	0.018 ⁽⁴⁾	0.005 ⁽⁵⁾	1563-66-2	EPA 531.1
Chlordane	mg/L	0.0001 ⁽⁴⁾	0.0001 ⁽⁵⁾	57-74-9	EPA 505/508
2,4-D	mg/L	0.07 ⁽⁴⁾	0.01 ⁽⁵⁾	94-75-7	EPA 515.1

Constituent	Units	MCL	Detection Limit for Reporting	CAS Registry Number	Recommended Analytical Method
Dalapon	mg/L	0.2 ⁽⁴⁾	0.01 ⁽⁵⁾	75-99-0	EPA 515.1
Dibromochloropropane	mg/L	0.0002 ⁽⁴⁾	0.00001 ⁽⁵⁾	96-12-8	EPA 502.2/504.1
Di(2-ethylhexyl)adipate	mg/L	0.4 ⁽⁴⁾	0.005 ⁽⁵⁾	103-23-1	EPA 506
Di(2-ethylhexyl)phthalate	mg/L	0.004 ⁽⁴⁾	0.003 ⁽⁵⁾	117-81-7	EPA 506
Dinoseb	mg/L	0.007 ⁽⁴⁾	0.002 ⁽⁵⁾	88-85-7	EPA 5151-4
Diquat	mg/L	0.02 ⁽⁴⁾	0.004 ⁽⁵⁾	85-00-7	EPA 549.2
Endothall	mg/L	0.1 ⁽⁴⁾	0.045 ⁽⁵⁾	145-73-3	EPA 548.1
Endrin	mg/L	0.002 ⁽⁴⁾	0.0001 ⁽⁵⁾	72-20-8	EPA 505/508
Ethylene Dibromide	mg/L	0.00005 ⁽⁴⁾	0.00002 ⁽⁵⁾	106-93-4	EPA 502.2/504.1
Glyphosate (Roundup)	mg/L	0.7 ⁽⁴⁾	0.025 ⁽⁵⁾	1071-83-6	EPA 547
Heptachlor.	mg/L	0.00001 ⁽⁴⁾	0.00001 ⁽⁵⁾	76-44-8	EPA 508
Heptachlor Epoxide	mg/L	0.00001 ⁽⁴⁾	0.00001 ⁽⁵⁾	1024-57-3	EPA 508
Hexachlorobenzene	mg/L	0.001 ⁽⁴⁾	0.0005 ⁽⁵⁾	118-74-1	EPA 505/508
Hexachlorocyclopentadiene	mg/L	0.05 ⁽⁴⁾	0.001 ⁽⁵⁾	77-47-4	EPA 505/508
Lindane (gamma-BHC)	mg/L	0.0002 ⁽⁴⁾	0.0002 ⁽⁵⁾	58-89-9	EPA 505/508
Methoxychlor	mg/L	0.03 ⁽⁴⁾	0.01 ⁽⁵⁾	72-43-5	EPA 505/508
Molinate	mg/L	0.02 ⁽⁴⁾	0.002 ⁽⁵⁾	2212-67-1	EPA 525.1
Oxamyl	mg/L	0.05 ⁽⁴⁾	0.02 ⁽⁵⁾	23135-22-0	EPA 531.1
Pentachlorophenol	mg/L	0.001 ⁽⁴⁾	0.0002 ⁽⁵⁾	87-86-5	EPA 515.1-3
Picloram	mg/L	0.5 ⁽⁴⁾	0.001 ⁽⁵⁾	1918-02-1	EPA 515.1-3
Polychlorinated Biphenyls	mg/L	0.0005 ⁽⁴⁾	0.0005 ⁽⁵⁾	1336-36-3	EPA 130.1
Simazine	mg/L	0.004 ⁽⁴⁾	0.001 ⁽⁵⁾	122-34-9	EPA 505
Thiobencarb (Bolero)	mg/L	0.07 ⁽⁴⁾	0.001 ⁽⁵⁾	28249-77-6	EPA 527
Toxaphene	mg/L	0.003 ⁽⁴⁾	0.001 ⁽⁵⁾	8001-35-2	EPA 505
1,2,3-Trichloropropane	mg/L	0.000005 ⁽⁴⁾	0.000005 ⁽⁵⁾	96-18-4	SRL 524M
2,3,7,8-TCDD (Dioxin)	mg/L	3 x 10 ⁻⁸ ⁽⁴⁾	5 x 10 ⁻⁹ ⁽⁵⁾	1746-01-6	EPA 130.3
2,4,5-TP (Silvex)	mg/L	0.05 ⁽⁴⁾	0.001 ⁽⁵⁾	93-72-1	EPA 515.1
<i>Other Organic Chemicals</i>					
Chlorpyrifos	µg/L	0.015 ⁽¹¹⁾		2921-88-2	EPA 8141A
Diazinon	µg/L	0.10 ⁽¹¹⁾		333-41-5	EPA 8141A

Sources:

- Recommended Analytical Methods: <https://www.nemi.gov/home/>
- Maximum Contaminant Levels (MCL): Title 22. The Domestic Water Quality and Monitoring Regulations specified by the State of California Health and Safety Code (Sections 4010-4037), and Administrative Code (Sections 64401 et seq.), as amended.
- (1) Title 22. Table 64431-A Maximum Contaminant Levels, Inorganic Chemicals
- (2) Title 22. Table 64432-A Detection Limits for Reporting (DLRs) for Regulated Inorganic Chemicals
- (3) Title 22. Table 64442 Radionuclide Maximum Contaminant Levels (MCLs) and Detection Levels for Purposes of Reporting (DLRs)
- (4) Title 22. Table 64444-A Maximum Contaminant Levels, Organic Chemicals
- (5) Title 22. Table 64445.1-A Detection Limits for Purposes of Reporting (DLRs) for Regulated Organic Chemicals
- (6) Title 22. Table 64449-A Secondary Maximum Contaminant Levels "Consumer Acceptance Contaminant Levels"
- (7) Title 22. Table 64449-B Secondary Maximum Contaminant Levels "Consumer Acceptance Contaminant Level Ranges"
- (8) Title 22. Table 64678-A DLRs for Lead and Copper
- (9) Title 22. Section 64678 (d) Lead Action level
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dw_regulations_2019_03_28.pdf
- California Regional Water Quality Control Board, Central Valley Region, Fourth Edition of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins. Revised June 2015
- (10) Basin Plan, Table III-1 (ug/L) (selenium in Grasslands water supply channels)
- (11) Basin Plan, Table III-2A. 4-day average (chronic) concentrations of chlorpyrifos & diazinon in San Joaquin River from Mendota to Vernalis
https://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_op_pesticide/
- Ayers, R. S. and D. W. Westcot, Water Quality for Agriculture, Food and Agriculture Organization of the United Nations - Irrigation and Drainage Paper No. 29, Rev. 1, Rome (1985).
- (12) Ayers, Table 1 (mg/L) (sodium)
- (13) Ayers, Table 1 (mg/L) (boron)
<http://www.fao.org/3/T0234E/T0234E00.htm>
- (14) Requested by State Water contractors, no MCL specified.

- California Regional Water Quality Control Board. PFAS Per-and Polyfluoroalkyl Substances. (15) Testing Methods in California Drinking Water
<https://www.waterboards.ca.gov/pfas/>

Table 2. Check Structure Locations for Real-Time Measurements of Electrical Conductivity

Check Structure	Milepost
Little Dry Creek	5.50
Kings River	28.52
Sand Creek	46.04
Dodge Ave	61.03
Kaweah River	71.29
Rocky Hill	79.25
Fifth Ave	88.22
Tule River	95.67
Deer Creek	102.69
White River	112.90
Reservoir (Woollomes)	121.51
Poso Creek	130.03
Shafter	137.20
Kern River	151.81

Table 3. Friant-Kern Canal In-Prism Water Quality Thresholds

Period	Salinity expressed as EC ($\mu\text{S}/\text{cm}$)	Chloride (mg/L)	Boron (mg/L) ¹	Turbidity (NTU) ⁶	Total Suspended Solids (ppm) ⁶	SAR ⁷	Sodium (mg/L) ⁷
Period 1 March 1 – June 30	1,000 ²	102 ³	0.4	40	20	3	69
Period 2 July 1 – August 31	500 ⁴	55 ⁴	0.4	40	20	3	69
Period 3a September 1 – February 28	1,000 ²	102 ³	0.4	40	20	3	69
Period 3b September 1 – February 28	1,000 ²	123 ⁵	0.4	40	20	3	69

Notes:

Thresholds adapted from Grieve, C.M., S.R. Grattan and E.V. Maas. 2012. Plant salt tolerance. In. (W.W. Wallender and K.K. Tanji, eds). Agricultural Salinity Assessment and Management (2nd edition). ASCE pp 405-459; and Ayers, R.S. and D.W. Westcot 1985. Water quality for agriculture. FAO Irrigation and Drainage Paper 29 (rev 1). Food and Agriculture Organization of the United Nations. Rome

For addition detail, see Attachment C – Agronomic Impacts and Mitigation.

When Friant-Kern Canal in-prism water quality conditions in this table are exceeded, Friant Division Long-Term Contractors will work together to seek 1:1, unleveraged, and cost-neutral exchanges for pump-in and pump-back programs. This does not apply to spot-market or third-party exchanges.

¹ Grapes are used as a representative crop for boron sensitivity and are prevalent in the Friant Division. They are used as a surrogate for many other sensitive crop types such as apricots, figs, and grapefruits. Threshold assumes conventional irrigation with minimum 20 percent leaching fraction applied.

² Threshold assumes minimum of 20 percent leaching requirement applied and adjusted to account for regulated deficit irrigation during almond hull split period (July 1 – August 31) to not exceed maximum EC_{et} . Almonds on Nemaguard rootstock are used as a representative crop for salinity sensitivity and are prevalent in the Friant Division. They are used as a surrogate for many other sensitive crop types such as apples, cherries, pears, pistachios, and walnuts.

³ Threshold assumes minimum of 20 percent leaching requirement applied and then adjusted to account for regulated deficit irrigation during almond hull split period (July 1 – August 31) to not exceed maximum Cl_{et} . Almonds on Nemaguard rootstock used as a representative crop for chloride sensitivity. They are used as a surrogate for other sensitive crops including cherries, pistachios, and walnuts. If the measured average chloride concentration for Period 1 exceeds 70 mg/L, the chloride threshold remains at 102 mg/L.

⁴ Threshold applies to almond hull split period when regulated deficit irrigation is applied to avoid hull rot. This threshold is used assuming irrigation applications are reduced to 50 percent of the tree water requirement and subsequently thresholds applied for the remainder of the year have been adjusted to account for additional salt accumulation. This threshold was developed with consideration of existing program operations, historical water quality data, and absolute water quality thresholds.

⁵ If the measured average chloride concentration in Period 1 (March 1 – June 30) is less than or equal to 70 mg/L, the allowable chloride threshold for Period 3 (September 1 – February 28) is increased to 123 mg/L.

⁶ Applied TSS and turbidity thresholds from section 3 of the Final Initial Study/Negative Declaration for: Warren Act Contract and License, and Operation and Maintenance Agreement to Introduce Floodwaters from Reclamation District 770 into the Friant-Kern Canal, March 2017. Additional detail provided in Attachment C – Agronomic Impacts and Mitigation

⁷ SAR and Sodium are managed together. If the measured SAR value exceeds 3 AND the measured sodium concentration exceeds a threshold of 69 mg/L, management will be necessary. SAR is derived from Ayers Table 1 and assumes surface irrigation. The sodium threshold is also derived from Ayers Table 1 and suggests that irrigation waters <3 meq/L (69 mg/L) is suitable for crops that are sprinkler irrigated.

Key:

$\mu\text{S}/\text{cm}$ = microsiemens per centimeter (1 $\mu\text{S}/\text{cm}$ = 1 $\mu\text{mhos}/\text{cm}$ = 1/1,000 dS/m)

ASCE = American Society of Civil Engineers

Cl_{et} = maximum chloride threshold of the saturated soil paste

EC = electrical conductivity of applied water

EC_{et} = Soil salinity threshold for a given crop

FAO = Food and Agriculture Organization of the United Nations

Friant Division = Friant Division of the Central Valley Project

mg/L = milligrams per liter

SAR = sodium adsorption ratio

TDS = total dissolved solids

Table 4: Friant-Kern Canal Water Quality Constituents Short List

Constituent	Units	Thresholds
1,2,3 TCP	(µg/L)	0.005
Arsenic	(mg/L)	0.010
Bicarbonate	(mg/L)	--
Boron	(mg/L)	See Table 3
Bromide	(mg/L)	--
Calcium	(mg/L)	--
Chloride	(mg/L)	See Table 3
Chromium, total	(mg/L)	0.05
Hexavalent chromium	(mg/L)	0.010
Iron	(µg/L)	300
Magnesium	(mg/L)	--
Manganese	(µg/L)	50
Nitrate	(mg/L)	10
pH		--
SAR		See Table 3
Salinity (as EC)	(µS/cm)	See Table 3
Selenium	(µg/L)	2
Sodium	(mg/L)	See Table 3
Sulfate	(mg/L)	500
TDS	(mg/L)	-- *
Total Organic Carbon	(mg/L)	--
TSS	(ppm)	See Table 3
Turbidity	(NTU)	See Table 3
Gross alpha	pCi/L	15

Notes:

Thresholds are Title 22 MCLs unless otherwise noted.

Constituent with threshold denoted as "--" do not have an established MCL.

Refer to Table 1 and Notes for Table 1 for additional details.

*TDS MCL not listed for the purposes of these Guidelines. TDS and EC are both a measure of salinity and the EC thresholds shown in Table 3 are controlling.

Attachment A. Water Quality Advisory Committee Charter

Background and Objective

The Guidelines for Accepting Water into the Friant-Kern Canal (“Guidelines”) were adopted by the Friant Water Authority (FWA) based on the voluntary consensus of and written agreement with a significant majority of the contractors of the Friant Division of the Central Valley Project (“Friant Division”). The Guidelines address concerns regarding the implementation of programs and projects that could introduce water of a lesser quality to the Friant-Kern Canal (“FKC”), when compared to water quality of historic deliveries from Millerton Lake. The Guidelines include water quality constituent thresholds based on agronomic principles and a ledger mechanism to determine the required mitigation for introducing water of lesser quality into the FKC.

The Guidelines provide that FWA will appoint a Water Quality Advisory Committee (“Committee”) composed of Friant Division long-term contractors (“Friant Contractors”) involved in either introducing water to or receiving water from the FKC. The Committee will provide recommendations to FWA and Reclamation on operations and water quality monitoring requirements of the FKC as well as potential revisions to the Guidelines. This document describes Committee membership and Committee roles and responsibilities.

Water Quality Advisory Committee Membership

The appointed Committee will be composed of Friant Contractors who may either be introducing water to or receiving water from the FKC. Committee membership is described in Table 1. New members in replacement of an existing member or as a new addition to the membership list requires majority approval following notice to and the consent of the FWA Board of Directors.

Table 1. Water Quality Advisory Committee Membership

Members
Arvin-Edison Water Storage District
Delano-Earlimart Irrigation District
Kern-Tulare Water District

Lindsay Strathmore Irrigation District
Lower Tule River Irrigation District
Pixley Irrigation District
Porterville Irrigation District
Saucelito Irrigation District
Shafter Wasco Irrigation District
South San Joaquin Municipal Utility District
Terra Bella Irrigation District

Roles and Responsibilities

The Committee will convene on an annual basis prior to the irrigation season or planned reverse flow operations. The Committee will:

- Evaluate current year operations related to Guidelines implementation including but not limited to Ledger operation modifications, potential schedule changes, and potential changes to mitigation deliveries.
- Review and approve annual monitoring.
- Make recommendations regarding the costs and budgets associated with administering and implementing the Guidelines.

The Committee may also convene on an as needed basis under the following conditions:

- When Friant Division Class 1 contract allocation is less than or equal to 25 percent.
- If a future regulatory cost or equivalent fee is imposed on Friant Contractors and a portion of such fee can reasonably be attributed to the incremental difference of water quality conditions in the FKC.
- If there is a significant, scientifically based justification and three out of the following five water contractors agree that a change to Guideline principles and/or criteria should be discussed: Arvin-Edison Water Storage District, Shafter Wasco Irrigation District, Delano-Earlimart Irrigation District, South San Joaquin Municipal Utility District, or Kern-Tulare Water District.

- If FKC water quality continuously exceeds one or more constituent thresholds and pump-in operations must cease.

The Committee will make recommendations to the FWA Board via consensus decision making. If 100% consensus cannot be reached, a recommendation will be made, and minority viewpoints will also be communicated. The Committee will provide all recommendations to the FWA Board. Single-year modifications to Guidelines implementation, monitoring, and/or pump-in operations will be noticed to all Friant Contractors. Recommendations requiring substantial modifications or updates to the Guidelines will be provided to the FWA Board and the FWA will coordinate with Reclamation to implement recommended changes.

Monitoring Subcommittee

The Committee will appoint at least three and no more than five representatives of its members to serve on a Monitoring Subcommittee that will coordinate with FWA on the implementation of the Guidelines particularly with respect to potential or actual exceedance of the water quality thresholds established under these Guidelines and the implementation of required mitigation, including the reduction of discharges of Non-Millerton water into the FKC. The Subcommittee will make recommendations to FWA in accordance with Section B.2.d above, but the final operational decisions will be made by FWA.

Attachment B. Monitoring Program Summary

Summary of requirements for monitoring campaign specified in the Guidelines for Accepting Water into the Friant-Kern Canal

Sample Source/Type		Trigger	Constituents/Bacterial Organisms	Frequency	Location	Communication
<i>Source of Discharge Water</i>						
1	Non-Millerton Lake Source	Routine sampling.	All in Table 1	Every three years	Discharge Location.	Reported to FWA and Reclamation FKC's Contracting Office for review. FWA will report to Friant contractors.
2	Non-Millerton Lake Source	Routine sampling.	All in Table 4	Annually	Discharge Location.	
3	Non-Millerton Lake Source	If routine sampling of Table 4 water quality constituents shows exceedance of an established threshold buffer. **	Any in Table 4 exceeding the established threshold buffer.	Weekly for targeted constituents of concern, until four consecutive tests show consistent water quality results.	Discharge Location.	
4	Non-Millerton Lake Source	Reclamation on a case-by-case basis per condition of program operations.	Any	Any	Any	
<i>Blended Canal Water</i>						
5	FKC Water	Routine sampling (continuous).	EC	Real-time, Every 15 minutes	Check structures and mile posts in Table 2	Uploaded to FWA's IOS. FWA will regularly calibrate equipment.
6	FKC Water	If Friant Water Quality Model forecasts exceedance of an established threshold buffer. **	Any in Table 4 exceeding the established threshold buffer.	Weekly. Until sampled data, supported through modeling, show four consecutive tests below the established threshold buffer.	Check structures and mile posts in Table 2, where water quality changes are expected.	FWA will deliver to ELAP certified lab. Forecasted and measured in-prism water quality will be communicated by FWA to Friant contractors.
7	FKC Water	Specific operation disruptions (servicing of real-time equipment, unexpected outages, etc.).	EC	Any	Any	
8	CVC	Reverse-flow, and pump-back operations.	All in Table 4	Weekly	CVC, near Intertie	FWA will deliver to ELAP certified lab. Water quality data will be communicated via FWA's IOS.
9	CVC	Initiation of pump-back operations, and/or anticipated that CVC operations will significantly change water quality	All in Table 1 and Table 4	As needed	CVC, near Intertie	FWA will deliver to ELAP certified lab. Water quality data will be communicated via FWA's IOS.

Notes: References to tables above (Table 1, 2, 4) from Friant Water Authority draft Guidelines for Accepting Water into the Friant-Kern Canal.

**Threshold buffers that will trigger continued monitoring are 80% of the thresholds established in Table 4.

Key:

EC = electrical conductivity

CVC = Cross Valley Canal

ELAP = Environmental Laboratory Accreditation Program

FKC = Friant-Kern Canal

IOS = Intellisite Operation System

Reclamation = U.S. Department of the Interior, Bureau of Reclamation

Attachment C. Agronomic Impacts and Mitigation

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ACRONYMS AND ABBREVIATIONS

$\mu\text{mhos/cm}$	micromhos per centimeter ($1 \mu\text{mhos/cm} = 1 \mu\text{S/cm} = 1/1,000 \text{ dS/m}$)
$\mu\text{S/cm}$	microsiemens per centimeter ($1 \mu\text{S/cm} = 1 \mu\text{mhos/cm} = 1/1,000 \text{ dS/m}$)
Ad hoc Committee	Ad hoc Water Quality Committee
AEWSD	Arvin-Edison Water Storage District
ATP	adenosine triphosphate
AW	applied water
B	boron
B_e	boron concentration of the saturated soil paste (rootzone boron)
B_{et}	maximum boron threshold of the saturated soil paste
B_w	boron concentration of applied irrigation water
B_{sw}	boron threshold for soil water concentration
Ca	calcium
Ca^{2+}	calcium ion
CaCO_3	calcite or calcium carbonate
cfs	cubic feet per second
Check 21	Check Structure 21 at milepost 172,40 on the California Aqueduct
Cl^-	chloride ion
Cl_e	chloride concentration of the saturated soil paste (rootzone chloride)
Cl_{et}	maximum chloride threshold of the saturated soil paste
Cl_w	chloride concentration of applied irrigation water
CO_2	carbon dioxide
CO_3^{2-}	carbonate ion
CVC	Cross Valley Canal
DEID	Delano-Earlimart Irrigation District
dS/m	deciSiemens per meter ($1 \text{ dS/m} = 1,000 \mu\text{mhos/cm} = 1,000 \mu\text{S/cm}$)
EC	electrical conductivity
EC_e	electrical conductivity of the saturated soil paste (rootzone salinity)
EC_{dw}	electrical conductivity/salinity of irrigation drainage water
EC_w	electrical conductivity/salinity of applied irrigation water
ET	evapotranspiration
F_c	concentration factor
FKC	Friant-Kern Canal
Friant Division	Friant Division of the Central Valley Project
FWA	Friant Water Authority

HCO ₃ ⁻	bicarbonate
Intermediate	Water quality representing the average of California Aqueduct Check 21 and Cross Valley Canal water qualities
KTWD	Kern Tulare Water District
LF	leaching fraction
LR	leaching requirement
Mg ²⁺	magnesium ion
Mg	magnesium
meq/L	milliequivalents per liter
mg/L	milligrams per liter (equivalent to ppm)
Na ⁺	sodium ion
Na	sodium
pH	Measure of acidity or alkalinity
Policy	Friant-Kern Canal Water Quality Policy
ppm	parts per million (equivalent to mg/L)
RDI	regulated deficit irrigation
SAR	sodium adsorption ratio
SAR _{adj}	adjusted sodium adsorption ratio
SID	Saucelito Irrigation District
SSJMUD	South San Joaquin Municipal Utility District
SWID	Shafter-Wasco Irrigation District
TDS	total dissolved solids

BACKGROUND

The Guidelines for Accepting Water into the Friant-Kern Canal (Guidelines) were developed in response to concerns regarding the implementation of programs and projects that could introduce water of a lesser quality to the Friant-Kern Canal (FKC), when compared to water quality of historic deliveries from Millerton Lake. The Guidelines define requirements for discharging water into the FKC, water quality monitoring and reporting requirements, mitigation requirements, and forecasting and communication protocols. The Guidelines propose a ledger mechanism to determine the required mitigation for introducing water of lesser quality into the FKC. This attachment to the Guidelines provides additional information on agronomic effects, mitigation requirements, and approach for defining maximum water quality thresholds for key constituents. The thresholds are specific to irrigation periods that correspond to the growing season and agricultural management practices during the year.

AGRONOMIC EFFECTS

When assessing the suitability of water for irrigation, three main hazards or “agronomic thresholds” are considered (Ayers and Westcot, 1985): (1) the salinity hazard (electrical conductivity of the applied irrigation water [EC_w]), (2) the hazard posed by specific ions (chloride [Cl⁻], boron [B], and sodium [Na⁺]), and (3) the infiltration hazard (sodium adsorption ratio [SAR] and EC_w). There are other parameters, such as acidity (pH) or alkalinity, sediments and nutrients that can affect calcite (CaCO₃) deposits, emitter clogging, crop development, and corrosion, but these do not fall under “agronomic thresholds.”

The primary source of imported water is proposed to come from the Friant-Kern Canal/Cross Valley Canal Intertie (Intertie) and conveyed via reverse-flow, pump-back operations. Water being introduced at the Intertie might include previously banked groundwater of Kern Fan water quality, Cross Valley Contract supplies, recaptured and recirculated San Joaquin River Restoration Program Restoration Flows, and other colors. Water quality conditions from the Cross Valley Canal (CVC) could range from existing conditions in the Cross Valley Canal (CVC) to that from the California Aqueduct, depending on respective canal operations. For the analysis presented herein, both CVC and California Aqueduct (measured at Check 21) water qualities were used, as well as a weighted average of those two sources (Intermediate) applied to show the range of potential imported water qualities. Source water quality concentrations are shown in Table 1 and Table 2.

Table 1. Average Concentrations of Various Irrigation Water Quality Constituents

LOCATION	WATER QUALITY CONSTITUENTS			
	TDS (/L)	EC _w (µS/cm)	Boron (B) (mg/L)	Chloride (Cl ⁻) (mg/L)
FKC ^{1,2}	24	40	0.04	1.9
CVC ^{1,3}	180	340	0.11	45.0
Intermediate ⁴	232	420	0.16	63.2
Check 21 ⁵	283	500	0.21 ⁶	81.3

Note:

¹ Water quality data from AEWS D grab samples lab data from 2010 – 2019. Averages exclude months when mixing occurred.

² Sample taken at terminus of FKC.

³ Sample taken at AEWS D CVC, Pumping Plant 6 or 6B Forebay.

⁴ Weighted average of CVC and Check 21 water quality.

⁵ California Aqueduct measured at Check 21 from 2009-2017.

⁶ Check 21 Boron measurements only available for years 1967 – 1976.

Key:

AEWS D = Arvin Edison Water Storage District

Check 21 = Check Structure 21 at milepost 172,40 on the California Aqueduct

CVC = Cross Valley Canal

µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)

EC_w = electrical conductivity of applied water

FKC = Friant-Kern Canal

Intermediate = Water quality representing the average of California Aqueduct Check 21 and Cross Valley Canal water qualities

mg/L = milligrams per liter

TDS = total dissolved solids

Table 2. Average Monthly Electrical Conductivity, Chloride, and Boron Concentrations by Source and Year Type

MONTH	CVC ¹			CHECK 21 ²		
	Wet ³	Average ⁴	Dry ⁵	Wet ⁶	Average ⁴	Critical ⁷
Average Monthly Electrical Conductivity Concentrations by Source and Year Type (µS/cm)						
January	431	369	287	309	523	598
February	570	433	378	269	551	680
March	261	273	275	248	545	671
April	240	270	277	255	500	616
May	--	306	306	195	479	575
June	385	384	383	174	471	597
July	257	292	307	206	385	542
August	286	308	335	249	425	643
September	323	326	329	247	524	689
October	429	360	315	539	573	628
November	396	356	330	480	529	614
December	368	349	337	532	554	624
Average Monthly Chloride Concentrations by Source and Year Type (mg/L)						
January	74.5	54.4	27.7	34.0	84.5	99.0
February	104.0	63.0	46.6	31.5	87.4	104.3
March	21.0	21.8	22.0	27.5	82.9	104.3
April	19.0	21.4	22.0	33.5	72.1	100.0
May	--	31.4	31.4	25.0	73.0	88.7
June	48.5	46.1	45.2	19.0	73.4	98.3
July	28.5	33.7	35.8	25.5	55.8	84.0
August	39.6	40.7	42.0	31.0	70.3	109.0
September	53.0	48.4	43.8	22.0	92.6	116.7
October	76.0	55.0	41.0	105.5	101.6	106.7
November	68.5	54.8	45.7	90.5	86.8	95.7
December	55.5	46.7	40.8	101.0	95.5	103.0
Average Monthly Boron Concentrations by Source and Year Type (mg/L)⁸						
January	0.12	0.11	0.10	0.23	0.20	0.20
February	0.16	0.15	0.14	0.30	0.26	0.25
March	0.10	0.11	0.11	0.33	0.31	0.30
April	0.11	0.12	0.12	0.30	0.29	0.10
May	--	0.12	0.12	0.27	0.25	0.20
June	0.16	0.15	0.14	0.20	0.18	0.20
July	0.11	0.11	0.12	0.13	0.16	0.20
August	0.09	0.10	0.12	0.10	0.19	0.20
September	0.08	0.09	0.11	0.10	0.16	0.10
October	0.11	0.10	0.09	0.25	0.19	0.15
November	0.11	0.11	0.11	0.20	0.18	0.15
December	0.11	0.11	0.12	0.20	0.19	0.15

Note:

¹ Water quality data from AEWSD grab samples lab data from 2010 – 2019.

² California Aqueduct measured at Check 21 from 2009-2017.

³ CVC wet year averages represent the monthly average for San Joaquin Index year types below normal, above normal, and wet and excludes months where there is mixing.

⁴ Average concentrations shown represent the average of all year types and excludes months where there is mixing.

⁵ CVC dry year averages represent the monthly average for San Joaquin Index year types dry and critical and excludes months where there is mixing.

⁶ Check 21 wet year averages represent the monthly average for San Joaquin Index wet year types only.

⁷ Check 21 critical year averages represent the monthly average for San Joaquin Index critical years only.

⁸ Check 21 Boron measurements represent years 1967 – 1976 per available data.

Key:

-- = no available data. CVC water quality in wet years during May were only mixed water quality.

AEWSD = Arvin-Edison Water Storage District

Check 21 = Check Structure 21 at milepost 172,40 on the California Aqueduct

CVC = Cross Valley Canal

µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)

mg/L = milligrams per liter

SALINITY EFFECTS ON CROPS

The effects of salinity on crops are due to two separate properties in the saline media that can impact the crop individually but more often collectively (Läuchli and Grattan, 2012): (1) Salinity increases the electrical conductivity (EC) of the soil solution which reduces its the osmotic potential and (2) specific ions (i.e. Cl⁻, Na⁺ and B) in the soil solution can potentially be toxic to certain crops.

Osmotic effects occur when the concentration of salt in the soil solution is too high to allow for normal for crop growth. Dissolved salts reduce the osmotic potential of the soil solution. Plants must adjust osmotically through either the absorption of ions from the soil solution, or the synthesis and/or accumulation of organic solutes in the root cells. The synthesis of compatible organic solutes allows a plant to adjust osmotically and survive, but at the expense of plant growth (Munns and Tester, 2008). The synthesis of organic solutes requires a considerable amount of metabolic energy (i.e., adenosine triphosphate (ATP)) that is used for cell maintenance and osmotic adjustment that could otherwise be used for growth. As a result, salt-stressed plants are stunted, even though they may appear healthy in all other regards. Both processes of adjustment (accumulation of ions and synthesis of organic solutes) occur but the extent by which one process dominates depends on the type of crop and level of salinity (Läuchli and Grattan, 2012). And in a cell, compartmentalization is critical to keep toxic ions away from sensitive metabolic processes in the cytoplasm (Hasegawa et al., 2000). Such compartmentation is controlled by transport processes in the plasma membrane and tonoplast (i.e., vacuolar membrane). The efficiency of ion transport processes, as well as metabolic costs for organic-solute synthesis, differ from crop to crop and even within a species giving rise to different salinity tolerances.

TOXIC ION EFFECTS

Specific ions (i.e., Na⁺, Cl⁻, and B) in the soil solution can cause direct injury to crops, causing further crop damage from what occurs from osmotic effects. Typically, toxic ion effects are commonly found in woody perennials, such as tree and vine crops, while most annual row crops remain injury free unless salinity stress is severe. Woody perennial crops have little ability to exclude sodium or chloride from their leaves, and the plants are long-lived; hence, they often suffer toxicities at even moderate soil salinities. Typically, toxic ion effects become more critical to sensitive tree and vine crops over the years.

Chloride

Chloride and sodium toxicity can damage a plant/tree physically, biochemically and physiologically. As sodium and chloride move in the transpiration stream, they are deposited in the leaves. Older leaves have more water transpire from them and consequently have higher concentrations of sodium and chloride. Once accumulated in a leaf, sodium and chloride typically do not remobilize to other tissues. As the concentration in that leaf increases, the salts can physically desiccate cells causing injury in the form of leaf burn. Necrotic leaves no longer photosynthesize and produce carbohydrates for the tree, which in turn, will impact growth and production. But even before salts accumulate in leaves to levels that cause physical injury, those salts can reduce the chlorophyll content in leaves (Dejampour et al., 2012) and interfere with enzymatic activities affecting key metabolic pathways in both respiration and photosynthesis (Munns and Tester, 2008).

Boron

Although not a main “salinizing” constituent in applied irrigation water, boron can also cause injury to the crop. Boron is an essential micronutrient for plants, but the concentration range of plant-available boron in the soil solution optimal for growth for most crops is very narrow. Above this narrow range, toxicity occurs (Grieve et al., 2012). Boron toxicity, including how and where it is expressed in the plant, is related to the mobility of boron in the plant. Boron is thought to be immobile in most species where it accumulates in the margins and tips of the oldest leaves where injury occurs. However, boron can be re-mobilized by some species due to high concentrations of sugar alcohols (polyols) where they bind with boron and carry it to younger tissues (Brown and Shelp, 1997). These boron-mobile plants include almond, apple, grape, and most stone fruits. For these crops, boron concentrations are higher in younger tissue than in older tissue, and injury is expressed in young, developing tissues in the form of twig die back, gum exudation, and reduced

bud formation. Boron-immobile plants such as pistachio, tomato, and walnut do not have high concentrations of polyols, and the boron concentrates in the margins of older leaf tissues. Injury in these crops is expressed as the classical necrosis on leaf tips and margins.

Sodium

Sodium can be problematic to a crop in several ways. It can be directly toxic to the plant, it can interfere with the nutritional status of the plant (e.g., Na⁺-induced calcium [Ca²⁺] deficiency), or it can indirectly affect the crop due to its adverse effect on soil structure. Some trees are very sensitive and can develop Na⁺ toxicity when concentrations of Na⁺ are as low of 5 milliequivalents per liter (meq/L) (115 mg/L) in the soil water. However, this observation was made before scientists realized the importance of adequate Ca²⁺ in the soil water for root membrane stability to maintain their selectivity for ion uptake. With adequate Ca²⁺, such as that provided by gypsum applications, sodium toxicity may never be observed in these sensitive trees at such low sodium concentrations. Therefore, rather than having a threshold for Na⁺ per se, the sodium-calcium ratio in the soil solution is a better indicator of Na⁺ toxicity. The SAR of the applied irrigation water has been used as a surrogate for the sodium-calcium ratio, and the general rule is an SAR < 3 is not problematic.

$$SAR = \frac{Na^+}{\sqrt{\frac{(Ca^{2+} + Mg^{2+})}{2}}}$$

Where Na⁺, Ca²⁺, and magnesium ion (Mg²⁺) concentrations are expressed in meq/L.

This is different when assessing sodium’s indirect effect on soil structural stability (see the Infiltration Hazard section that follows). Table 3 shows critical SAR of the applied irrigation water above which can cause injury or nutritional distress in sensitive crops. Table 4 shows the seasonal average SAR for various water sources.

Table 3. Critical SAR of Applied Irrigation Water

CROP ¹	CRITICAL SAR OF APPLIED IRRIGATION WATER
All Crops	< 3

Note:

¹ Many tree crops are sensitive to Na⁺ toxicity after several years when sapwood converts to heartwood releasing Na⁺ from the root to the shoot. Most annual crops are insensitive to Na⁺ per se provided there is sufficient Ca²⁺ in the soil solution to maintain membrane integrity and ion selectivity. Hence, the ratio of sodium to calcium is more critical (Grattan and Grieve, 1992).

Key

Ca²⁺ = calcium ions

Na⁺ = sodium ions

SAR = sodium adsorption ratio

Table 4. Seasonal Average SAR for Various Water Sources

VALUE ¹	FKC ^{2, 3}	CVC ^{2, 4}	INTERMEDIATE ⁵	CHECK 21 ⁶
Average	0.46	1.68	1.99	2.27
Maximum	0.87	2.04	2.46	2.96
Minimum	0.28	1.10	1.61	1.79

Note:

¹ March through October period.

² Water quality data from AEWS D grab samples lab data from 2011 – 2017.

³ Sample taken at terminus of FKC.

⁴ Sample taken at AEWS D CVC, Pumping Plant 6 or 6B Forebay.

⁵ Weighted average of CVC and Check 21 water quality.

⁶ California Aqueduct measured at Check 21 from 1968-2017.

Key

AEWS D = Arvin Edison Water Storage District

Check 21 = Check Structure 21 at milepost 172,40 on the California Aqueduct

CVC = Cross Valley Canal

FKC = Friant-Kern Canal

Intermediate = Water quality representing the average of California Aqueduct Check 21 and Cross

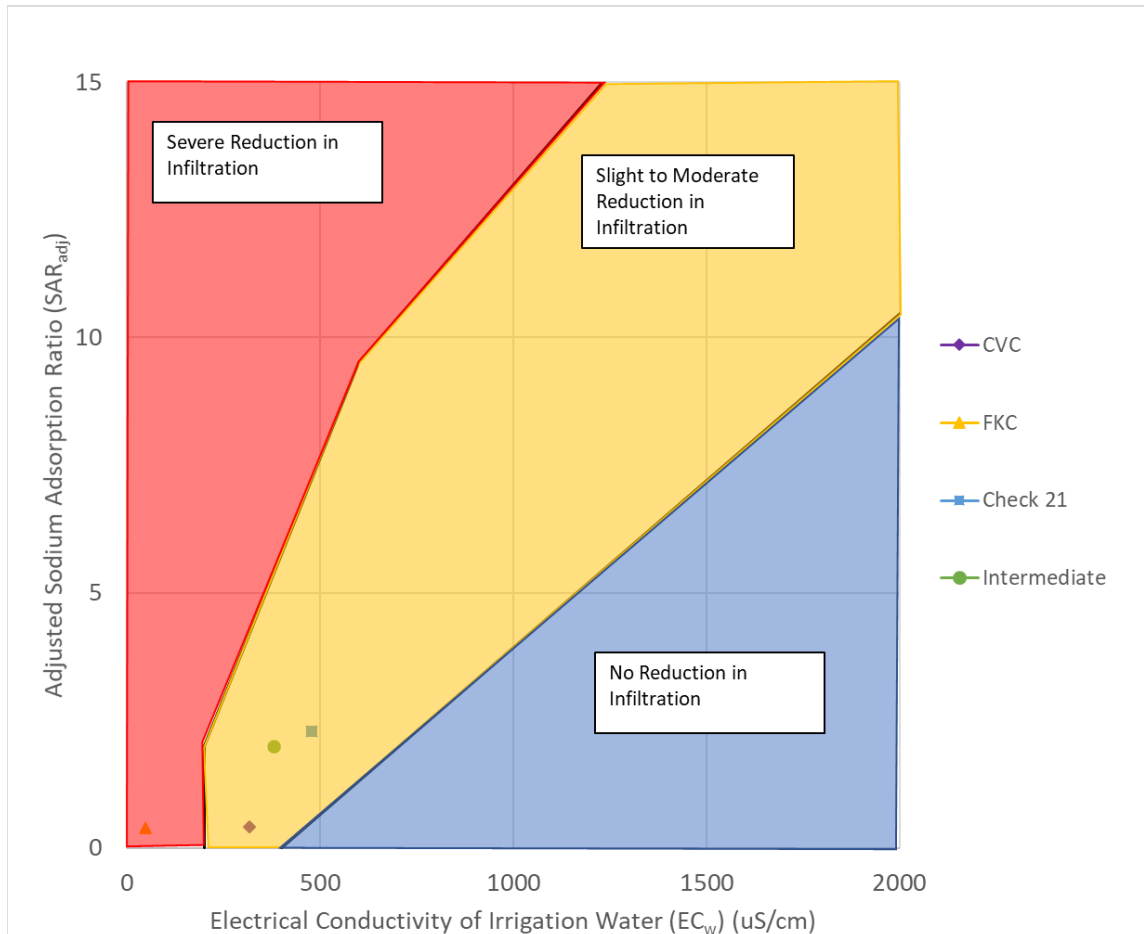
Valley Canal water qualities

SAR = sodium adsorption ratio

INFILTRATION HAZARD

Sodium Adsorption Ratio

The SAR has been the standard used for assessing the infiltration hazard of applied irrigation water (Ayers and Westcot, 1985). But the actual infiltration hazard is assessed by balancing the opposite effects of salinity (EC_w) and sodicity (i.e., SAR) on aggregate stability. High salinity and low SAR are both important in maintaining adequate soil structure, which promotes better infiltration. Even though coarse-textured soils infiltrate faster than fine-textured soils, the hazard exists for all soil types. Typically, the adjusted SAR (SAR_{adj}) is used rather than the SAR as it more accurately accounts for $CaCO_3$, precipitation, and dissolution processes in the soil solution near the soil surface that control the free Ca^{2+} concentration. Figure 1 shows the relationship between the EC_w of the applied irrigation water and the SAR_{adj} as it relates to zones of “likely reductions” in infiltration rates (red), “slight to moderate reductions” in infiltration rates (yellow) and “no reductions” in infiltration rates (blue), adapted from Hanson et al., 2006. The threshold value is, therefore, variable and is considered to be the line that separates the “blue” and “yellow” zones on Figure 1. It is very important to note that low EC_w concentration (i.e., $EC_w < 200 \mu S/cm$) causes a reduction in water infiltration regardless of the SAR. Figure 1 also compares this relationship with various water sources. Note that FKC water falls in the red “severe reduction in infiltration” zone because of its low EC_w concentration, while water from the CVC or mixed with CVC water falls in the yellow “slight to moderate reduction in infiltration” zone. The addition of gypsum to FKC water increases the EC_w concentration, moving the point to the right and away from the “severe reduction in infiltration” zone while slightly reducing the SAR.



Key:
 $\mu\text{S/cm}$ = microsiemens per centimeter
 Check 21 = California Aqueduct Check 21
 CVC = Cross Valley Canal
 FKC = Friant-Kern Canal
 Intermediate = Water quality representing the average of California Aqueduct Check 21 and Cross Valley Canal water qualities

Figure 1. Comparison of Various Water Source Relationship between the Salinity of Applied Irrigation Water and the Adjusted Sodium Adsorption Ratio

Calcium-Magnesium Ratio

Calcium nutrition can be problematic under several conditions. Calcium deficiency can occur under low-saline conditions when the concentration of free calcium $[\text{Ca}^{2+}]$ is $\leq 1\text{-}2$ millimoles/L in the soil solution. Deficiency can also occur under high sodic conditions where the SAR exceeds 10-15 in sensitive plants due to high sodium-calcium ratios or in alkaline conditions where Ca^{2+} precipitates out of the soil solution as it forms CaCO_3 . Due to competition in the plant between calcium and magnesium at the root membrane, calcium nutrition could potentially be compromised when the calcium-magnesium ratio is generally less than 1 (Rhoades, 1992). Table 5 shows the seasonal average calcium-magnesium ratio for various water sources. Note the ratios for both FKC and CVC water are considerably higher than 1, while the ratio at California Aqueduct Check 21 is very close to 1 but will likely increase in the soil solution as the infiltrating water dissolves existing gypsum in the soil from previous amendment use. Therefore, calcium deficiencies, using CVC or Check 21 water or any mixture of the two, are unlikely.

Table 5. Seasonal Average Calcium-Magnesium Ratio for Various Water Sources

VALUE ¹	FKC, ^{2,3}	CVC ^{2,4}	INTERMEDIATE ⁵	CHECK 21 ⁶
Average	3.54	4.37	1.55	0.92
Maximum	6.16	8.24	2.00	1.00
Minimum	0.17	2.14	1.20	0.77

Note:

Based on molar or equivalent concentrations.

¹ March through October period.

² Water quality data from AEWSD grab samples lab data from 2011 – 2017.

³ Sample taken at terminus of FKC.

⁴ Sample taken at AEWSD CVC, Pumping Plant 6 or 6B Forebay.

⁵ Weighted average of CVC and Check 21 water quality.

⁶ California Aqueduct measured at Check 21 from 1968-2017.

Key

AEWSD = Arvin Edison Water Storage District

Check 21 = Check Structure 21 at milepost 172,40 on the California Aqueduct

CVC = Cross Valley Canal

FKC = Friant-Kern Canal

Intermediate = Water quality representing the average of California Aqueduct Check 21 and Cross Valley

Canal water qualities

SAR = sodium adsorption ratio

BICARBONATE EFFECTS

The pH of both the applied irrigation water and the soil solution are important factors that may affect either the suitability of water for irrigation or its effect on nutrient availability to the crop. And many of the adverse effects of pH are associated with combined high alkalinity (high concentrations of bicarbonate [HCO₃⁻] and carbonate [CO₃²⁻]). In slightly alkaline waters (pH 7- 8.3), the alkalinity is from bicarbonate. Only when the pH exceeds 8.3 does carbonate become present. The pH of the water is an indication of the activity of the hydrogen ion. The numerical pH value is expressed on a negative log scale such that a one-unit increase or decrease corresponds to a ten-fold increase or decrease in the hydrogen ion activity. Therefore, a change of soil pH from 6 to 8 corresponds to a hundred-fold decrease in the hydrogen ion activity.

The pH of applied irrigation water can affect irrigation equipment or cause calcite (i.e. lime) deposits on vegetation. Regarding irrigation equipment, the pH is one of several water quality factors than can influence corrosion of galvanized pipes or other metallic parts. The pH can also influence precipitation of calcite (CaCO₃) at the orifices of drip emitters or minisprinklers which will affect the system’s overall performance. This can be problematic if alkaline irrigation water, combined with sufficiently high bicarbonate and calcium concentrations, is used over the long term without periodic acid flushes to reduce scale buildup. Calcite precipitation becomes more problematic if the pH of the applied irrigation water exceeds 8.5. In addition, if such water is sprinkler irrigated above the canopy, it can cause unsightly white deposits that form on leaves and fruit. While these deposits typically do not cause harm to the crop, they nonetheless can affect the aesthetic quality. Acid additions to the irrigation water will not only reduce the pH but will reduce the [HCO₃⁻], reducing the potential for CaCO₃ precipitation. Acid additions convert bicarbonate to carbon dioxide (CO₂) gas.

As the applied irrigation water infiltrates the soil, it interacts with the soil minerals. Therefore, the pH of the infiltrating water will change as it interacts with soil minerals, but soils are typically well buffered, as are soils in the FWA service area. Well buffered soils resist large changes in pH in the soil solution. The seasonal average pH of the irrigation water ranges from 7.1 to 8.4 depending upon the mixture of FKC water and California Aqueduct water. Because of the buffering capacity of the soil, this range in applied irrigation water pH will make little impact of the pH of the soil solution.

The pH of the soil solution has a profound influence on plant nutrient availability, nutrient uptake and ion toxicity to plants. The vast majority of soils that are cultivated for crop production around the world fall within the neutral, slightly acid and slightly basic pH range (i.e. pH 6-8). This is the general range where nutrient availability is optimal. However, there are those soils where the pH falls far from this normal range and these,

if not corrected to an adequate range, can pose adverse effects on crops. Soils that are highly acidic (pH < 5.5) or highly alkaline (pH > 8.5) present a spectrum of challenges for the plant including nutrient availability, ion toxicities, and nutrient imbalances influencing the ion relations and nutrition within the plant itself (Läuchli and Grattan, 2012).

Most nutrients are not equally available to plants across the pH spectrum (Epstein and Bloom, 2005). Several mineral nutrients are severely affected in these non-optimal pH soils, particularly calcium, potassium, phosphorus, and iron. The reactions of plants to these nutrient elements under extreme soil pH conditions can affect plant growth, physiological processes and their morphological development (Läuchli and Grattan, 2012). The majority of the soils irrigated with waters from districts within the FWA, however, fall in the slightly alkaline range with the pH in the rootzone between 7.5 and 8.3 (UC Davis Soilweb <https://casoilresource.lawr.ucdavis.edu/gmap/>). Therefore, these soils are slightly alkaline, based largely on the natural abundance of calcite in the soil, and are at the upper end of the optimal pH range. Depending on the alkalinity of the soil water and $[Ca^{2+}]$, some of the Ca^{2+} can precipitate out as $CaCO_3$ which decreases the calcium-magnesium ratio. Intermittent injection of acids in the applied irrigation water will reduce the pH and, consequently, the alkalinity of the water. Not only is this a maintenance measure to reduce calcite buildup on the orifices of drip emitters and minisprinklers, it drops the pH of the water which decreases bicarbonate, increases the $[Ca^{2+}]$ and availability of other plant nutrients. Most growers in the San Joaquin Valley have some maintenance, acid-injection program in place. However, in Kern county, this may not be common practice in all districts. Acid applications, the residual gypsum in the soil and periodic applications of additional gypsum, are all a means of providing sufficient free Ca^{2+} in soils in Kern country. Moreover, increasing the $[Ca^{2+}]$ in the soil water simultaneously improves the calcium-magnesium ratio.

Sprinkler irrigated fruit and vegetable crops (approximately 20% of studied districts) could be susceptible to formation of white deposits on leaves and fruit, or “white wash,” and reduced marketability if bicarbonate concentrations, or $[HCO_3^-]$, in applied irrigation water are too high (> 1.5 meq/L, leaving a white residue on the crop surface. Bicarbonate concentrations in the California Aqueduct water theoretically could cause “white washing” under sprinkler irrigation, especially during dry and breezy conditions. “White washing” is a concern to some growers and has been seen by growers occasionally in the study area; however, it is not known what the exact cause of the “white washing” was, whether it was from undiluted California Aqueduct water or some other source. Bicarbonate levels of 1.5 meq/L or 92 mg/L and higher may increase formation of white deposits. The seasonal average for $[HCO_3^-]$ of CVC water is 78.5 mg/L. While this concentration is less than 92 mg/L, special management practices may be needed to mitigate or avoid “white wash” impacts during periods of elevated bicarbonate levels. These may include blending with higher quality sources or changing irrigation methods away from sprinklers that wet the foliage (Provost & Pritchard, 2012).

CORROSION AND DEGRADATION OF MATERIALS

The comparison of corrosion potential of California Aqueduct water and FKC water from Millerton Lake was performed by Provost & Pritchard in 2012 on several chemical constituents and calculated indices including: pH, Langelier Index, Ryzner Index, EC, resistivity, sulfates, and chlorides. This comparison generally showed that FKC water has a slight tendency to degrade concrete structures by leaching out minerals, but metallic corrosion will be low. Comparatively, California Aqueduct water will have a lower tendency to leach out minerals from concrete, and will have a more corrosive effect on metals, although there is only a slight difference between the two water sources in either case (Provost and Pritchard, 2012).

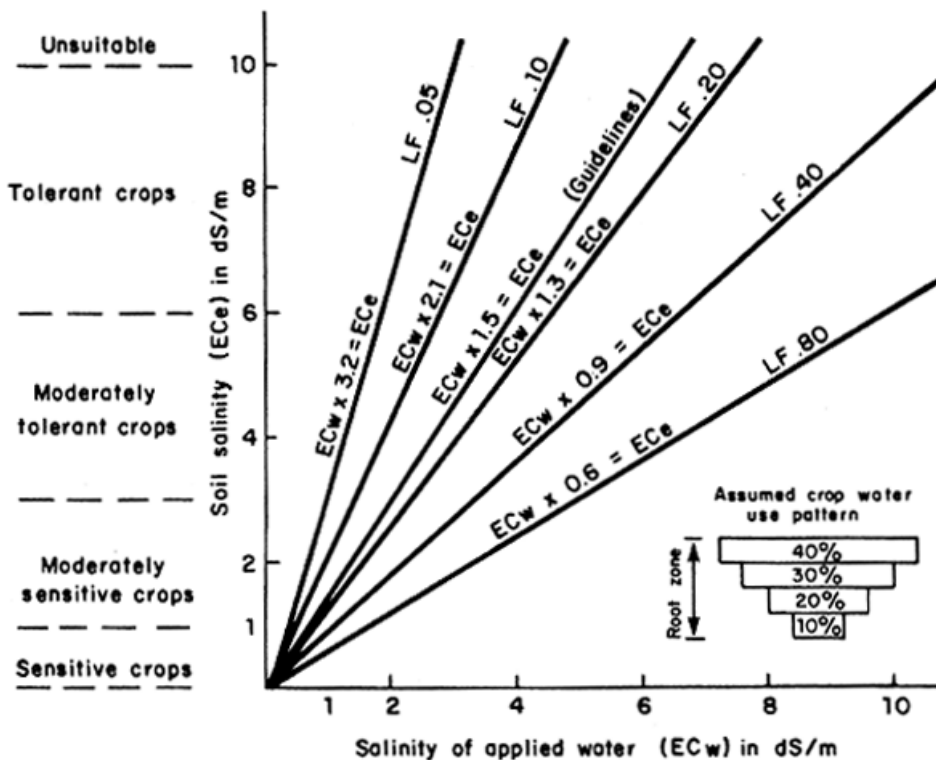
Materials such as brass, bronze, PVC, polyethylene, and stainless steel usually have a high corrosion tolerance, and therefore would not likely be affected by the exchange of source waters. The forecasted increase in corrosion from using more California Aqueduct water is likely manageable with the use of special coatings and proper selection of new materials and would likely result in minor increase in O&M costs (Provost and Pritchard, 2012).

AGRONOMIC LEACHING REQUIREMENTS

Agronomic leaching is the application of irrigation water in excess of the soil water holding capacity to neutralize the agronomic effects associated with increased salinity and ion toxicity in the crop rootzone. This approach aims to balance concerns related to long-term groundwater quality with a multi-layered assessment of agronomic impacts as a durable solution. The amount of leaching required, referred herein as maintenance leaching, depends upon the sensitivity of the crop to salinity and the irrigation water salinity. The higher the salinity of the applied irrigation water and the more sensitive the crop is to salinity, the greater the amount of leaching is required. This same leaching concept can also be applied to chloride and boron.

LEACHING FRACTION VS LEACHING REQUIREMENT

Often, leaching fraction (LF) and leaching requirement (LR) are used interchangeably. The two, in fact, are different. The LF is defined as the volume of water that drains below the rootzone divided by the volume of water that infiltrates the soil surface (equivalent to applied irrigation water assuming no surface runoff or evaporation). The LF can also be estimated based on the salinity of the applied irrigation water, or $[EC_w]$, and that of the drainage water, or $[EC_{dw}]$, where $LF = EC_w/EC_{dw}$. The crop roots extract water from the rootzone leaving the salts behind. If the crop rootzone is divided in quarters, typically the top quarter uses 40% of the water, the second quarter 30%, third quarter 20% and bottom quarter 10%. Therefore, the salt concentration increases with soil depth. The lower the LF, the more salts accumulate and concentrate at lower depths. Figure 2 is a representation of this relationship under conventional irrigation. The relationship between irrigation water salinity (EC_w) and soil salinity (EC_e) is linear but the slopes of the relationships are dependent upon the LF. The slopes decrease with increasing LF. The higher the LF, the higher the irrigation water salinity can be to maintain the yield of a crop. In Figure 2, note the dashed lines along the y-axis indicating the general salt tolerant categories as the salinity of the applied irrigation water changes.



Key:
 dS/m = deciSiemens per meter (1 μ S/cm = 1 μ mhos/cm = 1/1,000 dS/m)
 LF = leaching fraction

Figure 2. Relationship Between Soil Salinity (EC_e) and Salinity of the Applied Irrigation Water (EC_w) under a Series of Steady-State Leaching Fractions (0.05 to 0.80) (from Ayers and Westcot, 1985)

The LF concept is attractive in that it allows predictions of average rootzone salinity (EC_e) conditions from the applied irrigation water EC (EC_w) and assumed LF. Knowing the scientifically determined salinity threshold value (EC_{et}) for a particular crop, one can use this relationship to determine the maximum irrigation water salinity (EC_w) for a given LF. The relationship between EC_w , EC_e , and LF also depends on irrigation management. That is, $EC_e = \text{Concentration Factor } (F_c) * EC_w$ where 'F_c' depends not only on the LF but the type of irrigation method. Applicable F_c values for conventional irrigation methods such as furrow or flood, and high frequency irrigation methods, such as drip and minisprinklers, are provided in Table 6.

Table 6. Concentration Factor Values for Conventional and High Frequency Irrigation (adapted from Suarez, 2012)

LEACHING FRACTION (LF)	CONCENTRATION FACTOR (F_c)	
	Conventional Irrigation	High Frequency Irrigation
0.05	2.79	1.79
0.10	1.88	1.35
0.20	1.29	1.03
0.30	1.03	0.87
0.40	0.87	0.77
0.50	0.77	0.70

The difference in F_c values between conventional and high frequency irrigation is largely based on how crop roots respond to the salinity in the rootzone. Under conventional irrigation, crops typically respond to the average rootzone salinity (i.e. the seasonal average of the four rootzone quarters of salinity). Under high frequency irrigation, crops respond to the water uptake weighted salinity (i.e. the salinity in the top quarter is weighted 40 percent, salinity in the second quarter is weighted 30 percent, and so on). Because the salinity in the top quarter is lower where evapotranspiration (ET) is higher and higher in bottom where ET is lower, the average rootzone salinity is lower under high frequency irrigation.

The LR, on the other hand, is the lowest LF needed to sustain maximum yield given the applied irrigation water salinity concentration, or [EC_w], and yield threshold for the given crop. In other words, it is the minimum leaching needed, given the crop type and water quality, to maintain the salinity (or chloride or boron), at the maximum rootzone concentration in the rootzone that the crop can tolerate. Any increase in rootzone concentration above this maximum level will cause injury or yield reductions. LR is an attractive concept because, given an irrigation water quality and crop sensitivity, the minimum leaching needed to sustain the rootzone salinity EC_e , rootzone chloride (Cl_e), or rootzone boron (B_e) at levels that would avoid or reduce damage or yield losses can be estimated.

LR can be estimated using the following equation (Rhoades and Merrill, 1976; Ayers and Westcot, 1985):

$$LR\% = \frac{EC_w}{5(EC_{et}) - EC_w} \times 100$$

EC_w = Electrical conductivity of irrigation water

EC_{et} = Soil salinity threshold for a given crop

Note that the LR relationship can apply to chloride and boron by substituting their respective irrigation water concentrations (i.e. Cl_w or B_w) and their threshold values (Cl_{et} or B_{et}). The LR equation assumes that crops respond to an average rootzone salinity created by a 40-30-20-10% root water extraction pattern, similar to LF predictions using conventional irrigation. The difference is that LR predicts the minimal LF to achieve maximal yields whereas the LF approach assumes an LF first, then predicts what the EC_e will be given the EC_w of the irrigation water. Both are similar but solve the problem from different directions.

LIMITATIONS TO THE STEADY-STATE LEACHING CONCEPT

The leaching fraction or requirement is an attractive concept but has limitations. First, the leaching concept assumes steady-state conditions and thus has no time element. Therefore, there is no accounting for how long leaching will take, which will differ depending upon the permeability of the soils. Second, the evapotranspiration (ET) of the crop is assumed to be independent of the average rootzone salinity, but it is not (Letey and Feng, 2007). A salt-stressed crop will use less water than a non-stressed crop. Consequently, crop ET will be reduced, and leaching, with the same quantity of applied irrigation water, will be increased. And third, in drip irrigated fields, actual LFs are difficult to quantify because LF, soil salinity, soil water content, and root density all vary with distance and depth from the drip lines.

In light of these limitations, recent studies have shown that the EC_w and EC_e relations described by Ayers and Westcot (1985), which are based on steady-state LF conditions, tend to be too conservative and overestimate soil salinity and, therefore, overestimate yield losses in most cases (Corwin and Grattan, 2018; Letey et al., 2011). Transient-state models may more accurately predict soil salinity, as well as soil chloride, sodium and boron, but they are more complicated and require many more site-specific inputs and assumptions. Therefore, transient models are still too cumbersome and time consuming to replace steady-state models.

The LF and LR concepts are both steady-state, so they assume the amount of irrigation is not limiting. The amount of water needed for irrigation can be estimated as:

$$AW = ET/(1-LR)$$

AW = applied water

ET = evapotranspiration or crop water requirement

LR = leaching requirement

The units for applied water (AW) and ET or crop requirement are typically depths of water (i.e. inches or millimeters). But in many cases, the amount of water is limiting and therefore crops can be under-irrigated and therefore not achieve the required leaching. In this case, the salts in the crop rootzone will increase over time. At some point, depending upon the salinity of the imported water and crop sensitivity, the salt content (or chloride or boron) can exceed the threshold level. Because the threshold values are based on seasonal averages, exceedances above the threshold are allowed to some degree without experiencing a reduction in yield. For example, if the average Cl_e was 100 mg/L for the first 2/3 the season and then reached 200 mg/L for the last 1/3 of the season due to insufficient leaching, almonds on “Nemaguard” rootstock would not be expected to be damaged because the seasonal average Cl_e would be 133 mg/L given the Cl_e threshold is 150 mg/L. Nevertheless, if the required leaching is not achieved, reclamation leaching would be required. Similarly, if the pre-season soil salinity is over 150 mg/L and little to no leaching is applied during the season, injury would be expected to develop on almonds on “Nemaguard” rootstock. Therefore, the LR values for various crops and salinities are based on soils where the maintenance leaching fraction is achieved each irrigation. If the pre-existing soil salinity is initially high, then the soil is not at steady-state.

DIFFERENCE BETWEEN MAINTENANCE LEACHING AND RECLAMATION LEACHING

There is a distinct difference between maintenance leaching and reclamation leaching. Maintenance leaching occurs during each irrigation by applying more irrigation water than the soil can hold. This is the leaching fraction or requirement concept described above. Therefore, the AW is higher than the ET to accommodate the necessary leaching (see equation above). Reclamation leaching, on the other hand, occurs at the end of the irrigation season by applying excess irrigation water to flush the salts from the crop rootzone. Ideally, reclamation leaching would not be required if correct maintenance leaching is achieved each irrigation during the irrigation season. However, because some fields may not get the necessary leaching, salts can accumulate, and fields may require reclamation leaching at some time. In addition, low pressure systems such as drip and mini-sprinkler systems produce characteristic salt accumulation patterns in fields, even with sufficient downward leaching. Whether salts are building up in the rootzone or between drippers or

minisprinklers, reclamation leaching is a valuable preventative measure from time to time at the end of the irrigation season.

At the end of the irrigation season, salt can be removed by sprinkler irrigation (i.e equivalent to intermittent ponding). Figure 3 shows the extent of leaching needed to address rootzone salinity. For example, if the average rootzone salinity (ECe) at the end of the season is 3000 $\mu\text{S}/\text{cm}$ and the goal is to reduce the salinity in the soil down to 600 $\mu\text{S}/\text{cm}$ the salinity needs to be reduced to $600/3000 = 0.2$ (y-axis) or 20% of what it was before leaching. Then the amount of sprinkler irrigation water to apply is 0.5 ft (x-axis) for every foot of soil to reclaim. If the goal is to reduce the top 2 feet, then $0.5 \times 2\text{ft} = 1\text{ft}$ of water would be needed. This assumes the combined rainfall and applied reclamation leaching water needed.

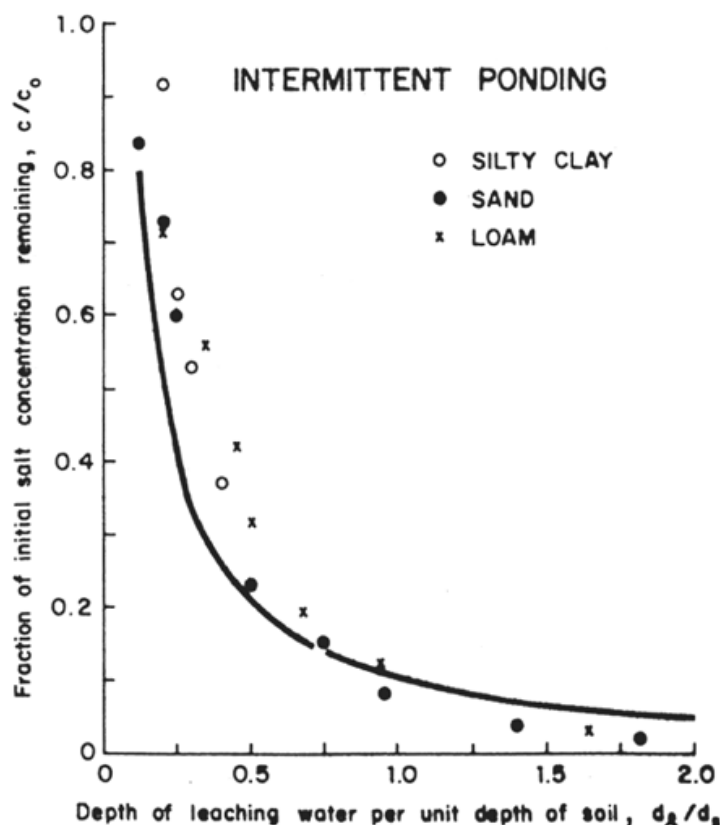


Figure 3. Reclamation Leaching Function under Sprinkler Irrigation or Intermittent Ponding (Ayers and Westcot, 1985).

The amount of reclamation leaching can be reduced by the amount of effective rainfall. To take advantage of rainfall, reclamation leaching should ideally take place after the rainfall season but before spring budding and leaf out begins, typically from October/November through March.

LEACHING AND NITROGEN MANAGEMENT

It is also important to address nitrogen management strategies combined with the salt leaching strategies. Unlike salts, nitrogen is very dynamic in the rootzone as it undergoes form changes from organic pools to inorganic fractions (primarily nitrate $[\text{NO}_3^-]$ and ammonium $[\text{NH}_4^+]$). Ammonium, and particularly nitrate, are the forms primarily taken up by plants. Nitrate, being an anion, is relatively mobile in soils and is highly susceptible to leaching below the rootzone. Once nitrate leaches below the rootzone, chemical transformations are less likely to occur, and nitrate commonly continues leaching downward and eventually ends up in the aquifers. A 2002 study conducted by the Lawrence Livermore National Laboratory concluded that nitrate contamination in groundwater is “the number-one contaminant threat to California’s drinking water supply” (LLNL 2002).

Rootzone salinity control and nitrogen management is a conflicting problem. It is necessary to leach salt from the rootzone to avoid damage from salinity or ion toxicity, but nitrates will unavoidably be leaching below the

rootzone as well. If soil salinity is low at the beginning of the irrigation season (see reclamation versus maintenance leaching), then leaching at less than the critical LR is possible to avoid salt damage. Then, salinity in the profile will steadily build up over the season while soil nitrogen will be depleted due to crop uptake. At the end of the irrigation season, salinity will be the highest, and nitrate will be the lowest. Therefore, reclamation leaching can be implemented at the end of the irrigation season, and the process cycle repeats itself.

MITIGATION LEACHING REQUIREMENTS

ESTIMATING LEACHING REQUIREMENTS FOR MOST SENSITIVE CROPS

The most sensitive crops in the Friant Division were used for this analysis. Crops selected were based on their varied sensitivities to salinity, chloride, and boron. By using the most sensitive crops, all crops with higher tolerances should also be protected. The most salt-sensitive crops, or those with the lowest soil salinity threshold (EC_{et}), are beans, carrots, onions (seed), melons, and strawberries. All have an EC_{et} of 1000 $\mu S/cm$. For chloride, the most sensitive crops are almonds and other stone fruits on “Nemaguard” rootstock. The threshold Cl_{et}^1 is estimated to be 150 mg/L. The relationship between boron in the applied irrigation water and the saturated soil paste is more complicated because of boron’s high affinity to adsorb onto the soil. Irrigation water with higher boron concentrations than predicted can be used until the boron saturates the soil adsorption sites. Because of this complexity, Ayers and Westcot (1985) concluded that the “...maximum concentration (of boron) in the irrigation water are approximately equal to these values (boron tolerance reported based on soil water bases) or slightly less,” suggesting that applied irrigation water tolerances would be 0.5 – 0.75 mg/L which would protect the most sensitive crops.. However, over the long term (more than several years), boron will behave similarly to salts and chloride (D. Suarez, US Salinity Laboratory, personal communication). With the boron threshold for soil water ranging from 0.5 – 0.75 mg/L, the B_{et} is equivalent to half of the soil water concentration, or 0.25 – 0.375 mg/L. For more information on conversions from saturated soil paste to soil water concentrations, see Ayers and Westcot (1985). To be conservative, and based on the above tree and vine crop sensitivities, the B_w threshold is assumed to be 0.25 mg/L.

Table 7 shows the acreage and percentage of sensitive crops for representative water districts, and sensitivities to boron, chloride, and EC within each representative water district.

¹ It is important to note that most ‘threshold’ values for chloride and boron reported in literature (e.g. Grieve et al., 2012) are based on the soil water concentration. The saturated soil paste concentration (i.e. Cl_e or B_e) for most mineral soils is about half this value over the long-term (Ayers and Westcot 1985).

Table 7. Percentage and Area of Sensitive Crop Types within Representative Water Districts

CROP TYPE	WATER DISTRICT											
	AEWSD		DEID		KTWD		SID		SSJMUD		SWID	
	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Boron Sensitive⁵	15%	18,883	5%	2,842	30%	5,969	6%	1,211	8%	4,629	1%	358
Berries ¹	1%	761	2%	873	1%	200	n/a		<1%	63	n/a	
Cherries	2%	2,196	<1%	228	1%	160	<1%	22	<1%	211	1%	358
Citrus	11%	15,024	2%	1,301	28%	5,609	4%	825	7%	4,355	n/a	
Stone Fruits ⁴	1%	902	1%	440	n/a		2%	364	n/a		n/a	
Chloride Sensitive⁶	6%	7,593	22%	12,399	5%	1,040	17%	3,366	22%	13,577	56%	21,649
Almonds (Nemaguard rootstock)	6%	7,593	22%	12,399	5%	1,040	17%	3,366	22%	13,577	56%	21,649
EC Sensitive⁷	7%	8,490	<1%	175	n/a		<1%	50	1%	375	2%	862
Carrots	3%	3,748	<1%	100	n/a		n/a		<1%	148	2%	784
Melons ²	1%	777	<1%	74	n/a		<1%	50	n/a		<1%	75
Onions ³	3%	3,961	n/a		n/a		n/a		<1%	228	<1%	1
Strawberries	<1%	4	n/a		n/a		n/a		n/a		<1%	2

Source: Data compiled from California Department of Water Resources Land Use Viewer (2017) developed by LandIQ using 2014 land use data. Districts provided updates to 2017 land use data where appropriate. DEID data was provided by the District, and data gaps were filled with LandIQ data.

Notes:

Grape Crops in DEID take up 43% (26,443 ac) of the District's land area.

"n/a" indicates that there is zero amount of a crop type in a district.

¹ Data Source lists Berries as "Bush Berries"

² Data Source groups Melons with Squash and Cucumbers

³ Data Source groups Onions with Garlic

⁴ Stone Fruits include Apricots, Nectarines, Peaches, Plums, and Prunes

⁵ Boron Sensitive Crops include Berries, Citrus, and Stone Fruits

⁶ Chloride Sensitive Crops include Almonds

⁷ EC Sensitive Crops include Carrots, Melons, Onions, and Strawberries

Key:

% = percentage

AEWSD = Arvin-Edison Water Storage District

DEID = Delano-Earlimart Irrigation District

KTWD = Kern-Tulare Water District

n/a = not applicable

SID = Saucelito Irrigation District

SSJMUD = South San Joaquin Municipal Utility District

SWID = Shafter-Wasco Irrigation District

DEVELOPING MITIGATION LEACHING CURVES

This section describes quantification of mitigation based on leaching requirements for sensitive crops. This approach does not directly address the physical characteristics or dynamic nature of the rootzone, but rather is specific to sensitive crop types grown in the region and implementing sufficient leaching volumes to prevent crop injury. In addition, the volumetric mitigation quantified through this approach is not specific to a water district but is representative of all crops grown in the Friant Division.

For salinity, EC_{et} values were used to calculate LR values, as presented in Table 8 in percentages. For chloride or boron the same LR equation is used except irrigation water concentrations (i.e. Cl_w and B_w) in mg/L are used in place of EC_w and respective threshold Cl_e and B_e are used in place of EC_{et} . At each location, the quantified LR by water quality constituent is based on the most stringent LR, which assumes all water is applied to the most sensitive crop. Analysis shows a long-term LR between 5.2 and 19 percent, using the average, seasonal statistics for EC, chloride, and boron concentrations.

Table 8. Leaching Requirements for Various Sensitive Crops by Water Source and Water Quality Constituent

MOST SENSITIVE CROP	CVC			INTERMEDIATE			CHECK 21		
	EC	Cl ⁻	B	EC	Cl ⁻	B	EC	Cl ⁻	B
Carrots, onions, melons, strawberries	6.7%	-	-	8.6%	-	-	10.6%	-	-
Almonds (Nemaguard rootstock)	-	5.2%	-	-	8.1%	-	-	11.1%	-
Stone fruits, citrus, berries	-	-	8.0%	-	-	13.6%	-	-	19.0%

Key:

B = boron

Check 21 = Check Structure 21 at milepost 172,40 on the California Aqueduct

Cl⁻ = chloride

CVC = Cross Valley Canal

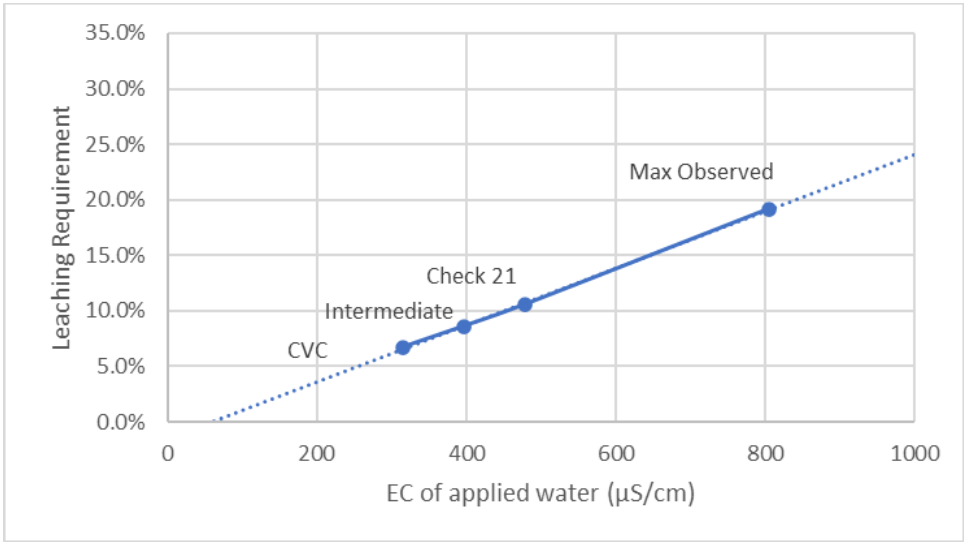
EC = electrical conductivity

Intermediate = Water quality representing the average of California Aqueduct Check 21 and Cross Valley Canal water qualities

Figures 4 through 6 show mitigation rating curves based on LR percentages, source water quality, and constituents of concern. Each mitigation rating curve was extended to show the maximum observed concentration from historical water quality data for both CVC and California Aqueduct Check 21 sources.

The LR percentages presented in Table 8 and Figures 4 through 6 represent quantified volumetric mitigation that would be applied as maintenance leaching. Maintenance leaching occurs at each irrigation by applying more water than the soil can hold, or in other words, the applied irrigation water is more than the crop requirement to accommodate the necessary leaching. The quantified LR assumes long-term steady-state conditions and does not account for leaching from rain or end-of-season reclamation practices. Any rain or end-of-season leaching will decrease the presented values.

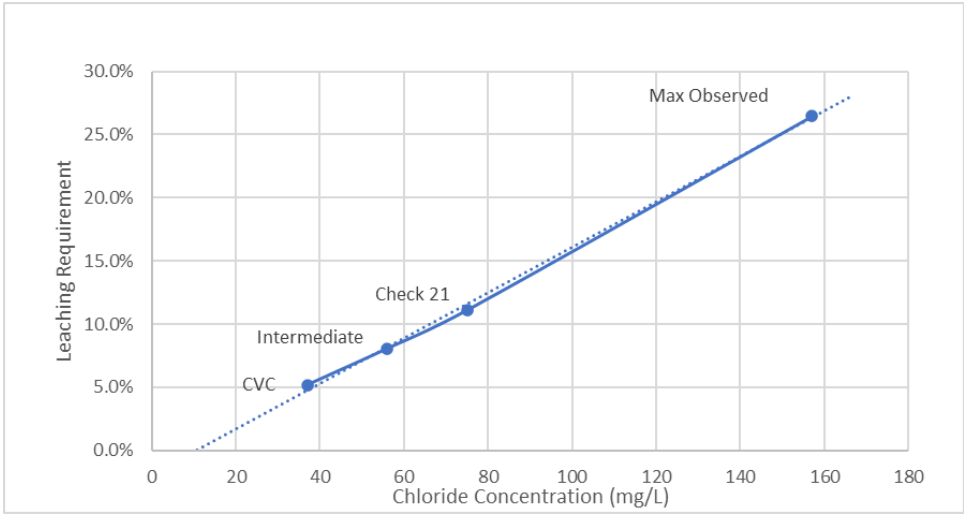
The quantified LR assumes mitigation water is delivered and applied at the same time as surface water delivery is taken. In addition, it assumes mitigation water is of the same water quality as the surface water delivery. Therefore, mitigation is only quantified for water of the same imported quality and not for both reverse flow pump-back and Millerton Lake supplies. If maintenance leaching practices are followed, reclamation leaching is unnecessary, except for in driest of years when surface supply does not meet irrigation demand or to leach salts that have accumulated between drip emitters and mini sprinklers. Using the most stringent LR, it is assumed all mitigation water is applied to the most sensitive crop.



Key:

Check 21 = California Aqueduct Check 21
 CVC = Cross Valley Canal
 EC = electrical conductivity
 $\mu\text{S/cm}$ = microsiemens per centimeter ($1 \mu\text{S/cm} = 1 \mu\text{mhos/cm} = 1/1,000 \text{ dS/m}$)
 Intermediate = Water quality representing the average of California Aqueduct Check 21 and Cross Valley Canal water qualities

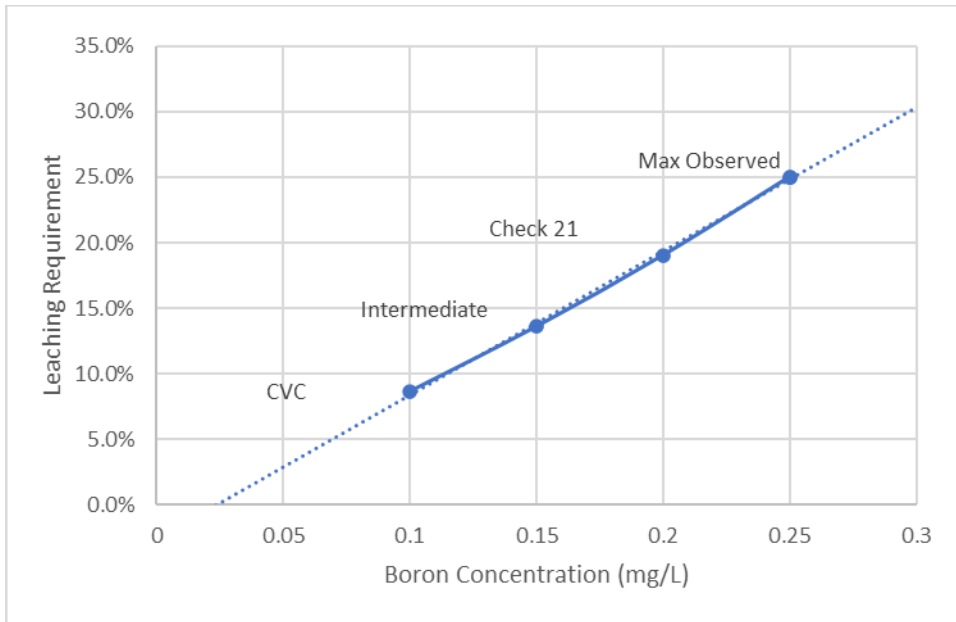
Figure 4. Leaching Requirement for Electrical Conductivity



Key:

Check 21 = California Aqueduct Check 21
 CVC = Cross Valley Canal
 EC = electrical conductivity
 Intermediate = Water quality representing the average of California Aqueduct Check 21 and Cross Valley Canal water qualities
 mg/L = milligrams per liter

Figure 5. Leaching Requirement for Chloride

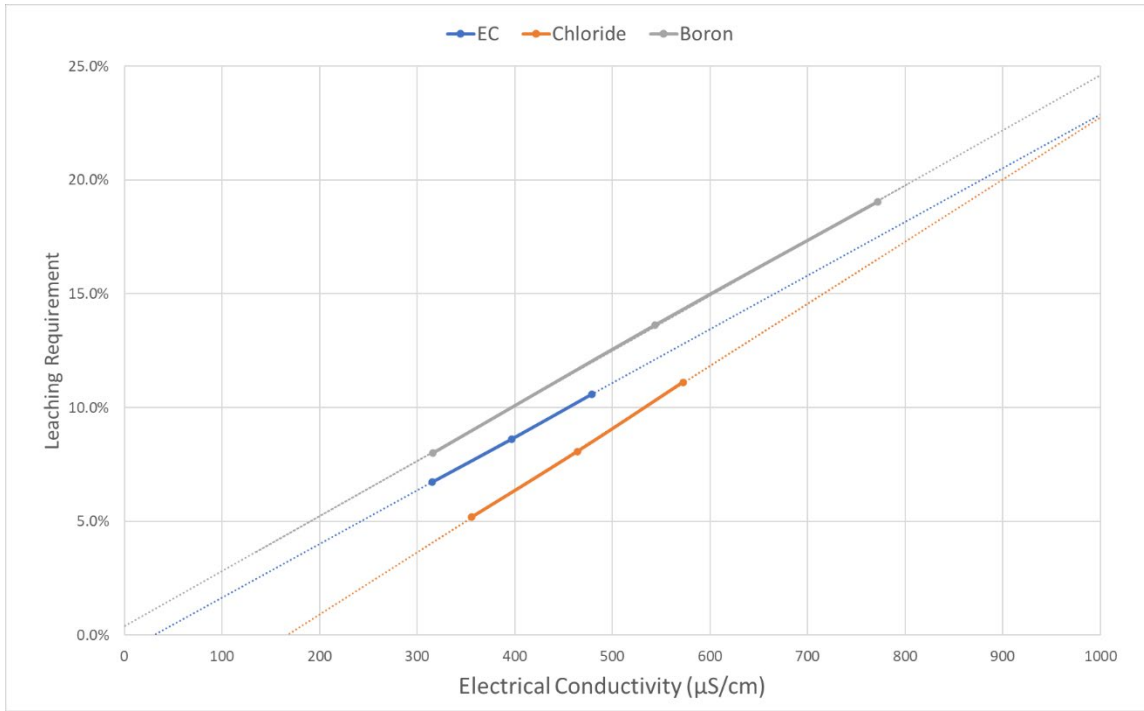


Key:
 Check 21 = California Aqueduct Check 21
 CVC = Cross Valley Canal
 Intermediate = Water quality representing the average of California Aqueduct Check 21 and Cross Valley Canal water qualities
 mg/L = milligrams per liter

Figure 6. Leaching Requirement for Boron

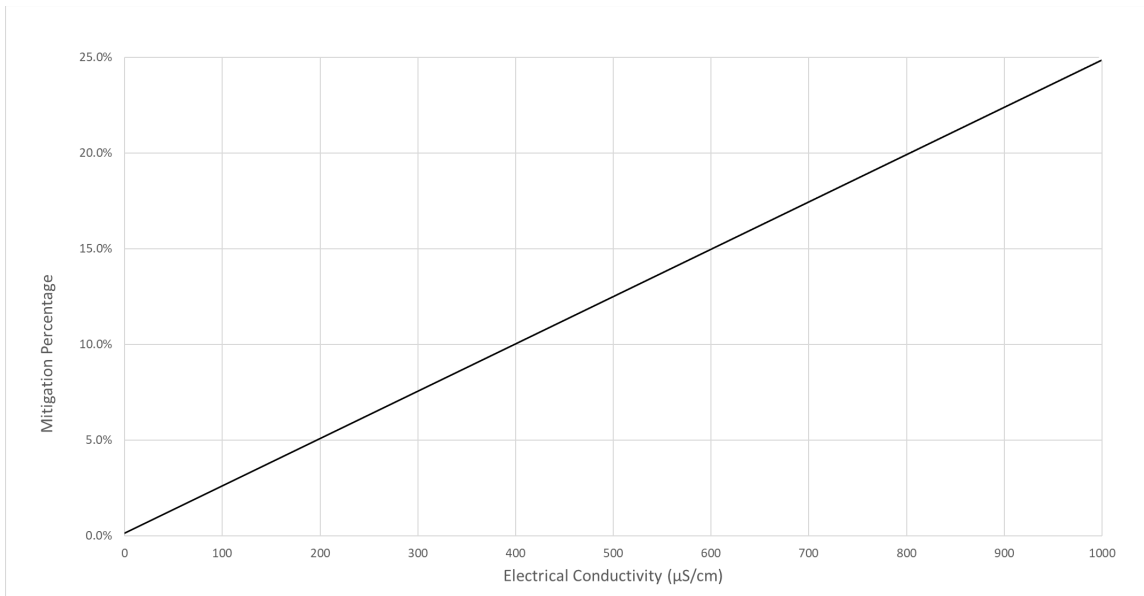
Leaching Requirement Normalization

In order to best understand the LR relationships amongst EC, chloride, and boron and to confirm the dominant constituent trend, individual rating curves were normalized to an EC concentration scale. The EC concentration was used as it can be easily measured in real-time. Figure 7 shows the stacked, normalized mitigation rating curves for all three constituents of concern. Boron is the dominant or driving constituent and has the highest LR, regardless of source water quality. The required leaching based on that curve would be sufficient to prevent crop injury due to increased EC or chloride concentrations in applied irrigation water, and, therefore, the boron curve is the proposed mitigation rating curve for the Water Quality Mitigation Ledger (Figure 8). The method for normalizing each constituent curve is described below.



Key:
 µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)
 EC = electrical conductivity

Figure 7. Rootzone Leaching Curves for Electrical Conductivity, Chloride, and Boron Normalized to an Electrical Conductivity



Key:
 µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)

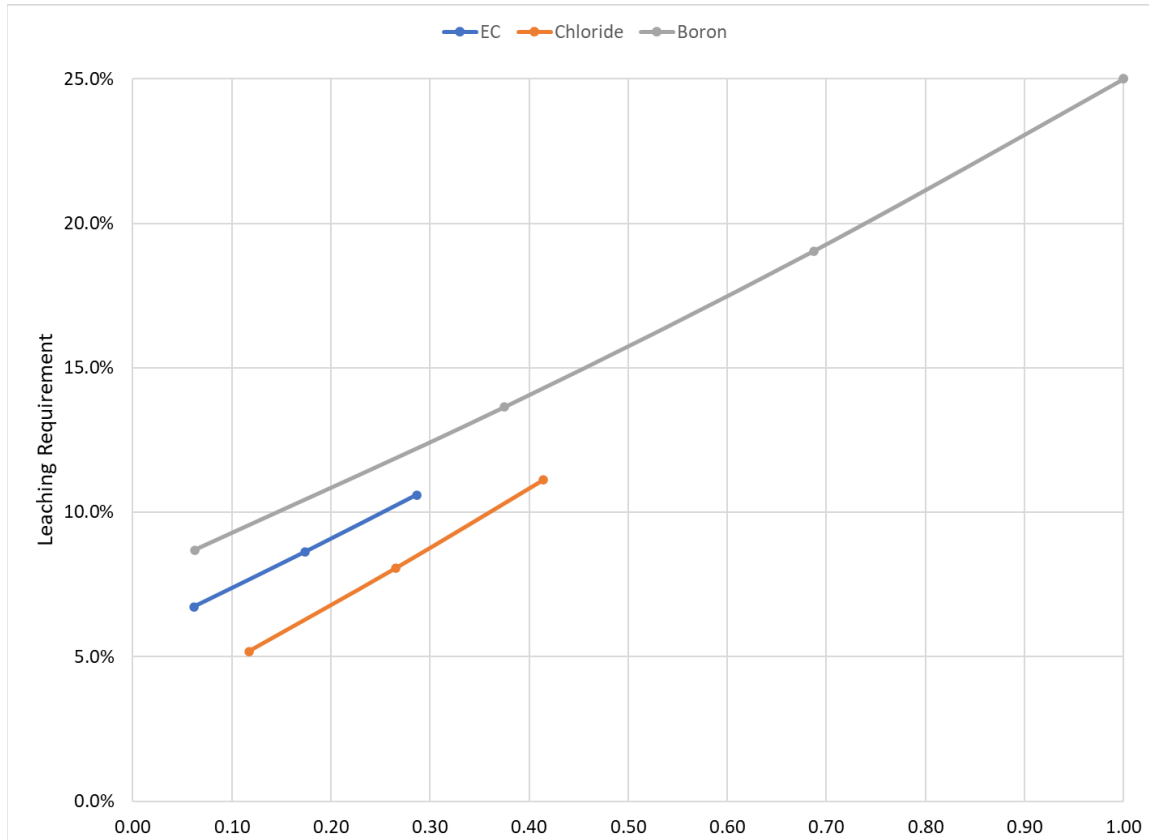
Figure 8. Proposed Mitigation Rating Curve based on Boron Sensitivity and Normalized to Electrical Conductivity

Normalization Method

As the three constituent curves have differing concentration scales and they do not show direct correlations to each other, the constituents were normalized to a common scale using the below equation.

$$X_{new} = \frac{X - X_{min}}{X_{max} - X_{min}}$$

In the equation, X represents the constituent concentration for EC, chloride, or boron. X_{min} is the minimum average, seasonal, observed concentration for a given constituent from either California Aqueduct Check 21 or CVC water quality data. The maximum observed concentration corresponded with varying leaching requirements for each of the constituents. To ensure that all constituents were normalized to the same scale and the full range of possible constituent concentrations was considered beyond the highest observed concentration for California Aqueduct Check 21 water, X_{max} represents the constituent concentration corresponding to a 25 percent LR. Figure 9 displays the normalized curves, and Table 9 presents the normalized data.



Key:
EC = electrical conductivity

Figure 9. Normalized Leaching Requirement curves for Electrical Conductivity, Chloride, and Boron

Normalized concentration values were then converted back to EC using the equation below, where X_{norm} represents the normalized concentration for chloride or boron. LR curves were then replotted using an EC scale (Figure 7).

$$EC = X_{norm}(EC_{max} - EC_{min}) + EC_{min}$$

Table 9. Constituent Normalization

SOURCE WATER	ELECTRICAL CONDUCTIVITY			CHLORIDE			BORON		
	Observed Concentration (µS/cm)	Normalized Value	Leaching Requirement	Observed Concentration (Seasonal Average) (mg/L)	Normalized Value	Leaching Requirement	Observed Concentration (Seasonal Average) (mg/L)	Normalized Value	Leaching Requirement
CVC	315	0.06	6.7%	37.00	0.12	5.2%	0.10	0.06	8.0%
Intermediate	397	0.17	8.6%	56.00	0.27	8.1%	0.15	0.38	13.6%
Check 21	479	0.29	10.6%	75.00	0.41	11.1%	0.20	0.69	19.0%
Maximum Observed	805	0.73	19.2%	157.00	1.05	26.5%	0.25	1.00	25.0%
Maximum normalization (25% Leaching Requirement)	1000	1.00	25.0%	150.00	1.00	25.0%	0.25	1.00	25.0%

Key:
 CVC = Cross Valley Canal
 µS/cm = microsiemens per centimeter
 mg/L = milligrams per liter

APPLIED AGRONOMIC THRESHOLDS

The Policy includes maximum water quality thresholds for the FKC. Although the mitigation rating curve quantifies mitigation water to account for appropriate maintenance leaching, FKC water quality thresholds for EC, chloride, boron, turbidity, total suspended solids (TSS), and SAR and sodium were developed and are proposed herein. These thresholds aim to (1) balance supply reliability, water quality concerns, and agricultural practices, such as regulated deficit irrigation (RDI); and (2) ensure that the EC_{et} , Cl_{et} , or B_{et} limits are not exceeded for the most prevalent and sensitive crops in the Friant Division. The thresholds are specific to three irrigation periods that correspond to the growing season and agricultural management practices during the year:

- Period one represents the beginning of the growing season (March 1 – June 30);
- Period 2 represents timing of hull split and the duration of RDI practices in the Friant Division (July 1 – August 31); and
- Period 3 is inclusive of the remainder of the growing season and contract year (September 1 – February 28).

Table 10 shows the established water quality constituent thresholds for each period as defined in the Policy. The threshold variations in Period 3, shown as Periods 3a and 3b, are described in more detail in the Threshold Flexibility subsection below.

Sections below describe methods applied to account for annual RDI practices; development of water quality thresholds, including thresholds for RDI; and adjustments to water quality thresholds to accommodate flexibility for water management within the Friant Division.

Table 10. Friant-Kern Canal In-Prism Water Quality Thresholds

Period	Salinity expressed as EC ($\mu\text{S/cm}$)	Chloride (mg/L)	Boron (mg/L) ¹	Turbidity (NTU) ⁶	Total Suspended Solids (ppm)	SAR ⁷	Sodium (mg/L) ⁷
Period 1 March 1 – June 30	1,000 ²	102 ³	0.4	40	20	3	69
Period 2 July 1 – August 31	500 ⁴	55 ⁴	0.4	40	20	3	69
Period 3a September 1 – February 28	1,000 ²	102 ³	0.4	40	20	3	69
Period 3b September 1 – February 28	1,000 ²	123 ⁵	0.4	40	20	3	69

Notes:

Thresholds adapted from Grieve, C.M., S.R. Grattan and E.V. Maas. 2012. Plant salt tolerance. In. (W.W. Wallender and K.K. Tanji, eds). Agricultural Salinity Assessment and Management (2nd edition). ASCE pp 405-459; and Ayers, R.S. and D.W. Westcot 1985. Water quality for agriculture. FAO Irrigation and Drainage Paper 29 (rev 1). Food and Agriculture Organization of the United Nations. Rome

For addition detail, see Attachment C – Agronomic Impacts and Mitigation.

When Friant-Kern Canal in-prism water quality conditions in this table are exceeded, Friant Division Long-Term Contractors will work together to seek 1:1, unleveraged, and cost-neutral exchanges for pump-in and pump-back programs. This does not apply to spot-market or third-party exchanges.

1 Grapes are used as a representative crop for boron sensitivity and are prevalent in the Friant Division. They are used as a surrogate for many other sensitive crop types such as apricots, figs, and grapefruits. Threshold assumes conventional irrigation with minimum 20 percent leaching fraction applied.

2 Threshold assumes minimum of 20 percent leaching requirement applied and adjusted to account for regulated deficit irrigation during almond hull split period (July 1 – August 31) in order to not exceed maximum EC_{et}. Almonds on Nemaguard rootstock are used as a representative crop for salinity sensitivity and are prevalent in the Friant Division. They are used as a surrogate for many other sensitive crop types such as apples, cherries, pears, pistachios, and walnuts.

3 Threshold assumes minimum of 20 percent leaching requirement applied and then adjusted to account for regulated deficit irrigation during almond hull split period (July 1 – August 31) in order to not exceed maximum Cl_{et}. Almonds on Nemaguard rootstock used as a representative crop for chloride sensitivity. They are used as a surrogate for other sensitive crops including cherries, pistachios, and walnuts.

4 Threshold applies to almond hull split period when regulated deficit irrigation is applied to avoid hull rot. This threshold is used assuming irrigation applications are reduced to 50 percent of the tree water requirement and subsequently thresholds applied for the remainder of the year have been adjusted to account for additional salt accumulation. This threshold was developed with consideration of existing program operations, historical water quality data, and absolute water quality thresholds.

5 If the measured average chloride concentration in Period 1 (March 1 – June 30) is less than or equal to 70 mg/L, the allowable chloride threshold for Period 3 (September 1 – February 28) is increased to 123 mg/L.

6. Turbidity threshold is taken from section 3 of the Final Initial Study/Negative Declaration for: Warrant Act Contract(s) and License, and Operation and Maintenance Agreement, to Introduced Floodwaters from Reclamation District 770 into the Friant-Kern Canal, March 2017.

7. SAR and Sodium are managed together. If the measured SAR value exceeds 3 AND the measured sodium concentration exceeds a threshold of 69 mg/L, management will be necessary. SAR value is derived from Ayers Table 1 and the 69 mg/L sodium is derived and converted from the Ayers Table 6.

Key:

$\mu\text{S/cm}$ = microsiemens per centimeter (1 $\mu\text{S/cm}$ = 1 $\mu\text{mhos/cm}$ = 1/1,000 dS/m)

ASCE = American Society of Civil Engineers

Cl_{et} = maximum chloride threshold of the saturated soil paste

EC = electrical conductivity of applied water

EC_{et} = Soil salinity threshold for a given crop

FAO = Food and Agriculture Organization of the United Nations

Friant Division = Friant Division of the Central Valley Project

mg/L = milligrams per liter

SAR = sodium adsorption ratio

TDS = total dissolved solids

REGULATED DEFICIT IRRIGATION

This section describes methods applied to account for annual RDI practices in the Friant Division for EC and chloride agronomic thresholds, specific to almonds. Note, grapes may also be deficit irrigated during the blooming period; however, the deficit irrigation period for grapes is not aligned with that of almonds, and grapes are most prone to boron toxicities. Consequently, a similar RDI analysis and threshold adjustment is unnecessary for grapes. See Boron Thresholds subsection in Water Quality Thresholds section for additional discussion on applied boron thresholds for grapes in the Friant Division.

Hull Rot Control

Hull rot is problematic in almond orchards in the San Joaquin Valley, and trees are particularly sensitive during the hull split period. Hull split is where 1 percent of the almonds exhibit split, and it typically lasts one to two weeks. The initiation of hull split depends on the almond variety, weather conditions, and tree stress. Although variety has the largest influence on hull-split timing, the temperature 90 days after flowering also affects the hull split initiation. Unseasonably cool temperatures delay hull split while unseasonably warm weather accelerates it.

Hull rot occurs due to infestation by one of two types of fungi, *Monilinia fructicola* or *Rhizopus stolonifera* (Holtz, 2009). Some almond varieties, particularly Nonpareil and Monterey, are more susceptible to fungal attack than are other varieties. High nitrogen application to an orchard combined with full irrigation, or irrigation to completely meet tree ET demands, at the time of hull split can make trees considerably more vulnerable to hull rot.

Hull rot can be largely controlled through a combination of nitrogen management, water management, and antifungal sprays. It is best controlled by RDI practices. A 2001 study showed that by cutting back irrigation to 50 percent of the trees' water requirements between June 1 to July 31 (70 percent regulated) or July 1 to July 15 (85 percent regulated), hull rot was substantially reduced as evidenced by fewer dead leaf clusters and fewer dead spurs and branches (Teviotdale et al., 2001). Such mild to moderate water stress results in drier hull conditions, making trees less vulnerable to fungal attack. Many almond growers in the San Joaquin Valley have adopted RDI practices to help synchronize hull split timing and reduce potential for hull rot. To monitor the degree of tree stress, these growers have implemented the University of California recommendation of trying to maintain a stem water potential between -14 to -16 bars using pressure chambers by drying down the soil rootzone (B. Sanden, Personal communication, April 5-6, 2020). The more negative the number, the more stress the tree experiences. It could take between one to six weeks to achieve this stress level, depending on soil type and irrigation systems (B. Lampinen, personal communication, April 7, 2020). Growers should take care to not to stress trees too much because that could compromise kernel size as kernels continue to grow at the onset of hull split (Doll and Shackel, 2015). After almond harvest, irrigation is critical to maximize floral bud development for the subsequent season.

During the RDI period when there is no effective leaching, irrigation application is reduced to 50 percent of the tree water requirement, and some additional salts and chlorides accumulate in the rootzone. Absent leaching, the steady-state model breaks down because the salt content in the applied water would need to be zero to maintain the same rootzone salinity. In this situation, preseason irrigation management should target an adjusted soil salinity to maintain the appropriate soil salinity thresholds and avoid crop injury.

Regulated Deficit Irrigation Analysis

The RDI analysis applied a predictive model based on timing of flowering to estimate hull split for various types of almond varieties in different parts of the Central Valley (UC Fruit & Nut Research & Information Center, 2020). From the model and historical California Irrigation Management Information System (CIMIS) data from the AEWSD weather station, hull split was determined to typically initiate around the end of June or beginning of July and, depending upon the variety, continue through mid-August (B. Sanden, personal communication, April 6, 2020). To account for potential variances in hull split initiation in the Friant Division, an 8-week period (July 1 to August 31) was assumed for this RDI analysis. Determination of water quality

thresholds during the RDI practices period, or Period 2, also considered effective rootzone depth, applied irrigation water quality, soil capacity, and irrigation requirements. The RDI analysis is considered to be conservative because: (1) rainfall was not considered; (2) surface irrigation was assumed, despite the fact that crops under high frequency drip irrigation (typical for most water districts in the Friant Division) are able to tolerate higher salinity for the same assumed LF; and (3) steady-state models typically overestimate rootzone salinity (Corwin and Grattan, 2018).

The RDI analysis was completed for both EC and chloride. Salt accumulation was quantified as a percentage increase, and then rootzone and applied irrigation water thresholds (assuming 20 percent maintenance leaching) were adjusted to maintain maximum EC_{et} or Cl_{et} through the season. Assuming steady-state leaching, the analysis targeted maintenance of rootzone salinity at soil salinity thresholds of 150 mg/L for chloride, and 1,500 $\mu S/cm$ for EC, resulting in adjustments to Cl_w and EC_w thresholds.

The RDI calculation assumed the effective rootzone to be between three and five feet (UC Almond Rootzone Workgroup, 2015). Soil was considered to be at field capacity meaning that volumetric soil moisture content was 25 percent, based on monthly average ET or irrigation water requirements for mature almonds in Kern County during months of July and August, 9.5 inches and 8.8 inches, respectively (Sanden, personal communication, April 6, 2020; Goldhamer 2012). The RDI calculation included soil water concentration thresholds of 300 mg/L for Cl_{sw} , and 3,000 $\mu S/cm$ for EC_{sw} , or twice that of the thresholds expressed on a saturated soil paste basis.

During the RDI period, water was assumed to be applied at 50 percent ET_c . The total amount of irrigation water required for 100 percent irrigation application, in inches, was calculated but then halved to account for 50 percent deficit irrigation. The amount of irrigation water during RDI periods was then multiplied by the irrigation water concentrations of salt and chloride to determine the percentage increase above the salt and chloride concentrations in the rootzone. Calculating the percentage increase of chloride in the rootzone meant first determining irrigation water and soil water amounts.

For example, 50 percent of the total ET for July and August was 9.1 inches, and the total water in the effective rootzone was 15 inches (rootzone depth (5 ft, or 60 inches) * 25 percent water content = 1.25 feet, or 15 inches). The 15 inches of soil water had 300 mg/L chloride at the beginning of the RDI period. After 9.1 inches of water was applied, adding salts to the soil water in the rootzone, the irrigation water concentration was 55 mg/L. The percentage of additional salt was determined by calculating the ratio of the salt added in the deficit irrigation water to that in the soil water, $(9.1 \text{ inches} \times 55 \text{ mg/L}) / (15 \text{ inches} \times 300 \text{ mg/L}) = 11$ percent. If the salt level in the rootzone remained at critical soil threshold levels at the end of the RDI period, the Cl_e at the beginning of RDI period would have needed to be proportionally lower than the critical soil salinity threshold of 150 mg/L, such that the 150 mg/L threshold concentration would be achieved at the end of the season. Thus, the Cl_{et} is reduced to 122 mg/L and the corresponding Cl_w becomes 102 mg/L.

WATER QUALITY THRESHOLDS

This section presents the RDI analysis-based chloride and EC thresholds and proposed flexible thresholds for chloride, boron thresholds, turbidity and TSS thresholds, and SAR and sodium thresholds.

Chloride and Electrical Conductivity Thresholds

Tables 11a and 11b show the RDI analysis for a variety of applied irrigation water qualities for chloride and EC, respectively. In consideration of historical water quality data representative of Kern-Fan or CVC programs that currently introduce water into the FKC, as well as temporal water quality trends, an applied irrigation water threshold for the RDI period was selected to be 55 mg/L Cl_w . The Cl_w value of 55 mg/L during the RDI period correlated to an adjusted Cl_w of 102 mg/L for the remainder of the year, assuming a three-foot (36 inch) effective rootzone – a conservative assumption as the effective rootzone is assumed to be three to five feet (Table 12a).

The same logic described above for Cl_w thresholds was applied to determine RDI EC_w and adjusted EC_w thresholds. The chloride threshold for the RDI period (55 mg/L) was approximately 49 percent greater than

the average historical water quality of representative Kern-Fan programs for all year types during months of July and August (37 mg/L). The average EC_w during July and August for all year types representative of Kern-Fan programs was 300 $\mu\text{S}/\text{cm}$, and a 49 percent increase is 447 $\mu\text{S}/\text{cm}$. Rounding up, the RDI threshold for EC_w is 500 $\mu\text{S}/\text{cm}$, and, in order to maintain an EC_{et} of 1,500 $\mu\text{S}/\text{cm}$, the adjusted EC_w for the remainder of the year was 1,000 $\mu\text{S}/\text{cm}$.

Table 11a. Regulated Deficit Irrigation Analysis for Chloride

Cl _w (mg/L)	Effective Rootzone (in)	Sum ET _c Average (in) ¹	RDI %	RDI Water (in)	Rootzone Water (in) ²	% Cl ⁻ Increase	Adjusted Cl _e Needed (mg/L)	Adjusted Cl _w (mg/L)
10	36	18.3	50%	9.2	9	3.4%	145	121
10	60	18.3	50%	9.2	15	2.0%	147	122
20	36	18.3	50%	9.2	9	6.8%	140	117
20	60	18.3	50%	9.2	15	4.1%	144	120
30	36	18.3	50%	9.2	9	10.2%	135	112
30	60	18.3	50%	9.2	15	6.1%	141	117
40	36	18.3	50%	9.2	9	13.6%	130	108
40	60	18.3	50%	9.2	15	8.1%	138	115
50	36	18.3	50%	9.2	9	16.9%	125	104
50	60	18.3	50%	9.2	15	10.2%	135	112
55	36	18.3	50%	9.2	9	18.6%	122	102
55	60	18.3	50%	9.2	15	11.2%	133	111

Notes:

¹ ET_c averages from Sanden and Goldhamer based on water use of mature almond trees in Wasco area for July and August (Goldhamer and Girona 2012).

² Rootzone at field capacity is 25 percent by volume.

Key:

Cl⁻ = chloride

Cl_e = chloride concentration in saturated soil paste or rootzone chloride

Cl_w = chloride concentration in applied irrigation water

ET_c = evapotranspiration or tree water use

in = inches

mg/L = milligrams per liter

RDI = regulated deficit irrigation

Table 11b. Regulated Deficit Irrigation Analysis for Electrical Conductivity

EC _w (μS/cm)	Effective Rootzone (in)	Sum ET _c Average (in) ¹	RDI %	RDI Water (in)	Rootzone Water (in) ²	% EC Increase	Adjusted EC _e Needed (μS/cm)	Adjusted EC _w (μS/cm)
200	36	18.3	50%	9.2	9	6.8%	1,400	1,120
200	60	18.3	50%	9.2	15	4.1%	1,440	1,150
300	36	18.3	50%	9.2	9	10.2%	1,350	1,080
300	60	18.3	50%	9.2	15	6.1%	1,410	1,130
400	36	18.3	50%	9.2	9	13.6%	1,300	1,040
400	60	18.3	50%	9.2	15	8.1%	1,380	1,100
500	36	18.3	50%	9.2	9	16.9%	1,250	1,000
500	60	18.3	50%	9.2	15	10.2%	1,350	1,080
600	36	18.3	50%	9.2	9	20.3%	1,200	960
600	60	18.3	50%	9.2	15	12.2%	1,320	1,050

Notes:

¹ ET_c averages from Sanden and Goldhamer based on water use of mature almond trees in Wasco area for July and August (Goldhamer and Girona 2012).

² Rootzone at field capacity is 25 percent by volume.

Key:

μS/cm = microsiemens per centimeter

EC = electrical conductivity

EC_e = electrical conductivity of saturated soil paste or rootzone salinity

EC_w = electrical conductivity of applied irrigation water

ET_c = evapotranspiration or tree water use

in = inches

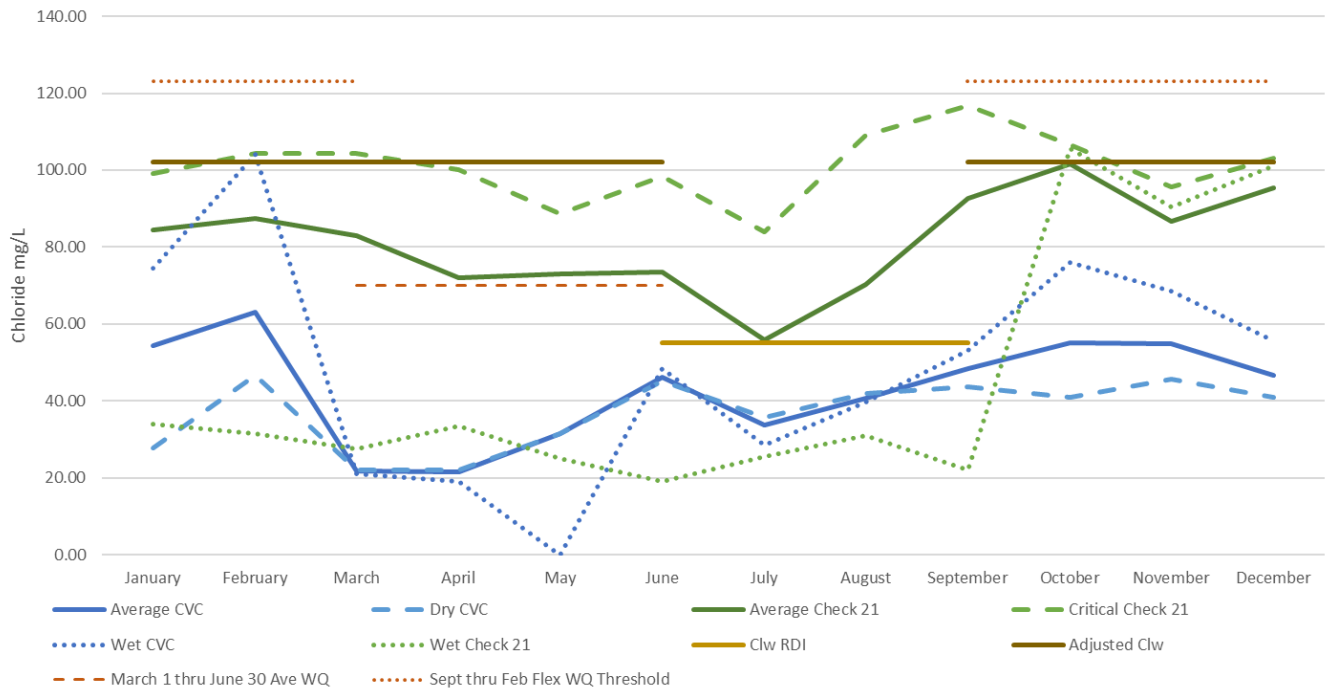
RDI = regulated deficit irrigation

By adjusting the Cl_e and EC_e thresholds for non-RDI irrigation periods, LR volumes for the assumed 20 percent leaching were adjusted by default, as LR is a function of the saturated soil paste concentration. Adjusted LR volumes and constituent thresholds affect the mitigation curve slope for each constituent. The adjusted curves for chloride and EC were plotted and were below the governing line, so the mitigation curve remained unchanged and further confirmed the conservative nature of the mitigation curve in ensuring that all constituents would be sufficiently mitigated.

Chloride Threshold Flexibility

In evaluating and comparing the developed, in-prism water quality thresholds with temporal water quality trends during Period 1 (March 1 to June 30), or prior to the RDI period (July 1 to August 31), observed average constituent concentrations were typically below the proposed thresholds. If water with lower constituent concentrations was applied to a crop for the first four months of the growing season, assuming that the rootzone concentration was properly maintained, the rootzone concentration would decrease below the threshold and, even with reductions in irrigation and LFs, could allow the application of higher irrigation water concentrations during the post-RDI period. The period following RDI, or Period 3 (September 1 to February 28), is often used for reclamation leaching; however, it is also the period in which new sources of water may be available for the Friant Division. Thus, having flexibility in the allowable irrigation water quality could be opportune for increasing supply reliability for the region.

Based on the RDI analysis and evaluation of water quality temporal trends, the Guidelines define an alternative water quality threshold for chloride for Period 3 to provide flexibility for irrigation management. Determination of whether the alternative chloride threshold for Period 3 is applied is based on the average chloride concentration of the irrigation water during Period 1. The alternative value was developed considering historical, temporal water quality trends and applying a weighted average calculation to meet the targeted rootzone chloride threshold. If the average measured chloride concentration for Period 1 is less than or equal to 70 mg/L, the allowable chloride concentration threshold increases from 102 mg/L to 123 mg/L for Period 3. If the measured average chloride concentrations for Period 1 exceed 70 mg/L, the chloride threshold remains at 102 mg/L for Period 3. Figure 10 shows the proposed thresholds compared to the chloride water quality trends for CVC and California Aqueduct water sources by year type.



Key:

Average = Average of all San Joaquin Index year types and excludes months where there is mixing.

Cl_w = chloride concentration of applied irrigation water

CVC = Cross Valley Canal

Dry= Monthly average for San Joaquin Index year types dry and critical and excludes months where there is mixing.

mg/L = milligrams per liter

RDI = regulated deficit irrigation

Wet = Monthly average for San Joaquin Index year types below normal, above normal, and wet and excludes months where there is mixing.

Figure 10. Chloride water quality trends by source water and year type with proposed water quality thresholds

Because the average water quality for Kern-Fan or CVC programs for Period 1 (March 1 to June 30) was approximately 30 mg/L (see Table 2), 70 mg/L was chosen as a midpoint between the adjusted Cl_w threshold determined in the RDI analysis and the average historic water quality. Using a weighted average approach, if 70 mg/L water was applied for the four months in Period 1, assuming an LR of 20 percent, the resulting Cl_e would be 84 mg/L. With the target weighted average for Cl_e of 122 mg/L, the necessary Cl_e for Period 3, the six months post-RDI (September 1 – February 28) was determined using the following equation:

$$84 \frac{mg}{L} * .4 + Cl_e * .6 = 122$$

The resulting Cl_e was 147 mg/L, correlating to a Cl_w of 123 mg/L with an assumed 20 percent LR. This approach was conservative in that observed chloride concentrations for Kern-Fan programs were significantly lower than 70 mg/L, and these calculations did not consider rainfall or any reclamation leaching applied in addition to the assumed 20 percent maintenance leaching.

Note that adjusting the Cl_e thresholds for non-RDI irrigation periods (Period 1 and Period 3) would adjust the LR volumes for the assumed 20 percent leaching provided by the mitigation curve. Adjusted curves were plotted and it was confirmed that even with a reduced Cl_e, the established mitigation curve would provide adequate mitigation.

Boron Thresholds

Table 12 shows B_w thresholds for tree and vine crops above which injury occurs under differing irrigation management practices, or LF values of 10 and 20 percent. Grapes have a boron tolerance of 0.4 mg/L when the LF is between 10 to 25 percent (Grattan et al., 2015). The actual boron threshold tolerance range is 0.3-

0.5 mg/L if one considers different combinations of the soil water threshold (B_{sw}) tolerance (0.5 - 0.75 mg/L) and LF (10 - 25%).

The maximum in-prism water quality threshold for boron was set at 0.4 mg/L for all three irrigation periods (Periods 1, 2, and 3). Grapes were used as the representative crop for boron sensitivity because of their prevalence in the Friant Division, serving as a surrogate for other sensitive crop types, such as apricot, fig, and most citrus. The applied threshold assumed conventional irrigation with a LF of 10-25 and was used rather than the LR concept that was used in development of the mitigation curves.

Table 12. Boron Tolerance of Various Crops

CROP	BORON CONCENTRATION OF APPLIED WATER (B_w) (mg/L)	
	Leaching Fraction 10%	Leaching Fraction 25%
Alfalfa	2.0	2.8
Apricot	0.4	0.4
Asparagus	4.8	6.7
Barley	1.4	1.9
Bean (kidney, lima, mung)	0.4	0.6
Bean, snap	0.5	0.6
Beet, red	2.0	2.8
Bluegrass, Kentucky	1.2	1.7
Broccoli	0.5	0.6
Cabbage	1.2	1.7
Carrot	0.7	0.9
Cauliflower	1.6	2.2
Celery	3.8	5.3
Cherry	0.4	0.4
Clover, sweet	1.2	1.7
Corn	1.2	1.7
Cotton	3.1	4.3
Cucumber	0.7	0.9
Fig, Kadota	0.4	0.4
Garlic	1.7	2.4
Grape	0.4	0.4
Grapefruit	0.4	0.4
Lemon	<0.3	<0.4
Lettuce	0.6	0.8

Note: Adapted from data in Grattan, S.R., F.J. Diaz, F. Pedrero and G.A. Vivaldi. 2015. Assessing the suitability of saline waste waters for irrigation of citrus: Emphasis on boron and specific ions interactions. *Agric Water Manag.* 157:48-58.

Key:
mg/L = milligrams per liter

In addition, the applied B_w threshold of 0.4 mg/L was far more conservative than those defined in literature by Ayers and Westcot (1985). This analysis indicated that B_{sw} could be used as protective irrigation water thresholds (B_e) because of the complexities related to boron adsorption and equilibrium concentrations with the soil water. Historical water quality data also indicate that CVC or California Aqueduct water would be below this threshold.

Turbidity and Total Suspended Solids Thresholds

Turbidity and TSS are of concern to water users in the Friant Division. Turbidity and TSS are not agronomic constituents of concern, but elevated levels are problematic for water management infrastructure and facilities, specifically spreading and groundwater recharge basins. TSS and Turbidity are also less of a concern in water supplies introduced via the Intertie and apply more to water being introduced via gravity flow to the FKC during high-flow or flood events.

The precedent for the defined thresholds was established under the environmental compliance documentation Final Initial Study/Negative Declaration for the Warren Act Contract and License and Operation and Maintenance Agreement to Introduce Floodwaters from Reclamation District 770 into the Friant-Kern Canal (DL770 Contract). As part of the agreement, water introduced into the FKC by Delta lands

Reclamation District 770 would not cause in-prism water quality to exceed 40 nephelometric turbidity units (NTU) of turbidity or more than 20 parts per million (ppm) of TSS (Delta Lands Reclamation District 770 2017). These same thresholds are included in the Guidelines.

The TSS and turbidity thresholds defined are based on operational and maintenance practices for spreading and groundwater recharge basins in the region. AEWS has an allowable upper limit for TSS, 25 ppm, for water applied to spreading basins in their district (Bookman-Edmonston Engineering, Inc. 1972). A value of 20 rather than 25 ppm is included in the document to be protective of this upper, allowable limit. Monitoring of TSS requires lab analysis of water quality samples and thus management cannot be done in real time, however turbidity can be measured with a handheld meter and can be done in real time. Although the numerical relationship between turbidity and TSS can be affected by water source location, seasonal timing, and flow velocities (Meozzi 2011), a generalized relationship between the two constituents was developed to facilitate real-time water quality management. The defined turbidity threshold of 40 NTU correlates with the 20 ppm TSS value based on correlation analysis that AEWS performed between 2011 and 2016.

SAR and Sodium Thresholds

The established SAR and sodium thresholds defined in the Guidelines are designed to be managed together. As detailed under the Agronomic Effects section, sodium by itself can be potentially problematic and cause direct toxicity to tree crops. However, because of the importance of adequate Ca^{2+} in the soil water as a means of stabilizing root cell membranes and maintaining selective ion uptake by tree crops, the sodium-calcium ratio in the soil solution is often a better indicator of Na^+ toxicity. Therefore, SAR of the applied irrigation water has been used as a surrogate for the sodium-calcium ratio. The general rule is an SAR less than 3 is not problematic. However an SAR threshold on its own was not acceptable to water managers and water users as there are concerns related to potential acute crop injuries due to observed spikes in sodium concentrations of applied irrigation water. A combination approach to sodium management was developed, where if the measured SAR value exceeds 3 and the measured sodium concentration exceeds 69 mg/L, introduced water would need to be managed. The SAR threshold of 3 is from Ayers and Westcot Table 1 and assumes surface irrigation. The sodium concentration threshold of 69 mg/L is also derived from Ayers and Westcot Table 1 and suggests that irrigation waters $< 3 \text{ meq/L}$ (69 mg/L)² is suitable for crops that are sprinkler irrigated. Crops that are sprinkler irrigated are more susceptible to salt damage than by other irrigation methods as sodium can accumulate in the leaves by direct foliar absorption in addition to root absorption processes. Surface and low-pressure irrigated crops (i.e., drip and mini-sprinklers), on the other hand, can only accumulate sodium in leaves by root absorption and translocation. The defined thresholds are conservative as the assumed sprinkler irrigation and more salt-damaging method is not widely used for crops within the Friant Division, as growers tend to use more efficient, on-the-ground irrigation methods.

The defined thresholds are designed to address sodium toxicities and although SAR is also used to assess the infiltration hazard (described previously), it assumed that given the wide range of observed SAR values relative to water supply source, growers already appropriately manage SAR through the application of gypsum to increase EC and maintain adequate infiltration.

² The value assumes that calcium and magnesium are both at or above 2 meq/L (40 mg/L Ca^{2+} and 24 mg/L Mg^{2+}) where equivalent concentration of Ca^{2+} is greater or equal to Mg^{2+} . It is further assumed that this condition is met as the protection of these divalent constituents is their presence in the rootzone soil water. Nearly all growers in the region apply amendments such as gypsum (CaSO_4), and thus soil water concentrations would meet the criteria. (Maas and Grattan, 1999).

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Attachment D. Ledger Standard Operating Procedures

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ACRONYMS AND ABBREVIATIONS

Ad hoc Committee	Ad hoc Water Quality Committee
CVC	Cross Valley Canal
CVP	Central Valley Project
EC	electrical conductivity
FKC	Friant-Kern Canal
Friant Contractor	Friant Division long-term contractor
Friant Division	Friant Division of the Central Valley Project
FWA	Friant Water Authority
Guidelines	Friant-Kern Canal Water Quality Policy Guidelines
Ledger	Friant Kern Canal Water Quality Ledger
Policy	Friant-Kern Canal Water Quality Policy
Pool	Section of the Friant-Kern Canal between Check Structures
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RWA	Recovered Water Account
SJRRP	San Joaquin River Restoration Program
SOP	Standard Operation Procedures
URF	Unreleased Restoration Flow

PURPOSE

This document describes the proposed standard operating procedures for implementing the Friant-Kern Canal Water Quality Ledger (Ledger) that is associated to the Guidelines for Accepting Water into the Friant-Kern Canal (Guidelines). The concept for the Ledger was developed in late 2019 with the Ad hoc Water Quality Committee's (Ad hoc Committee) Small Workgroup during development of the Guidelines. The Ledger determines the required mitigation for introducing water of lesser quality in the Friant-Kern Canal (FKC). An initial, proof-of-concept version of the Ledger included a calculation of the pump-in mitigation percentage, total volume of mitigation water to be added to the FKC, and distribution of mitigation water to affected water users. As the Guidelines move toward implementation and the Ledger is fully developed, it is important that the defined Ledger process integrates with Friant Water Authority's (FWA) operations and accounting.

This Standard Operating Procedures (SOP) document for implementing the Ledger is intended to serve two purposes:

- 1) Define the complete process for pump-in project operations and agency (i.e., FWA and U.S. Department of the Interior, Bureau of Reclamation (Reclamation)) responsibilities relating to project approval, notification, mitigation water accounting, and reporting.
- 2) Document Ledger calculation assumptions.

PROCESS FOR IMPLEMENTING WATER QUALITY GUIDELINES

The Guidelines identify the need to develop standard operating procedures for a mitigation program and its administration. The processes and procedures for FWA implementation and management of the Guidelines will directly impact Ledger development, including the assumptions and calculations within the Ledger tool itself. The process for the implementation of the Ledger as part of the Guidelines includes:

- Approve pump-in projects.
- Measure, report, and track pump-in water quality.
- Collect pump-in project delivery data.
- Calculate preliminary mitigation water distribution.
- Final water accounting.
- Report volumetric deliveries and balance to Reclamation.

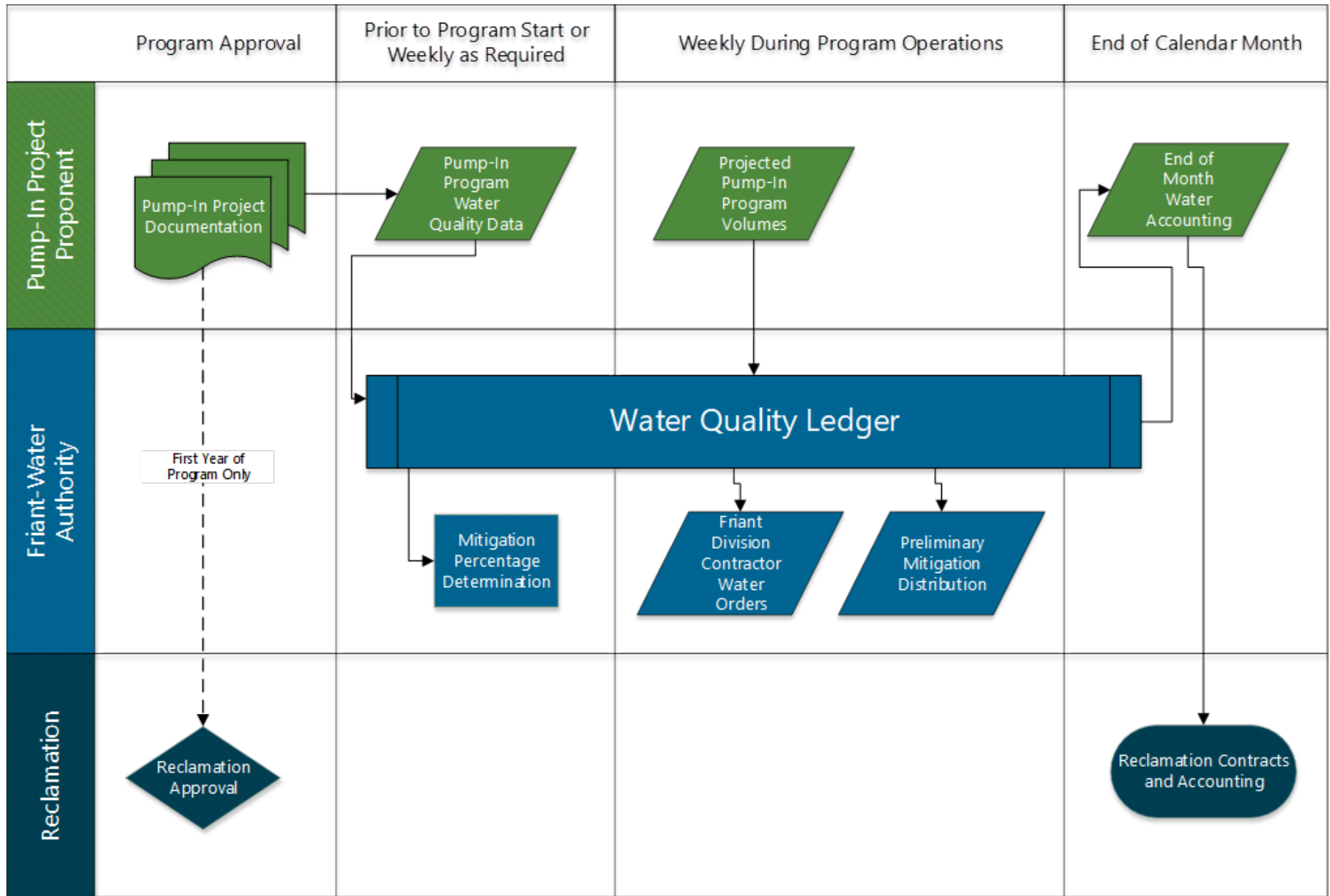


Figure 1. Water Quality Guidelines Implementation Process

PUMP-IN PROJECT APPROVALS

In consideration of the Ledger, a pump-in project (or program) is any project that introduces water into the FKC from a source other than Millerton Lake. Reclamation, with acknowledgement from FWA, provides the final approval for any pump-in project once the Warren Act Contract, other agreements, and environmental documentation is completed. Because the Warren Act Contract and environmental documentation for a pump-in project may have different effective durations, Reclamation will approve the necessary documentation to implement a pump-in project at the appropriate times. Each pump-in project will have a defined duration and maximum volume that can be introduced into the FKC. The pump-in project proponent will identify a point of contact who will work with FWA to coordinate required responsibilities outlined in the Guidelines.

PUMP-IN PROJECT WATER QUALITY

As described in Section B2 of the Guidelines, all waters discharged into the FKC must be tested at least annually. Pump-in projects that introduce a single source water quality and pump-in projects that bring water into the FKC via the Cross Valley Canal (CVC) will have different methods for collecting and reporting water quality data.

Mitigation Percentage Determination

Pump-in project water quality will be an input to the Ledger to determine the required mitigation water percentage and corresponding mitigation volume per pump-in project volume. Groundwater and CVC water quality are input to the Ledger at different frequencies as described below.

Single-Source Pump-In Projects via the FKC – Single-source pump-in projects include projects with Warren Act Contracts that introduce surface water or banked groundwater into the FKC. Before an approved pump-in project begins, FWA will work with the proponent to collect water quality data for the potential introduced surface water or groundwater to determine the required mitigation water percentage to be applied to the volume moved through the FKC. The determination of the required mitigation percentage will be calculated using the Ledger. Collection of the water quality data will follow requirements outlined in the Guidelines for Accepting Water into the FKC.

Pump-In Projects via the CVC - As described in Section B2 of the Guidelines, weekly water quality sampling will be performed by FWA during reverse flow pump-back operations and water quality data will be provided to Reclamation. Mitigation will be based on either the weekly average electrical conductivity (EC) concentrations measured continuously at the terminus of the FKC at the Kern River Check or the weekly grab samples collected from the CVC, whichever is deemed more appropriate by FWA. The CVC water quality conditions may represent multiple pump-in projects and will be updated in the Ledger at a greater frequency than once per year. FWA will coordinate with the pump-in project proponents regarding the required mitigation water percentage as determined by changes in water quality conditions.

The Ledger will document the water quality conditions for all pump-in projects and calculate the required mitigation percentage for each.

Ledger Calculations

As described above, pump-in project water quality data will be input to the Ledger. For each pump-in project, the Ledger will calculate the required mitigation water percentage. FWA will communicate this mitigation percentage to pump-in project proponents prior to operation and introduction.

Assumptions

- Water quality conditions for each pump-in project will be measured at least once per year or at a set frequency agreed to in the Guidelines and/or the Pump-In Project Approval and will determine the required mitigation water percentage.
- The Mitigation Percentage process follows the approach outlined in the Guidelines.

Friant-Kern Canal Water Quality Monitoring and Management

All pump-in projects must adhere to the water quality monitoring requirements stipulated in the Guidelines. FWA will implement continuous, real-time monitoring of in-prism water quality conditions in the FKC and at the FKC/CVC Intertie during reverse flow pump-back operations. Continuous, in situ measurements of EC will provide real-time data on incremental water quality changes and mixing in the FKC and will assist in water quality threshold management. If water quality thresholds are exceeded, FWA shall incrementally direct pump-in project proponents to cease operations of pump-in projects in order of greatest mass loading of the critical water quality constituent until the water quality drops below defined thresholds. Furthermore, if water quality monitoring results show an exceedance of 80% of the threshold for any water quality constituents, weekly monitoring will occur until four consecutive grab samples show consistent water quality results.

PUMP-IN PROJECT DELIVERY VOLUMES

During a contract year in which a pump-in project will be operated, FWA will work with the pump-in project proponent to implement the requirements stipulated in the Guidelines. This includes the addition of mitigation water to the FKC consistent with the pump-in project water quality conditions and quantity delivered. Pump-in project forecasted deliveries, calculated projected mitigation water, and all coordination related to pump-in project operations will be completed on a weekly basis.

Ledger Calculations

FWA will coordinate with pump-in project proponents to obtain an estimated volume of water to be introduced and conveyed in the FKC. The required mitigation water volume for the pump-in project is assumed to be included as part of that estimated volume. FWA will calculate losses, when appropriate, based on the total volume of water to be introduced into the FKC. The mitigation volume will be based on the total volume minus the calculated losses. The Ledger uses the mitigation water percentage for each pump-in project based on measured water quality and the net pump-in project volume to determine the projected mitigation volume requirement.

Assumptions

- Mitigation volumes are calculated based on projected weekly volume of a pump-in project and verified using measured volumes at the end of each month.
- Mitigation volumes are added to the FKC in real time with other pump-in project deliveries.
- FWA will have weekly volume, or weekly average flow, projections from pump-in project proponents.

PRELIMINARY MITIGATION DISTRIBUTION

The Ledger will be used to distribute mitigation water volumes to the impacted Friant Division long-term contractors (Friant Contractors). As described in the Pump-In Project Delivery Volumes section, mitigation water is introduced into the FKC simultaneously with the pump-in project volume introduction. FWA will add weekly water order data to the Ledger to distribute the mitigation volume based on volumetric proportioning. The preliminary, weekly mitigation distribution will be used by the FWA **for communication purposes only** (i.e., as the best available estimate of end-of-month mitigation requirements when communicating internally and with Friant Contractors). The mitigation water distribution will be updated at the end of each calendar month based on quality-controlled delivery data.

Ledger Calculations

The FWA will input water order data into the Ledger to be used in the mitigation water distribution calculations. The Ledger will determine the average weekly mixing interface position based on the weekly volumes for periods during FKC pump-back operations. An option to manually set the mixing interface position will also be available in the Ledger.

Assumptions

- Deliveries will be aggregated by Friant Contractor, and divided into pools, defined as the canal section between check structures.
- The division of deliveries by a Friant Contractor that has turnouts in multiple pools will be based on historical deliveries.
- Only Central Valley Project (CVP) (Class 1, Class 2, 215, and San Joaquin River Restoration Program (SJRRP) Recovered Water Account (RWA) and Unreleased Restoration Flow (URF)) deliveries for the Friant Contractors will be used to calculate the mitigation distribution.
- The interface, or location along the FKC that receives water from both gravity and reverse flow, will be determined using a weekly mass balance. An option will also be included to manually define the interface.
- The FKC Pool with the Interface will be assumed to be fully mixed with gravity and reverse flow.

END OF MONTH WATER ACCOUNTING

At the end of each month that a pump-in project is operating, the preliminary mitigation water distribution will be updated based on quality-controlled delivery data for both the pump-in project and Friant Contractors. The updated mitigation distribution volume will be shared with impacted Friant Contractors and included as part of their normal water accounting. The mitigation volume will be assumed to be the first water taken for their monthly deliveries. For pump-in project proponents that take more water than pump-in project delivery minus the mitigation volume, proponents will be assumed to make up that delivery with their CVP contract supply. For pump-in projects that end with water delivery to a Friant Contractor, adjustments for mitigation volumes are not needed.

For pump-in projects that do not end with delivery to a Friant Contractor, there is potential need for a mitigation volume adjustment. For these pump-in projects, FWA will track pump-in project water introduced into the FKC and deliveries to the non-Friant Contractor. If the volume of mitigation water is not equal to the expected volume, FWA will contact the pump-in project proponent to either increase the mitigation volume or increase their own delivery.

Ledger Calculations

FWA will add quality-controlled data to the Ledger at the end of each calendar month. The Ledger will replace the preliminary data and recalculate the mitigation water distribution to determine the monthly volumes of mitigation delivery, pump-in project delivery, and CVP delivery.

Assumptions

- Mitigation water delivery to impacted Friant Contractors is the first water to be delivered.
- If delivery to a pump-in project proponent exceeds pump-in project input to FKC minus the mitigation volume, the remainder will be accounted for as CVP delivery.

FINAL WATER ACCOUNTING

The end of the month water accounting will be provided to the Friant Contractors for confirmation and their use for accounting with Reclamation. Friant Contractors will clearly show mitigation on their accounting reports as a separate volume of water. As needed, Friant Contractors will work with Reclamation to revise reporting in a timely manner. Mitigation volumes should be rounded and reported as a whole number in acre-feet.

WATER QUALITY ANNUAL REPORTING

The water quality for each year will be maintained in a database by FWA. The mitigation curve developed for the Ledger, as part of the Guidelines, uses relationships between water quality constituents of concern and

in-prism measurements of EC. At the conclusion of each year, the relationships will be updated with new water quality data collected during the year. The updated relationship will be shared with the Friant Contractors. Reclamation may also propose and/or require modifications to the Guidelines in coordination with FWA. Additionally, the Guidelines may be re-evaluated if any of the following conditions occurs:

- A future regulatory cost or equivalent fee is imposed on Friant Contractors and a portion of such fee can reasonably be attributed to the incremental difference of water quality conditions in the FKC.
- When Friant Division Class 1 contract allocation is less than or equal to 25 percent, the Water Quality Advisory Committee will convene as outlined in Attachment A of the Guidelines. In these years, mitigation will be accounted for as presented in these Guidelines, but will be deferred to a mutually agreed to later date unless those responsible for the put and take mutually agree to put and take the mitigation in the critical year. All monitoring requirements will remain as presented in the Guidelines.
- There is a significant, regulatory change or scientifically based justification and three out of the following five Friant Contractors agree and work with the Water Quality Advisory Committee to recommend a change: (1) Arvin-Edison Water Storage District, (2) Shafter Wasco Irrigation District, (3) Delano-Earlimart Irrigation District, (4) South San Joaquin Municipal Utility District, and (5) Kern-Tulare Water District.

Attachment E. FKC Water Quality Guidelines Cost Allocation

**Special Project
Summary Sheet**
Budget Sheet

Project Title: Friant-Kern Canal Water Quality Guidelines

Job Code: 6370

Project Location: Friant-Kern Canal (entire 152 miles)

Project Description: Friant Water Authority implementation and administration of the Friant-Kern Canal (FKC) Water Quality Guidelines (Guidelines). The Guidelines include requirements of discharge of water into the FKC, monitoring and reporting requirements, management, mitigation, communications, and forecasting.

Estimated Annual Project Costs (x1000): \$189.4

Materials and Laboratory

The continuous, real-time sampling of electrical conductivity (EC) at each of the specified check structures requires FWA to install a total of fourteen (14) Seametrics CT2X conductivity meters in the canal, at each structure. Costs for purchase and installation of the real-time water quality monitoring equipment, including integration with IOS, are approximately \$60,477 (\$1,898 per unit cost and total of \$33,905 for installation). It is assumed the useful life of a Seametrics CT2X conductivity meter is about 10 years at an interest rate of 3%. Additionally, FWA staff will maintain two (2) existing handheld Hanna DIST5 conductivity meters. Real-time water quality monitoring equipment and handheld conductivity meters will be calibrated and maintained according to manufacturer recommendations. Costs for maintenance of equipment is estimated to be about 10% of the capital cost (\$6,048 annually, shown as Item 5 in Table 1 below).

Table 1 summarizes the annual materials and lab costs of each monitoring requirement. Specifically, the item numbers in Table 1 refer to the sample source/type item numbers presented in Attachment B – Monitoring Program Summary. Details regarding assumptions are outlined in the narrative following Table 1.

Table 1: Materials and laboratory costs associated with monitoring activities.

Item ¹	Description	Estimated Annual Cost
5	Annual maintenance of equipment for continuous, real-time sampling of electrical conductivity at each specified check structure	\$6,048
6	Estimated exceedance testing	\$936
8	Weekly testing at FKC-CVC Intertie during pump-back operations	\$23,788
9	Testing during initiation of FKC-CVC Intertie pump-back operations	\$11,490
Materials and Lab Testing Subtotal:		\$42,262

¹ Item numbers refer to sample source/type item numbers presented in Attachment B.

Most requirements of the monitoring program (items 6 through 9 in Table 1) require FWA to collect samples and send them to labs for testing. Testing can include a full list of Title 22 constituents in Table 1 of the Guidelines, the short list of constituents in Table 4 of the Guidelines, or single constituents. Testing costs can vary significantly by lab. To be conservative, it was assumed that testing for full Title 22 constituents would be \$5,745, testing for the short list of constituents in Table 4 of the Guidelines would be \$915, and testing for single constituents would be \$59/constituent.

For a given year, it was assumed that single constituents would exceed the thresholds for two months per year and would result in 16 tests annually (4 weekly tests for each month with an exceedance, and 4 weekly tests below the threshold after the exceedance). This results in a total cost of \$936 for testing because of exceedances (item 6 in Table 1). Costs for EC testing during operations outages were not included as this will be done with the handheld units by FWA staff. It was assumed that pump-back operations would occur during 6 months of the year, which would require 26 samples of the full list of constituents in Table 4 of the Guidelines. This results in a total cost of \$23,788 for testing because of pump-back operations (item 8 in Table 1). Finally, it was assumed that full Title 22 testing due to initiation of pump-back operations or anticipated Cross Valley Canal operations that will impact water quality will occur two times per year and will cost \$11,490.

Annualized Capital Install and Replacement of Equipment Subtotal: \$7,090

Annual Materials and Lab Testing Subtotal: \$42,262

Friant Water Authority Staff

For implementation of the Guidelines, the following activities will be required of FWA staff:

- Maintain and calibrate conductivity meters on a bi-weekly basis
- Perform water quality sampling during pump-in operations
- Coordinate laboratory water quality testing
- Coordinate with Friant Division Long-Term Contractors on water quality data monitoring and analysis
- Manage water quality and operations database
- Perform weekly water quality reporting and forecasting using FKC Water Quality Model
- Perform weekly analysis to determine mitigation and distribution to respective Friant Division Long-Term Contractors using the FKC Water Quality Mitigation Ledger
- Coordinate with U.S. Department of the Interior, Bureau of Reclamation’s South-Central California Area Office on water quality reporting, mitigation, and contractual requirements
- Coordinate and facilitate FWA committee on water quality

The annual cost for FWA Executive Team and Operations staff is estimated below:

Executive Team (WRM).....	104 hrs @\$111.43/hr	\$11,589
Water Operations (Senior Engineer).....	1664 hrs @\$77.16/hr	\$128,400

Annual Staff Labor Subtotal: \$139,989

General Justification: The Board of Directors, at the request of the Water Quality Ad Hoc Committee requested that staff develop new water quality guidelines for non-Millerton water introduced into the FKC. This plan originally stemmed from the environmental compliance requirements of both the Long-Term Recapture and Recirculation Plan and the FKC Reverse Pump-back Project.

Operating Impact: This estimate assumes implementation of the Guidelines will occur. Although the costs for finalizing the Guidelines, agreements, and environmental compliance will be applied separately, the administration and water quality monitoring outlined in the Guidelines will be applied to 6370. A portion of these costs will be reimbursed through a surcharge applied to those Friant contractors that introduce water into the FKC once the Guidelines are implemented.

Cost Allocation: Costs for implementation and administration of the Policy will be paid initially by the subset of Friant Division Long-Term Contractors who pay for FKC O&M to the FWA and subsequently will be reimbursed by contractors that introduce water (Put into the FKC (Contributor). The Contributor will pay a dollar per acre-foot (\$/acre-foot[AF]) surcharge, or ‘Guidelines Surcharge,’ that will be credited back to the Friant Division Long-Term Contractors who pay for O&M to the FWA. The Guidelines Surcharge will be calculated by dividing the total annual costs incurred for administration of the Guidelines Program by the total annual deliveries of pump-in programs into the FKC. The Guidelines Surcharge will be applied to all introduced water even if it is not required to provide mitigation as defined in the Guidelines. Surcharge estimates can be provided for budgeting purposes on an annual basis. FWA will bill contractors for reimbursement of Guidelines Program costs based on actual volumes and costs incurred.

Guidelines Surcharge Estimate: Current pump-in programs pump approximately 36.6 thousand acre-feet (TAF) per year into the FKC based on recent 5-year average (2013-2018) as shown in Table 2.

Table 2: Current Pump-In Program 5-year Average (2013-2018)

Source	Annual Average (TAF)	Annual Maximum ¹ (TAF)
Sierra Water	17.8	344
Groundwater	14.7	117
CVC	4.1	149
Total Annual Average	36.6	610

¹ Based on existing compliance and approvals and anticipated renewals.

The potential annual maximum is much greater than the annual average; however, for purposes of setting an initial Guidelines Surcharge, an estimated 40 TAF per year of pump-ins is assumed to occur. This estimate includes the recent average of existing programs and anticipated 10% initial increase due to new programs or greater use of existing programs.

Monitoring and lab costs can be allocated based on location or source of introduced water. It is assumed that all monitoring and lab costs associated with operations at the CVC Intertie will be allocated to a surcharge applied only to water being brought in from the CVC. All other

monitoring and lab costs (e.g., lab costs associated with exceedances) will be allocated to other pump-ins. Other costs (e.g., annual maintenance of equipment, staff time) would be allocated to all pump-ins via a surcharge base.

Based on this approach, the estimated **Guidelines Surcharge would average about \$10.73 per AF for CVC Water and \$3.88 per AF for other pumps ins.** Each surcharge would increase about \$0.70 per AF if the surcharge were to consider recovering CEQA compliance costs over 10 years. The surcharge applied at the end of every year will be based on actual costs and deliveries, and methods for allocation can be reassessed every year by the Water Quality Advisory Committee.

**Extraordinary Maintenance Projects
Cost Summary**

Project Title: Friant Kern Canal Water Quality Program

Project Location and Department: Friant-Kern Canal (entire 152 miles) / Operations
Department

Estimated Total Project Cost (x1000): \$189.4

Estimated Total Material Cost (Including Fuel Costs, x1000): \$49.4

Breakdown of Estimated Costs

*All costs outside of Friant staff costs for CEQA compliance are not covered as part of this program
cost budget.*

Materials and Laboratory

Annualized Capital Install and Replacement of Equipment	\$7,090
Annual Materials and Lab Testing	\$42,246

Subtotal: \$49,336

Regular Labor (Hours and Cost):

Executive Team (WRM)..... 104 hrs @\$111.43/hr	\$11,589
Water Operations (Senior Engineer).....1664 hrs @\$77.16/hr	\$128,400

Subtotal: \$139,989

Total: \$189,325

Guidelines Surcharge (CVC) \$10.73 per AF

Guidelines Surcharge (All other) \$4.58 per AF

Appendix B
**Mitigation Monitoring and
Reporting Program**

APPENDIX B

Mitigation Monitoring and Reporting Program

Introduction

Public Resources Code (PRC) Section 21081.6 and Section 15097 of the California Environmental Quality Act (CEQA) Guidelines require public agencies to adopt a program for monitoring or reporting on the revisions which it has required in the project and the measures it has imposed to mitigate or avoid significant environmental effects, in order to ensure that the mitigation measures and project revisions are implemented.

This Mitigation Monitoring and Reporting Program (MMRP) identifies the mitigation measures adopted by the Friant Water Authority (Friant) from the *Guidelines for Accepting Water into the Friant-Kern Canal* (proposed Guidelines) Environmental Impact Report (EIR). It also identifies: (1) responsibility for implementation of the mitigation measures; (2) responsibility for monitoring implementation of mitigation measures; (3) actions taken to monitor and report on implementation; and (4) timing of actions. Mitigation measures are numbered consistent with the numbering included in the proposed Guidelines EIR (State Clearinghouse No. 2022120093).

The MMRP table (Table B-1) includes the following:

- **Mitigation Measure:** lists the adopted mitigation measures from the proposed Guidelines EIR.
- **Responsibility for Implementing:** identifies the entity(ies) responsible for implementing the actions described in the mitigation measures.
- **Responsibility for Monitoring:** identifies the entity(ies) responsible for monitoring implementation of the actions described in the mitigation measures.

Monitoring and Reporting Actions: describes the actions taken to monitor and report implementation of the mitigation requirements.

Timing: identifies the timing of implementation of the actions described in the mitigation measures. Implementation of the action must occur before or during some part of project approval, project design, or construction, or on an ongoing basis.

Definition of terms used in MMRP:

Entity implementing action in response to the proposed Guidelines: the term “entity” can refer to Contractors¹ that might need to take certain actions to comply with the proposed Guidelines with respect to existing programs and future projects. In addition, it can refer to Friant or Contractors that may need to construct and/or maintain facilities for monitoring and forecasting water quality (e.g., water quality monitoring stations). Entities are also the CEQA lead agencies.

CEQA: California Environmental Quality Act

CDFW: California Department of Fish and Wildlife

CHRIS: California Historical Resources Information System

DPR: Department of Parks and Recreation

HCS: California Health and Safety Code

NAHC: California Native American Heritage Commission

USFWS: United States Fish and Wildlife Service

PRC: Public Resources Code

SOI PQS: U.S. Secretary of the Interior’s Professional Qualifications

USACE: United States Army Corps of Engineers

¹ “Contractors” are defined as water contractors and other parties authorized to introduce or receive Non-Millerton water into or from the Friant-Kern Canal.

Mitigation Measure	Responsibility for Implementing	Responsibility for Monitoring	Monitoring and Reporting Actions	Timing
Biological Resources				
Mitigation Measure 3.5-1a: One botanical survey shall be conducted prior to construction activities to determine the presence or absence of special-status plant species within the construction footprint, including staging and haul routes. The surveys shall be conducted in general accordance with the Protocols for Surveying and Evaluating Impacts to Special-Status Native Plant Populations and Natural Communities (CDFW 2018) and shall be timed to appropriately coincide with the blooming period in all suitable habitat located within any anticipated disturbance areas.	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	Verify and document that surveys were conducted in the construction footprint in general accordance with CDFW Protocols for Surveying and Evaluating Impacts to Special-Status Native Plant Populations and Natural Communities.	Prior to construction; during appropriate blooming period
Mitigation Measure 3.5-1b: In the event that special-status plant species are found during the botanical surveys, the locations of the special-status plants shall be marked and a 50-foot buffer shall be established as avoidance areas both in the field, using flagging, staking, fencing, or similar devices, and on construction plans.	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	Verify and document that 50-foot buffers were installed to protect special-status plant species.	Prior to construction
Mitigation Measure 3.5-1c: If non-listed, special-status plants are identified during botanical surveys and complete avoidance is not practicable, coordination with CDFW and/or USFWS shall be conducted as appropriate to develop the conservation plan. No take of state-listed species shall occur without an Incidental Take Permit (ITP) from CDFW.	Entity implementing action in response to Guidelines	Entity implementing action in response to Guidelines	Verify and document development of conservation plan in coordination with CDFW and/or USFWS.	Prior to construction
Mitigation Measure 3.5-1d: To avoid special-status wildlife habitat, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures: <ul style="list-style-type: none"> To the extent practicable, site(s) shall be identified that avoid habitats of special-status species (which may include foraging, sheltering, migration, and rearing habitat in addition to breeding or spawning habitat). Buffers around special-status species habitats shall be established to exclude effects of construction activities. The size of the buffer shall be in accordance with USFWS and CDFW protocols for the applicable special-status species. To the extent practicable, construction activities shall be scheduled to avoid special-status species' breeding, spawning, or migration locations during the seasons or active periods that these activities occur. Where impacts on special-status species are unavoidable, impacts shall be compensated for by restoring or preserving in-kind suitable habitat on-site or off-site, or by purchasing restoration or preservation credits. 	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	Verify and document: <ul style="list-style-type: none"> special-status species habitat was avoided to extent practicable. buffers were installed in accordance with USFWS and CDFW protocols construction activities were scheduled to avoid breeding, spawning or migration seasons. compensation, restoration or preservation of in-kind habitat on or off site was implemented, as appropriate. 	Prior to and on-going during construction Prior to construction Prior to construction Prior to construction
Mitigation Measure 3.5-1e: To protect wildlife, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures: <ul style="list-style-type: none"> Avoidance of Vegetation Disturbance. Sites shall be selected that will minimize, to the greatest extent feasible, the amount of soil and upland vegetation disturbance during construction and use methods creating the least disturbance to vegetation. Disturbance to existing grades and native vegetation, the number of access routes, the size of staging areas, and the total area disturbed shall be limited to the extent of all temporary and permanent impacts as defined by the final project design. Environmental Awareness Training. Prior to engaging existing or new personnel in construction activities, new construction personnel shall participate in environmental awareness training conducted by an agency-approved biologist or resource specialist. Construction personnel will be informed about the identification, potential presence, legal protections, and avoidance and minimization measures relevant to special-status species that potentially occur on the site. Environmental Monitoring. A qualified biologist shall ensure that all applicable protective measures are implemented during construction. The qualified biologist shall have authority to stop any work if they determine that any permit requirement is not fully implemented. The qualified biologist will prepare and maintain a monitoring log of construction site conditions and observations, which will be kept on file by the lead agency. Work Area and Speed Limits. All construction work and materials staging shall be restricted to designated work areas, routes, staging areas, temporary interior roads, or the limits of existing roadways. <ul style="list-style-type: none"> Prior to start of work, brightly colored fencing or flagging or other practical means shall be erected to demarcate the limits of the activities within 100 feet of sensitive natural communities and habitat areas (e.g., any aquatic features), including designated staging areas; ingress and egress corridors; stockpile areas, soil, and materials; and equipment exclusion zones. Flagging or fencing shall be maintained in good repair for the duration of construction activities. Vehicles shall obey posted speed limits and will limit speeds to 20 miles per hour within the study area on unpaved surfaces and unpaved roads to reduce dust and soil erosion and avoid harm to wildlife. Daily Removal of Food Trash. All food trash shall be properly contained within sealed containers, removed from the work site, and disposed of daily to prevent attracting wildlife to construction sites. 	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	Verify and document: <ul style="list-style-type: none"> sites were selected to minimize vegetation disturbance. -qualified biologist conducted environmental awareness training. -qualified biologist monitored compliance with applicable protective measures. 	Prior to construction On-going during construction On-going during construction

Mitigation Measure	Responsibility for Implementing	Responsibility for Monitoring	Monitoring and Reporting Actions	Timing
<p>Mitigation Measure 3.5-1f: To protect nesting birds, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures:</p> <ul style="list-style-type: none"> To the extent practicable, vegetation removal shall be scheduled to avoid the breeding season for nesting raptors and other special-status birds (generally February 1 through August 31, depending on the species). Removal of vegetation outside of the nesting season is intended to minimize the potential for delays in vegetation removal due to active nests. If work is to occur during the breeding season for nesting birds, a qualified biologist shall conduct a minimum of one pre-construction survey for nesting migratory birds and raptors within the project area for all construction-related activities that will occur during the nesting season. The pre-construction survey shall be conducted no more than 15 days prior to the initiation of construction in a given area and will be phased based on the construction schedule. If an active nest is found, a construction-free buffer zone (250 feet for migratory birds, 500 feet for raptors) shall be established around the active nest site. If establishment of the construction-free buffer zone is not practicable, appropriate conservation measures (as determined by a qualified biologist and approved by CDFW) shall be implemented. These measures may include but are not limited to consulting with CDFW to establish a different construction-free buffer zone around the active nest site, conducting daily biological monitoring of the active nest site, and delaying construction activities in the vicinity of the active nest site until the young have fledged. If burrowing owls are detected within the project area during the non-breeding season and maintaining a 150-foot, no-disturbance buffer is not practicable, a qualified biologist shall submit an exclusion and passive-relocation plan to CDFW for approval. The exclusion and passive-relocation plan will generally follow the guidelines outlined in Appendix E of the Staff Report on Burrowing Owl Mitigation (CDFG 2012). If occupied burrows are detected during the breeding season and maintaining a 250-foot no-disturbance buffer is not practicable, CDFW will be consulted to determine and approve alternative measures to minimize the potential for disturbance to occupied burrows and nesting activities. Measures may include but are not limited to continuous biological monitoring by a qualified biologist until it has been determined that the young have fledged and are no longer reliant on the nest or parental care for survival or construction is complete. No direct disturbance of burrows with eggs or young can be conducted without written authorization from CDFW and USFWS. For construction activities that occur between February 1 and August 31, a qualified biologist shall conduct pre-construction surveys for raptors. The pre-construction surveys will include the project footprint and a minimum of a 0.50-mile radius where access is permitted around the construction area in suitable nesting habitat (i.e., large trees). The preconstruction surveys shall be conducted no more than 10 days before ground disturbance in a given area and will be phased based on the construction schedule. If nesting raptors are detected, an appropriate no-disturbance buffer (initially set at 500 feet for raptors; reductions in the standard buffer for raptors may be allowed where circumstances suggest the birds will not abandon the active nest with a reduced buffer size. A qualified biologist will determine whether reducing the buffer is likely to substantially increase disturbance of nesting birds, taking into account the presence or absence of dense vegetation, topography, or structures that would block project activities from view; the life history and behavior of the bird species in question; and the nature of the proposed activity. If a reduced buffer is implemented, the biologist shall monitor bird behavior in relation to work activities. At a minimum, the biologist will monitor the baseline behavior of the birds for at least 30 minutes prior to the commencement of the work activity and for at least one hour immediately following the initiation of the work activity, when response by the nesting birds to the novel activity is expected to be greatest) shall be established and monitored by a qualified biologist. Buffers shall be maintained until a qualified biologist has determined that the young have fledged and are no longer reliant on the nest or parental care for survival. If construction results in permanent loss of alfalfa fields (high-quality foraging habitat for Swainson's hawk), this loss shall be mitigated; at a minimum of a 1:1 ratio. Mitigation shall occur in coordination with CDFW and may consist of but is not limited to purchasing mitigation credits from a CDFW-approved mitigation bank, obtaining conservation easements with appropriate provisions to maintain the land as suitable foraging habitat in perpetuity, establishing new alfalfa fields, or implementing other habitat conservation measures as approved by CDFW. 	<p>Entity implementing action in response to Guidelines Construction Contractor</p>	<p>Entity implementing action in response to Guidelines</p>	<p>Verify and document:</p> <ul style="list-style-type: none"> vegetation removal was scheduled to avoid breeding season for nesting raptors; qualified biologist conducted pre-construction surveys for nesting migratory birds and raptors. buffers for nesting burrowing owls were installed in accordance with USFWS and CDFW protocols. mitigation for loss of foraging habitat was implemented in coordination with and approval by CDFW. 	<p>Prior to construction (February 1 - August 31)</p> <p>Prior to and during construction</p> <p>Prior to construction</p>
<p>Mitigation Measure 3.5-1g: To protect special-status amphibians and reptiles, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures:</p> <ul style="list-style-type: none"> If western spadefoot is encountered during construction activities, it will be allowed to move out of harm's way of its own volition, or a qualified biologist will relocate it to the nearest suitable habitat that is at least 100 feet outside of the construction impact area. Prior to moving equipment at the start of a day, construction personnel shall inspect underneath parked vehicles and heavy machinery for amphibians or reptiles. If any are found, they will be allowed to move out of the construction area under their own volition, or a qualified biologist will relocate the organism(s) to the nearest suitable habitat that is at least 100 feet outside of the construction impact area. 	<p>Entity implementing action in response to Guidelines Construction Contractor</p>	<p>Entity implementing action in response to Guidelines</p>	<p>Verify and document that special-status amphibians and reptile encountered during construction activities were allowed to move on their own out of harm's way or be relocated by a qualified biologist to nearest suitable habitat at least 100 feet outside construction area.</p>	<p>On-going during construction</p>
<p>Mitigation Measure 3.5-1h: To protect Crotch's bumble bee, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures:</p> <ul style="list-style-type: none"> If construction activities will involve conversion of grassland or shrublands, a survey for Crotch's bumble bee shall be conducted prior to construction activities during the Crotch's bumble bee active period (i.e., March to July). The survey will be a visual survey conducted by a qualified biologist who will search for Crotch's bumble bee activity and the presence of ground nests. If an active ground nest is observed, it shall be avoided. If avoidance of the active nest is not possible, CDFW will be consulted for approval of alternative measures to protect the Crotch's bumble bee. 	<p>Entity implementing action in response to Guidelines</p>	<p>Entity implementing action in response to Guidelines</p>	<p>Verify and document:</p> <ul style="list-style-type: none"> qualified biologist conducted survey. active ground nests were avoided or if avoidance was not possible, CDFW was consulted and approved alternative measures were implemented 	<p>Prior to construction (March - July)</p> <p>On-going during construction</p>
<p>Mitigation Measure 3.5-1i: To protect San Joaquin kit fox, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures:</p> <ul style="list-style-type: none"> Before the start of ground-disturbing activities within suitable habitat areas for San Joaquin kit fox (i.e., alkali desert scrub, annual grassland, pasture, barren) an approved biologist shall conduct preconstruction surveys in accordance with USFWS' Standardized Recommendations for Protection of the San Joaquin Kit Fox prior to or during Ground Disturbance (USFWS 2011). Preconstruction surveys shall be conducted no less than 14 days and no more than 30 days prior to the beginning of ground disturbance and/or construction activities or any project activity likely to impact the San Joaquin kit fox. If a natal/pupping den is discovered within the work area or within 200-foot buffer of the work area boundary, the USFWS shall be immediately notified and under no circumstances should the den be disturbed or destroyed without prior authorization from USFWS. If the preconstruction survey reveals an active natal/pupping den, the Contractor shall contact the Service immediately to obtain the necessary take authorization. No construction work shall be allowed within 200 feet of the newly discovered natal/pupping den without written approval from the Service. 	<p>Entity implementing action in response to Guidelines Construction Contractor</p>	<p>Entity implementing action in response to Guidelines</p>	<p>Verify and document:</p> <ul style="list-style-type: none"> qualified biologist conducted survey in accordance with USFWS' Standardized Recommendations for Protection of the San Joaquin Kit Fox. construction work was stopped, USFWS was notified, and necessary take authorization was obtained for active dens identified within work area and 200-foot of work area boundary 	<p>Between 14 and 30 days prior to construction</p> <p>On-going during construction</p>

Mitigation Measure	Responsibility for Implementing	Responsibility for Monitoring	Monitoring and Reporting Actions	Timing
<p>Mitigation Measure 3.5-1j: To protect Tipton kangaroo rat, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures:</p> <ul style="list-style-type: none"> • Before the start of construction, the approved biologist shall conduct a habitat assessment to determine presence of special-status small mammal species burrows or their signs. If no observations, burrows, or signs of special-status small-mammal species are detected, no further measures will be required. • If burrows and signs of special-status small mammal species are observed, the approved biologist will conduct protocol-level surveys in accordance with Survey Protocol for Determining Presence of San Joaquin Kangaroo Rats (USFWS 2013) • If signs of Tipton kangaroo rat are detected during the survey, the Contractor, under the supervision of the approved biologist, shall establish non-disturbance exclusion zones (using wildlife exclusion fencing [e.g., a silt fence or similar material]). The non-disturbance exclusion fence with one-way exit/escape points shall be placed to exclude the Tipton kangaroo rat from the construction area. 	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	<p>Verify and document:</p> <ul style="list-style-type: none"> • approved biologist conducted habitat assessment. • approved biologist conducted protocol-level survey in accordance with USFWS Survey Protocol for Determining Presence of San Joaquin Kangaroo Rats. • approved biologist established non-disturbance exclusion zones. 	<p>Prior to construction</p> <p>Prior to and on-going during construction</p> <p>Prior to and on-going during construction</p>
<p>Mitigation Measure 3.5-1k: To protect American badger, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures:</p> <ul style="list-style-type: none"> • No more than 30 days before the start of construction activities, a qualified biologist shall conduct pre-construction surveys for American badgers within suitable habitat on the project site. If a potentially active den is found in a construction area, a burrow probe shall be used to determine the presence of badgers, or the den openings may be monitored with tracking medium or an infrared-beam camera for three consecutive nights to determine current use. Potential (inactive) dens within the limits of disturbance shall be blocked or excavated to prevent use during construction. If American badgers or active dens are detected during these surveys, the following measures shall be implemented. • Disturbance of any American badger dens shall be avoided to the extent practicable. American badger dens are used for shelter, escape, cover, and reproduction, and are thus vital to the survival of American badgers. If present, occupied badger dens shall be flagged, and ground-disturbing activities avoided, within 50 feet of the occupied den during the nonbreeding season (July 1 through February 14). Dens determined to be occupied during the breeding season (February 15 through June 30) shall be flagged, and ground-disturbing activities avoided, within 200 feet to protect adults and nursing young. Buffers may be modified by a qualified biologist with the written concurrence of CDFW. • If avoidance of an active non-maternity den is not feasible, badgers shall be relocated by slowly excavating the burrow (either by hand or with mechanized equipment under the direct supervision of a qualified biologist) before or after the rearing season (February 15 through June 30). Any passive relocation of American badgers shall occur only under the direction of a qualified biologist. 	Entity implementing action in response to Guidelines Contract Contractor	Entity implementing action in response to Guidelines	<p>Verify and document:</p> <ul style="list-style-type: none"> • qualified biologist conducted survey. • Occupied American badger dens were flagged by qualified biologist and ground disturbing activities avoided within 50-feet of den. • Occupied American badger dens were flagged by qualified biologist and ground disturbance avoided within 200-feet of den during breeding season. • any modification to buffers were implemented by qualified biologist with written concurrence of CDFW. • any passive relocation of American badgers conducted under direction of qualified biologist. 	<p>No more than 30 days prior to construction</p> <p>Prior to construction (July 1 – February 14)</p> <p>Prior to construction (February 15-June 30)</p> <p>Prior to construction</p> <p>Prior to construction (February 15-June 30)</p>
<p>Mitigation Measure 3.5-2: To avoid or minimize disturbance of sensitive natural communities, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures:</p> <ul style="list-style-type: none"> • Avoidance of Sensitive Natural Communities. The proponent of the action will select sites that will avoid sensitive natural communities, including riparian habitats, by doing the following: <ul style="list-style-type: none"> ○ To the maximum extent practicable, project elements shall be designed to avoid effects on sensitive natural communities. ○ Flagging or fencing shall be installed by a qualified biologist around any sensitive natural community to be avoided by construction. ○ Flagging or fencing shall remain in place throughout the duration of the construction activities and will be inspected and maintained regularly by a qualified biologist until completion of construction activities. Fencing shall be removed when all construction equipment is removed from the site, the area is cleared of debris and trash, and the area is returned to natural conditions. ○ Where impacts on sensitive natural communities other than waters of the United States or state are unavoidable, impacts shall be compensated for by restoring and/or preserving in-kind sensitive natural communities on-site, or off-site at a nearby site, or by purchasing in-kind restoration or preservation credits from a mitigation bank. • Restoration of Temporarily Affected Areas. For any areas temporarily affected by construction activities, the following measures shall be implemented: <ul style="list-style-type: none"> ○ Prepare a restoration plan for sites with temporary impacts, for review by CDFW. ○ Minimize soil disturbance and stockpile topsoil for later use in any areas to be graded. ○ Amend soil as necessary before installing replacement plants. ○ Use only native plant species for revegetation. • Preservation of Large Trees. Existing native vegetation shall be retained as practicable, with special focus on the retention of shade-producing and bank-stabilizing trees and brush with greater than 6-inch-diameter branches or trunks. If large trees must be removed, compensation shall be implemented within 12 months of removal of such large trees. Compensation shall be implemented through one of three mechanisms or some combination thereof: (1) replacement via replanting at a minimum ratio of 1:1 based on a diameter-at-breast-height (DBH) basis, (e.g., planting six 1-inch DBH trees for a single, removed 6-inch DBH tree); (2) permanent preservation of large, native trees, which could include, but not be limited to, establishment of a conservation easement on lands that support native trees; or (3) contribution to the respective, established, approved tree conservation fund where the tree impact occurred. • Avoidance of Excessive Soil Compaction. Wherever possible, vegetation disturbance and soil compaction shall be minimized by using low-ground-pressure equipment with a greater reach than other equipment, or that exerts less pressure per square inch on the ground. • Materials and Methods of Native and Invasive Vegetation Removal. If riparian vegetation is removed with chain saws or other power equipment, machines that operate with vegetable-based bar oil will be used, if practicable. All invasive plant species (e.g., those rated as invasive by the California Invasive Plant Council or local problem species) shall, if feasible, be removed using locally and routinely accepted agricultural practices. Stockpiling of invasive plant materials is prohibited during the flood season. 	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	<p>Verify and document for Sensitive Natural Communities:</p> <ul style="list-style-type: none"> • sites were selected to minimize disturbance of sensitive natural communities. • qualified biologist installed flags or fencing around sensitive natural community • compensation, restoration or preservation of in-kind habitat on or off site was implemented, as appropriate. <p>Verify and document for restoration of construction areas:</p> <ul style="list-style-type: none"> • Measures to protect and restore construction areas have been implemented including those for preservation of large trees, soil compaction, native vegetation. • invasive vegetation was removed using locally and routinely accepted agricultural practices and stockpiling of invasive plant material has not occurred during flood season. • Construction areas have been restored to preconstruction conditions or redesigned to provided increased biological and hydrological function, using a CDFW-approved plant palette. 	<p>Prior to construction</p> <p>Prior to construction until end of construction</p> <p>Prior to construction</p> <p>On-going during construction and at end of construction</p>

Mitigation Measure	Responsibility for Implementing	Responsibility for Monitoring	Monitoring and Reporting Actions	Timing
<ul style="list-style-type: none"> Revegetation of Disturbed Areas. All temporarily disturbed areas shall be de-compacted and seeded/planted with a mix of native riparian, wetland, and/or upland plant species suitable for the area. The proponent of the action shall develop a revegetation plan, including (as applicable) a schedule; plans for grading of disturbed areas to pre-construction contours; a planting palette with plant species native to the study area; invasive species management; performance standards; and maintenance requirements (e.g., watering, weeding, and replanting). Plants for revegetation shall come primarily from active seeding and planting; natural recruitment may also be proposed if site conditions allow for natural recruitment to reestablish vegetation and avoid potential negative risks associated with erosion and impacts on water quality. Plants imported to the restoration areas will come from local stock, and to the extent possible, from local nurseries. Only native plants (genera) will be used for restoration efforts. Certified weed-free native mixes and mulch will be used for restoration planting or seeding. Revegetation Materials and Methods. Following the completion of work, site contours shall be returned to preconstruction conditions or redesigned to provide increased biological and hydrological functions. <ul style="list-style-type: none"> Any area barren of vegetation as a result of implementation of an action shall be restored to a natural state by mulching, seeding, planting, or other means with native trees, shrubs, willow stakes, erosion control native seed mixes, or herbaceous plant species. Where disturbed, topsoil shall be conserved for reuse during restoration to the extent practicable. Native plant species comprising a diverse community structure (plantings of both woody and herbaceous species, if both are present) that follow a CDFW-approved plant palette shall be used for revegetation of disturbed and compacted areas, as appropriate. Irrigation may also be required to ensure the survival of shrubs, trees, or other vegetation. Soils that have been compacted by heavy equipment shall be de-compacted, as necessary, to allow for revegetation. Materials and Methods of Revegetation Erosion Control. If erosion control fabrics are used in revegetated areas, they shall be slit in appropriate locations to allow for plant root growth. Only non-monofilament, wildlife-safe fabrics shall be used. Revegetation Monitoring and Reporting. All revegetated areas shall be maintained and monitored for a minimum of two years after replanting is complete and until success criteria are met, to ensure that the revegetation effort is successful. The standard for success is 60 percent absolute cover compared to an intact, local reference site. If an appropriate reference site cannot be identified, success criteria will be developed for review and approval by CDFW on a project-by-project basis based on the specific habitat affected and known recovery times for that habitat and geography. A summary report of the monitoring results and recommendations at the conclusion of each monitoring year shall be prepared. 			<ul style="list-style-type: none"> revegetated sites have been maintained and monitored for a minimum of two years after replanting was complete and until success criteria developed in consultation with and approved by CDFW was met. A summary report of the monitoring results and recommendations was prepared at the conclusion of each monitoring year. 	Two years following revegetation End of each year following revegetation
<p>Mitigation Measure 3.5-3: To avoid or minimize disturbance to wetlands and waters, Contractors implementing actions in response to the proposed Guidelines shall implement the following measures:</p> <ul style="list-style-type: none"> Avoidance of Jurisdictional Wetlands and Other Waters. Sites shall be selected that shall avoid, minimize, and if necessary, compensate for reduction in area and/or habitat quality of wetlands and jurisdictional waters, through the following measures: <ul style="list-style-type: none"> To the maximum extent practicable, elements of Contractor actions shall be designed to avoid effects on wetlands and other waters, including rivers, streams, vernal pools, and seasonal wetlands. Flagging or fencing shall be installed by a qualified biologist around any jurisdictional wetland or other aquatic feature to be avoided by construction. Flagging or fencing shall remain in place throughout the duration of construction and will be inspected and maintained regularly by a qualified biologist until completion of the project. Fencing shall be removed when all construction equipment is removed from the site, the area is cleared of debris and trash, and the area is returned to natural conditions. Staging areas, access roads, and other facilities shall be placed to avoid and limit disturbance to waters of the state and other aquatic habitats (e.g., streambank or stream channel, riparian habitat) as much as possible. When possible, existing ingress or egress points shall be used and/or work shall be performed from the top of the creek banks or from barges on the waterside of the stream or levee bank, or dry gravel beds. Wetlands and other waters of the United States, and waters of the state that would be removed, lost, and/or degraded shall be replaced, restored, or enhanced on a "no net loss" basis (in accordance with all permits secured from and related requirements imposed by USACE and State Water Board). 	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	Verify and document: <ul style="list-style-type: none"> sites were selected to minimize disturbance of jurisdictional wetlands and other waters. qualified biologist installed flags or fencing around jurisdiction wetlands and other aquatic features; area is returned to natural conditions. Removal, loss, or degradation of wetlands and other waters of the US and waters of the state are replaced, restored, or enhanced on a "no net loss" basis in accordance with USACE and State Water Board permits and requirements. 	Prior to construction Prior to construction until end of construction activities Prior to construction
<p>See Mitigation Measures 3.5-1, 3.5-2, and 3.5-3</p>	See Mitigation Measures 3.5-1, 3.5-2, and 3.5-3	See Mitigation Measures 3.5-1, 3.5-2, and 3.5-3	See Mitigation Measures 3.5-1, 3.5-2, and 3.5-3	See Mitigation Measures 3.5-1, 3.5-2, and 3.5-3
<p>See Mitigation Measures 3.5-2 and 3.5-3</p>	See Mitigation Measures 3.5-2 and 3.5-3	See Mitigation Measures 3.5-2 and 3.5-3	See Mitigation Measures 3.5-2 and 3.5-3	See Mitigation Measures 3.5-2 and 3.5-3

Mitigation Measure	Responsibility for Implementing	Responsibility for Monitoring	Monitoring and Reporting Actions	Timing
Cultural Resources				
<p>Mitigation Measure 3.6-1a: Before implementation of any construction-related activities associated with the proposed Guidelines, the need for an inventory and significance evaluation of architectural resources shall be assessed, based upon the type of activity and the potential for architectural resources to be present or disturbed. The assessment shall consist of a review of maps and aerial photos to determine whether existing buildings, dams, levees, roads, or other built features are present. If so, and if these features either are of unknown age or are known to be older than 45 years old, then an inventory and evaluation shall be completed by, or under the direct supervision of, a qualified architectural historian, defined as one who meets the SOI PQS for Architectural History or History. This inventory and evaluation shall include the following:</p> <ol style="list-style-type: none"> Map(s) and verbal description of the project area that delineates both the horizontal and vertical extents of potential direct and indirect effects —on architectural resources. A records search at the appropriate repository of the CHRIS for the project area and vicinity (typically areas within 0.25 or 0.5 mile, based on setting), to acquire records of previously recorded cultural resources and previously conducted cultural resources studies. This task can be performed by either the qualified archaeologist or the appropriate local CHRIS center staff. Background research on the history of the project area and vicinity for all actions determined to need additional historical architecture assessment. If, after review, features of the built environment are determined to be less than 45 years old, inclusion in the description a summary statement of their age and references for this determination. If architectural resources (45 years of age or older) are determined to likely be present in or near the project area, an architectural field survey of the project area, unless previous architectural field surveys no more than two years old have been conducted for the project area, in which case a new field survey is not necessary. Any architectural resources identified in the project area during the survey shall be recorded on the appropriate California DPR 523 forms (i.e., site record forms). An evaluation of any architectural resources identified in the project area for California Register eligibility (i.e., whether they qualify as historical resources, as defined in CEQA Guidelines Section 15064.5). An assessment of potential impacts on any historical resources identified in the project area. This shall include an analysis of whether potential impacts on the historical resource would be consistent with the U.S. Secretary of the Interior’s Standards for the Treatment of Historic Properties and applicable guidelines. A technical report meeting the U.S. Secretary of the Interior’s Standards for architectural history technical reporting. This report shall document the mitigation measures taken and any study results. The report shall be submitted to the appropriate CHRIS repository for the project area upon approval by the CEQA lead agency. 	Entity implementing action in response to Guidelines	Entity implementing action in response to Guidelines	<p>Verify and document:</p> <ul style="list-style-type: none"> qualified architectural historian conducted assessment of architectural features and an inventory and evaluated was conducted for those features known to be older than 45 years. inventory and evaluation includes the items listed in (a) through (h). 	Prior to construction
<p>Mitigation Measure 3.6-1b: If potentially significant impacts on historical resources are identified through implementation of Mitigation Measure 3.6-1a, an approach for reducing such impacts shall be developed before implementation of the action and in coordination with interested parties (e.g., historical societies, local communities). Typical measures for reducing impacts include:</p> <ol style="list-style-type: none"> Modification of the action to avoid impacts on historical resources. Documentation of historical resources, to the standards of and to be included in the Historic American Building Survey, Historic American Engineering Record, or Historic American Landscapes Survey, as appropriate. As described in the above standards, the documentation shall be conducted by a qualified architectural historian, defined above, and shall include large-format photography, measured drawings, written architectural descriptions, and historical narratives. The completed documentation shall be submitted to the U.S. Library of Congress. Relocation of historical resources in conformance with the U.S. Secretary of the Interior’s Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings. Monitoring of construction-related and operational vibrations at historical resources. For historical resources that are landscapes, preservation of the landscape’s historic form, features, and details that have evolved over time, in conformance with the U.S. Secretary of the Interior’s Guidance for the Treatment of Cultural Landscapes. Development and implementation of interpretive programs or displays, and community outreach. <p>Any technical report developed as part of this mitigation measure shall meet the U.S. Secretary of the Interior’s Standards for architectural history technical reporting and shall be submitted to the appropriate CHRIS repository for the project area upon approval by the CEQA lead agency.</p>	Entity implementing action in response to Guidelines	Entity implementing action in response to Guidelines	<p>Verify and document:</p> <ul style="list-style-type: none"> measures to avoid or minimize impacts to historical resources have been implemented. a technical report meeting the U.S. Secretary of the Interior’s Standards for architectural history technical reporting was submitted to the appropriate CHRIS repository for the project area. 	Prior to construction
<p>Mitigation Measure 3.6-2a: Before implementation of any construction-related activity that includes ground disturbance associated actions taken by Contractors in response to the proposed Guidelines, an archaeological records search and sensitivity assessment, and an inventory and significance evaluation of archaeological resources identified in the project area shall be conducted. The inventory and evaluation shall be done by or under the direct supervision of a qualified archaeologist, defined as one who meets the SOI PQS for Archeology, and shall include the following:</p> <ol style="list-style-type: none"> Map(s) and verbal description of the project area that delineates both the horizontal and vertical extents of potential direct and indirect effects on archaeological resources. A records search at the appropriate CHRIS repository for the project area and vicinity (typically areas within 0.25 or 0.5 mile, based on setting) to acquire records of previously recorded cultural resources and previously conducted cultural resources studies. This task can be performed by either the qualified archaeologist or the appropriate local CHRIS center staff. Outreach to the NAHC, including a request of a search of the Sacred Lands File for the project area and a list of California Native American Tribes culturally and geographically affiliated with the project area, to determine whether any documented Native American sacred sites could be affected by the action. 	Entity implementing action in response to Guidelines	Entity implementing action in response to Guidelines	<p>Verify and document:</p> <ul style="list-style-type: none"> qualified archeologist conducted an archeological records search and sensitivity assessment, and archeological resources were inventoried and evaluated. inventory and evaluation includes the items listed in (a) through (k). 	Prior to construction

Mitigation Measure	Responsibility for Implementing	Responsibility for Monitoring	Monitoring and Reporting Actions	Timing
<p>d) Consultation with California Native American Tribes pursuant to PRC Section 21080.3 to determine whether any indigenous archaeological resource or tribal cultural resources could be affected by the action. The CEQA lead agency shall consult with California Native American Tribes culturally and affiliated with the project area and who have requested to be notified by the CEQA lead agency regarding projects, pursuant to AB 52; this consultation shall consist of the CEQA lead agency providing written notification of the action to any such Tribes and follow-up consultation if any Tribes request, in writing, from the CEQA lead agency consultation on the action within 30 days of receiving the CEQA lead agency's initial notification. Consultation shall include discussion regarding the design of the action, cultural resources survey, protocols for construction monitoring, and any other Tribal concerns.</p> <p>e) Background research on the history, including ethnography and indigenous presence, of the project area and vicinity.</p> <p>f) An archaeological sensitivity analysis of the project area based on mapped geologic formations and soils, previously recorded archaeological resources, previous archaeological studies, and Tribal consultation.</p> <p>g) An archaeological field survey of project area shall be conducted. The field survey shall include, at a minimum, a pedestrian survey. If the archaeological sensitivity analysis suggests a high potential for buried archaeological resources in the project area, a subsurface survey shall also be conducted. If previous archaeological field surveys no more than two years old have been conducted for the project area, a new field survey is not necessary, unless their field methods do not conform to those required above (e.g., no subsurface survey was conducted but project area has high potential for buried archaeological resources). Any archaeological resources identified in the project area during the survey shall be recorded on the appropriate DPR 523 forms (i.e., site record forms).</p> <p>h) An evaluation of any archaeological resources identified in the project area for California Register eligibility (i.e., as qualifying as historical resources, as defined in CEQA Guidelines Section 15064.5) as well as whether they qualify as unique archaeological resources pursuant to PRC Section 21083.2. Such evaluation may require archaeological testing (excavation), potentially including laboratory analysis, and consultation with relevant California Native American Tribes (for indigenous resources).</p> <p>i) An assessment of potential impacts on any archaeological resources identified in the project area that qualify as historical resources (per CEQA Guidelines Section 15064.5) and/or unique archaeological resources (per PRC Section 21083.2). This shall include an analysis of whether the potential impacts would materially alter a resource's physical characteristics that convey its historical significance and that justify its inclusion (or eligibility for inclusion) in the California Register or a qualified local register.</p> <p>j) A technical report meeting the U.S. Secretary of the Interior's Standards for archaeological technical reporting. This report shall be submitted to the appropriate</p> <p>k) CHRIS repository for the project area upon approval by the CEQA lead agency unless the document contains information that any California Native American Tribes involved in its development determine should not be filed with the CHRIS, in which case the report shall be submitted to the NAHC.</p>				
<p>Mitigation Measure 3.6-2b: If potentially significant impacts on archaeological resources that qualify as historical resources (per CEQA Guidelines Section 15064.5) and/or unique archaeological resources (per PRC Section 21083.2) are identified during an action implemented in response to the Guidelines, the Contractor implementing the action shall develop an approach for reducing such impacts, before implementing the action and in coordination with interested or consulting parties (e.g., California Native American Tribes [for indigenous resources], historical societies [for historic-era resources], local communities). Typical measures for reducing impacts include:</p> <p>a) Modify the action to avoid impacts on resources.</p> <p>b) Plan parks, green space, or other open space to incorporate the resources.</p> <p>c) Develop and implement a detailed archaeological resources management plan to recover the scientifically consequential information from archaeological resources before any excavation at the resource's location. Treatment for most archaeological resources consists of (but is not necessarily limited to): sample excavation, artifact collection, site documentation, and historical research, with the aim to target the recovery of important scientific data contained in the portion(s) of the resource to be affected by the action. The archaeological resources management plan shall include provisions for analysis of data in a regional context, reporting of results within a timely manner, curation of artifacts and data at an approved facility, and dissemination of reports to local and state repositories, libraries, and interested professionals.</p> <p>d) Develop and implement interpretive programs or displays and conduct community outreach.</p> <p>e) Any technical report developed as part of this mitigation measure shall meet the U.S. Secretary of the Interior's Standards for archaeological technical reporting and shall be submitted to the appropriate CHRIS repository for the project area upon approval by the CEQA lead agency unless the document contains information that any California Native American Tribes involved in its development determine should not be filed with the CHRIS, in which case the report shall be submitted to the NAHC.</p>	Entity implementing action in response to Guidelines	Entity implementing action in response to Guidelines	<p>Verify and document:</p> <ul style="list-style-type: none"> measures to avoid or minimize impacts to areological resources were implemented. a report meeting the U.S. Secretary of the Interior's Standards for archaeological technical reporting was submitted to the appropriate CHRIS repository for the project area. if the document contained information that any California Native American Tribe determined should not be filed with the CHRIS, the report was filed with the NAHC. 	Prior to construction
<p>Mitigation Measure 3.6-2c: Before any ground-disturbing construction activities related to actions implemented by Contractors in response to the Guidelines, an archaeologist meeting, or under the supervision of an archaeologist meeting, the SOI PQS for Archeology shall conduct a training program for all construction field personnel involved in the ground-disturbing activities. If a California Native American Tribe expresses interest, the CEQA lead agency shall invite the Tribe to participate in the training program. On-site personnel shall attend the training before the start of any ground-disturbing activities. The training shall outline the general archaeological sensitivity of the project area and the procedures to follow in the event that archaeological resources and/or human remains are inadvertently discovered during construction (see Mitigation Measures 3.6-2d and 3.6-2e). Documentation of the training attendance shall be maintained by the CEQA lead agency.</p>	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	<p>Verify and document:</p> <ul style="list-style-type: none"> qualified archeologist conducted archaeological resource awareness training Tribal representative participated in training if interest to participate was expressed to CEQA lead agency. training attendance. 	Prior to and on-going during construction

Mitigation Measure	Responsibility for Implementing	Responsibility for Monitoring	Monitoring and Reporting Actions	Timing
<p>Mitigation Measure 3.6-2d: If archaeological resources are encountered during construction activities, all activity within 100 feet of the find shall cease and the find shall be flagged for avoidance. The CEQA lead agency and a qualified archaeologist, defined as one meeting the SOI PQS for Archeology, shall be immediately informed of the discovery. The qualified archaeologist shall inspect the discovery and notify the CEQA lead agency of their initial assessment. If the qualified archaeologist determines that the resource is or is potentially indigenous in origin, the CEQA lead agency shall consult with California Native American Tribes culturally and geographically affiliated with the project area to assess the find and determine whether it is potentially a tribal cultural resource.</p> <p>If the CEQA lead agency determines based on recommendations from the qualified archaeologist—and, if the resource is indigenous, from California Native American Tribes culturally and geographically affiliated with the project area—that the resource may qualify as a historical resource (per CEQA Guidelines Section 15064.5), unique archaeological resource (per PRC Section 21083.2), or tribal cultural resource (per PRC Section 21074), then the resource shall be avoided if feasible. If avoidance of an identified indigenous resource is not feasible, the lead agency shall consult with a qualified archaeologist, culturally affiliated California Native American Tribes, and other appropriate interested parties to determine treatment measures to minimize or mitigate any potential impacts on the resource pursuant to PRC Section 21083.2 and CEQA Guidelines Section 15126.4.</p> <p>Once treatment measures have been determined, the CEQA lead agency shall prepare and implement an archaeological (and/or tribal cultural) resources management plan that outlines the treatment measures for the resource. Treatment measures typically consist of the following steps:</p> <ol style="list-style-type: none"> a) Determine whether the resource qualifies as a historical resource (per CEQA Guidelines Section 15064.5), unique archaeological resource (per PRC Section 21083.2), or tribal cultural resource (per PRC Section 21074) through analysis that could include additional historical or ethnographic research, evaluative testing (excavation), or laboratory analysis. b) If the resource qualifies as a historical resource (per CEQA Guidelines Section 15064.5) and/or unique archaeological resource (per PRC Section 21083.2), implement measures for avoiding or reducing impacts such as the following: <ol style="list-style-type: none"> i. Modify the action to avoid impacts on resources. ii. Plan parks, green space, or other open space to incorporate resources. iii. Recover the scientifically consequential information from the archaeological resource before any excavation at the resource’s location. This typically consists of (but is not necessarily limited to) sample excavation, artifact collection, site documentation, and historical research, with the aim to target the recovery of important scientific data contained in the portion(s) of the resource to be affected by the action. iv. Develop and implement interpretive programs or displays. c) If the resource qualifies as a tribal cultural resource (per PRC Section 21074), implement measures for avoiding or reducing impacts such as the following: <ol style="list-style-type: none"> i. Avoid and preserve the resource in place through measures that include but are not limited to the following: <ol style="list-style-type: none"> a) Plan and construct the action to avoid the resource and protect the cultural and natural context. b) Plan green space, parks, or other open space to incorporate the resources with culturally appropriate protection and management criteria. ii. Treat the resource with culturally appropriate dignity, taking into account the tribal cultural values and meaning of the resource, through measures that include but are not limited to the following: <ol style="list-style-type: none"> a) Protect the cultural character and integrity of the resource. b) Protect the traditional use of the resource. c) Protect the confidentiality of the resource. iii. Implement permanent conservation easements or other interests in real property, with cultural appropriate management criteria for the purposes of preserving or using the resource or place. <p>Any technical report developed as part of this mitigation measure shall meet the U.S. Secretary of the Interior’s Standards for archaeological technical reporting and shall be submitted to the appropriate CHRIS repository for the project area upon approval by the CEQA lead agency unless the document contains information that any California Native American Tribes involved in its development determine should not be filed with the CHRIS, in which case the report shall be submitted to the NAHC.</p>	<p>Entity implementing action in response to Guidelines</p> <p>Construction Contractor</p>	<p>Entity implementing action in response to Guidelines</p>	<p>Verify and document:</p> <ul style="list-style-type: none"> • work was stopped within 100 feet of a discovered archaeological resource • qualified archeologist and CEQA Lead Agency were immediately informed • qualified archeologist assessed the resource and notified Tribe if determined to be potentially indigenous in origin • the cultural resource was avoided, or if it could not be avoided an archaeological (and/or tribal cultural) resources management plan was developed and implemented that outlined the treatment measures for the resource as defined in (a) through (c). • a report meeting the U.S. Secretary of the Interior’s Standards for archaeological technical reporting was submitted to the appropriate CHRIS repository for the project area. • if the document contained information that any California Native American Tribe determined should not be filed with the CHRIS, the report was filed with the NAHC. 	<p>Prior to construction</p>

Mitigation Measure	Responsibility for Implementing	Responsibility for Monitoring	Monitoring and Reporting Actions	Timing
<p>Mitigation Measure 3.6-3: If human remains are encountered during construction activities, all work shall immediately halt within 100 feet of the find and the CEQA lead agency shall contact the appropriate county coroner to evaluate the remains and follow the procedures and protocols set forth in CEQA Guidelines Section 15064.5(e)(1). If the coroner determines that the remains are Native American in origin, the appropriate county shall contact the NAHC, in accordance with HSC Section 7050.5(c) and PRC Section 5097.98. Per PRC Section 5097.98, the CEQA lead agency shall ensure that the immediate vicinity, according to generally accepted cultural or archaeological standards or practices, of the location of the Native American human remains is not damaged or disturbed by further development activity until the CEQA lead agency has discussed and conferred, as prescribed in PRC Section 5097.98, with the most likely descendants and the property owner regarding their recommendations, if applicable, taking into account the possibility of multiple human remains.</p> <p>Any technical report developed as part of this mitigation measure shall meet the U.S. Secretary of the Interior's Standards for archaeological technical reporting and shall be submitted to the NAHC and the appropriate CHRIS repository for the project area upon approval by the CEQA lead agency unless the document contains information that any California Native American Tribes involved in its development determine should not be filed with the CHRIS, in which case the report shall be submitted only to the NAHC.</p>	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	Verify and document: <ul style="list-style-type: none"> work was stopped within 100 feet of discovered human remains. County corner was notified, and the remains evaluated following the procedures and protocols set forth in CEQA Guidelines Section 15064.5(e)(1). If remains were determined to be Native American in origin the NAHC was contacted and the requirements contained in HSC Section 7050.5(c) and PRC Section 5097.98 were implemented. a report meeting the U.S. Secretary of the Interior's Standards for archaeological technical reporting was submitted to the appropriate CHRIS repository for the project area. if the document contained information that any California Native American Tribe determined should not be filed with the CHRIS, the report was filed with the NAHC. 	Prior to construction
Noise				
<p>Mitigation Measure 3.13-1: The following measures shall be implemented during construction of any actions implemented by Contractors in response to the proposed Guidelines:</p> <ul style="list-style-type: none"> Noise- and vibration-generating activities shall comply with the applicable general plan and/or noise ordinances for the jurisdiction located within the vicinity of the project. Construction equipment shall be located as far away as possible from noise-sensitive receptors to the extent feasible, to reduce noise levels below applicable local standards. Construction equipment shall be maintained to manufacturers' recommended specifications, and all construction vehicles and equipment shall be equipped with appropriate mufflers and other approved noise control devices. Idling of construction equipment shall be limited to the extent feasible to reduce the time that noise is emitted. An individual traffic noise analysis of identified haul routes shall be conducted and mitigation, including but not limited to measures such as reduced speed limits, shall be provided at locations where noise standards cannot be maintained for noise-sensitive receptors. The action shall incorporate the use of temporary noise barriers, such as acoustical panel systems, between construction activities and noise-sensitive receptors if it is concluded that they would be needed to ensure compliance with applicable noise standards and effective in reducing noise exposure to sensitive receptors. 	Entity implementing action in response to Guidelines Construction Contractor	Entity implementing action in response to Guidelines	Verify and document implementation of noise/vibration avoidance measures	During construction
<p>See Mitigation Measure 3.13-1</p>	See Mitigation Measure 3.13-1	See Mitigation Measure 3.13-1	See Mitigation Measure 3.13-1	See Mitigation Measure 3.13-1
Tribal Cultural Resources				
<p>See Mitigation Measures 3.6-2a, 3.6-2b, 3.6-2c, 3.6-2d, and 3.6-3.</p>	See Mitigation Measures 3.6-2a, 3.6-2b, 3.6-2c, 3.6-2d, and 3.6-3	See Mitigation Measures 3.6-2a, 3.6-2b, 3.6-2c, 3.6-2d, and 3.6-3	See Mitigation Measures 3.6-2a, 3.6-2b, 3.6-2c, 3.6-2d, and 3.6-3	See Mitigation Measures 3.6-2a, 3.6-2b, 3.6-2c, 3.6-2d, and 3.6-3