WEST FALSE RIVER DROUGHT SALINITY BARRIER PROJECT

Adaptive Management and Monitoring Plan

Prepared for
California Department of Water Resources

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Acronyms and Other Abbreviations

Acronym or Abbreviation	Definition
AMMP	adaptive management and monitoring plan
Basin Plan	*The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region: The Sacramento River Basin and the San Joaquin River Basin*
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CVP	Central Valley Project
DBW	California Department of Parks and Recreation, Division of Boating and Waterways
Delta	Sacramento–San Joaquin Delta
DWR	California Department of Water Resources
EAT	Enhanced Acoustic Telemetry
EDB	emergency drought barrier
EDBPS	Emergency Drought Barrier Predation Study
NMFS	National Marine Fisheries Service
PATH	Pacific Aquatic Telemetry Hub
PDAT	predation detection acoustic tag
POD	Pelagic Organism Decline
project	West False River Drought Salinity Barrier Project
SOP	standard operating procedure
State Water Board	State Water Resources Control Board
SWP	State Water Project
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

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CHAPTER 1
Introduction

1.1 Project Background (Defining the Problem)

This is Step 1 of the Adaptive Management Approach outlined in Appendix 1B of the Delta Plan.

The California Department of Water Resources (DWR) will implement the West False River Drought Salinity Barrier Project (project). The drought salinity barrier is located in West False River, in Contra Costa County, California (**Figure 1**), at the western edge of the Sacramento–San Joaquin Delta (Delta).

Waters from the Sacramento and San Joaquin rivers join to create the Delta, an inland or inverted river delta. The Delta encompasses an area of approximately 1,000 square miles of tidal wetlands, sloughs, and islands, through which waters flow before reaching San Francisco Bay and eventually the Pacific Ocean (MacVean et al. 2018; The Bay Institute 2003).

The Delta is a complex system that provides numerous pathways for tidally influenced, higher salinity seawater to flow inland. Under normal conditions, the outflow of fresh water from upstream surface waters reduces salinity intrusion from the tides and prevents seawater from entering the interior Delta. This mixing of upstream fresh water and tidal seawater creates water quality conditions that are critical to regionally important plant and wildlife species and affects a resource used by people throughout California.

DWR and the U.S. Bureau of Reclamation operate, maintain, and manage the State Water Project (SWP) and the Central Valley Project (CVP), respectively. Both projects are water storage and delivery systems designed to store water and distribute it to urban and agricultural water suppliers throughout California. The SWP and CVP help control salinity intrusion by providing freshwater releases during the drier parts of the year by releasing previously stored water into the Delta, where a portion of that water is re-diverted along with natural flows for export within California through water conveyance facilities. The State Water Resources Control Board (State Water Board) regulates water quality in the Delta to ensure that water is managed to protect beneficial uses in the Delta, such as municipal and domestic water supply, irrigation and stock watering, fish and wildlife habitat, habitat for migration of aquatic species, recreation, and navigation.

Figure 1
Project Location

DWR plays a vital part in evaluating potential impacts on Delta water quality driven by changes in precipitation, temperature, and ocean levels, and in determining options for alleviating those impacts. The diversions that result from SWP and CVP operations redistribute the flow of water by decreasing river flows to San Francisco Bay. As a result, tidal flows may be able to propagate farther through the system (Szlemp 2020). During severe drought conditions when reservoirs are low, the impounded water in those upstream reservoirs is insufficient to meet the water needs of all beneficial uses in the Delta, and the SWP and CVP are required to preserve sufficient impounded water to meet health and safety and environmental regulatory flows. This potentially accelerates tidal flows and allows water salinity to intrude upstream (Fleenor and Bombardelli 2013).

The project consists of installing a temporary drought salinity barrier at the West False River location up to two times over 10 years, with each installation remaining in place for up to 20 months over two consecutive calendar years, if a drought occurs during the 2026–2035 period and low upstream reservoir storage indicate that a barrier in West False River is a necessary tool for reducing saltwater intrusion into the Delta.

1.2 Purpose of the Adaptive Management and Monitoring Plan

This adaptive management and monitoring plan (AMMP) has been developed to evaluate whether the drought salinity barrier is performing as intended and to understand how the structure affects abiotic and biotic conditions in the Central Delta and western Delta. This AMMP was developed to be consistent with what is presented in the environmental impact report and biological assessment and subsequently reflected in project permits (the National Marine Fisheries Service [NMFS] and U.S. Fish and Wildlife Service [USFWS] biological opinions, California Department of Fish and Wildlife [CDFW] incidental take permit).

1.3 Adaptive Management Approach

The documentation of the adaptive management and monitoring approach for the West False River Drought Salinity Barrier Project was developed in consideration of the Delta Plan's nine-step adaptive management approach (Delta Plan Appendix 1B). As summarized below, this AMMP describes how DWR will implement each of the nine adaptive management steps:

1. **Define the Problem—**During drought conditions, water stored in upstream reservoirs may be insufficient to repel salinity moving upstream from San Francisco Bay. Without the protection of the drought salinity barrier, saltwater intrusions could render Delta water unusable for agricultural needs and reduce habitat value for aquatic species.

2. **Goals and Objectives**—The objective of the project is to minimize the impacts of salinity intrusion on the beneficial uses of water during persistent drought conditions.

3. **Model Linkages—**This AMMP summarizes the current scientific understanding of the potential effects of the drought salinity barrier on water quality and biological resources.

4. **Select Actions, Development Performance Measures**—The project will result in construction of a rock barrier within West False River to minimize the extent of salinity intrusion into the interior Delta.

5. **Design and Implement Actions**—The drought salinity barrier at West False River has been implemented before, under emergency authorizations in 2015 and 2021, and has been shown to be effective at achieving its purpose. The project will be ready for implementation during subsequent drought years over the next decade.

6. **Monitoring**—This AMMP outlines the monitoring methods to evaluate areas of remaining uncertainty, including whether actual water quality meets modeling predications and whether the presence of the barrier will result in meaningful increases in the predation loss of native fishes by non-native piscivorous fish.

7. **Analyze, Synthesize, Evaluate**—Results from monitoring will be analyzed and used to assess the effectiveness of the drought salinity barrier and identify potential problems. DWR is funding a study to analyze the effects of fish predation loss at the salinity barrier. The study will consider a suite of different environmental and habitat variables (e.g., distance from barrier, tide, turbidity, temperature, conductivity, light levels) that were hypothesized to have a potential influence on seasonal trends in predation risk.

8. **Communicate**—DWR will prepare a final report on the project's effects on water quality. In addition, DWR will prepare a monthly water quality summary. Forums such as the Association of California Water Agencies' Conferences and the Bay-Delta Science Conference are potential opportunities to communicate lessons learned to a broad audience of scientists, managers, and decision-makers.

9. **Adaptive Site Management**—Information from the monitoring will be used to inform future implementation of the drought salinity barrier. Adaptive site management will include considerations of whether some slight refinements to the barrier design can be implemented to minimize effects on fisheries resources (if there are even any measurable effects) or improve its effectiveness at minimizing salinity intrusion.

CHAPTER 2
Project Summary

2.1 Overview

Implementing the West False River Drought Salinity Barrier Project will help protect the beneficial uses of water during severe droughts, when freshwater flows from upstream reservoirs may be insufficient to repel salinity moving upstream from San Francisco Bay. Without the protection of the drought salinity barrier in West False River, saltwater intrusions could affect more than 27 million Californians who rely on the Delta for at least a portion of their water supply; could render Delta water unusable for agricultural needs; and could reduce the value of habitat for aquatic species. The need for water delivery protection, water quality protection, and aquatic habitat protection to protect the beneficial uses of Delta water during drought periods is described below.

2.2 Goals and Objectives

This is Step 2 of the Adaptive Management Approach outlined in Appendix 1B of the Delta Plan.

The primary objectives of the project are as follows:

- Install a drought salinity barrier to protect water quality in the Central and South Delta, based on need demonstrated by drought conditions and low upstream reservoir storage.
- Install a drought salinity barrier in the Central Delta up to two times over 10 years, including consecutive years, should a drought occur during the period from 2026 to 2035.
- Minimize the impacts of salinity intrusion on the beneficial uses of interior Delta water during persistent drought conditions through the installation of a drought salinity barrier in the Central Delta.

Installing a drought salinity barrier in West False River has been shown to be an effective tool for reducing the intrusion of saltwater into the Central and South Delta. The West False River drought salinity barrier will be located in the Central Delta in West False River, a main channel that is located west of and connected to Franks Tract, the Delta's central hub. By hydraulically blocking the West False River corridor, the barrier will protect against the intrusion of saltwater from San Francisco Bay into Franks Tract and the Central Delta. This will prevent the fresh water from other channels, including the Mokelumne River and Old River, that is flowing into Franks Tract from other directions from mixing with the more saline water that otherwise would flow through West False River during flood tides. Without the barrier in place at this critical location, the saltier water carried through West False River would gradually contaminate the fresh water in Franks Tract and the Central Delta with salts, a condition that cannot be reversed during drought conditions, and thus would affect the beneficial uses of water. Given the current scientific understanding of the cyclical nature of drought in California, DWR anticipates needing to install a drought salinity barrier in West False River two times over the next 10 years (with each installation remaining in place for up to 20 months over two consecutive calendar years).

2.2.1 Water Delivery Protection

Salinity intrusion into the Central Delta would cause portions of the Delta to exceed water quality objectives. High salinity levels (with associated bromide levels) would compromise the use of Delta water for municipal and irrigation water supplies, reducing the amount of water available for downstream delivery to communities that rely on this water source. Protecting water delivery is critical for residents of the Delta and Contra Costa, Alameda, and Santa Clara counties and for the 27 million people who rely on the SWP and CVP for their water supply. Reduced deliveries of water from the Delta would pose a hardship for communities without alternative water supplies, including the approximately 500,000 people served by Contra Costa Water District, which is almost entirely dependent on the Delta for its water supply (Contra Costa Water District 2016), and some agricultural water users. Installing the drought salinity barrier will help to protect water quality in the Central Delta.

2.2.2 Water Quality Protection

Degradation of Delta water quality caused by an increase in salinity would negatively affect many beneficial uses. The results of water quality modeling analyses described in the efficacy report for the 2015 emergency drought barrier (EDB) project (California Department of Water Resources 2019) show that after the intrusion of higher salinity water into the Central Delta, the water would likely persist for an extended period until typical wet-weather patterns generate sufficient winter and spring freshwater river flows to displace it. Installing a drought salinity barrier in West False River will help block higher salinity waters from entering the Central Delta, thus reducing demand on reservoir releases.

Although the West False River barrier will be installed only under severe drought conditions, the amount of Delta water quality protection provided by the barrier will depend on the timing of installation during a drought. Modeling of salinity intrusion using variable barrier installation dates demonstrates that the greatest water quality protection will be gained by installing the West False River barrier when Delta water quality, especially at Franks Tract, is adequate for beneficial uses, typically in the spring (April or May). However, lesser benefits may still be gained from installing the drought salinity barrier later in the year when salinity intrusion has degraded water quality at Franks Tract to some degree, because the barrier can only protect existing water quality, not improve it. For this reason, installing the barrier before water quality conditions become too degraded is important.

2.2.3 Aquatic Habitat Protection

Increased salinity levels have the potential to adversely affect the sensitive aquatic resources that live in and migrate through the Delta. Greater salinity in the Delta could cause exceedances of the water quality objectives for beneficial uses described in *The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region: The*

Sacramento River Basin and the San Joaquin River Basin (Basin Plan) related to sensitive aquatic resources (e.g., fish, wildlife, wetlands, and vegetation) (Central Valley Regional Water Quality Control Board 2019). To support competing water needs early in the water year during severe drought without the barrier in place, some of the already limited water supplies stored in upstream reservoirs has to be released. Releasing this upstream stored water could negatively affect aquatic habitat by reducing the availability of water for aquatic habitat regulatory releases at a later date. For example, if coldwater resources in reservoirs were depleted, flows in late spring and summer would be insufficient to protect salmon eggs incubating in the gravels, as well as rearing habitat for juvenile salmon below Keswick, Oroville, and other dams.

Installing a drought salinity barrier in West False River will conserve coldwater pools in upstream reservoirs. The barrier will protect natural resource values after installation because less water will need to be released from the reservoirs earlier in the year to support the beneficial uses of water in the Delta. For example, various water quality objectives related to electrical conductivity exist for the protection of fish and wildlife habitat and other beneficial uses in the Delta. With greater preservation of reservoir storage, more water could become available to meet these objectives.

2.3 Barrier Installation

2.3.1 Design

The project includes installation of an approximately 800-foot-long barrier that will be trapezoid-shaped, with an approximately 150-foot-wide (2.75-acre) base (in water) tapering to an approximately 12-foot-wide top (above water), set perpendicular to the channel (see **Figure 2**). The top of the barrier will be at an elevation of 7 feet North American Vertical Datum of 1988 across the entire crest. From the crest, the barrier will slope down to the riverbed at a rate of 2 horizontal units to 1 vertical unit (2H:1V). As shown in Figure 2, the barrier consists of approximately 84,000 cubic yards of well-graded 18-inch-minus embankment rock, which will extend from the Jersey Island levee on the south side to the Bradford Island levee on the north side.

The banks at the project site are existing rock-lined levees. The project footprint is approximately 3.12 acres. Of this area, approximately 2.75 acres are situated in West False River (below the ordinary high-water mark) where embankment rock will be placed. The remaining approximately 0.37 acre of the project footprint, which will be used for staging purposes and placement of rock on the levee bank, is situated on the Jersey Island levee (above the ordinary high-water mark).

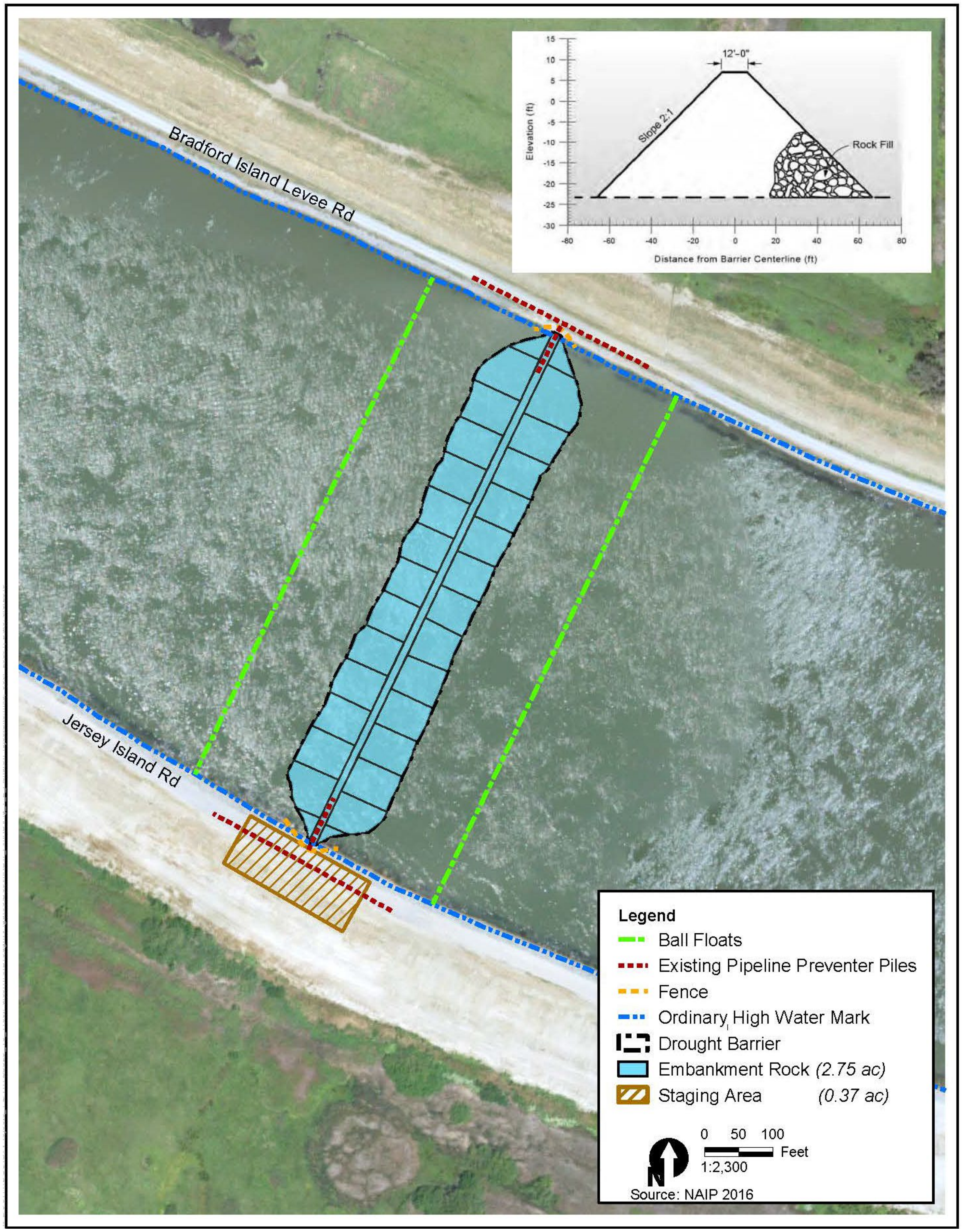

Figure 2
Aerial View of the Project Site and Project Design (without the Notch)

Embankment rock used to construct the drought salinity barrier may be sourced from a rock quarry in San Rafael, DWR's Rio Vista stockpile in Solano County, or the Weber stockpile in San Joaquin County (**Figure 3**). The project may use multiple stockpile sites and off-loading sites (Figure 3).

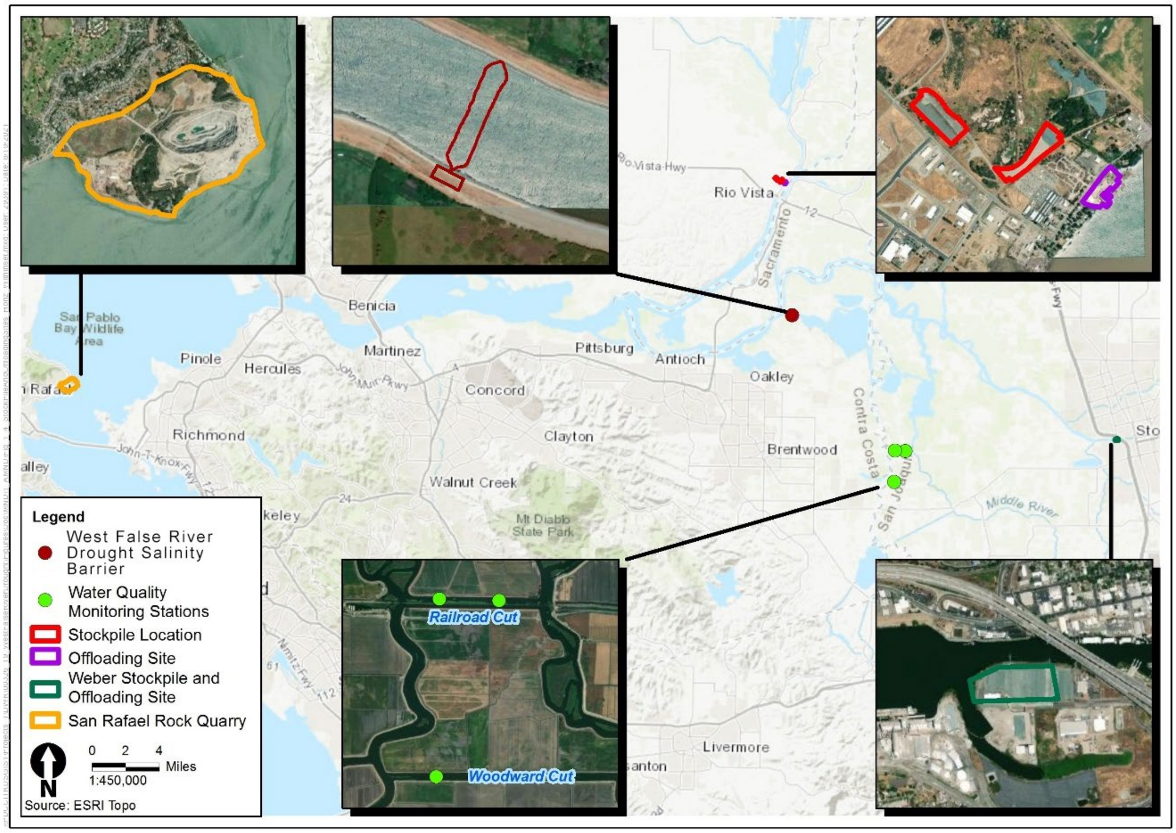

Figure 3
Project Features

The map in Figure 3 depicts the project site, which includes the drought salinity barrier project site, the Rio Vista stockpile site, the Weber stockpile and off-loading sites, and the three water quality monitoring stations. The project site does not include the San Rafael rock quarry or the Rio Vista off-loading site because they are private commercial businesses that have their own permits for operation.

2.3.2 Construction Methodology

The construction methodology for installation of the drought salinity barrier is based partially on the methodology for 2015 and 2021 EDB construction, except that unlike the 2015 work, no sheet piles will be installed. First, DWR contractors will mobilize their equipment and crew and will establish a staging area adjacent to Jersey Island Road (i.e., on the left bank) and erect exclusion fencing. The staging area will be used primarily for parking, equipment staging, portable toilets, and a job trailer. Next, the contractors will transport the rock to West False River via barges from DWR's Weber or Rio Vista stockpile site, or from an approved quarry, such as in San Rafael.

DWR contractors will begin placing rock into West False River using a dump scow and/or barge-mounted cranes with clamshells and/or dragline buckets and/or excavators on floats or material barges. First, rock will be placed near the levees; placement of rock will then progress toward the center of the river in a uniform manner to prevent levee scour. Because of the water's depth, the contractors will be able to use the dump scow for only a limited duration. They will use a barge-mounted crane to place up to eight concrete anchor blocks (approximately 9 square feet each) for the signs and buoy lines.

DWR contractors will install fencing on the levees near the rock to prevent trespassers and structures (e.g., bird spikes) intended to impede ground squirrel movement. They will also install float lines, signs, and warning buoys on both sides of the drought salinity barrier.

For construction activities occurring during non-daylight hours, contractors will use light plants, situated on the levees and/or barges, as needed. Lighting will be directed downward toward construction activities to the extent practical. Rock placement on the levee slope will occur only during daylight hours.

After installation activities are complete, DWR contractors will demobilize from the site and regrade the staging area and dirt access road to preconstruction conditions.

2.3.3 Operations and Maintenance

No operational features are associated with the drought salinity barrier; it is designed to be fully functional once installed. Because the drought salinity barrier will be in place only temporarily, maintenance will be minimal or nonexistent. However, DWR will inspect the barrier weekly and will inform the permitting agencies (CDFW, the U.S. Army Corps of Engineers [USACE], and USFWS and NMFS through USACE) should any major maintenance activities be required. DWR will maintain the navigational aids (e.g., signage, lights, buoy lines) while the drought salinity barrier is in place.

2.3.4 Barrier Removal

DWR contractors will strategically place a material scow adjacent to the barrier to excavate the rock. Barge-mounted cranes with clamshell or dragline buckets and/or excavators will excavate the rock and place it on an available barge. To prevent levee scour, removal of rock will begin at the center of the channel and work toward the levees. Excavation will occur from the top of the barrier down to approximate pre-project streambed contours. The contractors will restore the levee geometry to ensure compliance with the requirements of any local maintaining agency. DWR will conduct bathymetric surveys before and immediately after barrier removal to confirm that all exposed rock has been removed. This process may need to be repeated to ensure the removal of all embankment rock. The elevation of the channel bottom will be restored within the barrier footprint, although some rock that has settled below the mudline will not be removed.

DWR contractors will transport the rock on barges from the project site to an off-loading site, where it will be transferred onto dump trucks using conveyors, excavators, and loaders and then hauled to a stockpile location (outside of waters of the United States), shown in Figure 3.

Upon complete removal of the rock barrier, DWR contractors will remove the concrete anchor blocks, float lines, signs, and warning buoys. Because the buoys and signs are anchored by concrete blocks, the contractors will remove these structures using barge-mounted cranes. As directed by DWR, the contractors will be required to store the material at a stockpile location.

Disturbed upland areas will be restored after the barrier is completely removed. The affected areas will be restored to approximate pre-project conditions and revegetated as appropriate (e.g., via hydroseeding). Any levee access roads damaged by construction equipment or truck use will be restored to preconstruction conditions or better after construction is completed.

2.4 Installation Considerations and Deployment Scenarios

A variety of factors that can affect water quality and degrade beneficial uses in the Delta during a drought may influence a decision to install a drought salinity barrier. **Table 1** identifies the factors ("drought factors") that DWR will consider in any decision to plan installation of the drought salinity barrier, along with the "sub-factor" triggers related to each factor. In general, two or more drought factors are likely to occur before preparations to construct are triggered. Because the environmental conditions potentially contributing to an upcoming drought scenario may be highly variable, using numerical data triggers to define the drought for planning purposes may be impracticable. Defining physical triggers is also difficult, given the system's complexity and the vast combinations of conditions that could necessitate installing the drought salinity barrier.

TABLE 1
FACTORS POTENTIALLY TRIGGERING THE DECISION TO INSTALL A DROUGHT SALINITY BARRIER

Drought Factor	Sub-factor Trigger
Forecasted Multi-year Consecutive Drought Conditions (2+ Years)	Below-average runoff.
	Below-average rainfall.
	Below-average snowpack.
	Water year type that is or is expected to be Dry or Critical in the Sacramento and San Joaquin valleys, as published in DWR Bulletin 120.
Drop in Northern California Reservoir Storage Levels	Water levels below historical average during the current water year (i.e., October 1–March 30).
	Projections that indicate insufficient storage to protect water quality and meet health and safety and other critical water supply needs.
Delta Water Quality at Risk Due to Increasing Salinity Levels	Insufficient outflows that increase the risk of salinity intrusion, which would degrade Delta water quality and affect beneficial uses. D-1641 and its mandates are available as guidance.
Drought Modeling and Monitoring Results	Based on modeling/monitoring results, regular meetings conducted with representatives from DWR, the U.S. Bureau of Reclamation, the State Water Board, and the fisheries agencies.

NOTES: D-1641 = Water Right Decision 1641; Delta = Sacramento–San Joaquin Delta; DWR = California Department of Water Resources; State Water Board = State Water Resources Control Board

SOURCE: Data provided by California Department of Water Resources in 2021

The project consists of installing a drought salinity barrier made of rock in West False River, at the same location where the 2015 and 2021–2022 EDBs were installed. The barrier will be installed no sooner than April 1 and removed by November 30 of the subsequent year. Alternatively, removal may occur by November 30 of the same year if DWR determines that the barrier is no longer needed based on hydrologic conditions. DWR will generally make a decision before September 15 (i.e., the start of barrier removal activities) regarding whether the barrier should remain in place for a subsequent year. Potential indicators that necessitate leaving the barrier in for a subsequent year may include the following:

- Water levels in principal reservoirs across the state, including Shasta and Oroville, continue to drop and remain below the historical average.
- Forecasting models indicate it is unlikely that combined upstream reservoir releases and natural flows into the Delta are sufficient to provide the water quality needed for the beneficial uses of the Delta water while preserving upstream stored water for health, safety, and regulatory flows.

The barrier may be installed up to two times over 10 years, with each installation remaining in place for up to 20 months over two consecutive calendar years, if a drought occurs during the 2026–2035 period and drought conditions and low upstream reservoir storage indicate that a barrier in West False River is a necessary tool for reducing saltwater intrusion into the Delta. For the first installation, the barrier may be in place for up to 20 months, as it will be installed no earlier than April 1 and will be fully removed by November 30 of the subsequent year. The barrier may then be re-installed for the second time the following April after its full removal the previous November, remaining in place for up to another 20 months similar to its first installation. In this consecutive-installation scenario, the barrier will not be present during the December–March period between barrier installations. The project calls for up to two consecutive barrier installations over 10 years primarily because the project's potential effects on the physical environment after 10 years are speculative.

The project also includes the possible placement of a 400-foot notch in the middle portion of the barrier in early January of the second year after installation. The notch will be backfilled as early as the first week of April. DWR will consider information available at the time of potential notch placement to decide whether a notch should be placed. The following are examples of information to be considered in deciding whether to place a notch:

- Modeling of prevailing water quality conditions, hydrologic forecasts, and other relevant data obtained in the period leading up to potential notch placement, indicating whether the benefits of the barrier's ability to protect Delta water quality would be lost with a notch in place.
- The risk of scouring of the channel bottom, as observed during the 2021–2022 EDB installation period, which could eventually lead to safety concerns related to undercutting of the barrier or the adjacent levees, or creation of predatory fish habitat.
- Data comparing fish passage through the Delta with and without the barrier in place.

Therefore, the project includes the three potential installation scenarios listed in **Table 2**.

TABLE 2
INSTALLATION SCENARIOS

Project Scenario[1]	Drought Salinity Barrier Installation Date	Drought Salinity Barrier Removal Date	Total Length of Time Drought Salinity Barrier In Place	Notch Placed in Middle Portion of Barrier from Early January through Early April?	Determination on Type of Installation Scenario
Installation Scenario 1	April 1	November 30 of the subsequent year	20 months	No	Barrier left in place for 20 months based on continuing Dry/Critical water year conditions.[2] See the preceding list of potential indicators that no notch should be constructed.
Installation Scenario 2	April 1	November 30 of the subsequent year	20 months	Yes	Barrier left in place for 20 months based on continuing Dry/Critical water year conditions.[2]
Installation Scenario 3	April 1	November 30 of the same year	8 months	No	Barrier removed within the same year based on hydrologic conditions.[2]

NOTES:
1. The project includes any one of the installation scenarios, with the barrier installed up to two times over 10 years, and with each installation remaining in place for up to 20 months over two consecutive calendar years, if a drought occurs during the 2026–2035 period and drought conditions and low upstream reservoir storage indicate that a barrier in West False River is an effective tool for reducing saltwater intrusion into the Delta.
2. See Table 1, "Factors Potentially Triggering the Decision to Install a Drought Salinity Barrier."

SOURCE: Data provided by California Department of Water Resources in 2022

2.5 Water Quality Monitoring Stations

In 2015, a network of water quality and flow stations was established to evaluate how the EDB affected flow, water quality, and biological constituents in the Central and North Delta. Before or concurrently with the next installation of the drought salinity barrier, DWR may install additional water quality and/or flow monitoring stations in San Joaquin County, in Woodward Cut (one monitoring station) and Railroad Cut (two monitoring stations) (Figure 3). The stations will be installed on three new 12-inch-diameter steel pipe piles. First, the piles will be driven to a maximum depth of up to 40 feet, using a vibratory pile driver. The water quality and flow monitoring equipment will then be mounted on the piles. Navigational aids will be installed at the stations as needed. The stations will be able to monitor electrical conductivity, turbidity, dissolved oxygen, chlorophyll, nutrients, bromide, and organic carbon, and will be left in place after removal of the drought salinity barrier.

The expanded monitoring network will increase the amount of water quality data for the Central Delta and will allow further evaluation of changes in water quality and flow resulting from the project. DWR will visit the stations every three to four weeks to clear away any surrounding vegetation and algal growth and will replace equipment as needed. The monitoring stations will remain in place for continued in-situ water quality monitoring beyond the installation and period of time when the drought salinity barrier is in place. An updated water quality monitoring plan that will include details on new equipment locations, monitoring protocol, and data collection frequency will be submitted for final approval by the State Water Board.

2.6 Uncertainties

There are uncertainties about project actions and expected outcomes. These key uncertainties include:

- Whether Delta water quality will consistently confirm water quality modeling predictions, including whether seasonal hydrologic patterns under future drought conditions could differ from 2015 and 2021 conditions.
- The effects that the barrier will have on invasive aquatic weed distribution in the Central Delta, in particular Franks Tract.
- Whether the notch results in diminished ability to control Delta water quality.
- Whether the notch improves the ability of special-status aquatic species to use West False River as a migratory corridor.
- As climate change makes severe drought events in California more frequent, the timing of when the drought salinity barrier needs to be deployed.

CHAPTER 3
Site Conditions

3.1 Site Setting

The Delta is a complex and varied system that encompasses approximately 1,000 square miles of tidal wetlands, sloughs, and islands. Fresh waters from the Sacramento and Feather rivers in the Lower Sacramento River Basin and from the San Joaquin River in the San Joaquin River Basin merge to create the Delta, an inland or inverted river delta. These fresh waters flow through the Delta before reaching San Francisco Bay and eventually the Pacific Ocean.

The drought salinity barrier will be located on West False River approximately 0.4 mile east of its confluence with the San Joaquin River, in Contra Costa County between Jersey Island and Bradford Island, approximately 4.8 miles northeast of the city of Oakley. The staging area will be located on the Jersey Island levee. Rock could be sourced from an approved quarry located near San Rafael in Marin County, DWR's Rio Vista stockpile site in Solano County, or DWR's Weber stockpile site in Stockton. DWR's existing off-loading and stockpile sites are located in existing industrial areas.

Jersey Island is located within the service area of Reclamation District 830. The district, which encompasses only Jersey Island, was created in 1911; it disposes recycled water on irrigated hay crops and maintains the island's levees and drainage facilities (Contra Costa County Local Agency Formation Commission 2015). Bradford Island is located within Reclamation District 2059, which encompasses approximately 2,200 acres and 7.5 miles of levees. Reclamation District 2059 was created in 1921 to maintain and improve levees and maintain and operate the drainage control system consisting of pumps, canals, and ditches; Reclamation District 2059 also operates the local ferry service (Contra Costa County Local Agency Formation Commission 2015).

West False River consists of open water, and the shoreline at the project site is completely rock-lined. The surrounding land uses in the project vicinity are agricultural. Nine marinas operate on the southwest side of Franks Tract, approximately 1.5 to 4.5 miles east of the project site. Three other marinas exist along Taylor Slough, approximately 1.5 to 2.1 miles to the south. These marinas support extensive recreational opportunities, including boating, swimming, and fishing.

Three new water quality monitoring stations may be installed at two locations in San Joaquin County: Woodward Cut (one monitoring station) and Railroad Cut (two monitoring stations), which respectively are approximately 2 miles and 2.9 miles east and northwest of the community of Discovery Bay.

3.2 Hydrology

Tidal flows in the Delta are controlled by channel geometry, tidal elevations at the Golden Gate Bridge, inflows from the Sacramento and San Joaquin rivers, SWP and CVP export pumping in the South Delta, and Delta outflows. Average tidal flows in False River are on the order of ±35,000 cubic feet per second, and the mean tidal elevation is around 4 feet (North American Vertical Datum of 1988) with a tidal range of around 3.5 feet.

Salinity intrusion is the result of the dynamic balance between strong tidal mixing and the inflow of fresh water at the upstream end of the estuary (to Suisun Bay), which is often referred to as "Delta outflow." Diversions for agricultural use occur in the Delta, and the SWP and CVP pumping plants in the South Delta export water south of the Delta for municipal and agricultural uses. Therefore, the Delta outflow that controls the estuarine salinity gradient must be calculated from the measured river inflows minus the measured water exports and estimated agricultural diversions (channel depletions).

Because tidal mixing in the estuary is generally constant from day to day, with some differences between neap tide and spring tide, salinity intrusion increases with lower outflow and decreases with higher outflow. Higher Delta outflow (caused by higher river inflows) will "push" fresh water farther downstream, so that the upstream end of the salinity gradient will shift downstream with higher outflow. The upstream end of the salinity gradient has been defined as "X2," which is a point identified by its distance from the Golden Gate Bridge where salinity at the river's bottom is about 2 parts per thousand (2,000 milligrams per liter total dissolved solids).

3.2.1 Tidal Characteristics

The barrier site is located in a strongly tidally influenced area characterized by high tidal flows and strong seasonal variability that is heavily influenced by upstream flows and management activities. Twice-daily tidal cycles cause water to ebb and flow at high rates. At high and low tides, the waterway temporarily achieves slack water conditions, with limited movement, twice during each tidal cycle. Delta outflow is measured as the net movement of water, discounting tidal flows, out of the Delta. **Table 3** provides the tidal datum for Port Chicago, located about 19 miles west of the project area.

TABLE 3
PORT CHICAGO TIDAL DATUMS

Tidal Datum	Elevation (ft NAVD88)
Mean Higher High Water (MHHW)	6.01
Mean Tide Level (MTL)	3.67
Mean Lower Low Water (MLLW)	1.10

NOTE: ft NAVD88 = feet North American Vertical Datum of 1988
SOURCE: National Oceanic and Atmospheric Administration 2024

3.3 Vegetation Communities and Land Cover Types

Vegetation communities and land cover types present on the project site include aquatic habitat in which the drought salinity barrier will be placed and terrestrial habitat associated with the adjacent channel slopes, levee roads, and landside berm.

3.3.1 Aquatic Habitat

The majority of the project site is open water in West False River, which provides cover and foraging habitat for a variety of aquatic and water-dependent wildlife and native and non-native fish species. Small areas of emergent wetland vegetation (primarily hardstem bulrush [*Schoenoplectus acutus*]) are scattered along the channel edges. The three new water quality monitoring stations may be placed in Woodward Cut and Railroad Cut, which both provide perennial riverine habitat.

3.3.2 Terrestrial Habitat

The channel/levee slopes are completely rock-lined and generally absent of vegetation. Depending on how recently levee maintenance activities have been conducted, weedy vegetation may be present at the waterside levee crown. Regularly maintained ruderal vegetation occurs landside of the levee roads on both islands. More natural habitat, including some wetland and riparian vegetation, occurs beyond the berms landside of both levees, but this habitat is more than 100 feet from the boundary of the Jersey Island staging area and 200 feet from the boundary of the project site on Bradford Island.

3.4 Special-Status Species

Special-status species are legally protected under the California Endangered Species Act and federal Endangered Species Act or other regulations, or they are considered sufficiently rare by the scientific community to qualify for such listing. These species fall into several categories:

(1) Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (Code of Federal Regulations Title 50, Section 17.12 [listed plants] and Section 17.11 [listed animals], and various notices in the *Federal Register* [proposed species]).

(2) Species that are candidates for possible future listing as threatened or endangered under the federal Endangered Species Act (*Federal Register* Title 61, No. 40, February 28, 1996).

(3) Species listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (California Code of Regulations Title 14, Section 670.5).

(4) Plants listed as rare or endangered under the California Native Plant Protection Act (California Fish and Game Code Section 1900 et seq.).

(5) Animal species of special concern to CDFW.

(6) Animals fully protected under the California Fish and Game Code (Sections 3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians]).

(7) Species that meet the definitions of rare and endangered under the California Environmental Quality Act (CEQA). CEQA Section 15380 provides that a plant or animal species may be treated as rare or endangered even if the species is not on one of the official lists (State CEQA Guidelines Section 15380).

(8) Plants considered by CDFW and the California Native Plant Society to be “rare, threatened or endangered in California” (California Rare Plant Ranks 1A, 1B, 2A, and 2B).[1]

Species recognized under these terms are referred to collectively as “special-status species.”

3.4.1 Special-Status Wildlife

Review of the California Natural Diversity Database and knowledge of the project region identified terrestrial special-status wildlife species and special-status fish species that have at least a moderate potential[2] to be present on the project site. These species are listed in **Table 4**.

3.4.2 Special-Status Plants

Three special-status plant species (delta tule pea, Mason’s lilaeopsis, and Suisun marsh aster) have been recently documented at or very near the project site, and two additional species (delta mudwort and woolly rose-mallow) have been documented within approximately 1 mile of the site. Three additional plant species (bristly sedge, marsh skullcap, and side-flowering skullcap) have the potential to occur within the project site based on presence of suitable habitat. Special-status plant species with at least a moderate potential to be present on the project site are listed on Table 4.

[1] CDFW works in collaboration with the California Native Plant Society to maintain a list of plant species native to California that have low numbers or limited distribution, or that are otherwise threatened with extinction. These species are categorized by their rarity in the California Rare Plant Rank system.

[2] Based on a review of the biological literature of the region and information provided by the California Natural Diversity Database, and on an evaluation of the habitat conditions of the project footprint and vicinity, a species was designated into one of the following categories:

- “None” if (1) the species’ specific habitat requirements (e.g., serpentine grasslands, as opposed to grasslands occurring on other soils) are not present; or (2) the species is presumed, based on the best scientific information available, to be extirpated from the project footprint or region.
- “Low” for occurrence if (1) its known current distribution or range is outside of the project footprint and vicinity or (2) only limited or marginally suitable habitat is present within the project footprint and vicinity.
- “Moderate potential” for occurrence if (1) low- to moderate-quality habitat is present within the project footprint or immediately adjacent areas or (2) the project footprint is within the known range of the species, even though the species was not observed during biological surveys.
- “High potential” for occurrence if (1) moderate- to high-quality habitat is present within the project footprint and (2) the project footprint is within the known range of the species.

TABLE 4
SPECIAL-STATUS PLANT AND WILDLIFE SPECIES WITH POTENTIAL TO OCCUR WITHIN THE PROJECT SITE

Common Name	Scientific Name	Federal Listing	State Listing
Bristly sedge	Carex comosa	None	None
Delta mudwort	*Limosella australis*	None	None
Delta tule pea	*Lathyrus jepsonii*	None	None
Marsh skullcap	*Scutellaria galericulata*	None	None
Mason's lilaeopsis	*Lilaeopsis masonii*	None	Rare
Side-flowering skullcap	*Scutellaria lateriflora*	None	None
Suisun Marsh aster	*Symphyotrichum lentum*	None	None
Woolly rose-mallow	*Hibiscus lasiocarpos* var. *occidentalis*	None	None
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	Threatened	None
Giant garter snake	*Thamnophis gigas*	Threatened	Threatened
Western pond turtle	*Emys marmorata*	None	Special Concern
Chinook salmon–fall-/late fall-run	*Oncorhynchus tshawytscha*	EFH	Special Concern
Chinook salmon–winter-run	*Oncorhynchus tshawytscha*	Endangered, EFH	Endangered
Chinook salmon–spring-run	*Oncorhynchus tshawytscha*	Threatened, EFH	Threatened
North American green sturgeon	*Acipenser medirostris*	Threatened	None
White sturgeon	*Acipenser transmontanus*	None	Candidate
Delta smelt	*Hypomesus transpacificus*	Threatened	Endangered
Longfin smelt	*Spirinchus thaleichthys*	Proposed Endangered	Threatened
Sacramento splittail	*Pogonichthys macrolepidotus*	None	Special Concern
Pacific lamprey	*Entosphenus tridentata*	Special Concern	None
River lamprey	*Lampetra ayresi*	None	Special Concern
Starry flounder	*Platichthys stellatus*	EFH	None
Burrowing owl	*Athene cunicularia*	None	Special Concern
Song sparrow ("Modesto" population)	*Melospiza melodia*	None	Special Concern
Swainson's hawk	*Buteo swainsoni*	None	Threatened
White-tailed kite	*Elanus leucurus*	None	Fully Protected
Pallid bat	*Antrozous pallidus*	None	Special Concern
Western red bat	*Lasiurus blossevillii*	None	Special Concern

NOTE: EFH = Essential Fish Habitat

SOURCES: California Natural Diversity Database 2020; California Department of Fish and Wildlife 2021a, 2021b; California Native Plant Society 2021a, 2021b; U.S. Fish and Wildlife Service 2024a, 2024b, 2024c

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CHAPTER 4
Conceptual Models and Science Basis

This is Step 3 of the Adaptive Management Approach outlined in Appendix 1B of the Delta Plan.

The drought salinity barrier is a tool to reduce saltwater intrusion into the Delta. The project will be constructed only if DWR, in cooperation with other State and federal agencies, determines that drought conditions have reduced water storage in Northern California reservoirs to critical levels, such that projected Delta outflow will not be sufficient to control increased salinity intrusion into the Delta, thereby worsening water quality and threatening the drinking and irrigation water supply.

The results of water quality modeling analyses show that after higher salinity water intrudes into the interior Delta, the water will likely persist for an extended period until typical wet-weather patterns generate winter and spring freshwater river flows to displace it. Installing a drought salinity barrier will help block higher salinity waters from entering the Central Delta, thus reducing demand on reservoir releases. If Delta salinity objectives were to be maintained with reduced reservoir releases, more water in upstream reservoirs could be released later for beneficial uses, such as upstream fisheries and community needs.

Although the West False River barrier will be installed only under severe drought conditions, the amount of Delta water quality protection provided by each installation of the barrier will depend on the timing of installation during a drought. Modeling of salinity intrusion with variable installation dates demonstrates that the greatest water quality benefits will be gained by installing the West False River barrier when Delta water quality, especially at Franks Tract, is adequate for beneficial uses, typically in the spring (April or May). However, lesser benefits may still be gained from installing the drought salinity barrier later in the year when salinity intrusion has degraded water quality at Franks Tract to some degree, because the barrier could only protect water quality, not improve it. For this reason, installing the barrier before water quality conditions become too degraded is important.

4.1 Use of Best Available Science

Adaptive management entails having clearly stated goals, identifying alternative management practices or objectives, framing hypotheses about causes and effects, systematically monitoring outcomes, learning from the outcomes, sharing information with key players and decision-makers, and being flexible enough to adjust management practices and decisions (Delta Independent Science Board 2016). Conceptual models based on best available science are used in adaptive management to integrate available knowledge and to provide synthesis and a means of developing and exploring potential management actions. Monitoring approaches are subject to adjustment as new information arises and refinements to conceptual models are made.

DWR commits to utilizing the best available science to design, manage, and monitor the project. DWR benefited from reviewing the effects of the prior deployments of the rock barriers in 2015 and 2021 (DWR 2019, Hartman et al. 2022) and scientific studies funded or led by the Delta Science Program (Kimmerer et al. 2019, Delta Science Program 2024, Ta et al. 2017, Durand et al. 2020, Conrad et al. 2023). Adaptive management of the project will be based on the utilization of input from monitoring data in conjunction with adaptive review of whether the avoidance of potential issues of management concern (e.g., avoidance of secondary effects that affect levee integrity) is being achieved. The final design was informed by prior deployment of the rock barrier at the same location under emergency use authorizations.

4.2 Current Scientific Understanding

4.2.1 Aquatic Habitat Protection (Upstream of the Delta)

Increased salinity levels have the potential to adversely affect the sensitive aquatic resources that live in and migrate through the Delta. Greater salinity in the Delta could cause exceedances of water quality objectives and beneficial uses described in the Basin Plan. To support competing water needs early in the water year during severe drought without the barrier in place, some of the already limited water supplies stored in upstream reservoirs have to be released, which could have negative impacts on aquatic habitat. For example, if coldwater resources in reservoirs were depleted, flows in late spring and summer would be insufficient to protect salmon eggs incubating in the gravels, and rearing habitat for juvenile salmon below Keswick, Oroville, and other dams would be depleted.

Installing a drought salinity barrier will conserve coldwater pools in upstream reservoirs. The barrier will protect natural resource values later in the year because less water will need to be released from the reservoirs to maintain water quality earlier in the year. Various water quality objectives related to electrical conductivity exist for the protection of fish and wildlife beneficial uses in the Delta, and greater preservation of reservoir storage will allow more water to be available to meet these objectives.

4.2.2 Delta Fisheries

The Delta serves as a migration corridor for all anadromous fish species in the Central Valley as they return to their natal rivers to spawn, and during juvenile outmigration downstream to the ocean. Adult Chinook salmon move through the Delta during most months of the year (Moyle 2002). Chinook salmon and steelhead juveniles depend on the Delta as transient rearing habitat while they migrate through the system to the ocean; these juveniles could remain for several months, feeding in marshes, tidal flats, and sloughs. Numerous resident species live in the Delta year-round, such as delta smelt, longfin smelt, green sturgeon, Sacramento splittail (*Pogonichthys macrolepidotus*), and introduced threadfin shad (*Dorosoma petenense*) (Moyle 2002).

Since about 2002, four pelagic (occupying the open water) fish species have been subject to an area of study called the "Pelagic Organism Decline" (POD) (Sommer et al. 2007). The POD refers to the sudden, overlapping declines of pelagic fishes in the Delta that were first recognized in data collected between 2002 and 2004. The species identified in the POD consist of delta smelt, longfin smelt, threadfin shad, and young-of-year striped bass. Together, these species account for most of the resident pelagic fish biomass in the tidal water upstream from X2, the position (isohaline) at which 2 parts per thousand salinity occurs in the Delta. The causes of the POD and earlier declines are not fully understood, but studies are under way to evaluate potential causes. Among these potential causes are the stock-recruitment relationship (i.e., previous abundance), a decrease in habitat carrying capacity or production potential, predation and entrainment, and a decline (or changes) in primary productivity (Bennett 2005; Feyrer et al. 2007). In 2011, both delta smelt and longfin smelt populations increased, with delta smelt populations at their highest since 2001 and longfin smelt at their highest since 2006. However, their numbers have declined significantly since then.

Fish Movement/Migration

As installation of the drought salinity barrier proceeds and the amount of rock placed in the West False River channel increases, the barrier's in-water structure will affect hydrodynamics in False River, as observed during the 2015 EDB project (DWR 2019). Hydrodynamic modeling of the barrier illustrates that after partial installation, but before barrier closure, the velocity through the unclosed portion of the barrier on flood and ebb tides will be increased. With the progression of barrier construction, tidal flows in False River will be gradually reduced, but the differences in water surface elevation (i.e., water head) across the barrier will increase. The increased head will create faster velocities through the remaining barrier opening, and small fish that are entrained through this portion of the barrier could become disoriented and susceptible to predation when transitioning to slower waters beyond the barrier.

The hydrodynamic modeling also suggests that flow through the barrier before closure will create several hydrodynamic eddies in the False River channel. Small fish being entrained into these eddies may be more susceptible to predation because they could be exposed to predators in the channel for a longer time period. Without the barrier, flows in this area will be straighter and more uniform. Data from the 2015 EDB project indicate that these hydrodynamic effects will occur in the week before closure of the barrier. The barrier rocks will be removed starting from the center of the channel and working outward, with rocks removed from the top of the barrier to the streambed at each portion of the barrier; therefore, similar hydrodynamic effects, resulting in greater predation on small fish, could occur in the early stage of barrier removal.

Maintenance of the drought salinity barrier, including the presence of rocks on the channel bottom, will be temporary. Disturbance of the channel substrate resulting from the presence of the rock barrier will affect the benthic community within the approximately 2.75-acre barrier footprint. This is a very small area relative to the total amount of similar benthic habitat available in the Delta. The drought salinity barrier will create a physical blockage in West False River, thus impeding the free movement of fish, potentially attracting predatory fish, and creating areas that will enhance the foraging success of predatory fishes on susceptible species and life stages. This and other potential indirect effects of barrier operation are described further below.

Operation of the drought salinity barrier could trap juvenile salmonids and delta smelt emigrating from the San Joaquin River basin upstream of the barrier (e.g., in the Franks Tract area). These fish otherwise might have moved (emigrated) through False River into the lower San Joaquin River. However, the hydrodynamic effects of the drought salinity barrier will overlap with the occurrence of a relatively small percentage of the juvenile salmonid populations in the Delta. Adult salmonids returning to upstream natal tributaries—or, in the case of steelhead, adults that have survived spawning and are migrating downstream after spawning—could encounter the drought salinity barrier and therefore have passage blocked. However, this would represent only a minor delay and in some cases may reduce migration time through the Delta (e.g., for fish returning to the Sacramento River that had entered the lower San Joaquin River, and otherwise would have penetrated farther into the interior Delta through False River).

Assuming West False River could be hydraulically closed around three weeks after construction is initiated in early April, the overlap between the drought salinity barrier and the presence of juvenile salmonids in the Delta may be less than 5 percent for winter-run Chinook salmon and yearling spring-run Chinook salmon, less than 20 percent for young-of-the-year spring-run Chinook salmon, and just under 10 percent for San Joaquin River steelhead. Therefore, the relatively small hydrodynamic changes of the drought salinity barrier for a given hydrology and water operations will overlap the occurrence of a relatively small percentage of the total juvenile salmonid populations in the Delta. The presence of the drought salinity barrier will require out-migrating fish entering West False River to take an alternate route using either Fisherman's Cut or East False River. Fish taking these routes could be subject to longer migration time and delayed outmigration (Cavallo et al. 2015). This delay is not considered a significant impact because only a small portion of the total outmigrants will be affected and the potential delay will be limited to the additional time needed to travel the distance to the mainstem of the San Joaquin River.

The timing of barrier closure—based on the approximate three-week period between construction starting and barrier closure that occurred in 2015, this would be around April 22 with an April 1 construction start date—could overlap a considerable portion of the spring upstream migration period of adult green sturgeon (Heublein et al. 2009). However, for adult green sturgeon migrating to the Sacramento River, the barrier may prevent adult green sturgeon from following what otherwise may be a more circuitous pathway through the Central/South Delta, and could reduce the overall migration time.

Blockage of juvenile sturgeon passage would represent a delay in migration to juveniles generally moving around the Delta and seeking foraging areas without specific destinations. Green sturgeon actively migrating toward the ocean from the South Delta will be affected more by the presence of the barrier, but they will be able to seek alternative pathways through the adjacent San Joaquin River and other channels including Fisherman's Cut, East False River, and Dutch Slough.

The presence of the drought salinity barrier may reduce the likelihood of entrainment of juvenile salmonids and delta smelt toward the South Delta export facilities and downstream migration potential of delta smelt larvae/juveniles that occur in the Delta. The drought salinity barrier will eliminate the potential for delta smelt to move from the lower San Joaquin River through False River and Franks Tract into Old River and upstream toward the export pumps (where the risk of entrainment-related mortality is high). However, because water exports from the South Delta are likely to be low during drought conditions, the risk of entrainment in the lower San Joaquin River will likely be relatively low overall, and blockage of passage from the San Joaquin River through False River may have relatively little effect.

Estimates of seepage flow through the EDB in 2015 suggest that flow between the rocks of the drought salinity barrier may result in impingement of small delta smelt (e.g., larvae and early juveniles) that are present upstream and downstream of the drought salinity barrier. However, the 2015 estimates suggest that rock barriers of this type block more than 95 percent of the tidal flow into and out of False River. This means that water exchange between False River and adjacent water bodies is greatly reduced, limiting the potential for entrainment into the False River channel of additional delta smelt beyond those already occurring in False River (assuming that most delta smelt use tidal flows as the primary means of transport over longer distances).

Fish Predation Loss

Enhanced predation of juvenile salmonids in relation to artificial structures has been observed in the Delta (Sabal et al. 2016). Small fish, including juvenile salmonids, could be entrained toward the drought salinity barrier by seepage flows and then hold station in front of it to avoid being impinged on the rocks, resulting in concentrations of small fish near the barrier. Such concentrations of fish could attract piscivorous fishes and other predators. For example, biological monitors observed a Caspian tern fishing along the downstream side of the 2015 EDB for several hours. However, no other such documented observations of predatory birds occurred during biological monitoring, and it was not possible to establish whether predatory fishes also were exploiting concentrated small fishes in this manner. In addition, the 2015 barrier was estimated to have blocked more than 95 percent of flow into and out of False River, which would greatly limit the potential for fish to be entrained into the False River channel from the San Joaquin River or Franks Tract area. This would therefore limit the number of fish being concentrated at the barrier if the fish were moving primarily with tidal flows, although fish swimming without reliance on tidal flows could still enter the channel and be susceptible to near-field predation at the barrier.

As described previously, the drought salinity barrier could increase the extent of submerged aquatic vegetation in areas such as Franks Tract, which could increase predation risk for juvenile salmonids and other small fish passing through that area from vegetation-associated species such as largemouth bass (Conrad et al. 2016). Increased predation on special-status fish other than juvenile salmonids could result, although the relative susceptibility of other species to increased predation is not known. For example, juvenile and subadult green sturgeon are relatively large and bottom-dwelling, and are therefore likely less susceptible to predation than juvenile salmonids.

DWR investigated the impacts on fish predation from a rock barrier installation in West False River through the EDB Predation Study (EDBPS). This study coincided with the 2021 implementation of the emergency drought salinity barrier and the study has since been completed. The study had the following objectives:

1. Determine the effects of construction, presence, and notching of the barrier on the juvenile salmon predation rate relative to other environmental variables.

2. Examine the influence of the barrier on predation rate through time.
3. Examine the influence of the barrier on the movement and survival of acoustically tagged salmonids from other studies.

For the study, drifting predation loggers were constructed based on the National Oceanic and Atmospheric Administration's Predation Event Recorders to measure the relative predation rates on juvenile salmon swimming through our study reaches. These loggers—described in detail in Demetras et al. (2016)—are drifting buoys with a live hatchery fish attached as bait. The drifting predation loggers were outfitted with a GPS tracker and predation-triggered timer that allowed for determination of the exact time and location of predation events. For the EDBPS, a tethered golden shiner (*Notemigonus crysoleucas*) was attached to each predation event recorder as a surrogate bait species for Chinook salmon (*Oncorhynchus tshawytscha*). Golden shiners were selected because they are similar in size to juvenile salmon, are commercially available, and are robust in warm summer conditions (ICF-ESA Joint Venture 2022).

An array of coordinated acoustic receivers is currently maintained in the Central Valley along the Sacramento and San Joaquin rivers and in the Delta. Juvenile Salmonid Acoustic Telemetry System arrays were also deployed in 2021 to monitor the survival, passage, and behavior of juvenile salmonids at the EDB. The receivers were moored to the river bottom using a weighted frame (ICF-ESA Joint Venture 2022). While no tagged juvenile salmonids were released specifically to study the effects of the EDB (because the predation event records had tethered golden shiners in lieu of salmon), several concurrent studies released fish that were expected to be detectable by the acoustic receivers deployed for the EDBPS (ICF-ESA Joint Venture 2022).

Predation risk was expected to increase near the barrier because littoral predators could use the structure similar to shoreline habitat. Indeed, predation risk decreased strongly with increasing distance from shore (ICF-ESA Joint Venture 2022). The EDBPS examined the effect of distance from barrier within each study period (ICF-ESA Joint Venture 2022). As expected, there was no relationship between predation risk and distance from barrier during the preconstruction period, but the decreasing trend between predation risk and distance from barrier was apparent during periods when the barrier was in place (postconstruction, pre-notch, notch, and post-notch) (ICF-ESA Joint Venture 2022). In all cases, the confidence intervals associated with the linear effect narrowed around 150 meters from the barrier, suggesting that more predation records occurred within a consistent zone of influence of the barrier (ICF-ESA Joint Venture 2022). Overall, predation may have increased with proximity to the barrier, but this was evident only during the pre-notch period, which reflects the longest duration of the barrier-in-place condition (ICF-ESA Joint Venture 2022).

Results from the EDBPS indicate that distance to the barrier had a more pronounced effect on predation risk in the latter five months of the study, which may suggest that predators' colonization of the barrier over time led to increased predation risk (ICF-ESA Joint Venture 2022). If this is the case, this study's estimates of predation risk are likely to be low, and the degree of the underestimated risk could be evaluated by periodically conducting field trials at given periods throughout the duration of barrier presence (ICF-ESA Joint Venture 2022). On the other hand, if the barrier is to be removed or notched on an annual basis, the estimates are more likely to accurately reflect predation risk, because this study was carried out over the course of several months and encompassed various degrees of barrier construction and deconstruction (ICF-ESA Joint Venture 2022).

4.2.3 Invasive Aquatic Vegetation

Invasive aquatic vegetation, including submerged vegetation such as Brazilian waterweed (*Egeria densa*), provides habitat that is occupied less by delta smelt than are open-water habitats (Grimaldo et al. 2004; Ferrari et al. 2014). Egeria is the dominant submerged aquatic plant in the Delta and may reduce turbidity (with which delta smelt is positively associated) by slowing water velocity (Hestir et al. 2016). Irrespective of overall Delta hydrology and water operations, the drought salinity barrier could influence the occurrence of Egeria and other invasive aquatic vegetation by affecting water depth, turbidity, and channel velocity.

Kimmerer et al. (2019) hypothesized that the reduction in current speeds within Franks Tract with the 2015 EDB in place was expected to lead to a more lake-like environment, increasing the biomass of submerged aquatic vegetation and changing its distribution. To assess the change in submerged aquatic vegetation, Kimmerer et al. (2019) compared maps of submerged aquatic vegetation from summer 2004 and fall 2015–2017, produced using airborne hyperspectral imagery over the Delta, to determine the EDB's immediate effect on submerged aquatic vegetation extent and density. They concluded that the EDB may have helped submerged aquatic vegetation gain a foothold where it had not been prevalent before, given the greater extent observed during and after EDB installation and removal. On the basis of the observations from the 2015 EDB as studied by Kimmerer et al. (2019), it is possible that the drought salinity barrier could increase invasive aquatic vegetation in portions of the Delta such as Franks Tract, with the potential to have negative effects on delta smelt by decreasing turbidity (Hestir et al. 2016) or reducing spawning habitat availability, for example.

4.2.4 Cyanobacteria Harmful Algal Blooms

Harmful algal blooms in the Delta are chiefly caused by cyanobacteria (Hartman et al. 2022). Predicting when and where cynanobacteria harmful algal blooms (CHABs) will develops is challenging (Delta Science Program 2024). Blooms of cyanobacteria are correlated with flows and water residence time directly (Delta Science Program 2024). Delta channels with longer residence times, such as dead-end sloughs, are more commonly associated with areas where CHABs are more likely to be found. In 2021, a large CHAB occurred in the eastern side of Franks Tract, which could have been exacerbated by a combination of lower flows coupled with higher water temperatures (Hartman et al. 2022). Elsewhere in the Delta, areas that had experienced CHABs in prior years also showed similar CHABs in 2021 (Harman et al. 2022). Lack of routine CHAB monitoring data is considered to be a significant impediment to progress on mitigation and management of CHABs in the Delta (Delta Science Program 2024).

4.2.5 Golden Mussels

Golden mussel (*Limnoperna fortune*i) is an invasive, freshwater bivalve, that was recently discovered in the Port of Stockton by DWR in 2024. In waterways where this species is present, they have contributed to bio-fouling of municipal and industrial water intakes, harmed native species, and increased water clarity due to intense filter feeding (CDFW 2024). It is preliminarily suspected that golden mussels were introduced to California by a ship traveling from an international port (CDFW 2024). DWR considered whether the rocks used to construct the salinity barrier could be colonized by golden mussel while they are deployed in West False River and later contribute to further spread of golden mussels within portions of California's freshwater aquatic habitat that are not already invaded by the species. Golden mussels have a short tolerance to desiccation (a drought period longer than 12 days is generally lethal) (Wantzen et al. 2011). The rocks used to construct the barrier are stored on land when they are not deployed. Thus, the rocks are expected to naturally dry out and result in the mortality of golden mussels that may have attempted to colonize the rock surface.

4.2.6 Hydrodynamic Effects

Delta channel levees are composed of organic peat soil except where they have been upgraded with imported soil, and generally are stable under normal tidal flows and velocities. Tidal velocities are the result of tidal elevation gradients, and tidal velocities in most Delta channels range from 2 to 3 feet per second. Generally, tidal velocities of 2–3 feet per second do not cause channel scour (i.e., erosion), because nearby channel banks are likely already exposed to these velocities and fine sediments have already been transported to other locations. Bathymetric surveys used to review impacts of the 2015 EDB also indicate that scour near the barrier was not an issue and undercut levees did not show significant changes between pre- and post-project implementation of the 2015 EDB (California Department of Water Resources 2019).

DWR conducted prior bathymetric surveys of the riverbed to monitor progression of the scour after it appeared, collected inclinometer measurements on Bradford Island to monitor any potential movement, and tracked velocity measurements. Based on this information, DWR's Geotechnical Engineering Section determined that there does not appear to be an immediate threat of internal erosion, new seepage, or slope instability of the north or south river levees due to the scour. The presence of the salinity barrier could increase the potential for erosion and scour damage to occur; increased erosion and siltation rates can cause nearby existing levees to fail and scour can cause damage to levees by undermining its foundation.

4.2.7 Climate Change

Climate change projections for the Delta include earlier seasonal runoff, higher water temperatures, and Delta salinity intrusion. The project will increase operational flexibility and allow DWR to prepare for the foreseeable implication of climate change.

CHAPTER 5
Monitoring

This chapter encapsulates Steps 3–6 of the Adaptive Management Approach outlined in Appendix 1B of the Delta Plan.

Monitoring is important to demonstrate that the project objectives are being achieved to detect the need for corrective management actions (triggers), and to reduce uncertainty and improve understanding of the system.

5.1 Monitoring

5.1.1 Water Quality Monitoring

DWR will develop and implement a water quality monitoring plan to assess the effects of the project on flow and water quality throughout the Delta. The final water quality monitoring plan will be subject to final approval by the State Water Board. DWR may also use data from other existing and recently upgraded stations throughout the Delta. DWR will prepare monthly water quality summaries, monthly water quality maps for Franks Tract using discrete data, and a final report on the project's effects on water quality and development of cyanobacterial harmful algal blooms, or cyanoHABs.

Measurement Points

Monitoring data will be provided by strategically placed stations installed during the 2015 EDB project and the additional stations at Woodward Cut (one monitoring station) and Railroad Cut (two monitoring stations) that will be installed as part of the project.

Measurement Parameters

DWR will monitor flow, stage, water velocity, water temperature, specific conductance, turbidity, chlorophyll, nutrients, bromide, organic carbon, pH, dissolved oxygen. DWR will also collect surface water samples from stations D-19 and BET in Franks Tract for evaluation for cyanoHAB-associated parameters. Chlorophyll and nutrient data will be posted online as soon as the results are available. DWR may commit to additional water quality monitoring efforts in tandem with field studies conducted by the U.S. Geological Survey and/or other entities to better understand how the drought barrier will affect salinity and velocities in the Delta beyond West False River.

Measurement Intervals

The water quality data will be collected on a continuous basis. DWR staff members will post weekly water quality data summaries of the continuous data.

Trigger Levels

Water quality data indicates conditions are above/below (depending on metric) respective thresholds for aquatic life, along with evidence of fish die-offs.

5.1.2 Fish Passage Effects

DWR will assess the near-field occurrence of focal fish species by supplementing Pacific Aquatic Telemetry Hub (PATH) groups that are being used to assess far-field occurrence in the Delta. DWR will also consider supplementing efforts to incorporate predation detection acoustic tag (PDAT) technology to better understand predation effects in the vicinity of the barrier. Data will be collected during at least one season with the barrier in place and one season without the barrier in place. To the extent possible, DWR will use detections of fish tagged from other studies but will fund additional tagging should this be necessary to increase sample sizes. These data, in association with historical data from sources such as the PATH and Enhanced Acoustic Telemetry (EAT) databases, will be used to compare fish passage with and without the barrier. The comparison will be conducted by assessing overall through-Delta passage (i.e., the percentage of fish entering the Delta that were detected leaving the Delta), through-Delta passage time with and without the barrier installed, and coarse-scale route selection through the Delta.

5.1.3 Invasive Aquatic Vegetation

DWR will coordinate with the California Department of Parks and Recreation, Division of Boating and Waterways (DBW) Aquatic Weed Control Program for the control of invasive aquatic weeds near the barrier that are covered by the control program. DWR will coordinate with DBW on implementation of treatment or removal strategies for covered invasive aquatic weeds near the barrier to the greatest extent practicable. DBW tracks the prevalence of invasive aquatic vegetation in the Delta, including leveraging hyperspectral data to remotely detect distribution of invasive aquatic vegetation in the Delta. DWR has an ongoing interagency agreement with DBW to support their invasive aquatic weed control program, in which coverage includes the vicinity adjacent to the West Fast River Drought Salinity Barrier.

Measurement Points

For the purposes of this AMMP, the focus of measurements of invasive vegetation distribution will be on the areas in the immediate vicinity of the barrier, including West False River and Franks Tract. Any collection of hyperspectral data will likely cover a large geographic extent (e.g., Delta-wide survey).

Trigger Levels

Greater than 75 percent of West False River upstream of the barrier is covered by invasive aquatic vegetation.

5.1.4 Levee Scour

To evaluate the potential of the barrier to contribute to levee scour, DWR will monitor tidal velocities. Under Installation Scenario 2, DWR shall regularly conduct bathymetric surveys to monitor for potential scour at the riverbed, collect inclinometer measurements, and monitor velocity measurements around the barrier while the notch is in place.

Measurement Points

Under all three installation scenarios, DWR will monitor tidal velocities in West False River, Fisherman's Cut, and Franks Tract and the levees around Bradford Island (Reclamation District 2059) and Jersey Island (Reclamation District 830) while the West False River drought salinity barrier is in place.

Under Installation Scenario 2 (i.e., with the notch in place), DWR will regularly conduct bathymetric surveys to monitor for potential scour at the riverbed and collect inclinometer measurements on Bradford Island to ensure there is no observed movement of the adjacent levee. Additionally, DWR will monitor velocity measurements around the barrier while the notch is in place. Corrective measures, such as early filling of the notch, shall be implemented as expeditiously as possible if the stability of the barrier or levees may be compromised by the scour.

Trigger Levels

If there is discernable movement of the adjacent levee on Bradford Island, DWR will implement corrective actions.

5.2 Data Management

The monitoring program will include a plan for collecting, storing, documenting, and assuring quality in data management. This data management plan will be developed concurrent with the design of the monitoring program. The data management plan will address data handling from collection, processing, analysis, maintenance and sharing. Descriptions will include project history, detailed monitoring protocols and standard operating procedures (SOPs) for all field sampling and data entry activities, metadata, quality assurance/quality control process, SOPs for analyses, and data storage (including backup and security). Whenever possible, SOPs used will be comparable to those of existing Delta long-term regional monitoring programs to maximize data comparability. Metadata will be documented at all stages of data collection and processing and stored in standard formats along with the data.

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CHAPTER 6
Management Actions

6.1 Triggers

A "trigger" is the level or value of a metric that warrants a management response to address an undesired outcome. An example of a trigger can be a threshold of a critical ecological process (e.g., lack of extended inundation events of seasonal floodplain required for successful splittail spawning). A stressor can also be a trigger (e.g., excessively high cover of invasive plants).

6.2 Adaptive Management Actions

If a trigger level is reached, then a management response may be warranted. Potential management responses can include determining which installation scenario to conduct (e.g., installation of a notch under Scenario 2); further or more intensive monitoring of the situation; and reevaluation of conceptual models and assumptions about system and project function, and/or adjustment of goals and triggers. Any decisions beyond implementation of established best practices will be coordinated among DWR and relevant resource agencies.

6.2.1 Water Quality

DWR shall monitor flow, stage, water velocity, water temperature, specific conductance, turbidity, chlorophyll, nutrients, bromide, organic carbon, pH, and dissolved oxygen levels. DWR staff members will post weekly water quality data summaries of the continuous data. These data will eventually feed into a final report, which will provide an overview of the observed effects on Delta water quality when the barrier is in place. The information gleaned from the water quality monitoring efforts will help to refine modeling parameters and improve understanding of how the barrier affects water quality patterns. The information can also inform the future timing of installation and removal of future deployments of the salinity barrier.

6.2.2 Fish Predation

See the "Fish Predation Loss" section above (within Section 4.2.2, "Delta Fisheries") and Section 5.1.2, "Fish Passage Effects." Overall, predation may have increased with proximity to the barrier, but this was evident only during the pre-notch period (ICF-ESA Joint Venture 2022). Recognizing that information about fish passage in False River is limited, DWR is committed to further understanding fish passage effects near the barrier by evaluating data comparing fish passage with and without the barrier.

DWR will evaluate fish passage data through the use of acoustic telemetry receivers near the West False River barrier by funding and augmenting future or ongoing acoustic telemetry efforts around the Central Delta. These evaluations will be conducted to better understand fish passage effects of the project and assess focal fish species movement based on acoustic telemetry. DWR will assess the near-field occurrence of focal fish species by supplementing (PATH) groups that are being used to assess far-field occurrence in the Delta. DWR will also consider supplementing efforts to incorporate PDAT technology to better understand predation effects in the vicinity of the barrier. Data will be collected during at least one season with the barrier in place and one season without the barrier in place. To the extent possible, DWR will use detections of fish tagged from other studies but will fund additional tagging, should this be necessary to increase sample sizes. These data, in association with historical data from sources such as the PATH and EAT databases, will be used to compare fish passage with and without the barrier. The comparison will be conducted by assessing overall through-Delta passage (i.e., the percentage of fish entering the Delta that were detected leaving the Delta), through-Delta passage time with and without the barrier installed, and coarse-scale route selection through the Delta.

6.2.3 Invasive Aquatic Vegetation

If the drought barrier is determined to contribute to the spread of invasive aquatic weeds in portions of the Delta in the vicinity of the barrier, DWR will coordinate with DBW for implementing control methods of the invasive aquatic vegetation. DBW may implement a combination of herbicide, biological, and mechanical control methods. For infestations of submerged aquatic vegetation that spread through fragmentation, mechanical harvesting methods will not be employed because cutting back the plants can exacerbate the problem. For any application of herbicides, DBW will follow all U.S. Environmental Protection Agency–registered label guidelines.

6.2.4 Levee Scour

Under Scenario 2 with notch in place, if findings from bathymetric surveys, inclinometer measurements on Bradford Island, and velocity measurements around the barrier notch indicate the stability of the barrier or nearby levees may be compromised by scour, corrective measures, such as early filling of the notch, shall be implemented immediately.

In 2014 and 2015, in preparation for installation of the EDB, the Bradford Island and Jersey Island levees adjacent to the project site were strengthened for the barrier installation using rock protection on the waterside slope, the levee toes were repaired, and steel sheet piles were driven through the levees. In the unlikely event that the future installation of the drought barrier at West False River results in scour damages to nearby levees that were not predicted by modeling, similar waterside levee slope improvements could be considered again. However, it is important to note that either the local landowner or DWR will need to secure relevant permits from USACE and the Regional Water Quality Control Board to implement actions such as placement of rock slope protection. Thus, to address any issues regarding levee scour that are specifically attributable to the presence of the drought salinity barrier, DWR will first prioritize actions that it can implement on its own (e.g., early closure of a notch).

6.3 Reporting and Communications

A final report summarizing monitoring results will be prepared for DWR. The report will include a summary of work completed to date, methodologies, constraints, discussion of results, and recommendations for next steps, including lessons learned from the process (if applicable). This final report will be shared with the Delta Protection Commission. Additionally, DWR will prepare monthly water quality summaries and a final report on the project effects on water quality, pursuant to the water quality monitoring plan to be approved by the Central Valley Regional Water Quality Control Board.

Forums such as the Association of California Water Agencies' Conferences and the Bay-Delta Science Conference are potential opportunities to communicate lessons learned to a broad audience of scientists, managers, and decision-makers. If a future drought salinity barrier is present, DWR will post project updates and summaries of scientific monitoring on its website. The summaries will be presented in a clear and accessible manner to ensure that key takeaways are easy for the general public to understand.

6.4 Maintenance Actions

Given the temporary nature of the drought salinity barrier, maintenance will be minimal or nonexistent; however, DWR will inspect the barrier regularly and will inform the permitting agencies (CDFW, USFWS, and NMFS) should any major maintenance activities be required. DWR will maintain the navigational aids (e.g., signage, lights, buoy lines) while the drought salinity barrier is in place. DWR also will coordinate with DBW for the removal of non-native invasive freshwater plants, including water hyacinth (*Eichhornia crassipes*), as needed, while the drought salinity barrier is in place.

The three water quality monitoring stations located at Woodward Cut and Railroad Cut will each be installed on a 12-inch-diameter steel pipe pile and will include navigational aids as needed. DWR will conduct maintenance activities to the stations every three to four weeks to clear away any surrounding vegetation and algal growth and replace equipment as needed. These stations will remain in place beyond the removal of the drought salinity barrier to increase the monitoring network and provide expanded water quality data for the Central Delta.

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CHAPTER 7
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