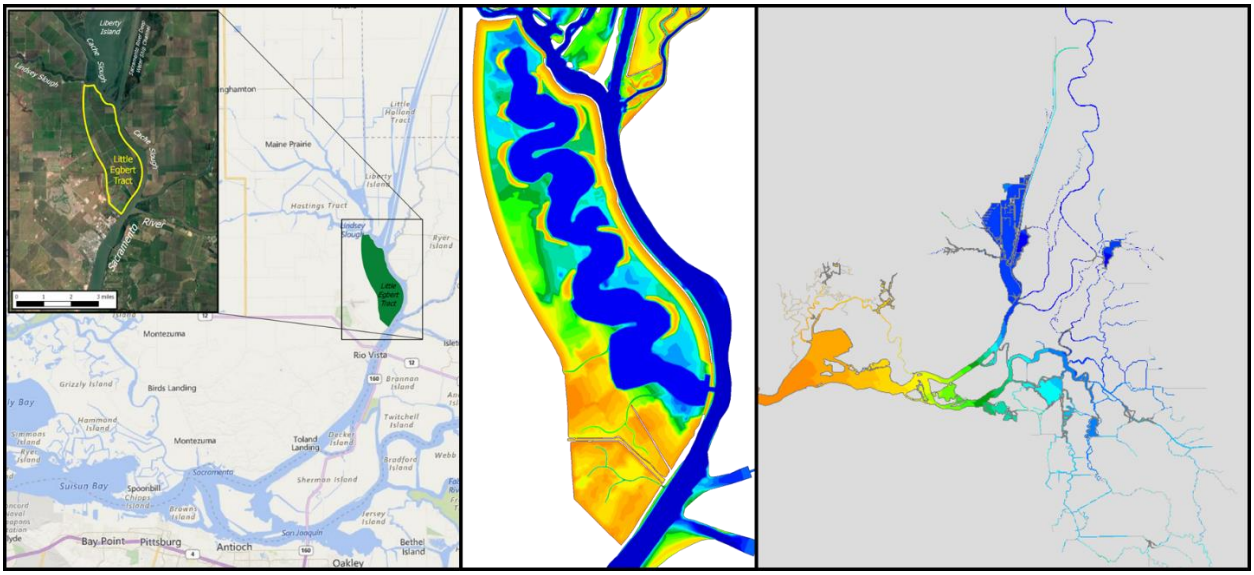
RESOURCE MANAGEMENT ASSOCIATES
WATER RESOURCES ENGINEERING

Little Egbert Multi-Benefit Project Modeling Evaluation of Salinity Changes for Alternatives



TECHNICAL MEMORANDUM

July 2023

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Executive Summary

The RMA Bay-Delta model was applied to evaluate salinity impacts of the Little Egbert Multi-Benefit Project (LEMBP or Project) relative to a Base (No Action) condition. The No Action condition represents the current state of Little Egbert Tract (no tidal action and not included in the grid). Three restoration alternatives (Alternative 19, Alternative 24 and Alternative 26) were considered, as well as a Future Without Project (FWOP) scenario with fully degraded RD2084 Cache Slough restricted height levee. The three alternatives were selected to cover the range of north and south breach/inlet weir scenarios. Alternative 17 was not simulated due to its similarity to Alternative 26, with full north and south breaches. All grids include newly constructed tidal marsh restoration sites as well as those in late planning stages under the California Eco Restore Program. Little Egbert Tract and all other restoration sites are represented in sufficient detail to achieve the modeling goal of assessing regional salinity impacts.

The RMA Bay-Delta model is a widely accepted tool that has been shown to be effective at predicting salinity distribution throughout the Delta. The model has been applied to flow and salinity impacts analysis for numerous tidal marsh restoration projects throughout the Bay-Delta.

The evaluation periods were January 1 to December 31, 2018 and January 1 to December 31, 2020. These periods cover a below normal hydrology (2018) and a dry year hydrology (2020). Periods were selected to reflect some of the historical salinity variation, including yearly and seasonal fluctuations in the dynamic Bay-Delta system.

The RMA Bay-Delta model is a 2-D depth averaged / 1-D cross-sectionally averaged model extending from the Golden Gate to the Sacramento River above the confluence with the American River, and to the San Joaquin River near Vernalis. The 2-D elements are employed to represent areas of open water and large channels (e.g., Suisun Bay, Cache Slough Complex, Cache Slough, the lower Sacramento River and restoration areas) while the 1-D elements are used to represent the channelized portions of the Delta.

The hydrodynamic model predicts depth and velocity throughout the model domain. These results are used to drive salt transport in the water quality model. In the model, Electrical Conductivity (EC) is used as a surrogate for salinity similar to other Delta models such as DWR DSM2.

The model has been calibrated for the years 2018 and 2020 during a parallel modeling effort that has focused on improving model boundary conditions in the Cache Slough Complex (RMA, 2023).

Salinity Evaluation

Electrical conductivity (µmhos/cm or µSiemens/cm), or EC, was modeled as a surrogate for salinity. EC is used as a stand-in for the more precise term of Specific Conductance (SC) for the electrical conductance corrected to 25° C. The RMA Bay-Delta model is limited to computing a depth-averaged EC. The salinity model analysis was performed for 2018 and 2020.

The State Water Resources Control Board (SWRCB) Decision 1641 (D-1641) was adopted December 29, 1999 and revised on March 15, 2000. D-1641 is the implementation plan for the 1995 Bay-Delta Plan, with respect to the operation of water projects within the Delta watershed, and includes water quality objectives to protect Municipal and Industrial (M&I) beneficial uses in the Delta, as well as water quality objectives to protect Fish and Wildlife beneficial uses. Salinity impacts were evaluated for select D-1641 compliance locations and Contra Costa Water District intake locations:

D-1641 Station ID	Location	Beneficial Use
D22	Sacramento at Emmaton	Agriculture
D15	San Joaquin at Jersey Point	Agriculture, Fish and Wildlife
D29	San Joaquin at Prisoners Point	Fish and Wildlife
C5	Contra Costa Canal at Pumping Plant 1	Municipal and Industrial
C9	West Canal at mouth of Clifton Court Forebay	Municipal and Industrial
DMC1	Delta-Mendota Canal at Tracy Pumping Plant	Municipal and Industrial
SLBAR3	Barker Slough NBA Intake	Municipal and Industrial
C19	City of Vallejo Intake Cache Slough	Municipal and Industrial
C2	Sacramento at Collinsville	Fish and Wildlife
D12	San Joaquin at Antioch	Municipal and Industrial
	CCWD Intake at Mallard Slough	
	CCWD Intake at Old River	
	CCWD Intake at Victoria Canal	

A map of these locations is shown in Figure 1. The locations were selected to assess the potential for the Project to affect salinity intrusion in the Delta.

The D-1641 evaluation periods include the Fish and Wildlife, and Agriculture compliance periods during 2018 and 2020, which vary by location.

The objectives of the model salinity evaluation were twofold:

1) Evaluate the Little Egbert Tract salinity impacts by quantifying the percentage change from the existing conditions.
2) Examine if Little Egbert alternatives have the potential to result in non-compliance with the D-1641 water quality objectives for select locations.

The modeling results showed that Little Egbert Tract alternatives produced both decreases and increases in computed EC both seasonally and spatially. The largest salinity increases occurred in the Sacramento River at Emmaton during the summer of 2020. The largest salinity decreases occurred in Barker Slough during the spring of 2020. South Delta export/water intake locations see salinity increases peaking at 2% – 4% during the fall months.

The alternatives generally increased EC by 1 to 4% from the Base condition for central and south Delta locations in the summer and fall, with larger increases occurring in 2020 versus 2018. At Emmaton, salinity increases of 3% to 11% occurred throughout much of the simulation periods. In Barker Slough, salinity decreased by as much as -6%.

The most favorable salinity results (smallest increases over Base) occur for Alternative 24. The least favorable salinity results (largest increases over Base) occur for Alternative 26 and FWOP, which produce very similar salinity results. The notable exception is at the Barker Slough NBA intake, where the FWOP alternative produces the largest salinity reductions and Alternative 24 produces the smallest reductions.

Salinity impacts appear to be greatest when Little Egbert Tract is fully breached at both ends (Alternative 26) or with fully degraded levees (FWOP). With a higher northern inlet weir that overtops only during high flows (Alternatives 19 and 24), the impacts are reduced. The compound southern breach in Alternative 24 further restricts flow and reduces impacts, however peak flood tide velocities at this breach are estimated to reach up to 6 ft/s.

The second goal of the salinity model evaluation was to determine the potential for Little Egbert Tract alternatives to result in non-compliance with the D-1641 water quality objectives. Seasonal EC standards apply to Agriculture, Fish and Wildlife compliance stations at the Sacramento River at Emmaton (D22), Sacramento River at Collinsville (C2), and the San Joaquin River at Jersey Point (D15) and Prisoners Point (D29). Little Egbert Tract alternatives EC values over the compliance periods (Apr 1 – Aug 15 for D22 and D15, Oct 1 – May 31 for C2, Apr 1 – May 31 for D29) were predicted to be well under the compliance limits, with the exception of

Jersey Point, where Alternatives 19 and 26 and the FWOP scenario were predicted to exceed the standards on the last day of the compliance period in 2018.

X2 is the location along the primary axis of the estuary where tidally averaged bottom salinity is two parts per thousand, which is a Bay-Delta Plan standard. Evaluation of changes to X2 indicates that the Little Egbert Tract alternatives would generally increase monthly averaged X2 by 0.2 km or less.

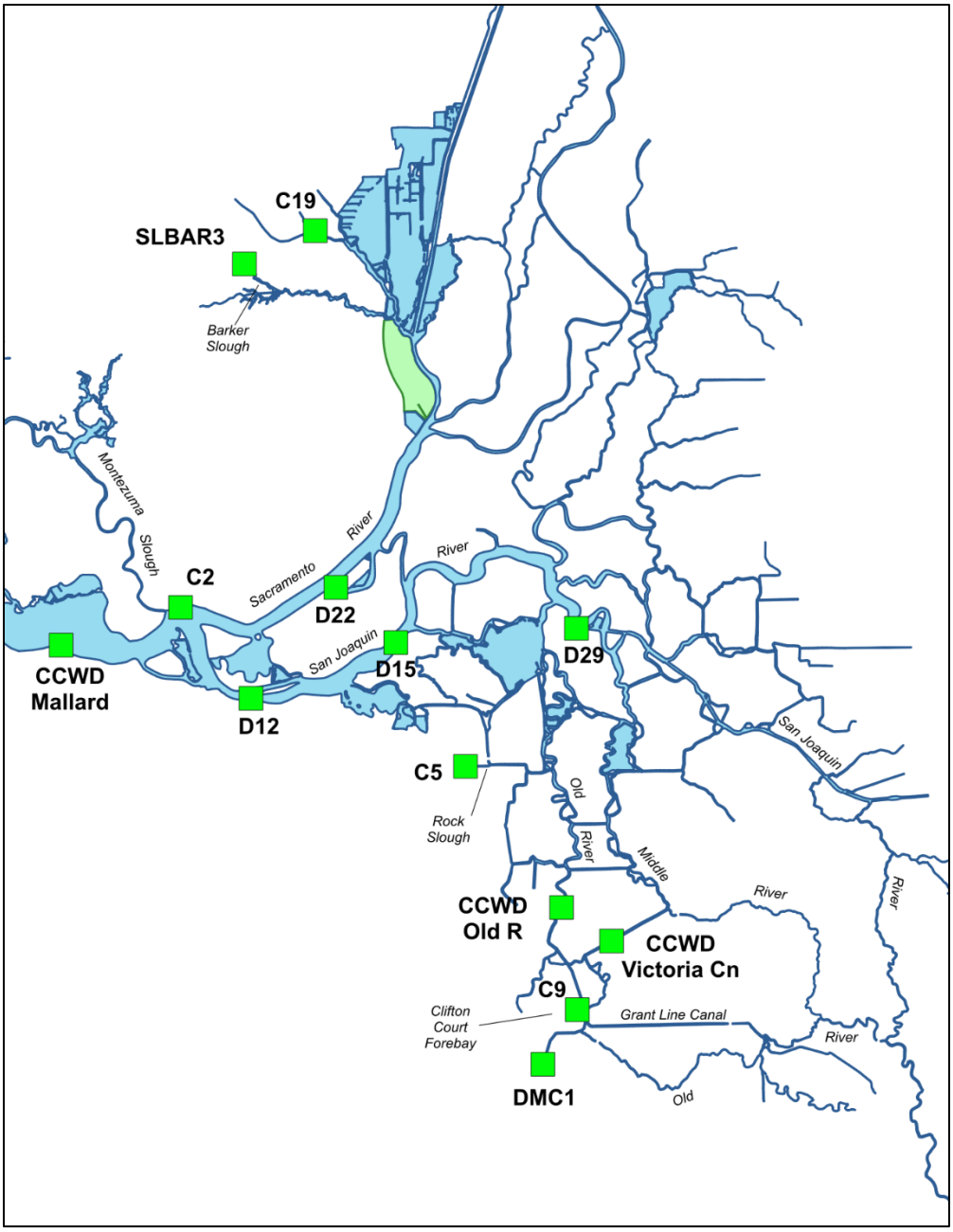

Figure 1 D-1641 compliance locations used for the Project alternatives model evaluation for salinity impacts.

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Introduction

The Little Egbert Multi-Benefit Project (LEBMP or Project) is an approximately 3150-acre site located in the northern Sacramento-San Joaquin Delta, bounded by Cache Slough on the east and Lindsey Slough and Cache Slough on the north (Figure 2). Three restoration alternatives and a Future Without Project (FWOP) alternative were analyzed. The restoration alternatives include various external breach and internal channel configurations. The FWOP considers a full degrade of the restricted height levees along Cache Slough and Lindsey Slough.

Hydrodynamic and water quality model simulations were performed to assess potential Project impacts on salinity at water intakes and salinity compliance standards. Impacts were considered relative to a No Action alternative, where there is no tidal action in Little Egbert Tract under the modeled conditions.

Background

The RMA Bay-Delta model of the San Francisco Bay and Sacramento – San Joaquin River Delta system was applied to assess salinity impacts for the Project. The RMA Bay-Delta model is a widely accepted tool that is effective at predicting EC throughout the Bay-Delta (RMA, 2023). The model has been applied to flow and salinity impacts analysis for numerous restoration projects in the Bay-Delta system, including Bay Delta Conservation Plan, Regional Salinity, Suisun Marsh PEIR/EIS, Prospect Island, Lookout Slough, McCormack-Williamson Tract, Decker Island, Winter Island, Dutch Slough, Chipps Island, Mallard Farms, Tule Red, Grizzly King, Potrero Marsh, Bradmoor Island, Arnold Slough, Hill Slough and Wings Landing (see for example RMA, 2009, 2012, 2013, 2015a and 2015b). The RMA Bay-Delta model has undergone continual development over more than 25 years to reflect currently available data and meet project needs. Similarly, since their original development in the 1970's, the RMA2 and RMA11 computational models have been updated over the years to best utilize the latest scientific knowledge and technology, and to meet new project needs.

Methods

The model evaluation was conducted using the RMA Bay-Delta model for flow and salinity. The model utilizes the finite element method to simulate 2-D depth averaged / 1-D cross-sectionally averaged flow and salinity for a 7.5-minute computational time step.

Electrical Conductivity (µmhos/cm or µSiemens/cm), or EC, was modeled as a surrogate for salinity. The reference to "EC" in this document is in keeping with some past conventions, and is used as a stand-in for the more precise term of Specific Conductance (SC) for the electrical conductance corrected to 25° C.

Hydrodynamic and EC simulations were performed for the periods of January – December, 2018 and January – December 2020. According to DWR's hydrologic classification index, the 2018 water year was classified as below normal and the 2020 water year was classified as dry.

To assess potential impacts associated with the LEMBP, simulations were performed for five scenarios examining a No Action condition (the Base condition to which other scenarios were compared), implementation of three tidal marsh restoration options and a Future Without Project FWOP alternative, where the RD2084 Cache Slough restricted height levee is fully degraded. The five scenarios are:

- Base (No Action)
- Alternative 19
- Alternative 24
- Alternative 26
- FWOP

Results were post-processed to evaluate relative impacts, potential for violation of D-1641 standards and impacts on X2. X2 is the location along the primary axis of the estuary where tidally averaged bottom salinity is two parts per thousand, which is a Bay-Delta Plan standard. Daily and monthly average salinity changes were assessed at D-1641 compliance locations and water export locations. Spatial plots of relative salinity change were provided for summer and fall months.

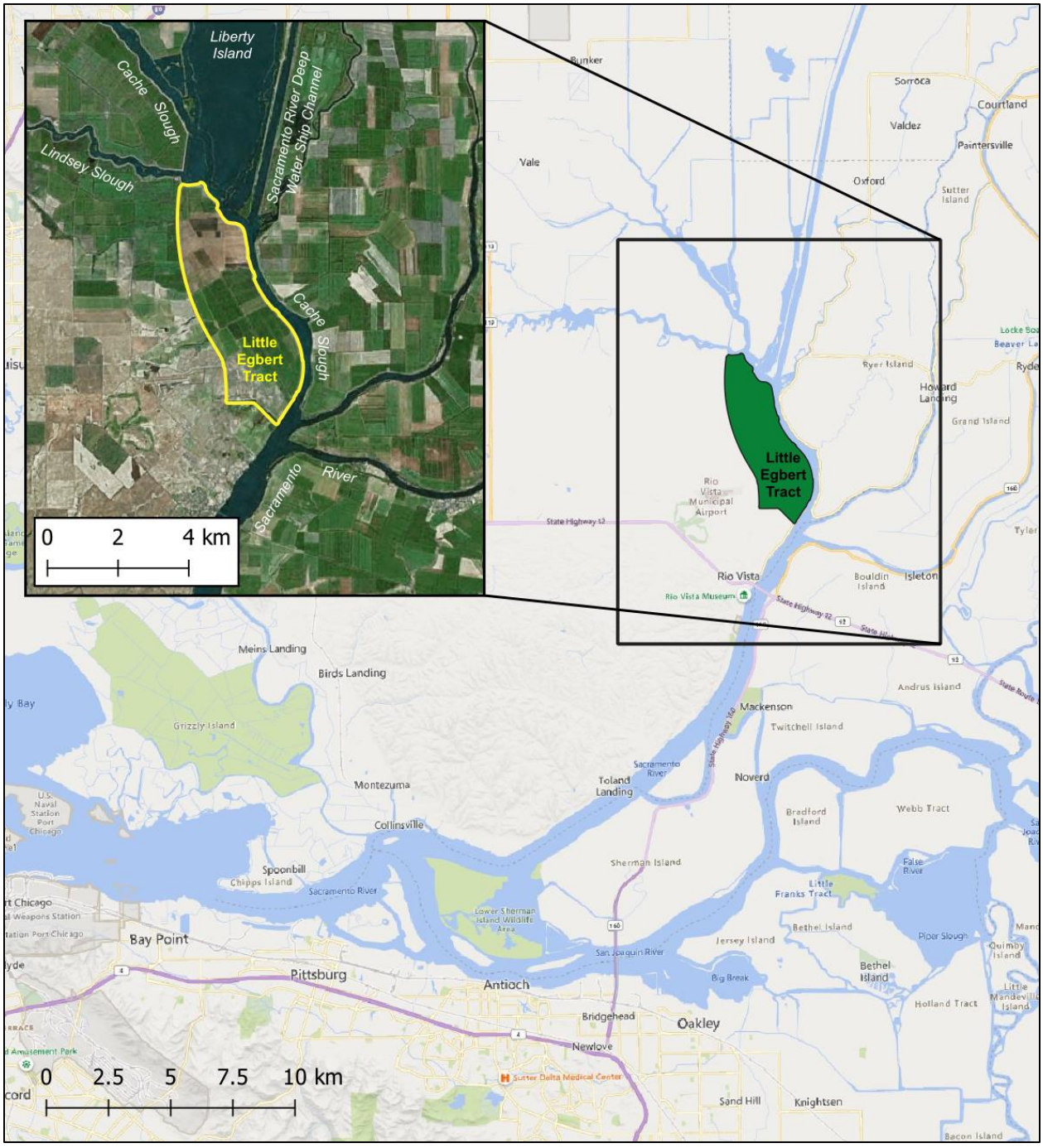

Figure 2 Location of the Little Egbert Tract Tidal Restoration site in the northern Delta.

Model Configuration

Geometric Extents

RMA's San Francisco Bay, Sacramento–San Joaquin Delta network was developed using an in-house GIS-based graphical user interface program (RMA, 2003) and the Janet commercial grid generation program (smile consult GmbH). The programs allow for development of the finite element mesh over layers of bathymetry points and bathymetry grids, GIS shapefiles and aerial images.

The RMA Bay-Delta model extends from the Golden Gate to the Sacramento River above the confluence with the American River, and to the San Joaquin River near Vernalis. A two-dimensional depth-averaged approximation is used to represent the San Francisco Bay, Suisun Bay region, the Sacramento-San Joaquin confluence area, Sherman Lake, the Sacramento River up to Rio Vista, Cache Slough, Liberty Island, Shag Slough, portions of Lindsey Slough, the Sacramento River Deep Water Ship Channel (DWSC) and Miner Slough, Big Break, the San Joaquin River up to its confluence with Middle River, False River, Franks Tract and surrounding channels, Mildred Island, Old River south of Franks Tract, and the Delta Cross Channel area. The model has undergone continuous development through dozens of projects since 1997 (e.g., RMA, 2012, 2015b).

The other Delta and Suisun Marsh channels and tributary streams are represented using a one-dimensional cross-sectionally averaged approximation. The two-dimensional representation of Cache Slough and Lindsey Slough has been slightly refined in this area for the purposes of this Project, to connect breaches and weirs to the channels.

The size and shape of elements are dictated by changes in bottom elevation and other hydraulic and salinity considerations. Wetting and drying of the tidal mudflats has been represented in sufficient detail to provide a good definition of change in the tidal prism with change in tidal stage.

The Base (No Action) model network does not include any restoration in Little Egbert Tract. The Little Egbert alternatives model networks include the detailed representation of Little Egbert.

All the model networks include the following recently constructed or planned projects (see Figure 3):

- Lower Yolo Ranch tidal restoration
- Yolo Flyway Farms tidal habitat restoration
- Lindsey Slough tidal restoration

- Decker Island tidal habitat restoration
- Liberty Island Conservation Bank
- RD 2093 North Delta Fish Conservation Bank
- Lookout Slough tidal restoration
- McCormack Williamson Tract habitat restoration
- Cache Slough Mitigation Bank
- Dutch Slough tidal restoration
- Prospect Island restoration

Bathymetry

The RMA Bay-Delta model grid and bathymetry has been continually updated over the years as new and better bathymetry data becomes available. For all areas of the model grid, the most current, best quality bathymetric data were used to set grid elevations (Figure 4) as follows.

- Most recently, elevations were set using data collected in the CSC during 2015, 2017 and 2018 by the USGS[1].
- Deepwater Ship Channel and Miner Slough elevations were set using data collected by DWR (DWR, 2012).
- Elevations in the portions of the Ship Channel upstream of the DWR survey were set using 2005 USACE data (USACE, 2005).
- In Cache Slough and Sutter Slough elevations were set using data collected by Environmental Data Solutions (EDS) 2012.
- For the San Francisco Bay and Suisun Bay, DWR's 2012 10m San Francisco Bay and Sacramento – San Joaquin Delta DEM version 3[2] were used.
- The model grid includes elevations based on the multi-beam bathymetry surveys performed by DWR for selected Suisun Marsh and Delta channels and posted on the DWR Delta Bathymetry websites[3,4]. The sites provide a documentation of the multi-beam and single-beam data sources.
- For all areas not covered by more recent data sets listed above, bottom elevations and the extent of mudflats were based on bathymetry data collected by NOAA, DWR, USACE and USGS. These datasets have been compiled by DWR and can be downloaded from DWR's Cross Section Development Program (CSDP) websites[5] and;

[1] https://www.sciencebase.gov/catalog/item/5d781129e4b0c4f70d020cdd
[2] https://data.cnra.ca.gov/dataset/san-francisco-bay-and-sacramento-san-joaquin-delta-dem-v3
[3] https://gis.water.ca.gov/app/bathymetry/
[4] https://data.cnra.ca.gov/dataset/san-francisco-bay-and-sacramento-san-joaquin-delta-dem-for-modeling-version-4-1
[5] https://data.ca.gov/dataset/cross-section-development-program-navd88-update

- The Lower Yolo Ranch tidal restoration grid was based on data provided by cbec.
- The Lower Flyway Farms tidal restoration grid was based on data provided by cbec.
- The Decker Island tidal restoration grid was based on data provided by Stillwater Sciences.
- The Liberty Island Conservation Bank grid was based on USGS[6] topography data.
- The RD 2093 North Delta Fish Conservation Bank tidal restoration grid was based on data provided by cbec.
- The Lookout Slough planned tidal restoration grid was based on design data provided by ESA.
- The McCormack Williamson Tract planned tidal restoration grid was based on design data proved by cbec.
- The Cache Slough Mitigation Bank planned tidal restoration grid was based on design data provide by MBK.
- The Dutch Slough tidal restoration grid was based on data provided by DWR.
- The Prospect Island planned tidal restoration grid was based on data provided by Stillwater Sciences.

In addition to a No Action alternative, where there is no tidal action in Little Egbert Tract, four Little Egbert alternatives have been modeled:

1. Alternative 19 (design provided by Westervelt, Figure 5)
2. Alternative 24 (design provided by Westervelt, Figure 6)
3. Alternative 26 (design provided by Westervelt, Figure 7)
4. Future Without Project (FWOP)

DEMs of the alternative design features were provided by MBK. Spatial plots of model bathymetry in the vicinity of Little Egbert Tract for each alternative are shown in Figure 8 - Figure 12. All features of the restoration alternatives, including swales, breaches and weirs, are represented in the model using 2D grid elements.

Model Boundary Conditions

Figure 13 shows the location of the model boundary conditions. A detail view of the Cache Slough Complex is shown in Figure 14. Figure 15 shows the DCD (Delta Channel Depletion) locations and major control structures through the Delta and Suisun Marsh. Each model inflow boundary condition requires a corresponding EC value be specified (see Appendix A: Model Boundary Conditions). The model boundary conditions are:

[6] https://www.sciencebase.gov/catalog/item/5d7810e1e4b0c4f70d020cdb

Tidal stage boundary at the Golden Gate (from NOAA, see 2018 Model Boundary conditions - Figure 100 and 2020 Model Boundary conditions - Figure 115)

Inflows:

Sacramento River above American River
American River near Sacramento
San Joaquin River near Vernalis
Yolo Bypass and Yolo Bypass Toe Drain
Fremont Weir Big Notch flows (project in construction)
Mokelumne River near Thornton
Cosumnes River
Calaveras River near Stockton
Ulatis Creek
Campbell Lake
Agricultural return flows (from Delta Channel Depletion - DCD[7])
Precipitation

Exports/Diversions:

State Water Project (SWP), Clifton Court Forebay gates
Central Valley Project (CVP) Tracy Pumping Plant
Contra Costa Water District (CCWD) intakes at Rock Slough, Old River and Victoria Canal
North Bay Aqueduct (NBA), Barker Slough Pumping Plant
Delta Channel Depletion (DCD), throughout Delta
Cache Slough Complex agricultural diversions
Evaporation

Major Control Structures:

Delta Cross Channel gates
Suisun Marsh Salinity Control Gate (SMSCG)
South Delta Temporary Barriers

- Old River near Tracy (DMC) temporary barrier
- Old River at Head temporary barrier
- Middle River temporary barrier
- Grant Line Canal temporary barrier

[7] https://data.ca.gov/dataset/dsm2

Time series plots of model boundary conditions for the model analysis periods of January – December 2018 and January – December 2020 are provided in Appendix A: Model Boundary Conditions.

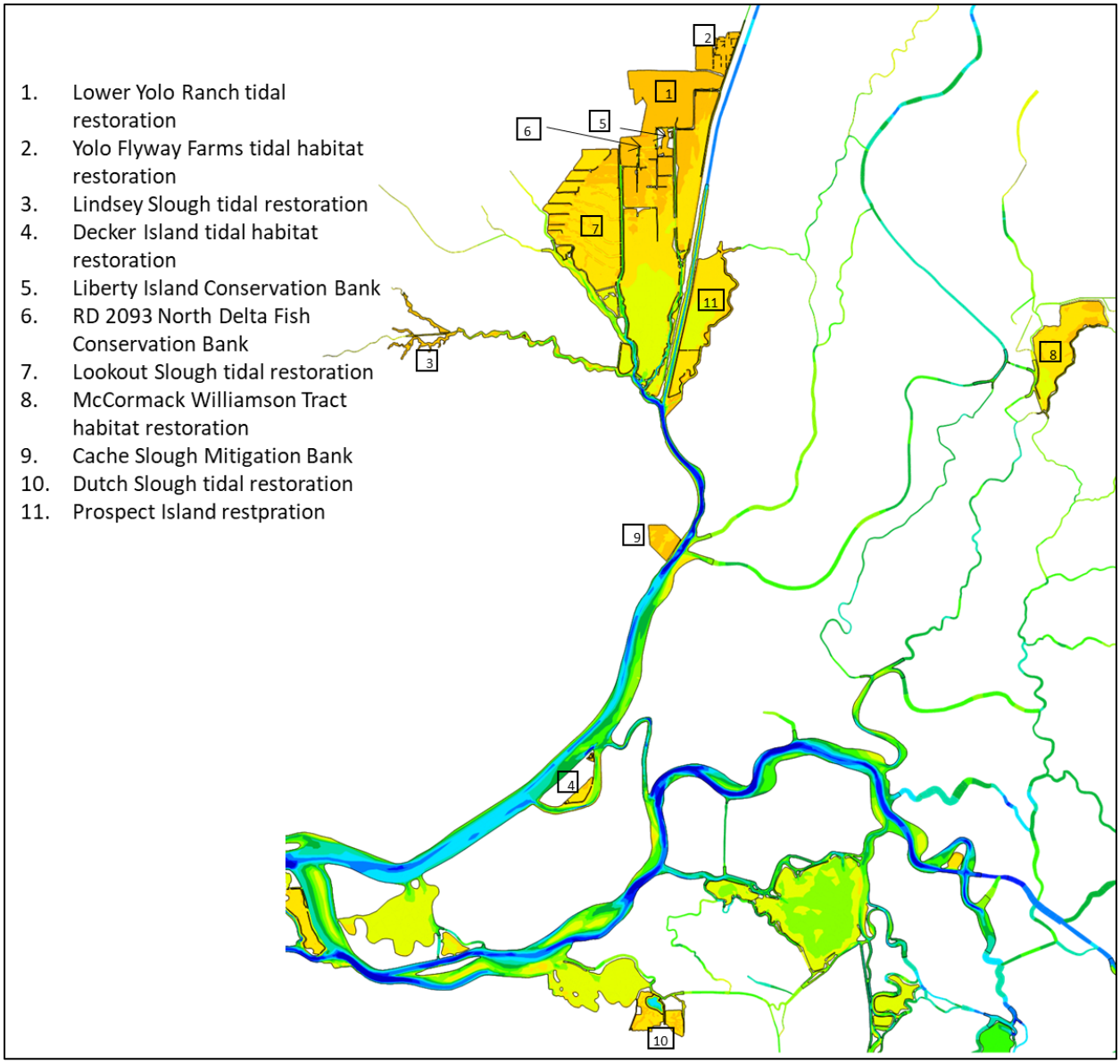

Figure 3 Recently constructed or planned tidal restoration projects included in model grids for all simulations.

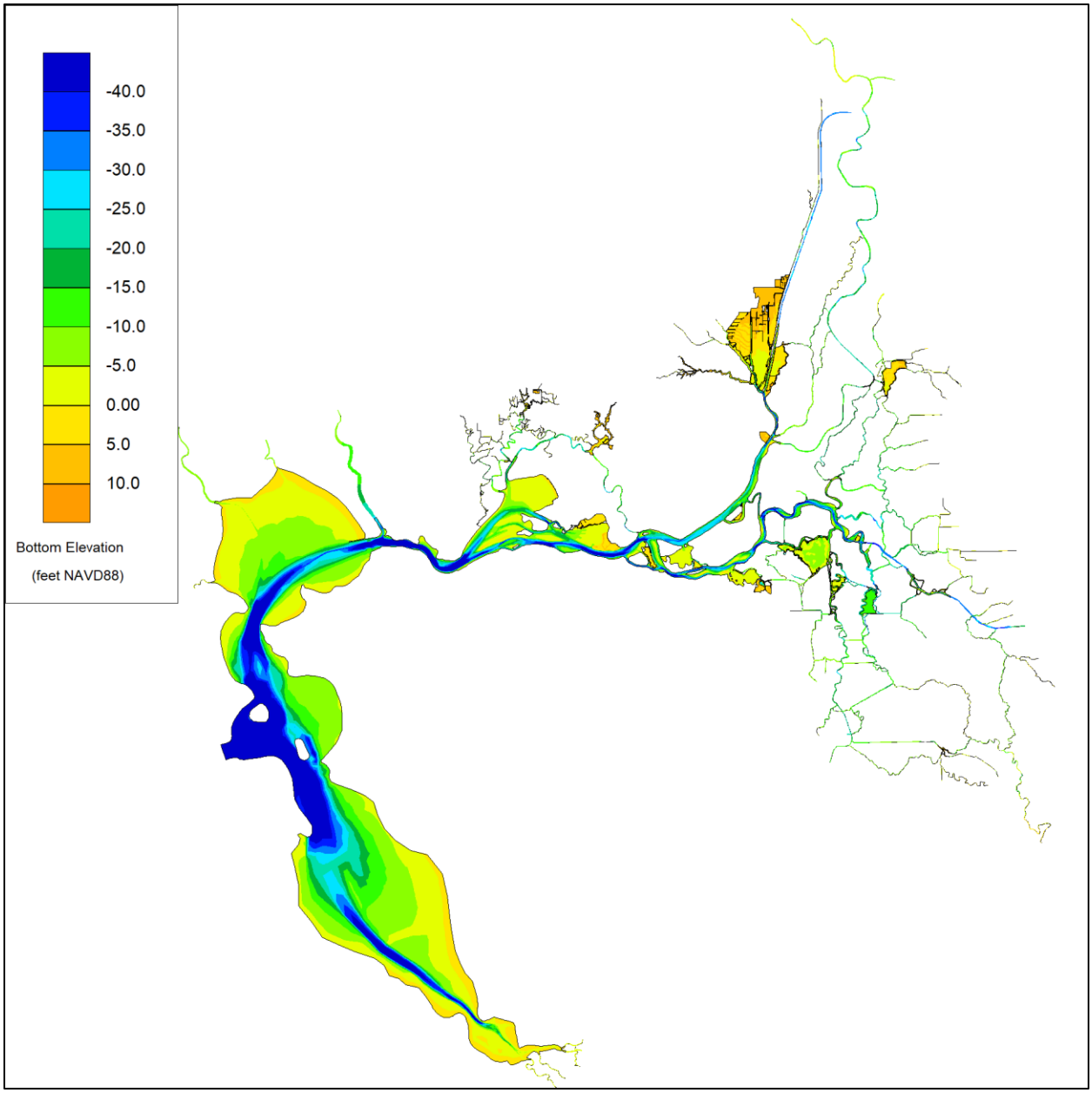

Figure 4 RMA Bay-Delta Base (No Action) model bathymetry.

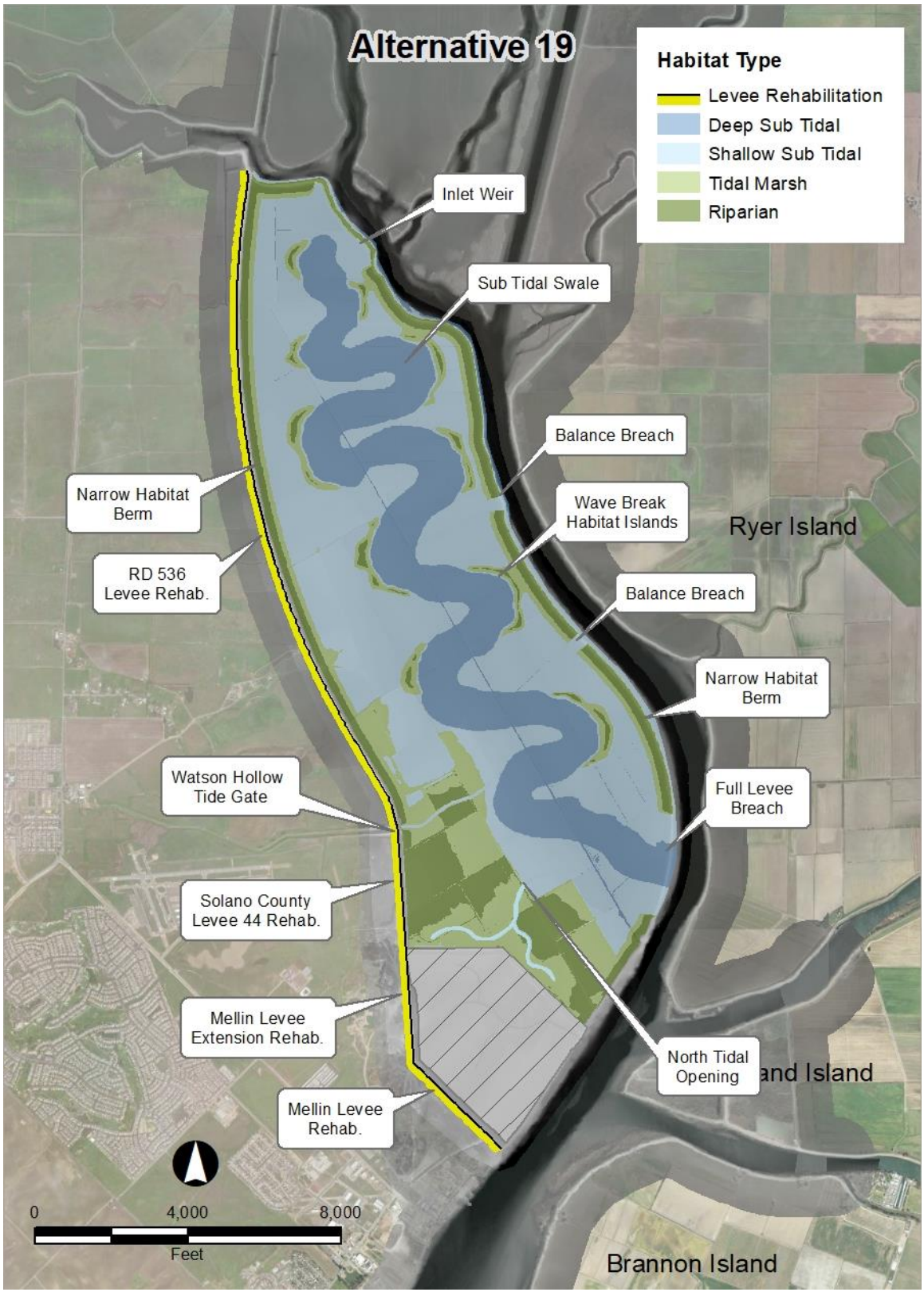

Figure 5 Little Egbert Tract Alternative 19 design.

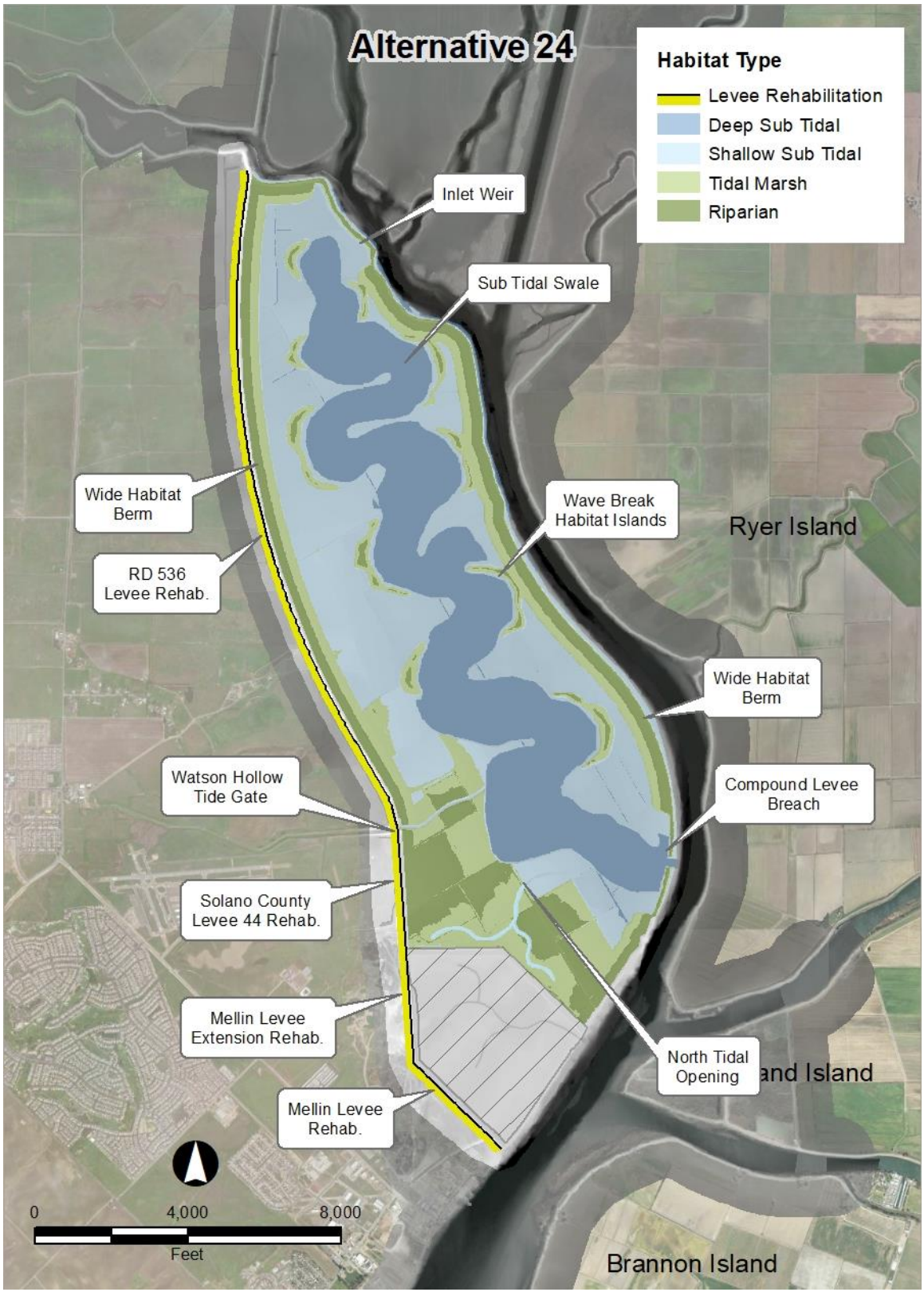

Figure 6 Little Egbert Tract Alternative 24 design.

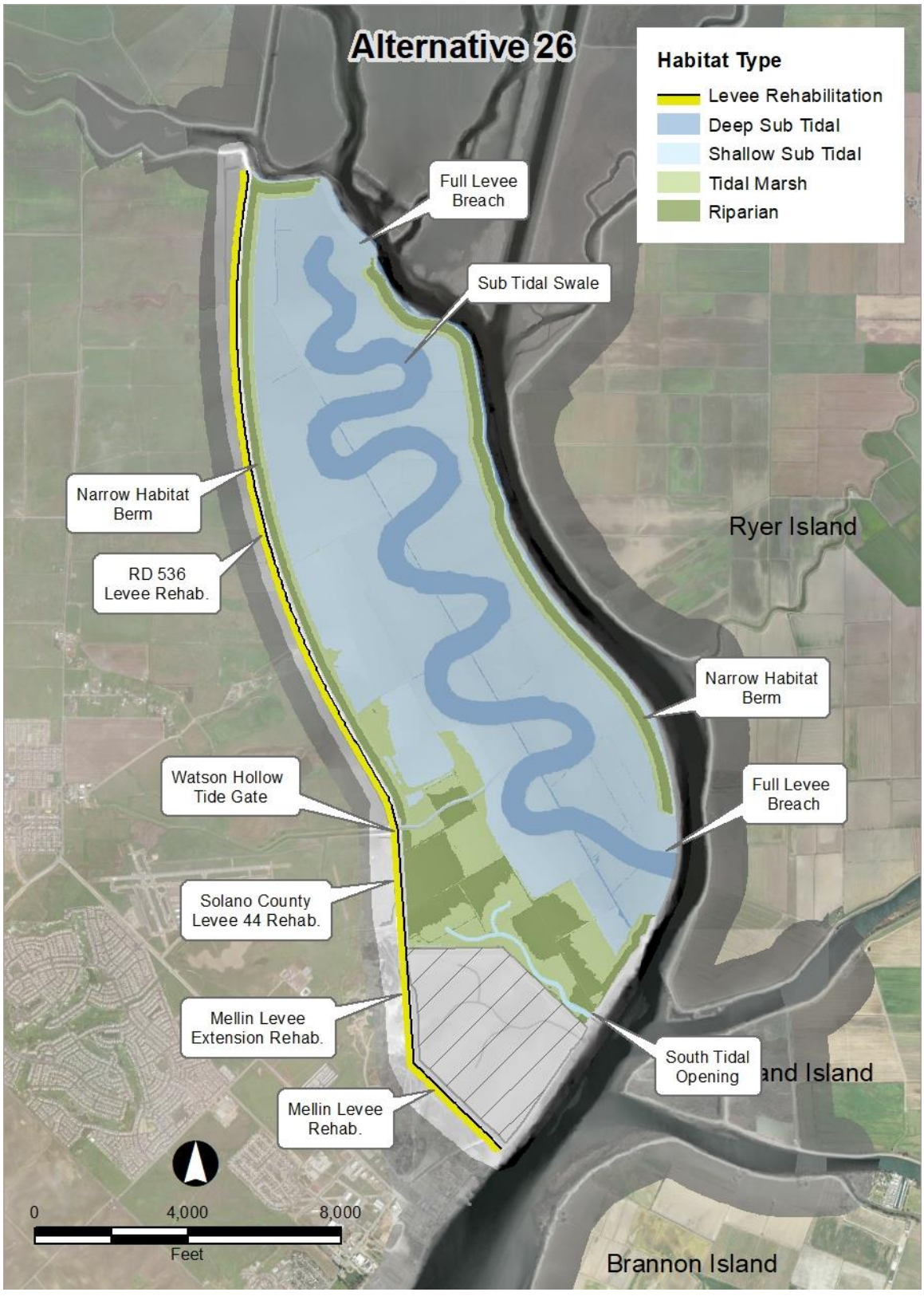

Figure 7 Little Egbert Tract Alternative 26 design.

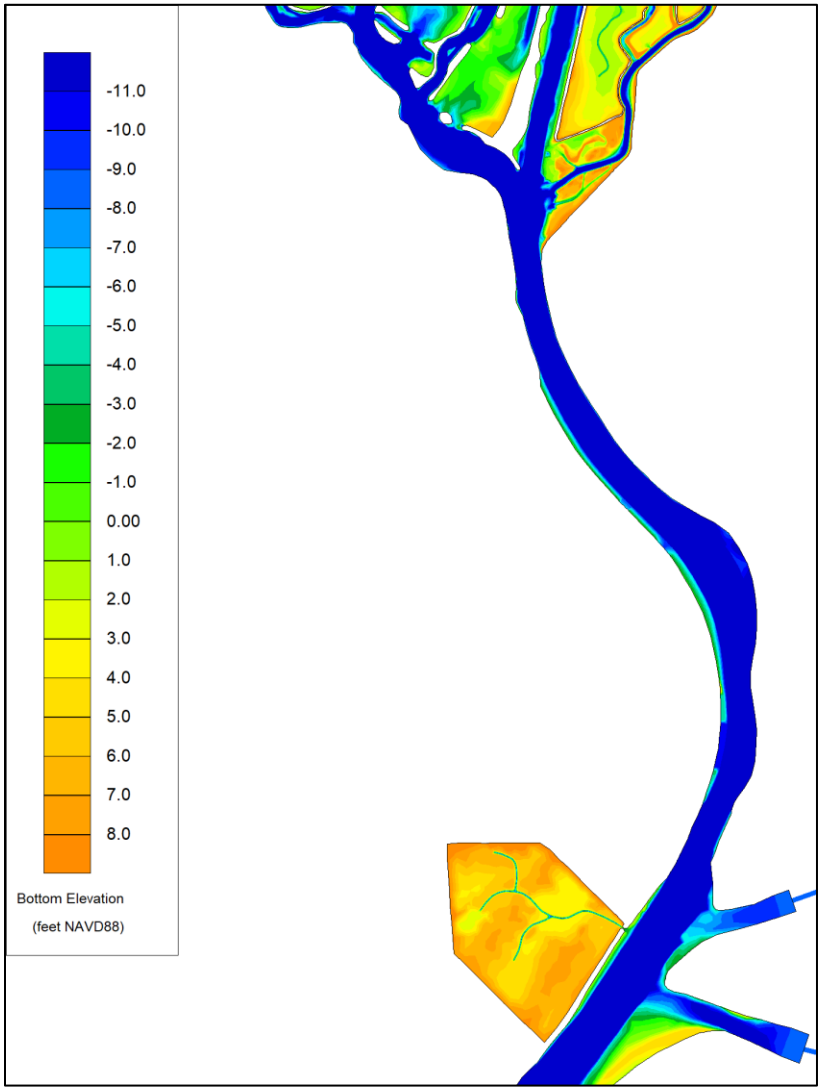

Figure 8 Little Egbert Tract Base (No Action) alternative model bathymetry.

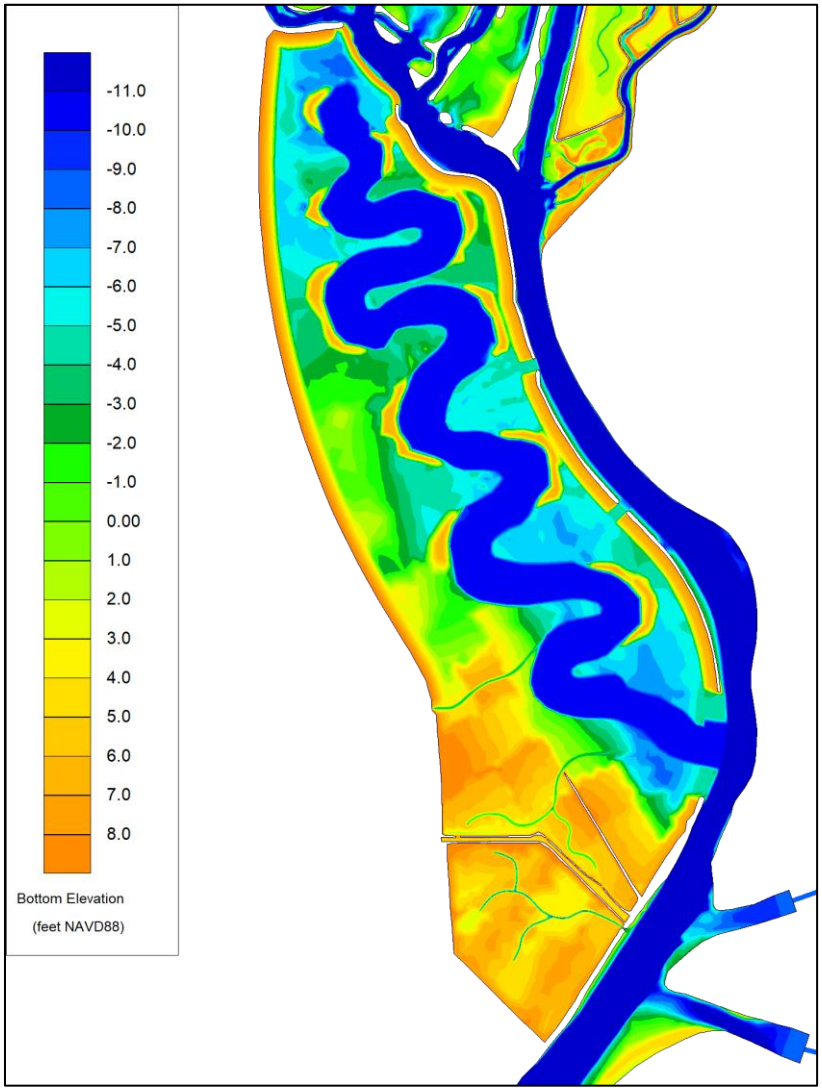

Figure 9 Little Egbert Tract Alternative 19 model bathymetry.

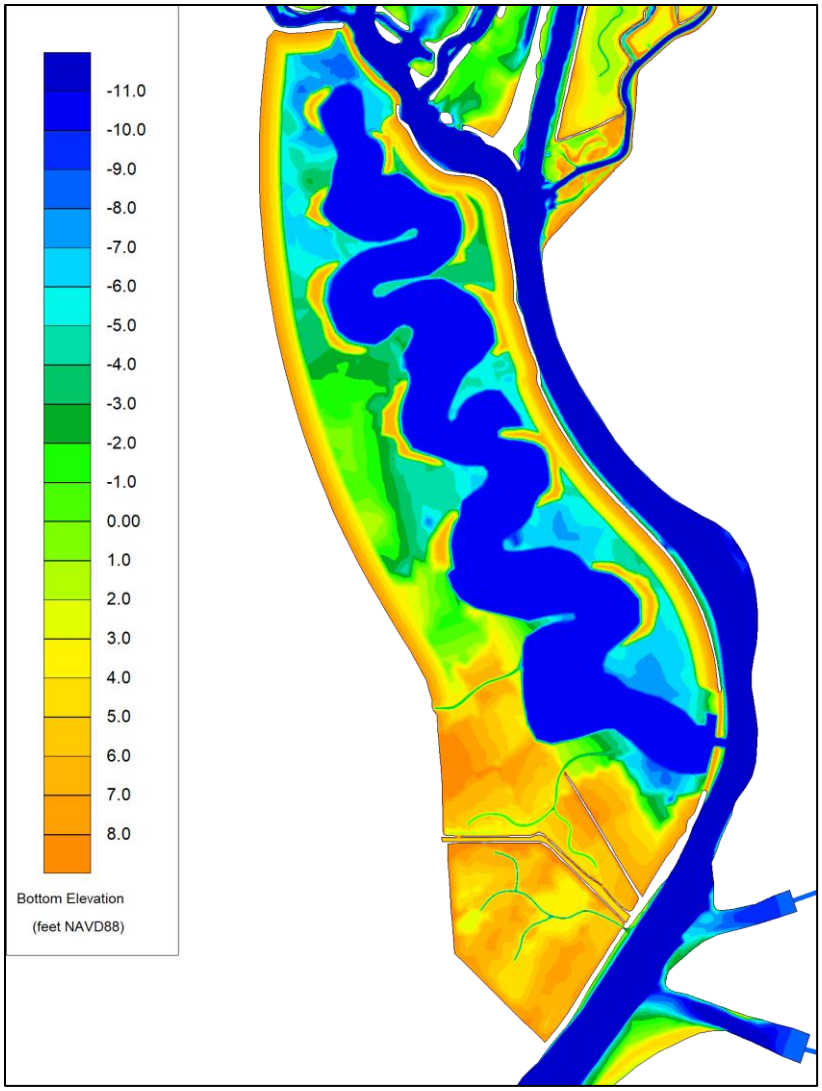

Figure 10 Little Egbert Tract Alternative 24 model bathymetry.

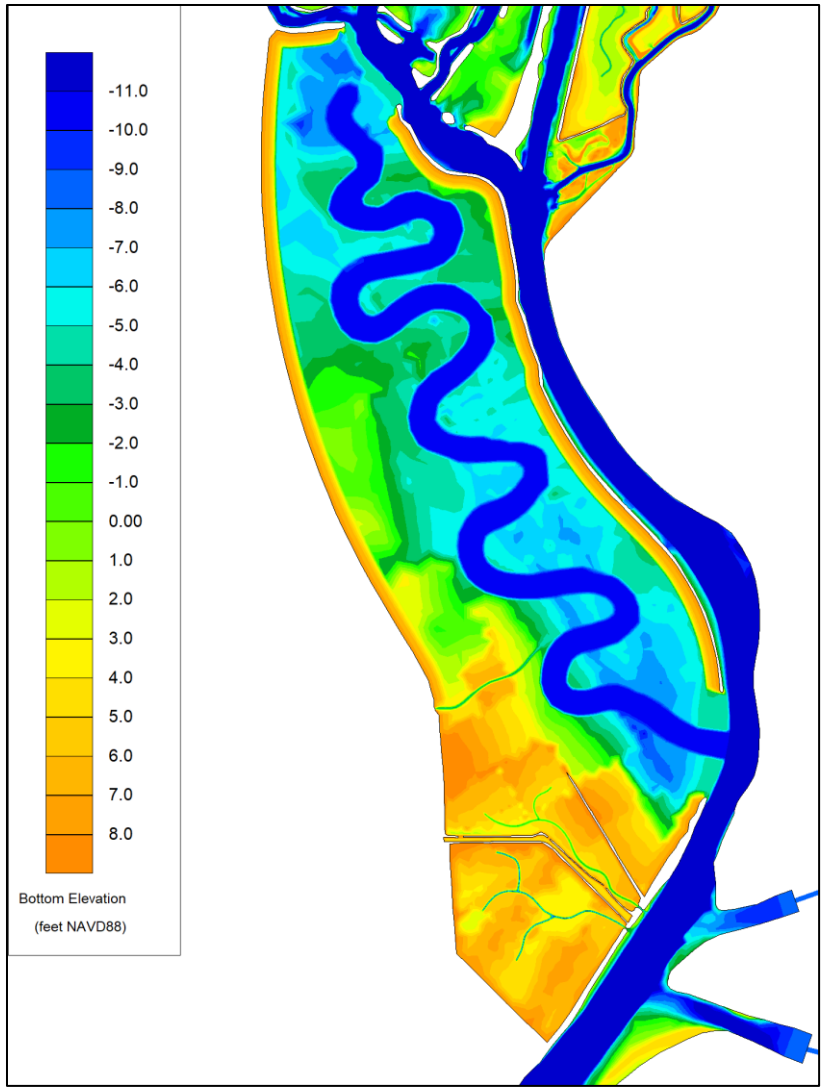

Figure 11 Little Egbert Tract Alternative 26 model bathymetry.

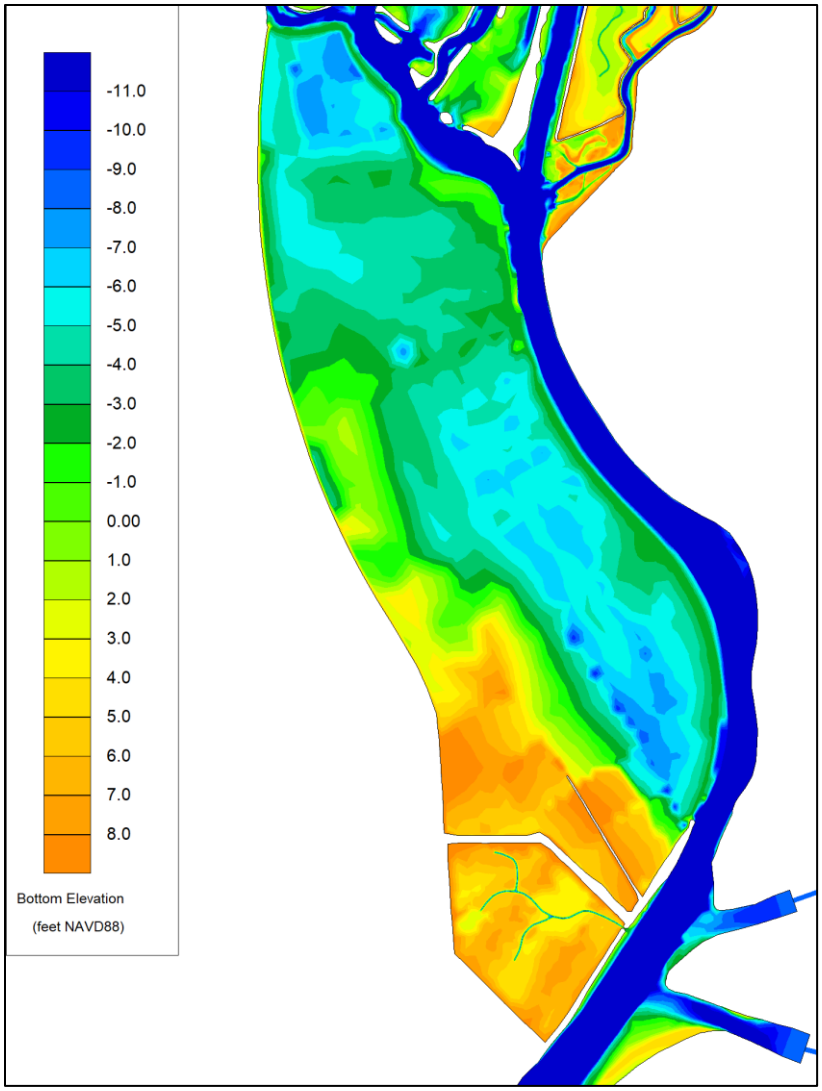

Figure 12 Little Egbert Tract FWOP alternative model bathymetry.

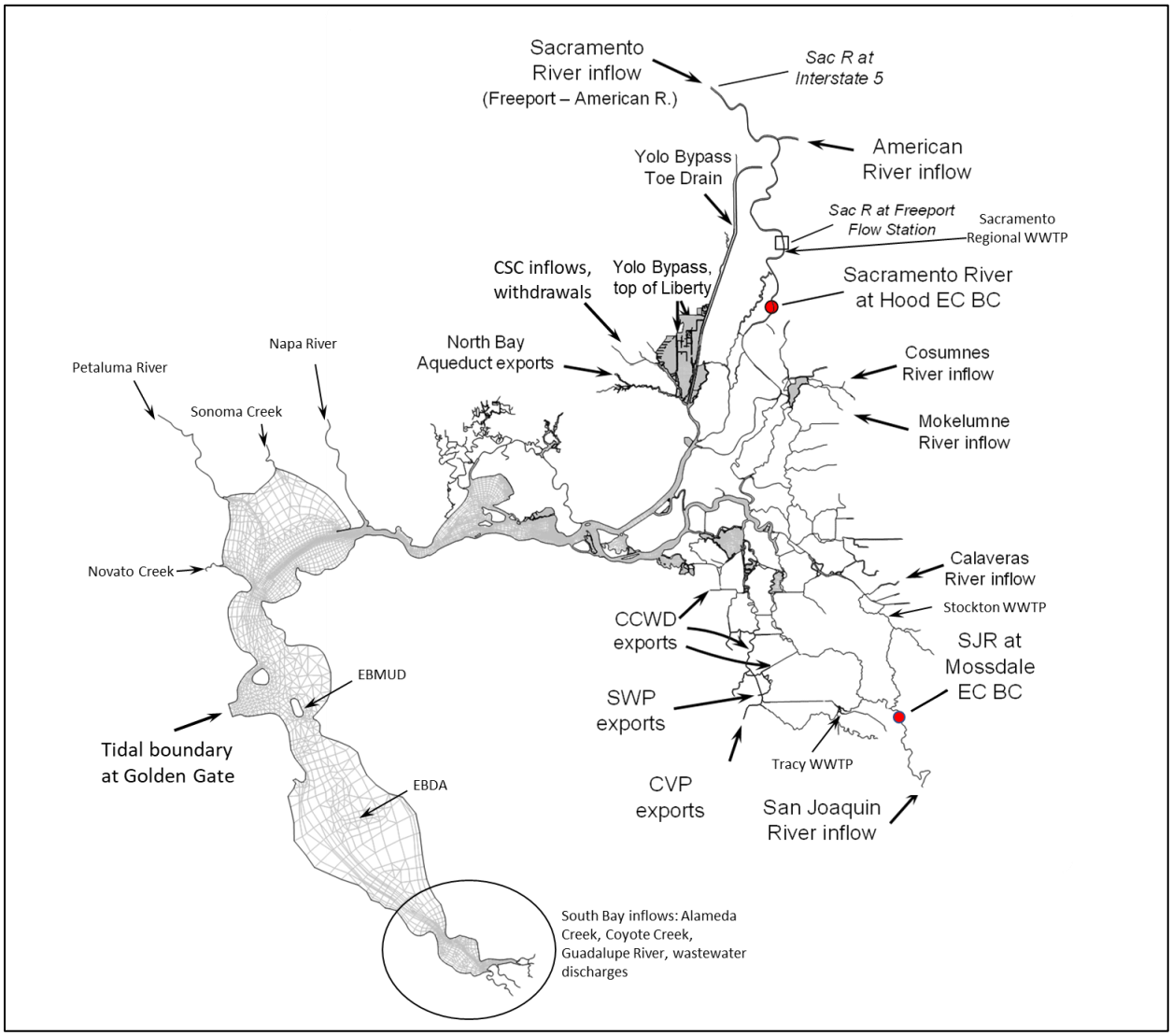

Figure 13 Model boundary condition locations. Internal EC boundary conditions are set for the Sacramento River at Hood and for the San Joaquin River at Mossdale.

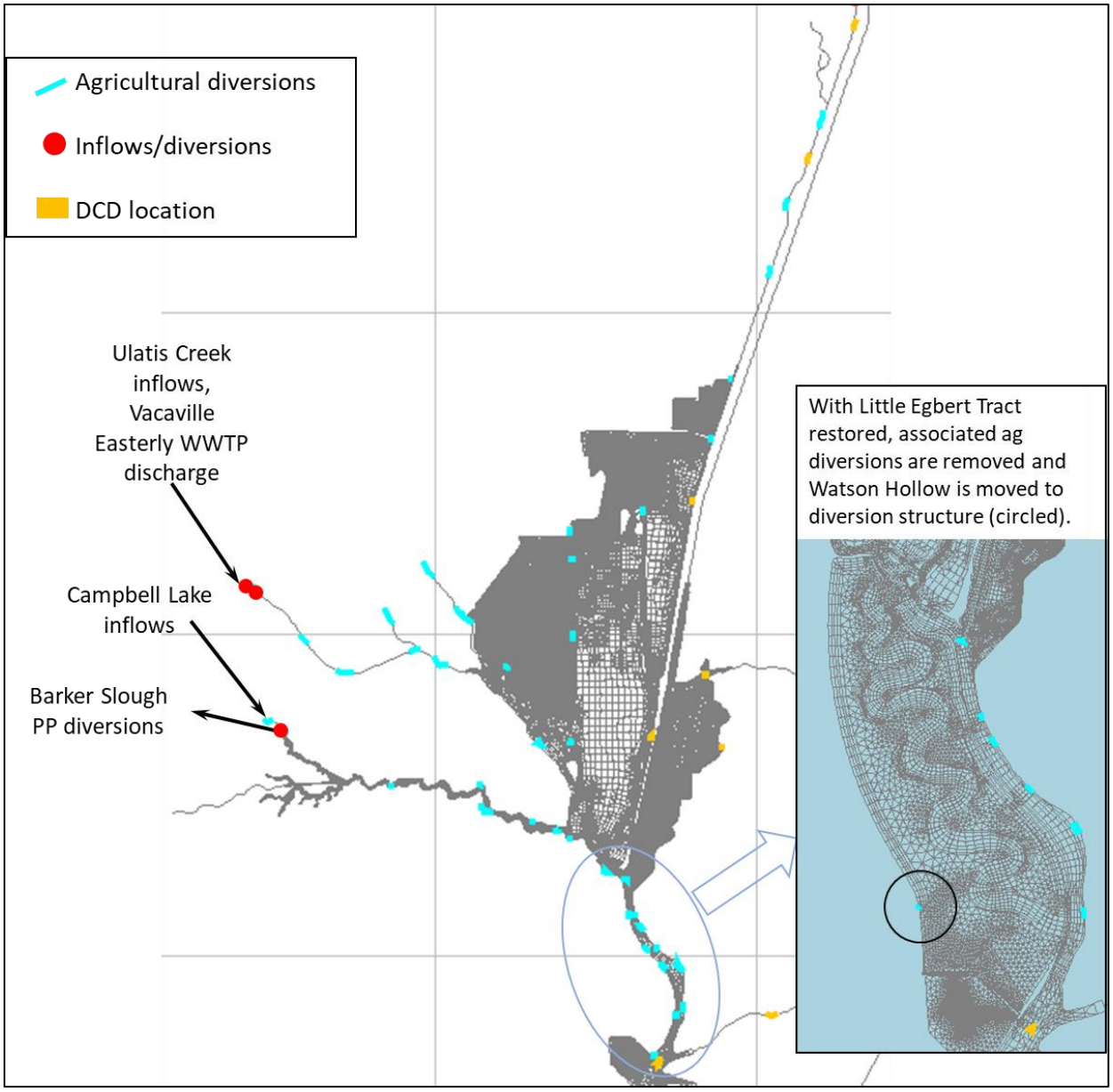

Figure 14 Cache Slough Complex model boundary condition locations

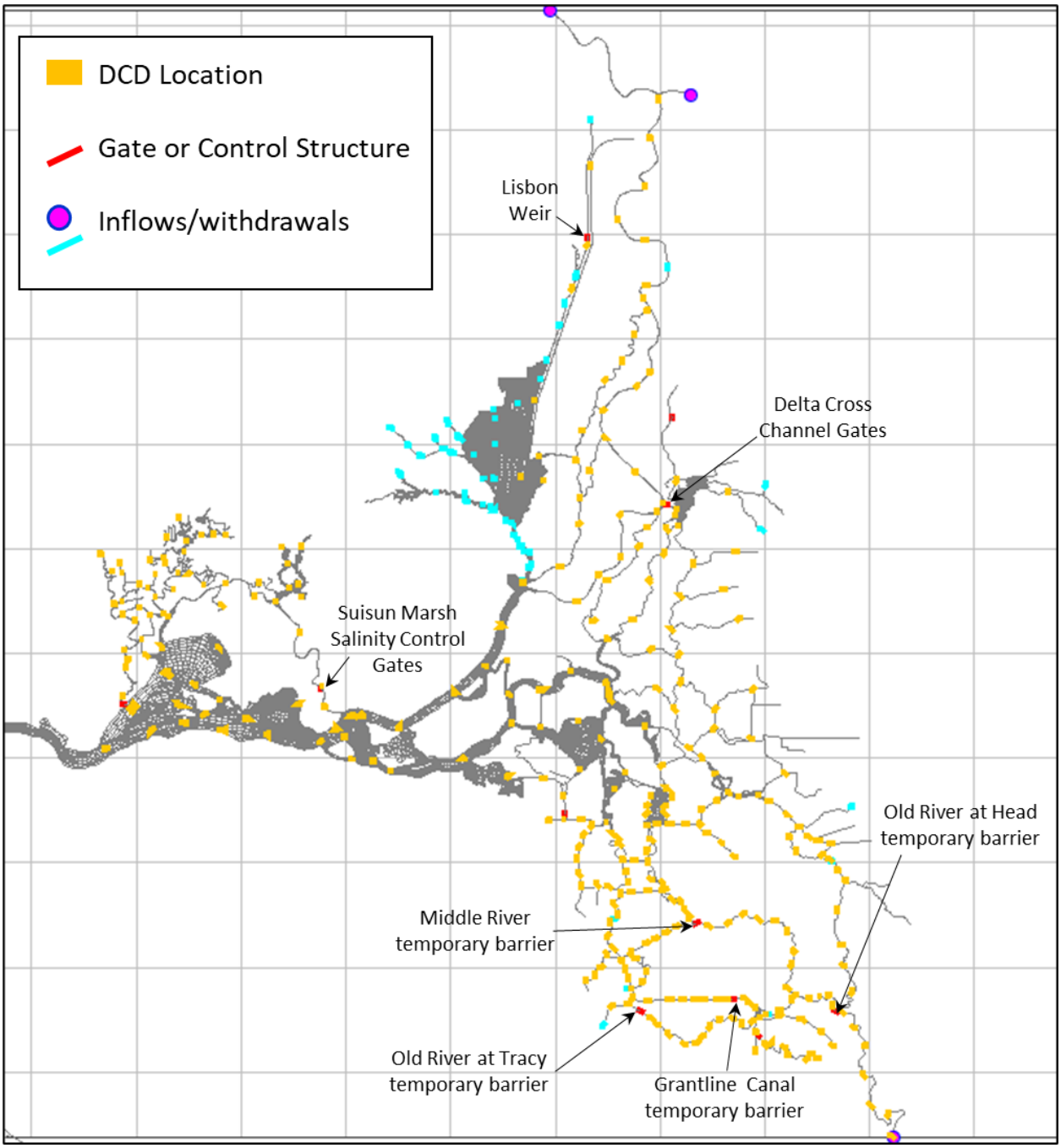

Figure 15 Location of DCD diversions and returns, and the major Delta control structures. DCD diversions in the Cache Slough Complex are replaced with estimated ag diversion flows provided by Solano County Water Agency.

Modeling Evaluation Process

Introduction

This section provides a description of the model configurations for the Base and Little Egbert Tract alternatives and describes and discusses the selected model simulation period for the analysis.

Base (No Action) and Little Egbert Tract Alternatives Model Configurations

The No Action alternative represents the current condition at Little Egbert Tract, with no flow onto the Project site. This alternative is used as the Base case, to which the remaining alternatives are compared. The proposed restoration alternative configuration designs for Alternative 19, Alternative 24 and Alternative 26 are shown in Figure 5 through Figure 7. These alternatives were selected from a larger set to represent the range of conditions and bookend the breaching conditions. Each restoration design includes construction of an inlet weir or breach at the north end of Little Egbert (connecting to Cache Slough near Lindsey Slough), a north-south subtidal channel, and a breach at the south end of the site, connecting to the downstream end of Cache Slough. Finally, a Future Without Project (FWOP) condition represents fully degraded levees around the Project site along Cache Slough.

All of the model networks include the following recently constructed or planned projects (see Figure 3):

- Lower Yolo Ranch tidal restoration
- Yolo Flyway Farms tidal habitat restoration
- Lindsey Slough tidal restoration
- Decker Island tidal habitat restoration
- Liberty Island Conservation Bank
- RD 2093 North Delta Fish Conservation Bank
- Lookout Slough tidal restoration
- McCormack Williamson Tract habitat restoration
- Cache Slough Mitigation Bank
- Dutch Slough tidal restoration
- Prospect Island restoration

Additionally, the Fremont Weir Big Notch flows were included. This project is in construction.

Analysis Period

The two one-year model analysis periods are January through December 2018 and January through December 2020. The hydrologic conditions for 2018 were classified as below normal

(BN) and conditions for 2020 were classified as dry for the Sacramento Valley and San Joaquin Valley[8]. For reference, Figure 16 and Figure 17 present the overall Delta hydrologic conditions for 2008-2020. Figure 16 shows the major Delta inflows. The salinity intrusion in the western Delta over the 2008-2020 period is illustrated with the plot of the observed EC for the San Joaquin River at Jersey Point location in Figure 17.

The water year effectively begins with the freshening of the Delta with the rise of the wintertime inflows. This was late-March for 2018. There was no significant freshening event in 2020.

The model runs were initialized from observed Delta EC values for January 1, 2018 and January 1, 2020. The high Delta inflows of the winter months generally flush the Delta and reduce the effects of the initial EC condition, however for 2020 this did not occur.

The salinity impacts of LEMBP alternatives are examined on a relative basis in terms of the change and percentage change of alternative salinities from the Base (No Action) condition values. The model analysis also examines the potential for non-compliance to the D-1641 water quality objectives. For this, model predicted values are compared to numerical thresholds. The model overestimates or underestimates EC at some locations at times during the simulation period, as seen in the verification results. When comparing the computed alternative EC values to the water quality compliance standards, these discrepancies can be taken into account by including observed data on the plots.

Time series plots of the major inflows, diversions and EC boundary conditions are provided for reference in Appendix A: Model Boundary Conditions.

[8] https://cdec.water.ca.gov/reportapp/javareports?name=wsihist

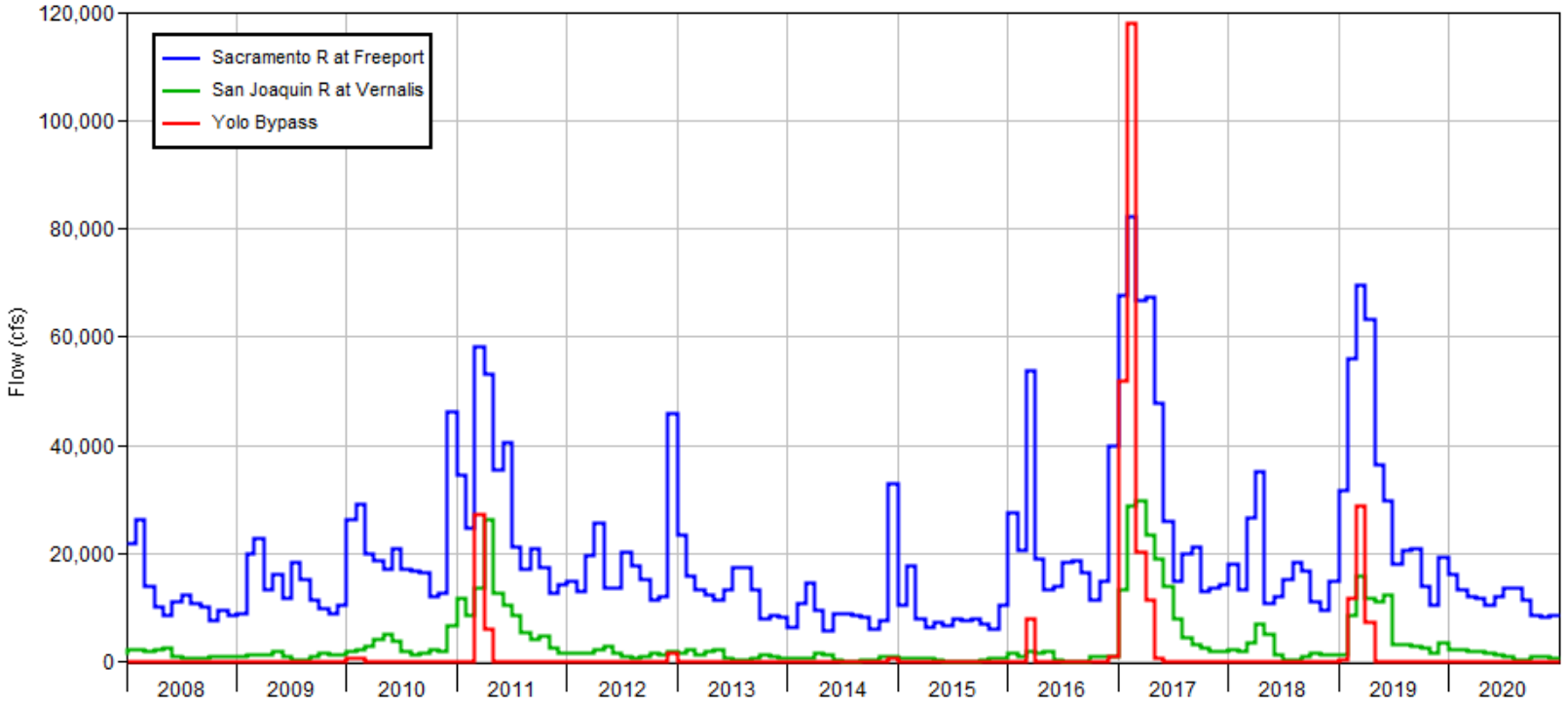

Figure 16 Monthly averaged Delta inflows for the Sacramento River, Yolo Bypass and San Joaquin River for 2008-2020.

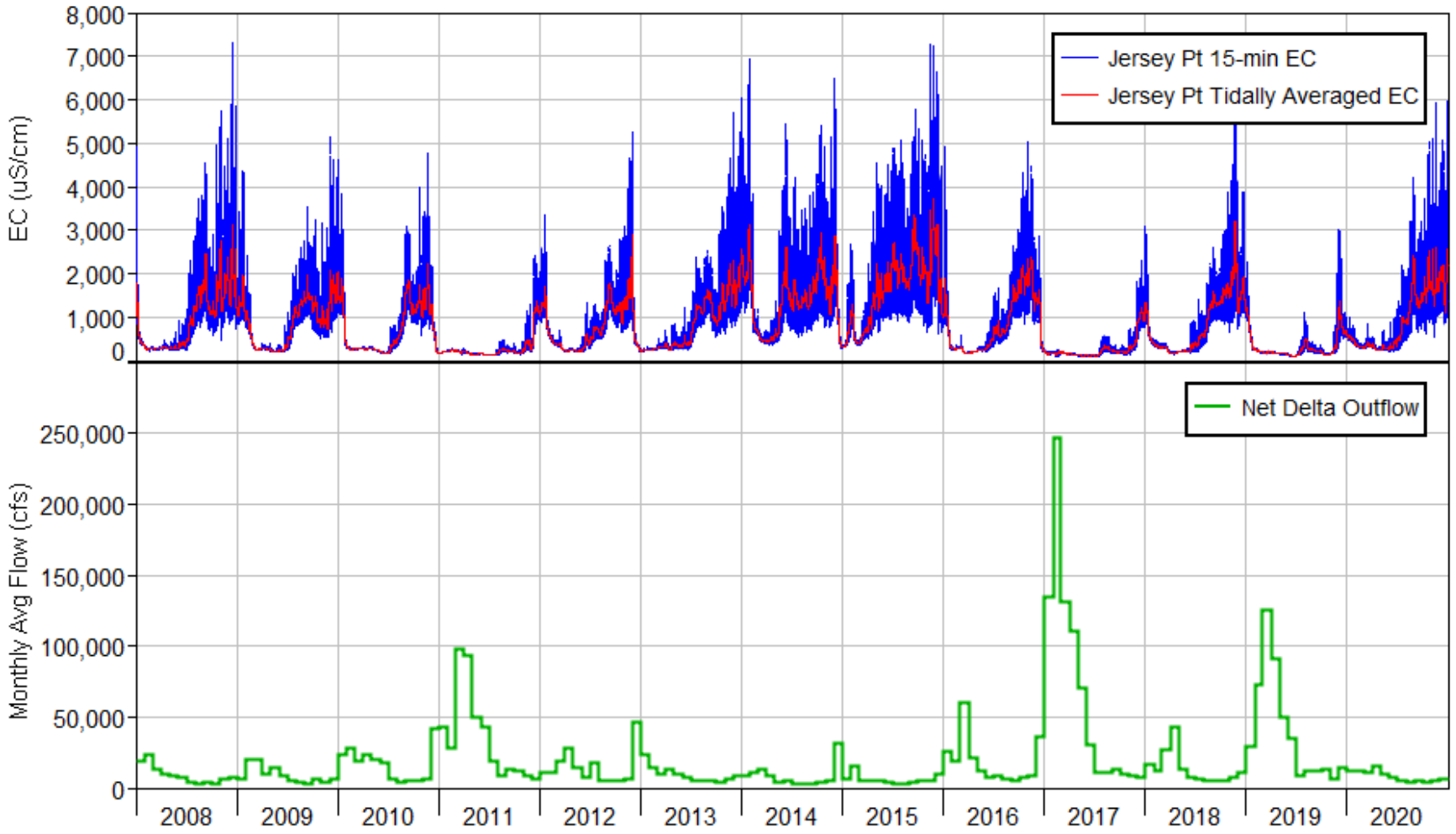

Figure 17 Observed San Joaquin River at Jersey Point EC and monthly averaged Net Delta Outflow (from DAYFLOW) for 2008-2020. The plots illustrate the dry season salinity intrusion into the western Delta with low NDO and the response of the Jersey Point EC to variations in the NDO over the different water years.

Evaluation of Salinity Changes at Select D-1641 Compliance Stations and CCWD Intake Locations

Introduction

The salinity (EC) transport component of the RMA Bay-Delta model was utilized to evaluate the potential salinity changes at select D-1641 compliance locations and Contra Costa Water District intake locations listed in Table 1 (see Figure 1 for map) and changes to X2.

Table 1 D-1641 Compliance Stations to be used for Project alternatives salinity evaluation.

D-1641 Station ID	Location
D22	Sacramento at Emmaton
D15	San Joaquin at Jersey Point
D29	San Joaquin at Prisoners Point
C5	Contra Costa Canal at Pumping Plant 1
C9	West Canal at mouth of Clifton Court Forebay
DMC1	Delta-Mendota Canal at Tracy Pumping Plant
SLBAR3	Barker Slough NBA Intake
C19	City of Vallejo Intake Cache Slough
C2	Sacramento at Collinsville
D12	San Joaquin at Antioch
	CCWD Intake at Mallard Slough
	CCWD Intake at Old River
	CCWD Intake at Victoria Canal

The modeling evaluation criteria were:

1) Evaluate the salinity impacts by quantifying the percentage change from the existing conditions at the Table 1 locations for Project alternatives.
2) Examine if Project alternatives have the potential to result in non-compliance with the D-1641 water quality objectives for the Table 1 locations.
3) The analysis will look at both a below normal and a dry water year.

EC Changes at Compliance Locations

Salinity (EC) model results were computed for the periods January 1, 2018 to December 31, 2018 and January 1, 2020 to December 31, 2020. The year 2018 is characterized as a near "average" year (below normal) and 2020 as a dry year. The results were stored at 15-minute intervals for all model computational points allowing both temporal and spatial analysis. The primary metric chosen for the alternatives analysis was the percentage change from Base (No Action) condition of monthly averaged EC at the Table 1 locations. Table 2 provides the monthly average computed Base EC and the relative (%) EC change from the Base condition for each alternative at each of the compliance locations listed in Table 1. For each compliance location, monthly average Base and alternatives EC are plotted with absolute change and percent change in Figure 18 through Figure 24.

The general observations for the alternatives monthly average EC results are:

1) The most favorable salinity results (smallest increases over Base) occur for Alternative 24. The least favorable salinity results (largest increases over Base) occur for Alternative 26 and FWOP, which produce very similar salinity results. The notable exception is at the Barker Slough NBA intake, where the FWOP alternative produces the largest salinity reductions and Alternative 24 produces the smallest reductions.
2) For the central and south Delta locations Jersey Point (D15), Rock Slough (C5), Clifton Court (C9), the DMC at the Tracy Pumping Plant (DMC1), CCWD at Old River and CCWD at Victoria Canal, EC generally increases from the Base condition for all alternatives in the summer and fall of 2018 by as much as 1 to 3%, and in the summer and fall of 2020 as much as 1 to 4%. The largest increases occur for Alternative 26 and the smallest increases occur for Alternative 24.
3) For Prisoners Point (D29), EC increases by as much as 3 to 4.5% in the summer and fall of 2018, and 3 to 5% in the summer and fall of 2020. The largest increases occur for Alternative 26 and the FWOP alternative (4.5% for 2018 and 4.9% for 2020), while Alternative 24 increases are the smallest (3.4% for 2018 and 3.9% for 2020).
4) At Antioch (D12), changes are in approximately the -1% to 0% range throughout both simulation periods. The largest decreases occur for Alternative 24 (-1.2% for 2018 and -1.3% for 2020). The largest increases occur for Alternative 26 (0.7% for 2018 and 0.5% for 2020).
5) At Emmaton (D22), EC increases by as much as 4 to 9% in the summer and fall of 2018, and 6 to 11% in the late spring, summer and fall of 2020. The largest increases occur for Alternative 26 and the FWOP alternative (9.3% for 2018 and 11.1% for 2020). The smallest increases occur for Alternative 24 (6.2% for 2018 and 7.3% for 2020).

6) In the north Delta, salinity is decreased at NBA in Barker Slough (SLBAR3). Decreases of as much as -4% occur throughout 2018 and decreases as much as -6% occur during 2020. The largest decreases (-4% for 2018 and -6.3% for 2020) occur for the FWOP alternative, while the smallest decreases (as much as -0.9% for 2018 and 2020) occur for Alternative 24.

Spatial plots of monthly average computed Base condition EC and absolute EC change from Base for alternatives are provided in Figure 44 through Figure 47 for July 2018. Percent change from Base EC plots are provided for July through October of 2018 in Figure 48 through Figure 63. Average computed Base condition EC and absolute EC change from Base for alternatives for July 2020 are provided in Figure 64 through Figure 67. Percent change from Base EC plots are provided for July through October of 2020 in Figure 68 through Figure 83. These plots provide a spatial illustration of the EC impacts occurring in the summer and fall, when impacts are the greatest. Large salinity increases can be seen in the Sacramento River around Emmaton, extending into the eastern side of Suisun Marsh. Smaller increases occur in the San Joaquin River around San Andreas Landing and extend into the south Delta. The timing of maximum increases varies by location. At Emmaton, the largest increases occur in July. Some areas of salinity decrease are evident around Antioch and Sherman Lake, and in the north Delta in Barker Slough and Liberty Island.

The computed EC values for the alternatives are near or below Base condition values throughout most of both simulation periods at the Barker Slough NBA Intake location (SLBAR3) (Figure 24). The reductions are most notable for the spring months when EC in the Cache Slough complex is highest from relatively high EC water from the Yolo Bypass entering the region. The restoration alternatives decrease tidal flows and mixing of salinity into the Cache Slough complex.

Nearby at the City of Vallejo intake in Cache Slough (C19) (Figure 25) the restoration alternatives produce small increases in EC throughout the simulation period (up to 3% for the FWOP alternative). At this location the reduced tidal flows have the opposite effect, bringing in less lower EC water to mix with the higher EC inflows in Upper Cache Slough.

Mechanisms that may be present that affect the Delta salinity distribution with the increased tidal prism due to the breaching of the Little Egbert Tract site include:

- Changes in net channel flows.
- Increased tidal flow in the lower Sacramento River that may increase salinity mixing both in the long axis of the channel and across the channel.
- Under present conditions, the average stage (thus volume of water) in the Delta increases on the spring tide and decreases on the neap tide. The Delta salinity intrusion

increases as the Delta “fills” on the spring tide and decreases as the Delta “drains” on the neap tide. In a previous Little Egbert Tract modeling study, with a north and south breach alternative, the breaching of Little Egbert Tract enhanced this effect for the lower Sacramento River (RMA, 2018).

These mechanisms appear to be the most impactful when Little Egbert Tract is fully breached at both ends (Alternative 26) or with fully degraded levees (FWOP). With a higher northern inlet weir that overtops only during high flows (Alternatives 19 and 24), the impacts are reduced. The compound southern breach in Alternative 24 further restricts flow and reduces impacts, however peak flood tide velocities at this breach are estimated to reach up to 6 ft/s. Spatial plots showing peak flood tide velocities at the southern breach for each of the restoration alternatives are shown in Figure 84 through Figure 86. A detail view of the Alternative 26 southern breach in Figure 87 shows the high velocities with an expanded velocity scale.

Table 2 Monthly average No Action (Base) EC and percent change from Base EC for the three restoration alternatives and FWOP at select D-1641 compliance stations and CCWD water intakes for the 2018 simulation period. The darkest blue cells indicate the largest decreases for the simulation period and the darkest red cells indicate the largest increases.

	D22 – Sacramento River at Emmaton					D15 – San Joaquin River at Jersey Point					D29 – San Joaquin River at Prisoners Point				
	No Action EC	% EC change				No Action EC	% EC change				No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2018	554.2	4.2%	3.6%	5.2%	5.3%	844.2	0.2%	-0.2%	0.2%	0.1%	381.3	0.2%	0.2%	0.3%	0.3%
Feb-2018	258.9	1.1%	0.7%	1.5%	1.5%	359.6	0.3%	-0.2%	0.2%	0.1%	306.3	0.5%	0.4%	0.6%	0.6%
Mar-2018	205.9	1.0%	0.7%	1.3%	1.3%	297.5	0.3%	0.0%	0.2%	0.2%	291.6	0.4%	0.4%	0.5%	0.5%
Apr-2018	141.9	-1.0%	-0.8%	-1.1%	-1.1%	199.5	0.0%	0.0%	0.0%	0.0%	232.8	0.3%	0.3%	0.3%	0.3%
May-2018	225.8	2.6%	2.1%	3.6%	3.6%	233.9	0.4%	0.3%	0.5%	0.5%	228.2	0.4%	0.3%	0.4%	0.4%
Jun-2018	506.6	7.2%	6.1%	9.1%	9.2%	373.5	1.1%	0.6%	1.3%	1.2%	191.4	0.5%	0.5%	0.5%	0.5%
Jul-2018	689.6	7.3%	6.2%	9.3%	9.3%	762.8	2.3%	1.5%	2.8%	2.7%	201.5	2.0%	1.8%	2.2%	2.3%
Aug-2018	608.3	6.7%	5.5%	8.7%	8.7%	1206.8	0.7%	-0.1%	1.0%	0.8%	313.3	3.5%	3.0%	4.2%	4.2%
Sep-2018	629.2	5.0%	4.1%	6.5%	6.5%	1396.0	0.1%	-0.7%	0.4%	0.1%	392.1	3.7%	3.2%	4.5%	4.5%
Oct-2018	1217.9	5.5%	4.8%	7.3%	7.3%	1410.5	1.0%	0.2%	1.2%	1.1%	346.3	3.9%	3.3%	4.4%	4.4%
Nov-2018	2093.9	6.5%	5.9%	8.1%	8.2%	1809.0	1.7%	0.9%	1.9%	1.7%	408.4	3.8%	3.2%	4.1%	4.1%
Dec-2018	580.6	6.4%	5.2%	8.1%	8.0%	1131.4	1.5%	0.6%	1.7%	1.4%	463.8	3.4%	2.6%	3.9%	3.7%

	C5 – Contra Costa Intake at Rock Slough					C9 – Clifton Ct Forebay Intake					DMC1 – Delta Mendota Canal at Tracy PP				
	No Action EC	% EC change				No Action EC	% EC change				No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2018	840.7	0.1%	0.1%	0.1%	0.1%	587.2	0.1%	0.0%	0.1%	0.0%	589.2	0.0%	0.0%	0.0%	0.0%
Feb-2018	617.1	0.6%	0.3%	0.6%	0.6%	503.7	0.2%	0.1%	0.1%	0.1%	542.2	0.2%	0.1%	0.2%	0.2%
Mar-2018	500.9	0.4%	0.2%	0.4%	0.4%	478.4	0.2%	0.2%	0.2%	0.2%	519.0	0.2%	0.1%	0.2%	0.2%
Apr-2018	461.1	0.3%	0.2%	0.3%	0.3%	268.9	0.1%	0.1%	0.1%	0.1%	270.1	0.0%	0.0%	0.0%	0.0%
May-2018	469.2	0.4%	0.4%	0.5%	0.5%	220.2	0.1%	0.0%	0.1%	0.1%	230.3	0.0%	0.0%	0.0%	0.0%
Jun-2018	388.1	0.4%	0.4%	0.5%	0.5%	282.8	0.3%	0.2%	0.3%	0.3%	295.2	0.3%	0.2%	0.3%	0.3%
Jul-2018	416.5	1.2%	0.9%	1.3%	1.2%	304.5	1.5%	1.2%	1.6%	1.6%	312.9	1.3%	1.0%	1.4%	1.4%
Aug-2018	556.5	2.1%	1.6%	2.5%	2.4%	415.1	2.5%	1.9%	3.0%	2.9%	395.9	2.1%	1.6%	2.5%	2.4%
Sep-2018	813.5	1.5%	0.9%	1.8%	1.7%	585.4	2.3%	1.6%	2.7%	2.6%	528.3	1.9%	1.4%	2.3%	2.2%
Oct-2018	800.9	1.7%	1.0%	2.0%	1.9%	554.9	2.3%	1.6%	2.6%	2.6%	514.0	2.0%	1.5%	2.3%	2.3%
Nov-2018	796.6	2.3%	1.6%	2.6%	2.5%	568.9	2.2%	1.6%	2.3%	2.3%	541.8	1.8%	1.3%	2.0%	1.9%
Dec-2018	893.0	2.5%	1.8%	2.7%	2.6%	654.2	2.5%	1.8%	2.7%	2.6%	671.9	1.8%	1.3%	1.9%	1.9%

	SLBAR3 – Barker Slough NBA Intake					C19 – City of Vallejo Intake Cache Slough					C2 – Sacramento River at Collinsville				
	No Action EC	% EC change				No Action EC	% EC change				No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2018	341.5	0.1%	0.1%	0.1%	-0.1%	715.1	1.2%	1.5%	1.5%	1.8%	2439.9	2.7%	2.6%	3.1%	3.2%
Feb-2018	345.6	-0.7%	-0.4%	-1.1%	-3.3%	802.4	1.8%	2.3%	2.3%	2.7%	1036.2	3.3%	2.9%	3.9%	4.0%
Mar-2018	497.2	-0.5%	-0.2%	-0.7%	-1.9%	676.1	0.9%	1.1%	1.1%	1.3%	705.4	3.9%	3.5%	4.6%	4.6%
Apr-2018	567.0	0.1%	0.4%	0.0%	-0.6%	660.2	1.3%	1.7%	2.1%	2.3%	167.7	0.4%	0.3%	0.7%	0.7%
May-2018	285.1	-0.6%	0.0%	-1.1%	-4.0%	368.2	0.9%	1.6%	2.4%	2.3%	860.5	2.6%	2.3%	3.2%	3.3%
Jun-2018	177.9	-0.8%	-0.6%	-0.7%	-2.0%	303.0	0.9%	1.2%	1.8%	1.8%	2663.2	2.0%	1.9%	2.5%	2.5%
Jul-2018	154.0	0.1%	-0.2%	0.1%	-0.4%	293.5	1.4%	1.5%	1.8%	2.1%	4042.7	1.8%	1.7%	2.2%	2.3%
Aug-2018	155.5	-0.6%	-0.6%	-0.8%	-1.0%	308.5	1.1%	1.4%	1.3%	1.6%	4669.4	1.8%	1.8%	2.2%	2.3%
Sep-2018	185.7	-1.0%	-0.9%	-1.9%	-2.2%	325.9	0.7%	1.0%	0.7%	1.0%	4443.0	1.5%	1.4%	1.8%	1.9%
Oct-2018	197.4	-1.0%	-0.8%	-2.1%	-3.7%	423.5	1.6%	2.0%	2.2%	2.5%	6251.6	1.0%	1.0%	1.2%	1.3%
Nov-2018	191.6	0.5%	0.1%	0.9%	0.5%	483.3	2.2%	2.6%	2.6%	3.1%	8726.3	1.2%	1.2%	1.4%	1.4%
Dec-2018	263.6	0.8%	0.2%	1.1%	1.0%	536.8	1.4%	1.7%	1.6%	2.0%	3763.5	3.1%	2.9%	3.6%	3.6%

	D-12 – San Joaquin River at Antioch					CCWD Intake at Mallard Slough					CCWD Intake at Old River				
	No Action EC	% EC change				No Action EC	% EC change				No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2018	1710.8	0.1%	-0.3%	0.2%	0.1%	5301.9	0.8%	0.6%	1.0%	1.0%	605.6	0.1%	0.0%	0.1%	0.1%
Feb-2018	590.4	0.0%	-0.7%	0.3%	0.1%	3109.2	0.7%	0.4%	0.9%	0.8%	460.4	0.4%	0.2%	0.4%	0.3%
Mar-2018	460.2	0.5%	-0.2%	0.7%	0.5%	2055.4	1.3%	1.0%	1.6%	1.6%	426.5	0.4%	0.3%	0.4%	0.4%
Apr-2018	191.2	0.0%	0.0%	0.1%	0.1%	371.3	0.1%	-0.1%	0.4%	0.3%	320.3	0.1%	0.1%	0.1%	0.1%
May-2018	417.7	-0.1%	-0.6%	0.3%	0.1%	2582.6	0.2%	0.0%	0.4%	0.3%	300.0	0.2%	0.1%	0.2%	0.2%
Jun-2018	1317.6	0.1%	-0.5%	0.4%	0.3%	5922.7	0.1%	0.0%	0.2%	0.2%	277.9	0.5%	0.4%	0.5%	0.5%
Jul-2018	2308.0	0.3%	-0.3%	0.7%	0.5%	8202.5	0.1%	0.0%	0.2%	0.2%	326.6	1.9%	1.5%	2.1%	2.0%
Aug-2018	2971.0	-0.2%	-0.8%	0.1%	0.0%	9409.5	0.1%	0.0%	0.2%	0.1%	479.9	2.5%	1.7%	2.9%	2.8%
Sep-2018	2978.9	-0.6%	-1.2%	-0.3%	-0.5%	9019.8	-0.1%	-0.2%	0.0%	-0.1%	680.7	2.1%	1.3%	2.4%	2.3%
Oct-2018	3743.0	-0.5%	-1.0%	-0.2%	-0.4%	11332.1	-0.3%	-0.3%	-0.2%	-0.3%	632.9	2.2%	1.5%	2.6%	2.5%
Nov-2018	5226.4	-0.1%	-0.5%	0.1%	-0.1%	14361.1	-0.2%	-0.2%	-0.1%	-0.1%	671.4	2.7%	1.9%	3.0%	2.9%
Dec-2018	2451.9	0.6%	-0.1%	0.9%	0.7%	8284.0	0.7%	0.5%	0.8%	0.7%	702.2	3.0%	2.1%	3.2%	3.1%

	CCWD Intake at Victoria Canal				
	No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2018	538.0	0.0%	0.0%	0.0%	0.0%
Feb-2018	476.6	0.3%	0.2%	0.3%	0.3%
Mar-2018	508.4	0.4%	0.3%	0.4%	0.4%
Apr-2018	343.1	0.0%	0.0%	0.0%	0.0%
May-2018	306.9	0.1%	0.1%	0.1%	0.1%
Jun-2018	272.0	0.2%	0.2%	0.2%	0.3%
Jul-2018	256.3	0.8%	0.7%	0.8%	0.8%
Aug-2018	275.7	2.4%	2.1%	2.9%	2.8%
Sep-2018	362.6	2.8%	2.4%	3.3%	3.3%
Oct-2018	371.1	2.4%	2.1%	2.8%	2.8%
Nov-2018	407.0	1.8%	1.4%	1.8%	1.8%
Dec-2018	489.7	2.4%	1.9%	2.6%	2.5%

Table 3 Monthly average No Action (Base) EC and percent change from Base EC for the three restoration alternatives and FWOP at select D-1641 compliance stations and CCWD water intakes for the 2020 simulation period. The darkest blue cells indicate the largest decreases for the simulation period and the darkest red cells indicate the largest increases.

	D22 – Sacramento River at Emmaton					D15 – San Joaquin River at Jersey Point					D29 – San Joaquin River at Prisoners Point				
	No Action EC	% EC change				No Action EC	% EC change				No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2020	307.8	3.0%	2.2%	3.7%	3.8%	486.7	-0.7%	-0.9%	-0.9%	-1.0%	303.6	0.3%	0.3%	0.3%	0.3%
Feb-2020	263.5	1.4%	1.0%	1.9%	1.9%	336.3	-0.4%	-0.8%	-0.6%	-0.7%	298.0	0.3%	0.2%	0.3%	0.3%
Mar-2020	280.9	3.7%	3.0%	4.8%	4.8%	342.2	0.1%	-0.2%	0.1%	0.0%	310.1	0.5%	0.4%	0.5%	0.5%
Apr-2020	252.8	3.8%	3.0%	4.7%	4.7%	302.0	0.1%	-0.2%	0.0%	0.0%	276.3	0.5%	0.4%	0.5%	0.5%
May-2020	424.5	8.1%	6.9%	10.1%	10.1%	338.9	0.6%	0.2%	0.7%	0.6%	277.0	0.7%	0.6%	0.7%	0.8%
Jun-2020	557.3	8.6%	7.3%	10.8%	10.9%	398.5	1.2%	0.6%	1.4%	1.3%	238.8	0.8%	0.7%	0.8%	0.8%
Jul-2020	920.0	8.7%	7.6%	11.0%	11.1%	738.2	1.7%	1.0%	2.1%	1.9%	201.0	1.4%	1.3%	1.5%	1.5%
Aug-2020	1307.3	7.8%	6.9%	10.0%	10.1%	1403.4	1.1%	0.4%	1.4%	1.3%	296.2	3.4%	2.9%	3.9%	3.8%
Sep-2020	1221.3	6.1%	5.4%	8.1%	8.1%	1435.4	1.8%	0.9%	2.1%	1.9%	353.3	3.9%	3.5%	4.4%	4.4%
Oct-2020	1932.9	6.6%	6.0%	8.4%	8.5%	1637.8	1.7%	0.9%	2.0%	1.8%	361.9	4.5%	3.9%	4.9%	4.9%
Nov-2020	1720.2	7.6%	6.7%	9.5%	9.5%	1521.5	2.2%	1.2%	2.5%	2.2%	392.8	3.9%	3.3%	4.1%	4.1%
Dec-2020	1418.5	8.4%	7.1%	10.2%	10.2%	1433.4	2.1%	1.0%	2.2%	2.0%	460.7	4.0%	3.1%	4.2%	4.2%

	C5 – Contra Costa Intake at Rock Slough					C9 – Clifton Ct Forebay Intake					DMC1 – Delta Mendota Canal at Tracy PP				
	No Action EC	% EC change				No Action EC	% EC change				No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2020	483.7	0.0%	0.0%	0.0%	0.0%	443.0	0.0%	-0.1%	-0.1%	-0.1%	494.6	0.0%	0.0%	0.0%	0.0%
Feb-2020	448.6	0.0%	-0.2%	-0.1%	-0.1%	496.2	0.0%	0.0%	0.0%	0.0%	533.2	0.0%	0.0%	0.0%	0.0%
Mar-2020	502.3	0.2%	0.0%	0.1%	0.1%	500.2	0.0%	0.0%	0.0%	0.0%	517.2	0.1%	0.1%	0.1%	0.1%
Apr-2020	407.4	0.3%	0.2%	0.3%	0.3%	503.8	0.1%	0.1%	0.1%	0.1%	533.6	0.1%	0.1%	0.1%	0.1%
May-2020	387.5	0.3%	0.2%	0.4%	0.4%	398.2	0.2%	0.2%	0.3%	0.3%	410.1	0.2%	0.2%	0.2%	0.2%
Jun-2020	363.5	0.7%	0.5%	0.8%	0.8%	355.6	0.6%	0.5%	0.7%	0.7%	355.5	0.6%	0.4%	0.6%	0.6%
Jul-2020	388.5	1.6%	1.2%	1.8%	1.7%	321.8	1.5%	1.1%	1.6%	1.6%	324.4	1.3%	1.0%	1.4%	1.4%
Aug-2020	575.3	2.0%	1.5%	2.3%	2.2%	429.8	2.4%	1.8%	2.7%	2.6%	419.5	2.1%	1.6%	2.4%	2.3%
Sep-2020	862.2	2.5%	1.8%	2.8%	2.7%	625.0	2.9%	2.2%	3.3%	3.2%	616.4	2.6%	2.0%	3.0%	2.9%
Oct-2020	783.5	3.1%	2.3%	3.5%	3.3%	562.2	3.0%	2.3%	3.3%	3.2%	560.6	2.7%	2.1%	3.0%	2.9%
Nov-2020	815.3	3.5%	2.5%	3.8%	3.6%	623.6	2.9%	2.1%	3.0%	2.9%	607.6	2.3%	1.7%	2.5%	2.4%
Dec-2020	918.3	2.6%	1.8%	2.8%	2.7%	727.9	2.2%	1.5%	2.3%	2.2%	745.1	1.6%	1.2%	1.7%	1.7%

	SLBAR3 – Barker Slough NBA Intake					C19 – City of Vallejo Intake Cache Slough					C2 – Sacramento River at Collinsville				
	No Action EC	% EC change				No Action EC	% EC change				No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2020	358.5	0.1%	0.2%	-0.2%	-0.6%	676.0	1.0%	1.1%	1.1%	1.3%	1664.9	2.9%	2.7%	3.4%	3.5%
Feb-2020	337.3	-0.8%	-0.3%	-2.2%	-5.0%	760.5	1.0%	1.3%	1.2%	1.4%	1121.5	3.6%	3.3%	4.2%	4.3%
Mar-2020	349.1	-1.5%	-0.9%	-3.0%	-6.1%	678.0	0.6%	0.8%	0.8%	0.9%	1526.3	3.8%	3.5%	4.4%	4.5%
Apr-2020	338.0	-1.3%	-0.6%	-3.1%	-6.3%	499.4	1.1%	1.8%	2.4%	2.2%	1294.5	3.5%	3.1%	4.2%	4.2%
May-2020	227.5	-1.5%	-0.8%	-2.9%	-5.6%	330.3	0.5%	1.1%	2.2%	1.7%	2461.4	2.9%	2.7%	3.4%	3.4%
Jun-2020	186.3	-0.8%	-0.6%	-1.1%	-2.2%	289.3	0.6%	0.9%	1.4%	1.4%	3083.1	2.3%	2.2%	2.8%	2.9%
Jul-2020	164.5	-0.2%	-0.3%	-0.5%	-1.2%	282.8	1.0%	1.1%	1.5%	1.6%	4954.7	1.9%	1.8%	2.2%	2.3%
Aug-2020	166.6	-0.5%	-0.6%	-0.7%	-0.9%	315.3	1.0%	1.2%	1.1%	1.4%	6840.6	1.4%	1.5%	1.7%	1.7%
Sep-2020	195.8	-0.6%	-0.7%	-0.5%	-0.4%	371.7	1.2%	1.4%	1.2%	1.6%	6609.4	1.1%	1.2%	1.4%	1.5%
Oct-2020	197.3	0.5%	0.0%	0.6%	0.2%	388.5	2.1%	2.2%	2.6%	3.1%	8585.2	0.9%	1.0%	1.2%	1.2%
Nov-2020	185.5	2.7%	1.3%	3.1%	3.0%	591.4	2.2%	2.4%	2.5%	3.0%	8030.7	1.4%	1.4%	1.6%	1.7%
Dec-2020	215.1	1.5%	0.5%	1.4%	0.7%	406.5	1.3%	1.3%	1.4%	1.7%	7094.3	2.1%	2.2%	2.4%	2.5%

	D-12 – San Joaquin River at Antioch					CCWD Intake at Mallard Slough					CCWD Intake at Old River				
	No Action EC	% EC change				No Action EC	% EC change				No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2020	997.9	-0.8%	-1.3%	-0.6%	-0.8%	4547.1	0.3%	0.1%	0.4%	0.4%	419.6	0.0%	0.0%	0.0%	0.0%
Feb-2020	589.1	-0.3%	-1.0%	-0.1%	-0.3%	3358.3	0.8%	0.6%	1.0%	0.9%	421.2	0.0%	-0.2%	-0.1%	-0.1%
Mar-2020	755.5	0.2%	-0.6%	0.5%	0.3%	4195.1	0.9%	0.7%	1.1%	1.1%	423.6	0.2%	0.1%	0.2%	0.2%
Apr-2020	637.1	-0.2%	-1.0%	0.0%	-0.3%	3701.7	0.7%	0.4%	0.9%	0.8%	404.2	0.3%	0.2%	0.3%	0.3%
May-2020	1135.7	-0.1%	-0.8%	0.2%	0.0%	5806.6	0.4%	0.2%	0.6%	0.5%	404.6	0.5%	0.4%	0.5%	0.5%
Jun-2020	1479.3	0.1%	-0.6%	0.5%	0.3%	6644.4	0.3%	0.1%	0.4%	0.4%	352.1	0.8%	0.6%	0.8%	0.8%
Jul-2020	2672.1	0.0%	-0.5%	0.4%	0.2%	9321.4	0.2%	0.0%	0.3%	0.3%	342.5	1.9%	1.4%	2.1%	2.0%
Aug-2020	4153.3	-0.3%	-0.7%	0.0%	-0.1%	11930.6	0.0%	-0.1%	0.0%	0.0%	509.9	2.6%	1.8%	2.9%	2.8%
Sep-2020	3924.1	-0.4%	-0.9%	0.0%	-0.2%	11792.2	-0.2%	-0.3%	-0.1%	-0.2%	739.0	3.0%	2.2%	3.4%	3.3%
Oct-2020	5008.2	-0.4%	-0.9%	-0.2%	-0.4%	14221.5	-0.3%	-0.4%	-0.3%	-0.3%	669.6	3.3%	2.5%	3.6%	3.5%
Nov-2020	4706.3	-0.2%	-0.7%	0.0%	-0.2%	13791.9	-0.2%	-0.2%	-0.1%	-0.2%	712.7	3.6%	2.6%	3.9%	3.8%
Dec-2020	4175.8	0.3%	-0.3%	0.5%	0.2%	12827.8	0.2%	0.2%	0.3%	0.3%	744.0	3.2%	2.2%	3.4%	3.3%

	CCWD Intake at Victoria Canal				
	No Action EC	% EC change			
	µS/cm	Alt 19	Alt 24	Alt 26	FWOP
Jan-2020	386.7	0.1%	0.1%	0.1%	0.1%
Feb-2020	443.5	0.2%	0.1%	0.1%	0.1%
Mar-2020	482.4	0.3%	0.2%	0.3%	0.3%
Apr-2020	443.5	0.4%	0.3%	0.4%	0.4%
May-2020	424.5	0.6%	0.5%	0.7%	0.7%
Jun-2020	363.1	0.7%	0.6%	0.7%	0.7%
Jul-2020	276.4	0.8%	0.7%	0.8%	0.8%
Aug-2020	284.8	1.5%	1.3%	1.7%	1.6%
Sep-2020	387.6	2.4%	2.0%	2.7%	2.6%
Oct-2020	402.8	2.5%	2.1%	2.7%	2.7%
Nov-2020	497.1	2.6%	2.0%	2.6%	2.6%
Dec-2020	574.5	2.4%	1.8%	2.5%	2.4%

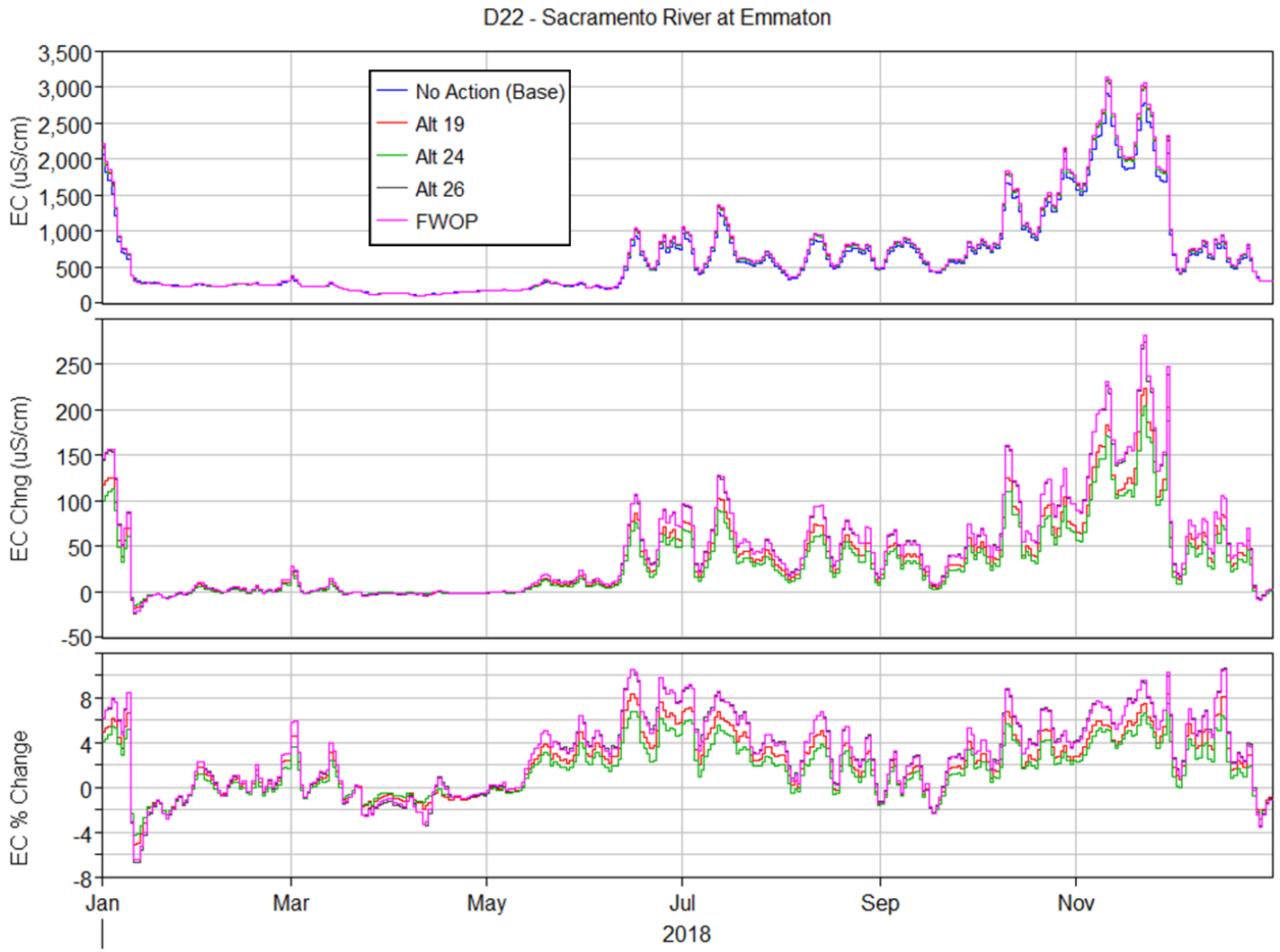

Figure 18 Daily average EC at station D22 – Sacramento River at Emmaton for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

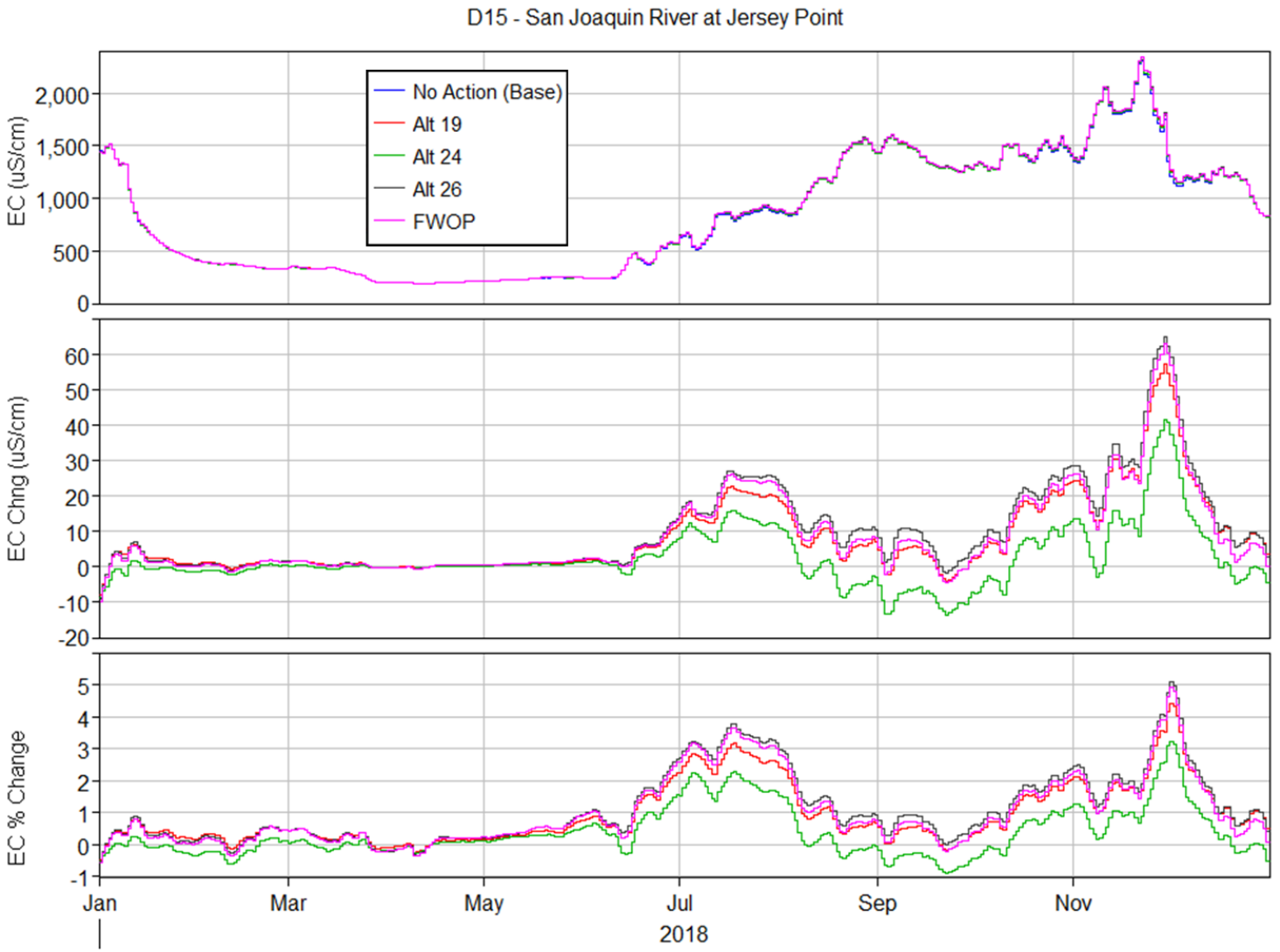

Figure 19 Daily average EC at station D15 - San Joaquin River at Jersey Point for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

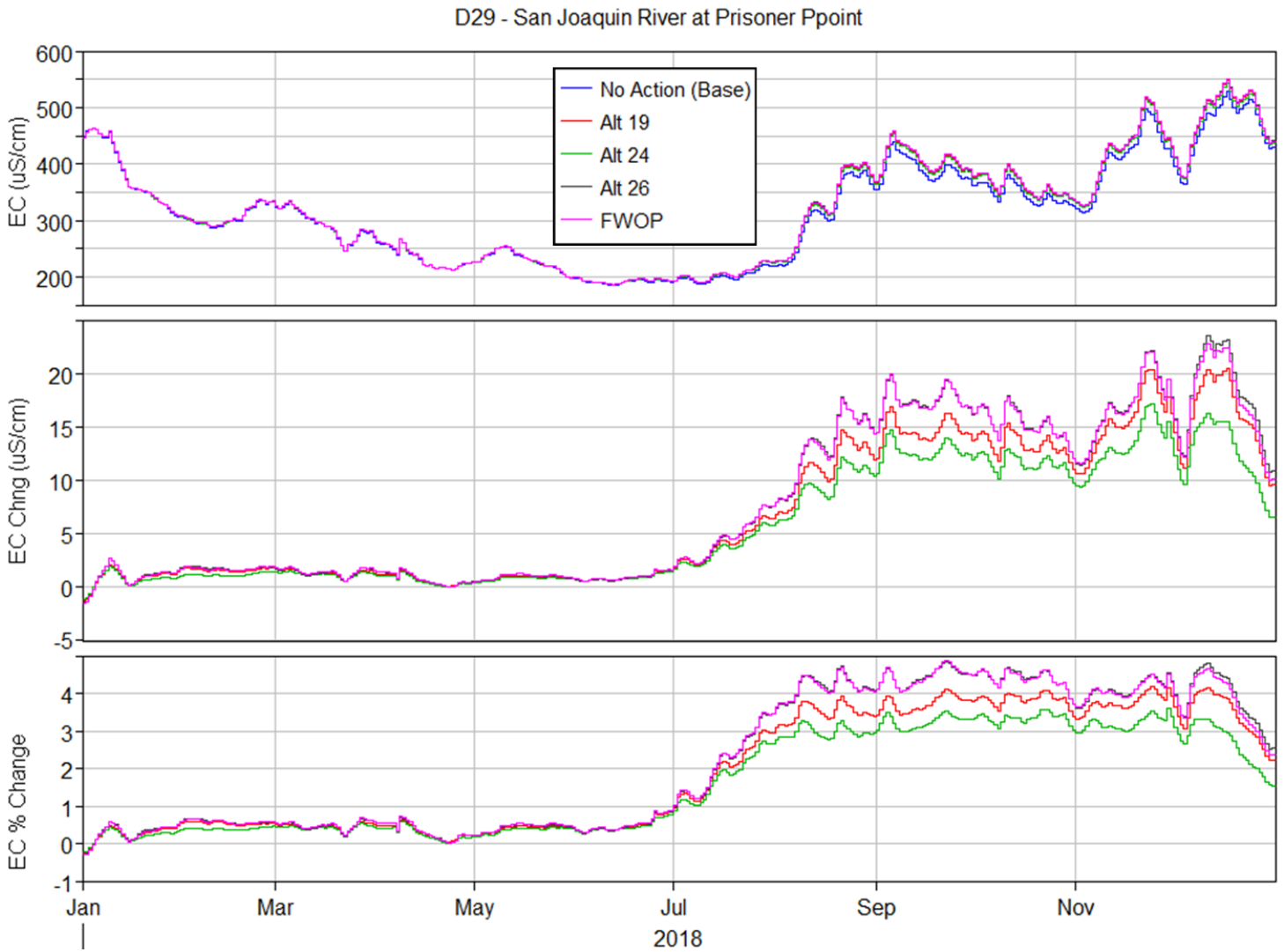

Figure 20 Daily average EC at station D29 - San Joaquin River at Prisoners Point for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

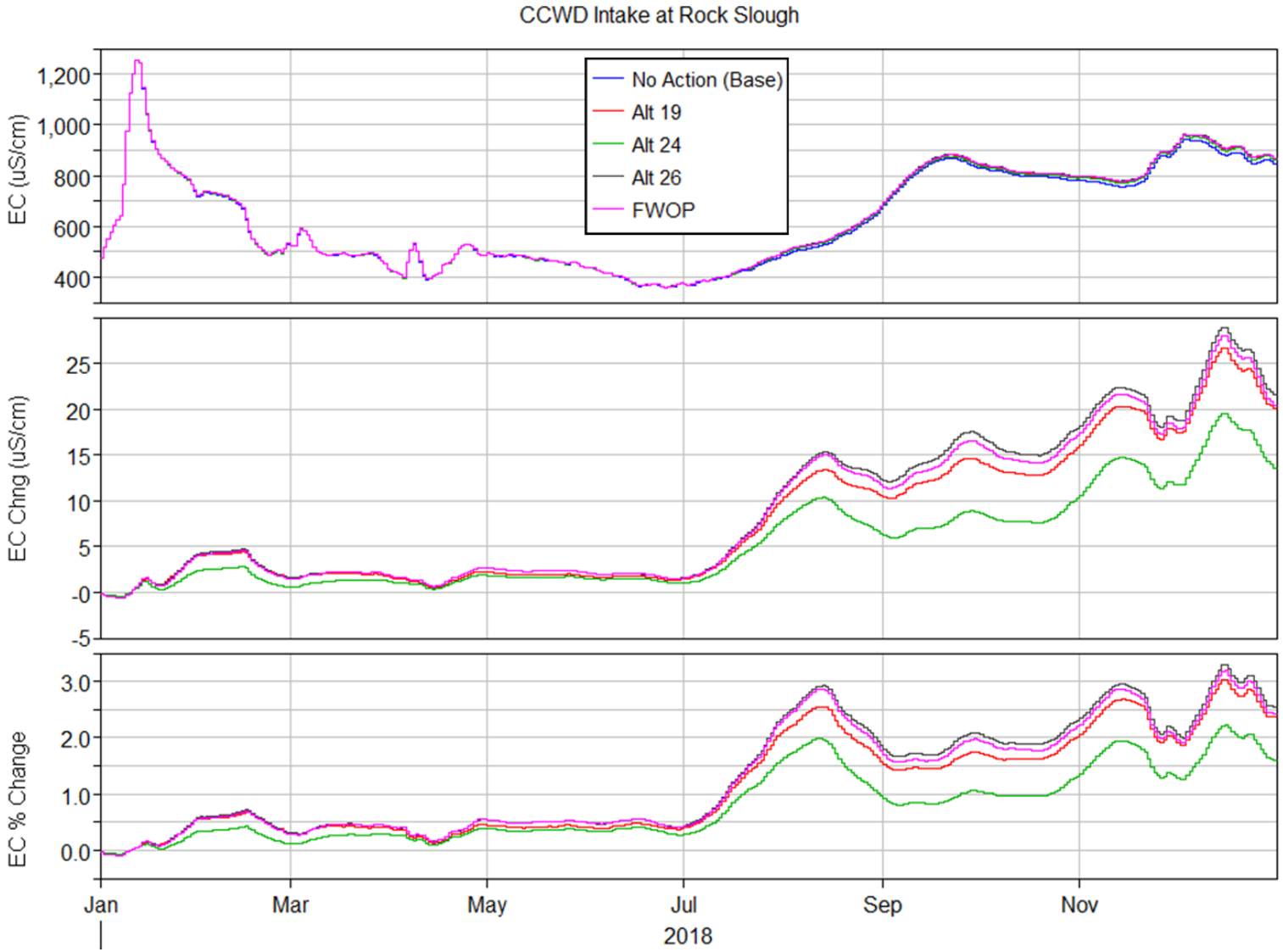

Figure 21 Daily average EC at station C5 - Contra Costa Canal for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

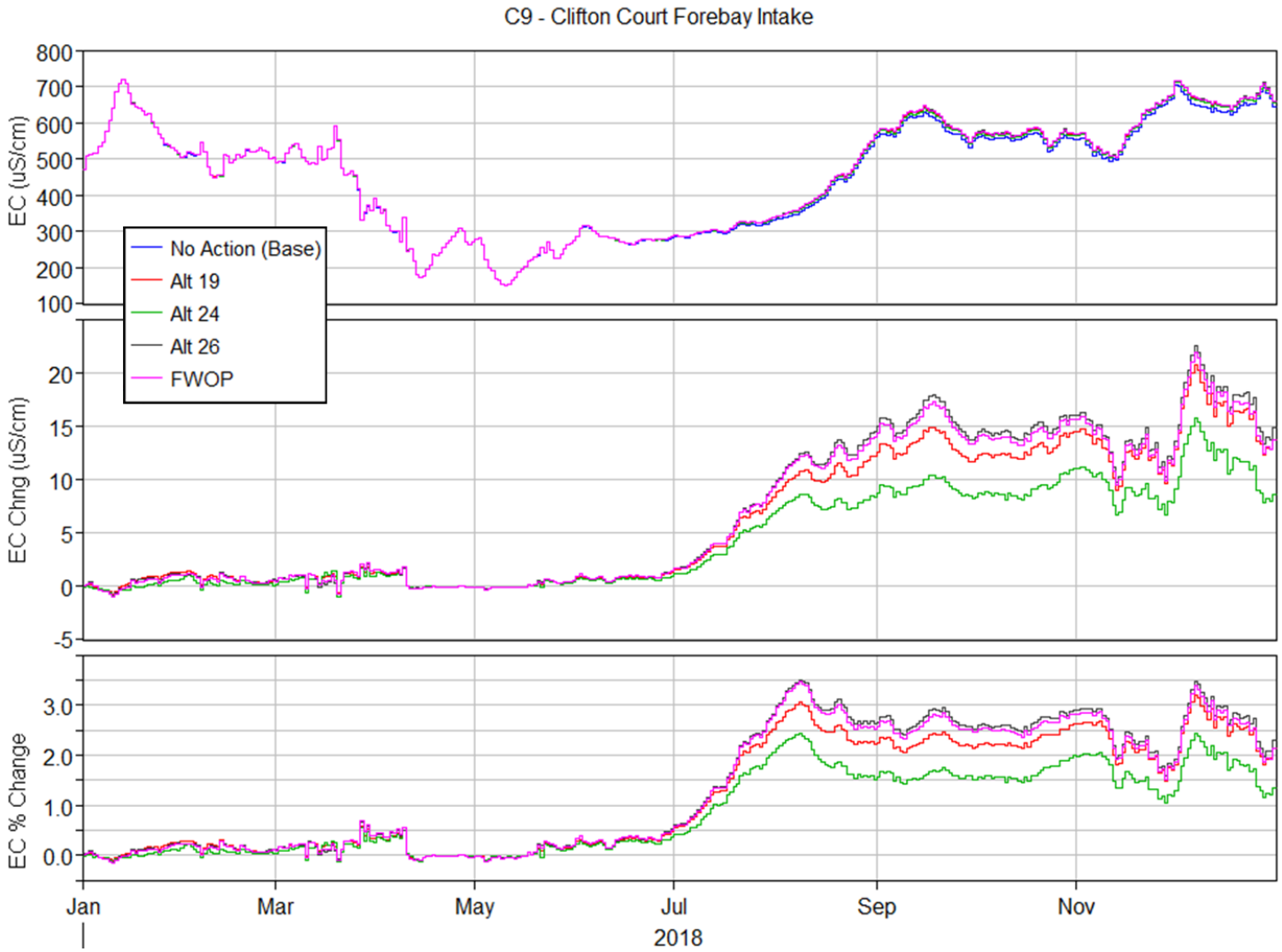

Figure 22 Daily average EC at station C9 – West Canal at Clifton Court Forebay for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

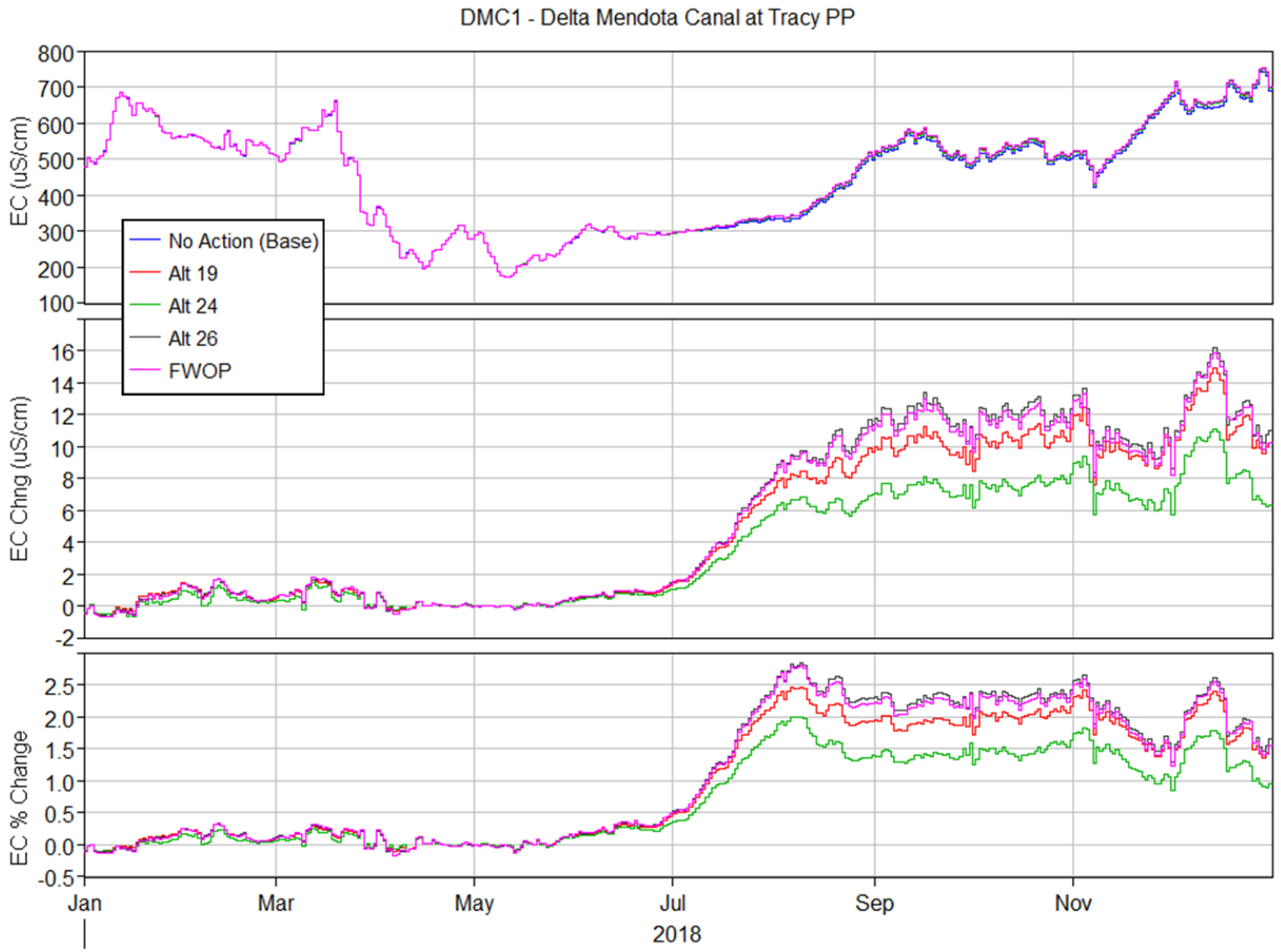

Figure 23 Daily average EC at station DMC1 – Delta-Mendota Canal at Tracy PP for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

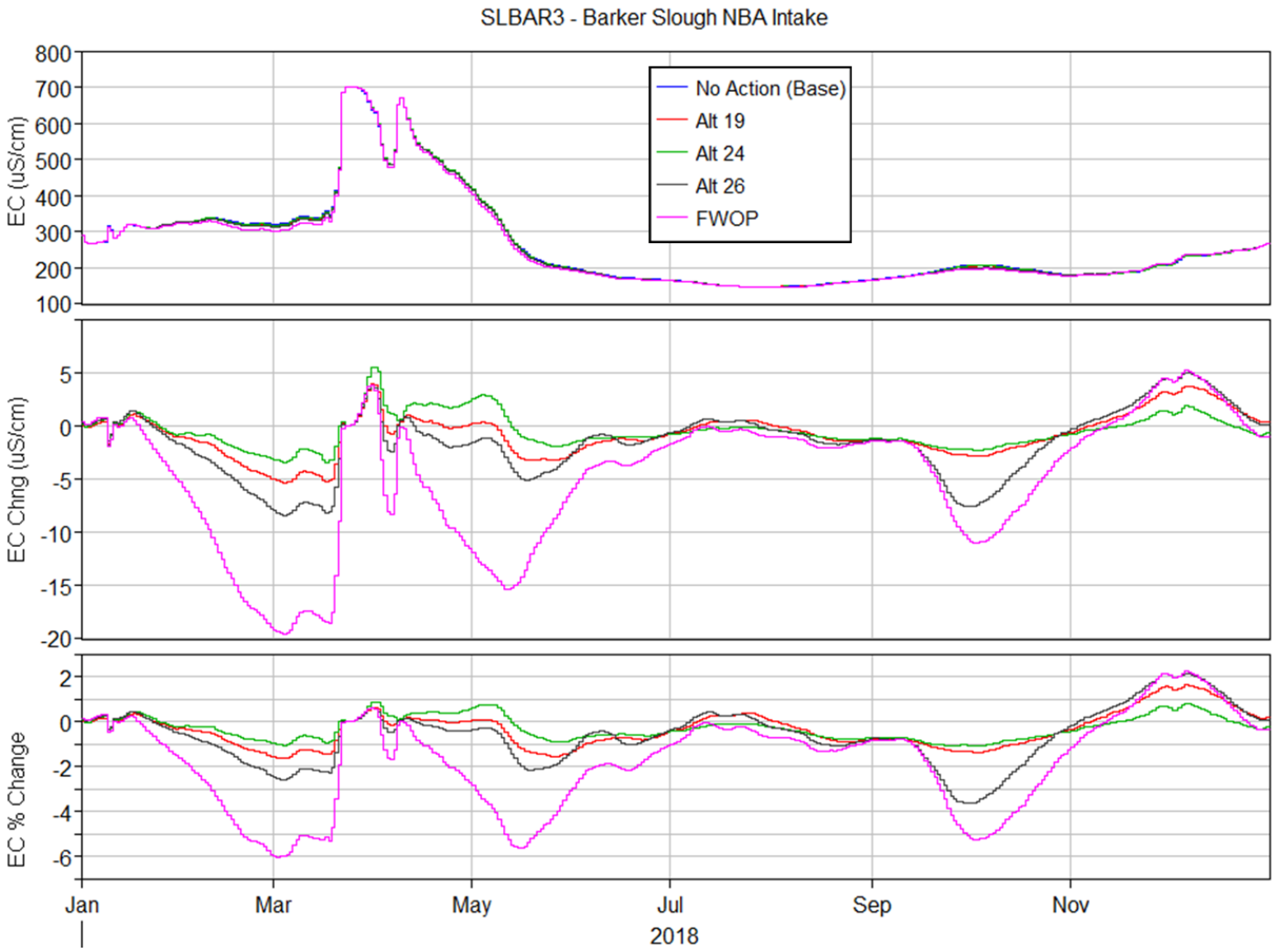

Figure 24 Daily average EC at station SLBAR3 – Barker Slough at NBA for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

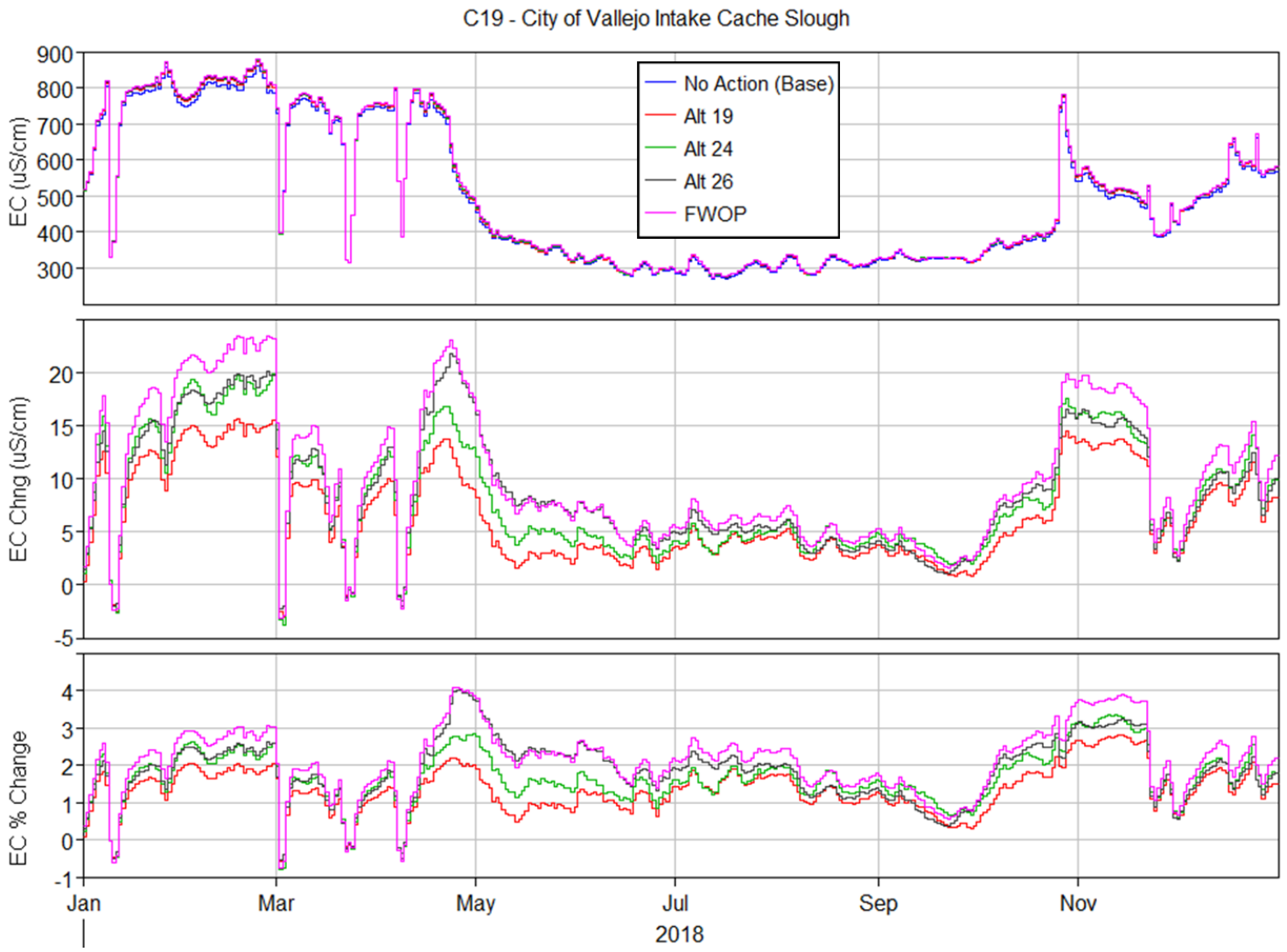

Figure 25 Daily average EC at station C19 – Cache Slough at City of Vallejo Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

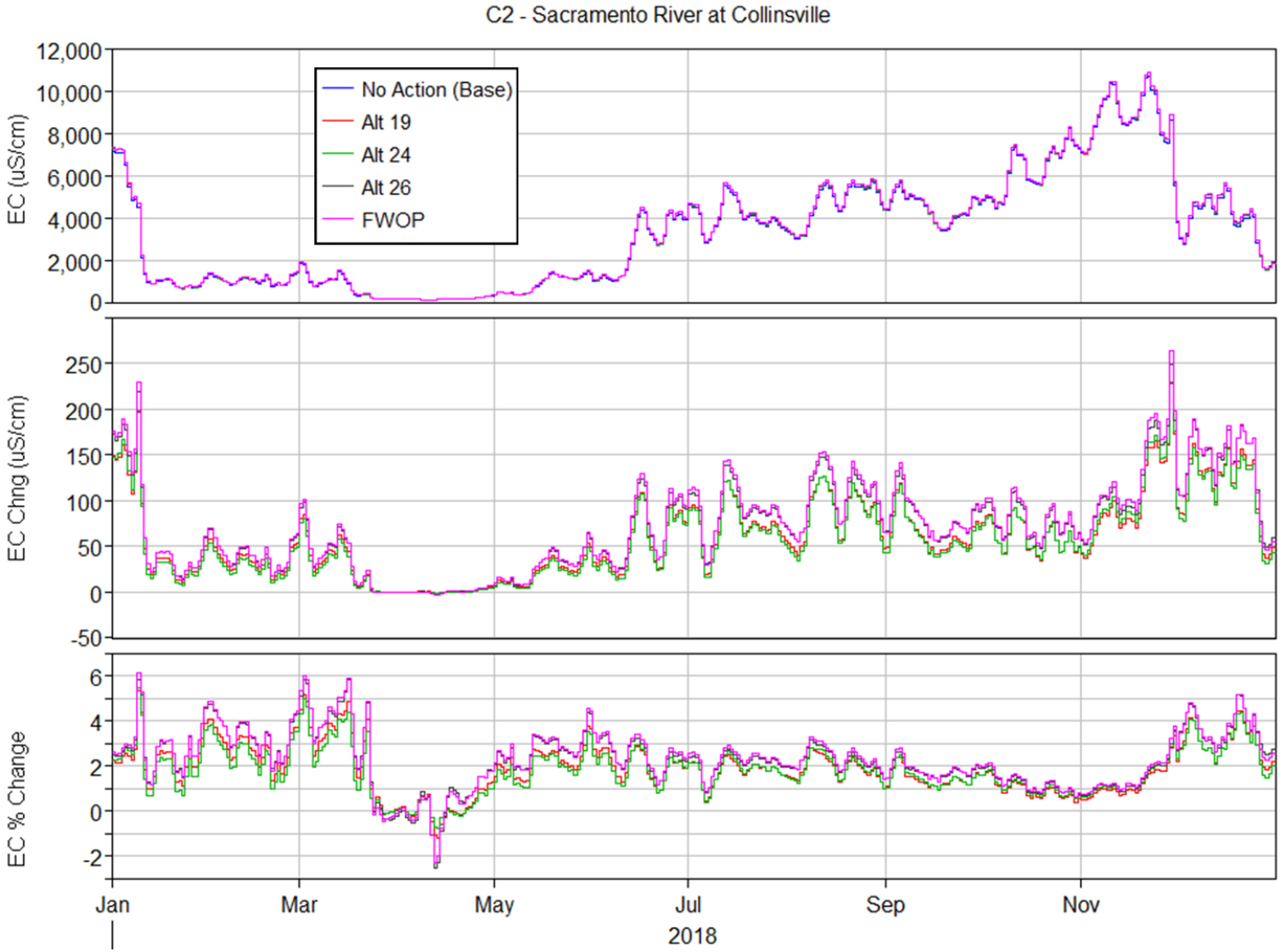

Figure 26 Daily average EC at station C2 – Sacramento River at Collinsville for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

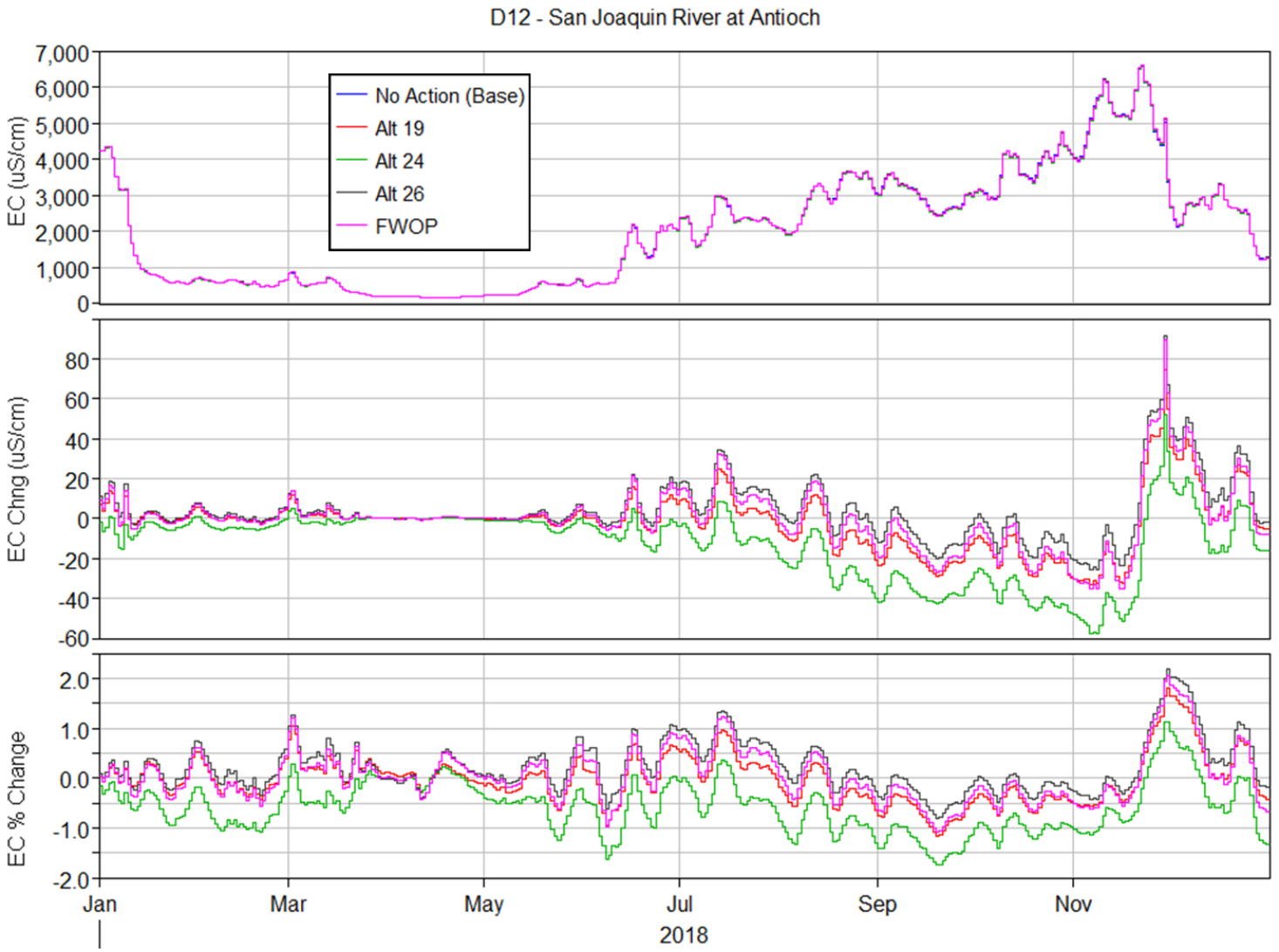

Figure 27 Daily average EC at station D12 – San Joaquin River at Antioch Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

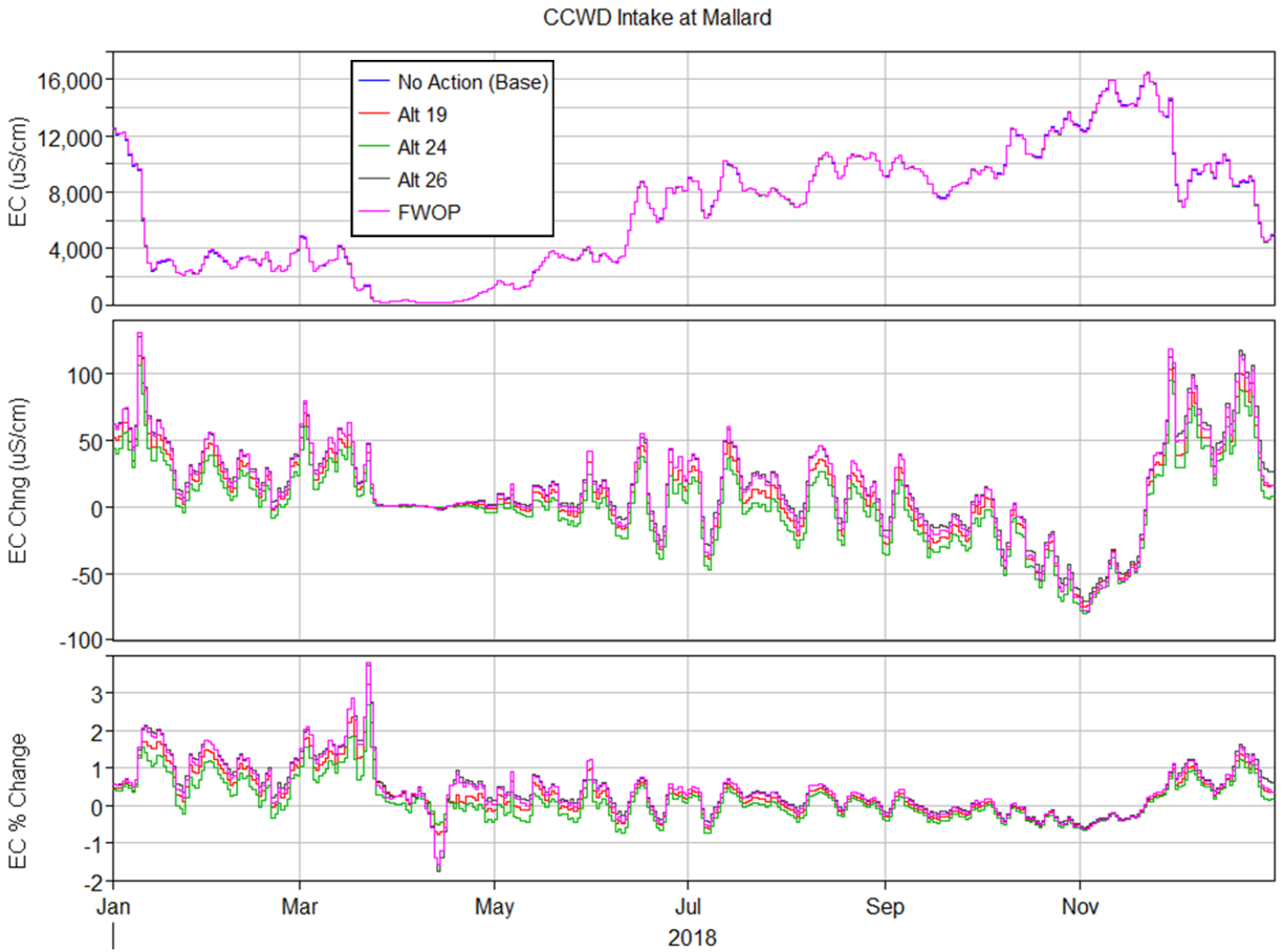

Figure 28 Daily average EC at station for Contra Costa Water District – Mallard Slough Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

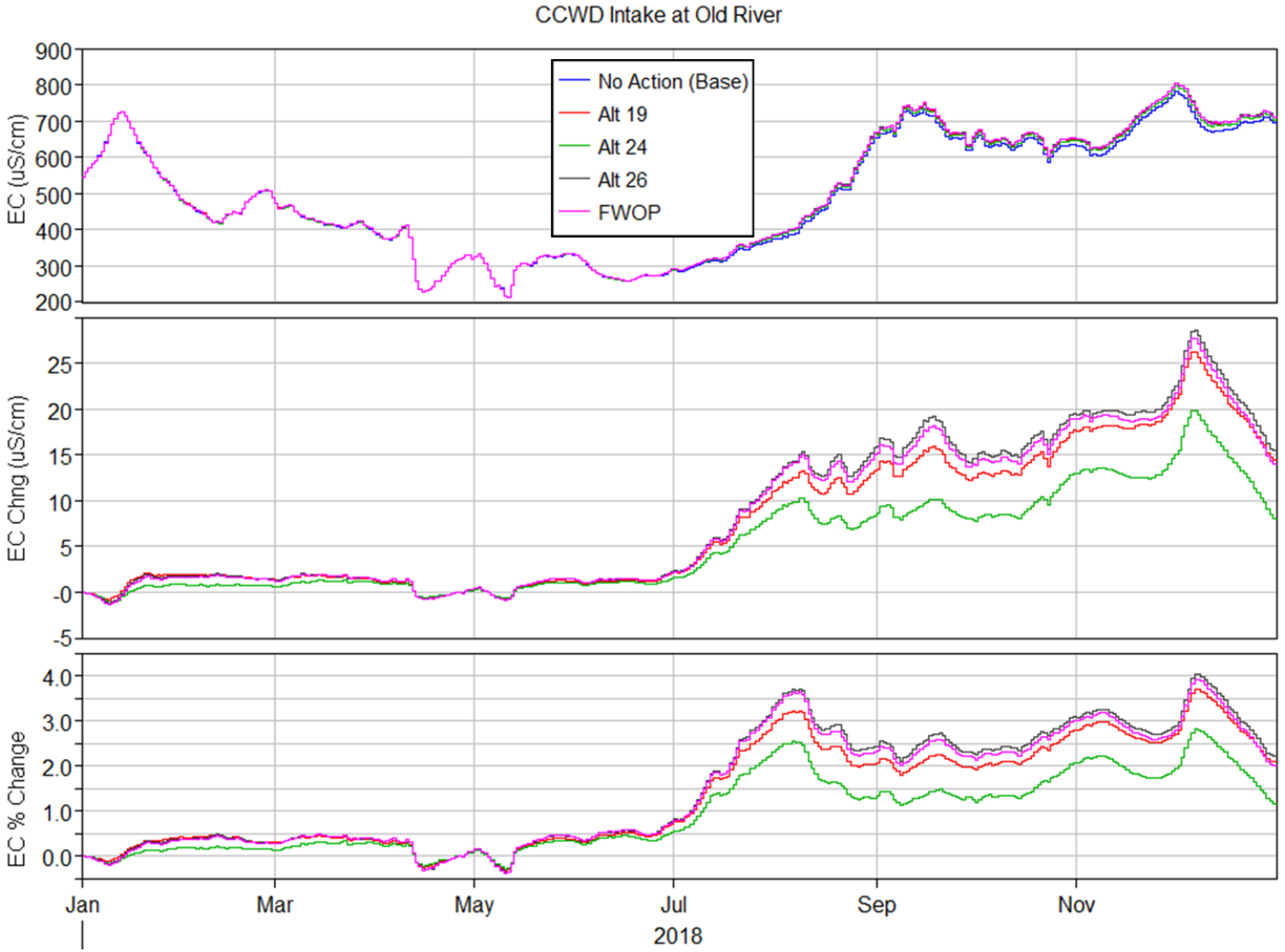

Figure 29 Daily average EC at Contra Costa Water District – Old River Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

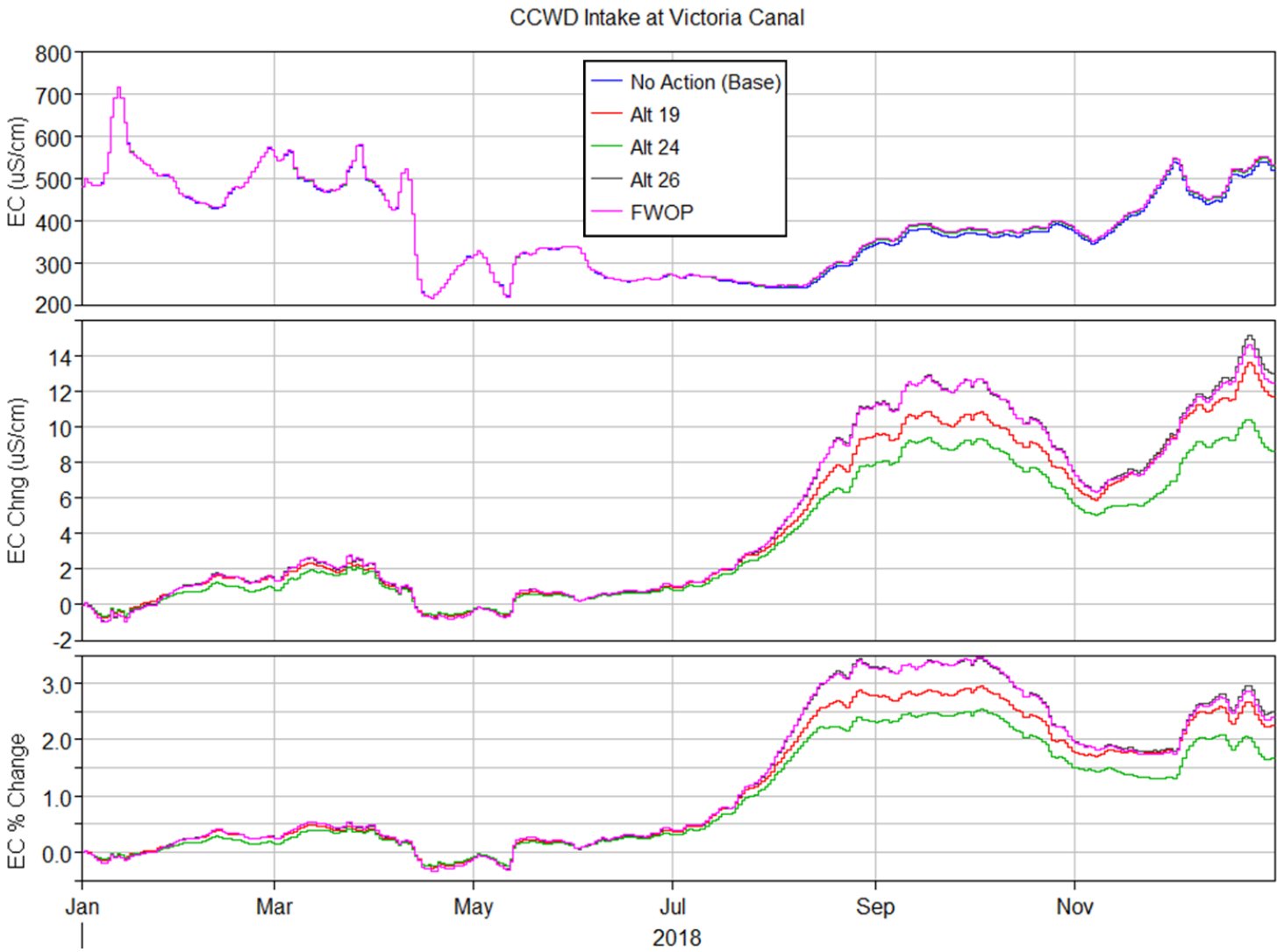

Figure 30 Daily average EC at Contra Costa Water District – Victoria Canal Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2018 simulation period.

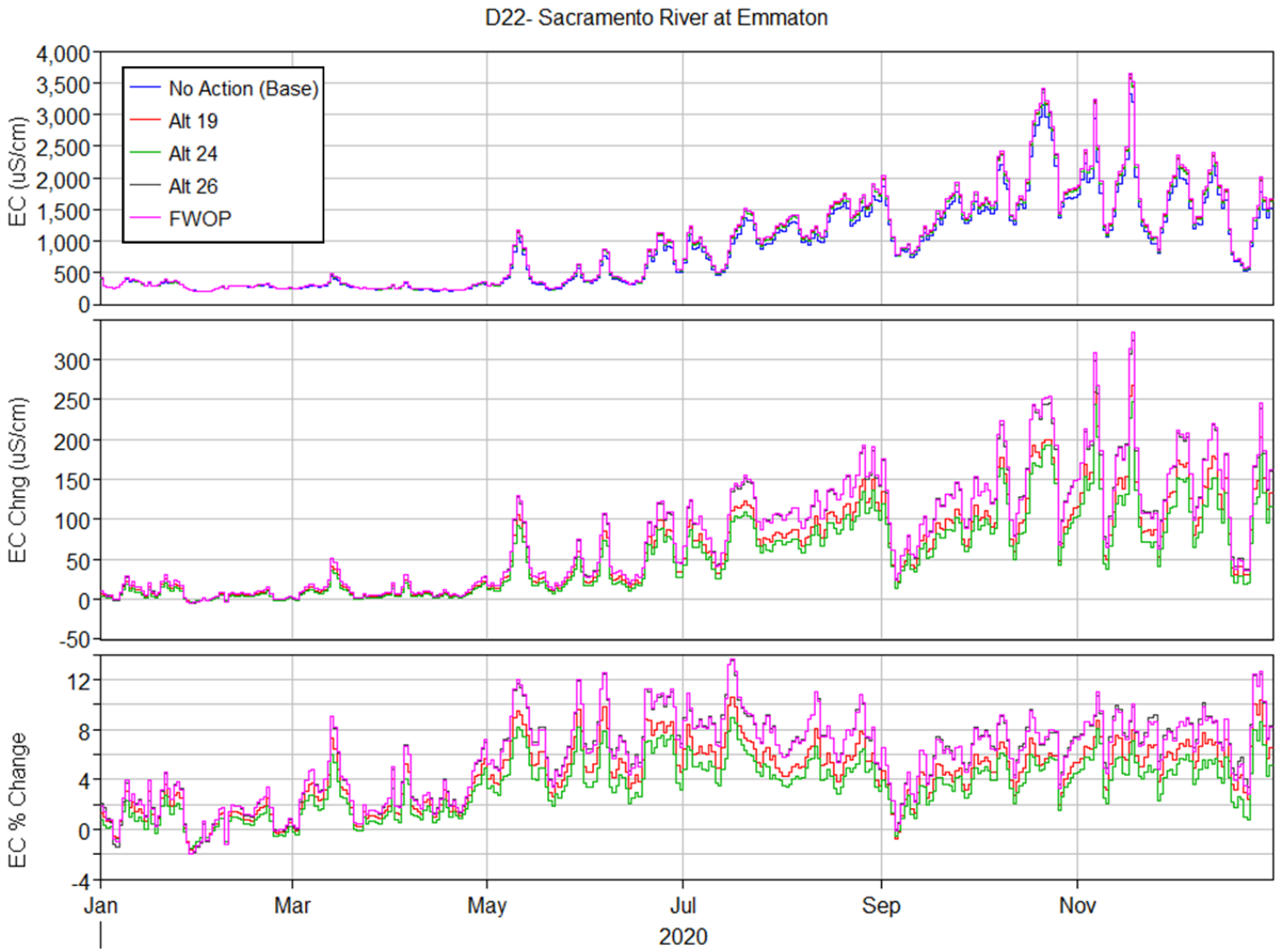

Figure 31 Daily average EC at station D22 – Sacramento River at Emmaton for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

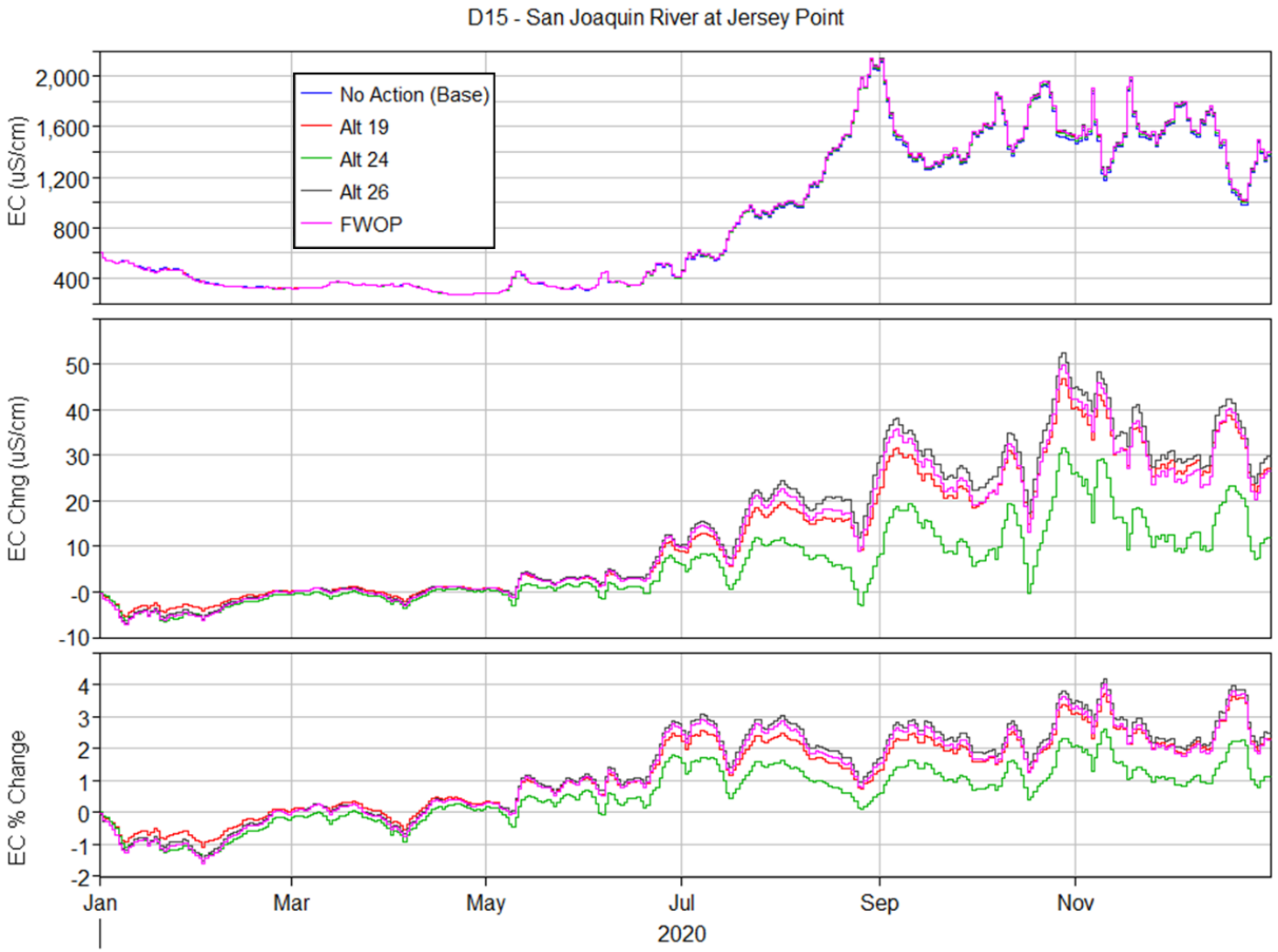

Figure 32 Daily average EC at station D15 - San Joaquin River at Jersey Point for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

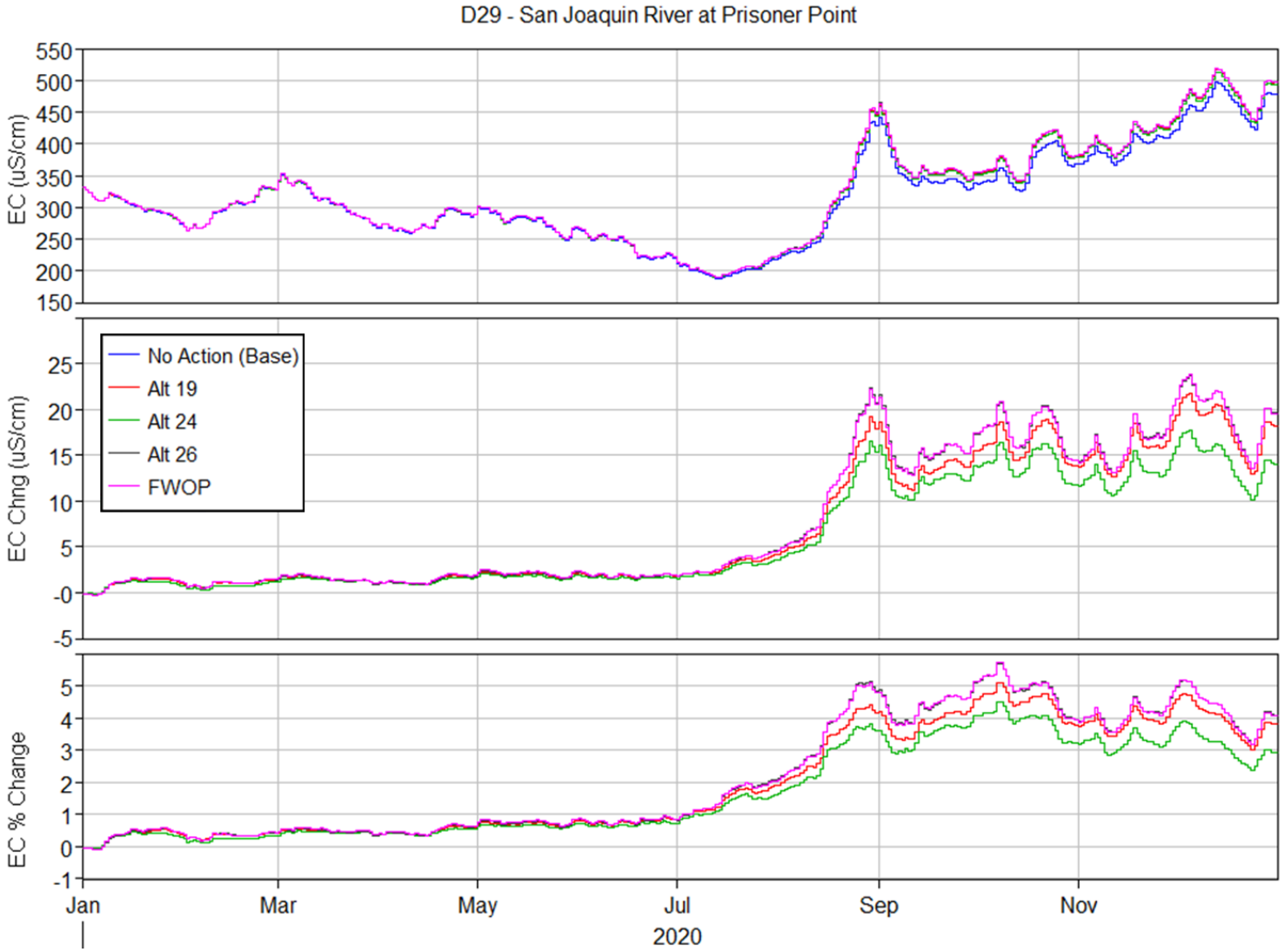

Figure 33 Daily average EC at station D29 - San Joaquin River at Prisoners Point for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

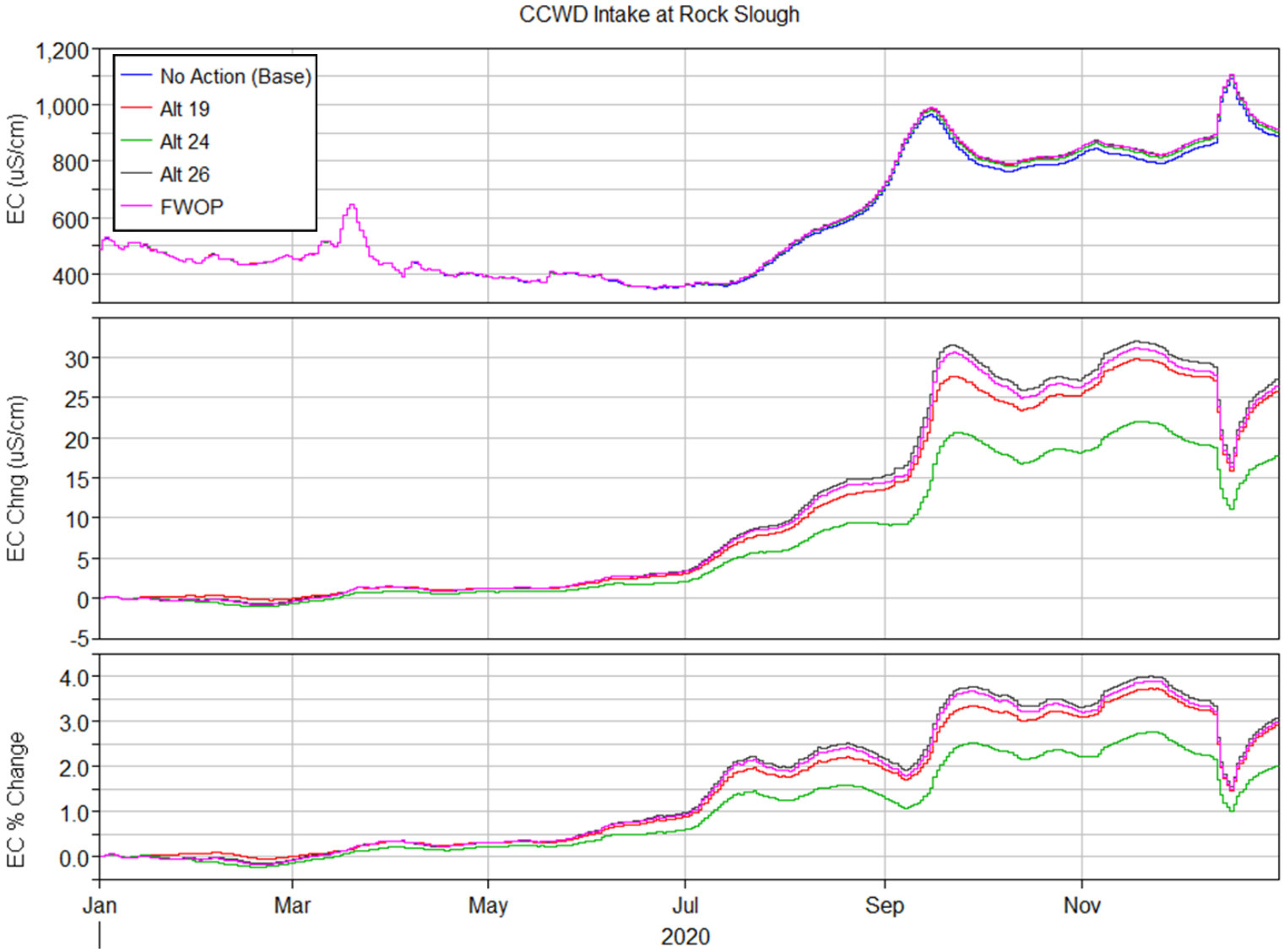

Figure 34 Daily average EC at station C5 - Contra Costa Canal for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

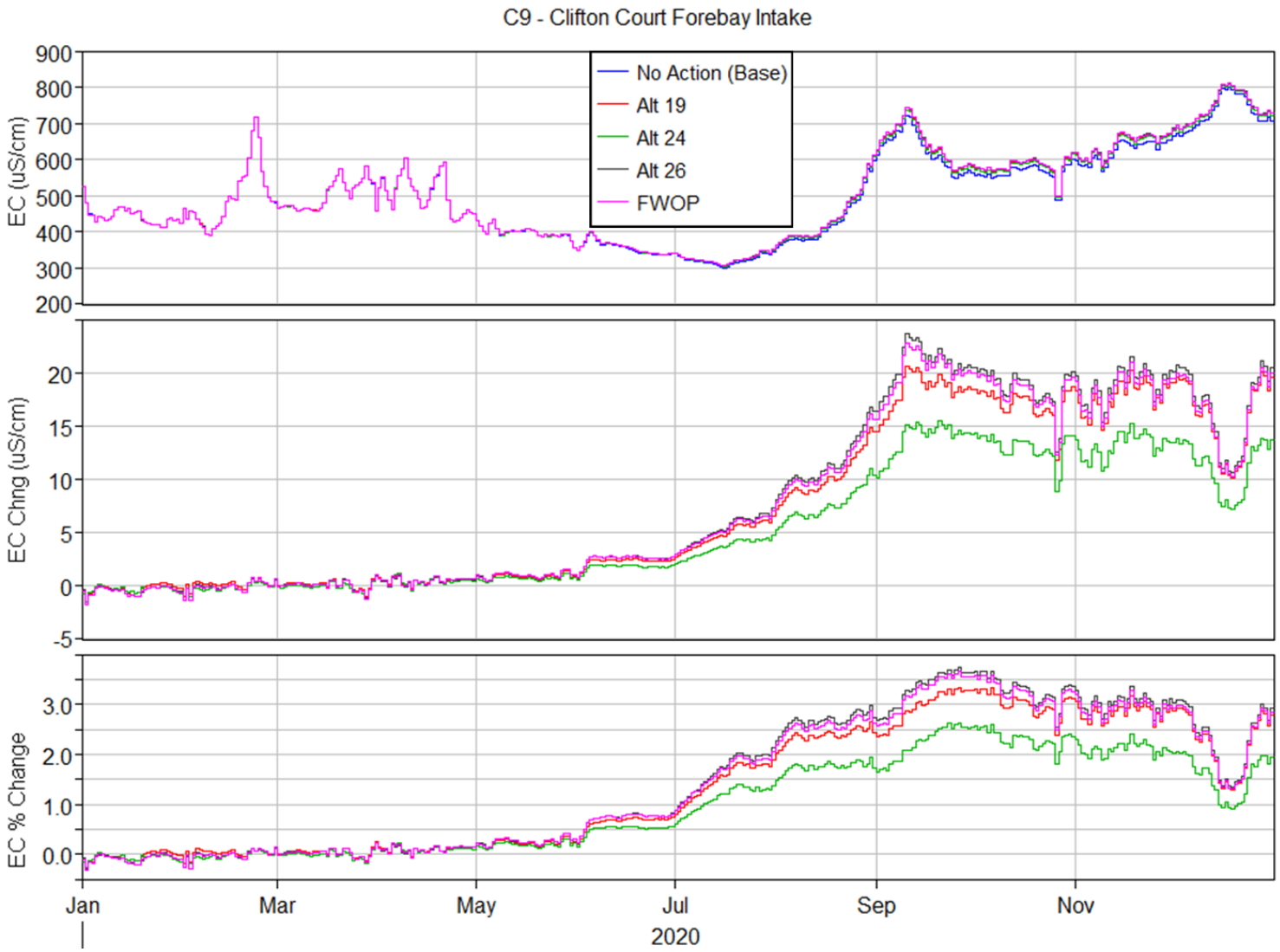

Figure 35 Daily average EC at station C9 – West Canal at Clifton Court Forebay for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

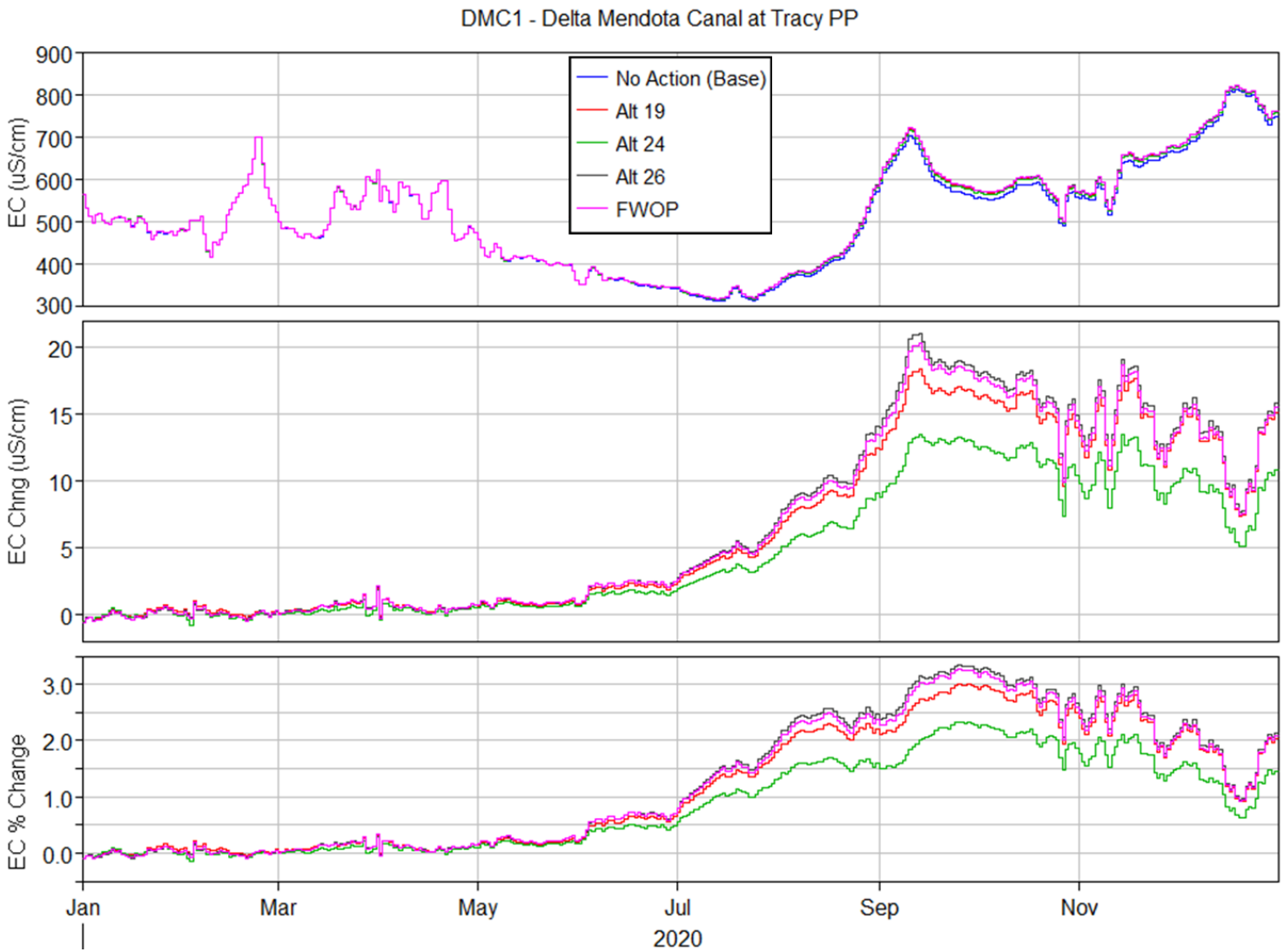

Figure 36 Daily average EC at station DMC1 – Delta-Mendota Canal at Tracy PP for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

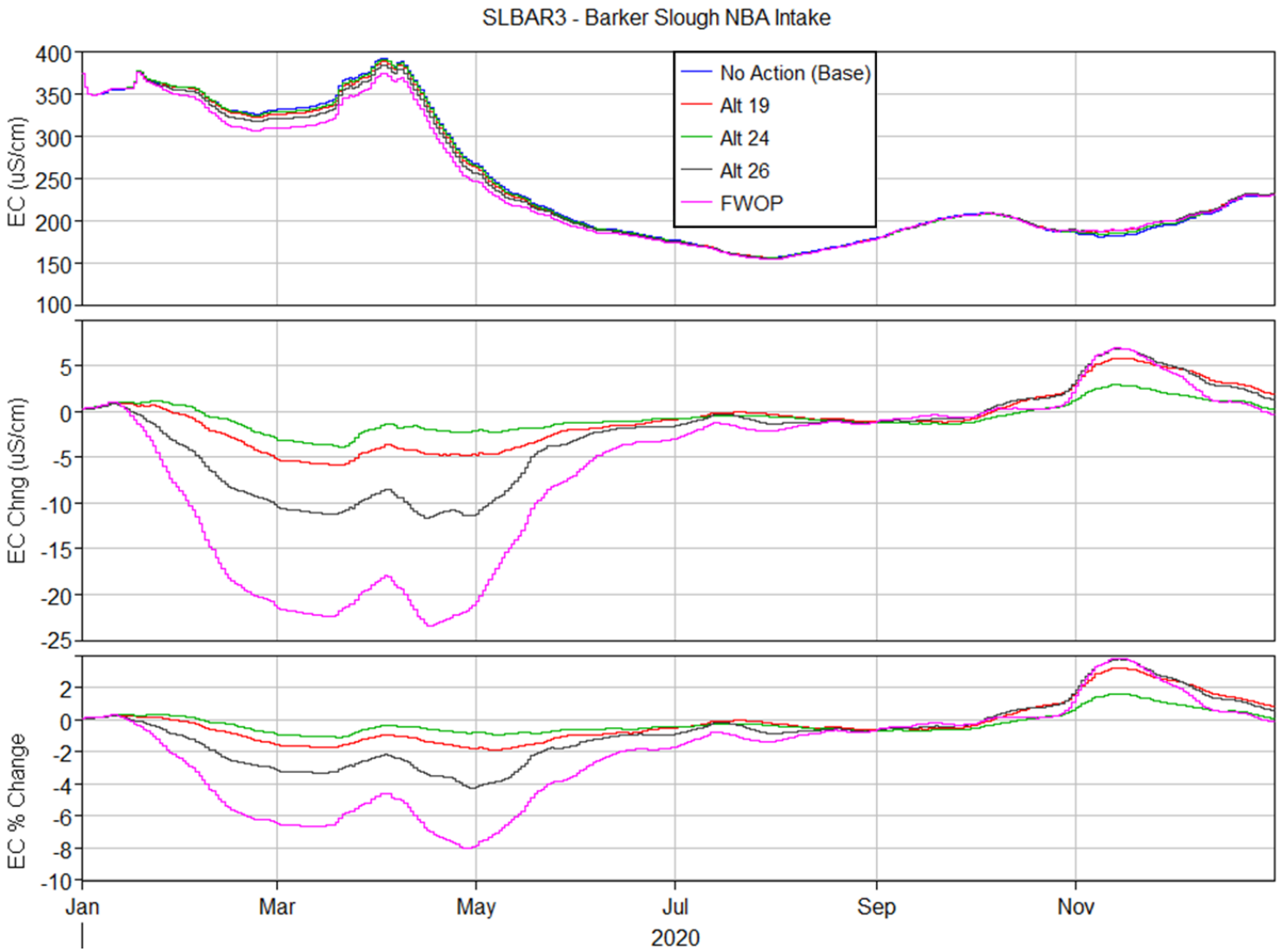

Figure 37 Daily average EC at station SLBAR3 – Barker Slough at NBA for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

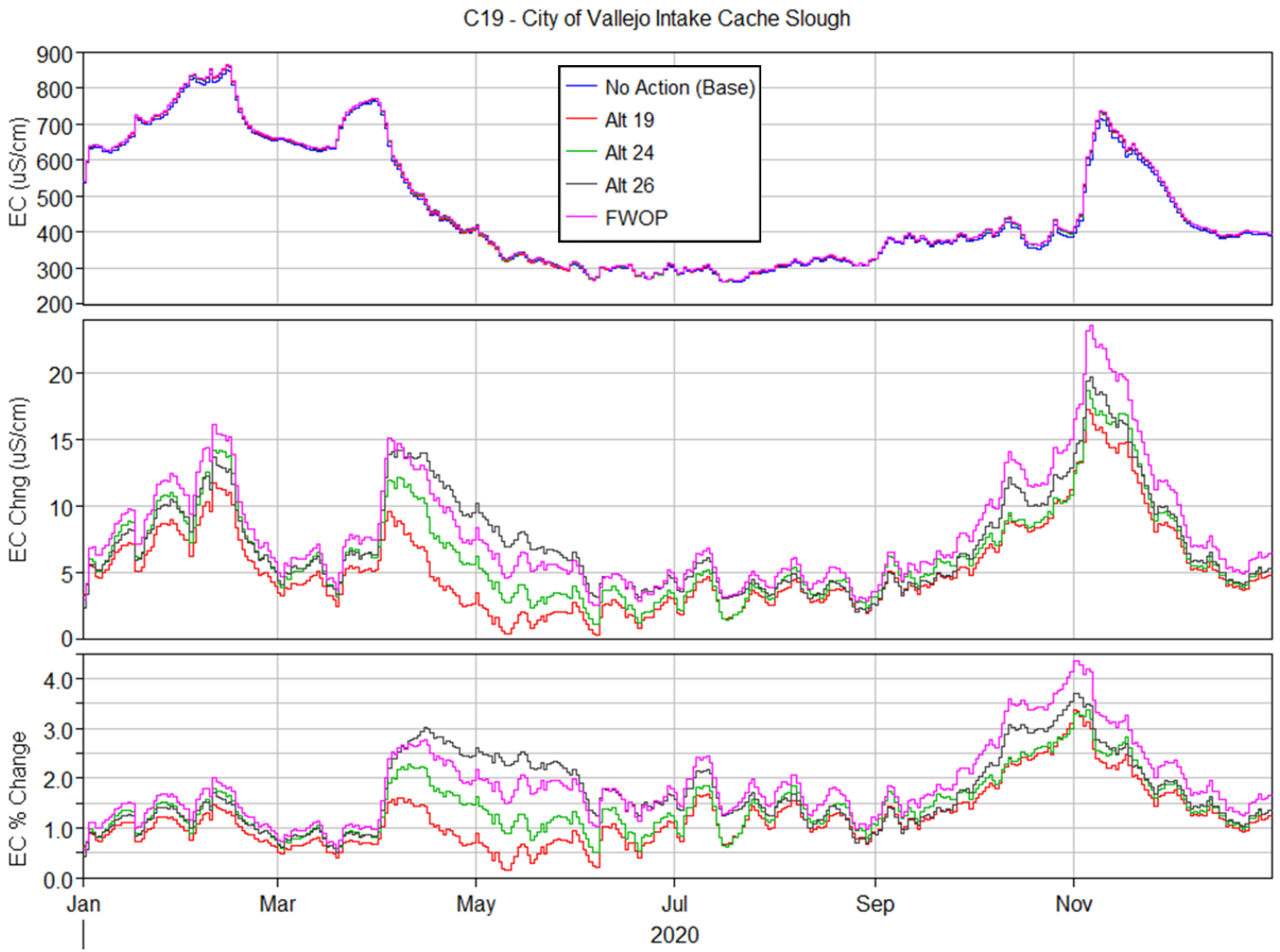

Figure 38 Daily average EC at station C19 – Cache Slough at City of Vallejo Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

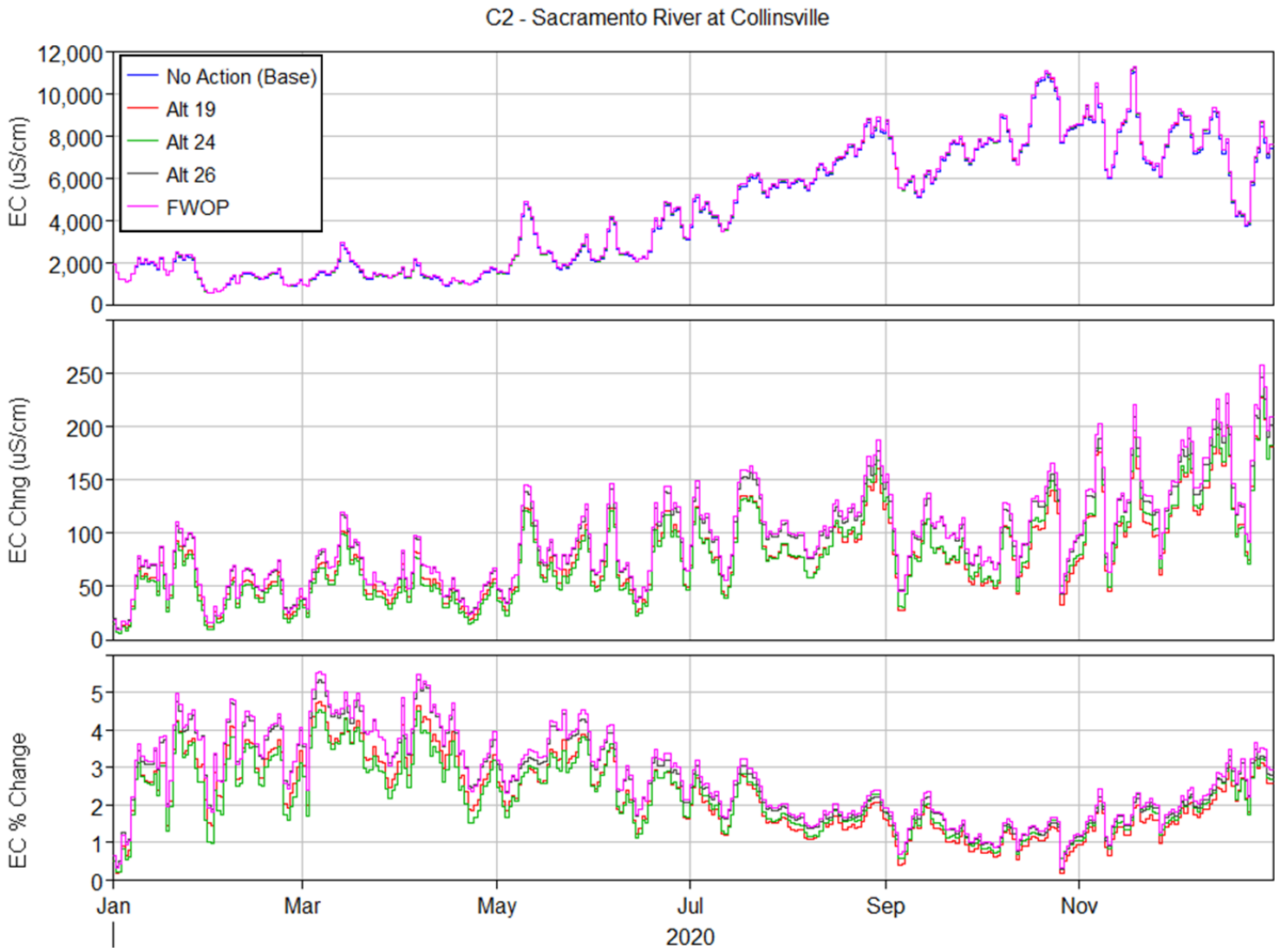

Figure 39 Daily average EC at station C2 – Sacramento River at Collinsville for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

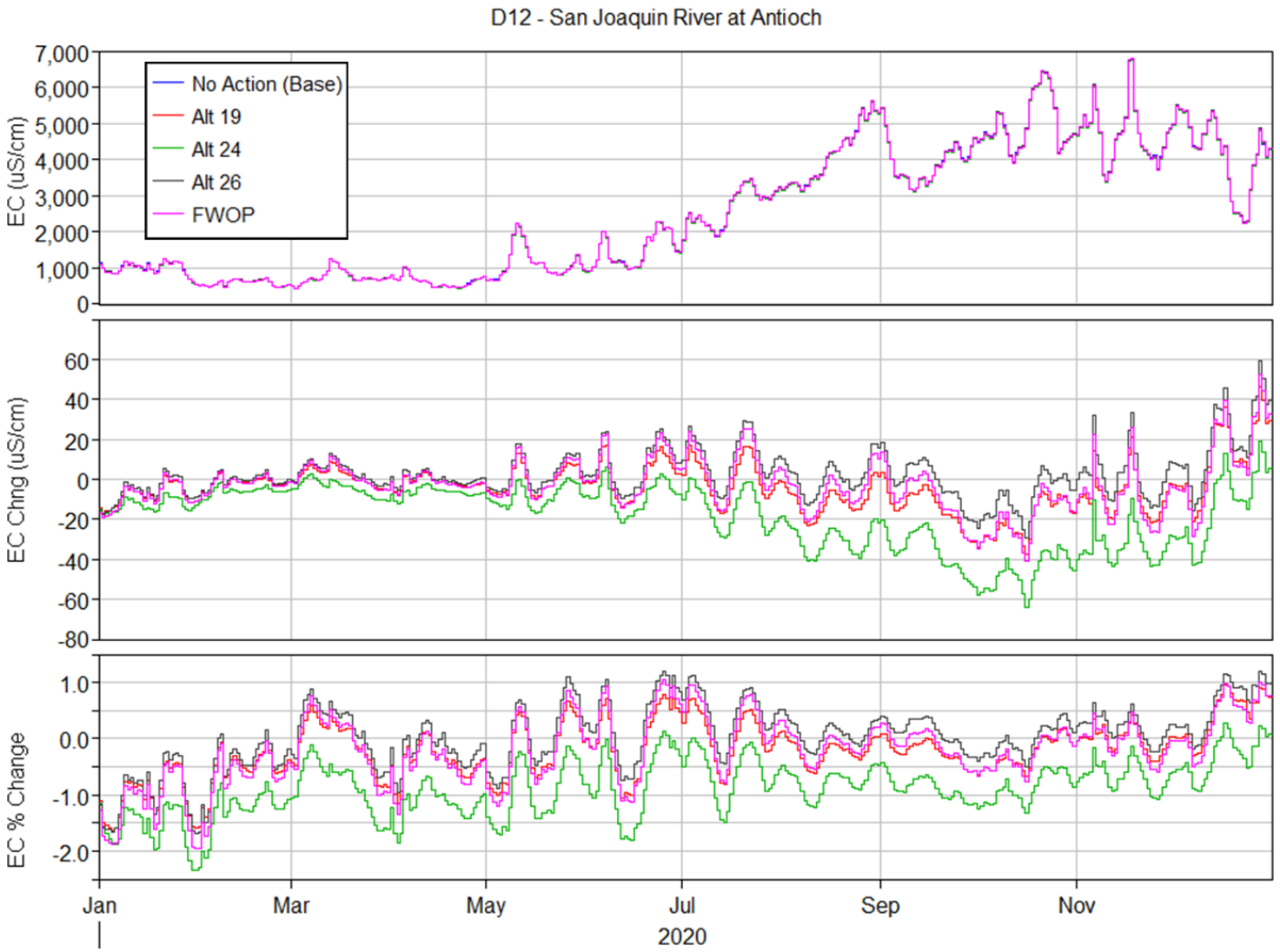

Figure 40 Daily average EC at station D12 – San Joaquin River at Antioch Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

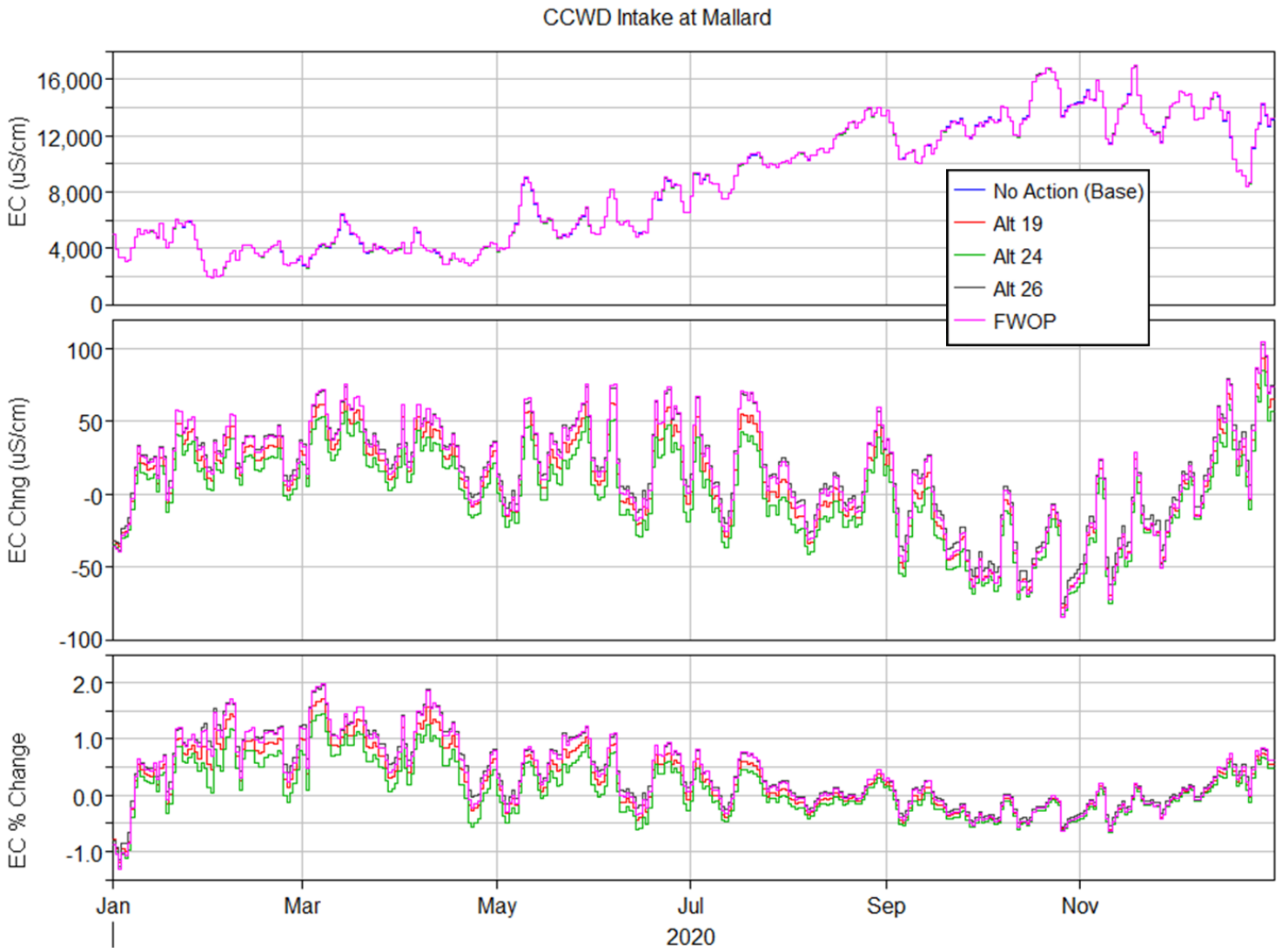

Figure 41 Daily average EC at station for Contra Costa Water District – Mallard Slough Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

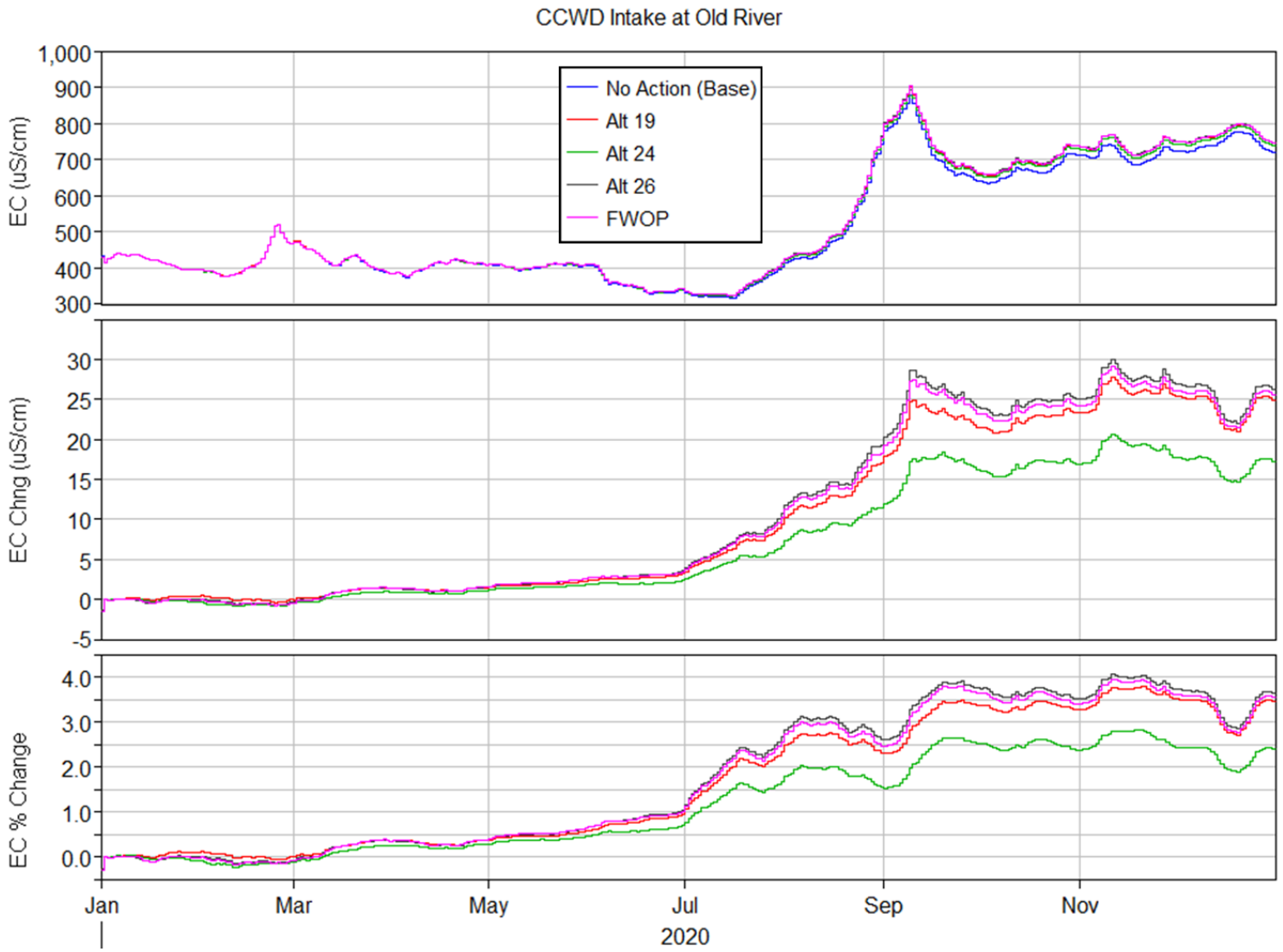

Figure 42 Daily average EC at Contra Costa Water District – Old River Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

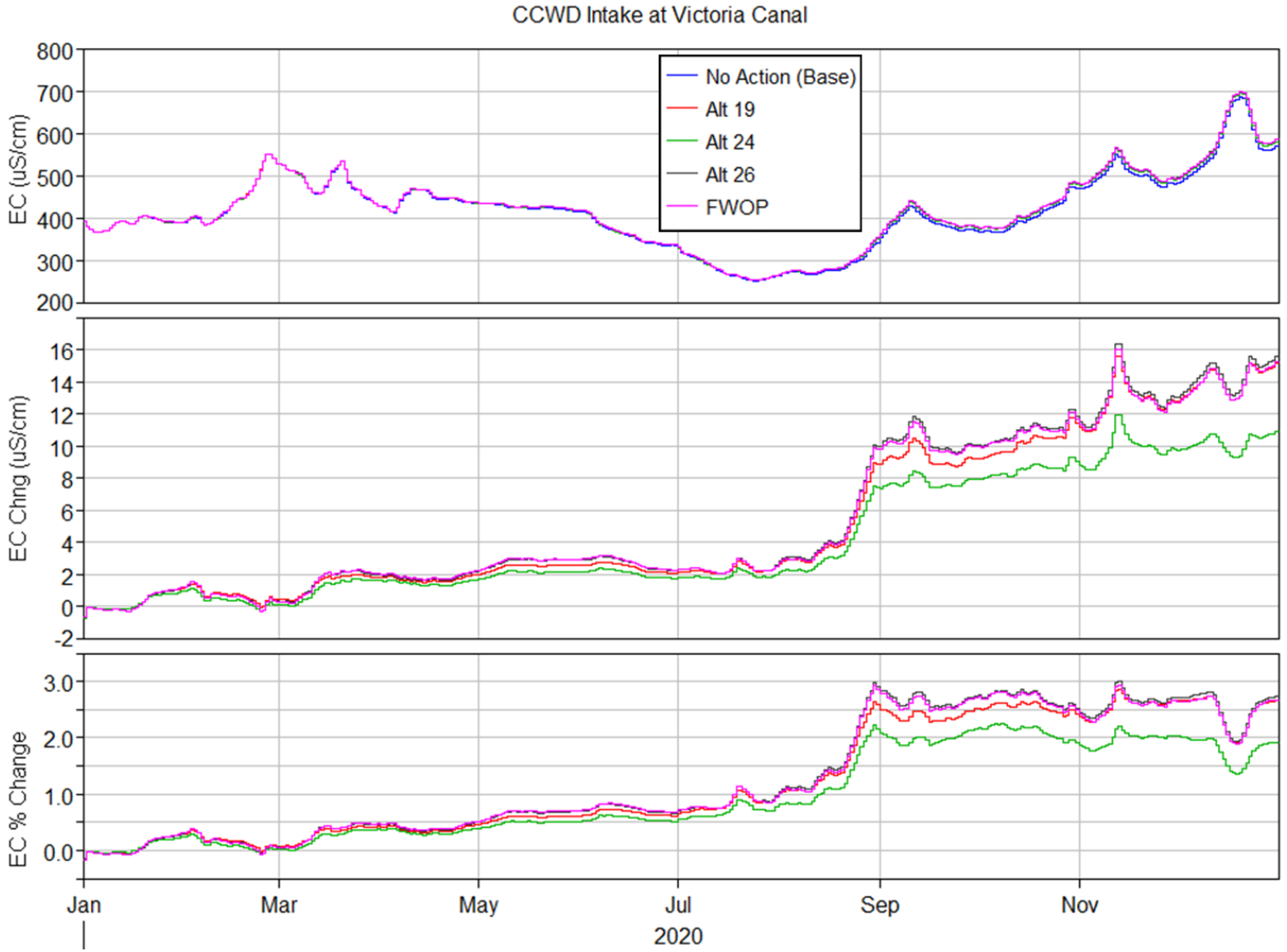

Figure 43 Daily average EC at Contra Costa Water District – Victoria Canal Intake for No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP, plotted with daily average absolute and relative (%) change from Base EC for the 2020 simulation period.

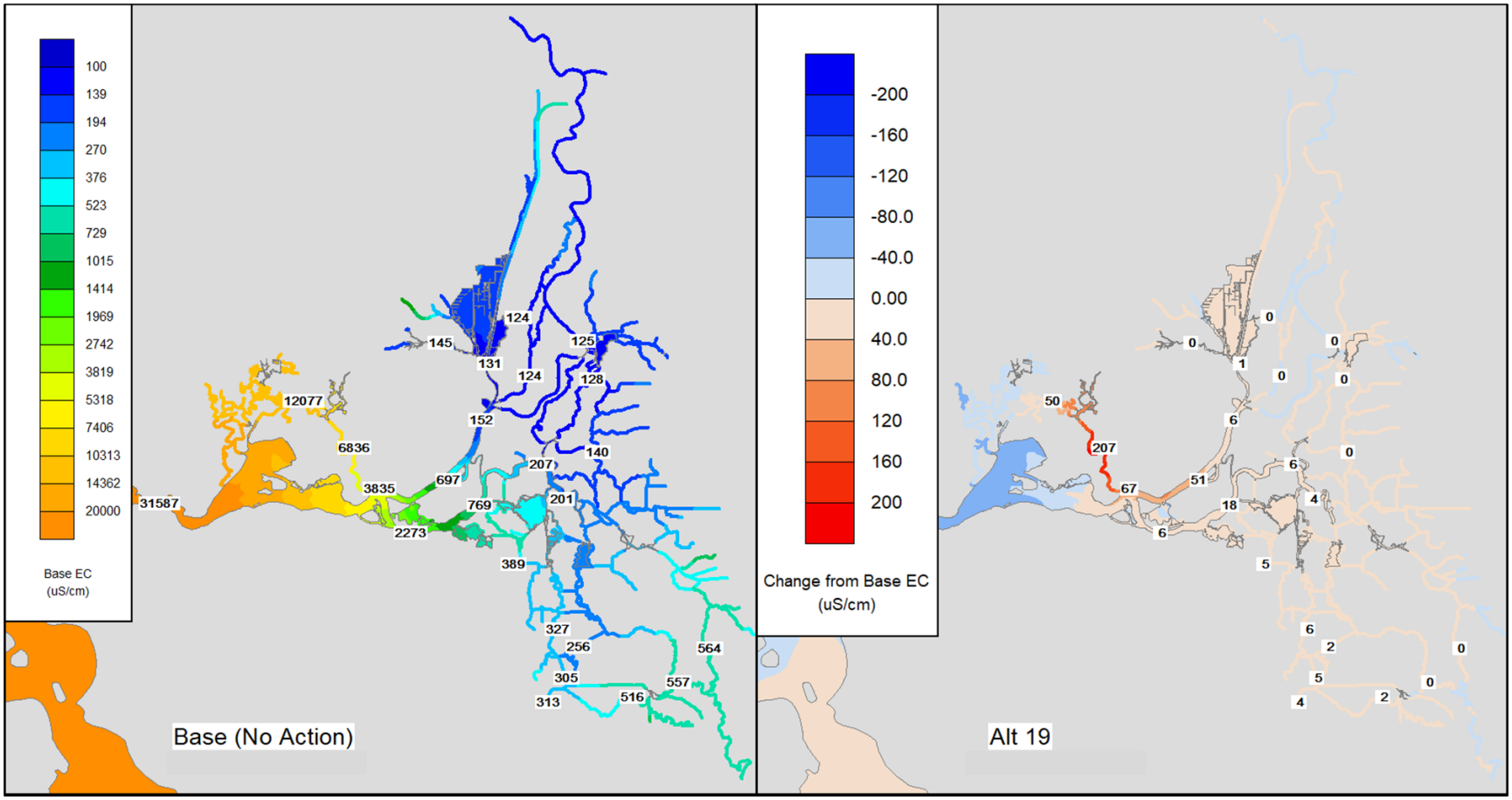

Figure 44 July 2018 (left) average Base condition EC and (right) change from Base condition average EC for Alternative 19.

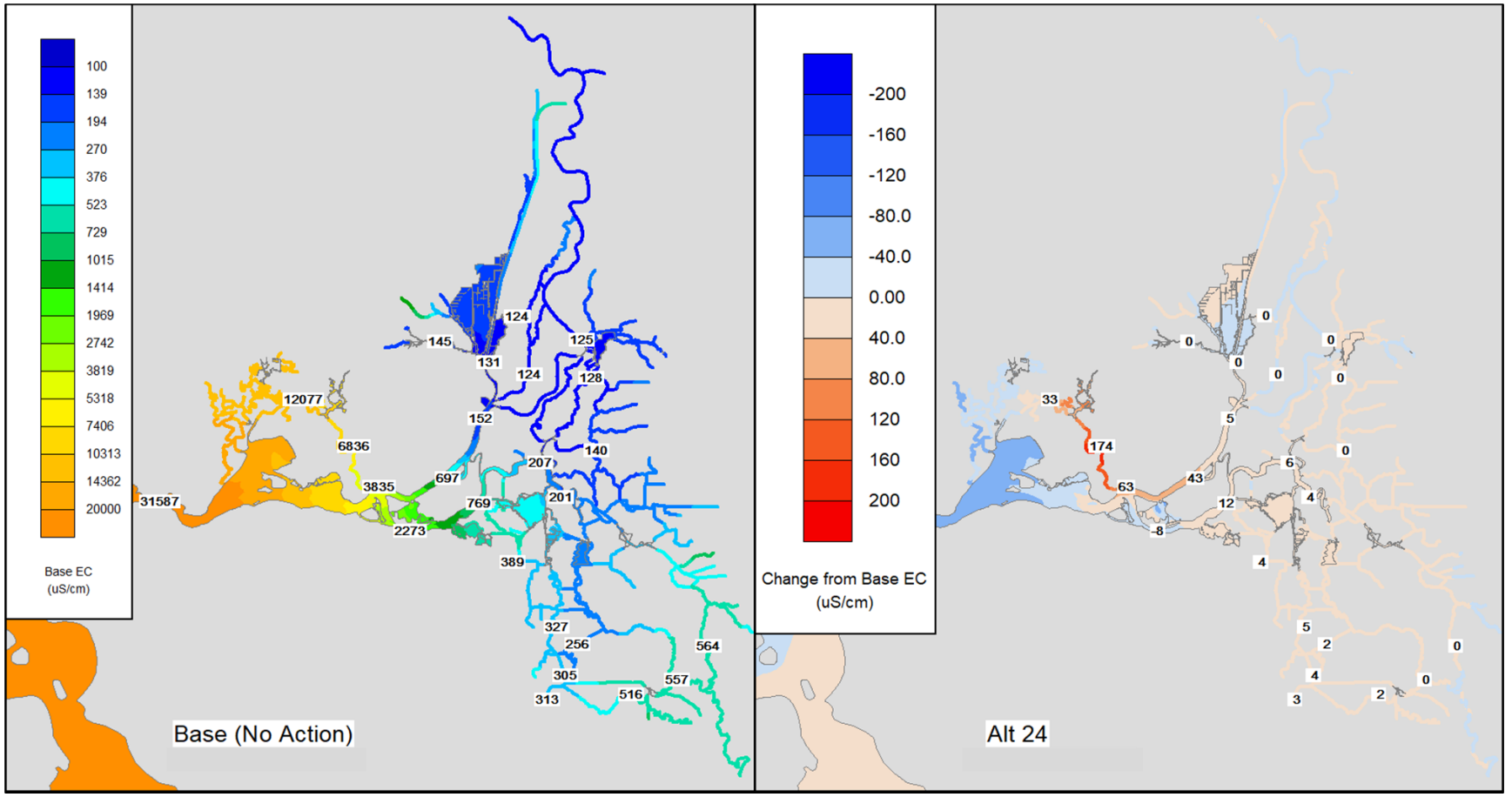

Figure 45 July 2018 (left) average Base condition EC and (right) change from Base condition average EC for Alternative 24.

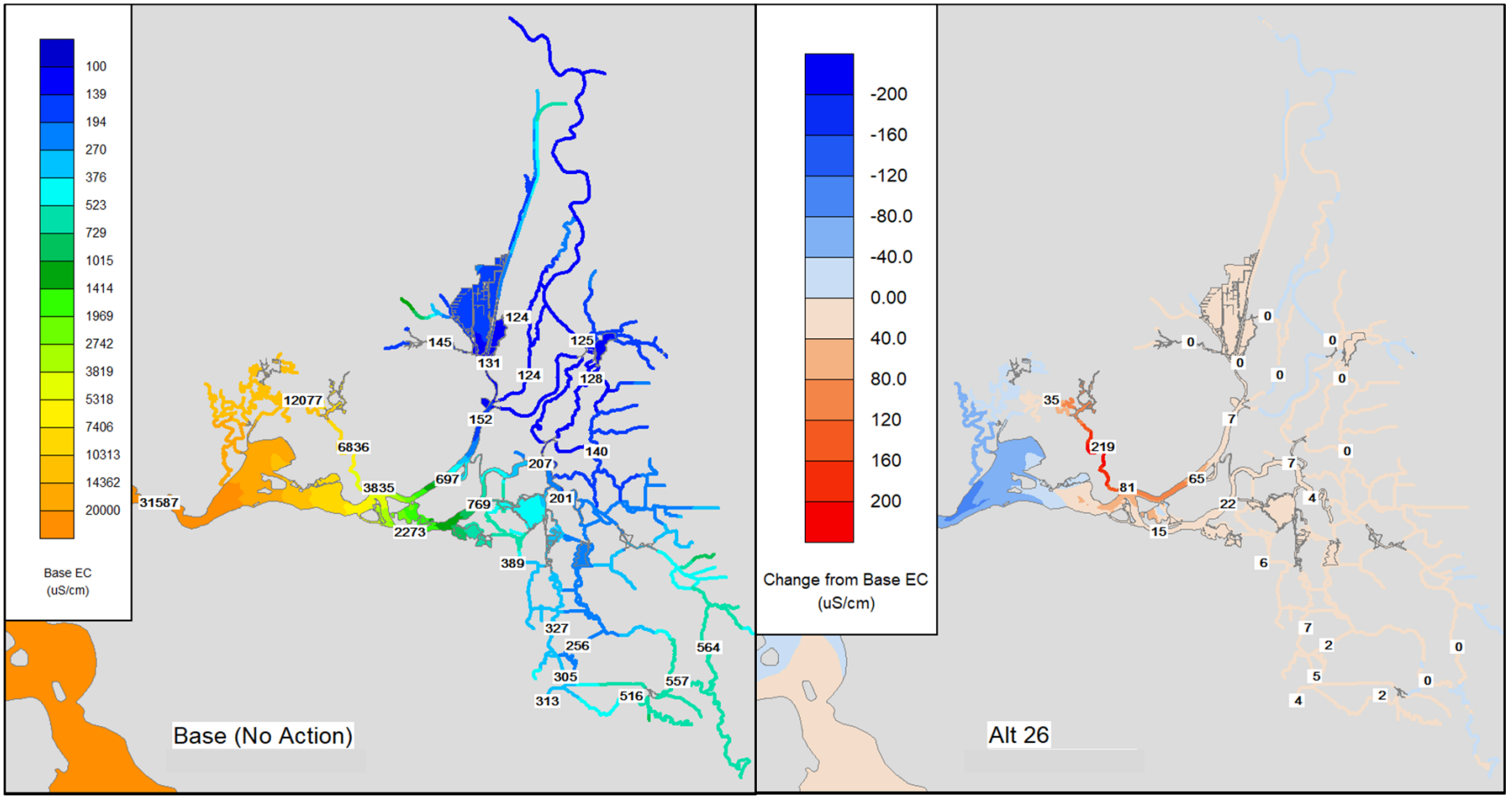

Figure 46 July 2018 (left) average Base condition EC and (right) change from Base condition average EC for Alternative 26.

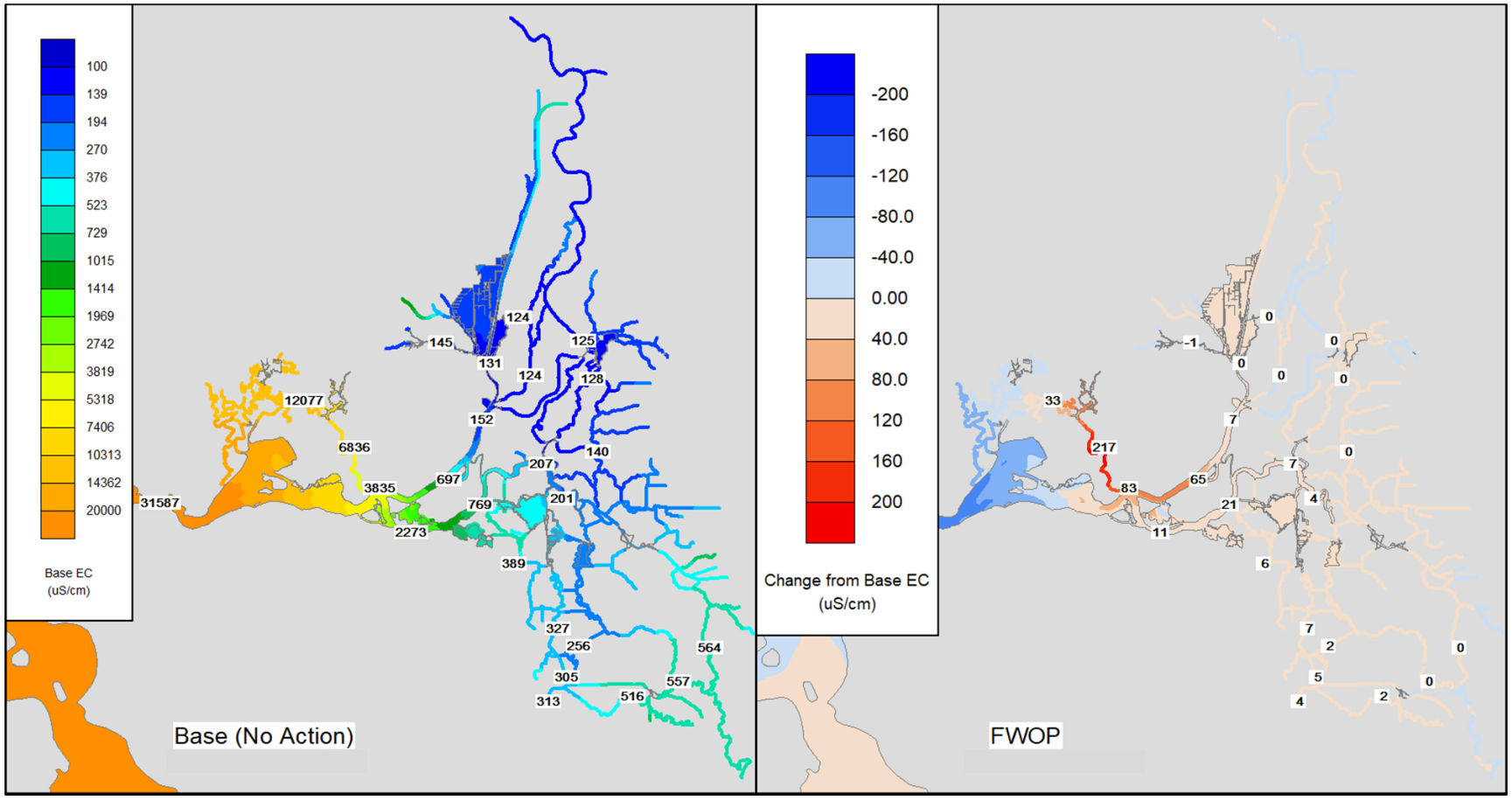

Figure 47 July 2018 (left) average Base condition EC and (right) change from Base condition average EC for FWOP.

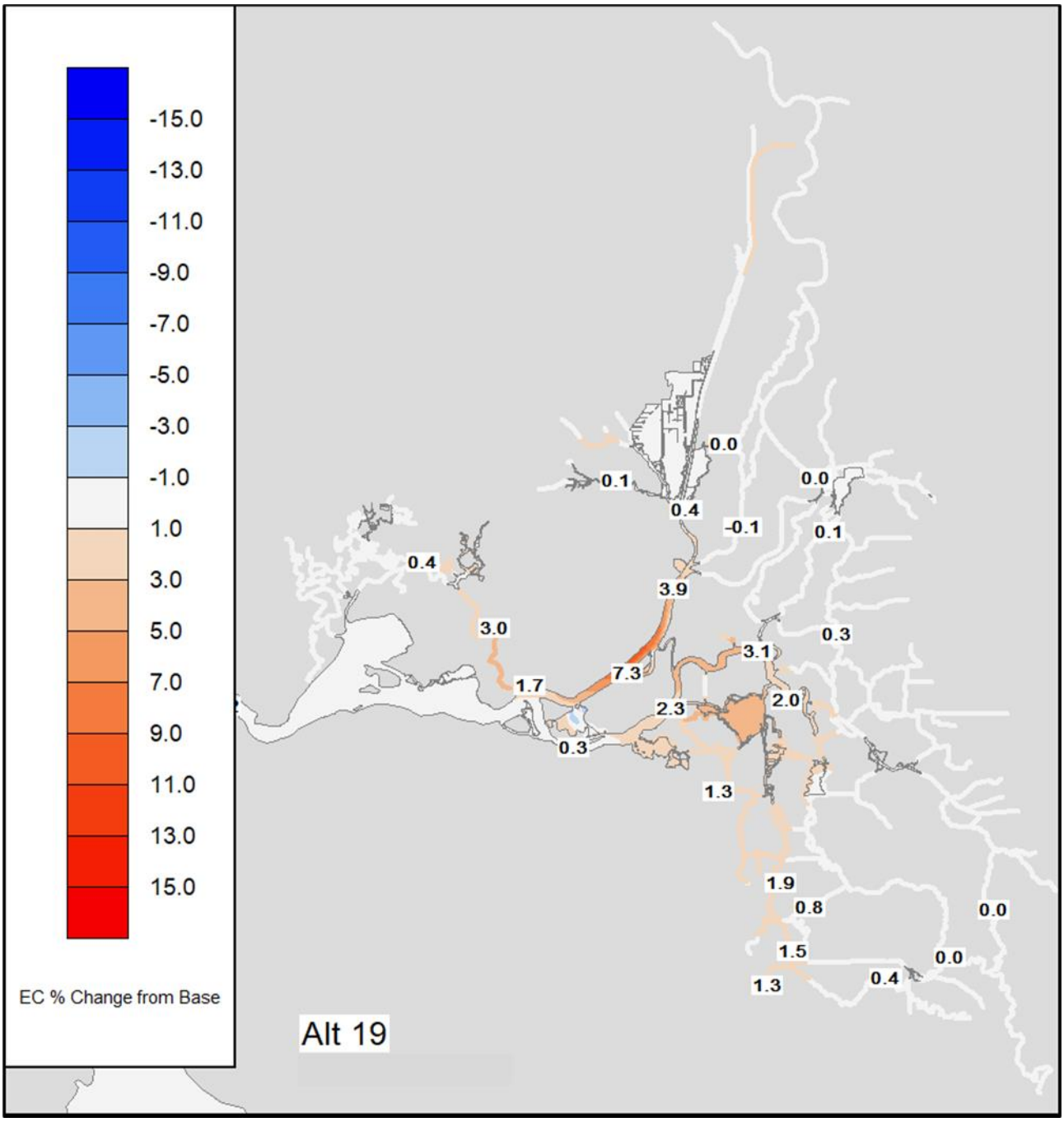

Figure 48 Alternative 19 average percent change from Base EC for July 2018.

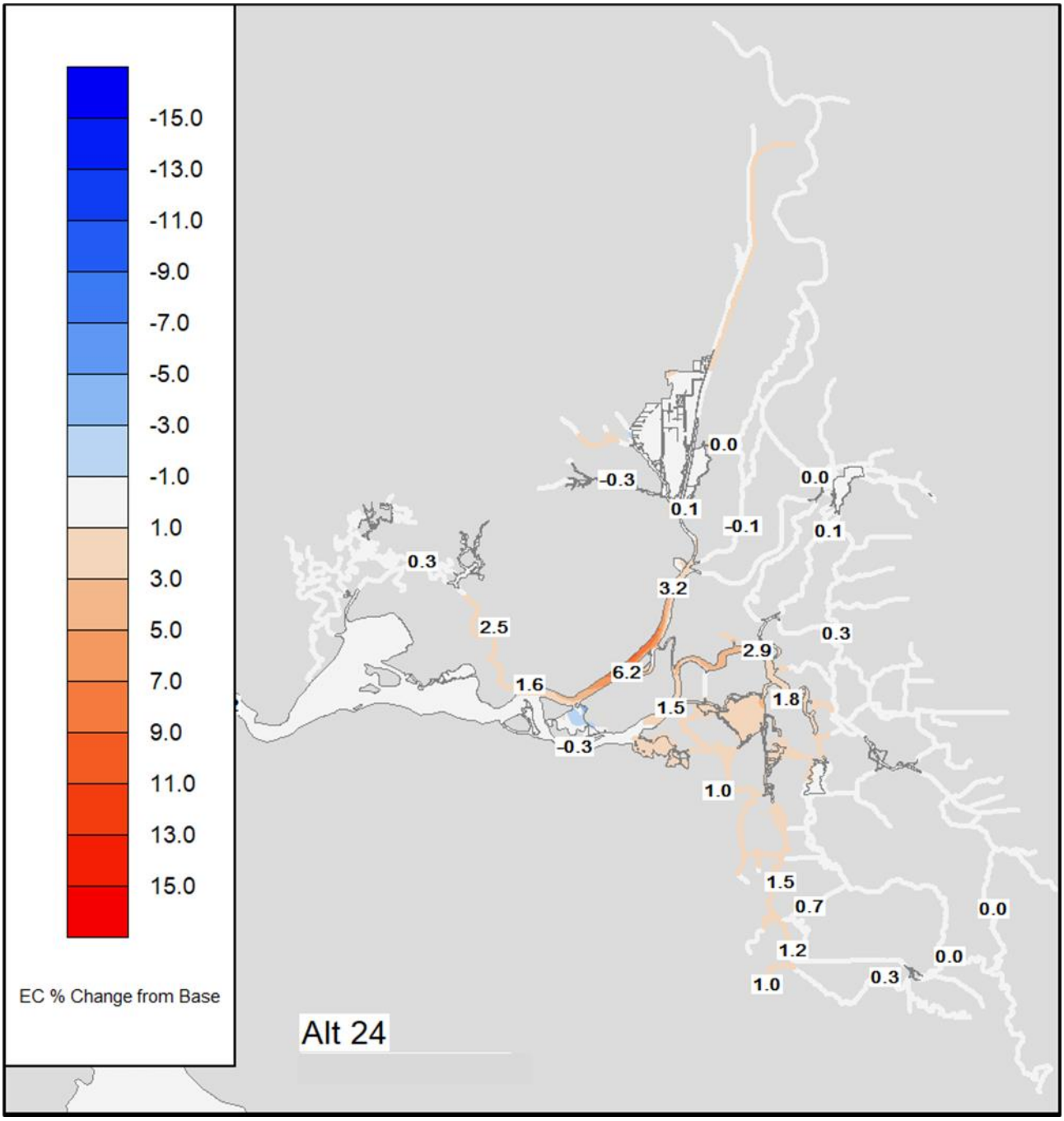

Figure 49 Alternative 24 average percent change from Base EC for July 2018.

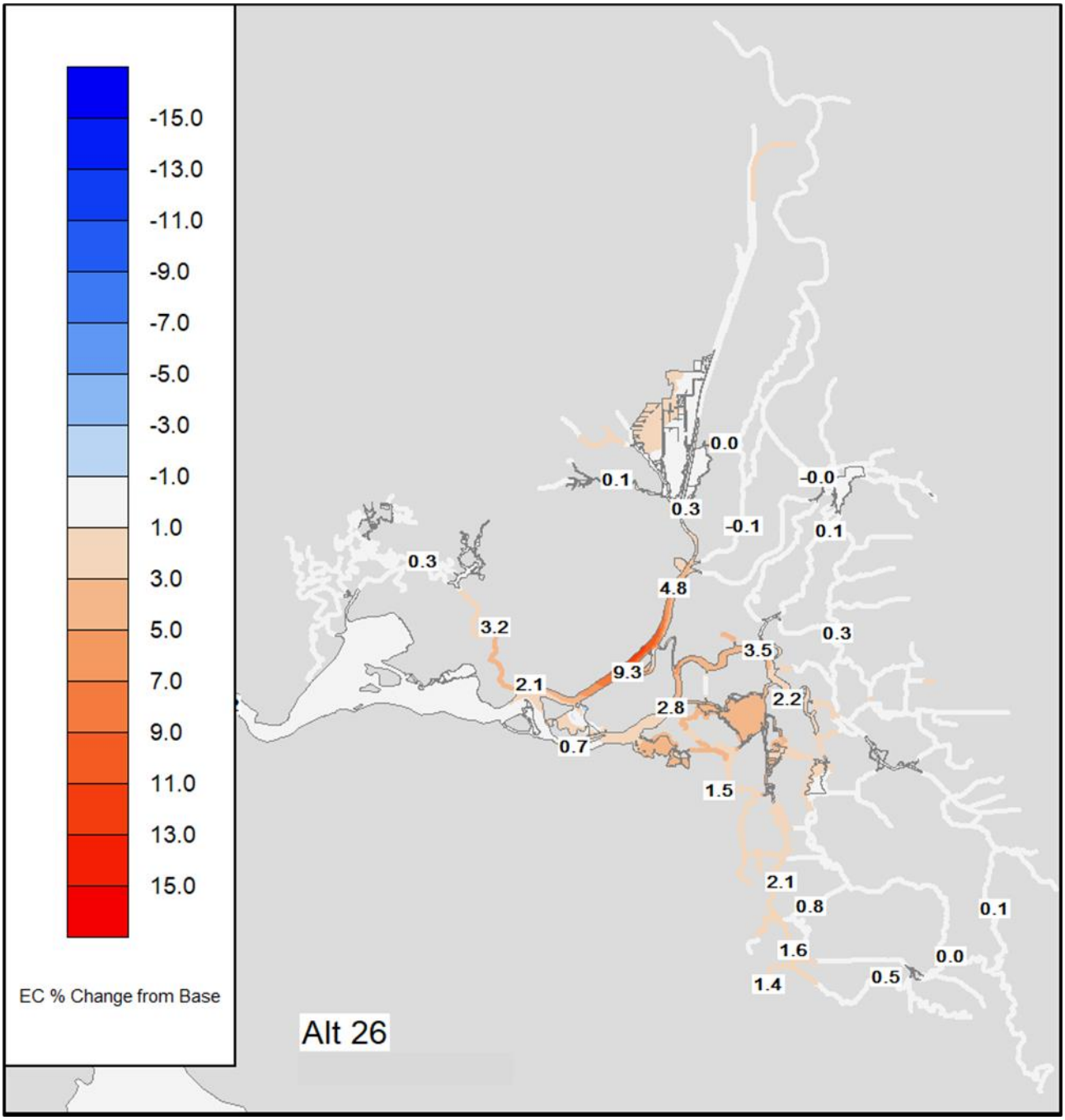

Figure 50 Alternative 26 average percent change from Base EC for July 2018.

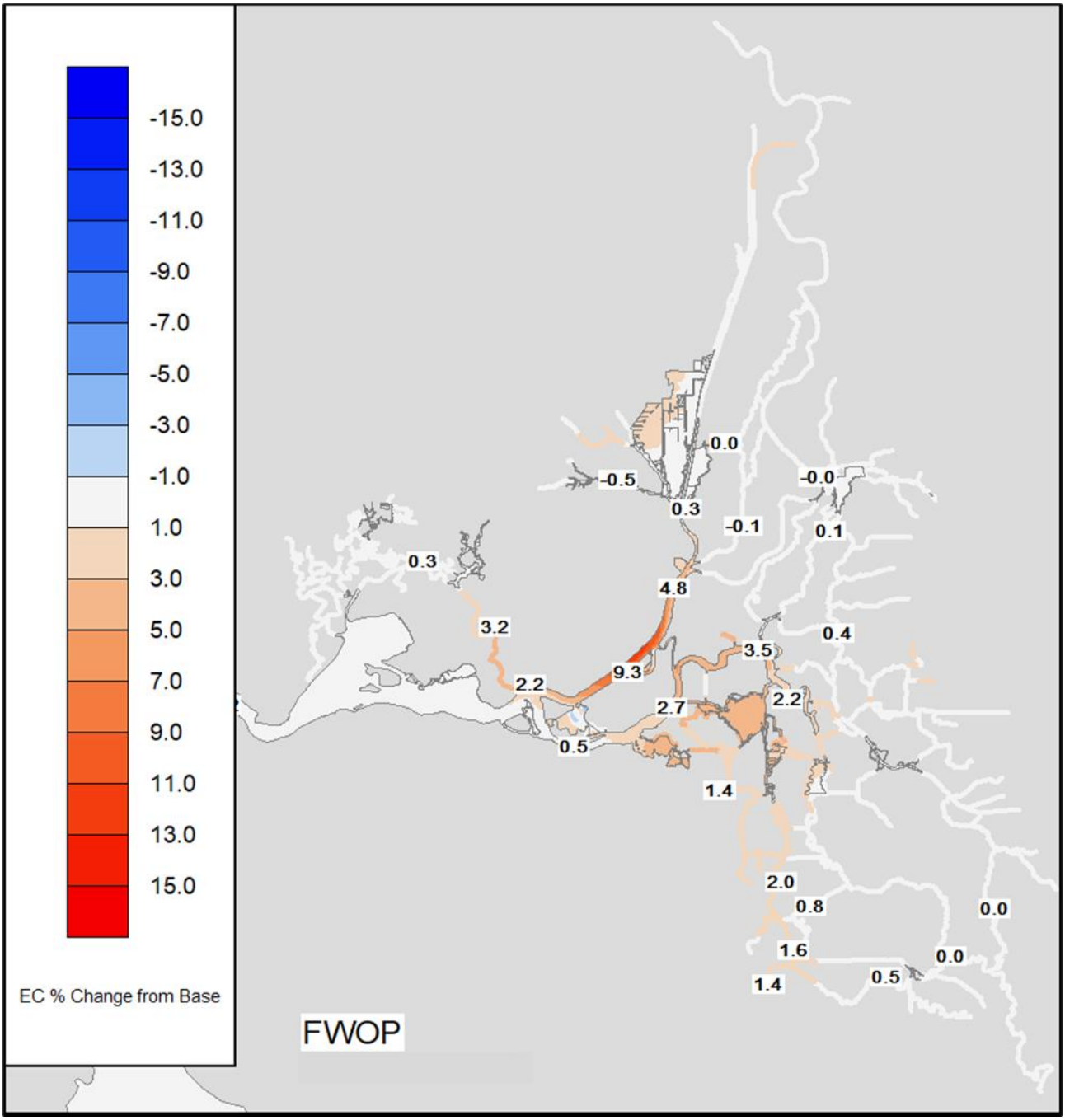

Figure 51 FWOP average percent change from Base EC for July 2018.

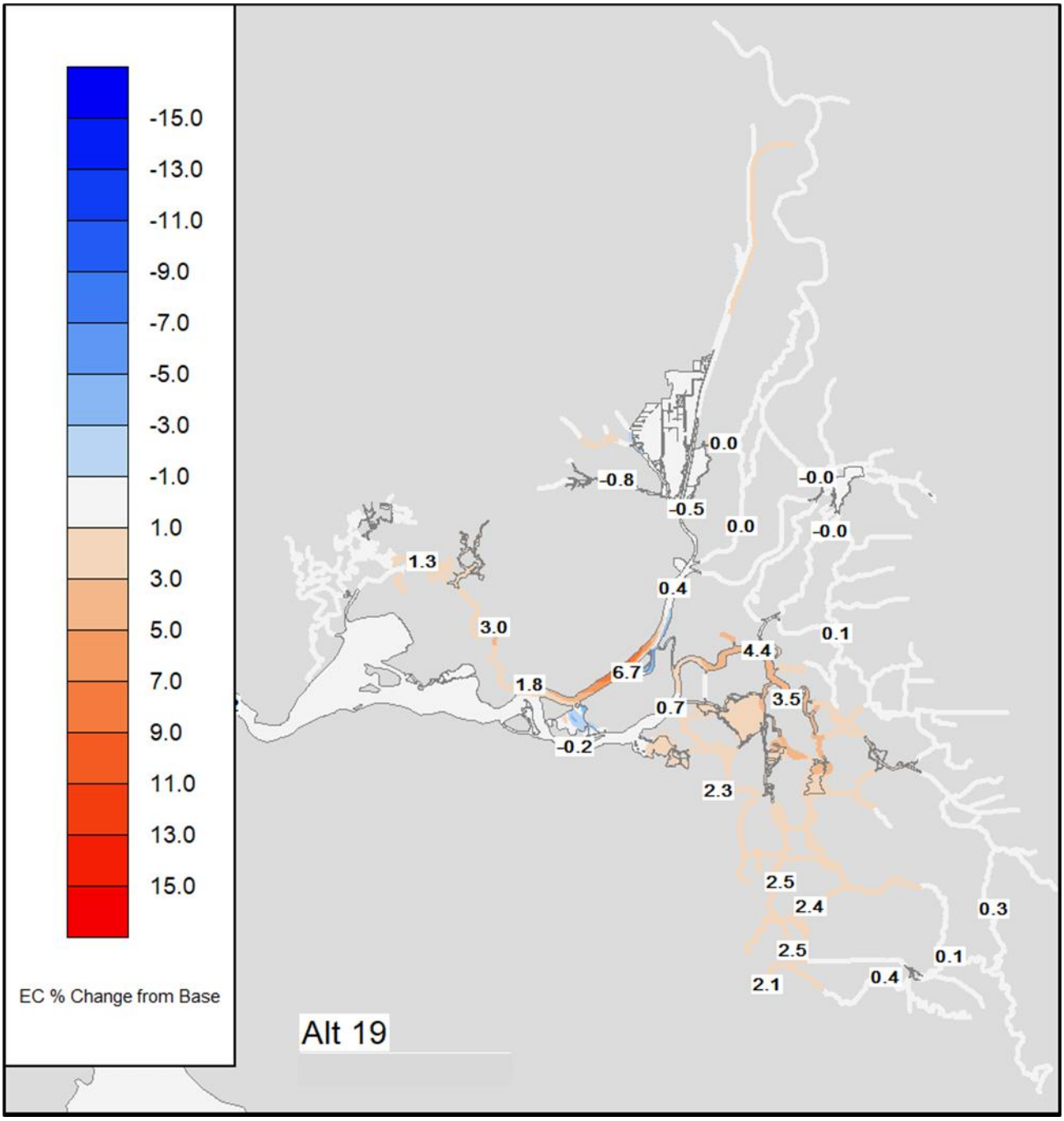

Figure 52 Alternative 19 average percent change from Base EC for August 2018.

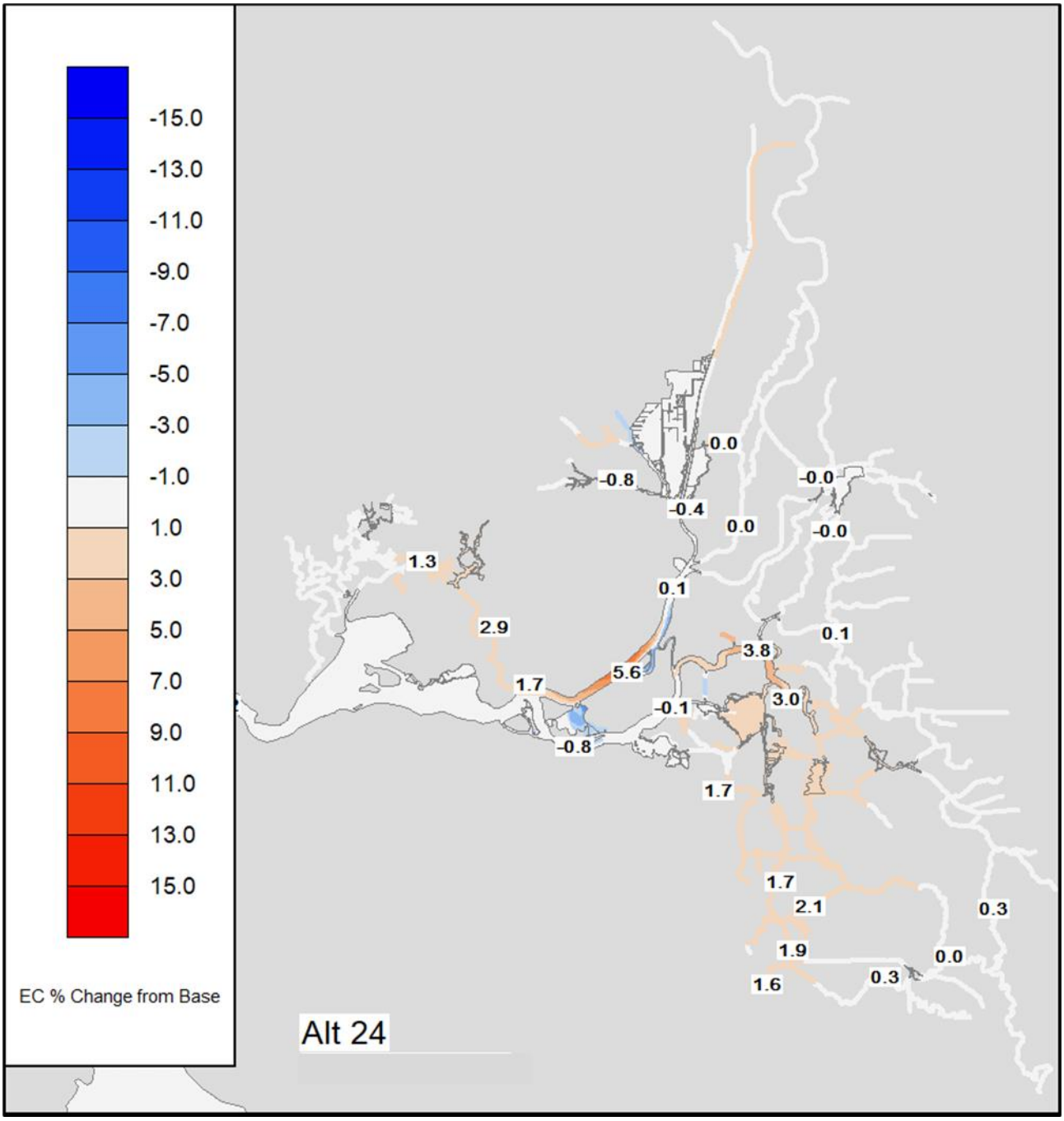

Figure 53 Alternative 24 average percent change from Base EC for August 2018.

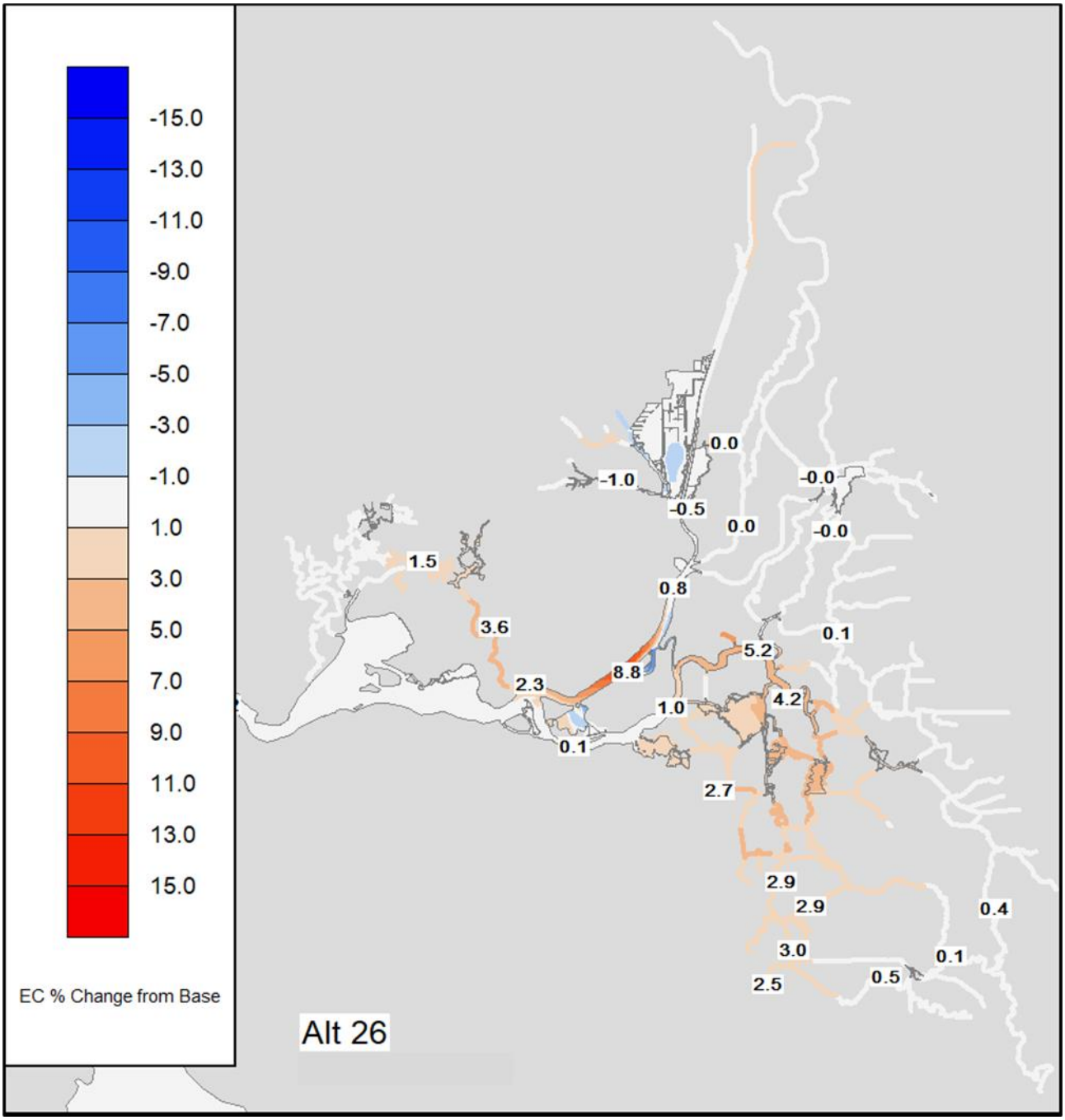

Figure 54 Alternative 26 average percent change from Base EC for August 2018.

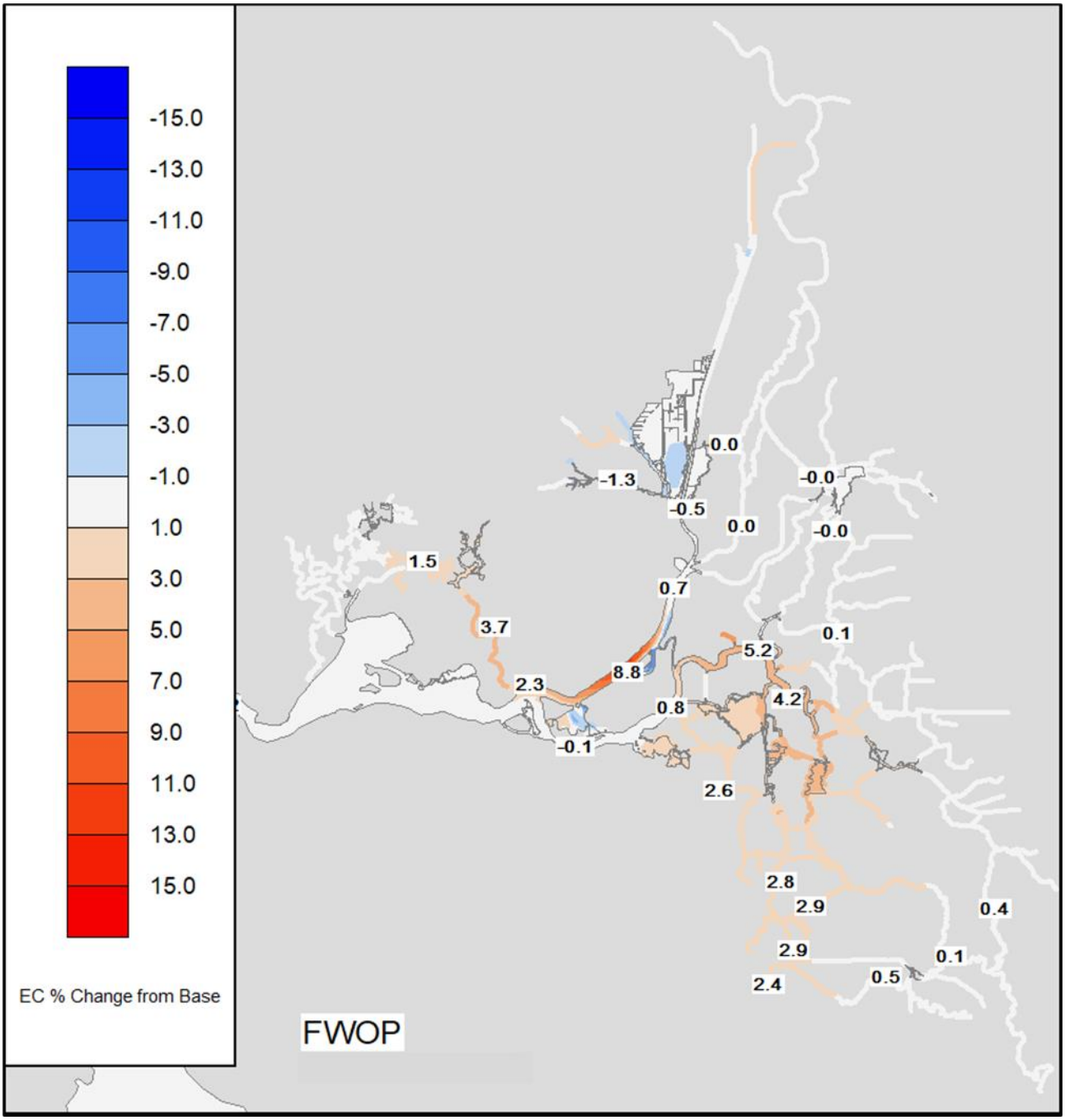

Figure 55 FWOP average percent change from Base EC for August 2018.

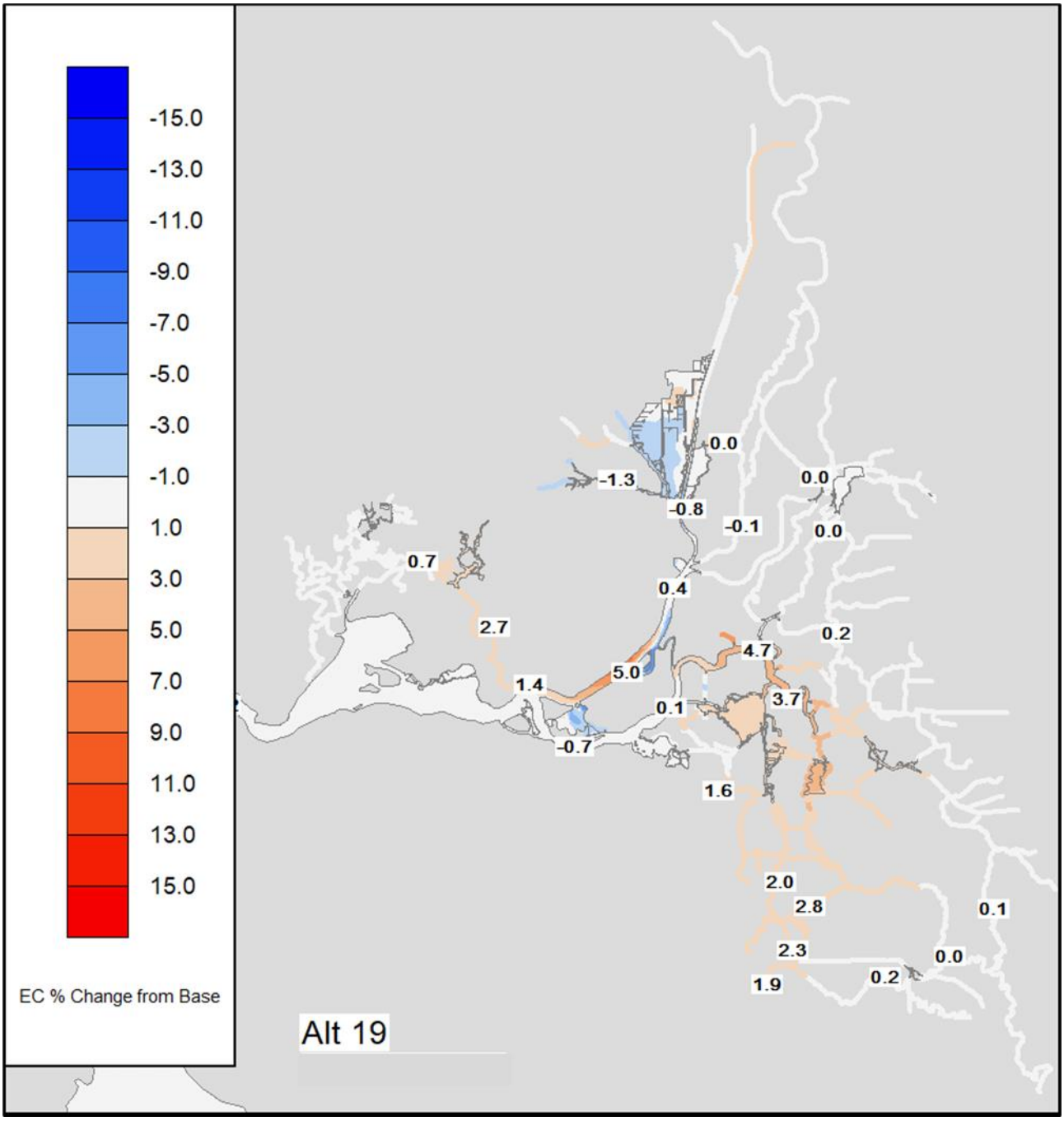

Figure 56 Alternative 19 average percent change from Base EC for September 2018.

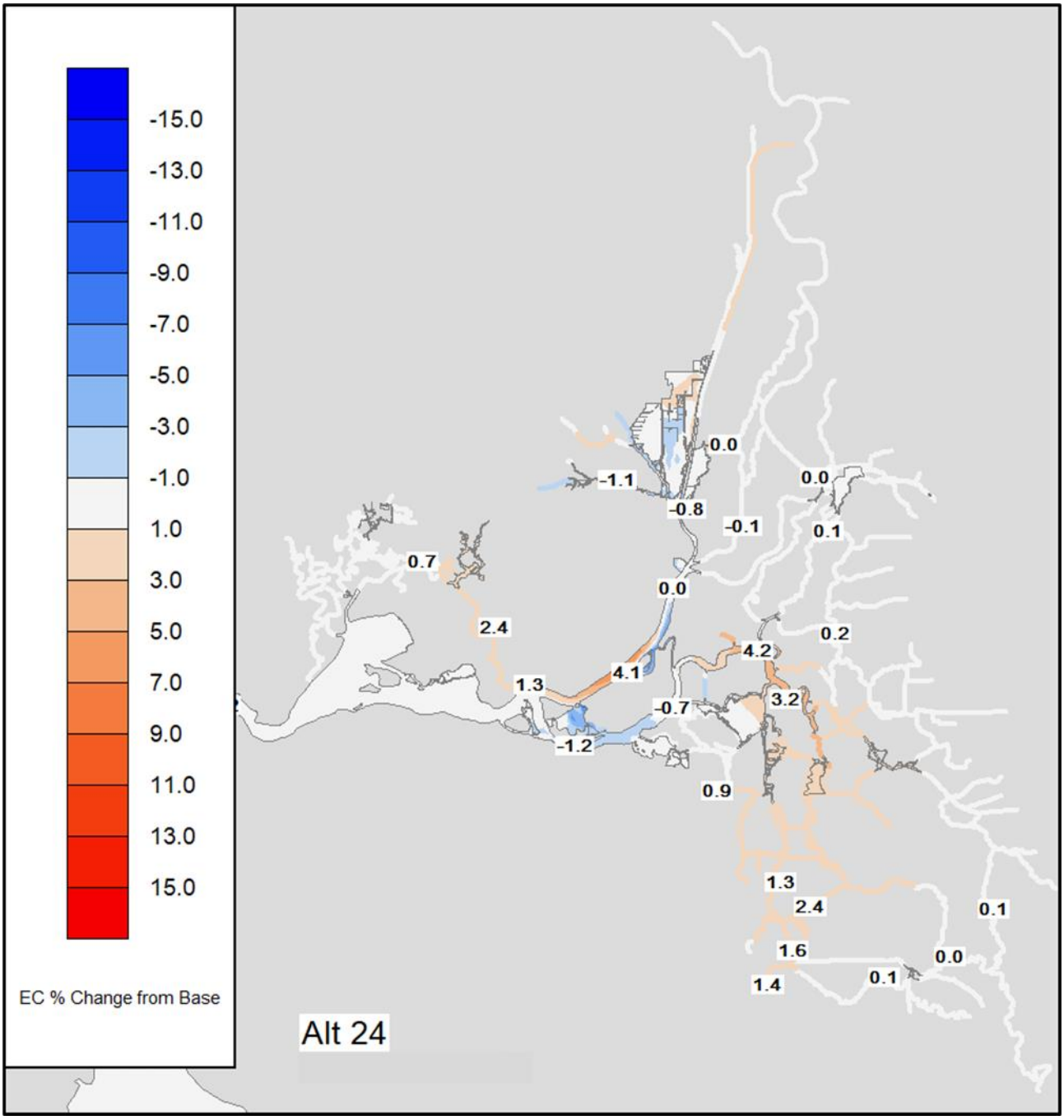

Figure 57 Alternative 24 average percent change from Base EC for September 2018.

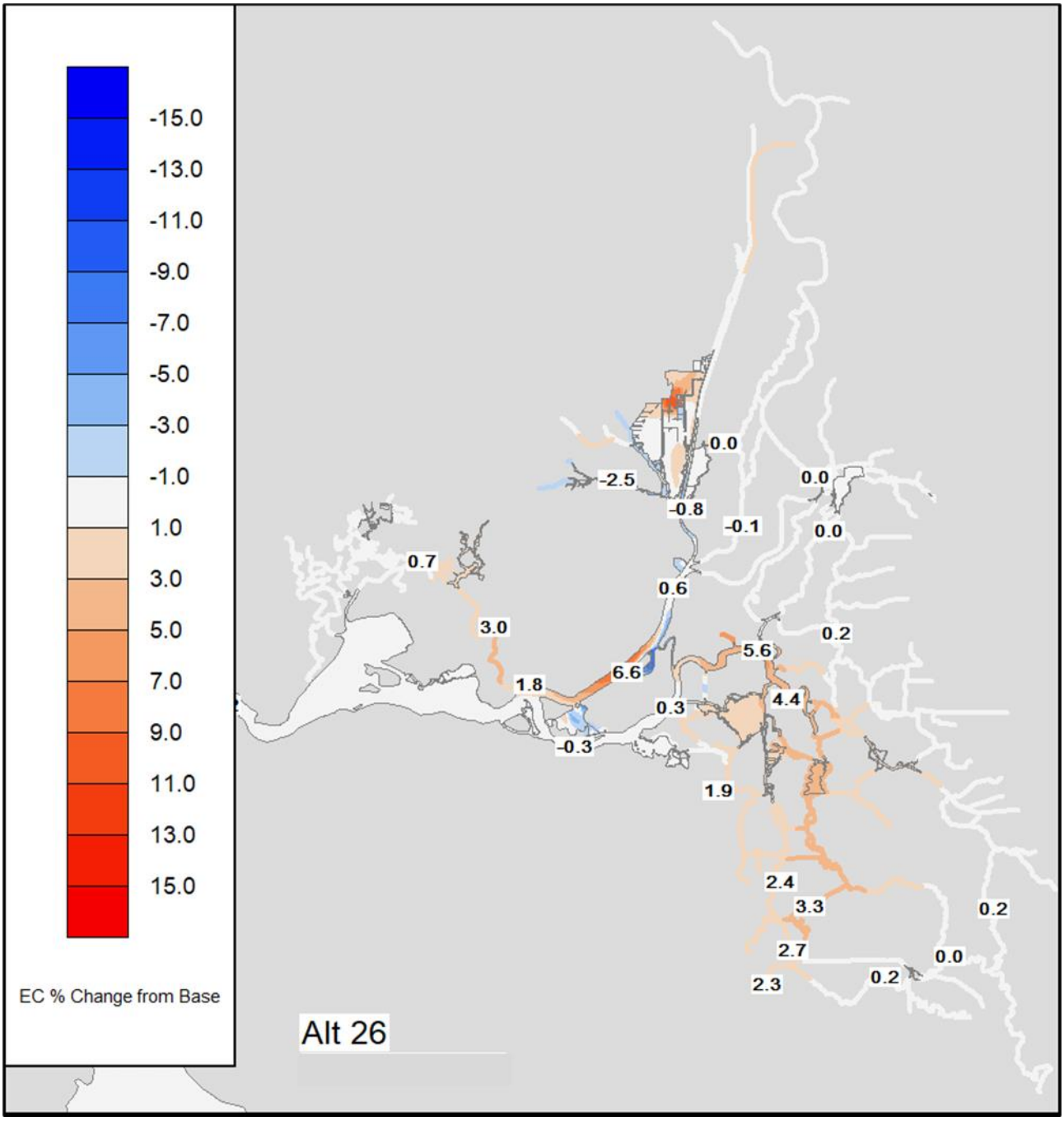

Figure 58 Alternative 26 average percent change from Base EC for September 2018.

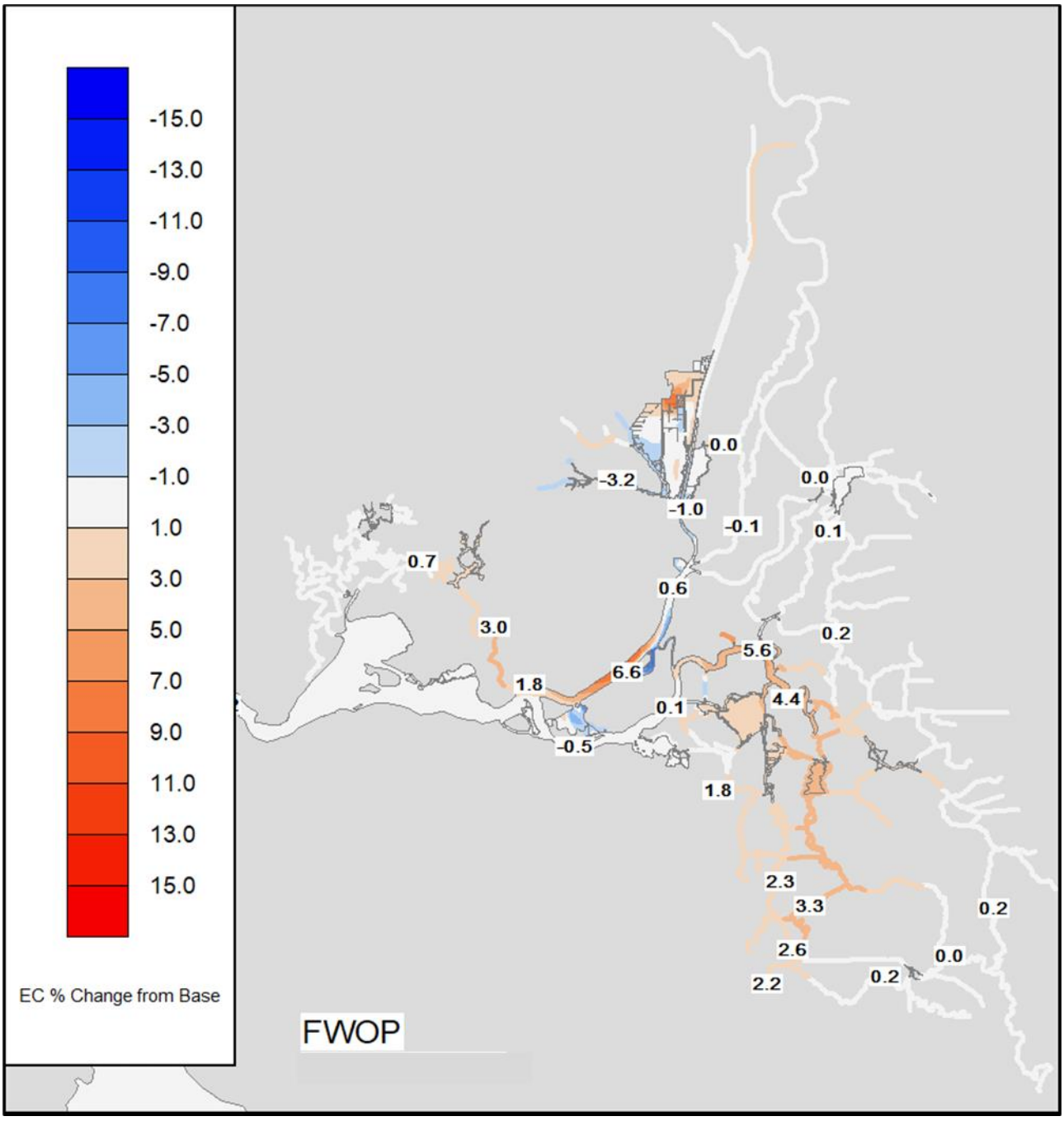

Figure 59 FWOP average percent change from Base EC for September 2018.

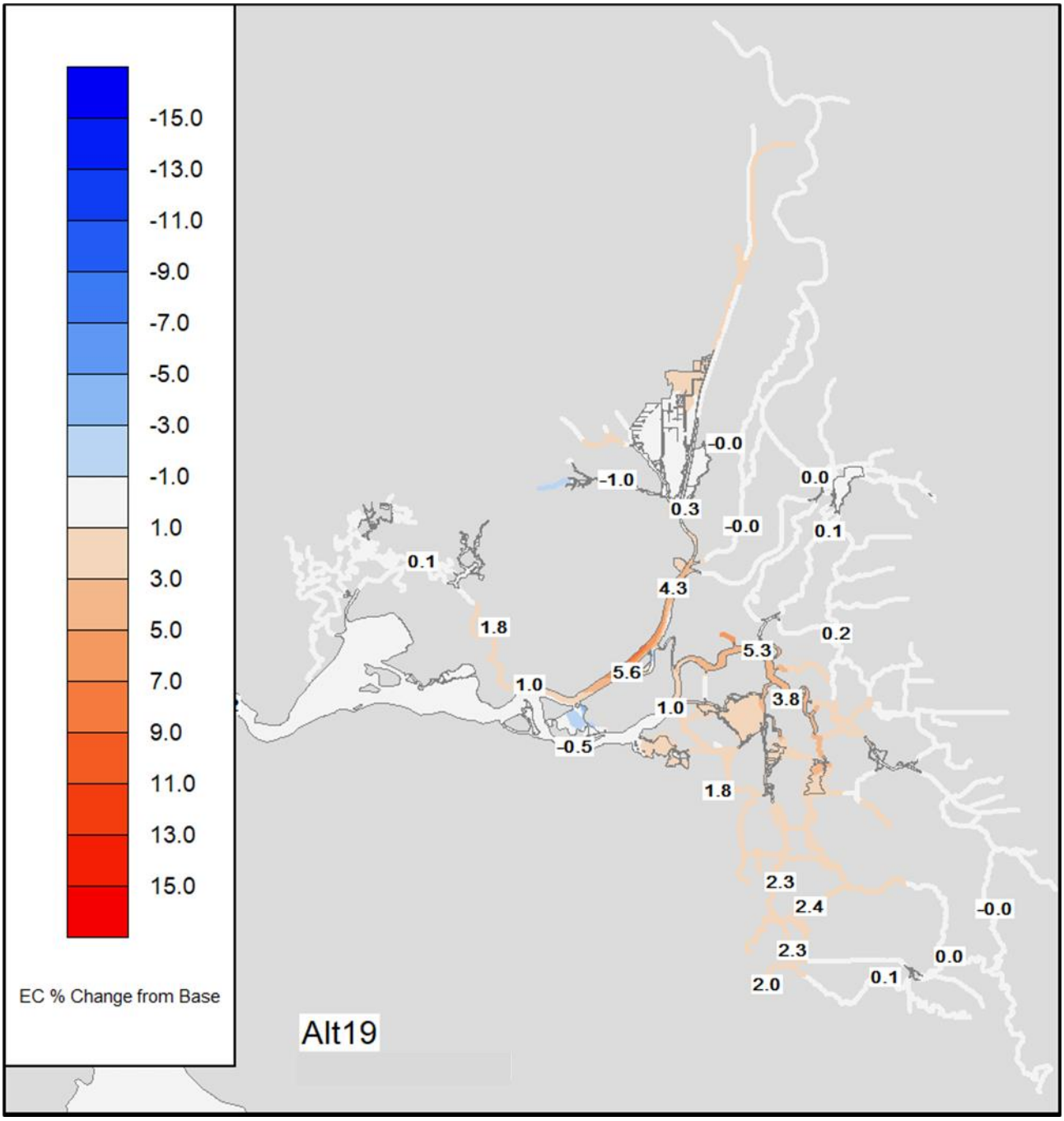

Figure 60 Alternative 19 average percent change from Base EC for October 2018.

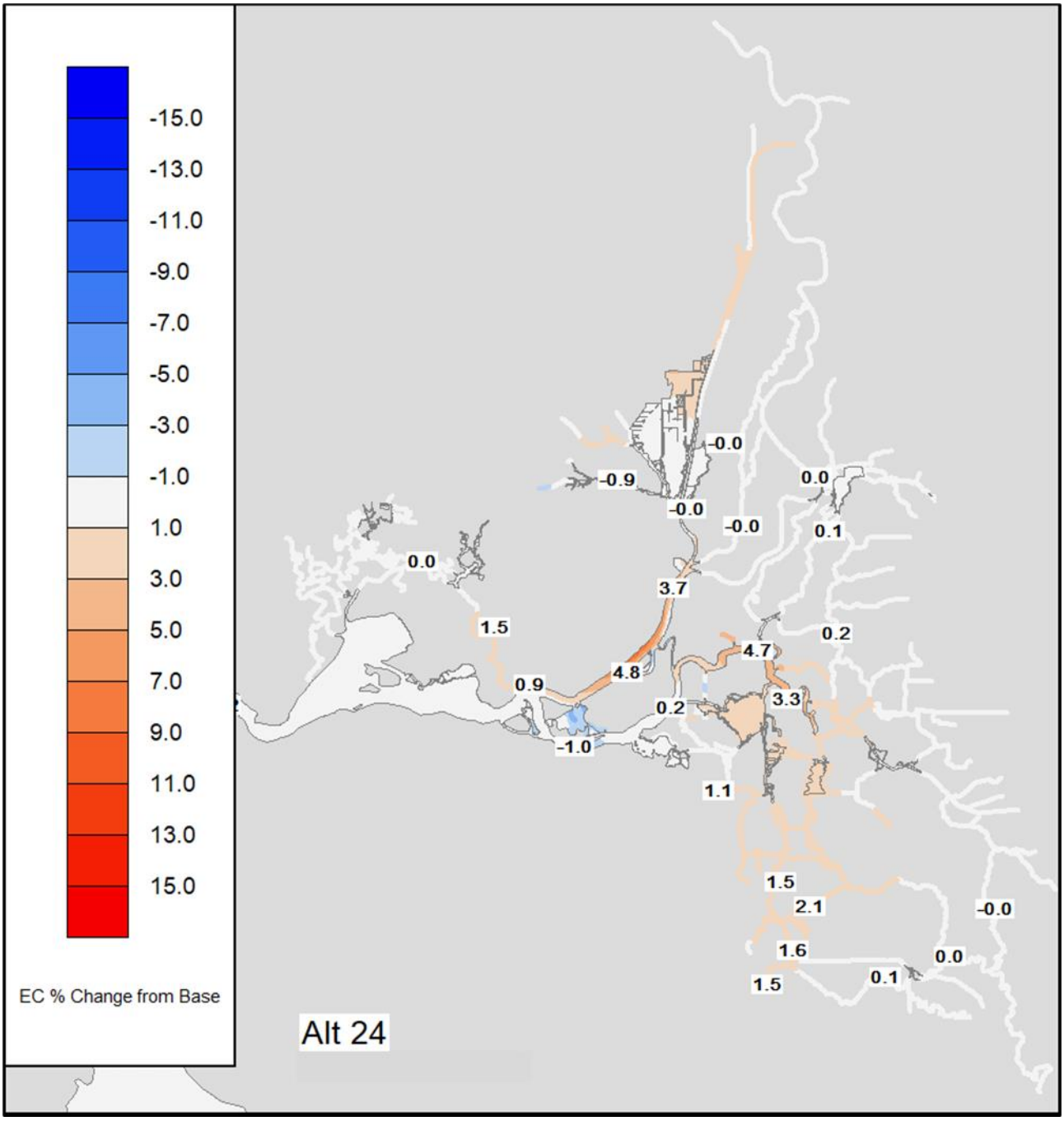

Figure 61 Alternative 24 average percent change from Base EC for October 2018.

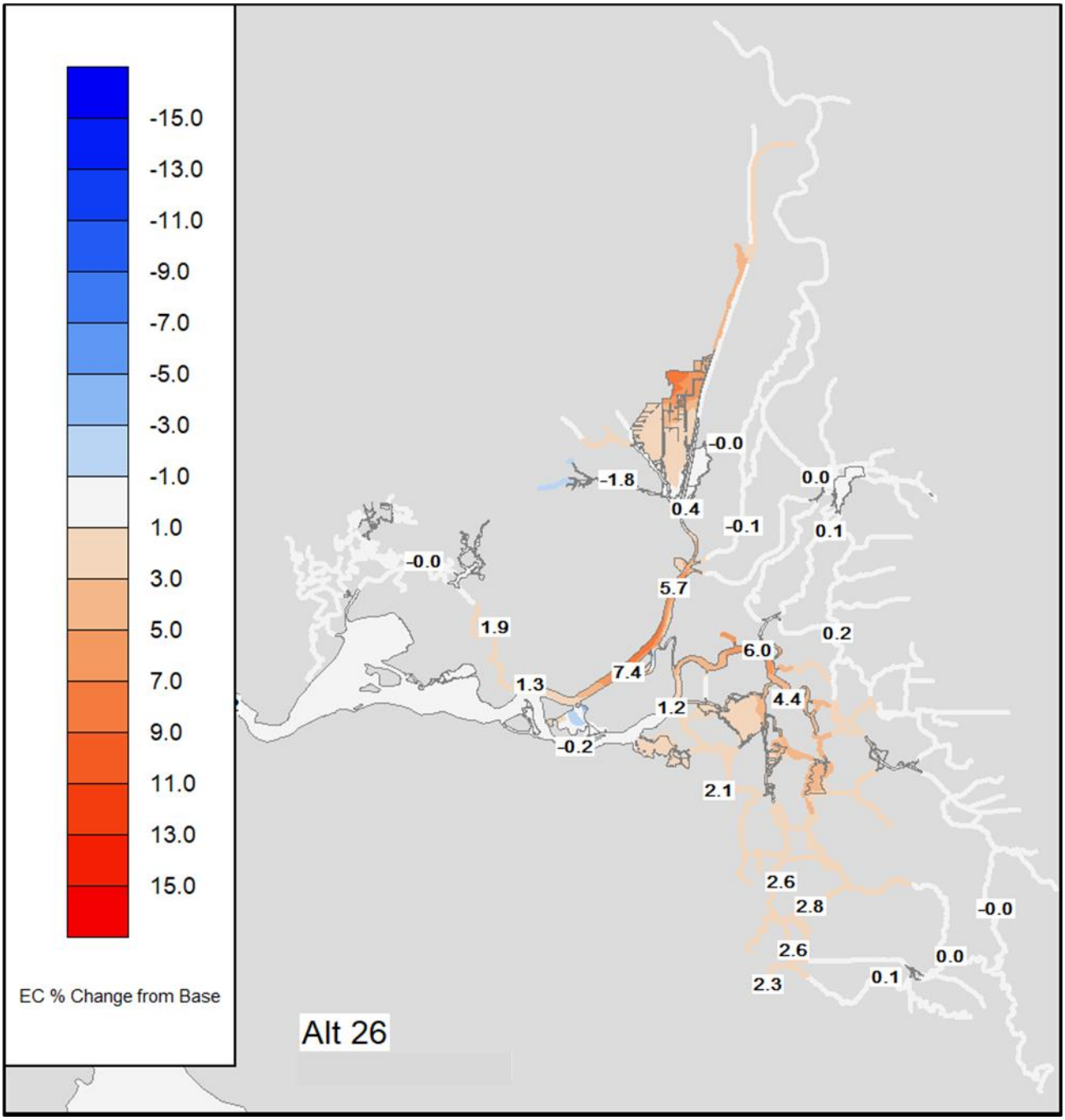

Figure 62 Alternative 26 average percent change from Base EC for October 2018.

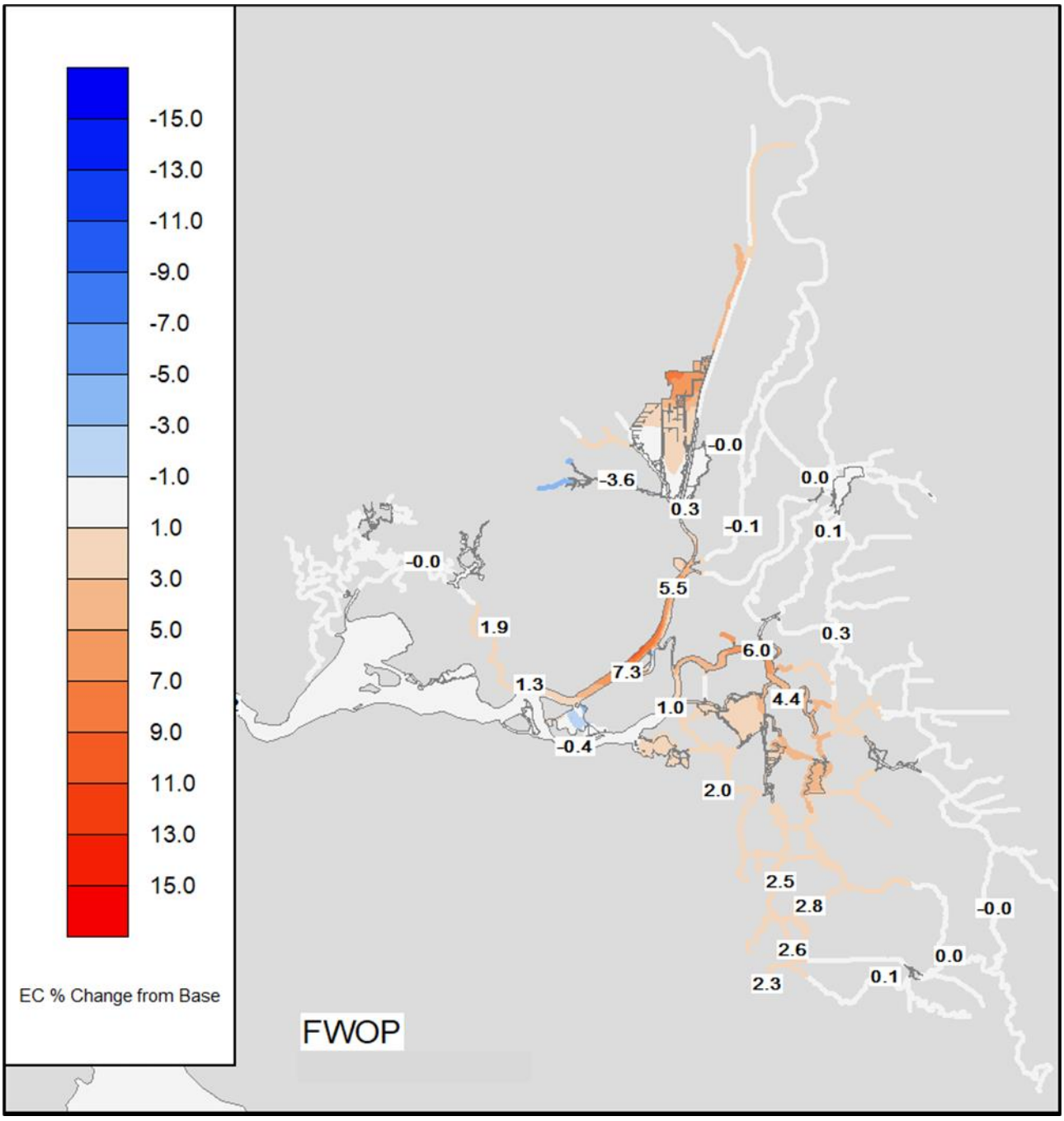

Figure 63 FWOP average percent change from Base EC for October 2018.

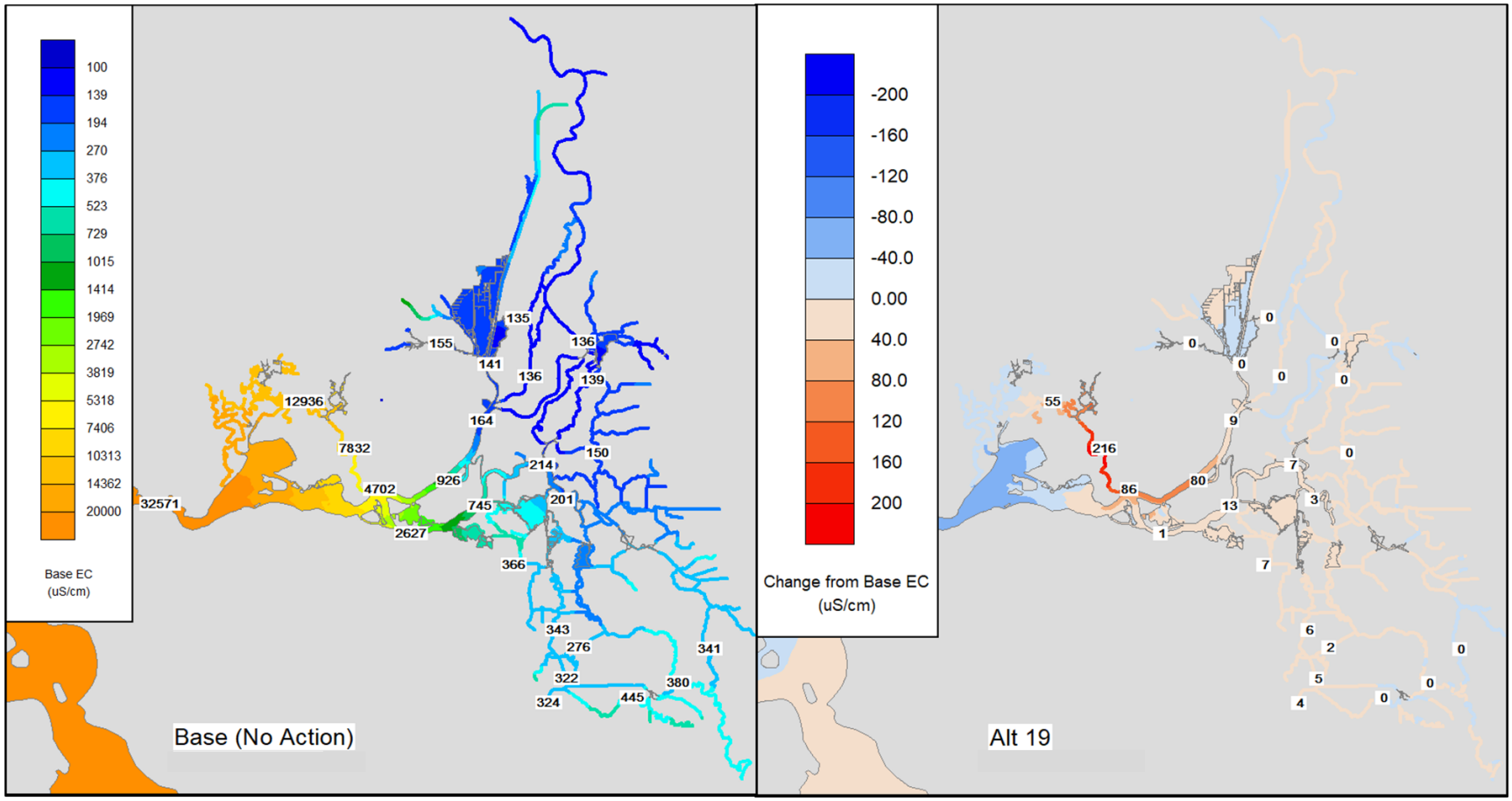

Figure 64 July 2020 (left) average Base condition EC and (right) change from Base condition average EC for Alternative 19.

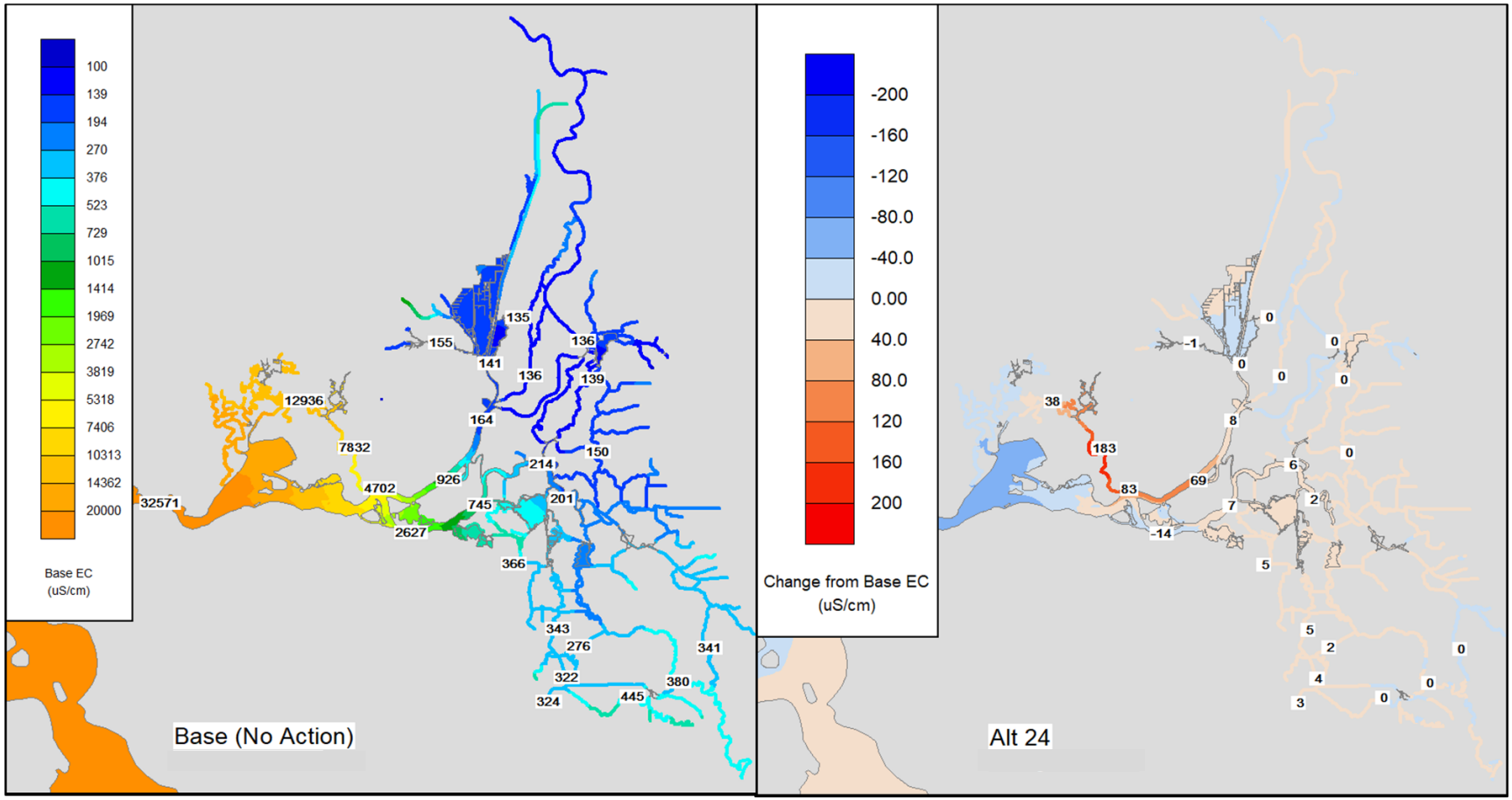

Figure 65 July 2020 (left) average Base condition EC and (right) change from Base condition average EC for Alternative 24.

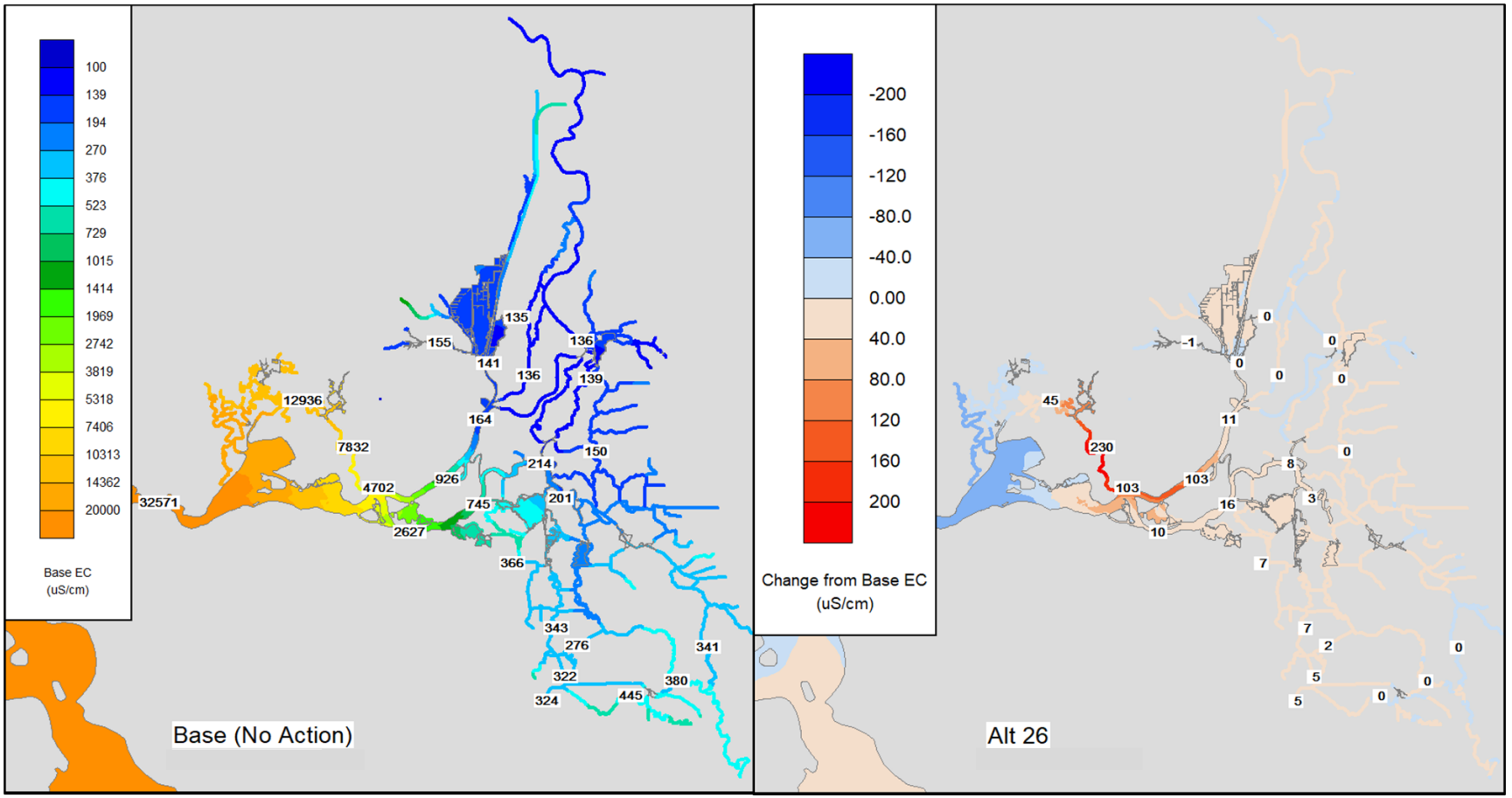

Figure 66 July 2020 (left) average Base condition EC and (right) change from Base condition average EC for Alternative 26.

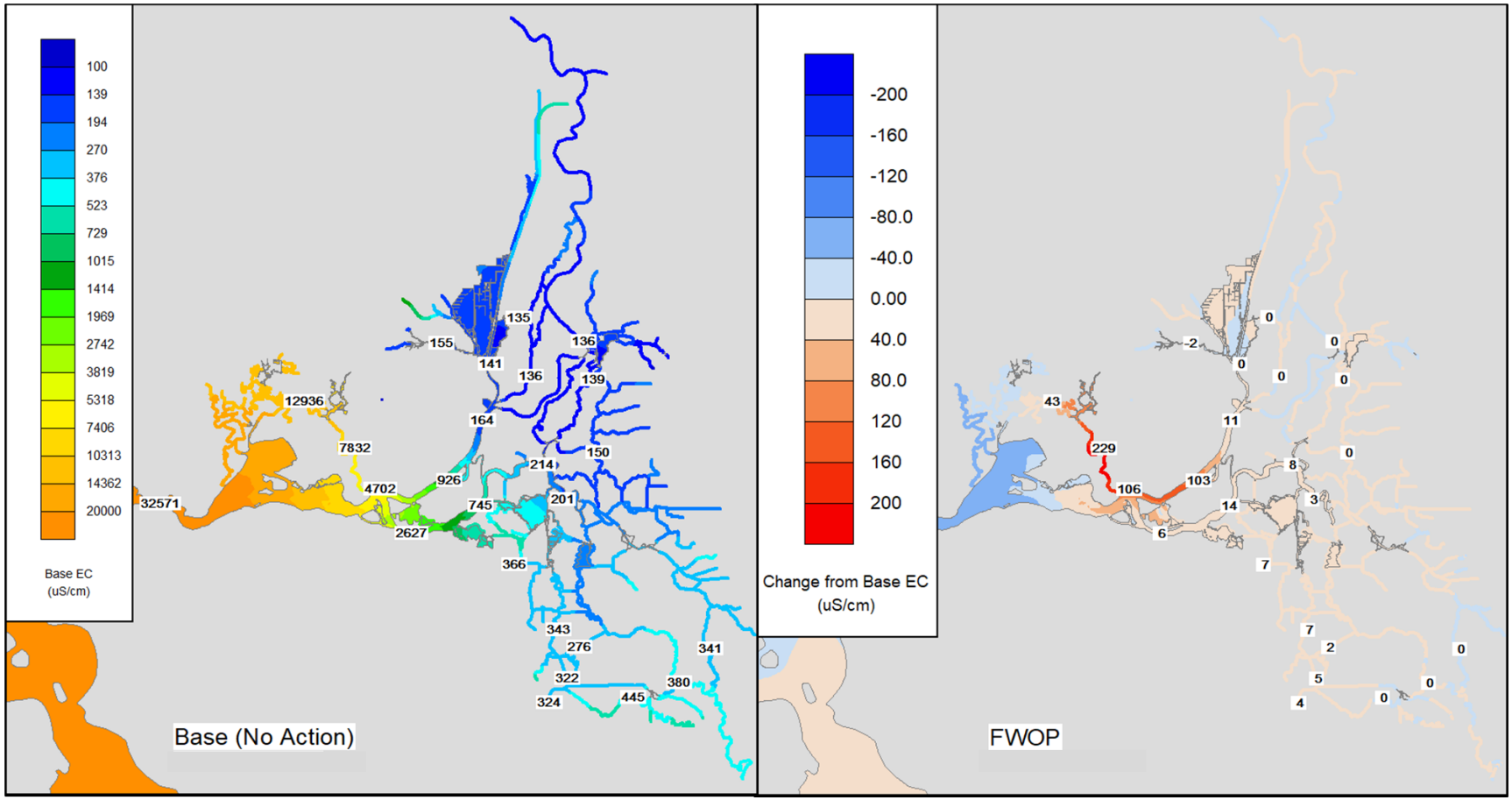

Figure 67 July 2020 (left) average Base condition EC and (right) change from Base condition average EC for FWOP.

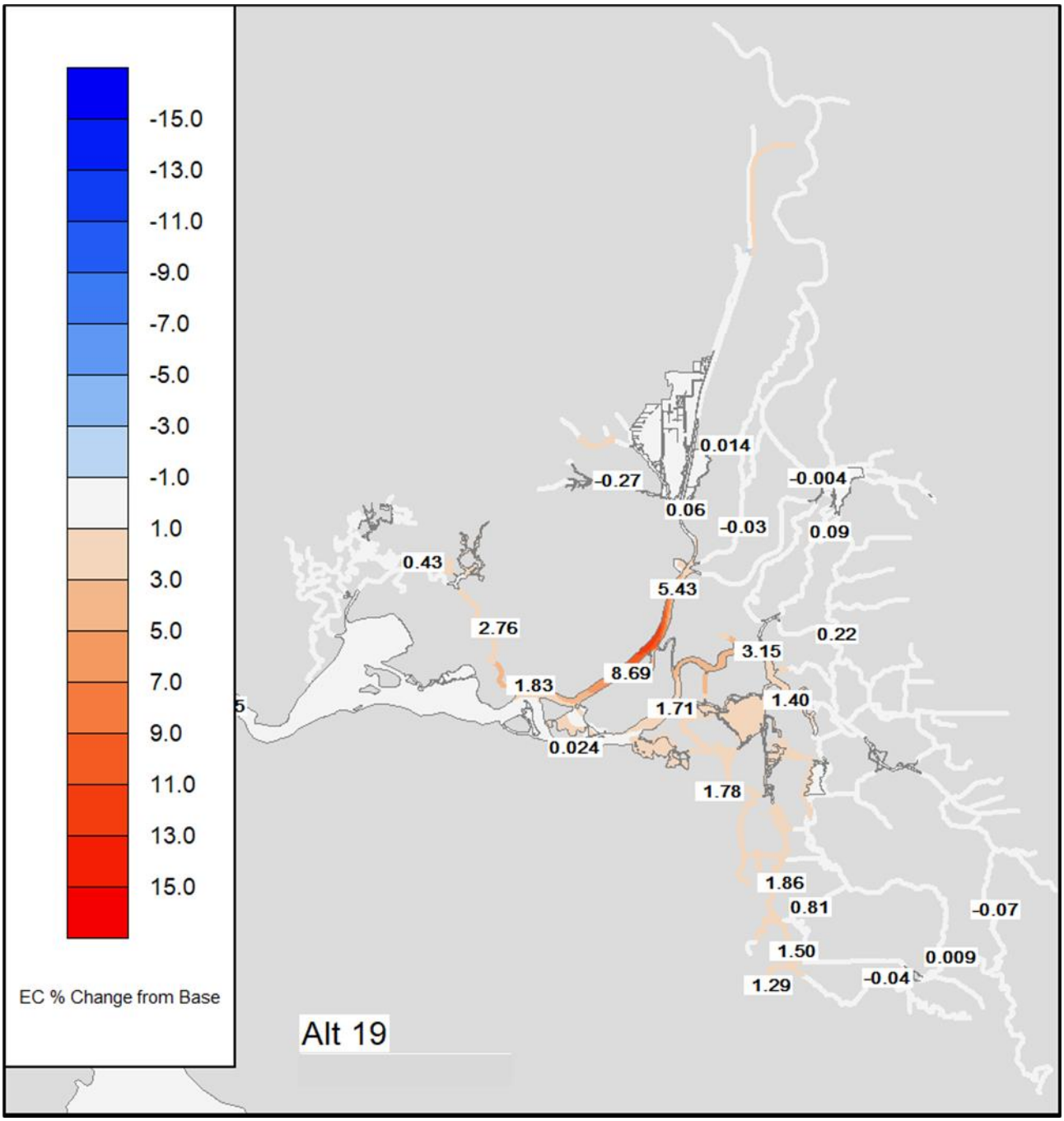

Figure 68 Alternative 19 average percent change from Base EC for July 2020.

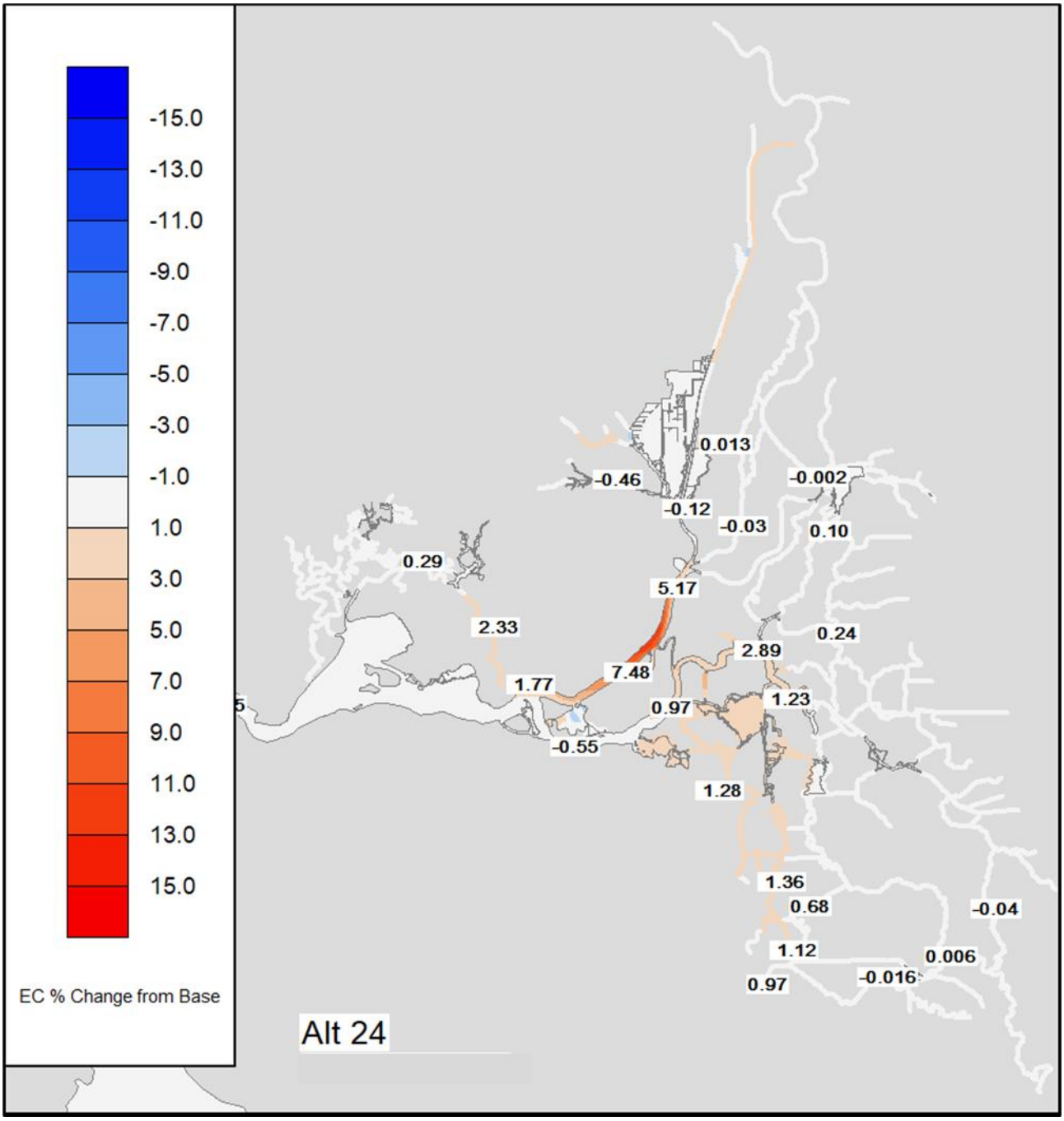

Figure 69 Alternative 24 average percent change from Base EC for July 2020.

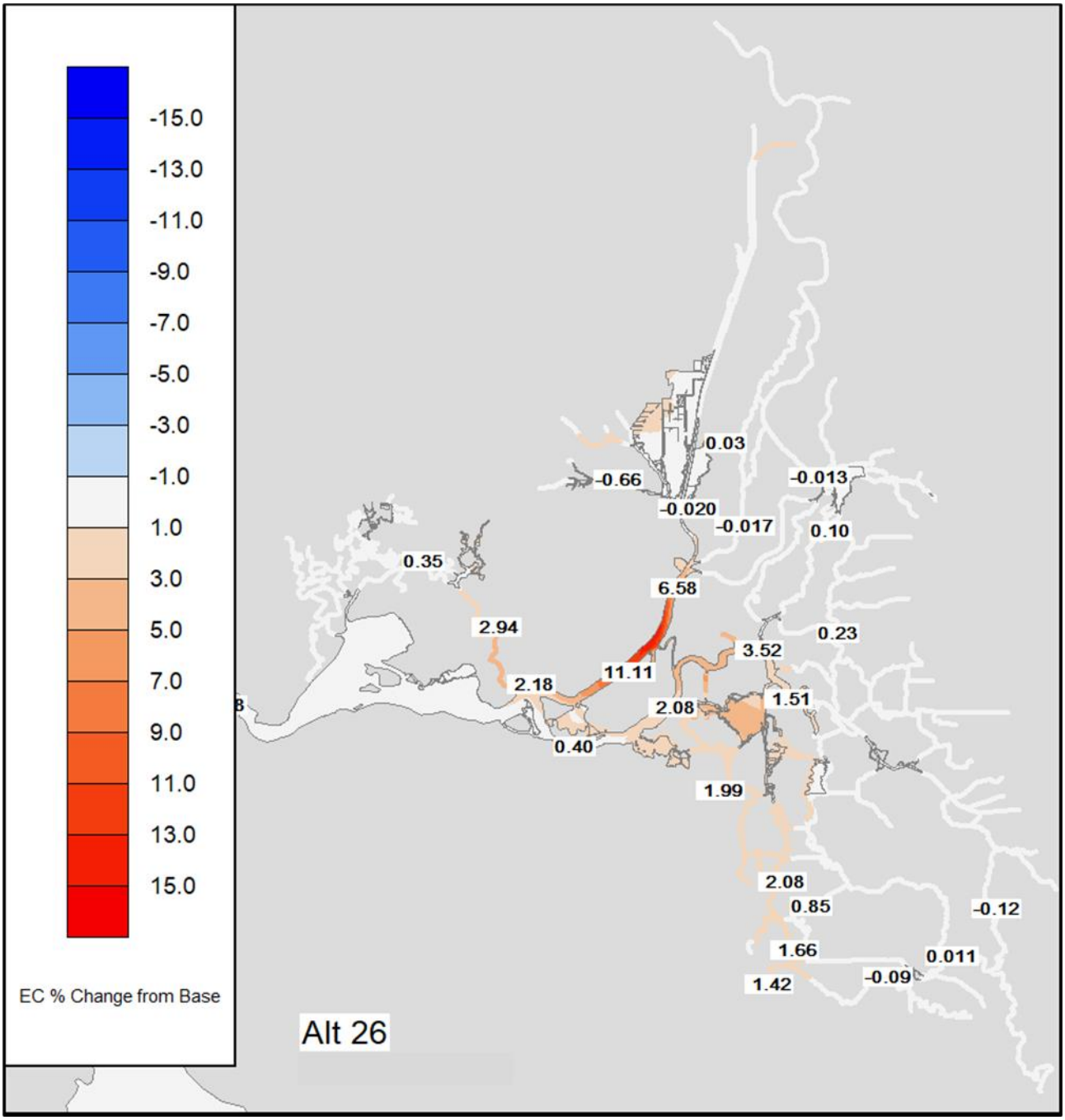

Figure 70 Alternative 26 average percent change from Base EC for July 2020.

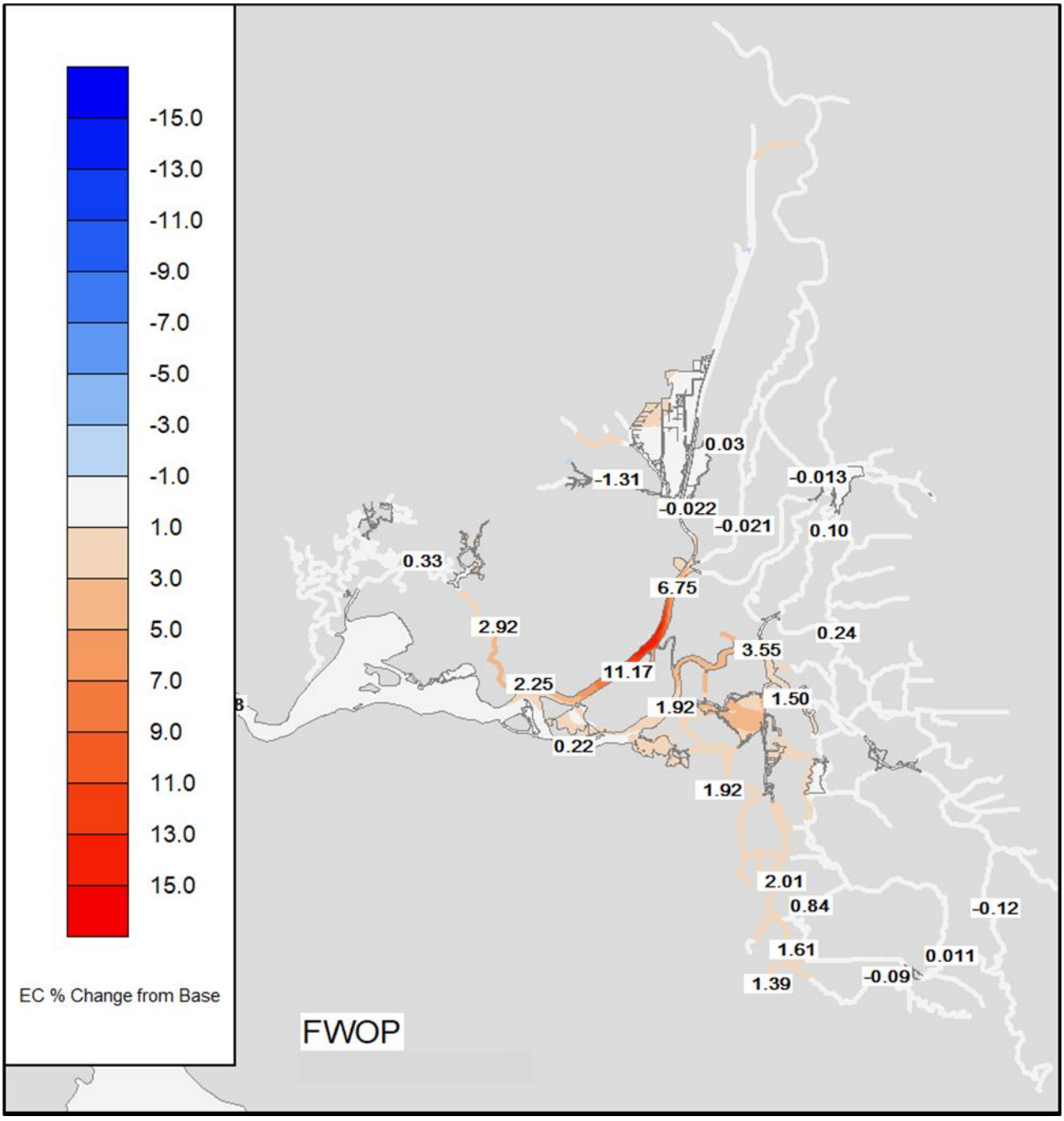

Figure 71 FWOP average percent change from Base EC for July 2020.

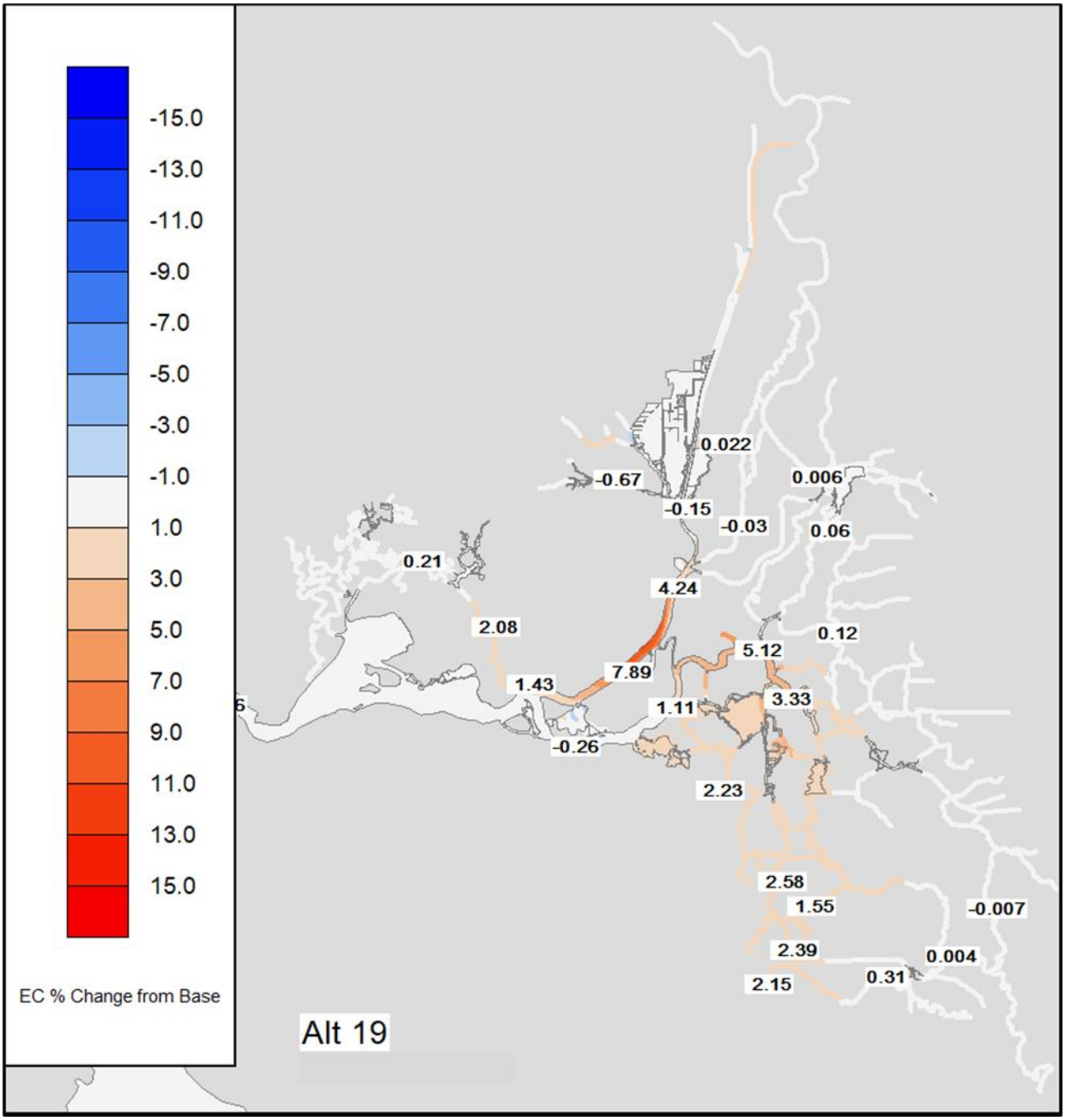

Figure 72 Alternative 19 average percent change from Base EC for August 2020.

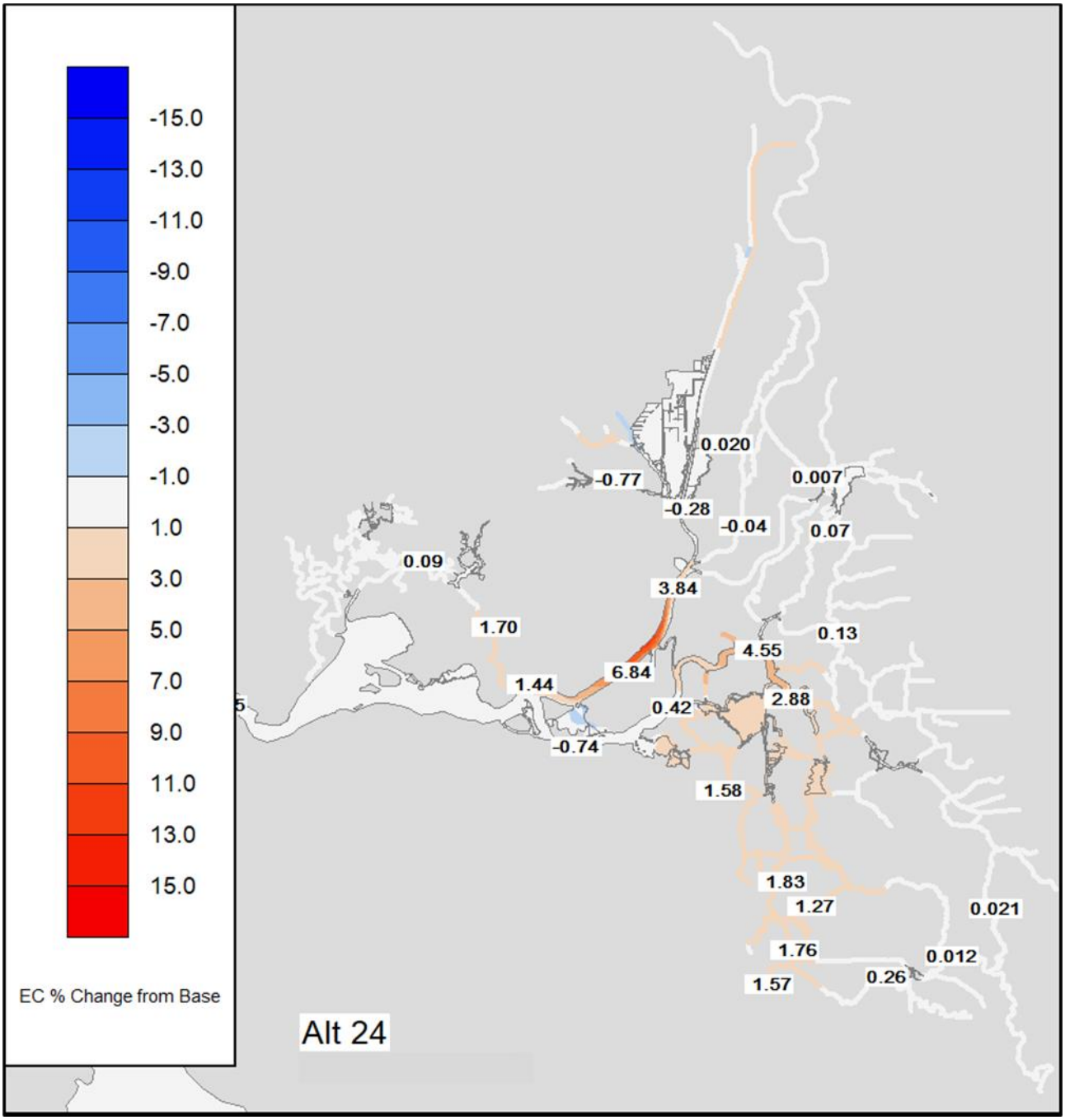

Figure 73 Alternative 24 average percent change from Base EC for August 2020.

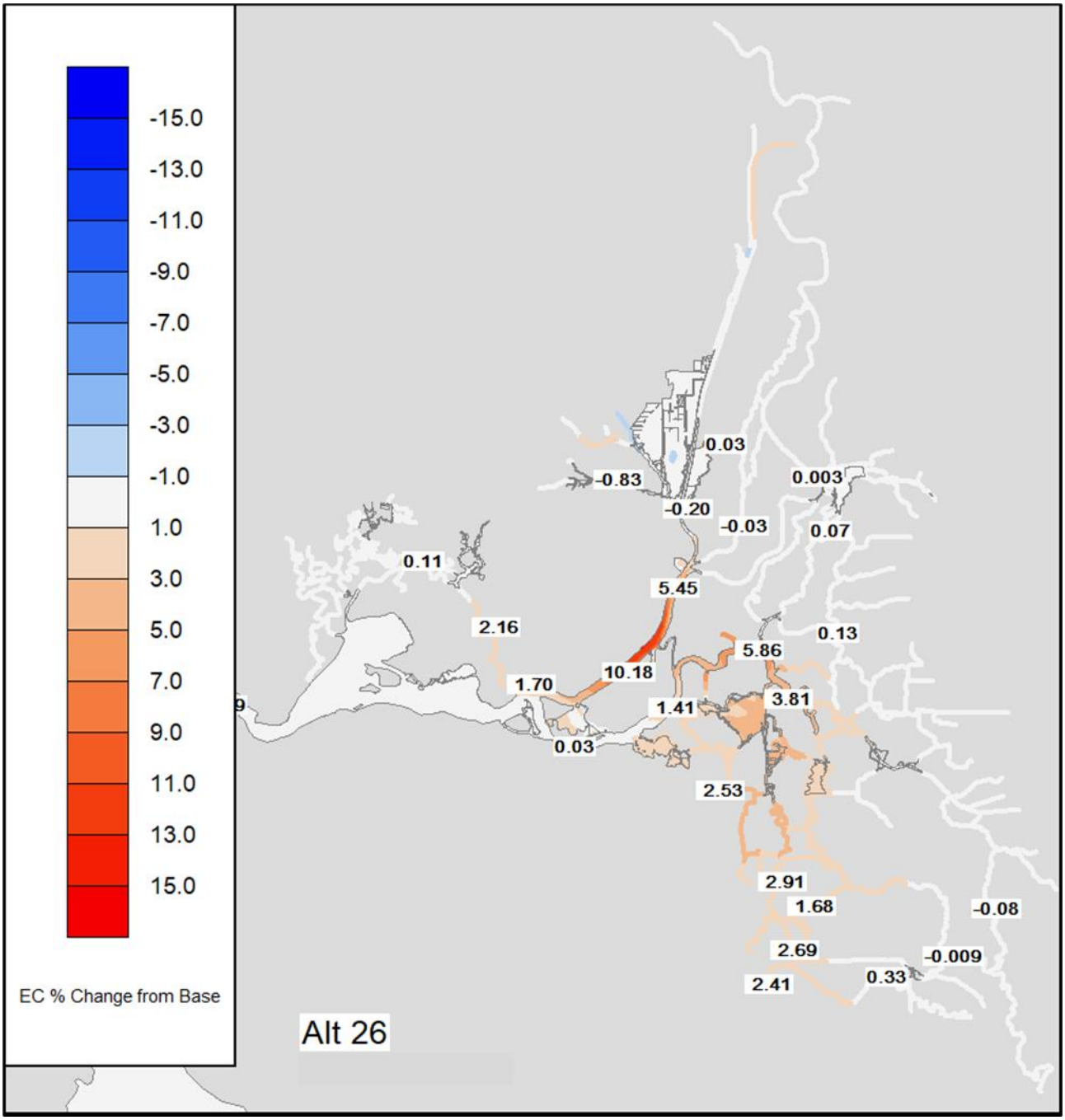

Figure 74 Alternative 26 average percent change from Base EC for August 2020.

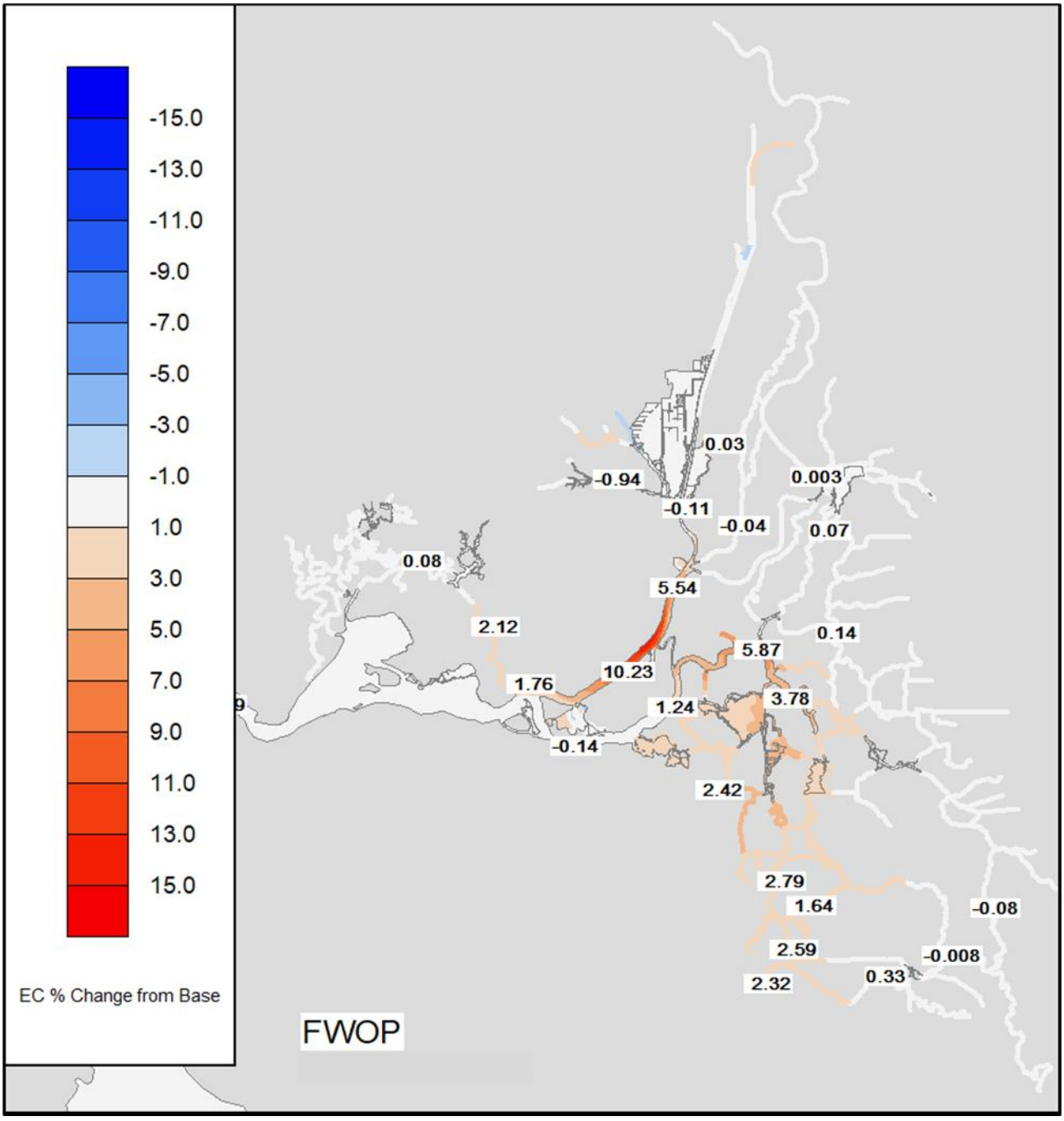

Figure 75 FWOP average percent change from Base EC for August 2020.

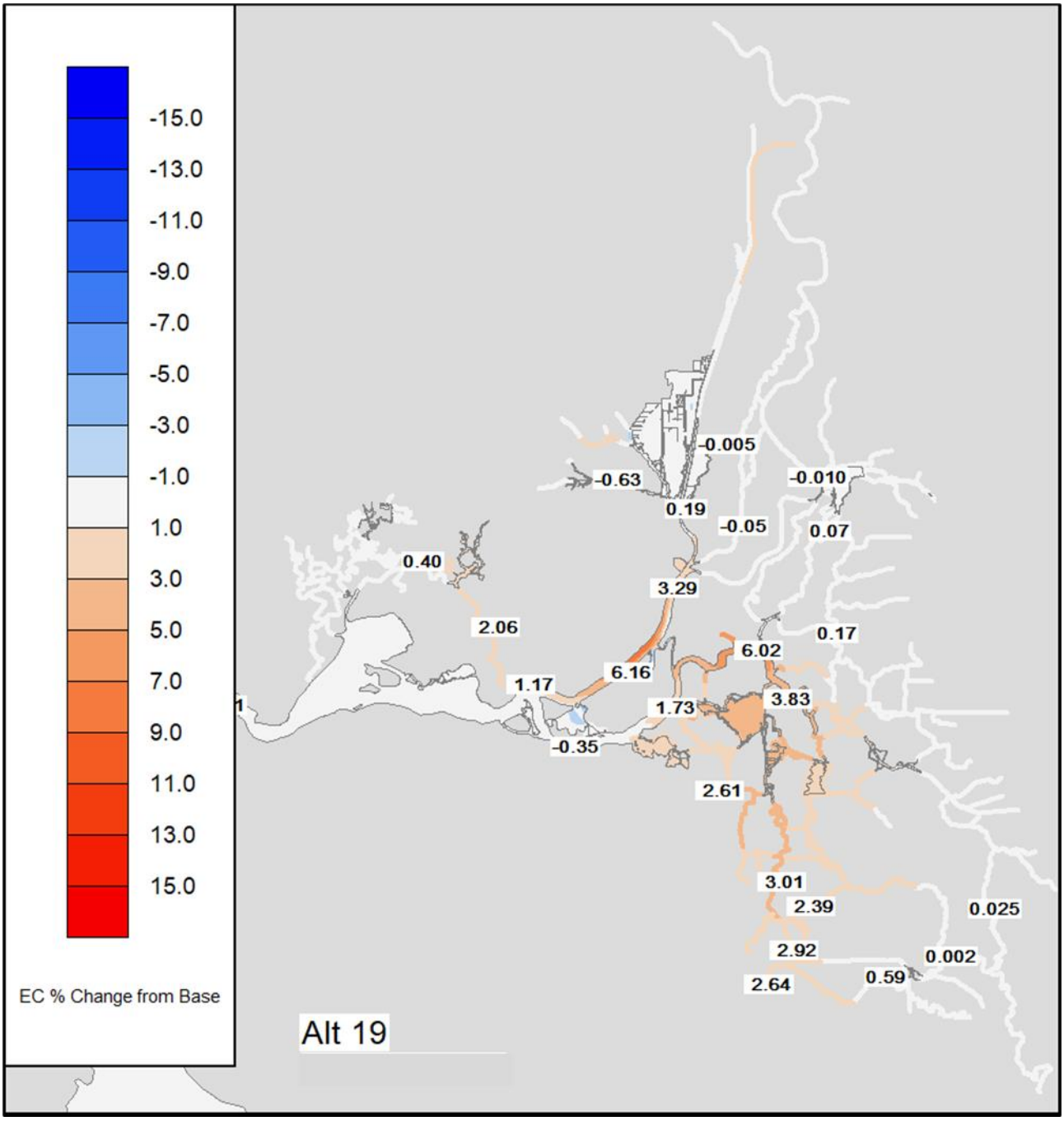

Figure 76 Alternative 19 average percent change from Base EC for September 2020.

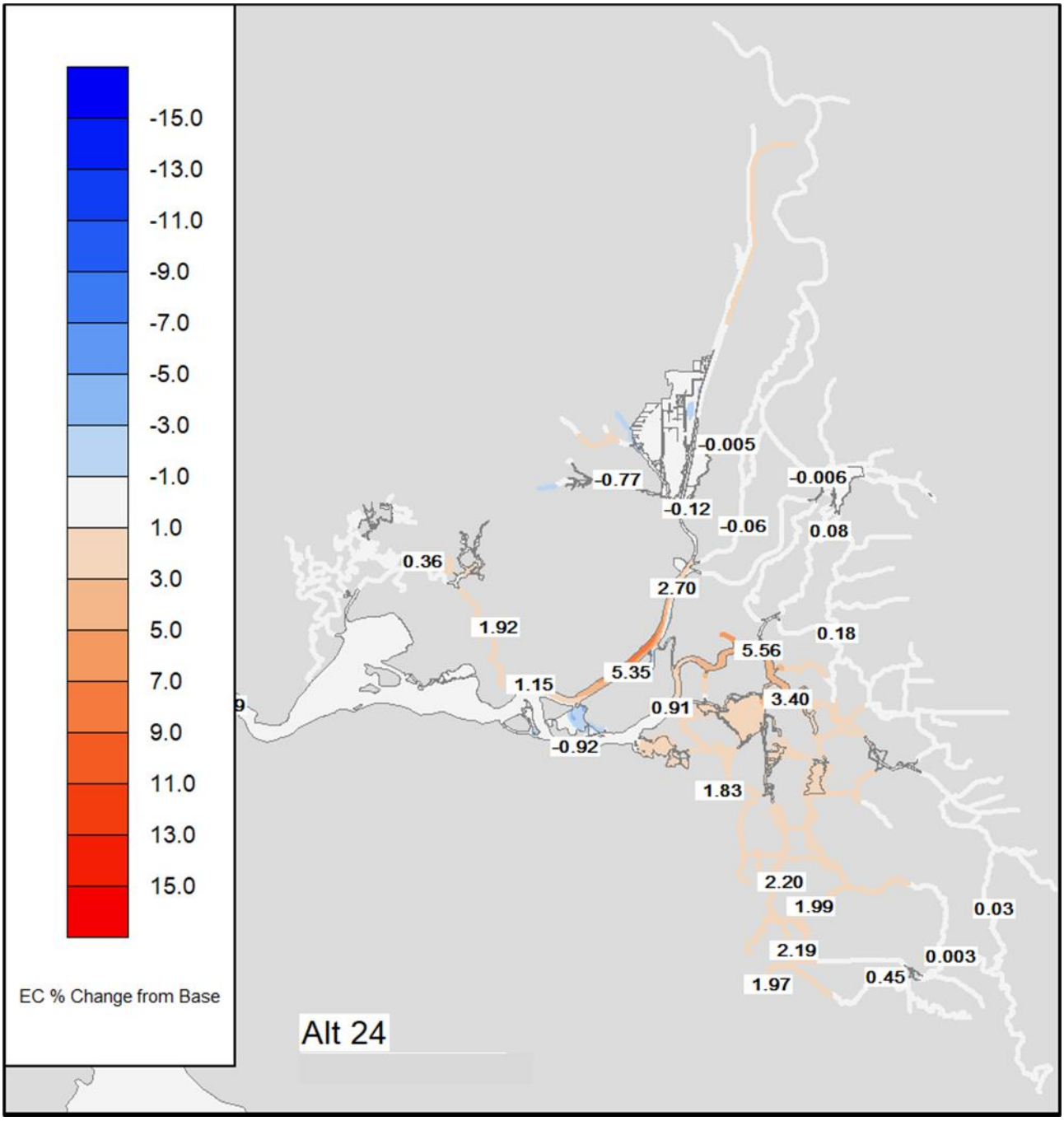

Figure 77 Alternative 24 average percent change from Base EC for September 2020.

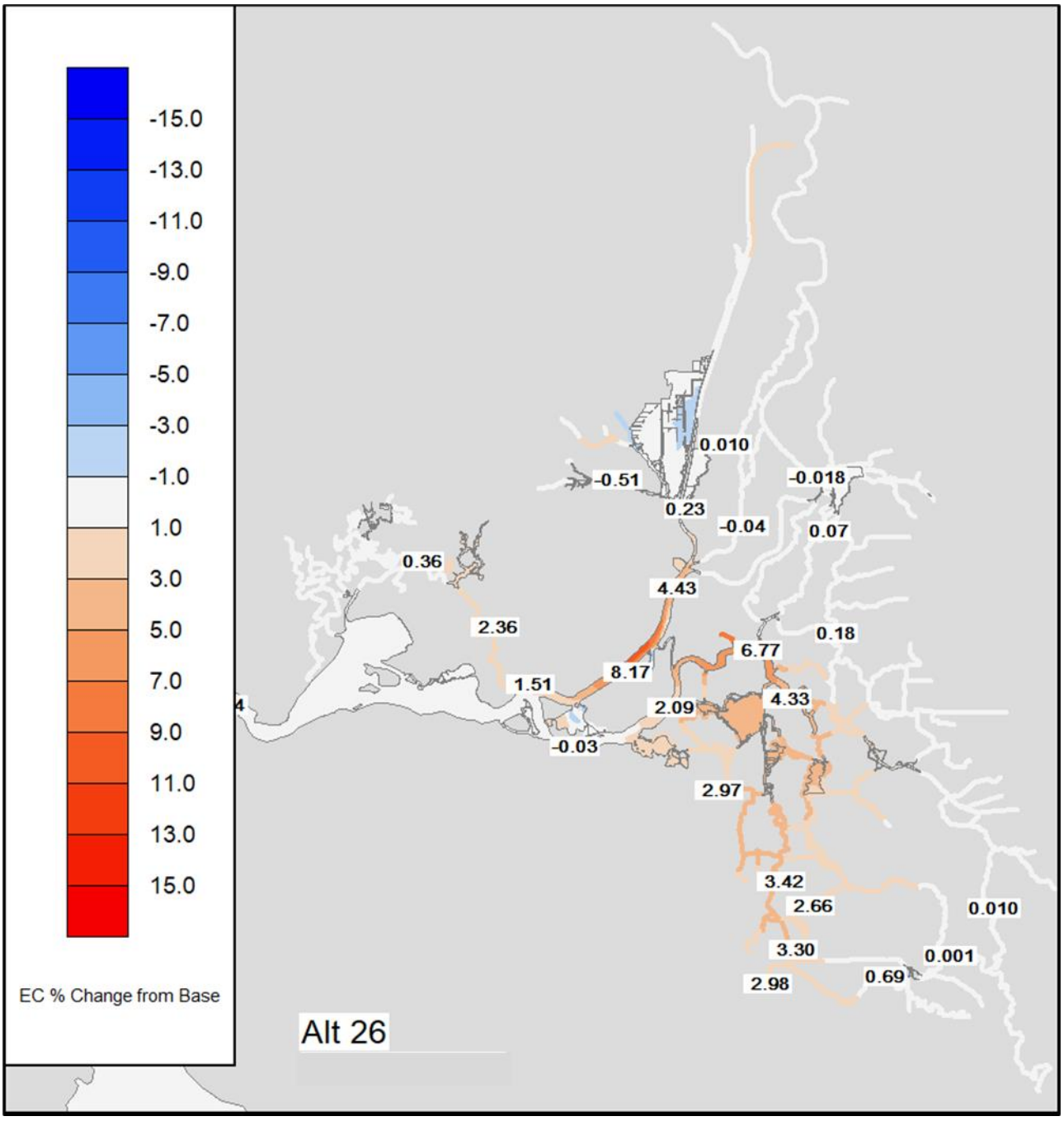

Figure 78 Alternative 26 average percent change from Base EC for September 2020.

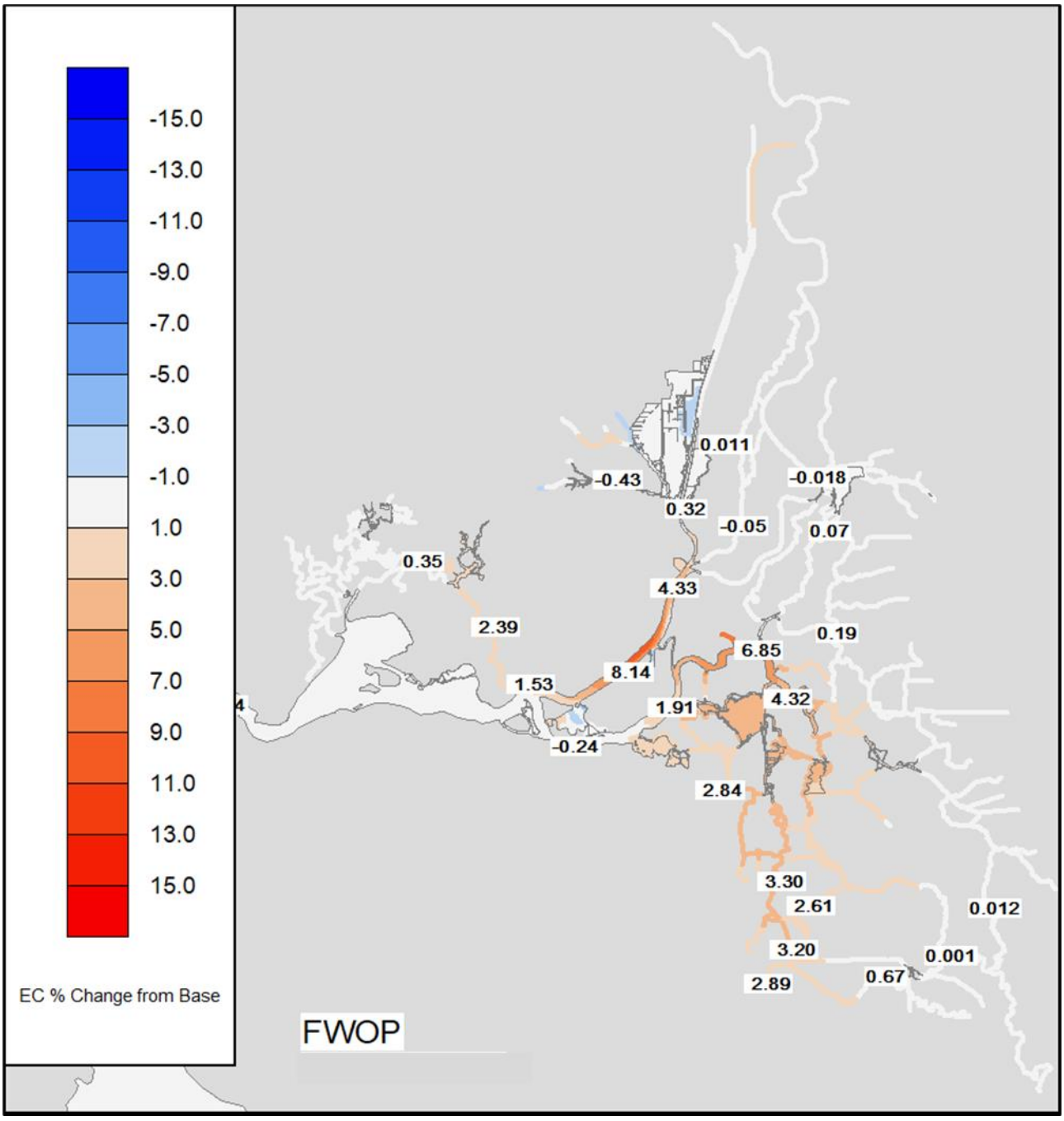

Figure 79 FWOP average percent change from Base EC for September 2020.

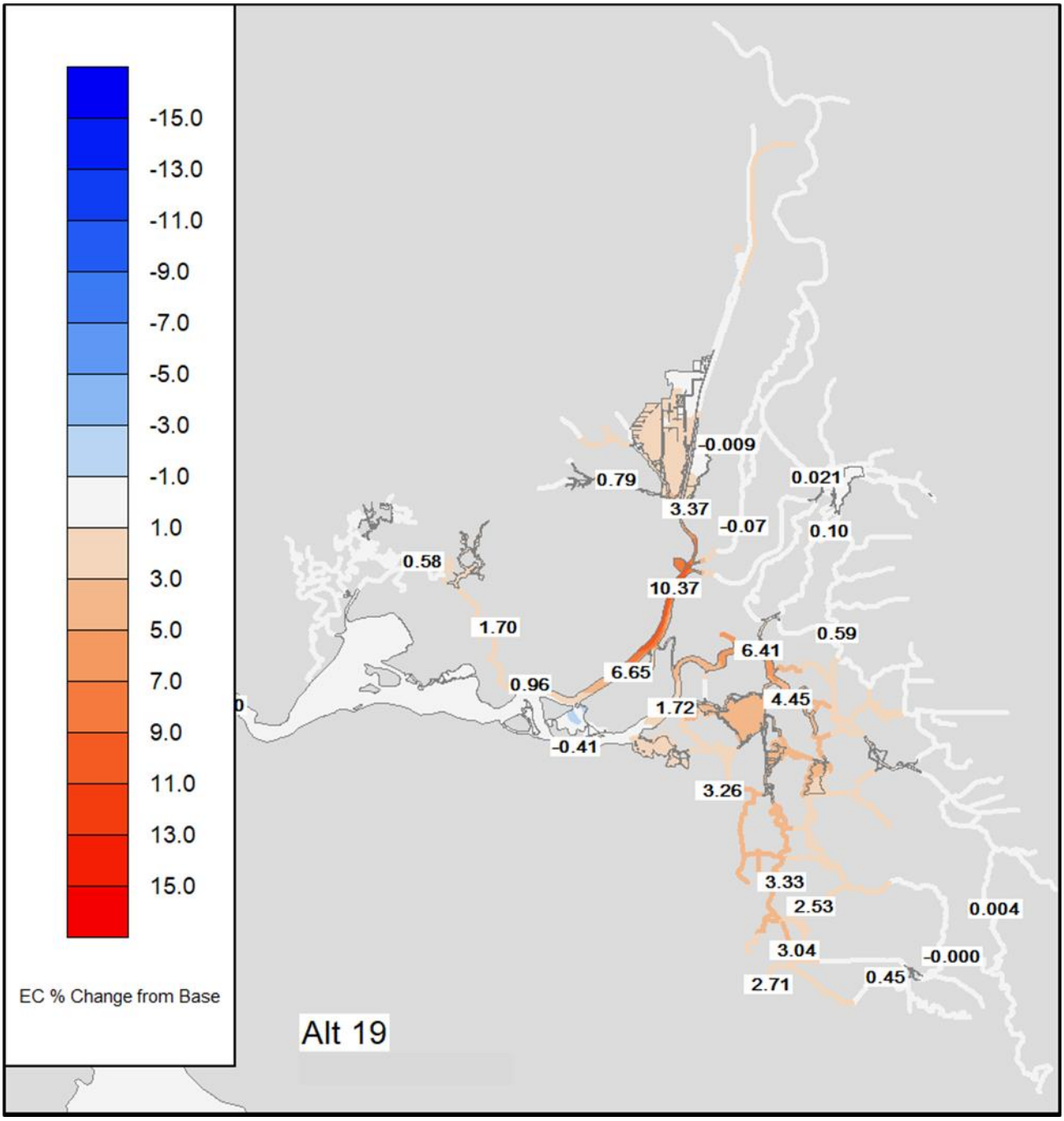

Figure 80 Alternative 19 average percent change from Base EC for October 2020.

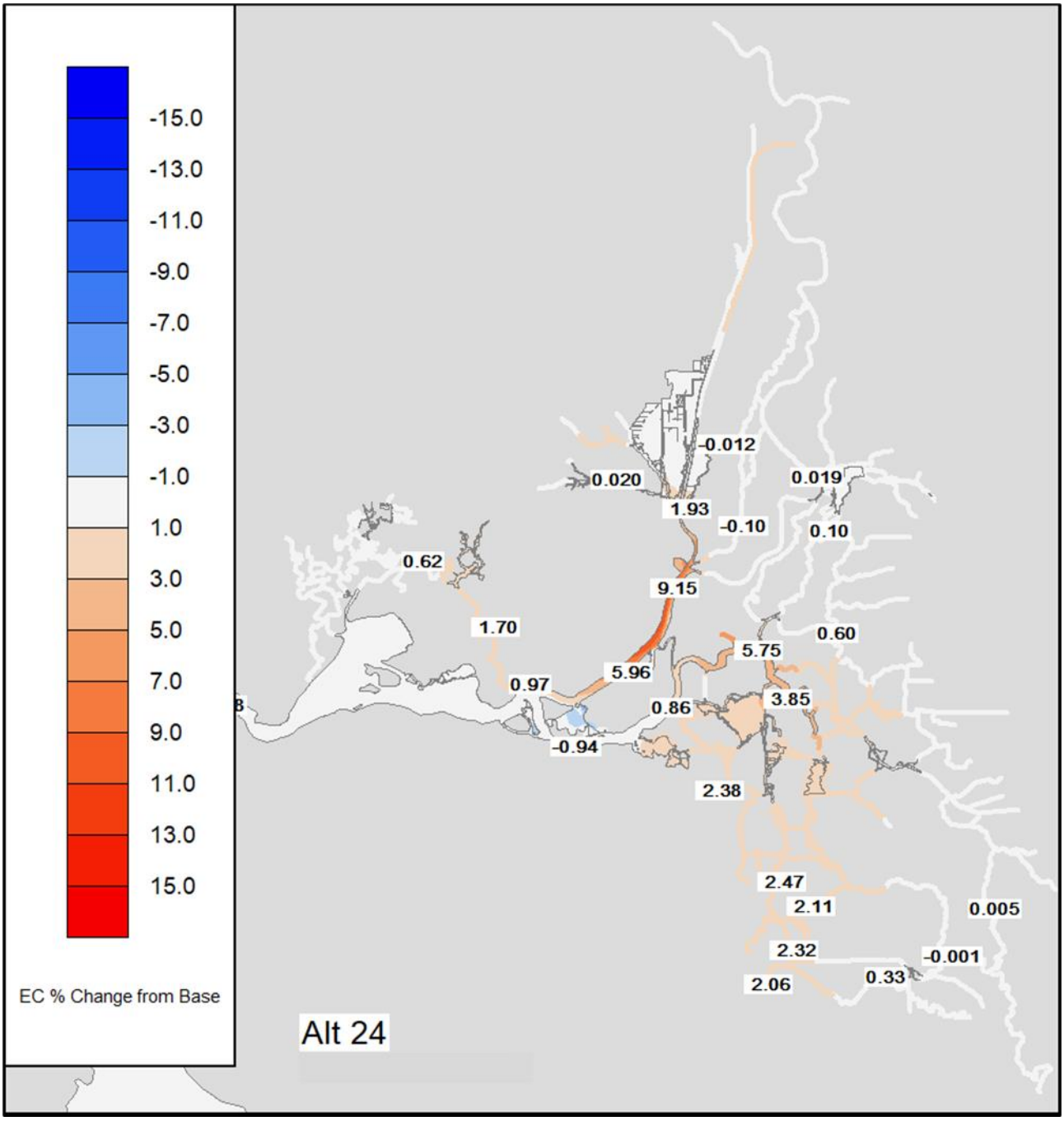

Figure 81 Alternative 24 average percent change from Base EC for October 2020.

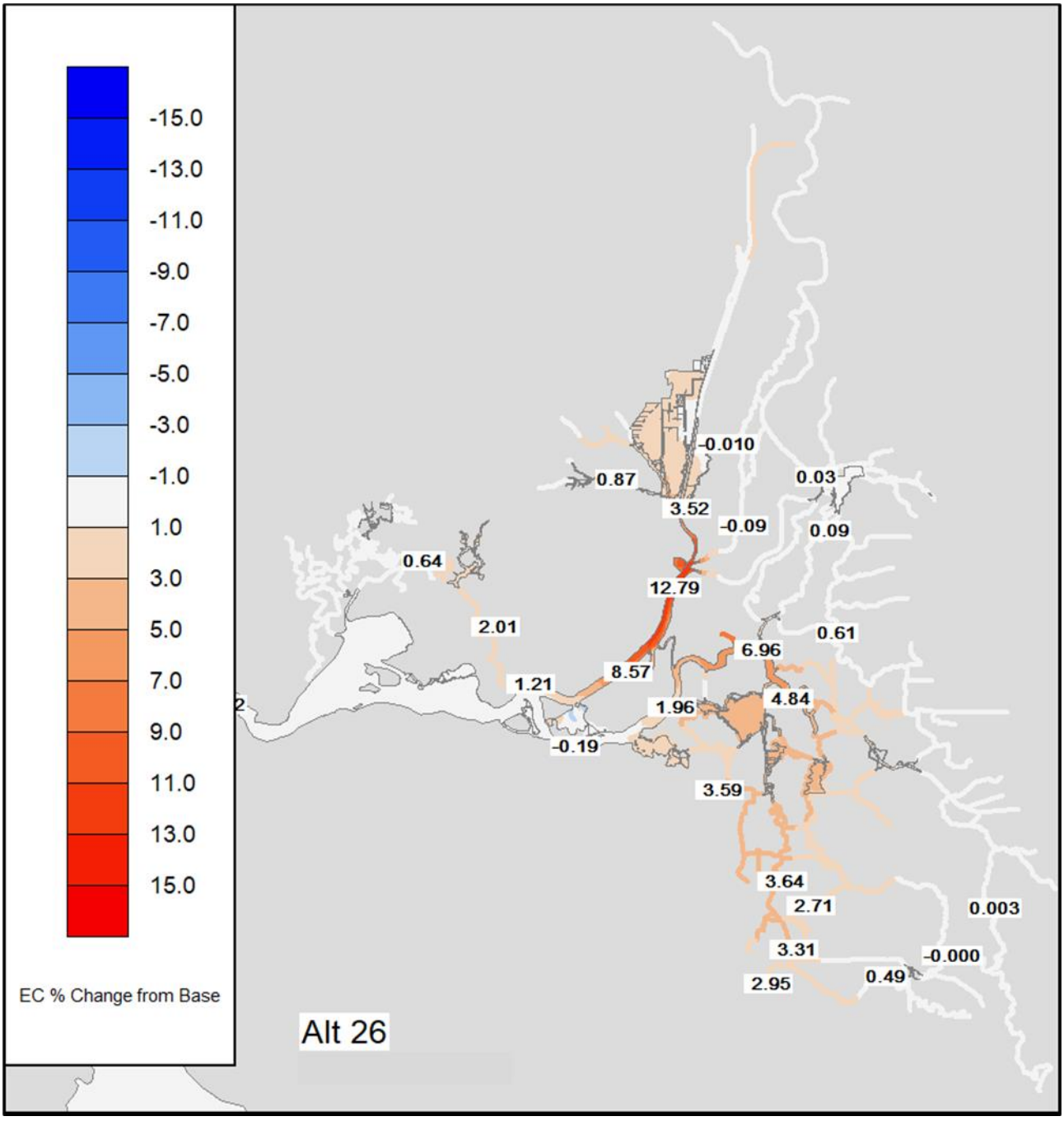

Figure 82 Alternative 26 average percent change from Base EC for October 2020.

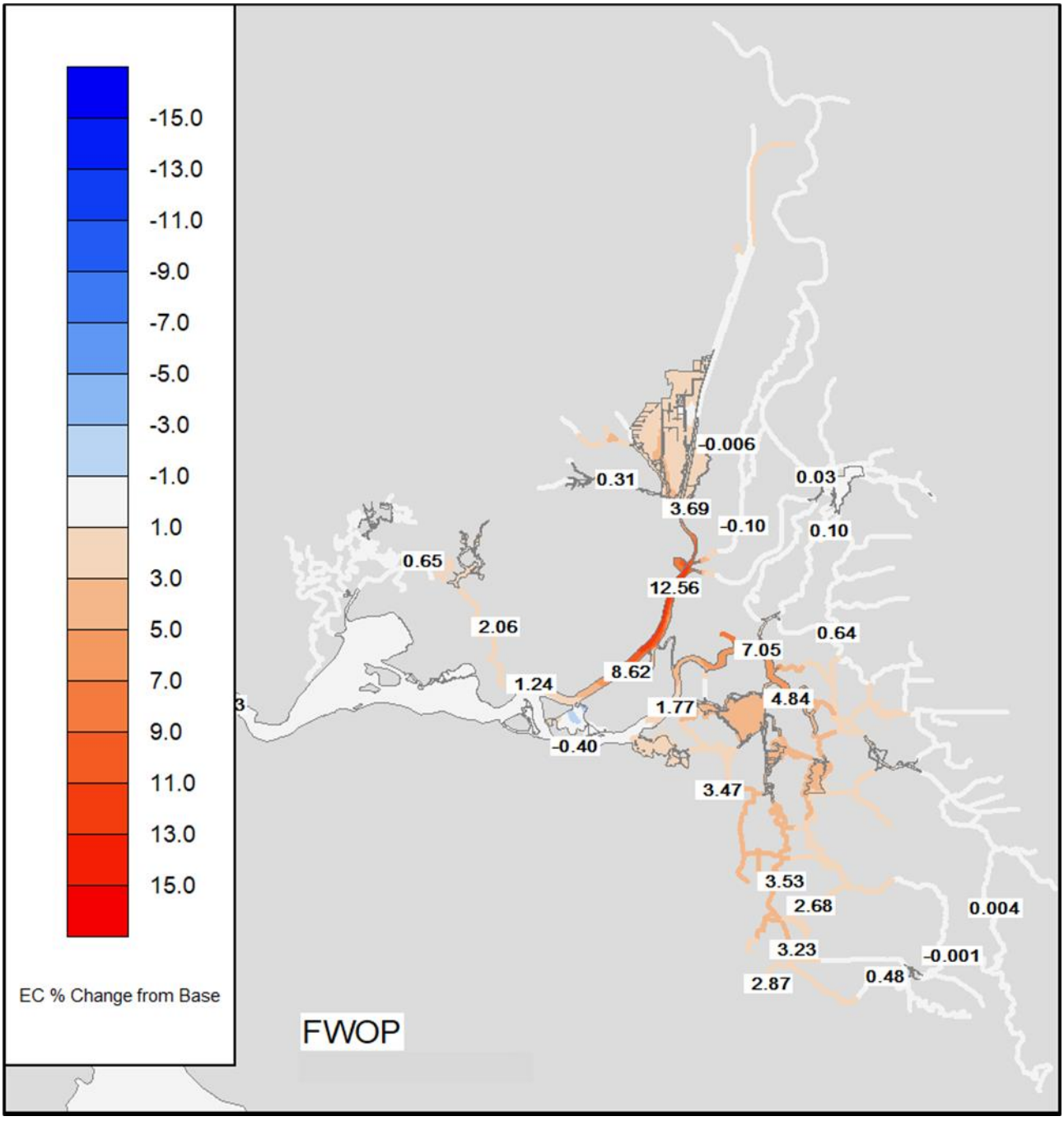

Figure 83 FWOP average percent change from Base EC for October 2020.

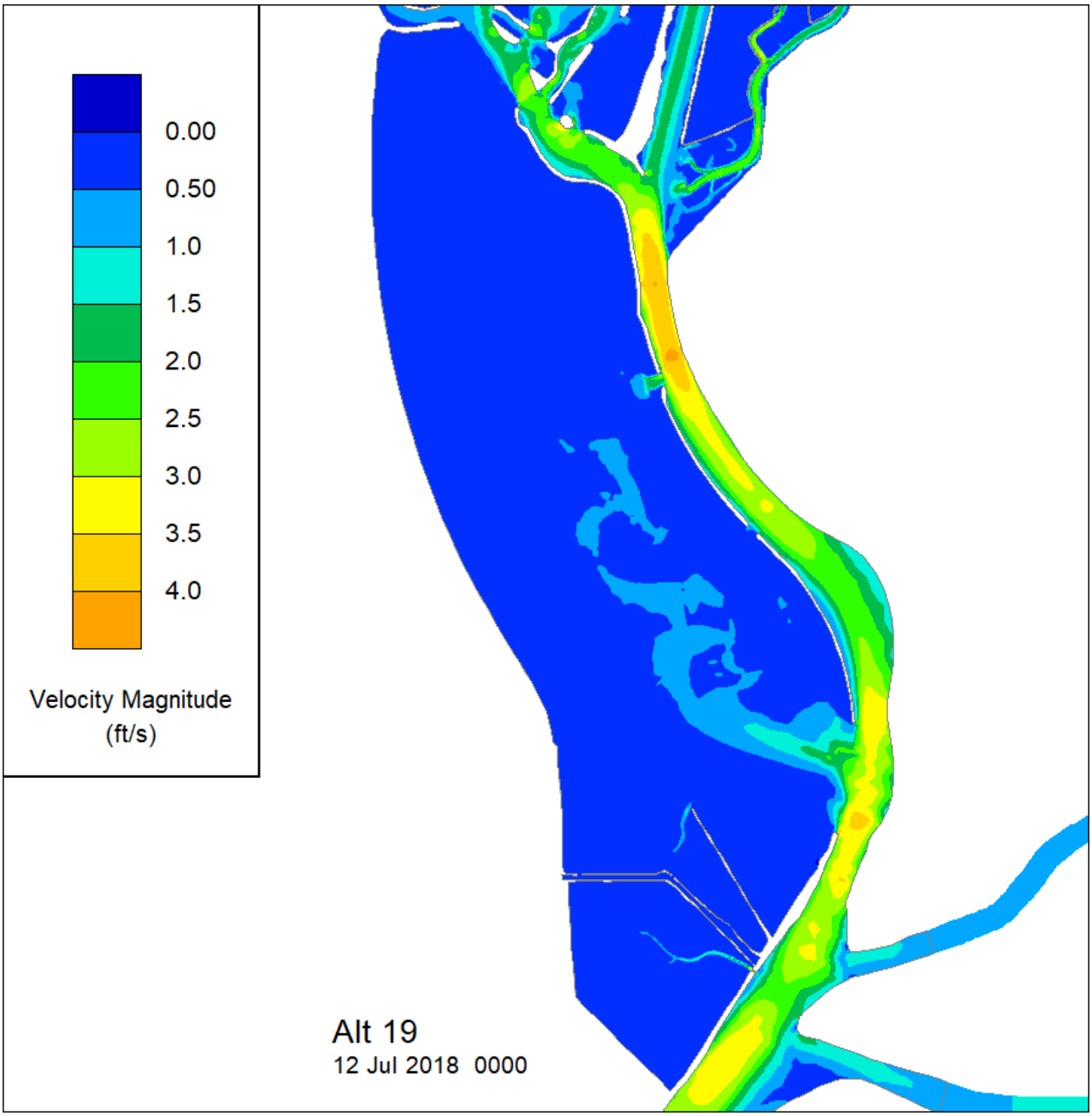

Figure 84 Representative peak flood tide velocities for Alternative 19.

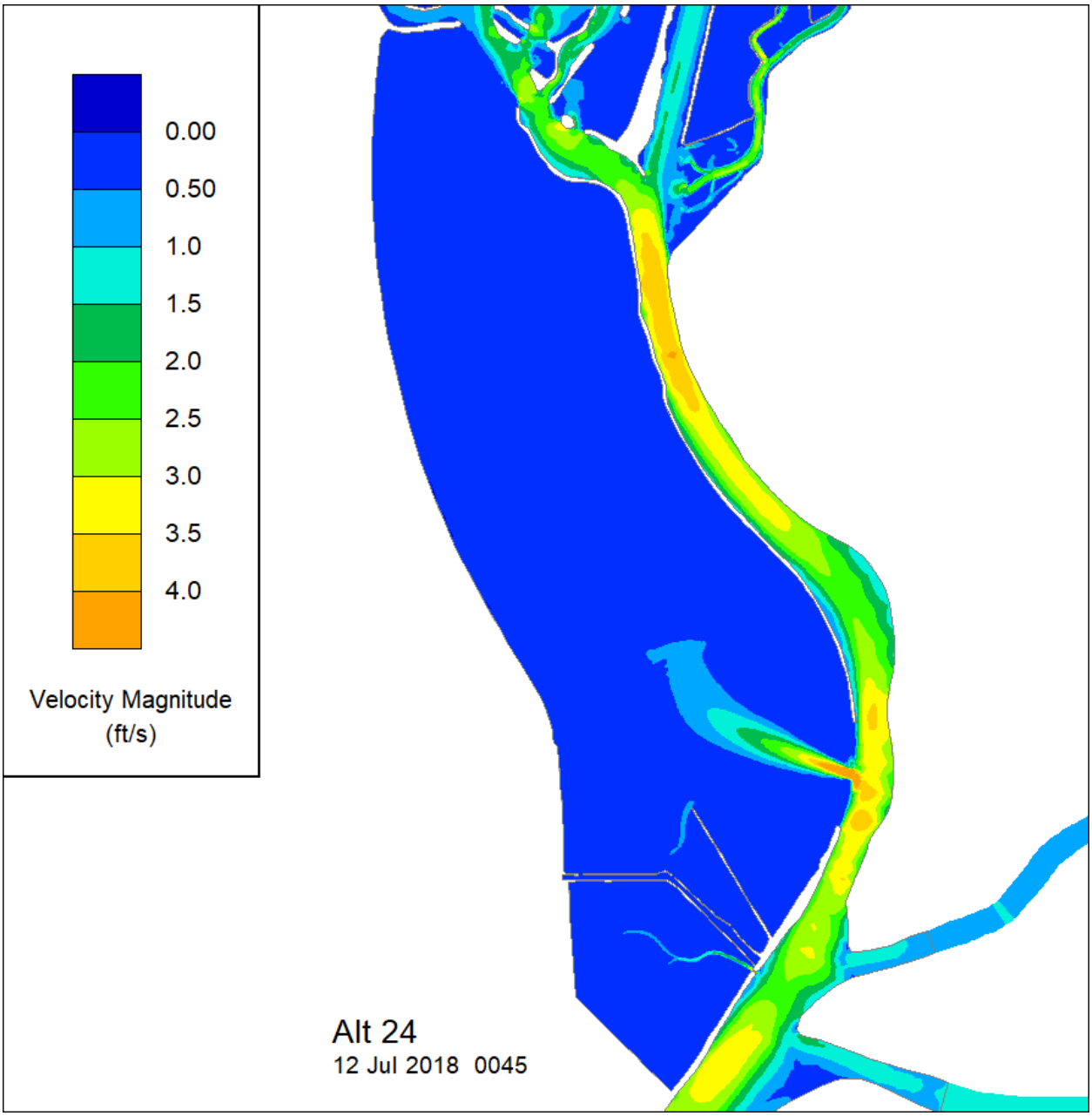

Figure 85 Representative peak flood tide velocities for Alternative 24.

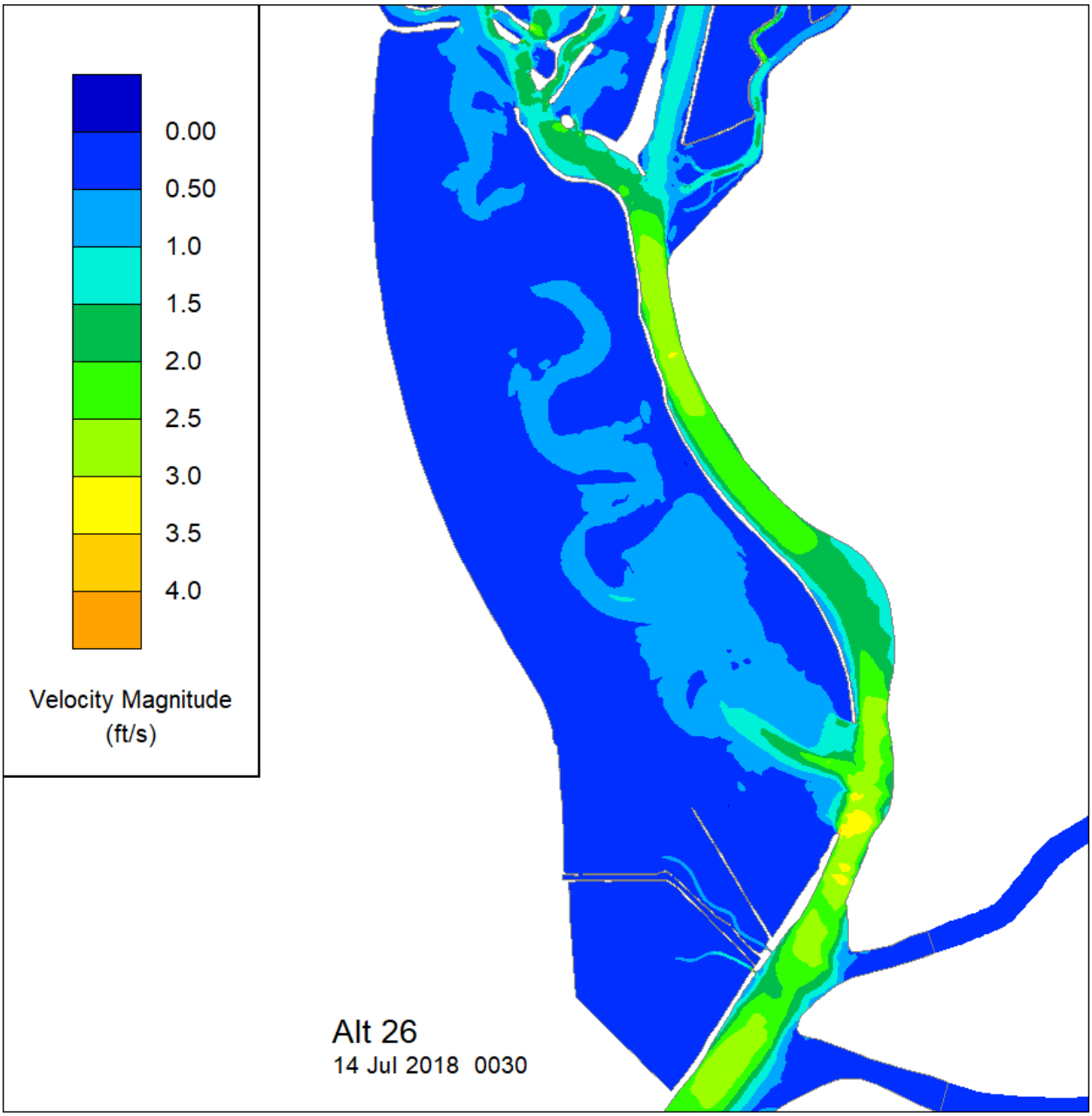

Figure 86 Representative peak flood tide velocities for Alternative 26.

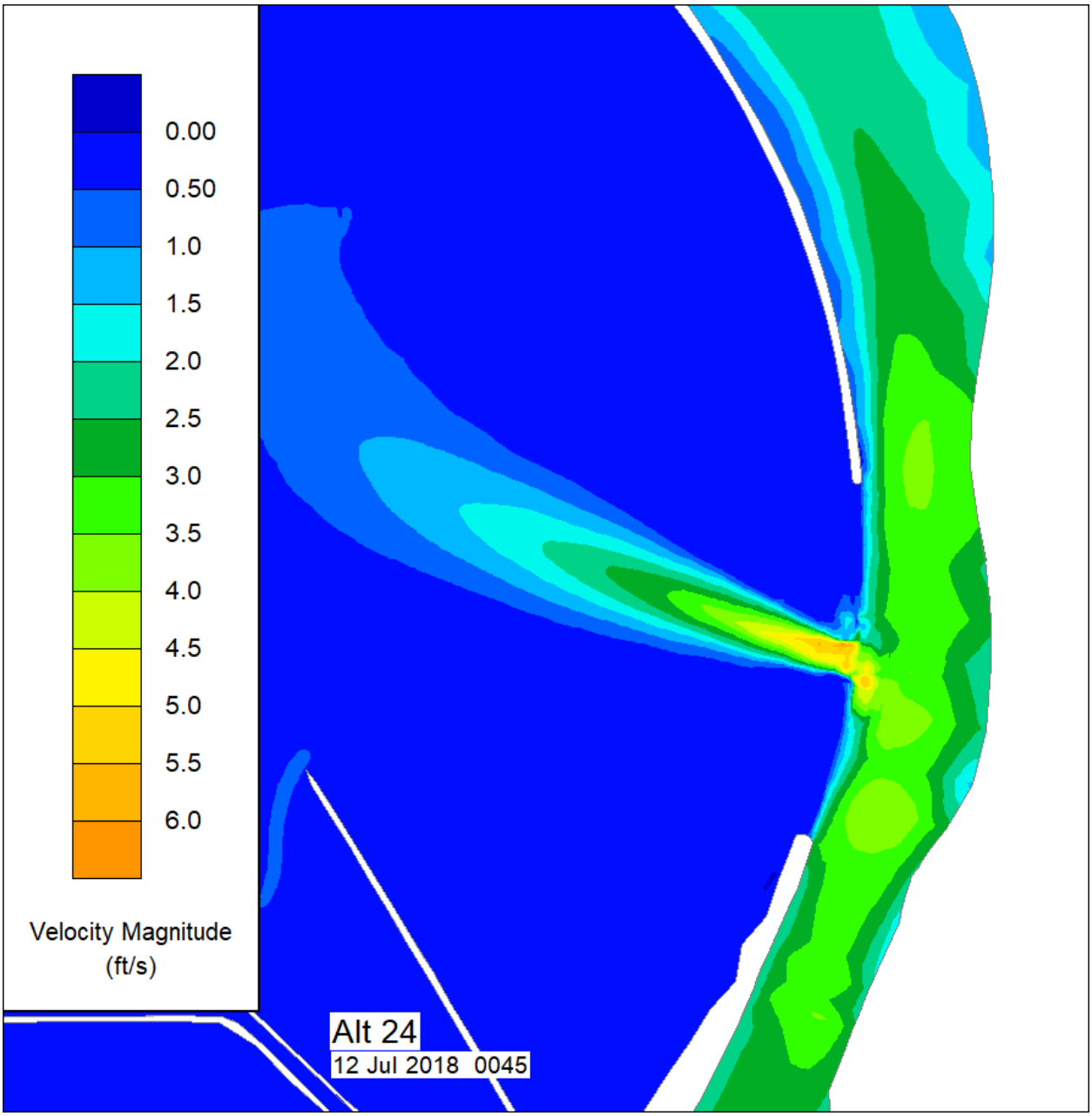

Figure 87 Detail view of representative peak flood tide velocities for Alternative 26. Note expanded velocity scale.

Evaluation of Potential Non-Compliance at Select D-1641 Stations

The second goal of the salinity modeling analysis was to evaluate the potential for restoration alternatives to result in non-compliance with the D-1641 water quality objectives. The compliance stations with salinity (EC) water quality objectives for agriculture, and fish and wildlife are listed in Table 4. The water quality objectives applied for 2018 are for the "Below Normal" Sacramento Valley hydrologic year type. The water quality objectives used for the 2020 evaluation are for a "Dry" hydrologic year type.

For the D-1641 locations analyzed below, time series plots are provided that include modeled EC results for the Base (No Action) and each of the alternatives. For reference, observed data and modeled Existing Condition results are also provided. The Existing Condition results come from calibration/validation model runs for the 2018 and 2020 periods (RMA, 2023), and represent the model geometry and boundary conditions present during those historical periods. In some cases, the Existing Condition is higher or lower than observed data during the D-1641 compliance period. When this happens, the incremental differences between the Existing Condition EC and alternatives EC should be considered relative to the observed value to determine if compliance standards violations might be expected to occur.

Agriculture, Fish and Wildlife Compliance Stations

Compliance for Emmaton (D22), Jersey Point (D15) and Prisoners Point (D29) is determined from the 14-day running average of mean daily EC. The compliance period begins on April 1 and ends August 15 for the Emmaton (D22) and Jersey Point (D15) stations, and ends May 31 for the Prisoners Point (D29) station. Collinsville (C2) compliance is based on the maximum monthly EC value of the daily average of the two high tides. The compliance periods are January through May and October through December. Specific details are provided in 4.

Sacramento River at Emmaton (D22)

No potential compliance issues for the Sacramento River at Emmaton (D22) are expected during the periods analyzed (2018 and 2020). The 14-day average observed, Base and alternatives are compared in Figure 88 for 2018 and Figure 89 for 2020. A detail view of the 2018 plot in Figure 90 shows that all alternatives increase EC values relative to the Existing Condition, resulting in possible non-compliance for two days. However, the model overestimates EC during this period. The incremental EC increases for the alternatives relative to observed EC would not cause a standard violation. This is also true for 2020, when computed EC briefly rises above the standard during May and June.

San Joaquin River at Jersey Point (D15)

The D-1641 compliance period for the Jersey Point location extends from April 1 to August 15. Figure 91 shows that the model predicts non-compliance for both Base and alternatives from mid-July through August 15, 2018, however a comparison with observed data shows that the model overpredicts EC during this time. When considered relative to observed data, Alternatives 19 and 26 and the FWOP are expected to cause non-compliance only on the last day of the compliance period, which could result in a water cost, with additional release requirements to maintain compliance at this location. During 2020, shown in Figure 93, no compliance standard violation is predicted.

San Joaquin River at Prisoners Point (D29)

Maximum computed 14-Day average Prisoners Point EC for all alternatives is 0.28 mmhos/cm during the 2018 compliance period and 0.30 mmhos/cm during the 2020 compliance period, thus well below the 0.44 mmhos/cm D-1641 compliance standard during both periods. Figure 94 and Figure 95 show computed EC for alternatives slightly above computed Base condition EC during the compliance period. Computed EC at the Prisoners Point location is a good match or slightly over-predicts observed EC for the compliance period.

Sacramento River at Collinsville (C2)

At Collinsville, EC compliance is based on the maximum monthly EC value of the daily average of the two high tides. These values are plotted for observed CDEC EC, Base and alternatives EC in Figure 96 for 2018 and Figure 97 for 2020, along with the EC standard. The alternatives slightly increase EC above Base. Both Base and alternatives EC are well below the standard during the compliance periods. Because computed Base EC is below observed during the compliance periods, the incremental increase should be added to the observed values, which still falls well below the standard, except for November 2018. At this time, the observed data violates the standard and all alternatives would slightly increase EC.

Table 4 D-1641 Station Salinity Water Quality Objects – Fish and Wildlife and Agriculture. Standards are presented in mmhos/cm (1 mmho/cm = 1000 µS/cm).

Station	Water Year Type[1]	Fish and Wildlife		Agriculture			
		Value[2]	Time Period	Value[2]	Time Period	Value[2]	Time Period
D22 - Sacramento at Emmaton	Wet	not applicable		0.45	Apr 1 – Aug 15		
	Above Normal			0.45	Apr 1 – Jun 30	0.63	Jul 1 - Aug 15
	Below Normal			0.45	Apr 1 – Jun 19	1.14	Jun 20 - Aug 15
	Dry			0.45	Apr 1 – Jul 14	1.67	Jul 15 - Aug 15
	Critical			2.78	Apr 1 – Aug 15	not applicable	
D15 - San Joaquin at Jersey Point	Wet	0.44	Apr 1 – May 31	0.45	Apr 1 – Aug 15	not applicable	
	Above Normal	0.44	Apr 1 – May 31	0.45	Apr 1 – Aug 15	not applicable	
	Below Normal	0.44	Apr 1 – May 31	0.45	Apr 1 – Jun 19	0.74	Jun 20 - Aug 15
	Dry	0.44	Apr 1 – May 31	0.45	Apr 1 – Jun 14	1.35	Jun 15 - Aug 15
	Critical	not applicable		2.2	Apr 1 – Aug 15	not applicable	
D29 - San Joaquin at Prisoners Point	Wet, Above Normal, Below Normal, Dry	0.44	Apr 1 – May 31	not applicable			
C2 - Collinsville[3]	not applicable	19.0	Oct	not applicable			
		15.5	Nov-Dec				
		12.5	Jan				
		8.0	Feb-Mar				
		11.0	Apr-May				

[1] Sacramento Valley Water Year Hydrologic Classification
[2] Maximum 14-day running average of mean daily EC (mmhos/cm)
[3] Maximum monthly average of both daily high tide EC values (mmhos/cm)

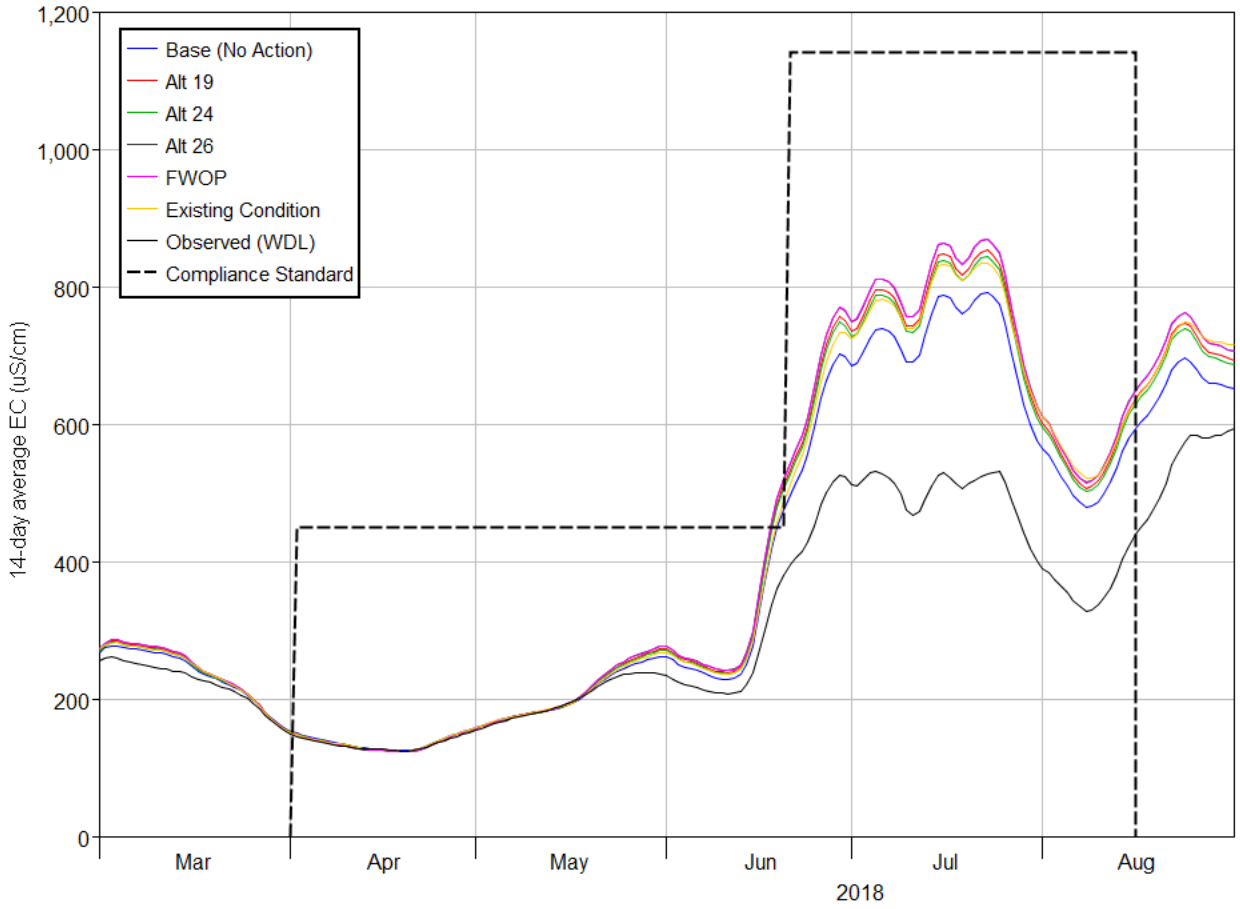

Figure 88 14-Day running average EC for the Sacramento River at Emmaton (D22). No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP computed results are plotted with the D-1641 standard and observed Emmaton EC for the 2018 simulation period.

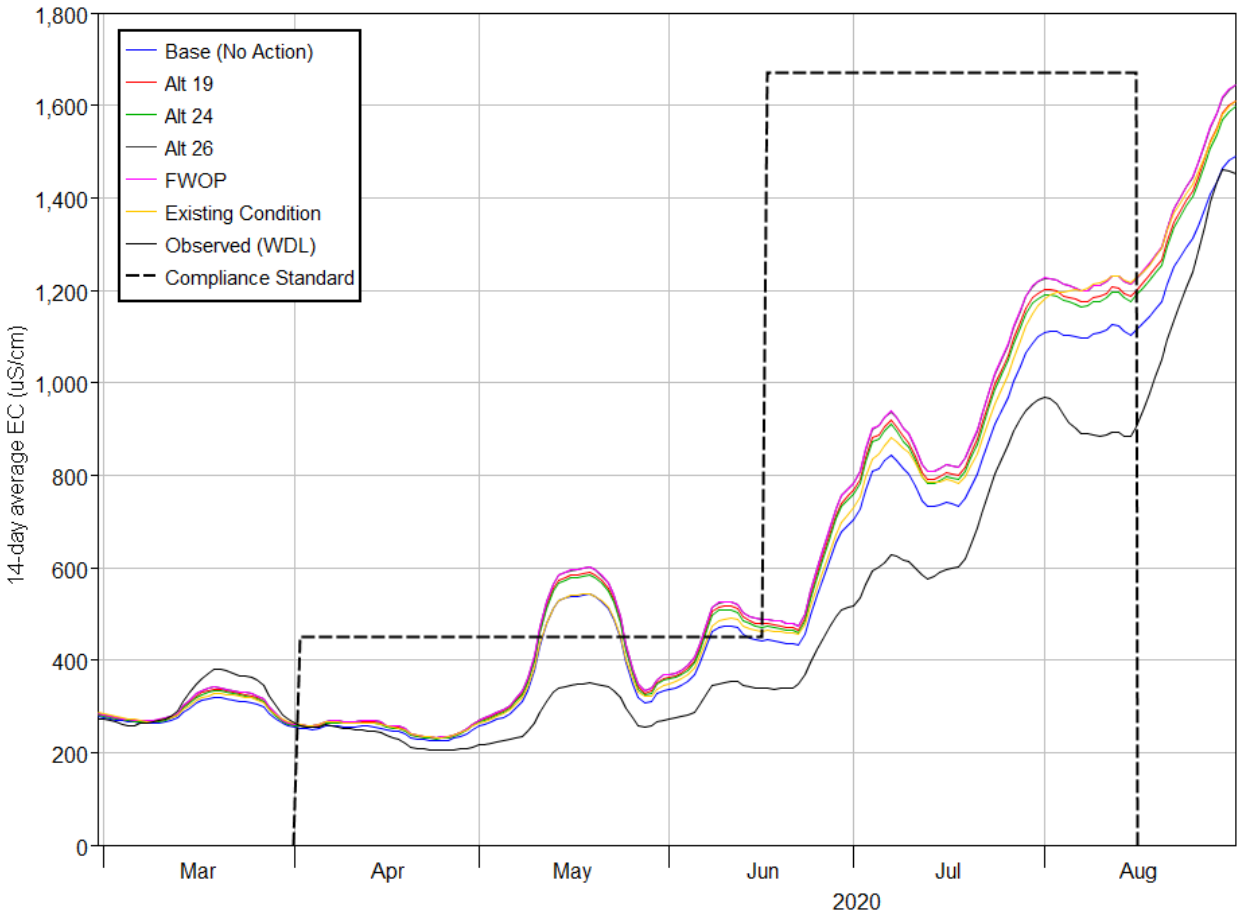

Figure 89 14-Day running average EC for the Sacramento River at Emmaton (D22). No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP computed results are plotted with the D-1641 standard and observed Emmaton EC for the 2020 simulation period.

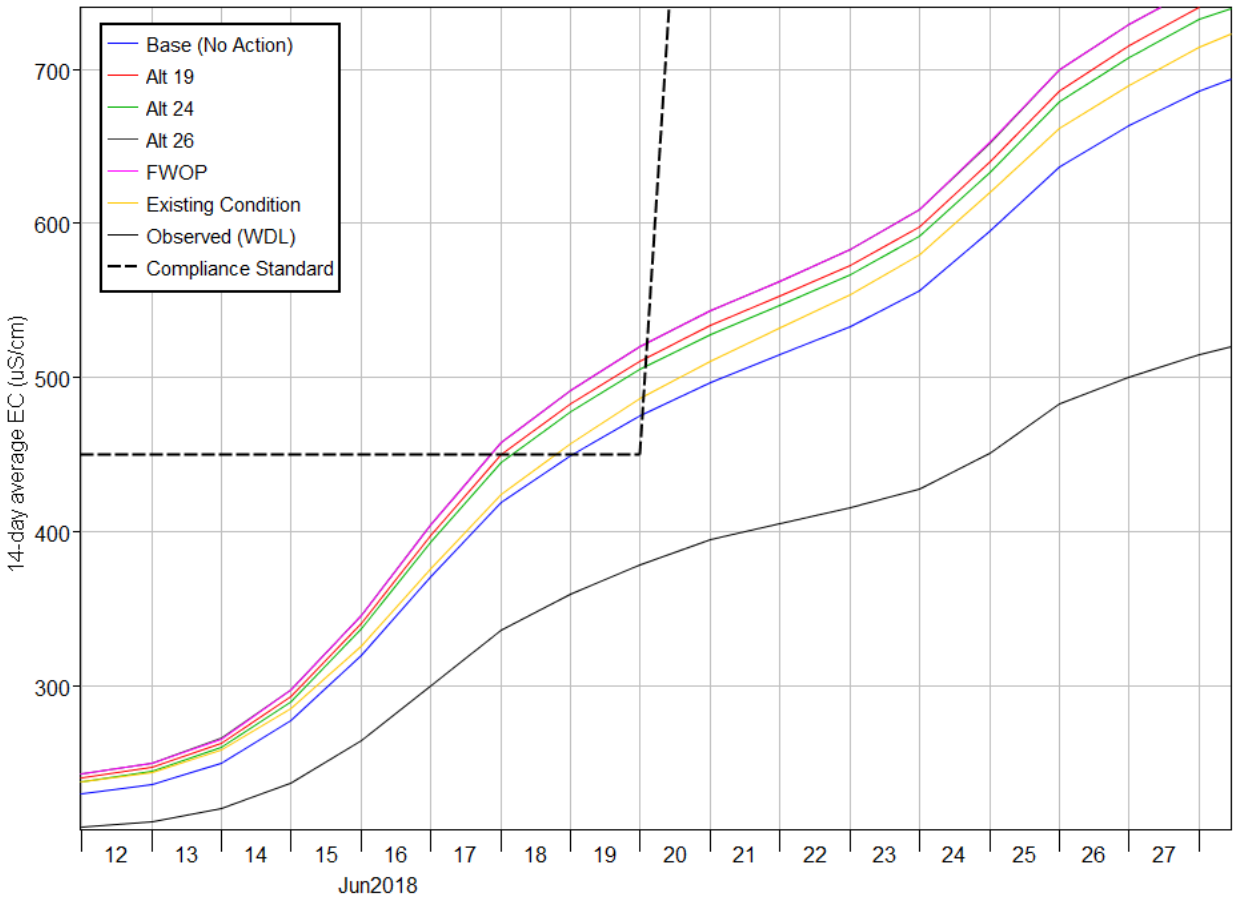

Figure 90 Detail view of Figure 88, 14-Day running average EC for the Sacramento River at Emmaton (D22) for the 2018 simulation period.

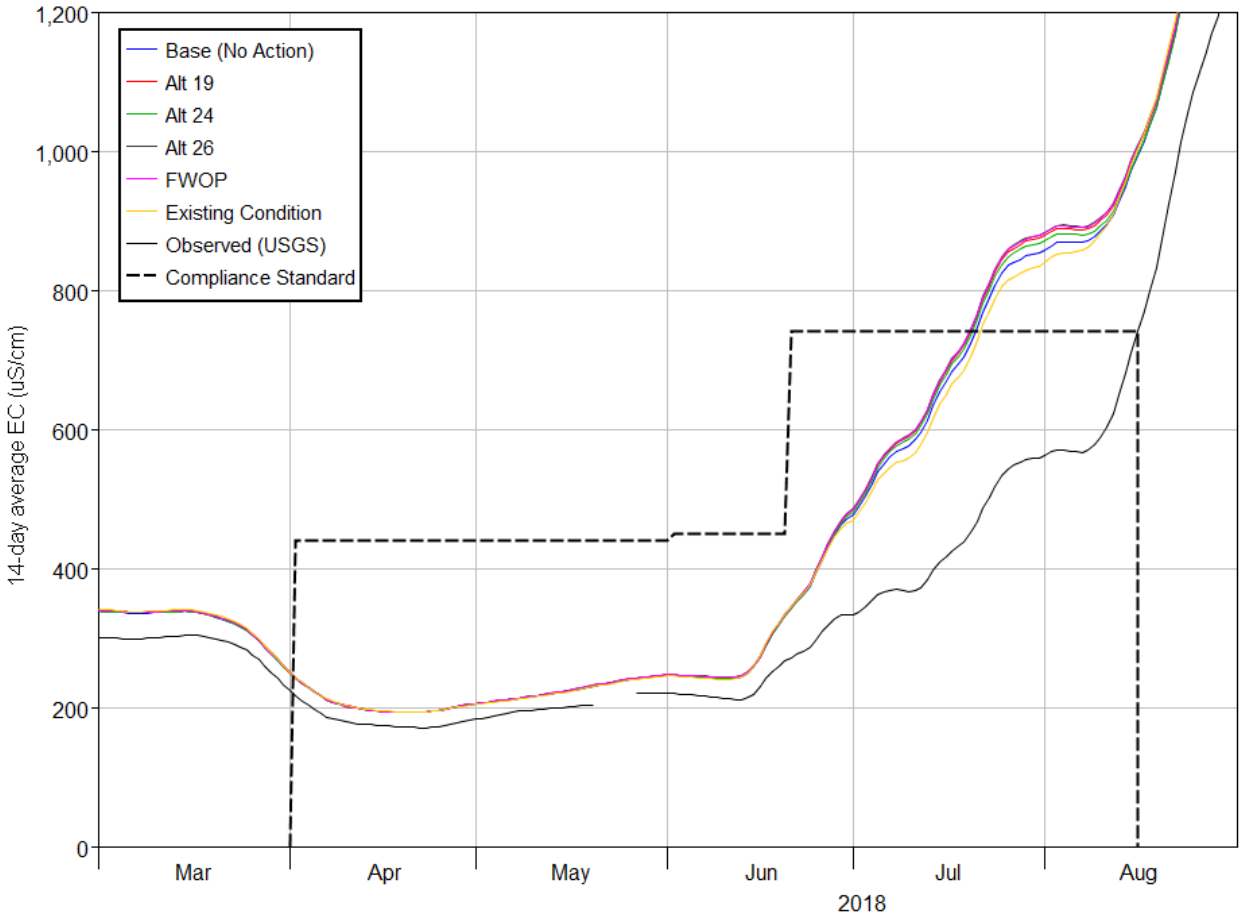

Figure 91 14-Day running average EC for the San Joaquin River at Jersey Point (D15). No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP computed results are plotted with the D-1641 standard and observed Jersey Point EC for the 2018 simulation period.

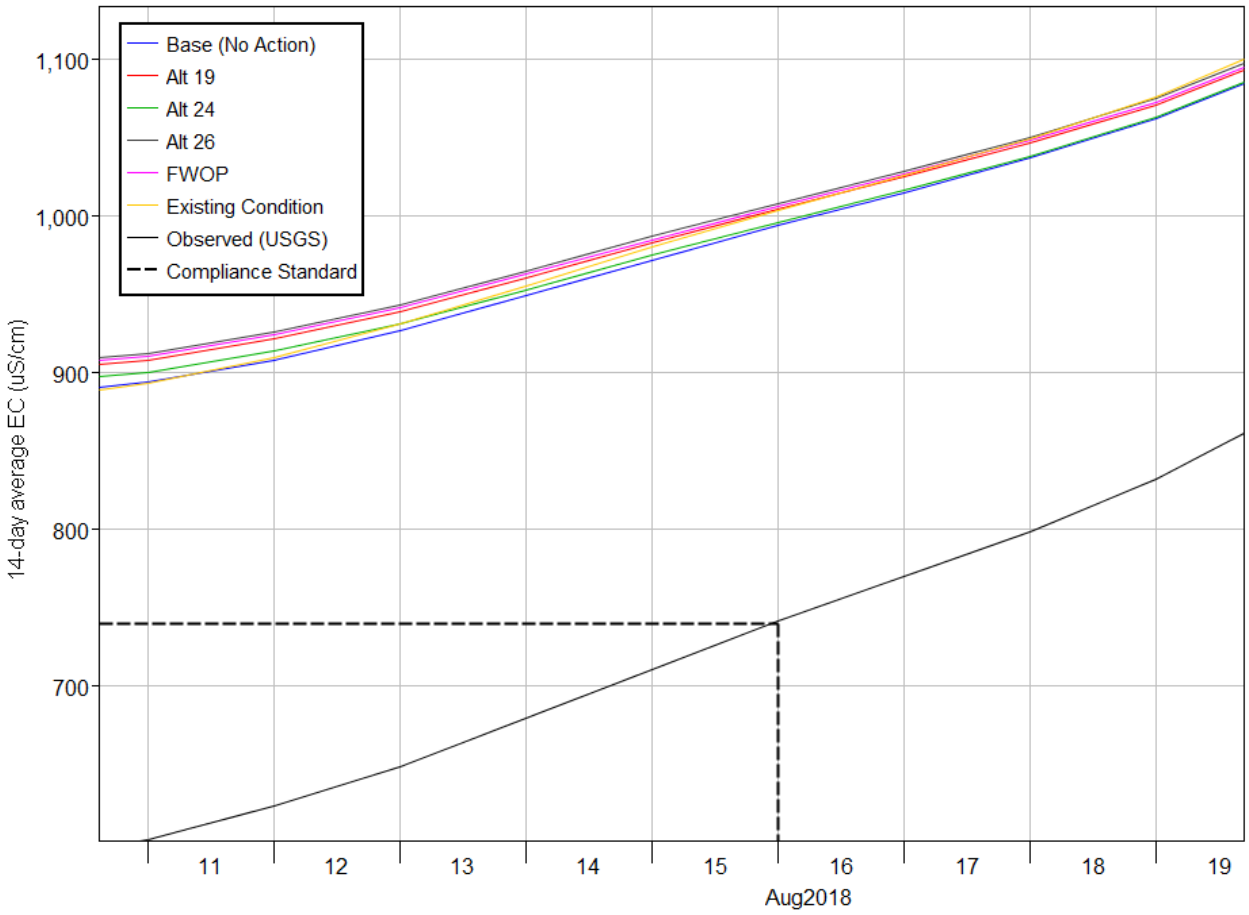

Figure 92 Detail view of Figure 91, 14-Day running average EC for the San Joaquin River at Jersey Point (D15) for the 2018 simulation period.

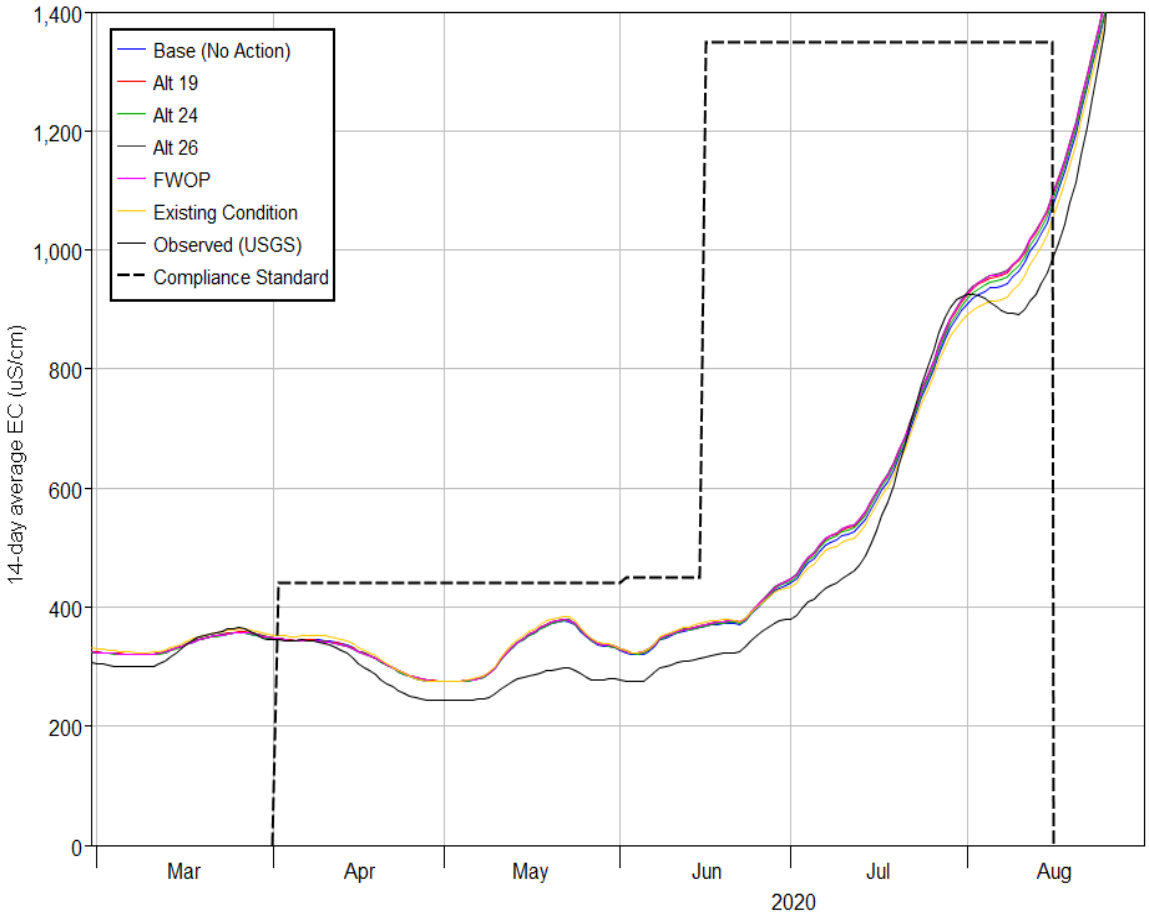

Figure 93 14-Day running average EC for the San Joaquin River at Jersey Point (D15). No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP computed results are plotted with the D-1641 standard and observed Jersey Point EC for the 2020 simulation period.

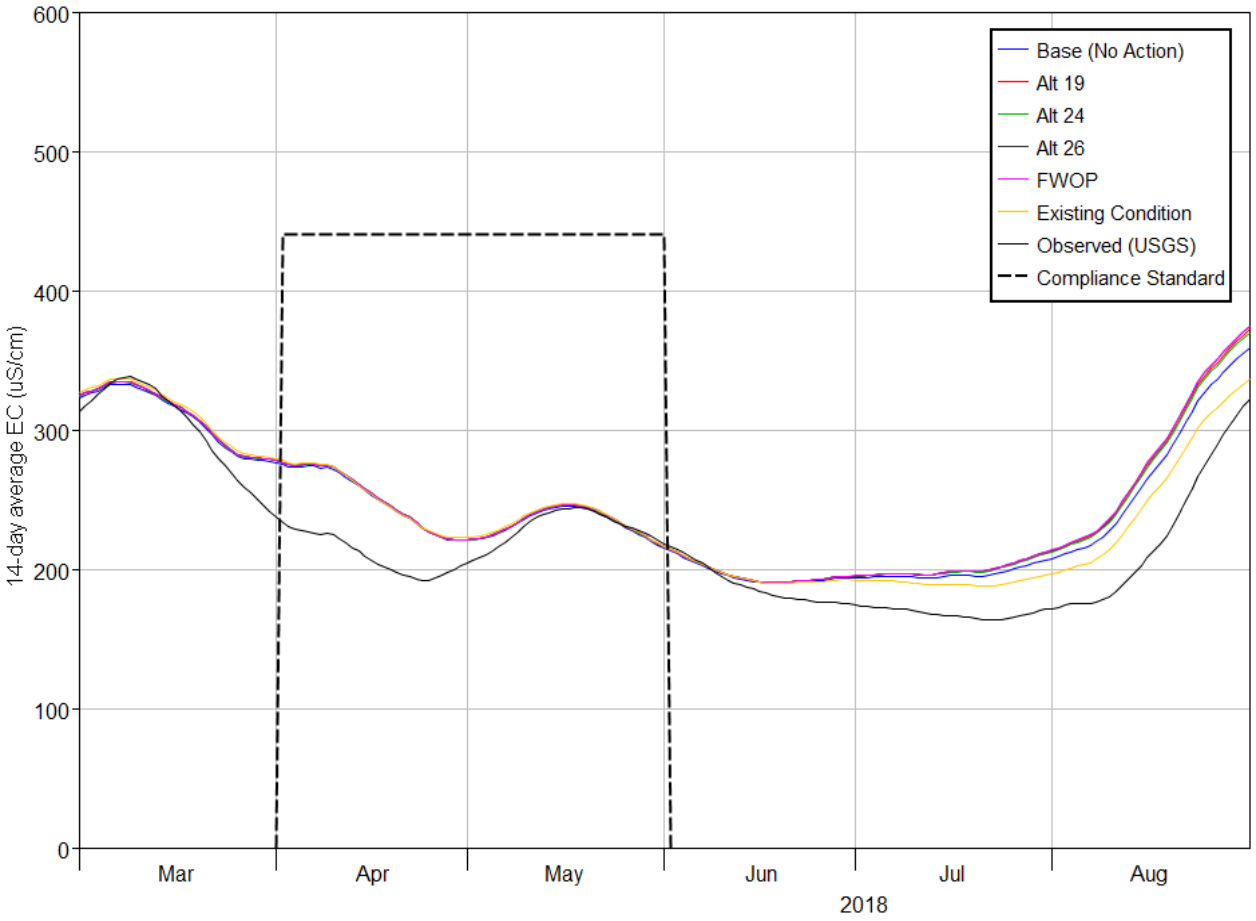

Figure 94 14-Day running average EC for the San Joaquin River at Prisoners Point (D29). No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP computed results are plotted with the D-1641 standard and observed Prisoners Point EC for the 2018 simulation period.

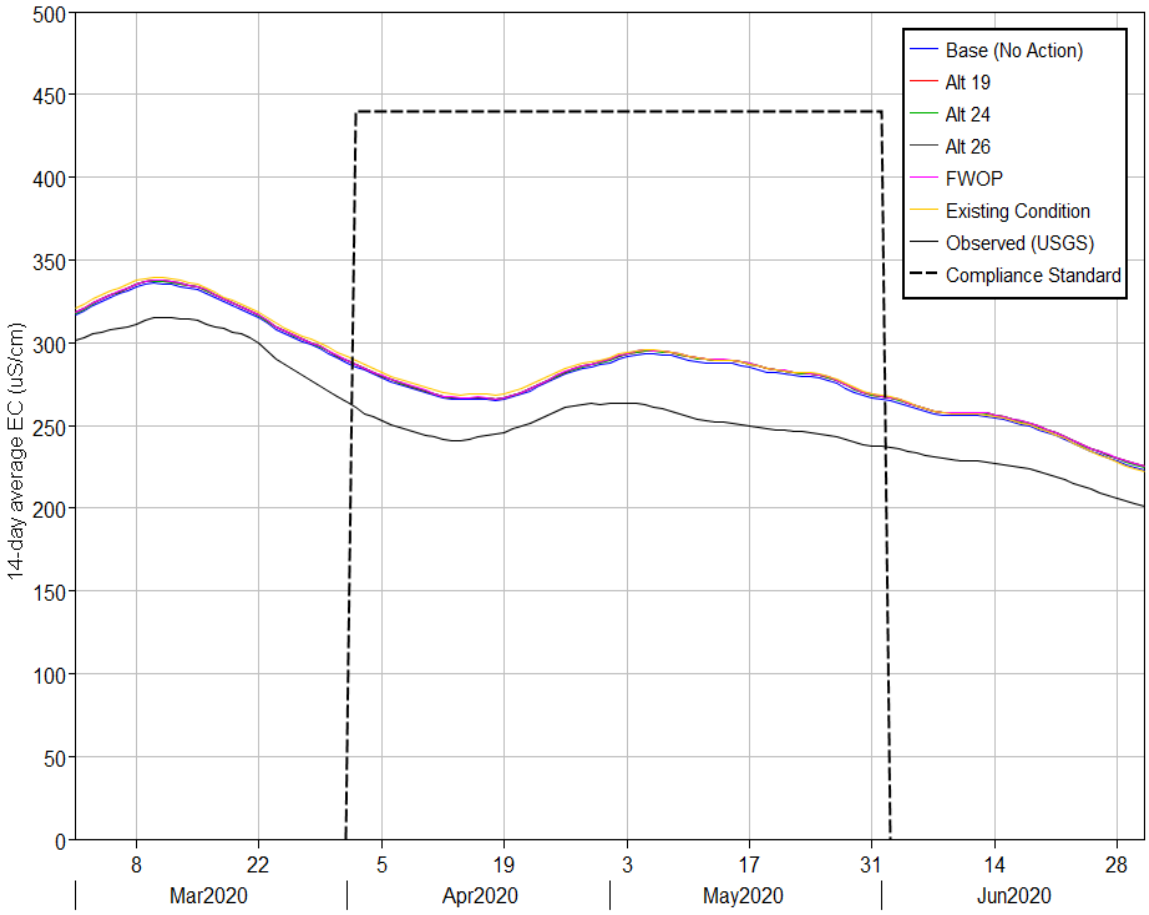

Figure 95 14-Day running average EC for the San Joaquin River at Prisoners Point (D29). No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP computed results are plotted with the D-1641 standard and observed Prisoners Point EC for the 2020 simulation period.

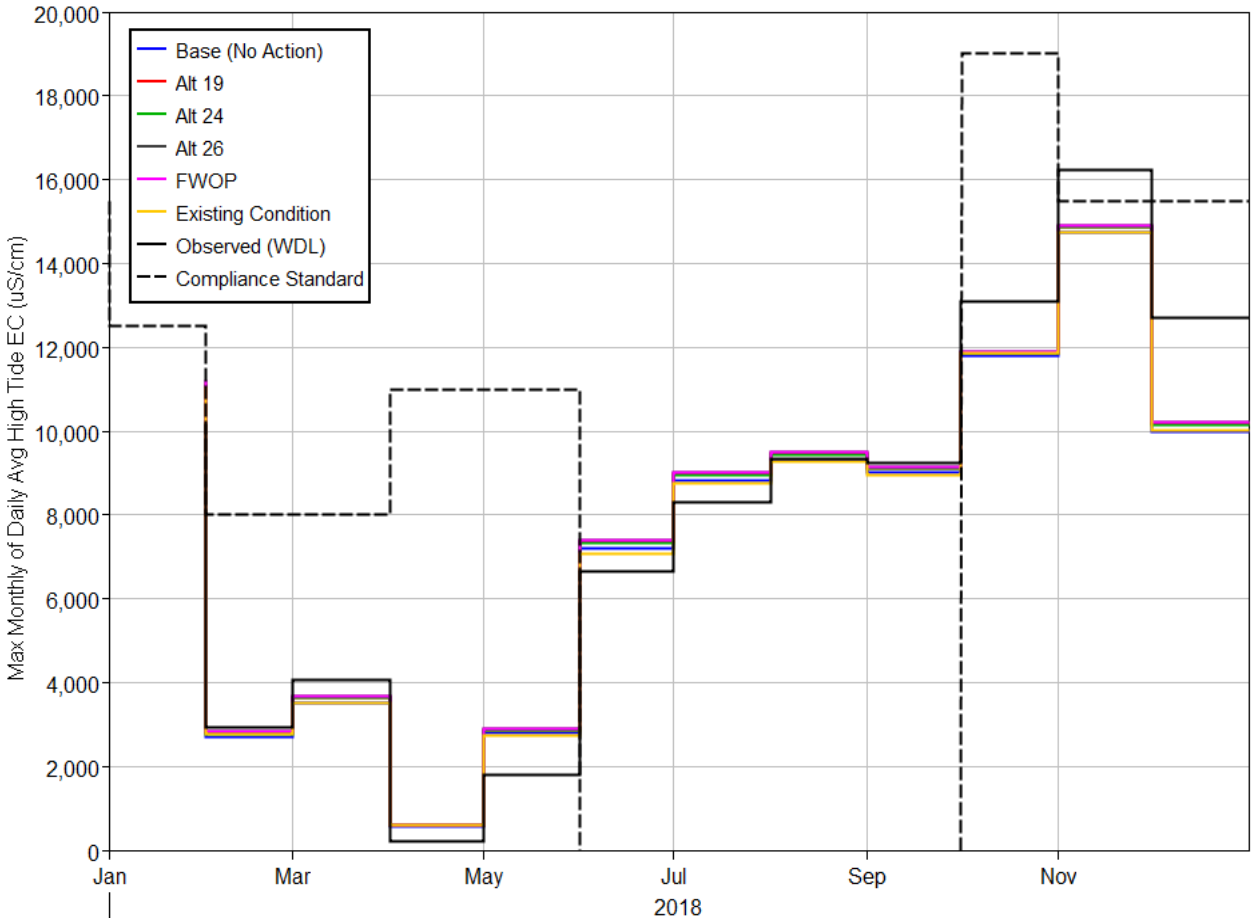

Figure 96 Max monthly of daily average of high tide EC for the Sacramento River at Collinsville (C2). No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP computed results are plotted with the D-1641 standard and observed Collinsville EC for the 2018 simulation period.

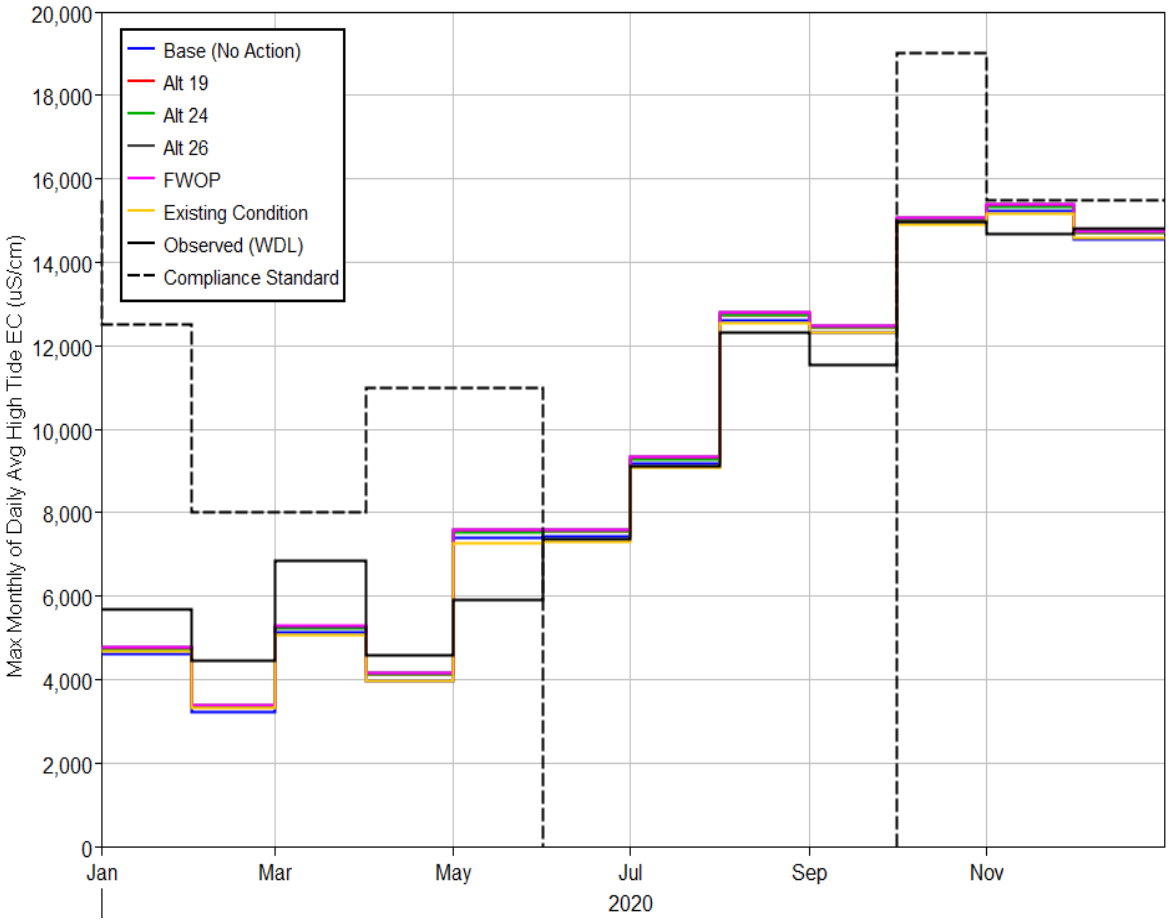

Figure 97 Max monthly of daily average of high tide EC for the Sacramento River at Collinsville (C2). No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP computed results are plotted with the D-1641 standard and observed Collinsville EC for the 2020 simulation period.

X2

Base and alternatives X2 distances are plotted with monthly averaged differences in Figure 98 for 2018 and in Figure 99 for 2020. Little Egbert restoration alternatives result in changes in X2 of less than 0.2 km. The maximum monthly averaged increase of 0.18 km occurs in December 2020 for the Alternative 26 scenario. At this time Alternative 24 has the smallest X2 increase of 0.12 km.

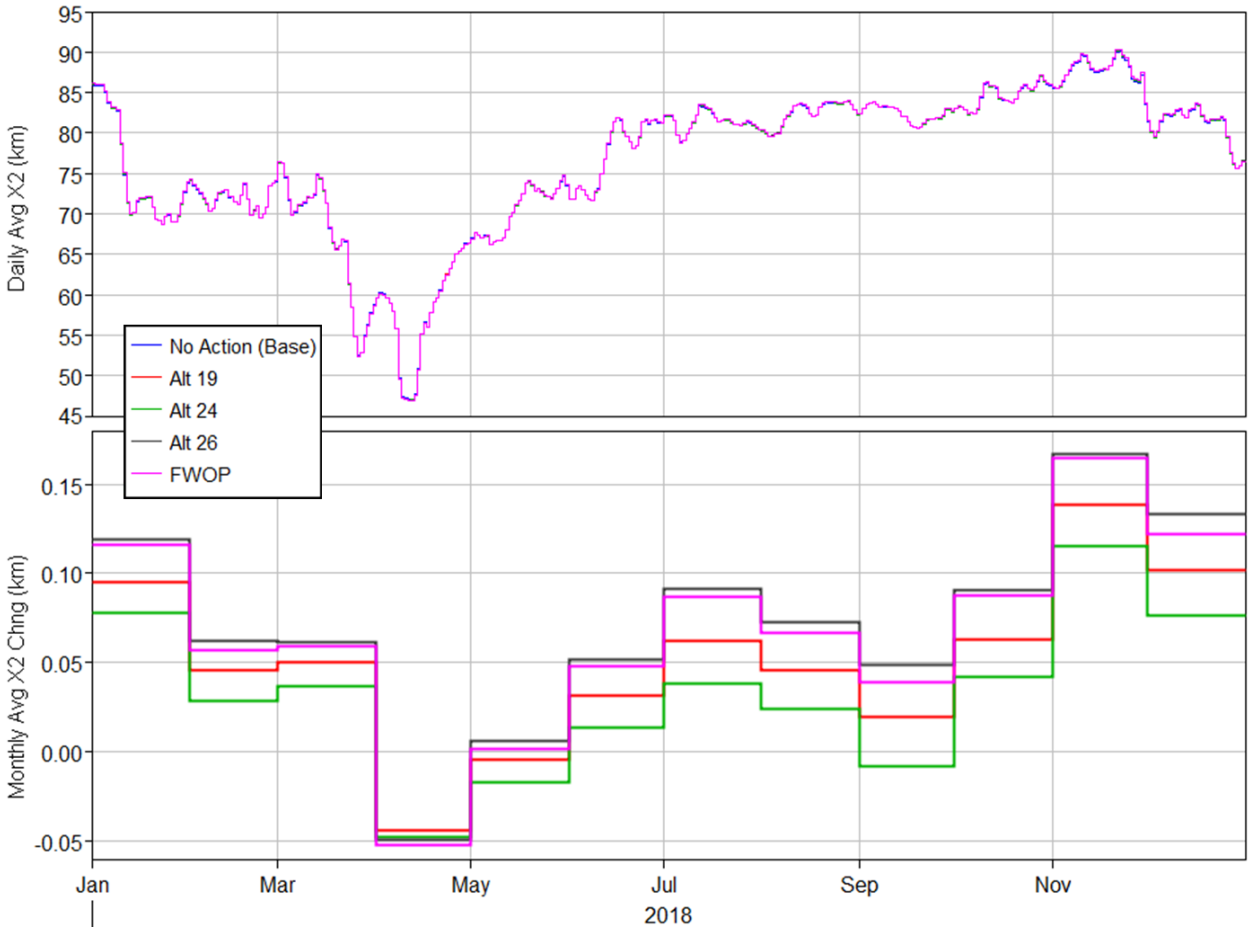

Figure 98 No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP daily average X2 location (top) and monthly average change from Base X2 location (bottom) for the 2018 simulation period.

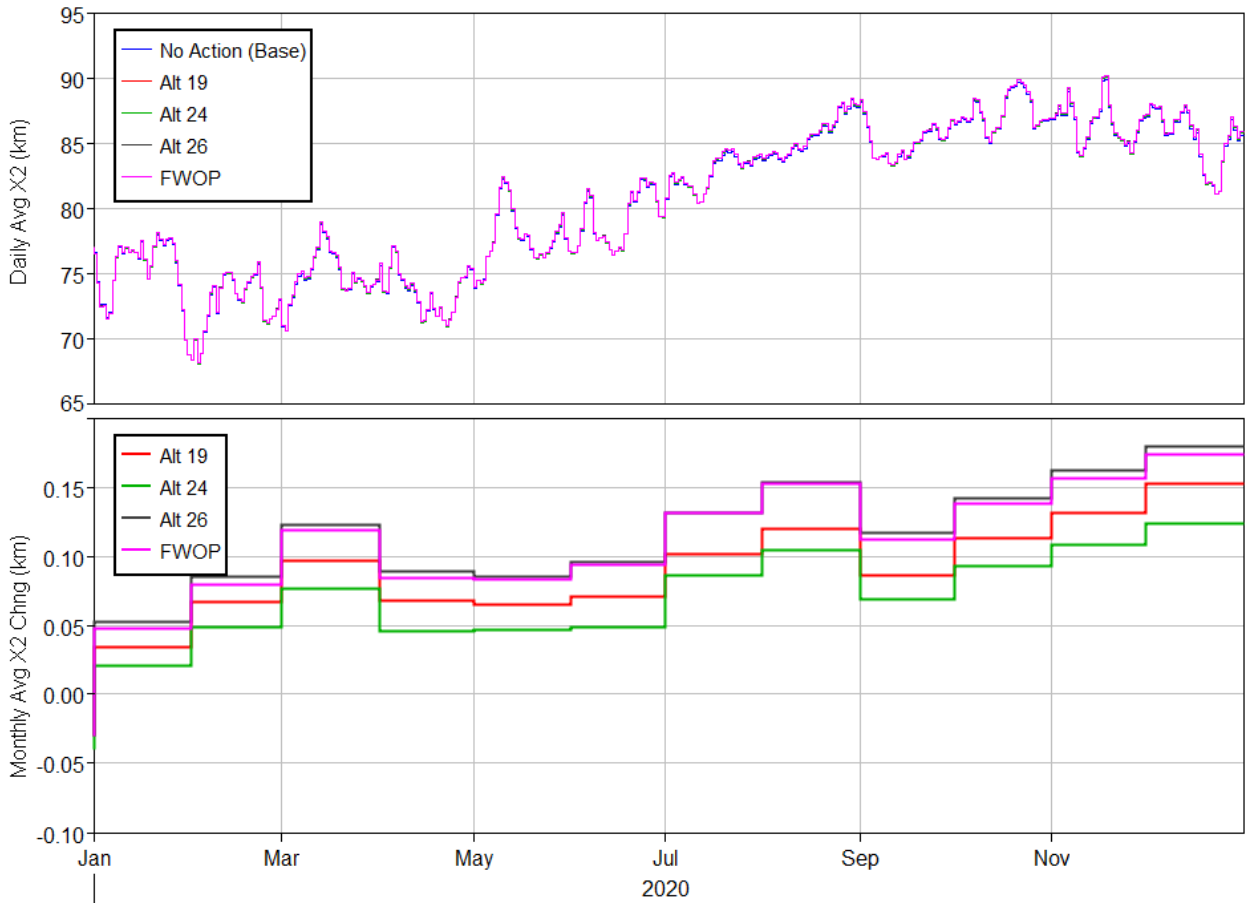

Figure 99 No Action (Base), Alternative 19, Alternative 24, Alternative 26 and FWOP daily average X2 location (top) and monthly average change from Base X2 location (bottom) for the 2020 simulation period.

Summary and Conclusions

The RMA Bay-Delta model was applied to evaluate the Little Egbert Multi-Benefit Project salinity impacts relative to a Base (No Action) condition. The No Action condition represents the current state of Little Egbert Tract (no tidal action and not included in the grid). Three restoration alternatives (Alternative 19, Alternative 24 and Alternative 26) were considered, as well as a Future Without Project (FWOP) scenario with fully degraded levees. Key features of the restoration alternatives included variations of breaches and/or inlet weirs at the north and south ends of the site connected by subtidal swales. All grids include newly constructed and late planning stage tidal marsh restoration sites throughout the Delta. Little Egbert Tract and all other restoration sites are represented in sufficient detail to achieve the modeling goal of assessing regional salinity impacts.

The first objective of the salinity (EC) evaluation was to quantify salinity changes from the Base (No Action) condition resulting from LEMBP alternatives. Monthly averaged EC was computed and compared for select D-1641 compliance locations and water exports. The modeling results showed that Project alternatives produced both decreases and increases in computed EC both seasonally and spatially. The largest salinity increases (up to 11%) occurred in the Sacramento River at Emmaton during the summer of 2020. The largest salinity decreases (as much as -6%) occurred in Barker Slough during the spring of 2020. South Delta export/water intake locations see salinity increases peaking at 2% – 4% during the fall months.

The alternatives generally increased EC by 1 to 4% from the Base condition for central and south Delta locations in the summer and fall, with larger increases occurring in 2020 versus 2018. At Emmaton, salinity increases of 3% to 11% occurred throughout much of the simulation periods. In Barker Slough, salinity decreased by as much as -6%.

The most favorable salinity results (smallest increases over Base) occur for Alternative 24. The least favorable salinity results (largest increases over Base) occur for Alternative 26 and FWOP, which produce very similar salinity results. The notable exception is at the Barker Slough NBA intake, where the FWOP alternative produces the largest salinity reductions and Alternative 24 produces the smallest reductions.

Salinity impacts appear to be greatest when Little Egbert Tract is fully breached at both ends (Alternative 26) or with fully degraded levees (FWOP). With a higher northern inlet weir that overtops only during high flows (Alternatives 19 and 24), the impacts are reduced. The compound southern breach in Alternative 24 further restricts flow and reduces impacts, however peak flood tide velocities at this breach are estimated to reach up to 6 ft/s.

The second goal of the salinity model evaluation was to determine the potential for Project alternatives to result in non-compliance with the D-1641 water quality objectives. Seasonal EC standards apply to Agriculture, Fish and Wildlife compliance stations at the Sacramento River at Emmaton (D22), Sacramento River at Collinsville (C2), and the San Joaquin River at Jersey Point (D15) and Prisoners Point (D29). Project alternatives EC values over the compliance periods (Apr 1 – Aug 15 for D22 and D15, Oct 1 – May 31 for C2, Apr 1 – May 31 for D29) were predicted to be well under the compliance limits, except for Jersey Point, where Alternatives 19 and 26 and the FWOP scenario were predicted to exceed the standards on the last day of the compliance period in 2018.

Evaluation of changes to X2 indicates that the Project alternatives would generally increase monthly averaged X2 by 0.2 km or less.

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Appendix A: Model Boundary Conditions

2018 Model Boundary conditions

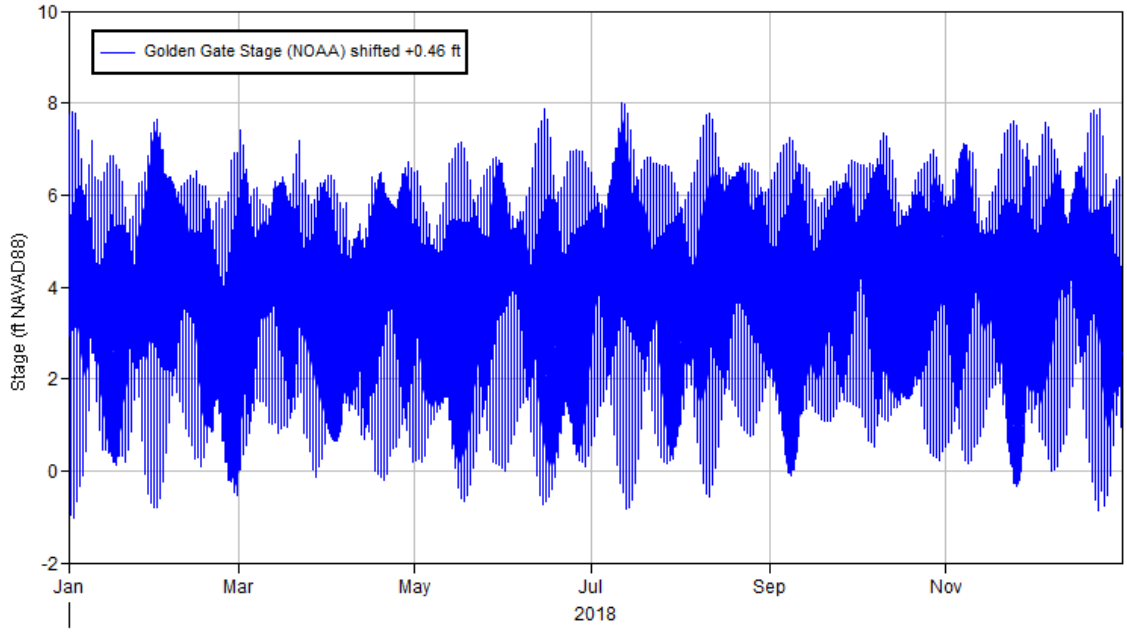

Figure 100 Golden Gate stage boundary for 2018 (data source: NOAA, shifted +0.46 ft). EC set constant at 50,000 uS/cm.

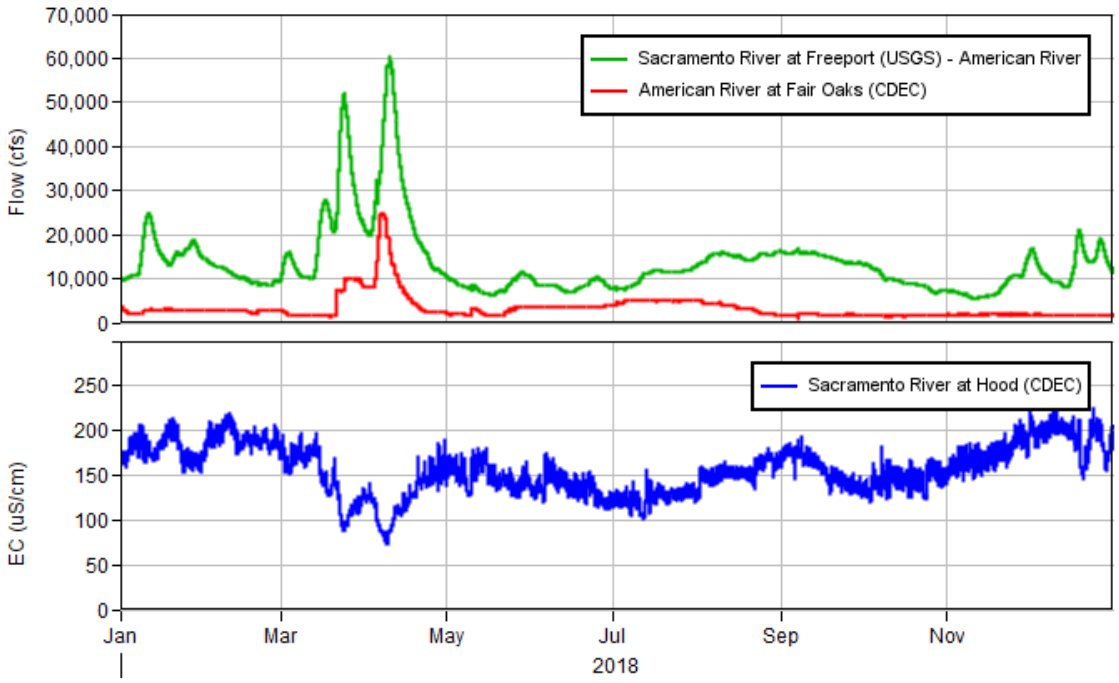

Figure 101 Flow and EC boundary conditions for the Sacramento River and American River for 2018. An internal EC boundary condition is applied in Sacramento River at Hood.

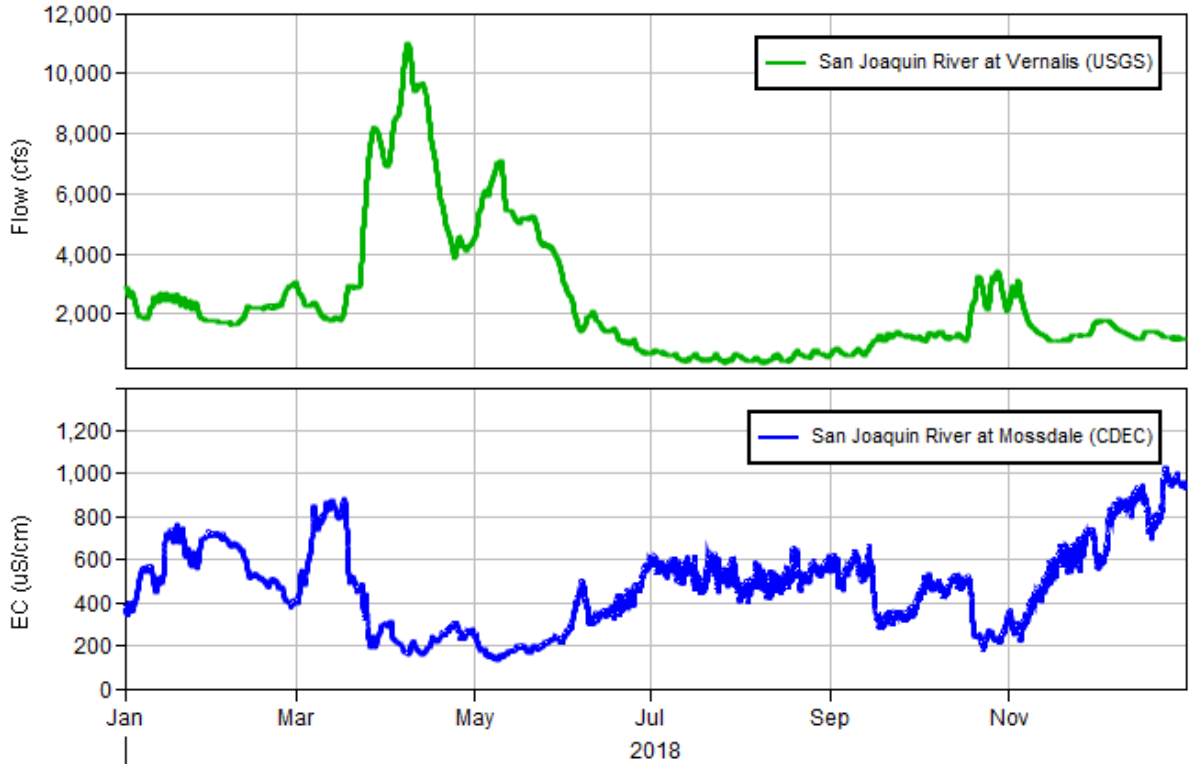

Figure 102 Flow and EC boundary conditions for the San Joaquin River for 2018. An internal EC boundary condition is applied in San Joaquin River at Mossdale.

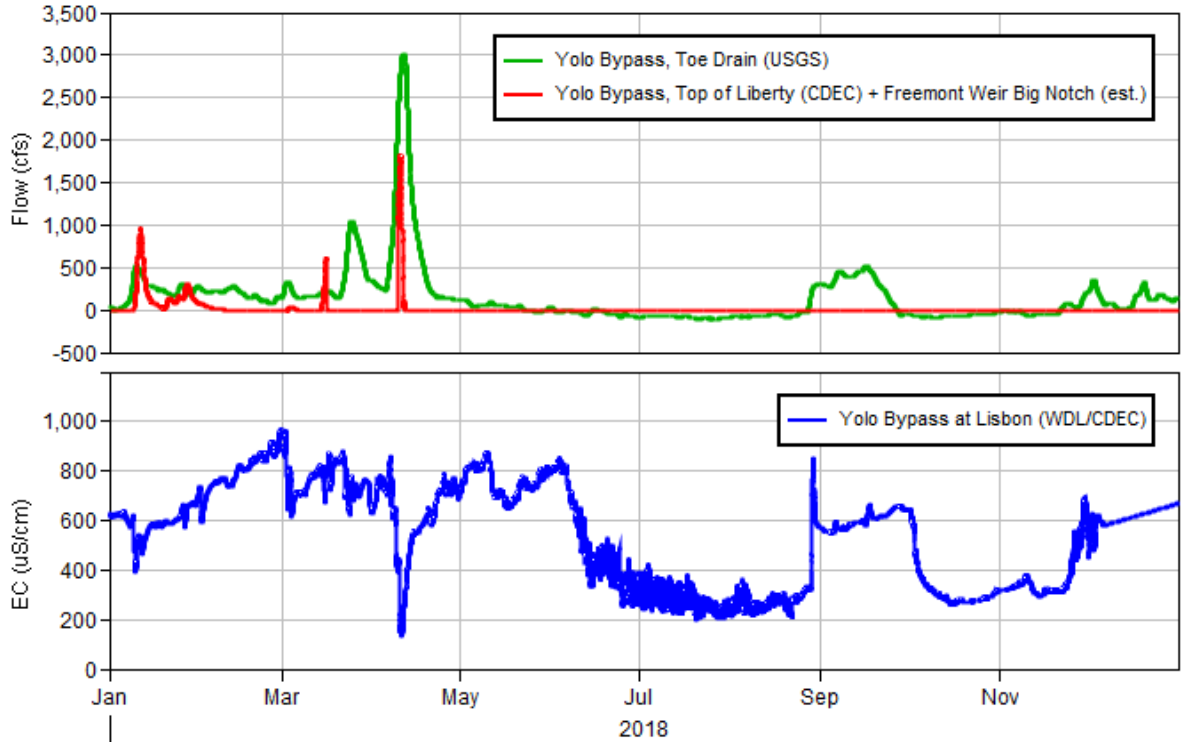

Figure 103 Flow and EC boundary conditions for the Yolo Bypass for 2018.

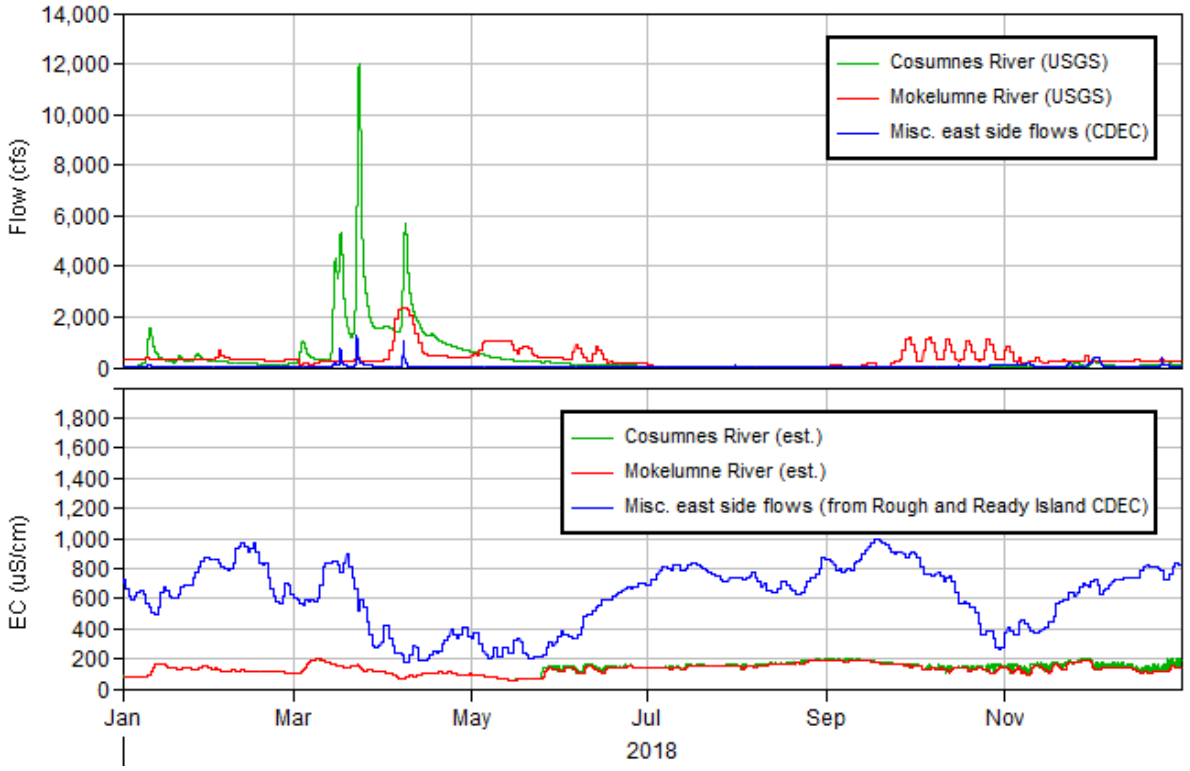

Figure 104 Flow and EC boundary conditions for east side inflows for 2018.

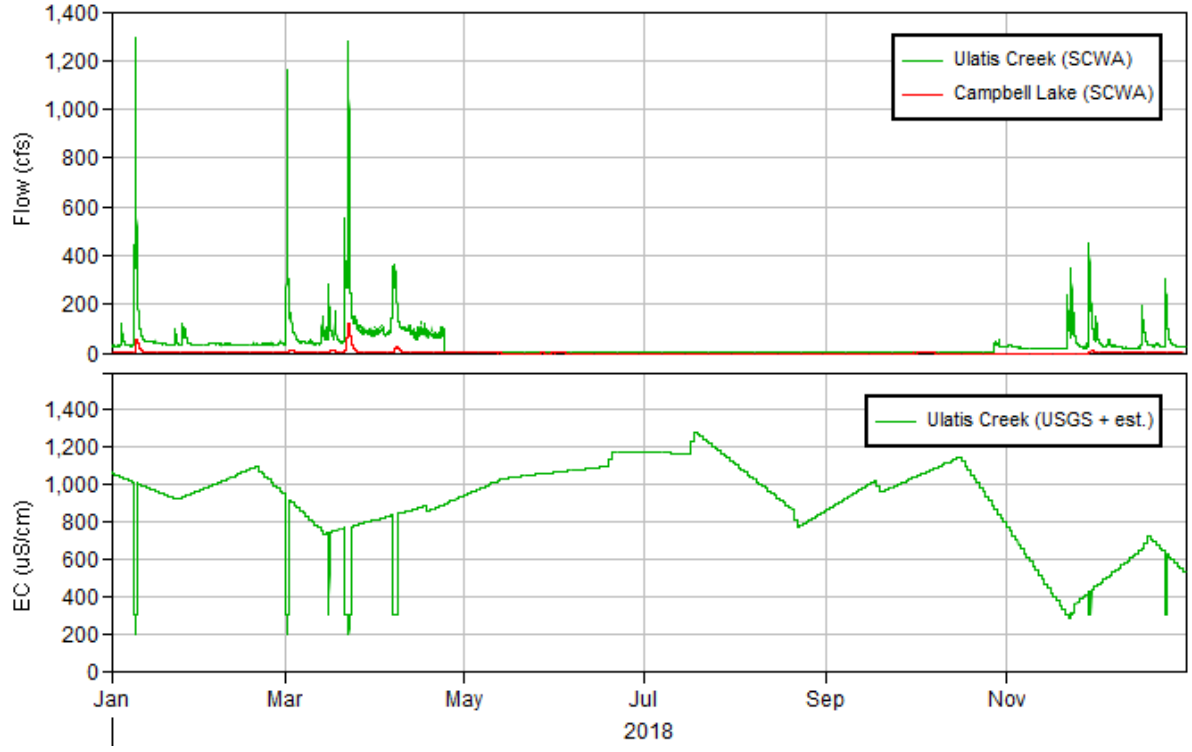

Figure 105 Flow and EC boundary conditions for Ulatis Creek and Campbell Lake for 2018 (EC set constant at 700 uS/cm for Campbell Lake).

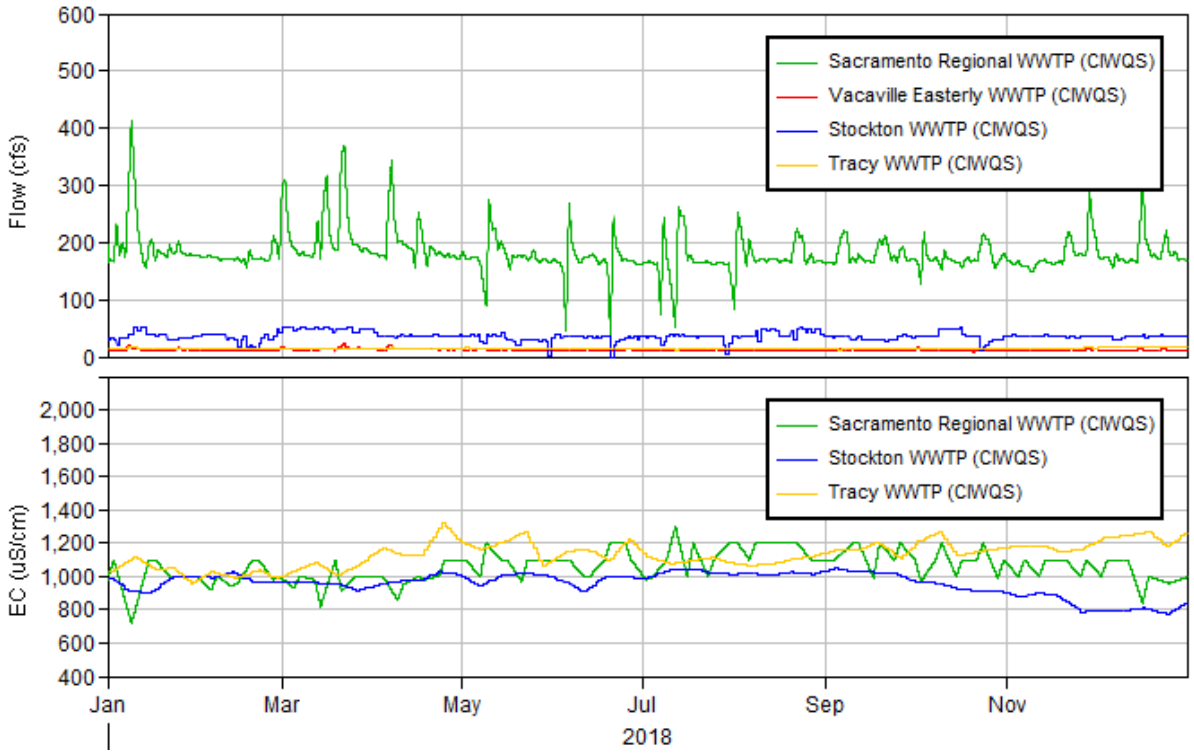

Figure 106 Flow and EC for Delta Wastewater Treatment Plants (WWTP) for 2018. Vacaville Easterly WWTP EC was set constant at 1050 uS/cm.

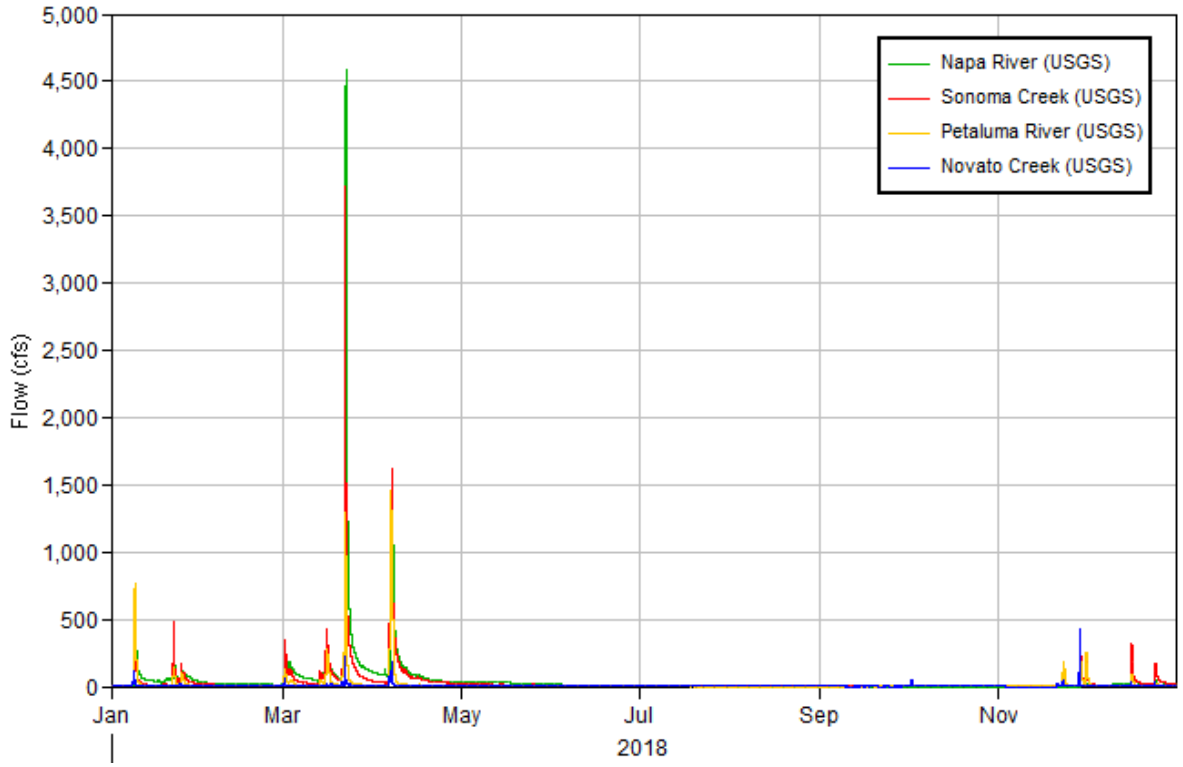

Figure 107 San Pablo Bay region inflows for 2018. EC set constant at 120 uS/cm.

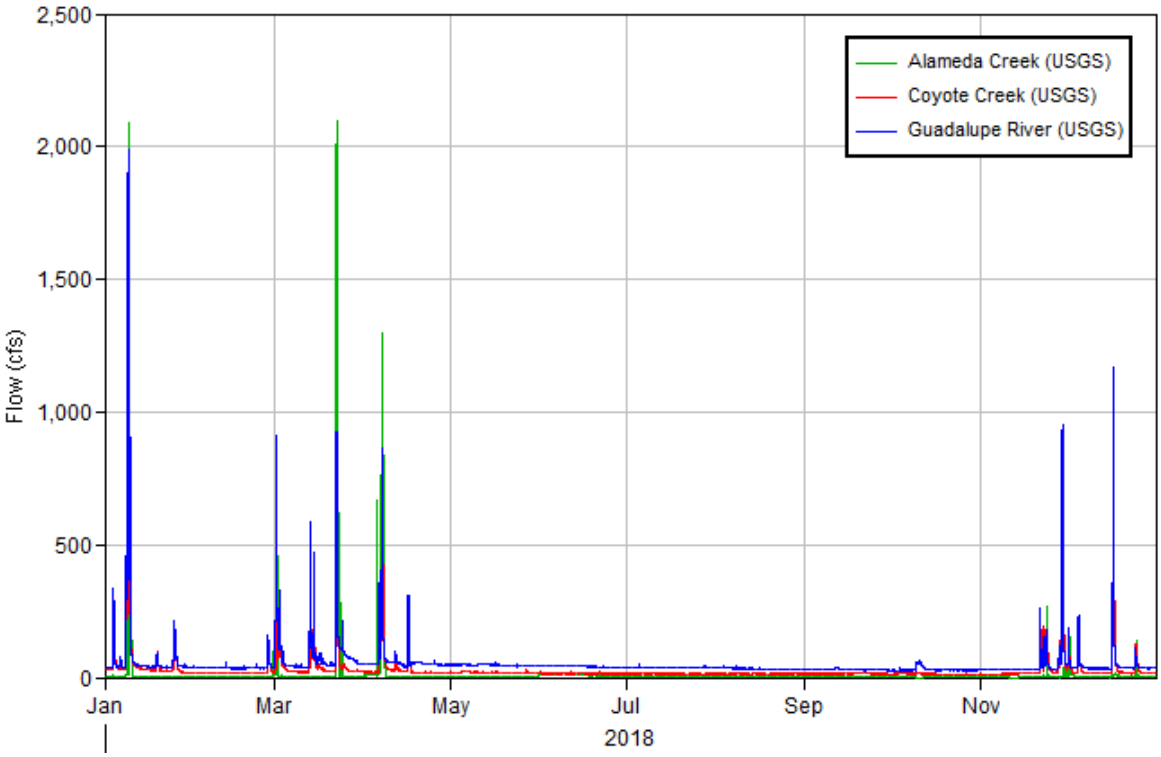

Figure 108 South Bay inflows for 2018. EC set constant at 120 uS/cm.

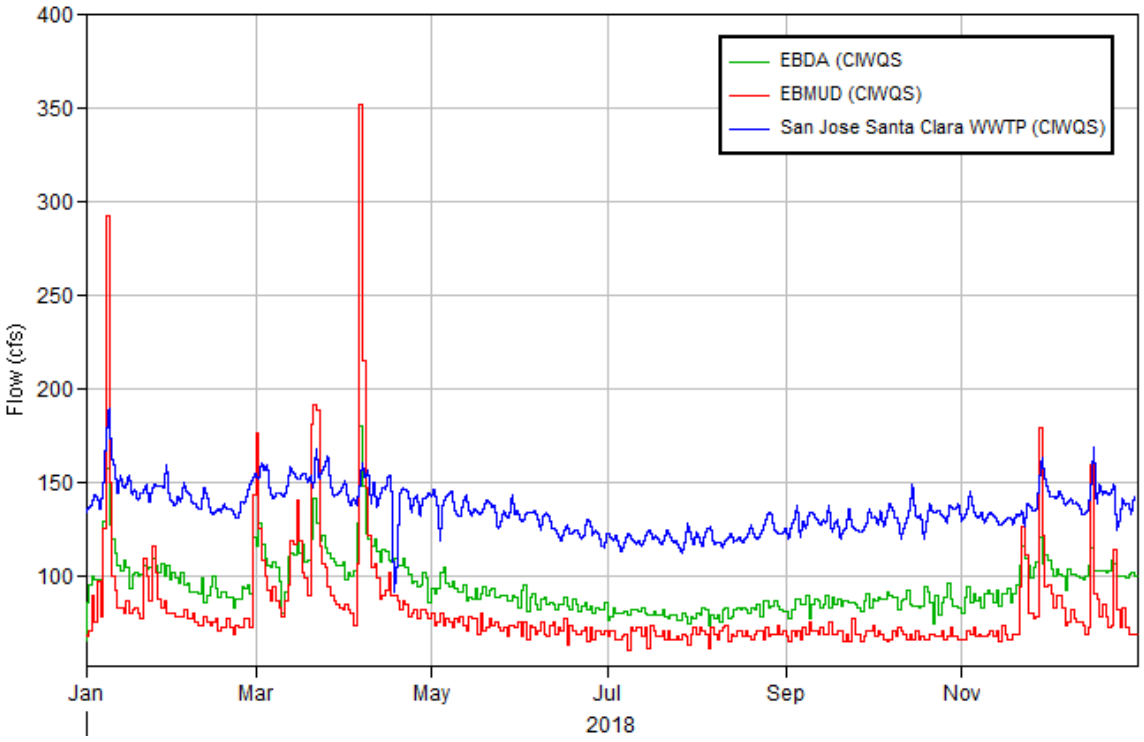

Figure 109 Wastewater Treatment Plant discharge flows in the south Bay region for 2018. EC set constant at 950 uS/cm.

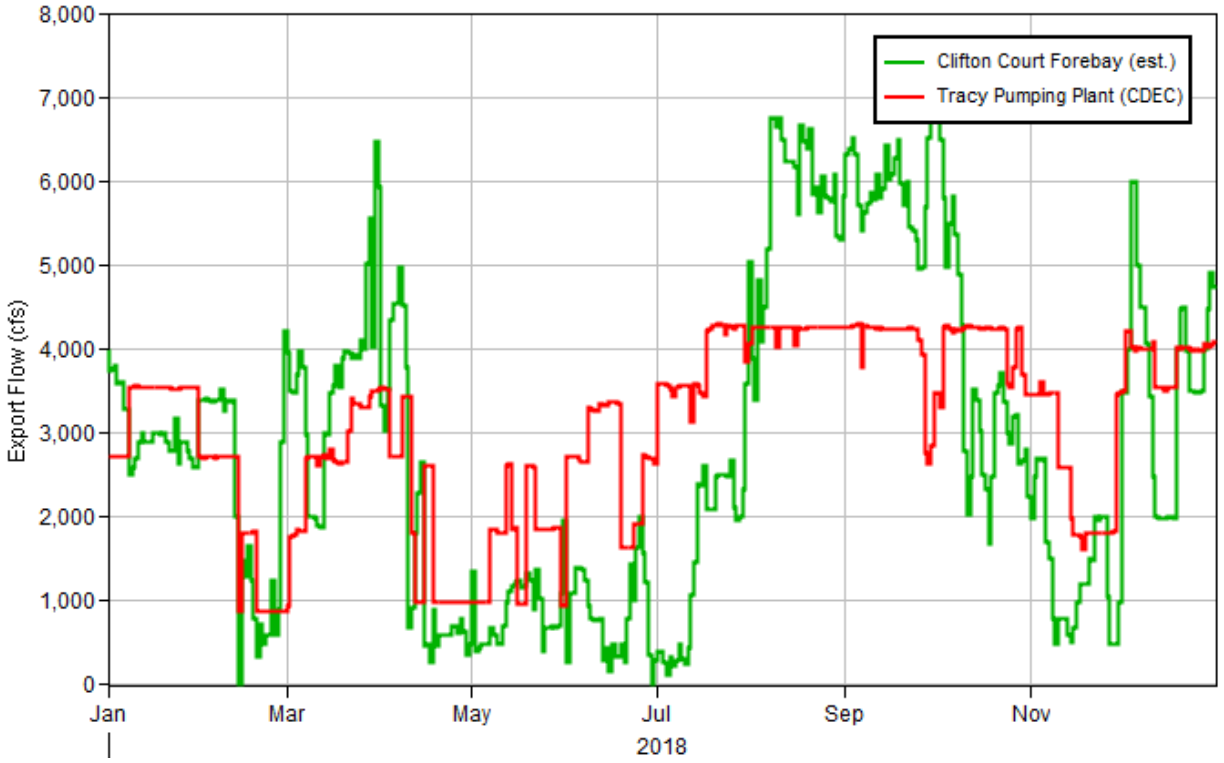

Figure 110 SWP (Clifton Court) and CVP (Tracy Pumping Plant) exports for 2018.

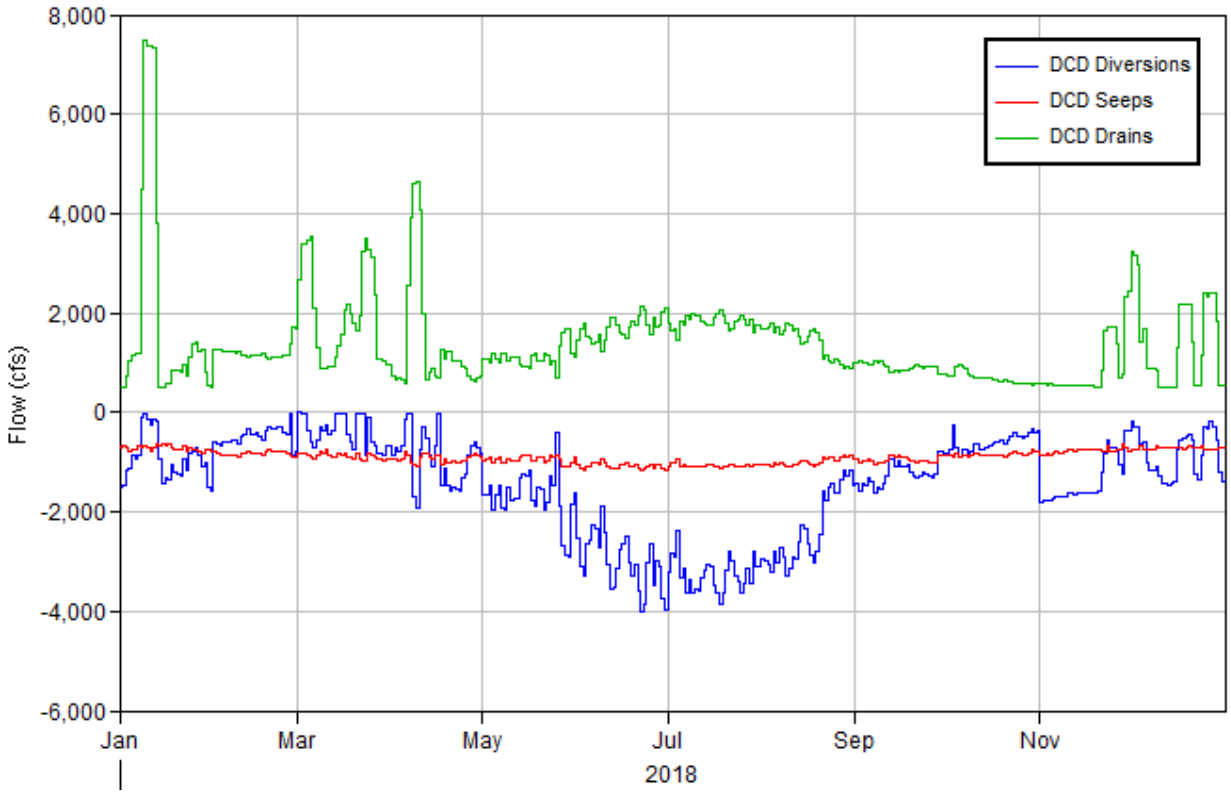

Figure 111 Sum of Delta DCD diversions, seeps and drains for 2018.

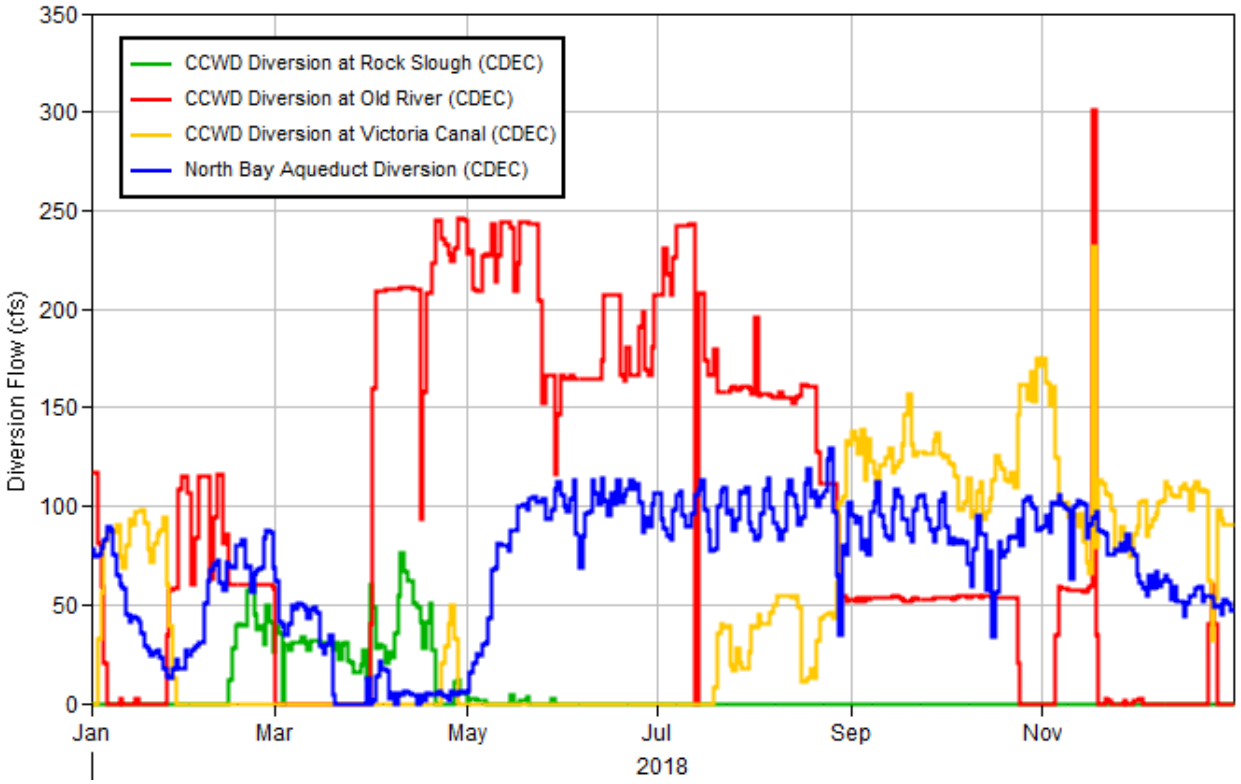

Figure 112 CCWD and North Bay Aqueduct diversions for 2018.

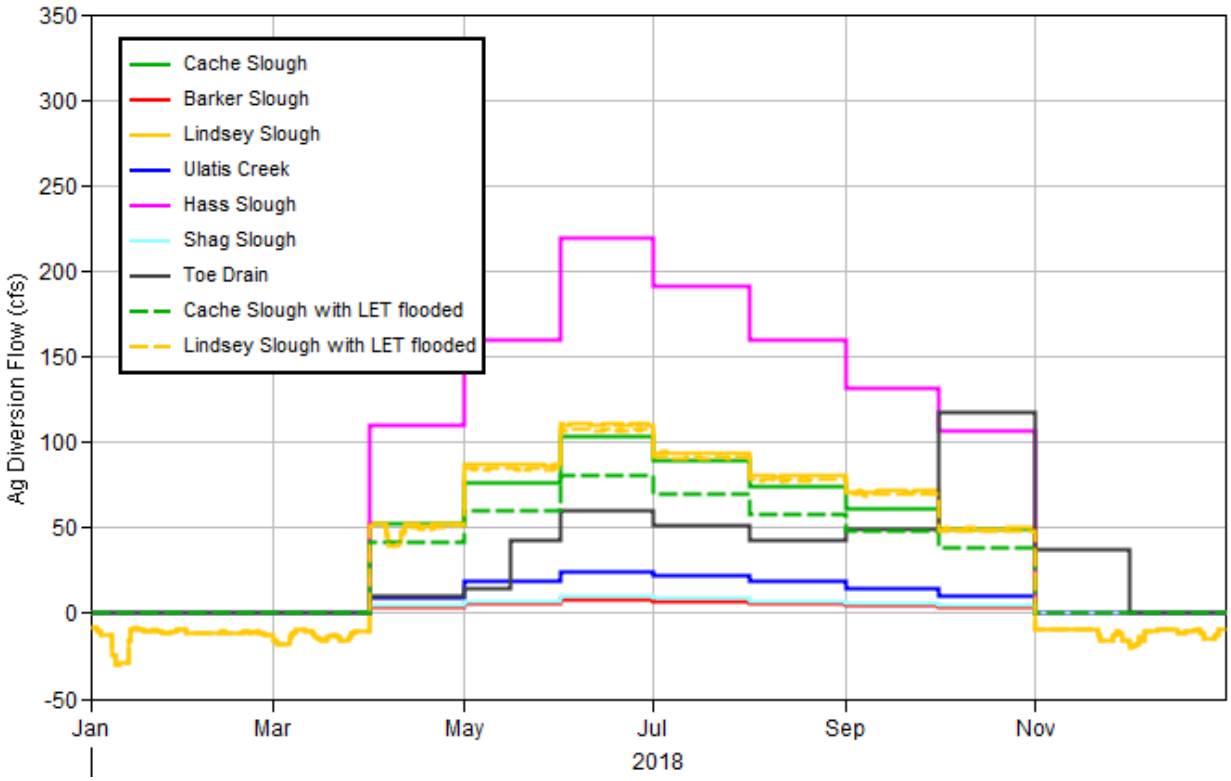

Figure 113 Agricultural diversions in the Cache Slough Complex channels for 2018.

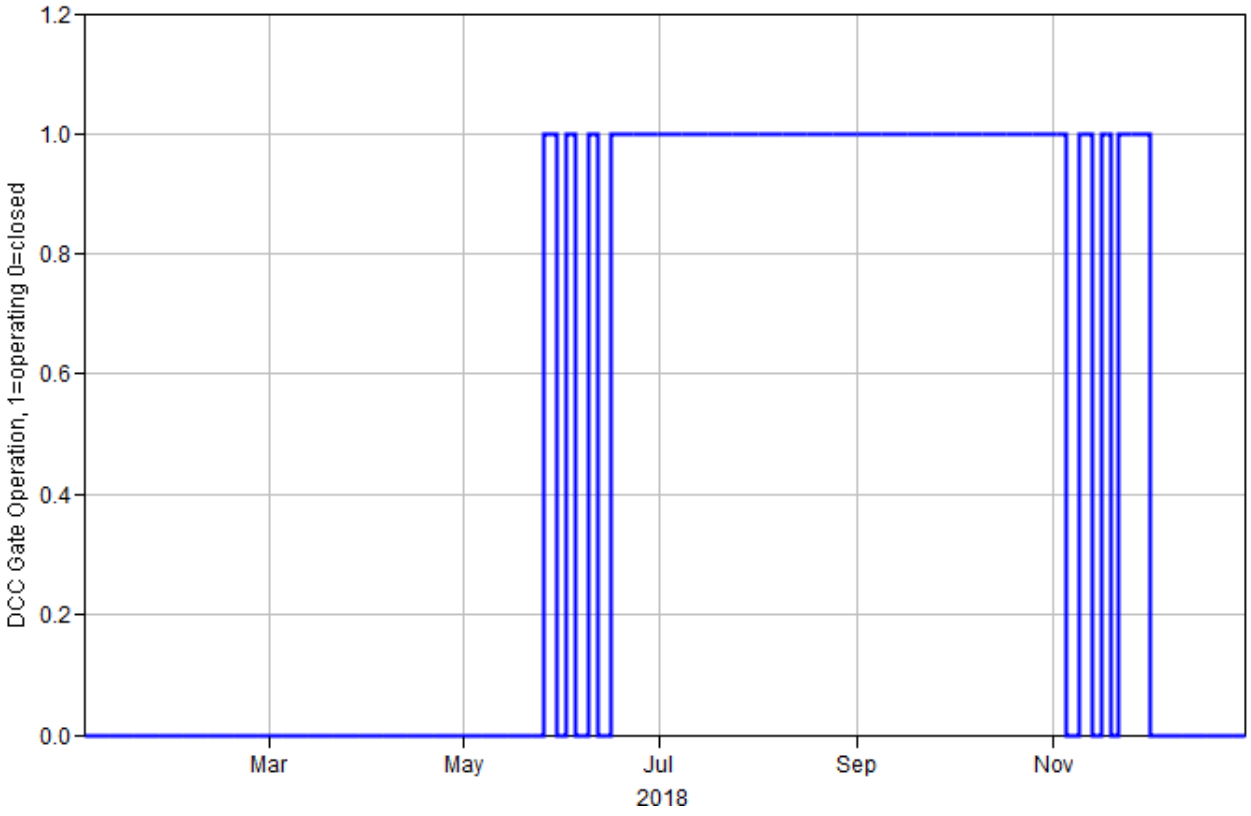

Figure 114 Delta Cross Channel operation schedule for 2018.

2020 Model Boundary conditions

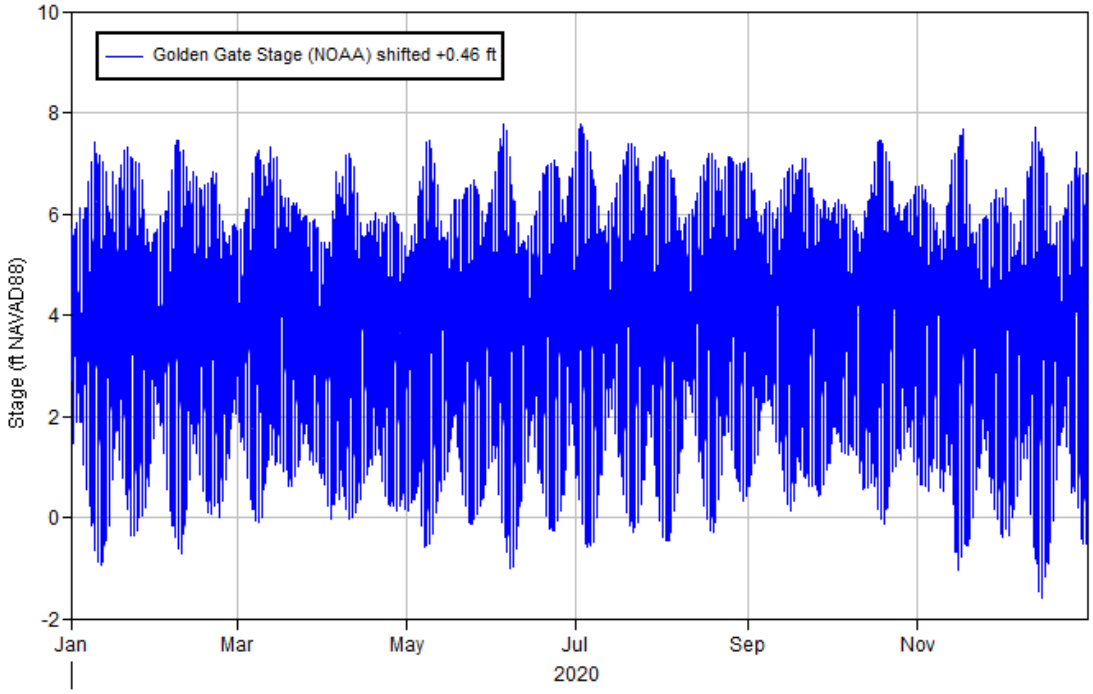

Figure 115 Golden Gate stage boundary for 2020 (data source: NOAA, shifted +0.46 ft). EC set constant at 50,000 uS/cm.

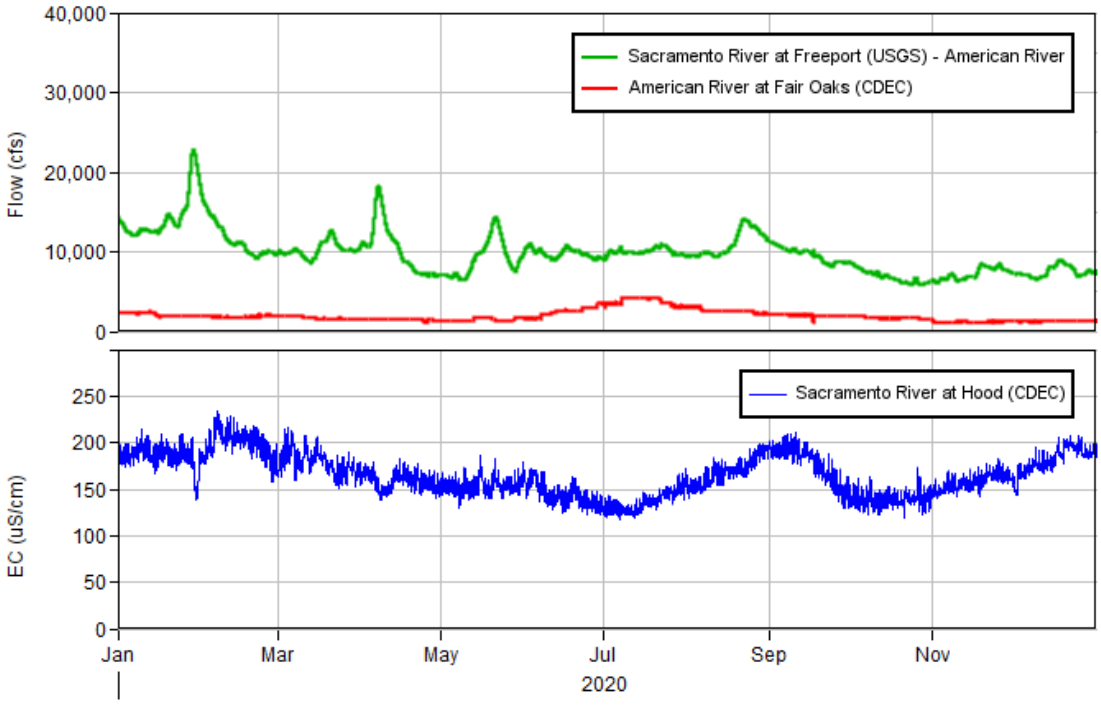

Figure 116 Flow and EC boundary conditions for the Sacramento River and American River for 2020. An internal EC boundary condition is applied in Sacramento River at Hood.

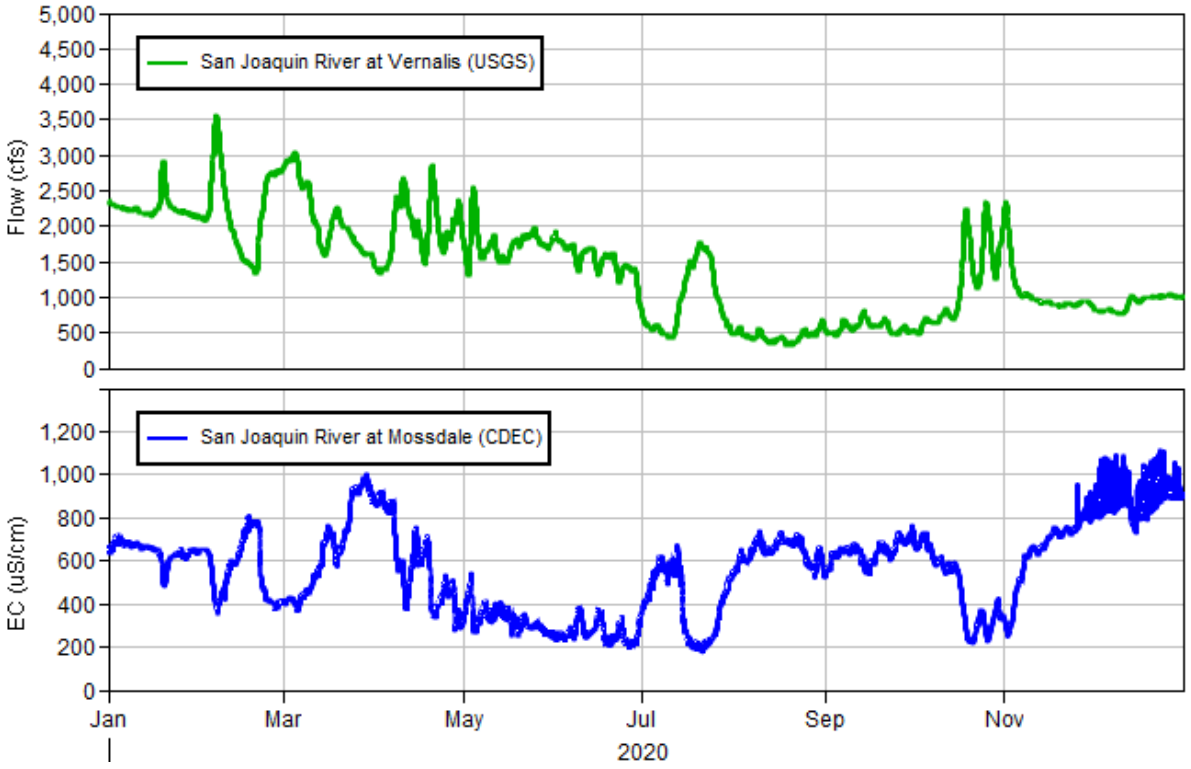

Figure 117 Flow and EC boundary conditions for the San Joaquin River for 2020. An internal EC boundary condition is applied in San Joaquin River at Mossdale.

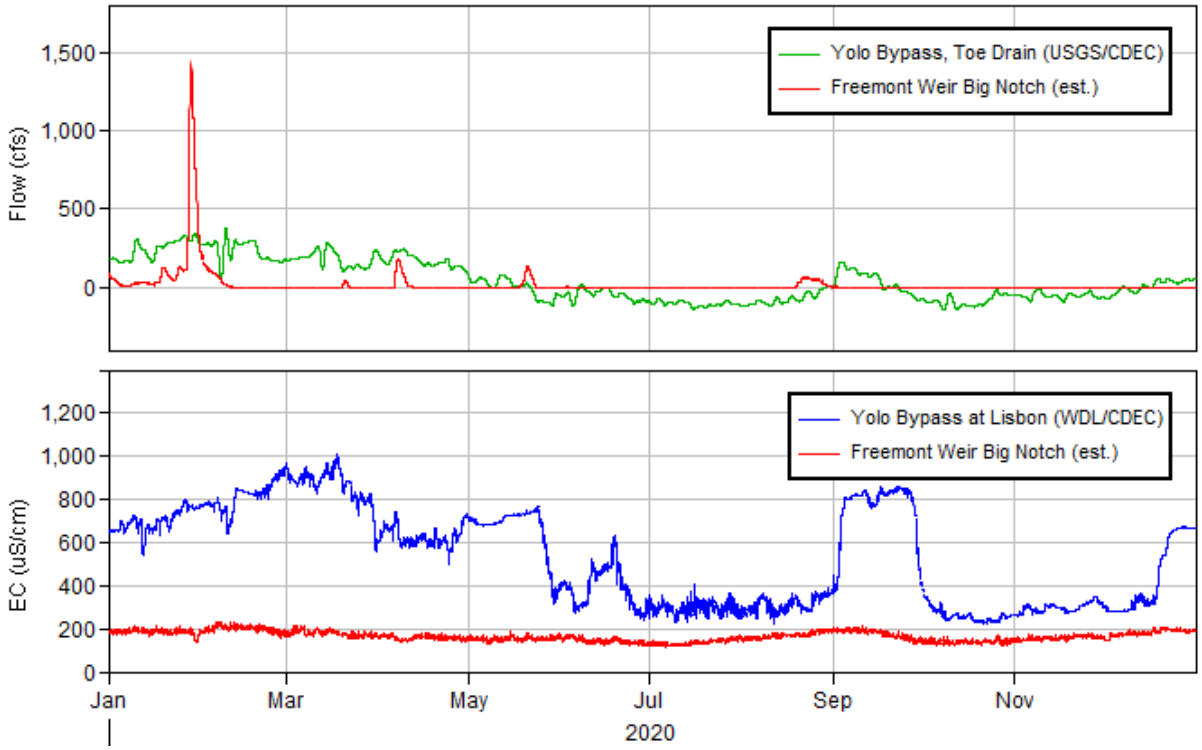

Figure 118 Flow and EC boundary conditions for the Yolo Bypass for 2020.

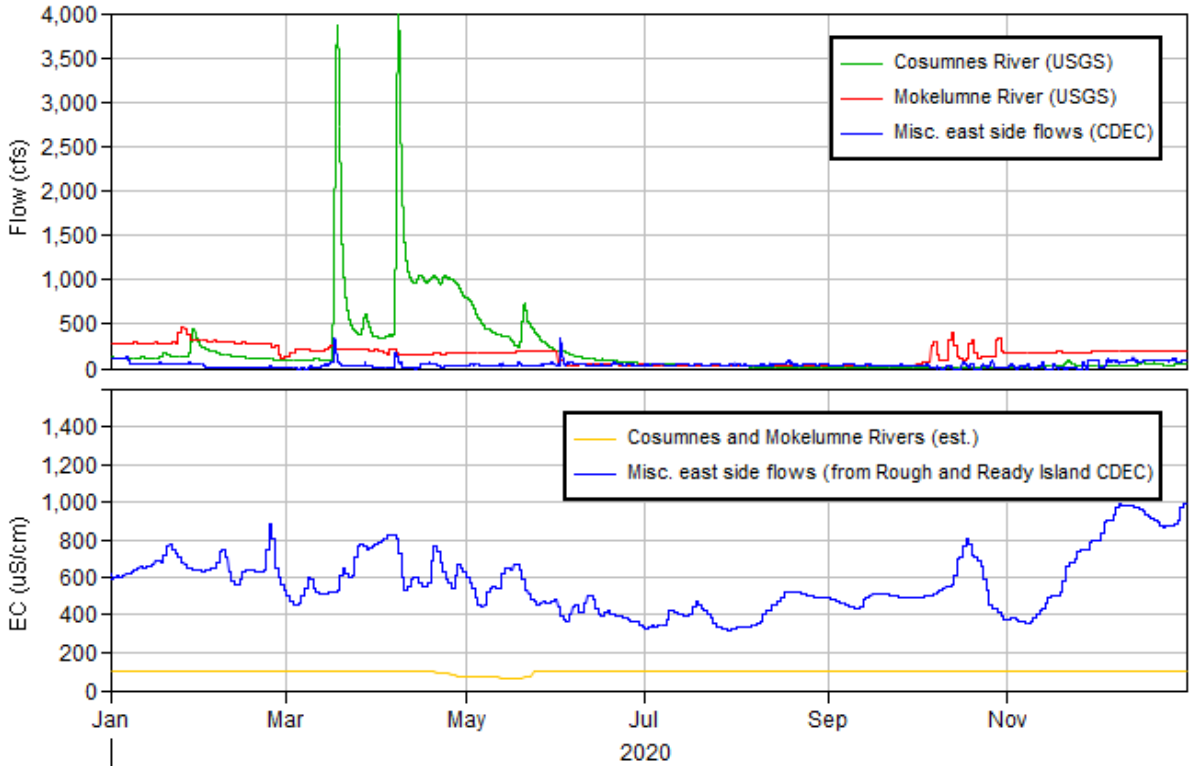

Figure 119 Flow and EC boundary conditions for east side inflows for 2020.

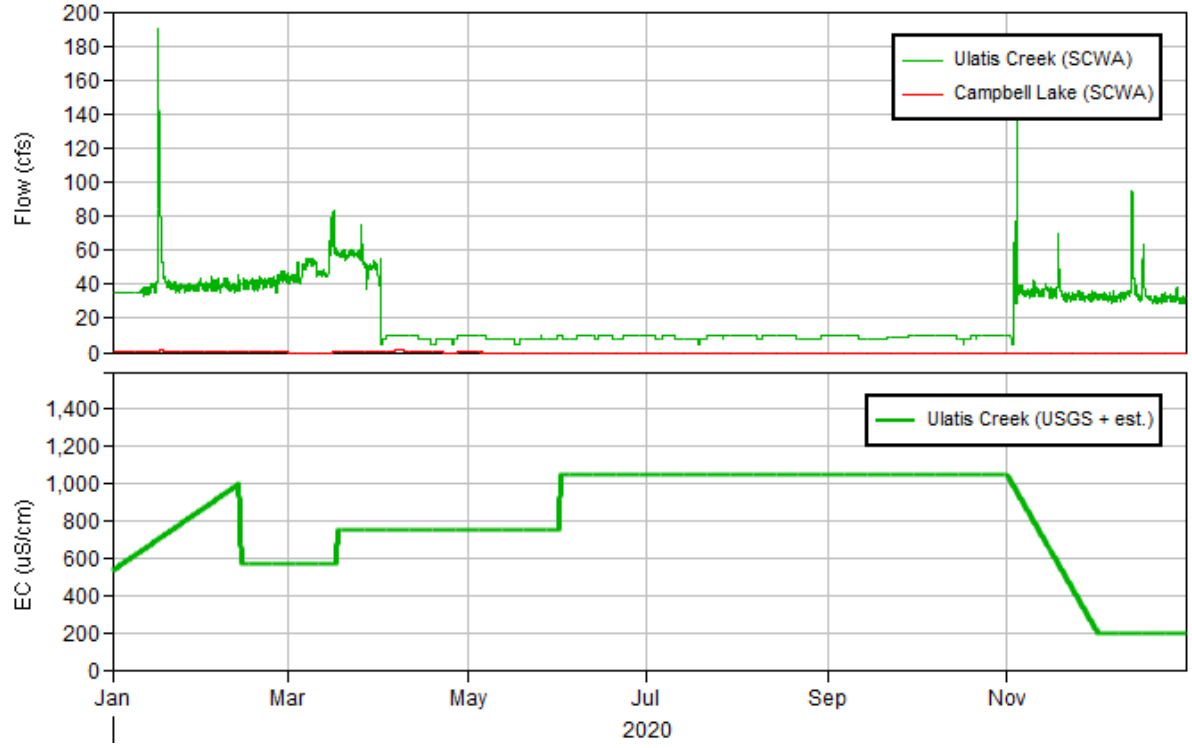

Figure 120 Flow and EC boundary conditions for Ulatis Creek and Campbell Lake for 2020 (EC set constant at 700 uS/cm for Campbell Lake).

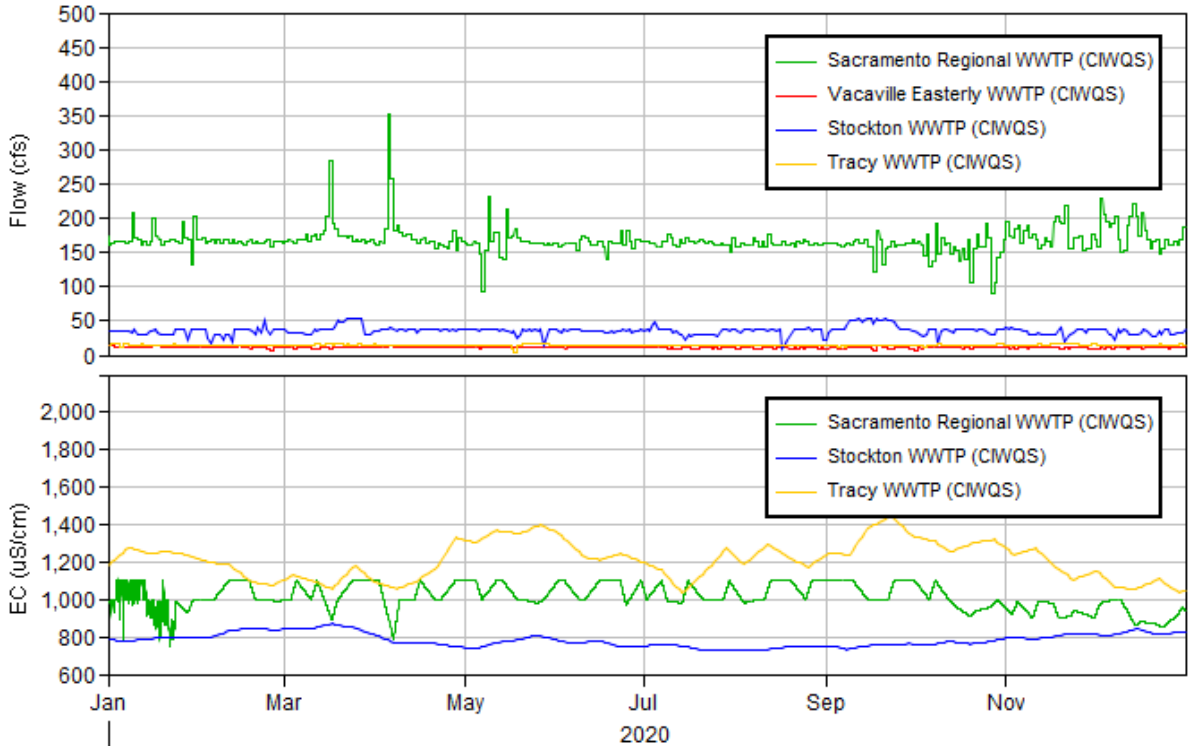

Figure 121 Flow and EC for Delta Wastewater Treatment Plants (WWTP) for 2020. Vacaville Easterly WWTP EC was set constant at 1050 uS/cm.

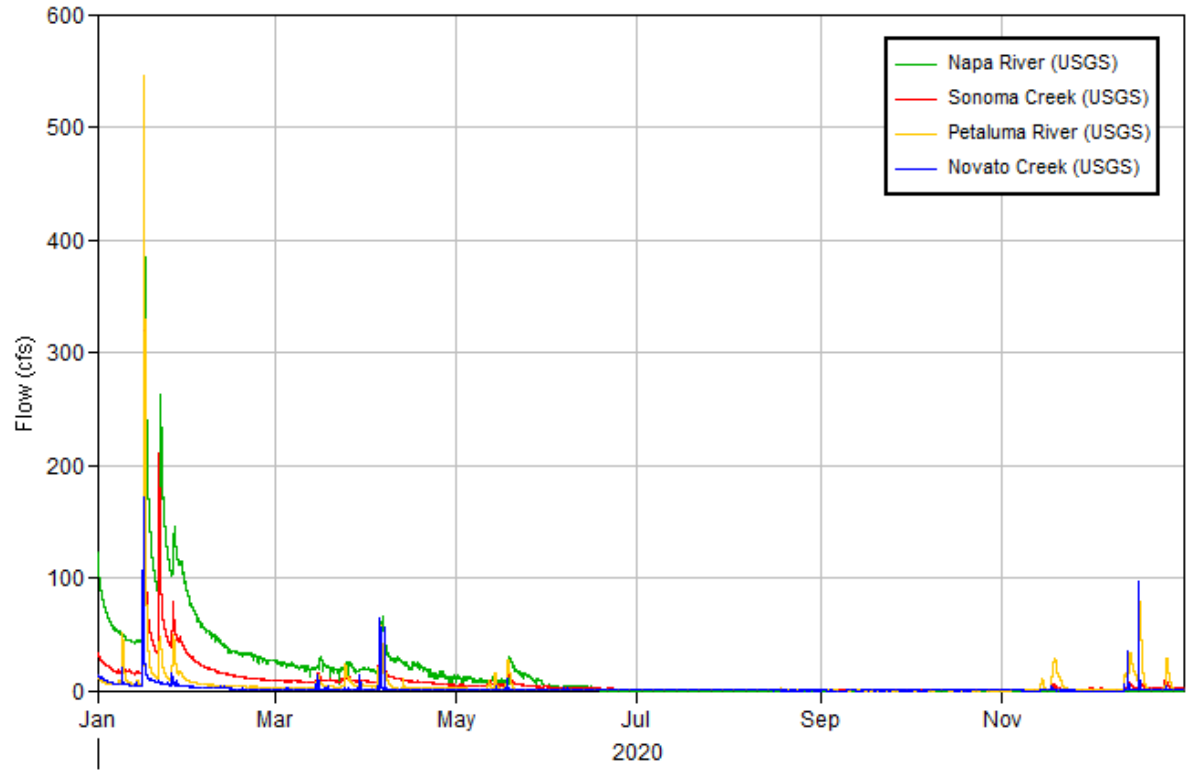

Figure 122 San Pablo Bay region inflows for 2020. EC set constant at 120 uS/cm.

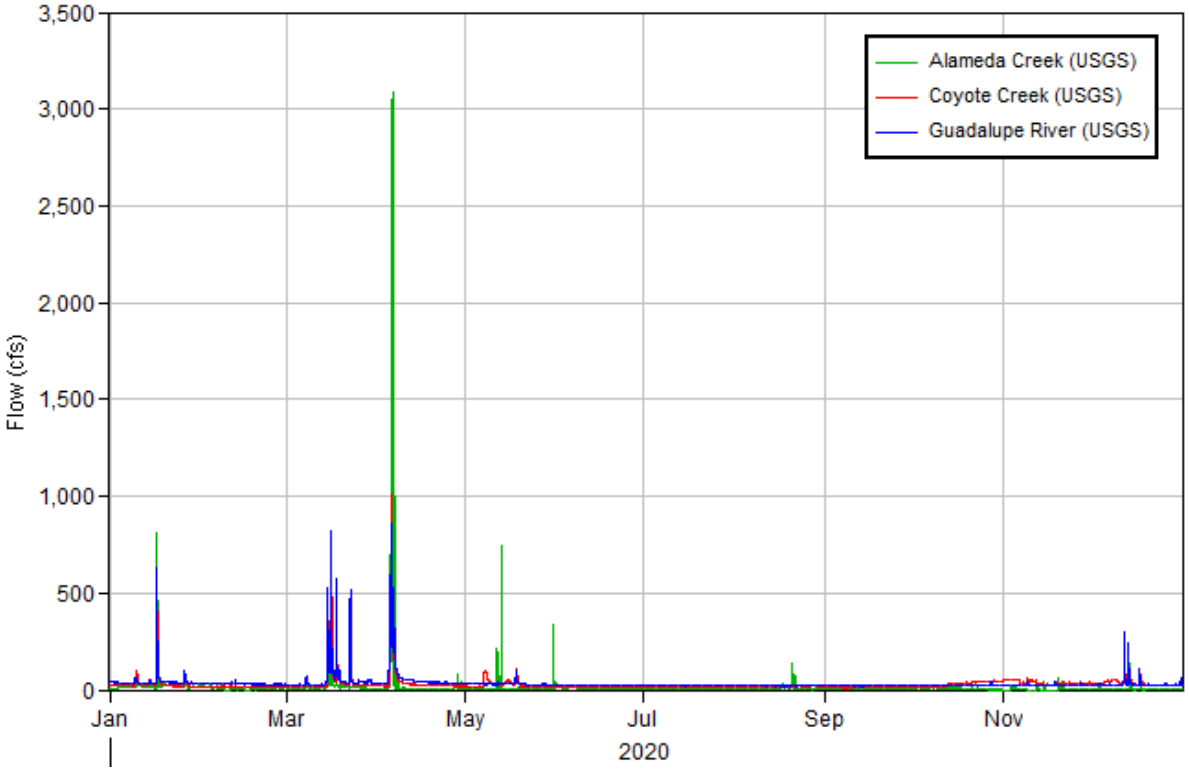

Figure 123 South Bay inflows for 2020. EC set constant at 120 uS/cm.

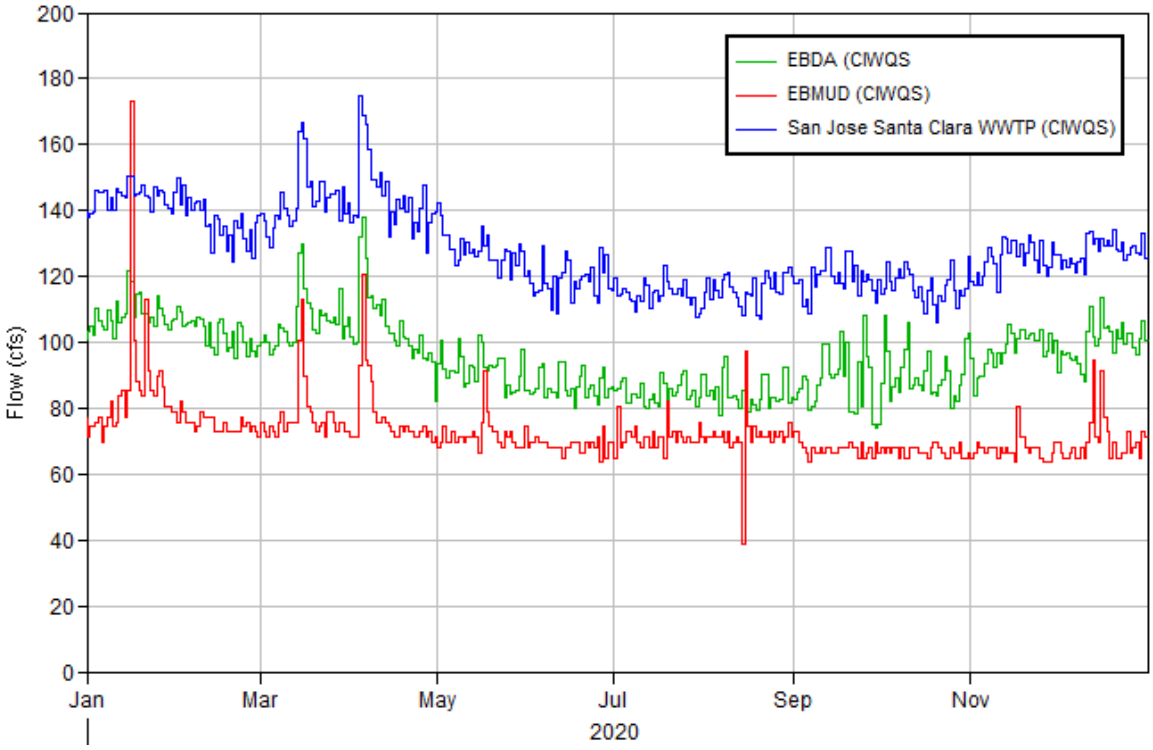

Figure 124 Wastewater Treatment Plant discharge flows in the south Bay region for 2020. EC set constant at 950 uS/cm.

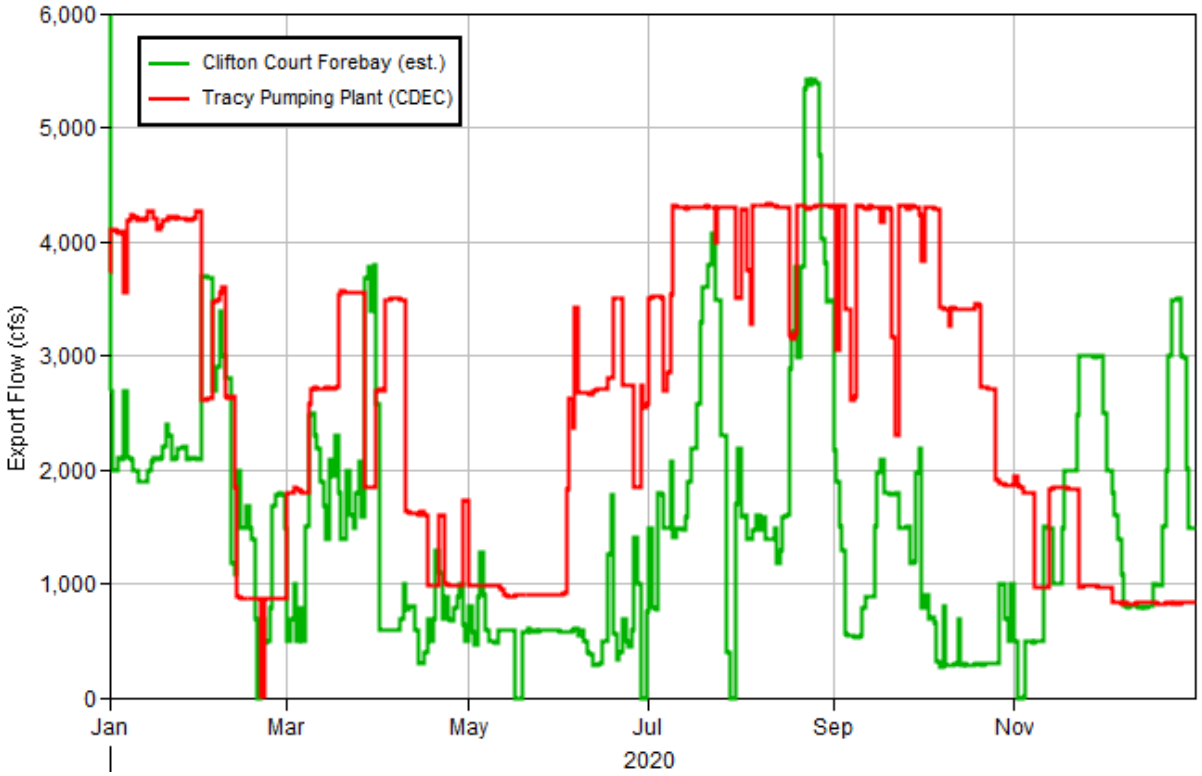

Figure 125 SWP (Clifton Court) and CVP (Tracy Pumping Plant) exports for 2020.

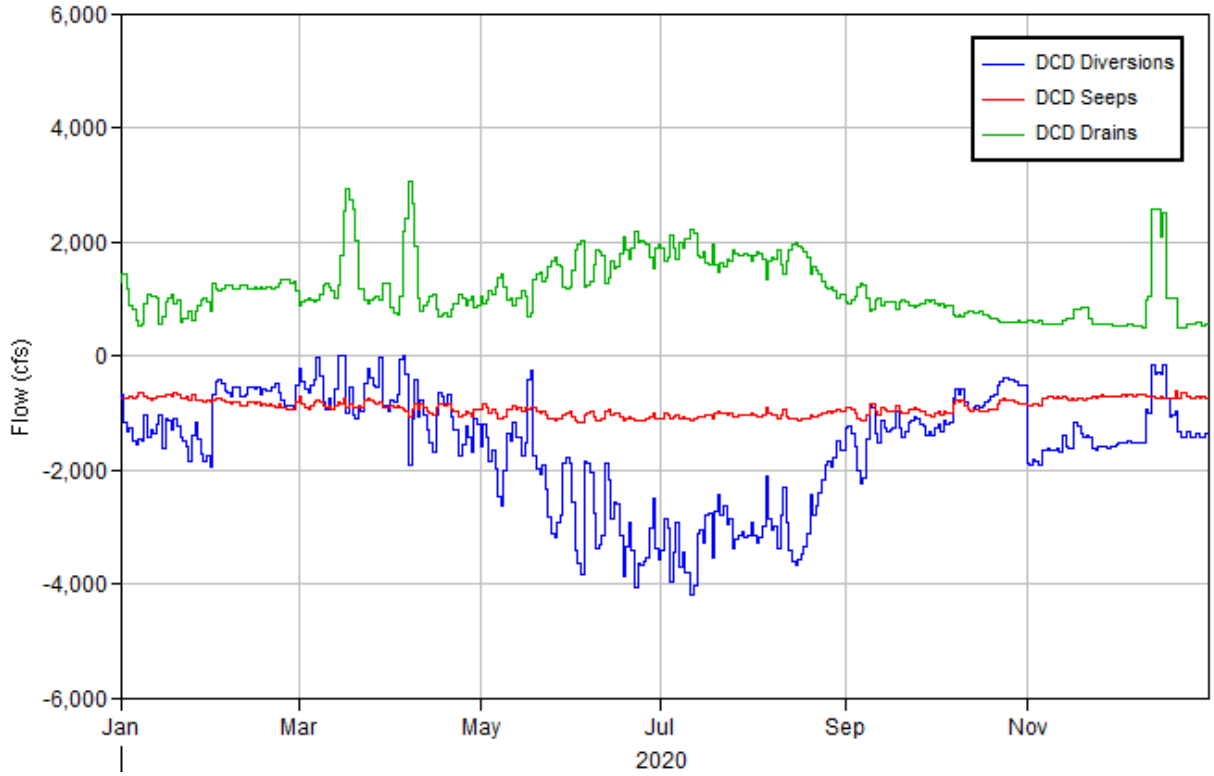

Figure 126 Sum of Delta DCD diversions, seeps and drains for 2020.

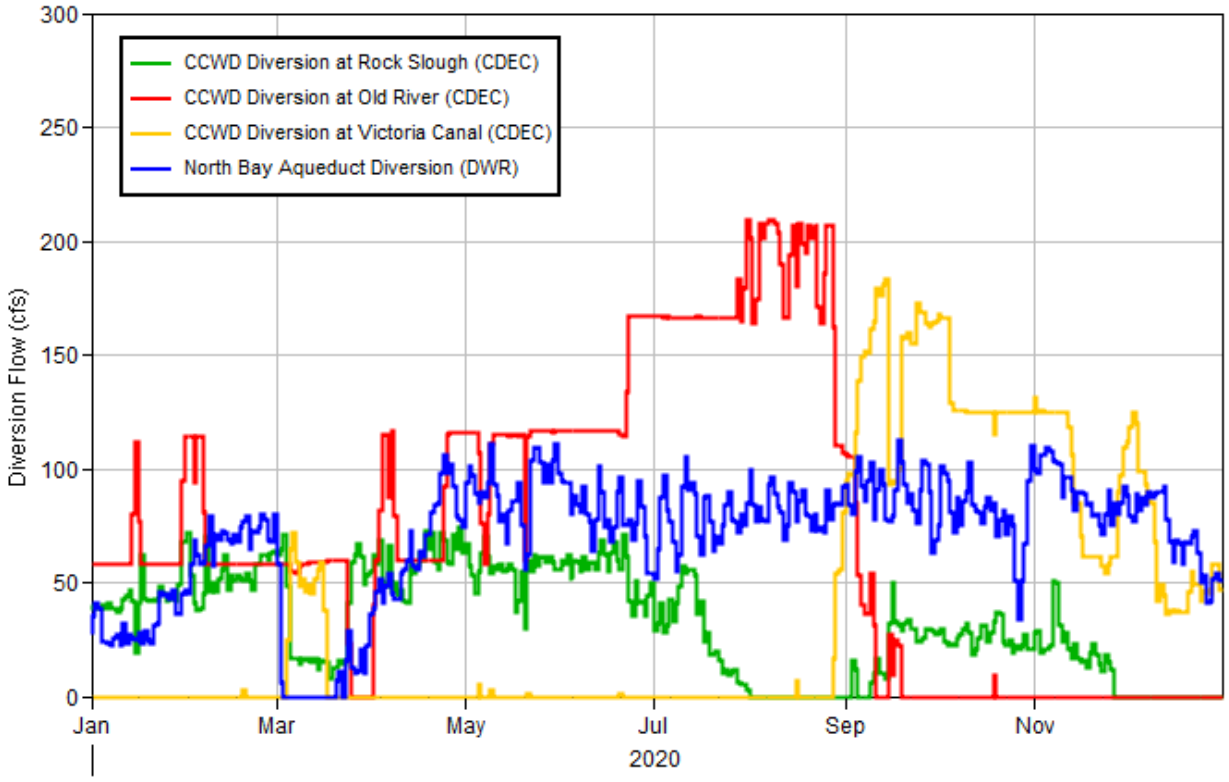

Figure 127 CCWD and North Bay Aqueduct diversions for 2020.

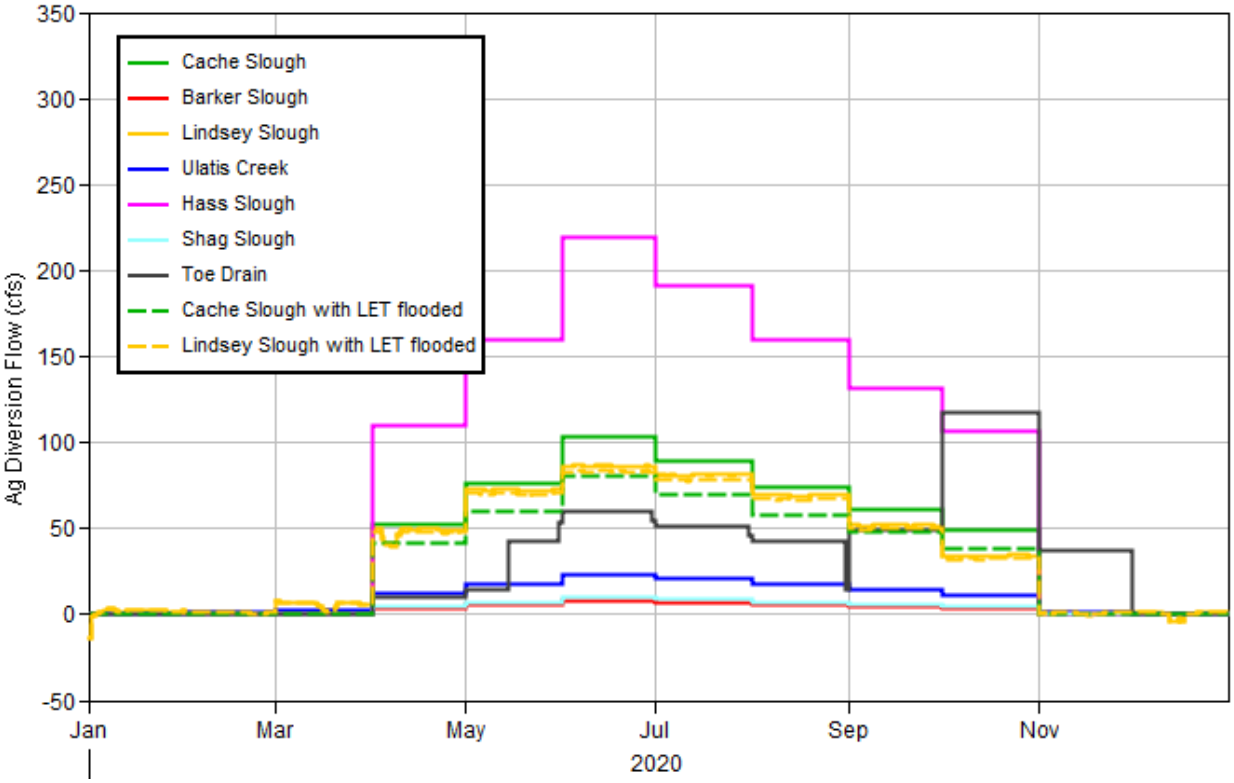

Figure 128 Agricultural diversions in the Cache Slough Complex channels for 2020.

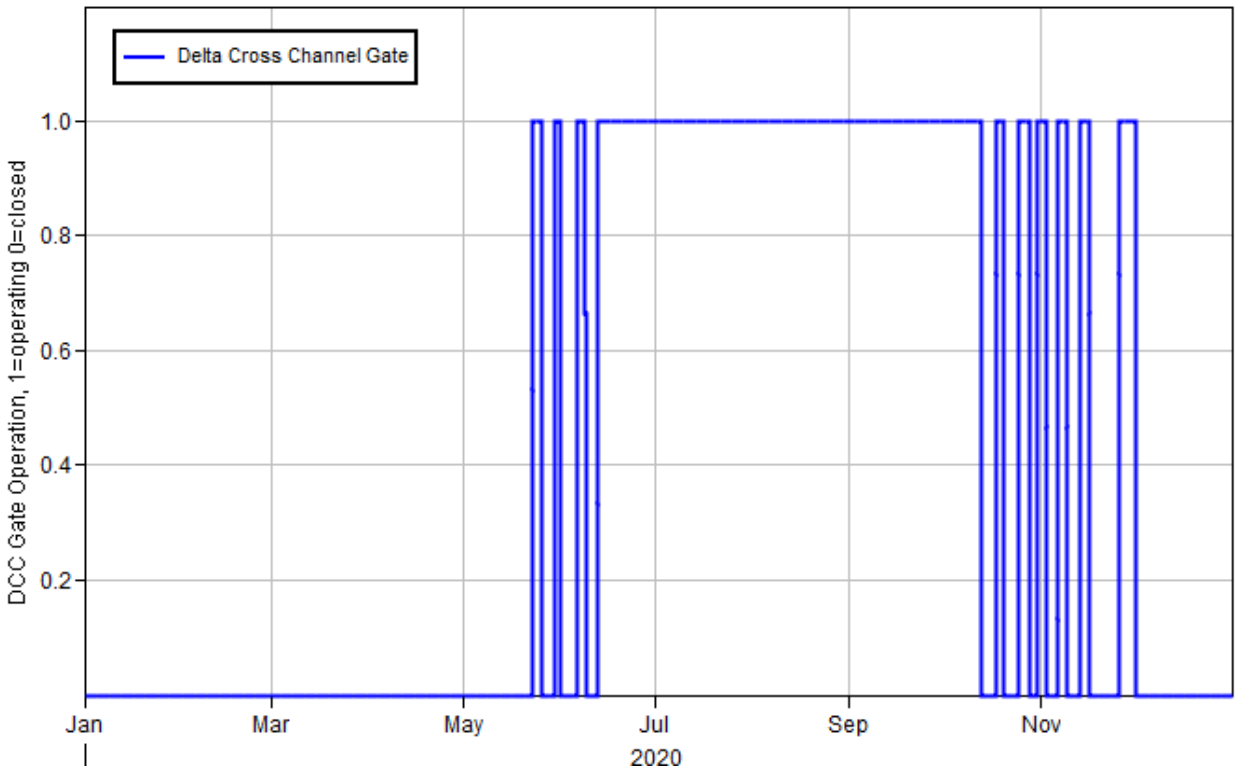

Figure 129 Delta Cross Channel operation schedule for 2020.