Appendix 4D, Part 2

Operations Sensitivity to Climate Change Projections

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4D.1 Introduction

For a description of why Alternative 1 is used in this document rather than the Proposed Project, please refer to Appendix 4J.

This document summarizes key findings from a sensitivity analysis of operational changes to the Baseline Conditions and Alternative 1 under climate change and sea level rise conditions. The Baseline Conditions and Alternative 1 for this EIR were simulated using CalSim 3 under the historical hydrologic conditions. For this sensitivity analysis, the Baseline Conditions and Alternative 1 were modeled using a 30-year climate period centered around year 2022 with 15 cm of sea level rise. The climate projections for 2022 conditions were derived from the ensemble of 40 CMIP5 global climate projections selected by the US Bureau of Reclamation (Reclamation) in collaboration with California Department of Water Resources (DWR) Climate Change Program as the most appropriate projections for California water resources evaluation and planning. The 40 climate projections were generated from 20 global climate models run with two emission scenarios, one optimistic (Representative Concentration Pathway [RCP] 4.5) and one pessimistic (RCP 8.5), identified by the IPCC for the Fifth Assessment Report (AR5) (2014). Before adjusting to represent 2022 climate conditions, historical temperature data were detrended, consistent with the approach documented by the California Water Commission (CWC) Water Storage Investment Program Technical Reference Document (CWC, 2016). Consistent with the Bay-Delta Conservation Plan/California WaterFix Analyses (ICF, 2016), historical temperature and precipitation were adjusted to represent future conditions with the quantile mapping approach. Adjustments to temperature and precipitation were calculated with cumulative distribution functions mapped with the 40 downscaled global climate model projections from the Coupled Model Intercomparison Project Phase 5 (CMIP5) (Taylor et al., 2012).

The selected period for the climate change projections reflects the expected duration of the SWP permit. The considered sea-level rise scenario reflects the projected sea level value identified in the latest Ocean Protection Council Sea-Level Rise Guidance released in 2018 (OPC, 2018). Operations results from these simulations were analyzed to understand if the incremental changes between the Baseline Conditions and Alternative 1 remain similar with and without climate change and sea level rise. This section summarizes key CalSim 3 results for the Baseline Conditions and Alternative 1 under the 2022 climate conditions and 15 cm of sea level rise. Part 1 includes detailed information about the climate change projections and the necessary changes to CalSim 3 inputs to reflect the projected hydrology and sea level changes.

4D.2 Study Objectives

The CalSim 3 model was applied to evaluate the sensitivity of the Baseline Conditions and Alternative 1 to the future climate and sea level rise conditions described above. The CalSim 3 model was used to quantify the changes in river flows, delta channel flows, exports, and water deliveries. Key output parameters from this analysis are shown in Figure 4D-1 through Figure 4D-9. Effects of climate change and sea level rise are summarized below.

4D.3 Climate Sensitivity Analyses

For this sensitivity analysis, the Baseline Conditions and Alternative 1 models were generated using the modified hydrologic inputs based on the projected runoff changes under a future climate scenario centered around 2022. The scenarios with historical climate (i.e., Baseline Conditions and Alternative 1 as presented in the EIR) did not include any sea level rise. CalSim 3 simulations in this sensitivity analysis only differ in the climate inputs and 15 cm of sea level rise. None of the other system parameters have been changed.

The purpose of conducting these simulations is to help describe the sensitivity in projected SWP system operations under the Baseline Conditions and Alternative 1 with respect to climate change and sea level rise. The incremental changes between the Baseline Conditions and Alternative 1 with the historical hydrologic conditions were compared to the incremental changes under the projected climate change conditions.

Figure 4D-1 through Figure 4D-9 show CalSim 3 simulation results for historical climate under the Baseline Conditions (black lines) and Alternative 1 (red lines) as well as 2022 future climate scenario with 15 cm of sea level rise under the Baseline Conditions (green lines) and Alternative 1 (blue lines). The plots presented in this document are relevant to assessing whether the conclusions in the hydrology, water quality, and aquatic biological resources analyzed in the EIR hold under the projected climate change conditions. Several key observations can be made based on these simulations:

- Under 2022 climate change conditions and 15 cm of sea level rise, monthly long-term average Sacramento River flow at Freeport for the Baseline Conditions and Alternative 1 remains similar. Consistent with historical hydrologic conditions, Alternative 1 flow shows little to no change from the Baseline Conditions across all months.
- Yolo Bypass flows are higher during December through March under the 2022 climate projection considered in this analysis relative to the historical hydrologic conditions modeled in the EIR. However, long-term average monthly flow patterns under Alternative 1 and the Baseline Conditions are nearly identical within each of these representations (i.e., with or without climate change and sea level rise).
- Incremental changes in flows between Alternative 1 and the Baseline Conditions at Georgiana Slough are similar under 2022 climate and 15 cm of sea level rise conditions. These flows reflect similar patterns shown for Sacramento River flow at Freeport due to climate change and sea level rise influence on tidal conditions in the estuary.

- Delta Cross Channel (DCC) flow is lower during August through October under the 2022 climate projection considered in this analysis relative to the historical hydrologic conditions modeled in the EIR. However, incremental changes in flows between Alternative 1 and the Baseline Conditions at the DCC are similar under 2022 climate and 15 cm of sea level rise conditions.
- Incremental changes in Qwest flows due to Alternative 1 compared to the Baseline Conditions are consistent across both the historical hydrology and 2022 climate change conditions with 15 cm of sea level rise. Alternative 1 operations result in lower Qwest flows in April and May compared to the Baseline Conditions, and slightly lower flows in July through September, with slightly greater flows in winter months and June under both with and without climate change and sea level rise conditions.
- Incremental changes in Delta outflow due to Alternative 1 operations compared to the Baseline Conditions under 2022 climate change and 15 cm of sea level rise are similar as compared to historical hydrologic conditions across all months. Delta outflow is higher in December through March and lower in May and June under these climate change and sea level rise conditions.
- Old and Middle River (OMR) flow incremental changes under Alternative 1 compared to the Baseline Conditions across all months are relatively consistent with and without climate change and sea level rise. However, incremental changes in September are lower under 2022 climate change and 15 cm of sea level rise, displaying a reduction in the decrease of OMR flow from the removal of the 2020 SWP ITP Summer - Fall Actions for Adaptive Management outflow block of 100 TAF under Alternative 1.
- Simulated exports show similar patterns in incremental changes under 2022 climate change and 15 cm of sea level rise to those presented above for OMR. With warming climate and salinity intrusion associated with sea level rise, available water supply and exports under the Baseline Conditions and Alternative 1 decrease, particularly in July through November. Exports in the months that are significantly constrained (i.e., December through June) are not as sensitive to climate change and sea level rise.

Overall, the relative incremental changes due to Alternative 1 as compared to the Baseline Conditions under 2022 climate and sea level rise conditions are similar to that described under the historical hydrologic conditions in the EIR. While future climate and sea level rise will alter some of the magnitude of flows, the relative incremental changes due to Alternative 1 are similar when compared to the Baseline Conditions.

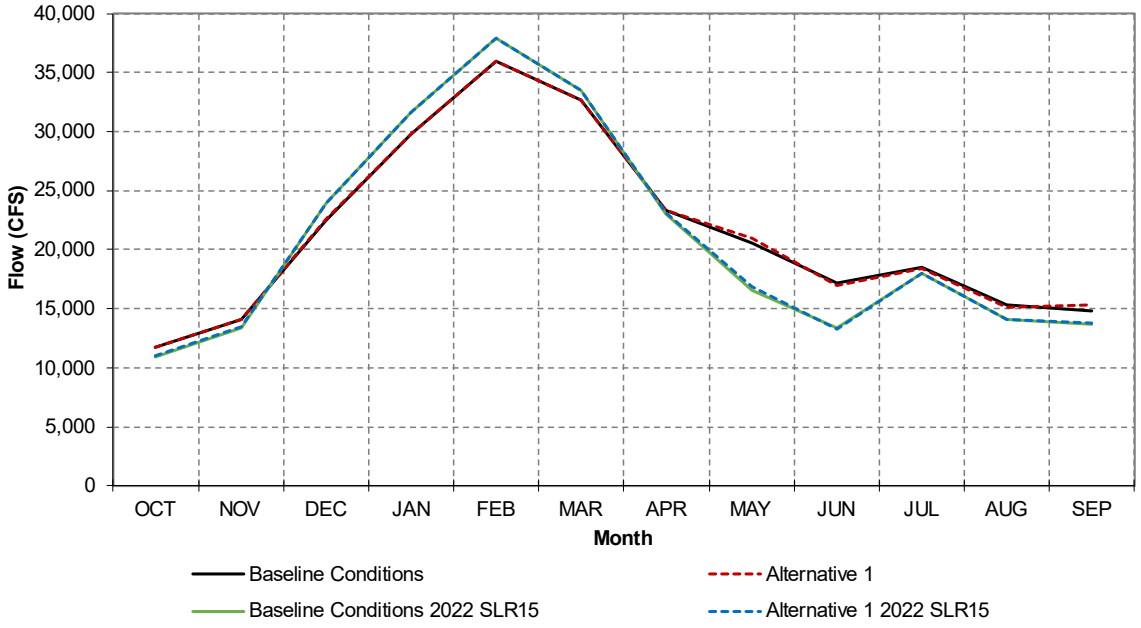

Figure 4D-1. Sacramento River at Freeport Monthly Long-term Average Flow for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

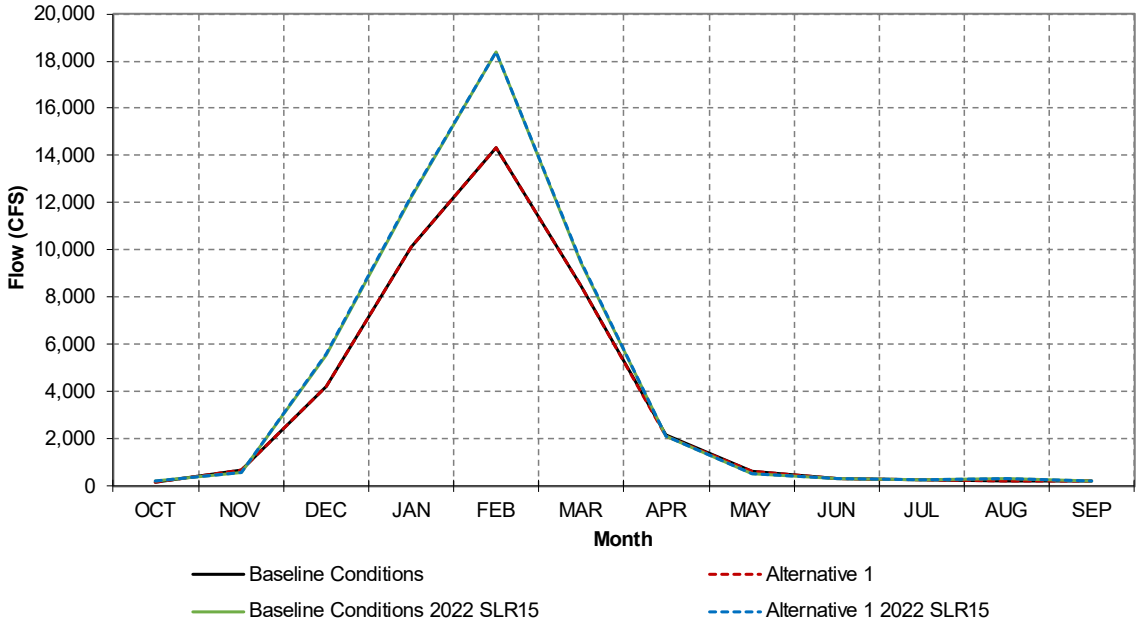

Figure 4D-2. Monthly Long-term Average Yolo Bypass Flow for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

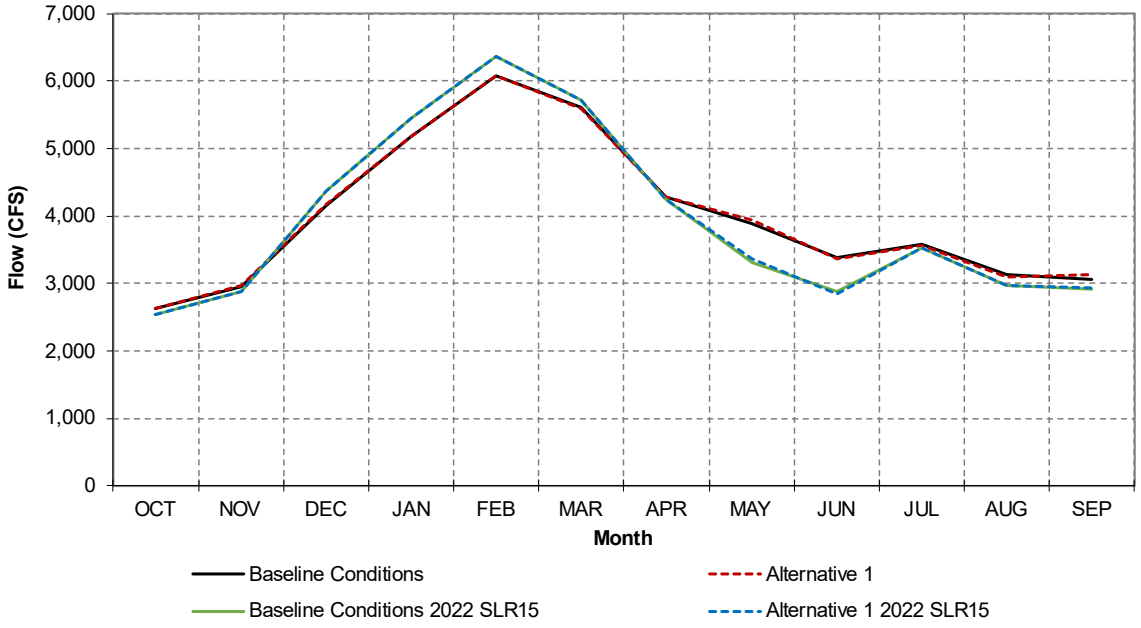

Figure 4D-3. Monthly Long-term Average Georgiana Slough Flow for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

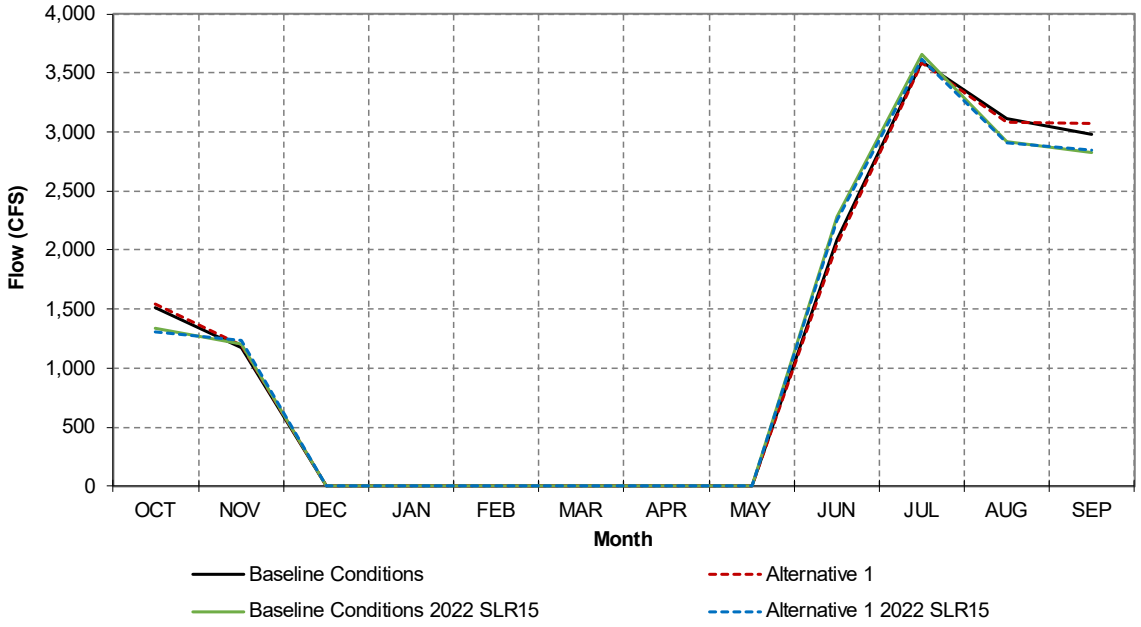

Figure 4D-4. Monthly Long-term Average Delta Cross Channel Flow for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

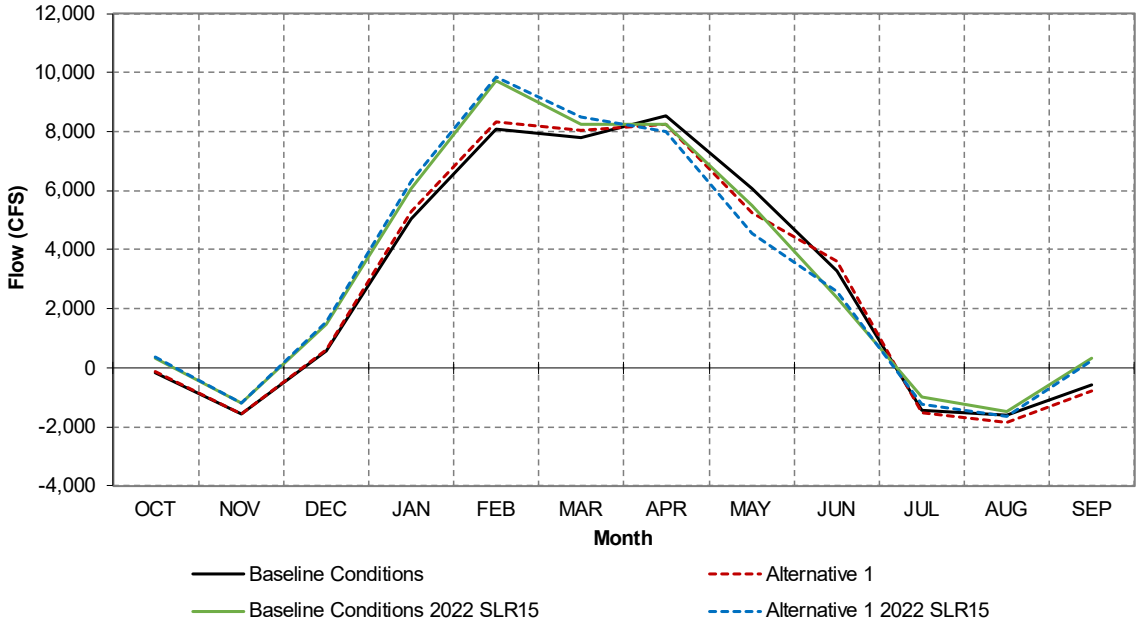

Figure 4D-5. Monthly Long-term Average Qwest Flow for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

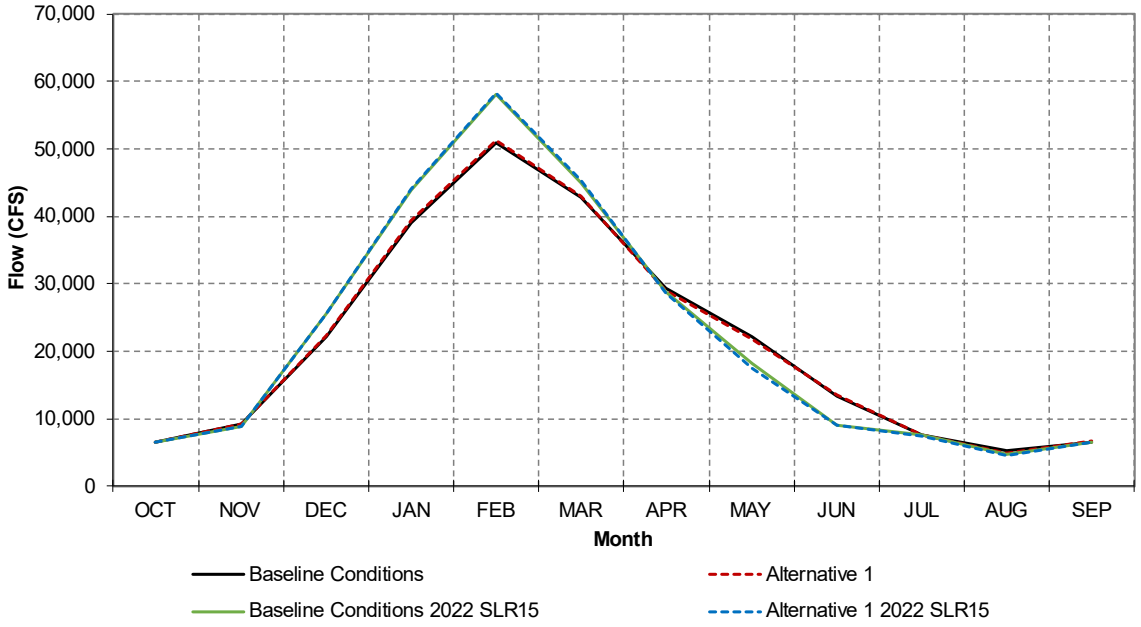

Figure 4D-6. Monthly Long-term Average Delta Outflow for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

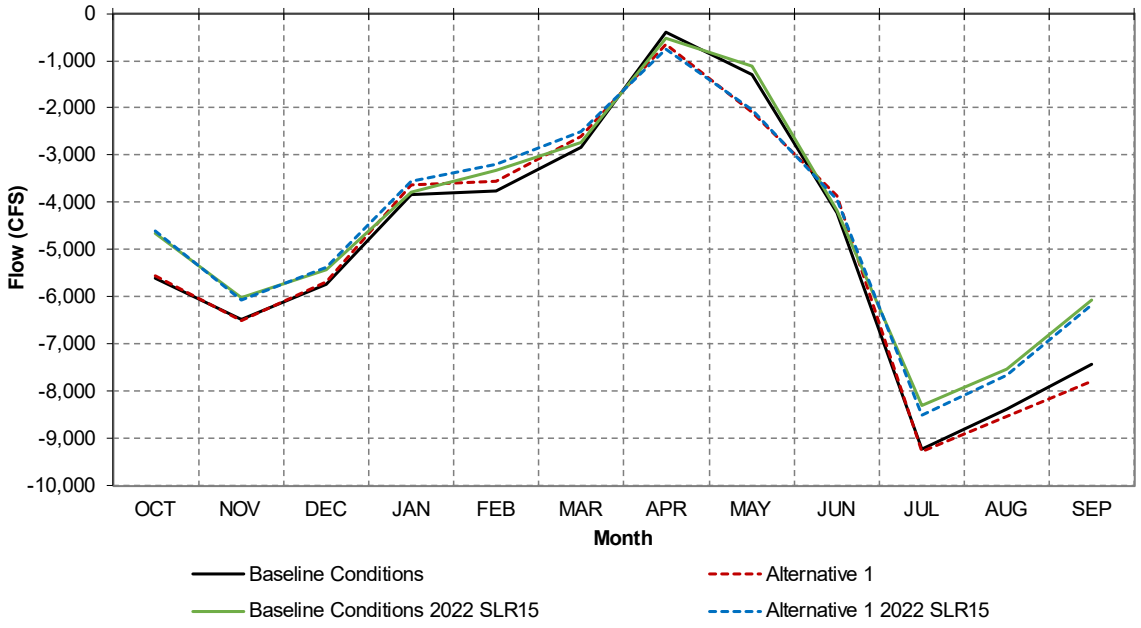

Figure 4D-7. Combined Old and Middle River Monthly Long-term Average Flow for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

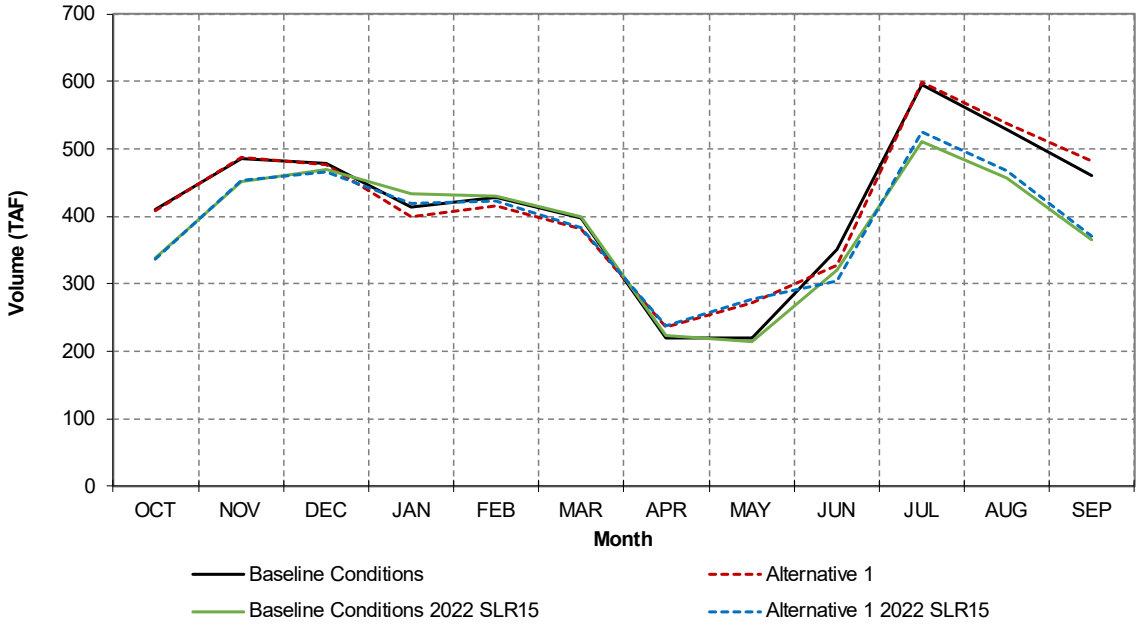

Figure 4D-8. Monthly Long-term Average Delta Exports for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

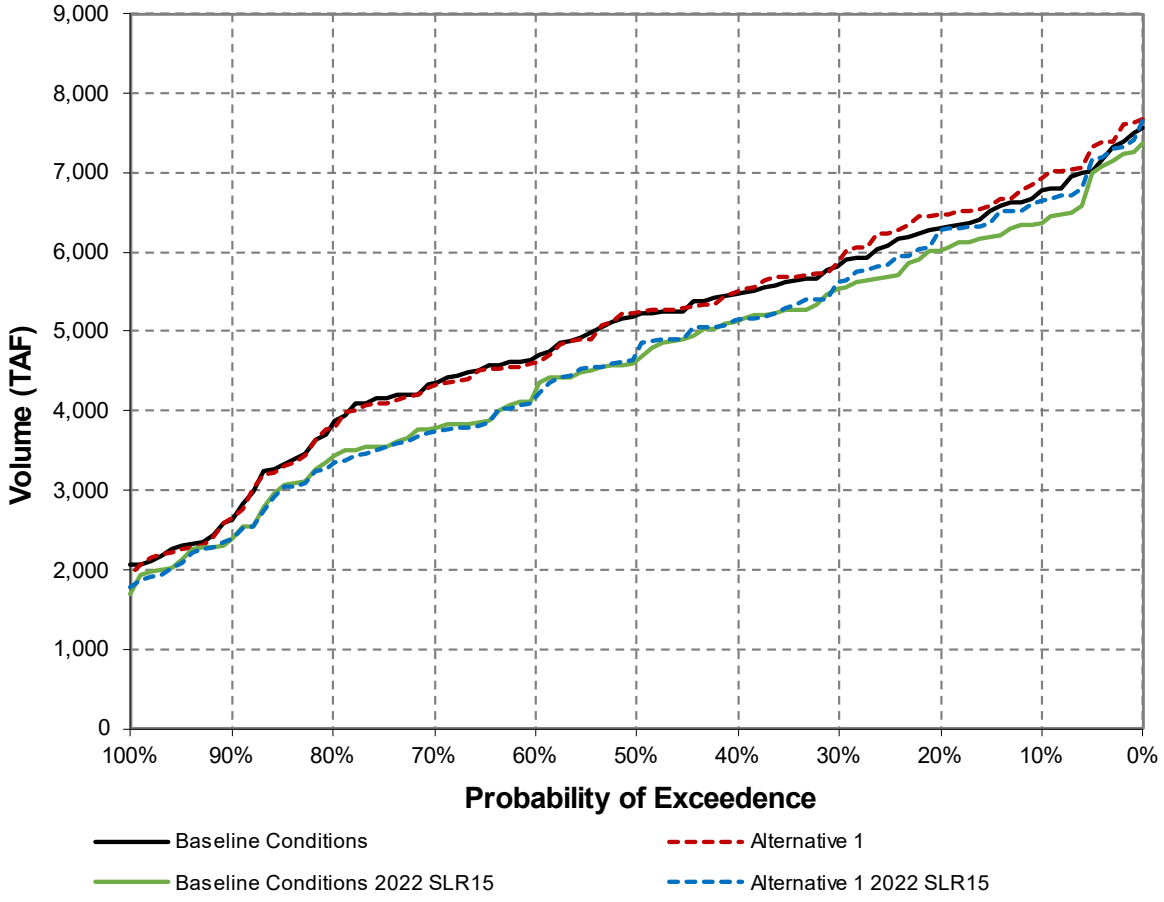

Figure 4D-9. Annual Delta Exports for the Baseline Conditions and Alternative 1 under Historical Hydrology and Future Climate Centered around 2022 with 15 cm of Sea Level Rise

4D.4 References

California Ocean Protection Council (OPC) 2018. State of California Sea-Level Rise Guidance: 2018 Update. March 2018.

California Water Commission (CWC) 2016. Water Storage Investment Program: Technical Reference. November 2016.

ICF 2016. Final Environmental Impact Report/Environmental Impact Statement for the Bay Delta Conservation Plan/California WaterFix Appendix 5A Section A: Modeling Methodology. December 2016.

Taylor, Karl E., Ronald J. Stouffer, and Gerald A. Meehl. 2012. An Overview of CMIP5 and the Experiment Design. Bull. Amer. Meteor. Soc. 93, 485–498.