Appendix 29D

Climate Change Analysis and Discussion of Future Uncertainty

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The BDCP/California WaterFix EIR/EIS evaluates one of the largest infrastructure development projects in the history of California and provides arguably the most in-depth analysis of project impacts that could occur under a range of potential future conditions. Despite the scientific rigor and reasoned assumptions that have gone into this analysis, there remain significant uncertainties about future conditions that would impact on the project area under both with and without project future conditions. This appendix provides additional information and context about the assumptions and uncertainties embedded in the BDCP/California WaterFix EIR/EIS analysis of future conditions. This information is provided to explicitly acknowledge that the assessment of future conditions is highly uncertain.

The BDCP/California WaterFix EIR/EIS attempts to provide the public and decision makers with as much information as possible about inherently uncertain future conditions. Anticipating future conditions require the lead agencies to make judgments and assumptions about future conditions. Section 29D.1 of this appendix discusses how scientific studies, historical data, observational trends, and modeling have been used for the BDCP/California WaterFix to improve assumptions about future climate conditions. Section 29D.2 of this appendix discusses other future conditions, which could also change as a result of climate changes and could in turn affect project performance and environmental conditions, but for which the lead agencies have determined that any assumption of change from current conditions would be speculative. This section also attempts to explore how the BDCP/California WaterFix and its operations might evolve over time in order to deal with hypothetical changes in environmental regulations and adaptive management strategies.

29D.1 Summary of How the Climate Change Analyses were Conducted

29D.1.1 Future Conditions Analysis Overview

For the environmental analysis required by CEQA and NEPA the No Project/No Action Alternatives analysis must take into account not only existing conditions at the time the NOP is published, but also must include "what would be reasonably expected to occur in the foreseeable future if the project were not approved" (CEQA Guidelines Section 15126.6, subd. (e)(2)). In envisioning No Project conditions nearly a half century away (2060), the lead agencies were required to make certain informed judgments about what might reasonably be expected to happen outside the immediate State Water Project (SWP) and Central Valley Project (CVP) context during an extended time period (see Appendix 3D, Section 3D.2.3, *No Project Alternative*). The effects of climate change and sea level rise are included in the No Action Alternative under NEPA and No Project Alternative under CEQA because they are reasonably foreseeable, based on current research and well-established scientific understanding (Appendix 3D, Section 3D.2.3).

In particular, the character of precipitation within the Sacramento and San Joaquin River basins is expected to change under warming conditions, resulting in more frequent rainfall and less snowfall. Increased warming is expected to diminish the accumulation of snow during the cool season and the availability of snowmelt to sustain runoff during the warm season. This shift is expected to lead to changes in peak runoff periods, causing higher flow potential in late winter and early spring and resulting in less runoff during the late spring and summer (Chapter 29, Section 29.2.3.3, *Climate Change Effects on the Plan Area*).

At the same time, sea level rise from the changing climate will push saltwater farther east into the Delta, requiring increased upstream water releases to push seawater out of the Delta and achieve in-Delta water quality standards. These hydrological and operational changes would, in turn, decrease available water supply and are thus important considerations for the EIR/EIS (Chapter 29, Section 29.2.3.3, *Climate Change Effects on the Plan Area*; Chapter 5, Section 5.3.1.1, *Quantitative Analysis of SWP and CVP Water Supply Impacts*).

While there is wide agreement that climate change is happening and that temperatures throughout California will continue to rise, there is a wide range of expectations for how fast changes will occur, how extreme those changes will be, and how precipitation and other indirect impacts of climate change will unfold. The EIR/EIS acknowledges this inherent uncertainty by exploring potential climate changes indicated by more than 30 global climate models and 3 different future emissions scenarios resulting in 112 different projections of future climate. Section A.7 and Section D of Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*, provide in-depth detail about how the climate change scenarios were developed to explore the likely range of future conditions.

The goal of the climate change analysis was to 1) determine whether future changes in climate and sea level rise are likely to exacerbate project impacts and 2) explore and disclose how the project would be likely to perform under potential future conditions. For the purposes of exploring the differences between the alternatives described in the EIR/EIS, the Alternatives were simulated at three periods in time: Near-Term (NT), representing a point in time 5–10 years into the permit (~2015), Early Long-Term (ELT) representing a point in time 15 years into the permit (~2025), and Late Long-Term (LLT) representing the end of the 50-year permit (~2060). For the purpose of EIR/EIS *impacts evaluation*, Alternatives' modeling results at the LLT (BDCP alternatives) and ELT (California WaterFix, or non-HCP, alternatives) period are considered.

In the evaluation of the No Action Alternative and the other Alternatives at the ELT and LLT phases, sea level rise was assumed to be inherent. ELT assumes 15cm and LLT assumes 45cm sea level rise to exist. These levels of sea level rise represent a median level of sea level rise as indicated by a range of different estimation and projection methods (see *Sea Level Rise* section in the Executive Summary of Appendix 5A, Section D, *Additional Modeling Information*).

29D.1.1.1 The Modeling Process

The EIR/EIS relies on a complex chain of computer modeling to estimate the projected effects of climate change on precipitation patterns in the Central Valley, sea level rise in the Delta, and the impacts on instream flow conditions, Delta conditions, and water system storage and delivery conditions. Detailed discussions are included in the EIR/EIS (see Chapter 29, Section 29.2.3.3, *Climate Change Effects on the Plan Area*; see also *Incorporation of Climate Change* section in Appendix 5A, Section A, and Appendix 5A, Section A.7, *Climate Change and Sea Level Rise Scenarios*;

Appendix 29A, *Effects of Sea Level Rise on Delta Tidal Flows and Salinity*; Appendix 29B, *Climate Change Effects on Hydrology in the Study Area Used for CALSIM Modeling Analysis*; and Appendix 29C, *Climate Change and the Effects of Reservoir Operations on Water Temperatures in the Study Area*).

CALSIM-II is the operations and planning model used by the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation) to simulate the operational performance of the SWP and CVP systems. Climate change and sea level rise are incorporated into the CALSIM II model in two main ways:1) changes in runoff and stream flow, and 2) changes to Delta flow-salinity relationships resulting from sea level rise.

The following key input parameters are adjusted in CALSIM II to incorporate the effects of climate change:

- Inflow time series records for all major and minor streams in the Central Valley-reflecting changes in future precipitation, temperature, soil moisture, snow accumulation and runoff, and runoff timing.
- Changes to Sacramento and San Joaquin Valley water year types resulting from shifts in precipitation and runoff.
- Revised runoff forecasts based on changed precipitation expectations.
- Delta water temperature as used in triggering biological opinion smelt criteria
- Modified "Artificial Neural Networks (ANN)" to reflect the flow-salinity response under sea level change scenarios

Changes in runoff and stream flow are simulated through the Variable Infiltration Capacity hydrology model, which is explained in Appendix 5A, Section A.8, *Regional Hydrologic Modeling*. Such regional hydrologic modeling is necessary to understand the watershed-scale impacts of historical and projected climate patterns on the processes of rainfall, snowpack development and snowmelt, soil moisture depletion, evapotranspiration, and, ultimately, changes in stream flow patterns. These simulated changes in runoff are applied to the CALSIM II models used to evaluate the alternatives. (For further detail, see Appendix 5A, Section A.8, *Regional Hydrologic Modeling*, and Appendix 29B, *Climate Change Effects on Hydrology in the Study Area Used for CALSIM Modeling Analysis*.)

Sea level rise and restored tidal marsh effects on the flow-salinity response is incorporated in the new ANN, which a discussed in Appendix 5A, Section A.2.1, *Analytical Tools*. The ANN is implemented within CALSIM II to constrain the operations of the upstream reservoirs and the Delta export pumps to satisfy particular salinity requirements.

In addition to hydrologic and Delta conditions changes that act as "external forcings" or boundary conditions and are provided as inputs to the CALSIM II model, the BDCP/California WaterFix itself includes several components that will affect SWP and CVP operations. Most of the alternatives include construction and operation of new north Delta intakes and associated conveyance, modifications to the Fremont Weir, large-scale tidal marsh restoration in the Delta, and changes in the operation of the existing south Delta export facilities – all of which can significantly influence the

[hydraulic] response of the system[1]. Evaluation of the interaction of these two types of changes (external forcings and new system components) is the primary focus of the numerical modeling analyses used in the EIR/EIS (see Appendix 5A, Sections A.1, *Introduction*, and A.2, *Overview of Modeling Approach*).

Appendix 5A is a lengthy and highly technical appendix to the EIR/EIS that provides detailed information about the numerical modeling methodology and analysis used for the EIR/EIS. For the alternatives analysis, the EIR/EIS relies on the modeling of physical variables such as flow to evaluate changes to conditions affecting resources within the Delta, as well as effects to upstream and downstream resources. Figure A-1 in Appendix 5A provides a helpful graphic illustration of how the various models used in the analysis are integrated to collectively provide data used to support the impact analyses.

The CALSIM II model is most appropriately applied for comparing one alternative to another and to the No Action/no project alternative and drawing comparisons between the results. This is the method in which CALSIM II is applied for the BDCP/California WaterFix. For each phase of the Alternatives a companion No Action Alternative simulation has been prepared. The No Action simulation includes the existing infrastructure, existing regulatory restrictions including the recent biological opinions, but may include future demands, climate, and sea level rise depending on the time frame. The Alternative is compared to the No Action Alternative to evaluate areas in which the project changes conditions and the seasonality and magnitude of such changes. The change in hydrologic response or system conditions is important information that informs the effects analysis related to water-dependent resources in Sacramento-San Joaquin watersheds.

Appropriate use of model results is important. Despite detailed model inputs and assumptions, the CALSIM II results may differ from real-time operations under stressed water supply conditions. Such model results occur due to the inability of the model to make real-time policy decisions under extreme circumstances, as the actual (human) operators and regulatory agencies must do. Therefore, these results should only be considered an indicator of stressed water supply conditions under that Alternative, and should not necessarily be understood to reflect literally what would occur in the future. For example, the model projects hitting dead-pool conditions under certain future conditions. In actual real-time operations operators would likely make operational changes which limit the risk of hitting dead-pool conditions as soon as forecasts indicate potential issues. If these operational changes are insufficient, then regulatory agencies would be prompted for potential policy decisions on temporary modification of requirements needed to avoid the adverse conditions. In actual future operations, as has always been the case in the past, the project operators would work in real time to satisfy legal and contractual obligations given the current conditions and hydrologic constraints.

29D.1.1.2 Applying the Modeling to the Alternatives

The alternatives analysis for the EIR/EIS focuses on 26 resource areas, including fish and aquatic species, terrestrial biological resources, water supply, water quality, groundwater, surface water, agricultural resources, and numerous other categories. Each resource area is addressed in a

[1] Note that the California WaterFix, or non-HCP, alternatives (i.e. 2D, 4A, and 5A), first presented in the RDEIR/SDEIS, do not include large-scale habitat restoration or modifications to Fremont Weir. Additional modeling has been conducted for the FEIR/EIS to reflect these changes in the new sub alternatives.

separate chapter of the EIR/EIS (Chapters 5 through 30). The alternatives' impacts for each resource in the study area – including the effects of climate change – thus are addressed throughout the EIR/EIS in the resource chapters.

29D.2 Future Conditions and Potential Operational Responses

Changes in climate mentioned previously and in Chapter 29 will impact species directly or the resources on which they depend. Climate change scenarios project that the San Francisco Bay-Delta Estuary will experience rising sea level, salinity intrusion further eastward into the interior Delta, warming water and air temperatures, decreased snowpack runoff, and earlier peak runoff. These factors have biological, hydrological, and operational ramifications for the regulatory agencies and may result in operational changes from DWR and Reclamation.

For a comprehensive list of actions the State of California, along with local and federal partners, will be taking to address climate change, please see the California Water Action Plan 2016 Update. The following section includes a brief discussion of water project operations and how they might respond to changes in regulations resulting from continued climate change.

29D.2.1 Regulatory Agencies and Guiding Polices

Currently, DWR and Reclamation operate under strict regulations and standards set forth by various bodies, such as the State Water Resource Control Board (State Water Board), National Marine Fisheries Services/National Oceanic and Atmospheric Administration (NMFS), United States Fish and Wildlife Services (USFWS), and California Department of Fish and Wildlife (CDFW). Operations of both water projects must meet these standards, among others, and be able to adapt to future ecosystem changes that may affect endangered and threatened species that occur throughout the Delta. The following sections describe the regulatory setting and guiding policies relevant to SWP and CVP operations in and upstream of the Delta, including processes that could modify SWP/CVP operating criteria in the future.

29D.2.1.1 State Water Resources Control Board

The State Water Board sets multiple standards to which water diversions such as the SWP/CVP must comply. The Bay-Delta Water Quality Control Plan (WQCP) aims to protect the beneficial uses of the Bay-Delta Estuary. The State Water Board periodically will review this plan pursuant to Water Code Section 13240 to ensure that it provides reasonable protection for the designated beneficial uses. The State Water Board's measures to implement this plan will consist of the regulation of existing water rights, regulatory measures to protect water quality, and recommendations to other entities. The WQCP and D-1641 sets standards needed to protect the beneficial uses of water for municipal and agricultural uses, and fish and wildlife; and assigns responsibility for meeting these standards to the SWP/CVP. Population growth may even be a contributing factor when updating the WQCP due to additional water demand. The extent of future California population growth is uncertain, but regulatory agencies are likely to consider this potential increase in demand in their planning.

Example of Potential State Water Board Modifications to Water Quality Objectives: Effects from climate change and sea level rise are expected to result in more saline waters intruding eastward into the Delta, higher water temperatures, and increasing frequency and severity of droughts, which could lead to changes in water quality objectives. Each of these changes could have dramatic effects on all beneficial uses of water. For example, increases in mean sea levels will put additional pressure on the levees in Suisun Marsh and the Delta. When combined with storm surges, there is an increase in risk of levee failure. At the higher end of the sea level rise projections, especially for the LLT, this could drive significant changes in land use patterns within Suisun Marsh and the Delta as the cost to strengthen and rebuild levees become prohibitive. Over time, if enough properties are abandoned the State Water Board could revise the current agricultural and fish and wildlife salinity objectives. At this time the WQCP does not have objectives related to water temperature; however, impacts to native species are expected under the projected increases in water temperature which could result in temperature objectives being added.

Temporary Urgency Change Petitions and Drought: California has just passed through its fourth consecutive year of below-average rainfall and snowpack, and Water Year (WY) 2015 was the eighth of nine years with below-average runoff. This extended drought has produced chronic and significant shortages to municipal and industrial, environmental, agricultural, and wildlife refuge water supplies and led to historically low groundwater levels. The cumulative effect of these sustained dry conditions is demonstrated in reduced natural runoff for streamflow, limited surface water storage in reservoirs, increased groundwater pumping, and significant effects to fish and wildlife populations (both listed and non-listed species, including salmon, smelt, and waterfowl). Resource, fish and wildlife, and protection agencies alike will need to develop or refine information, tools, and actions necessary to fulfill their missions.

In order to protect beneficial uses of water, the State Water Board may consider petitions for temporary modifications to State Water Board Water Rights Decisions. The State Water Board can issue an Order granting in part, in full, or to deny a petition for temporary modifications to D-1641. The process, as exemplified by the 2015 TUCP, is outlined briefly as follows:

- DWR and Reclamation jointly filed Temporary Urgency Change Petitions (TUCPs) pursuant to Water Code Section 1435 et seq., to request temporary modification of requirements in their water right permits and license for the SWP and CVP.
- TUCPs request (supported by the RTDOMT; See *Advisory Teams* below for more information) temporary modification of requirements included in State Water Board Revised Decision 1641 (D-1641) to meet water quality objectives in the Water Quality Control Plan (Plan) for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta).
- The State Water Board issued a notice of the TUCP, notice of public workshop on the TUCP, and open the public comment period on the TUCP.
- After considering the comments, the State Water Board issued an Order granting in part, in full or to deny the temporary modifications to D-1641
- Before implementation of any action that may be approved by the State Water Board, Endangered Species Act (ESA) and California Endangered Species Act (CESA) coverage will be confirmed:
    - Reclamation will confirm ESA coverage with NMFS under the 2009 NMFS CVP/SWP Long Term Operation Biological Opinion, as applicable, and USFWS under the 2008 CVP/SWP Long Term Operation Biological Opinion.

- DWR will seek confirmation of coverage under the CESA from CDFW.

Under a future scenario where dryer water year types more frequent, the State Water Board may consider similar modifications. Under a worst-case type scenario, greater demands on water due to population growth and climate change impacts on water supplies could result in the State Water Board changing or reallocating existing water rights.

Additional Bay-Delta standards can be issued through State Water Board decisions, decision amendments, and/or future updates to the WQCP, which could include revised Delta flow criteria and water quality objectives. Operations of SWP/CVP facilities, including the new north Delta intakes under the California WaterFix, would comply with additional constraints and modifications. As climate change impacts combine with other factors, such as population growth, resulting in additional demands on available water, there may be a shift in societal values as to what constitutes 'beneficial uses' of water leading to changes in the standards.

29D.2.1.2 National Marine Fisheries Service and U.S. Fish and Wildlife Service

The 2008 USFWS Biological Opinion (BiOp) for delta smelt and the 2009 NMFS BiOp for Sacramento River winter-run Chinook, Central Valley spring-run Chinook, Central Valley Steelhead, Southern Distinct Population Segment of North American green sturgeon, and Southern Resident killer whales set strict operating restrictions on the SWP/CVP Operations and Criteria Plan, which lays out the coordinated SWP and CVP operations. Delta smelt may be vulnerable to reductions in quality and/or extent of rearing habitat due to increases in salinity from sea level rise and increasing water temperatures, although other factors likely influence habitat quality as well (e.g., food web dynamics, invasive species.). Chinook and steelhead are vulnerable to increases in water temperatures, changes in estuarine rearing habitat due to sea level rise, and reduction in availability of floodplain rearing habitat from reductions in the duration and frequency of floodplain inundation due to changing runoff patterns. Green sturgeon are vulnerable to increases in water temperature and changes in flow. Impacts to Southern Resident killer whales are indirect and associated with declines in salmon populations due to inland and ocean conditions.

The BiOps state that continued operations of these two water projects were likely to jeopardize the continued existence of these species and adversely modify their critical habitat. The inclusion of reasonable and prudent alternatives, and their acceptance by the water agencies, avoids jeopardy and adverse modification. Since issuance of the BiOps, DWR and Reclamation have met the conditions of the BiOps. If the populations of the threatened and endangered species listed in the BiOps recover to sustainable levels, fish and wildlife agencies have the potential to re-initiate consultation and lift certain operating restrictions of the water projects. In the event impacts to listed species are greater under future conditions, or additional species are listed during project operations, re-initiation may be required to ensure SWP/CVP operations do not jeopardize the continued existence of listed species, which could lead to additional operational constraints. Future operations and environmental conditions, including those influenced by climate change, have a high degree of uncertainty, but regulatory and water agencies will have the opportunity to coordinate efforts to sustainably manage water resources for both humans and aquatic species. See *Advisory Teams* below for more.

29D.2.1.3 Delta Stewardship Council

The Delta Stewardship Council's Delta Plan is a comprehensive, long-term management plan for the Delta to further the co-equal goals of water supply reliability and ecosystem health. The Delta Plan was released in 2013 and will be updated every five years. Sea level rise, warmer air and water temperature, changes in runoff timing, reduction in flows due to snowpack loss, larger flood events, longer duration or more severe droughts will all have impacts on the Delta which could result in changes to the Delta Plan and its policies. Changes in the policies related to water supply reliability, ecosystem health, and flood risk reduction could impact SWP and CVP water operations and flood management activities.

29D.2.1.4 Other

In 2015, building on Governor Brown's Executive Order B-30-15, the state legislature passed a number of bills which require state agencies to more explicitly consider and account for climate change in their planning and infrastructure investments. As this and future climate change legislation is implemented, it is likely to result in changes to Delta specific regulations and policies which, in turn, could affect project operation and performance.

29D.2.2 Advisory Teams

Real-Time Drought Operations Management Team (RTDOMT): California is currently experiencing one of the worst drought periods in memory. Record high temperatures and low precipitation have led to reservoirs being depleted to historic lows, increased salinity in the Delta, and some of the SWP and CVP Delta requirements being temporarily changed. RTDOMT was established by the State Water Board to coordinate changes to D-1641 and temporary urgency change orders necessary to address risks presented by the ongoing and severe drought. RTDOMT is comprised of Reclamation, DWR, CDFW, the State Water Board, USFWS, and NMFS to coordinate and manage how to operate reservoirs to meet in-Delta water quality standards as well as state-wide water demands through forward-thinking and real time efforts. Through this effort state and federal agencies were able to provide necessary information to the State Water Board to support its evaluation of Reclamation and DWR's requests for modifications to operational standards required under Water Decision 1641 (D-1641).

Drought Contingency Plan (DCP): An example of future efforts can be drawn from the 2016 DCP, which builds on state and federal agency drought planning work over the previous years. The 2016 DCP for CVP and SWP water operations from February to November 2016 includes a quantitative analysis of potential operations based on forecasted hydrology for 2016 including 50%, 90%, and 99 % exceedance scenarios based on the January 1, 2016 hydrologic analysis. These quantitative analyses inform the DCP's list of potential requests for modifications to D-1641 and potential adjustments to Biological Opinions. Should drought conditions become more frequent, as predicted by several climate models, processes such as the RTDOMT and DCP will be necessary to ensure that standards meet essential water needs of all water users.

Delta Operations for Salmonids and Sturgeon (DOSS) and the Smelt Working Group (SWG): Other entities and technical teams, such as DOSS and the SWG, gather and assimilate the latest hydrological and biological data to make recommendations to NMFS and USFWS and the Water Operations Management Team. These recommendations can help inform operational adjustments to minimize adverse effects from the SWP/CVP on listed fish species. It is expected these groups,

among others, will continue to guide SWP/CVP operations in the future to minimize potential adverse effects, including those attributable to climate change.

Interagency Ecological Program (IEP): The IEP is multi-agency entity consisting of state and federal agencies which promote collaborative science and ecological stewardship of the San Francisco Estuary. This program provides the foundation for collaborative monitoring, research, modeling, and synthesizing information on the San Francisco Estuary ecosystem to address high priority management and policy needs, including adaptive management of water project operations. The IEP has developed a Science Agenda (Agenda) to integrate science needs and management challenges, and serves as a subject-matter guide for focusing the planning of scientific studies (http://www.water.ca.gov/iep/docs/2016_IEP_Science_Agenda_FINAL.pdf). One of the areas identified by the Agenda needing further scientific investigation is climate change and extreme events. The Agenda includes future research on climate change and developing potential adaption responses to minimize climate change- related impacts to the San Francisco Estuary ecosystem. Increased and more effective monitoring of various biological, chemical, and physical metrics will be incorporated into future actions necessary to assess the impacts of climate change and extreme events.

29D.2.3 Examples of Potential Changes in Operations in Response to Climate Change

As described above, reductions in snowpack due to warmer temperatures in the lower elevations may affect the water supply available to DWR and Reclamation in the summer and fall needed to meet the Delta water quality standards, requiring adjustments to the existing operating criteria. Changes in runoff timing and reductions in water supplies would likely require changes in upstream and in- Delta operations which could affect water deliveries of project water and transfers. More extreme events, both flooding and drought, could impact the operating rules as would salinity management in the Delta due to sea level rise. Examples of these potential changes are described below.

29D.2.3.1 Operators May Be Required to Release More Water

Climate change is expected to exacerbate many stressors on aquatic species. Increased water temperatures, drought conditions, and other climate-related events will compound the threats to sensitive species like Chinook salmon and delta smelt. With sea level rise, tidal energy will push ocean water more strongly into the Bay and Delta. Absent an opposing force of fresh water from reduced exports or increased releases, the position and area of the Low Salinity Zone (LSZ), which is commonly indexed by X2, may be affected. X2 (i.e., roughly the center of the LSZ) is defined as the distance from the Golden Gate Bridge upstream to where salinity near the bottom of the water column is approximately 2 ppt. Several scientific studies have documented species responses to the position of X2, which may be an indicator of available, higher quality habitat. As mentioned above, other factors (beyond salinity) influence habitat quality as well; however, the interactions among these factors and their relative effects to fish species populations are not well understood. The Adaptive Management Framework for the California WaterFix and existing BiOpS would help identify potential research actions to fill important knowledge gaps on the Delta ecosystem, support adaptive management responses, and reduce the uncertainty of effects from water project operations.

Increased salinity levels in the estuary associated with climate change could affect the location and extent of suitable habitat for various aquatic species. Generally, water operators maintain salinity compliance by releasing freshwater from upstream reservoirs during various times of the year to correspond with species presence and life history. As salinity pressure increases as a result of higher sea levels in the future, operators may need to provide more freshwater flow through the estuary to balance this increased pressure from the sea and meet these species standards. In addition, increased freshwater flow to meet in-Delta water quality standards may be required to protect anthropogenic uses of water. Several of the existing compliance standards and flow criteria are intended to ensure reasonable salinity levels for municipal, industrial, and agricultural uses, which may or may not be adequate under modeled sea level rise scenarios. As described above, any future changes in Delta standards would be guided by regulatory agency decisions to protect and consider all beneficial uses of water.

29D.2.3.2 Operators May Be Required to Release Less Water

Decreased snowpack due to warming air temperatures is already observable as another consequence of climate change. Reduced snowpack in combination with increased variability in precipitation patterns, earlier peak runoff, and more frequent drought conditions could lead to less cold water reservoir storage during the spring, summer, and early fall periods. This could be detrimental to species such as winter-run Chinook salmon, for example, which rely on Shasta reservoir releases to provide cold-water refugia for egg incubation and fry rearing in the summer and early fall. Warmer water temperatures stress embryos and decrease rates of survival, necessitating cold water releases from reservoirs. As a result, future operations may include more water curtailments to save cold water storage for releases later in the year to protect young salmon. With increased variability in precipitation and less snowfall, SWP and CVP project operators (including operators of Folsom and Oroville Reservoirs) will continue to be challenged to manage cold water supply and downstream flows to protect fish and wildlife species while simultaneously meeting Delta environmental standards and water demand.

It's important to note that while climate change may influence SWP/CVP operators to release more or less water from upstream reservoirs, depending on the circumstances, shifts in the timing of releases over the course of a given year (not necessarily the cumulative amount) is significant as well for both anthropogenic and fish and wildlife beneficial uses. In addition, Delta salinity is not only affected by tidal energy, upstream reservoir releases, and runoff (see above), but can also be influenced by south Delta diversions, installation of the Head of old River Barrier (HORB) and other temporary barriers, Suisun Marsh Salinity Control Gates, and even San Joaquin River inflows and Delta agriculture return flows, among others. Though the California WaterFix operations at the new north Delta intakes could affect water quality conditions at various downstream locations, the additional northern diversion point will give the operators another tool and considerably more flexibility in meeting water quality standards. Due to the implementation of specific mitigation measures designed to minimize and avoid water quality degradation and real-time operations and management, operations at both the north Delta intakes and south Delta export facilities will comply with existing and/or future standards to protect water quality, unless relaxations of standards are warranted, as determined by the regulatory agencies.

29D.2.4 BDCP/California WaterFix and the Collaborative Science and Adaptive Management Program

As discussed in this EIR/EIS, the California WaterFix will be operated with the guidance of the new Biological Opinion issued from the Section 7 consultation process and 2081(b) permit and the Collaborative Science and Adaptive Management Program (CSAMP)(See Chapter 3 in the BDCP for a description of the Adaptive Management and Monitoring Program under the BDCP alternatives). CSAMP comprises of DWR, Reclamation, CDFW, USFWS, NMFS, and the public water agencies. The broad purposes of the program will be to: 1) undertake collaborative science, 2) guide the development and implementation of scientific investigations and monitoring for both permit compliance and adaptive management, and 3) apply new information and insights to management decisions and actions. From its collaborative science, monitoring, and adaptive management the Adaptive Management and Monitoring Plan (AMMP) would influence the operation and management of facilities and protected or restored habitat associated with Alternative 4A. The CSAMP process and its Collaborative Adaptive Management Team (CAMT) rely on the Delta Science Program (DSP) to provide independent peer review of both science proposals and products. When the proposed project is online and operational, the CSAMP will carry out additional scientific studies that are reviewed by the DSP, an independent third party, to inform policy makers from the agencies implementing the proposed project on potential operational changes to minimize environmental impacts of the California WaterFix and ensure compliance with its ESA permits. Information gained from the CSAMP, including potential climate change- related effects on listed species, will provide guidance and recommendations on relevant science related to the operations of the CVP and SWP within the Delta to inform implementation of the existing and new BiOps and 2081(b) permits.

The CSAMP is a key component of the Five Agency Adaptive Management Framework for the California WaterFix and 2008/2009 Biological Opinions on the combined operations of the Central Valley and State Water Projects (Framework). Through this Framework the federal and state water operations agencies, Reclamation and DWR, and the state and federal fisheries agencies, USFWS, NMFS and CDFW, (Five Agencies) are committing to adaptively managing the ongoing operation of the CVP and SWP and future implementation and operation of the California WaterFix. The Framework will consist of a structured decision making process to integrate new science and research on the Delta ecosystem, water project operations, and future environmental conditions to facilitate adaptive management on multiple time-scales to address species and ecosystem needs. Scientific investigations and research into existing and potential future effects of climate change on species populations and ecosystem health could be incorporated into recommendations to help inform decisions on water project operations.

Environmental impacts of climate change will necessitate inter-agency cooperation to manage the SWP and CVP in a sustainable manner to continue to meet water quality standards and water demand, while providing enough flows and cold water for sensitive species. DWR and Reclamation are ultimately responsible for SWP and CVP project operations, but do not make the decisions alone. Federal and state agencies have put in place regulations that may be updated periodically when needed. Real-time operations management has become the new normal when dealing with climate variability. Future climate conditions may fluctuate from multi-year droughts to periodic flood events from weather phenomenon such as atmospheric rivers. Regulatory agencies will have the responsibility to ensure adaptive management of the state's water resources can accommodate future climate conditions. While several processes exist to deal with changes in environmental conditions we are currently experiencing, modeling and predicting exact changes in the future,

including the type of operational responses to environmental fluctuations and/or catastrophic events and when these changes/events would occur is not possible or would be based on speculation. Therefore, the analysis and modeling of potential changes in the future was performed within the confines of current operating criteria and regulations. Nevertheless, a dual conveyance system would provide additional flexibility in operations to help meet future regulations and water demand. DWR acknowledges that uncertainty is inherent in any planning effort of this geographic and temporal scale. However, DWR is committed to using the best available science throughout the proposed project's lifetime, consistent with the requirements of the ESA and other relevant regulations.

29D.3 Summary

Each of the changes to CALSIM II inputs to simulate future climate changes that are discussed above in Section 29D.1 were based on scientific studies, data, and modeling. The lead agencies have used the best available science and analytical tools to construct scenarios of future climate that are used to explore the system response to changes in temperature and precipitation. These changes will likely cause impacts such as changed water temperature conditions, changes in the timing and magnitude of Delta outflow, and other impacts as detailed in the various resource chapters of the EIR/EIS. As actual changes unfold and are realized throughout the system it is likely that there will be changes in policy and regulatory response by the multiple state and federal resource agencies that manage aspects of the Delta watershed. Section 29D.2 describes a number of these agency programs and some of the potential ways in which policies and regulations could be changed in the future. While it is virtually certain that changes to state and federal policy and regulations governing the Delta watershed will occur in the future, attempting to predict exactly what those changes would be and when and where they would occur is not supported by any data nor is there sufficient predictive capacity to estimate or extrapolate from existing conditions. Thus assumptions about operational criteria, regulatory constraints, and policy preferences differing from existing conditions are speculative and have been avoided. Therefore, throughout the BDCP/California WaterFix analyses, regulatory conditions have been assumed to remain unchanged from current conditions and water project operations are assumed to follow the same algorithm for determining future project operation as has historically been used.