Chapter 7
Flood Protection

This chapter describes the environmental setting and study area for flood protection; analyzes impacts that could result from construction, operation, and maintenance of the Delta Conveyance Project (project); and provides mitigation measures to reduce the effects of potentially significant impacts. This chapter also analyzes the impacts that could result from implementation of compensatory mitigation required for the project and describes any additional mitigation necessary to reduce those impacts, and analyzes the impacts that could result from other mitigation measures associated with other resource chapters in this Draft EIR. The flood protection resources considered are flood management systems (including State Water Project [SWP] and Central Valley Project [CVP] flood control reservoirs and downstream channels), drainage patterns and runoff flows, and flood flows in the study area.

7.0 Summary Comparison of Flood Protection Impacts by Project Alternatives

Table 7-0 provides a summary comparison of impacts on flood protection by project alternative. The table presents the CEQA findings after all mitigation is applied. If applicable, the table also presents quantitative results after all mitigation is applied.

Consistent with the evaluation of potential impacts on other resources, the qualitative and quantitative analyses discussed in this section assess the significance of project impacts in relation to existing conditions. All project alternatives are for water supply purposes and with exception of modification to levees at intake locations, include no changes in flood management infrastructure in the Sacramento River Basin and in the Delta, including the reservoirs of the SWP and CVP, and associated flood operation rules and management which contribute to the flood protection afforded by the Sacramento River Flood Control Project (SRFCP). Therefore, the impacts from project alternatives were evaluated for flood protection of nearby urban and nonurban areas along the reach of the Sacramento River from the American River confluence to Sutter Slough, where the drainage of floodwater may be affected by the construction and operation of the intakes. Potential impacts from project facilities impeding or redirecting localized flood flow were also evaluated. All of these impacts are contained in the Delta, which constitute the study area. The analysis of flood-related impacts included a quantitative and qualitative approach, depending on the location where these impacts may occur. These two categories of analysis require different settings to accommodate the different regulatory frameworks associated with applicable flood management practices. This section provides a summary of these two categories of impact assessments including the reasons for selecting the associated existing conditions and No Project Alternative, and the resulting flood control impacts.

The assessment of potential flood control impacts on the passage of floodwater in the Sacramento River was conducted to be consistent with the *2022 Central Valley Flood Protection Plan (CVFPP) Update* (2022 CVFPP Update) (California Department of Water Resources 2022a), based on consultation with the Central Valley Flood Protection Board (CVFPB). Consistency with the 2022 CVFPP Update is important because the channel and levees of this section of the Sacramento River are part of the State Plan of Flood Control (SPFC) as defined in California Water Code (Wat. Code) Section 9110(f). The 2022 CVFPP Update, which is the long-term plan for areas protected by the SPFC, has a 50-year planning horizon from 2022 for analysis purposes and for developing assessment strategy. Therefore, the analysis for potential flood control impacts on the area protected by the SPFC was conducted using a similar approach and planning horizon. To maintain consistency with the regulatory and planning purposes, flood control impact analyses along the Sacramento River protected by the SPFC used the years 2022 and 2072 as reference years for existing conditions and the No Project Alternative, respectively. This change from the approach used in other resource assessments (existing conditions at 2020 and No Project at 2040) is considered necessary for the flood control impact assessment to be consistent with the SPFC.

The nature of the proposed north Delta intake structures requires placement along the bank of the Sacramento River, with a portion of the structure projecting into the flowing water. This could effectively constrict the conveyance capacity of the river along the respective length of each intake, resulting in a rise in water surface elevation (WSE) upstream of the intakes. The corresponding WSE increase is dependent on the combination of intakes used to achieve project needs, the facility configuration, and the phase of construction for each intake.

Hydraulic analyses examined the effect of the project on WSEs in the Sacramento River between the American River confluence and Sutter Slough. The effects of the intakes on the WSE are expected to only occur within this reach of the Sacramento River. This reach of the river, which includes urban levees extending south from the American River confluence to around the location of the Freeport Regional Water Authority intake, protects Sacramento urban areas; these areas are subject to Urban Level of Flood Protection (i.e., 200-year level of flood protection). The rest of the levees further downstream along the Sacramento River are considered rural levees or nonurban levees that are not subject to the Urban Level of Flood Protection. Therefore, for completeness of the assessment for each project alternative, it was necessary to evaluate the impacts on WSEs of the Sacramento River for 100- and 200-year flood events under existing conditions (i.e., 2022 conditions) and future conditions (i.e., 2072 conditions) with climate change, including corresponding hydrologic change and sea level rise. The results of the hydraulic analyses indicate that WSE increases in the Sacramento River between the American River confluence and Sutter Slough during the 100-year and 200-year flood events would result in a less-than-significant impact on flood protection during construction and during operations with permanent facilities, except that Alternatives 2a and 4a, where all three intakes are used, would increase Sacramento River WSE upstream of the intakes between 0.11 and 0.12 foot during construction and result in a significant impact. Mitigation Measure FP-1: *Phased Construction of the Proposed North Delta Intakes* would reduce the magnitude of WSE increases during the 100-year and 200-year flood event to a less than significant level.

The assessment for potential flood protection impacts from the permanent project facilities during operations was also evaluated using flood flows consistent with those used to develop the 1957 U.S. Army Corps of Engineers (USACE) Sacramento River Project Levee design profiles. The 1957 design profile assessment is required by USACE and CVFPB as part of their corresponding permitting process for the project to demonstrate that project operations would not impede the continued functions of the levees and channels as originally designed. The 1957 levee design profiles were not considered as part of the CEQA impact assessment because the CEQA impact thresholds used by the California Department of Water Resources (DWR) in this Draft EIR are more stringent than the 1957 profiles. The details and results of the analysis using the 1957 levee profiles are provided in Appendix 7B, *Evaluation against U.S. Army Corps of Engineers 1957 Design Profiles*.

For the impact assessment on localized flood flow impacts from various project facilities, an approach consistent with the assessment of other resources in this Draft EIR was applied. This portion of the flood assessment compared changes in conditions resulting from the project with existing conditions. Existing conditions include existing facilities and ongoing programs that existed as of January 15, 2020 (i.e., the publication date of the Notice of Preparation). The No Project Alternative includes reasonably foreseeable changes in existing conditions (such as sea level rise and climate change) and changes that would be expected to occur in the year 2040 if the project were not approved.

The project would include permanent facilities within the 100-year flood hazard area and therefore, where necessary to protect the water conveyance infrastructure from flooding, facilities would be conservatively designed to withstand a 200-year flood event with projected climate change hydrology for 2100 and extreme sea level rise during operations (Delta Conveyance Design and Construction Authority 2022a:62, 2022b:42). For launch shaft sites at Bouldin and Lower Roberts Islands, the levees would be improved to meet the Delta-specific Public Law (PL) 84-99 standards, where applicable, which is an improvement to existing conditions. As a result, these areas would be out of the 100-year flood hazard area due to the levee improvement, alleviating the need to assess potential impacts on local flood flows. This approach was not proposed for the Twin Cities Complex and therefore, a two-dimensional (2-D) hydraulic analysis for the Twin Cities Complex was conducted. The analysis showed limited increases in flood depth and area around the Twin Cities Complex during construction (which includes a ring levee to minimize impacts on the surrounding lands) and operations. The flood effects analysis for the Twin Cities Complex site found that the ring levee (during construction) and stockpile storage areas (during operations) for all project alternatives would increase the 100-year flood depth by a maximum of approximately 0.4 foot and would increase the 100-year floodplain by approximately 15 acres when compared to existing conditions (i.e., 2022 conditions). The ring levee associated with construction at the Twin Cities Complex site exhibited the largest increases to the depth and areal extent of the 100-year flood event. The extent and change of the maximum WSE during a 100-year flood event was considered a less-than-significant impact. All launch, maintenance, and reception shaft sites would enact nonstructural flood risk management measures.

The Southern Forebay is not located in the 100-year flood hazard zone and would be designed in accordance with DWR Division of Safety of Dams (DSOD) requirements for jurisdictional dams based on the anticipated maximum embankment height and storage volume. The Southern Forebay includes an overflow emergency spillway that would be used in the unlikely condition that the forebay water level continued to rise above the design maximum elevation. The emergency spillway would discharge flow from the Southern Forebay into Italian Slough, which flows into Old River. To accommodate this, a portion of the existing Italian Slough levee would be removed. New levees would be constructed to channelize and contain the spillway discharge flows between the outboard toe of the spillway and the existing levee along Italian Slough. The discharge into Italian Slough would initially be contained within the slough’s existing levees but would, over a short distance, converge with Old River. The connection to Old River and the broader Delta waterways would allow spillway flows to be absorbed during any emergency discharge.

The potential hydraulic impact of the Southern Forebay Emergency Spillway on the existing levee system of Italian Slough and Old River was evaluated using a one-dimensional (1-D) hydraulic model. The change in WSEs was compared between the different operational scenarios (i.e., spillway releases of 3,000, 4,500, 6,000, and 7,500 cubic feet per second [cfs]) and the baseline (i.e., no spill event). The 7,500 cfs scenario exhibited the largest increases in WSEs when compared to the baseline for both the 100-year flood event and the mean higher high water event (Delta Conveyance Design and Construction Authority 2022c:Att 2-5). For the 100-year flood event, the 7,500 cfs scenario increased WSEs by 0.44 foot when compared to the baseline with the affected area extending 2.47 miles upstream and 1.55 miles downstream of the spillway location. For the mean higher high water event, the 7,500 cfs scenario increased WSEs by 0.67 foot when compared to the baseline with the affected area extending 2.47 miles upstream and 1.94 miles downstream of the spillway location. Although the spillway was assumed to flow for 12 hours, peak WSEs were achieved in 2 hours or less for the scenarios modeled. In the scenarios modeled, the peak WSE was located upstream of the spillway location due to backwater effects from the additional flow entering Italian Slough from the spillway. None of the scenarios analyzed resulted in overtopping levees of the main Italian Slough channel or Old River due to the releases from the Southern Forebay Emergency Spillway.

Constructions of the facilities under various project alternatives involve excavation, grading, stockpiling, soil compaction, and dewatering that could result in alterations to runoff, drainage patterns, erosion, stream courses, and WSEs during construction of facilities. All project features would be constructed to not increase peak runoff flows into adjacent storm drains, drainage ditches, or rivers and sloughs. All surface water runoff and dewatering flows or additional runoff during construction would be captured, treated, stored, and, if possible, reused on-site. If additional stored water is not needed, the treated runoff flows would be released in a manner that would not increase peak WSEs in adjacent channels. Shallow flooding has historically occurred at the sites of the proposed north Delta intakes due to natural depressions. Therefore, the project alternatives include drainage and pump enhancements to ensure intake facilities would not be subject to flooding during operation. During construction, the local drainage at intake facility sites would be managed to minimize local flooding through installing temporary pumps if necessary to allow continued construction activities. Because drainage and pump enhancements are included in facility design, the potential impacts of localized flooding at the intakes would be minimized. Overall, the project alternatives would have less-than-significant impacts on existing drainage patterns of the facility site or surrounding area.

Table 7-0 summarizes the comparison of impacts on flood protection by project alternatives disclosed in this chapter.

1 **Table 7-0. Comparison of Impacts on Flood Protection by Project Alternative**

Chapter 7 – Flood Protection	Project Alternative								
	1	2a	2b	2c	3	4a	4b	4c	5
Impact FP-1: Cause a Substantial Increase in Water Surface Elevations of the Sacramento River between the American River Confluence and Sutter Slough	LTS	S (LTS with mitigation)	LTS	LTS	LTS	S (LTS with mitigation)	LTS	LTS	LTS
Construction Phase									
River Reaches with Urban Levees – Max WSE Difference Relative to EC (feet) *100-Year Flood Event*	0.08	0.10	≤0.08	≤0.08	0.08	0.10	≤0.08	≤0.08	0.08
River Reaches with Urban Levees – Max WSE Difference Relative to EC (feet) *200-Year Flood Event*	0.08	0.10	≤0.08	≤0.08	0.08	0.10	≤0.08	≤0.08	0.08
River Reaches with Nonurban Levees – Max WSE Difference Relative to EC (feet) *100-Year Flood Event*	0.10	0.11	≤0.10	≤0.10	0.10	0.11	≤0.10	≤0.10	0.10
River Reaches with Nonurban Levees – Max WSE Difference Relative to EC (feet) *100-Year Flood Event with Mitigation*	N/A	0.09	N/A	N/A	N/A	0.09	N/A	N/A	N/A
River Reaches with Nonurban Levees – Max WSE Difference Relative to EC (feet) *200-Year Flood Event*	0.10	0.12	≤0.10	≤0.10	0.10	0.12	≤0.10	≤0.10	0.10
River Reaches with Nonurban Levees – Max WSE Difference Relative to EC (feet) *200-Year Flood Event with Mitigation*	N/A	0.09	N/A	N/A	N/A	0.09	N/A	N/A	N/A
Operations Phase									
River Reaches with Urban Levees – Maximum WSE Difference Relative to EC (feet) *100-Year Flood Event*	0.04	0.05	≤0.04	≤0.04	0.04	0.05	≤0.04	≤0.04	0.04
River Reaches with Urban Levees – Maximum WSE Difference Relative to EC (feet) *200-Year Flood Event*	0.04	0.05	≤0.04	≤0.04	0.04	0.05	≤0.04	≤0.04	0.04

	Project Alternative								
Chapter 7 – Flood Protection	1	2a	2b	2c	3	4a	4b	4c	5
River Reaches with Nonurban Levees – Maximum WSE Difference Relative to EC (feet) *100-Year Flood Event*	0.04	0.05	≤0.04	≤0.04	0.04	0.05	≤0.04	≤0.04	0.04
River Reaches with Nonurban Levees – Maximum WSE Difference Relative to EC (feet) *200-Year Flood Event*	0.04	0.05	≤0.04	≤0.04	0.04	0.05	≤0.04	≤0.04	0.04
Impact FP-2: Alter the Existing Drainage Pattern of the Site or Area, including through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner That Would Result in Flooding On- or Off-Site or Impede or Redirect Flood Flows	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS

Note: Alternatives 2b, 2c, 4b, and 4c (3,000-cfs and 4,500-cfs capacity alternatives) were not modeled since WSE impacts would be similar to, or less than, the corresponding alternatives of the same alignment but larger capacity (i.e., Alternatives 1 and 3 [6,000-cfs capacity alternatives]).

cfs = cubic feet per second; EC = existing conditions; N/A = not applicable; WSE = water surface elevation; LTS = less than significant; S = significant.

7.1 Environmental Setting

This section describes flood risks, flood management, and flood management facilities within the study area that could be affected by construction, operation, and maintenance of the project.

Flood protection is related to surface water resources discussed in Chapter 5, *Surface Water*, which describes Sacramento and San Joaquin River Basin hydrology, and the hydrology of the Delta. Chapter 6, *Water Supply*, describes SRFCP and CVP facilities and their operation, including facilities with specific flood-management responsibilities.

7.1.1 Study Area

The study area, defined as the area in which impacts may occur, primarily comprises the statutory Delta (or legal Delta)—as defined by Wat. Code Section 12220—as well as areas southwest and east of the legal Delta to include the facility footprints associated with Bethany Reservoir (for Alternative 5) and the Supervisory Control and Data Acquisition (SCADA) Fiber Route (for all project alternatives) near the proposed north Delta intakes, respectively. The study area includes portions of Sacramento, Yolo, San Joaquin, Contra Costa, and Alameda Counties. The assessments for potential flood control impact from the project alternatives focus on the legal Delta as well as the immediate area east of the Delta for the SCADA Fiber Route because the area around Bethany Reservoir is outside of the floodplain (Figure 7-1).

The Delta covers approximately 1,300 square miles and is a complex network of channels, levees, subsided islands, sloughs, rivers, and tributaries that is located at the confluence of the Sacramento and San Joaquin Rivers (Delta Stewardship Council 2021:1-3). The Sacramento and San Joaquin Rivers are the two biggest contributors to Delta inflows, with additional inflows being provided by tributaries to the east (i.e., Mokelumne, Cosumnes, and Calaveras Rivers). Historically, the natural Delta system was formed by water inflows from upstream tributaries in the Delta watershed and outflows to Suisun Bay and San Francisco Bay. In the late 1800s, local land reclamation efforts in the Delta resulted in the construction of channels and levees that began altering the Delta's surface water flows. Over time, the natural pattern of water flows continued to change as the result of upper watershed diversions and the construction of facilities to divert and export water through the Delta to areas where supplemental water supplies are needed. Chapter 5 includes a more detailed description of the Sacramento and San Joaquin River Basins and their influence on the Delta.

Because the area around Bethany Reservoir is outside of the floodplain, and the impact assessment focuses on the legal Delta, the area around the Bethany Reservoir Discharge Structure is not addressed in this analysis. The Delta includes many federal, state, regional, and local flood management facilities, including levee systems, bypasses, floodways, weirs, and other pertinent facilities. The construction or operations of the project alternatives would not affect these flood management facilities and do not include any changes in flood control operations. Flood control operation and associated rules are under the jurisdiction of USACE. Therefore, the operations of project alternatives would have no impacts on flood protection upstream of the Delta, and the level of flood protection under project alternatives would remain the same. Since the project would not affect the Sacramento River upstream of the Delta or the San Joaquin River Basin outside of the Delta, the study area associated with flood protection focuses on the specific areas in the Delta that may be affected by project facilities—including the intakes, launch/maintenance/reception shafts, and Southern Forebay (although the latter is applicable to Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c only). The proposed intakes are on the Sacramento River and the flow at intake locations are subject to the operation of upstream flood management facilities including the reservoirs of the SRFCP, SWP, and CVP. However, the effects of project alternatives on flows in the Sacramento River are expected to be minimal upstream of the American River confluence (see later sections for more discussion). Therefore, flood control and management facilities on the Sacramento River upstream of the American River confluence are only discussed briefly to provide context and references for discussing the existing flood management in the Delta. A more detailed description of the surface reservoirs, conveyance systems, and water diversion facilities in the Sacramento and San Joaquin River Basins can be found in Chapter 5.

7.1.2 Areas Subject to Flooding

The Delta, as part of the estuary formed by the Sacramento and San Joaquin Rivers, is an inherently flood-prone area. Fluctuations in Delta WSEs are often entirely driven by high discharge events in upstream areas of the Delta tributaries (i.e., the Sacramento River, San Joaquin River, and eastside tributaries discussed above). Delta WSE variations are heavily influenced by additional factors, including astronomical tides and atmospheric effects (pressure and wind); the effects of these processes decrease with distance into the Delta and along the river channels as riverine inflows become more dominant. Generally, the tidal influence can extend to the Sacramento River near Sacramento, and the San Joaquin River between Mossdale Bridge and Vernalis. Fluvial inflow, salinity control operations, and Delta exports also affect Delta WSEs, although these effects tend to be localized in non-flooding conditions.

The Federal Emergency Management Agency (FEMA) is a primary source of current flood risk information. FEMA uses Flood Insurance Studies to produce Flood Insurance Rate Maps (FIRMs). Probability of flooding is defined by the probability that a flood may occur in any given year. For example, a 100-year flood is a flood that has a 1% chance of occurring in any given year, or more formally, a 1% chance of annual exceedance probability (AEP). FEMA refers to areas that are subject to inundation by the 1% AEP flood as Special Flood Hazard Areas (SFHAs). Figure 7-1 shows floodplains in the Delta that have a 1% AEP (Federal Emergency Management Agency 2020). The Delta spans numerous FIRM panels and contains several FEMA flood zones. FEMA FIRMs indicate that much of the central Delta—essentially all of the nonurban Delta—is within SFHAs and considered to be subject to flooding with 1% AEP. Encroachments within these flood zones are subject to federal, state, and local regulatory requirements. The federal regulatory requirements represent the minimum level of compliance needed, while state and local requirements may be more stringent. FEMA continues to evaluate floodplain delineations as needed based on continued hydrology changes that may affect the AEP frequency calculation and additional evaluation of facility conditions and improvement.

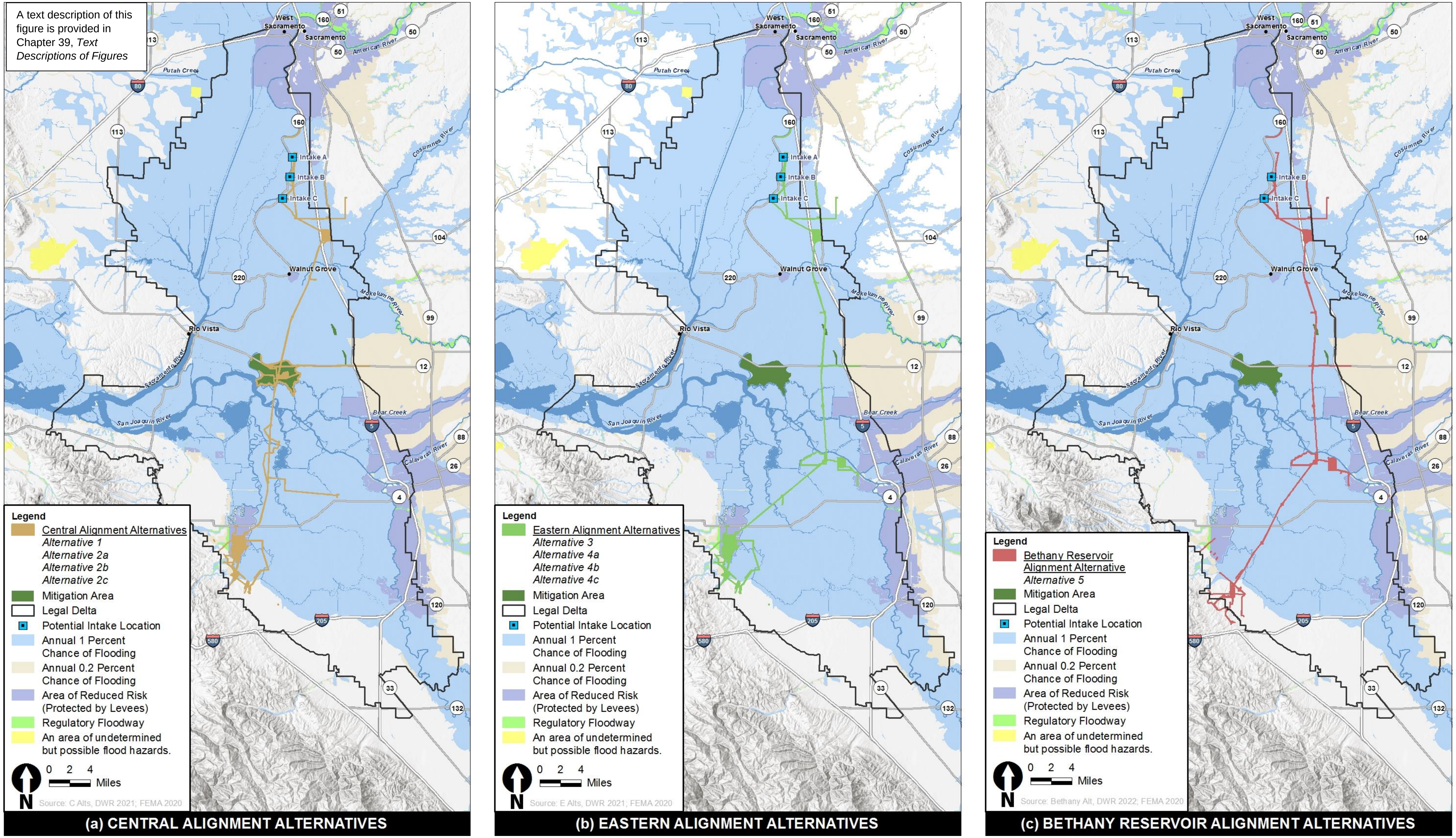

Figure 7-1 FEMA Floodplains for a 1% AEP Flood in the Delta

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For the assessment of potential impacts from project alternatives on local flood flows, the Delta's 100-year floodplain is generally considered the extent of the study area; however, the area subject to flooding is greater than shown in Figure 7-1 during a more significant flood event. Separate considerations are required to address the potential flood management impacts on the greater flood management system that resides in the part of the Delta near the proposed north Delta intakes. Detailed analyses are not needed in areas with reduced flood risks due to levee improvement because those areas are functionally out of the 100-year floodplain based on FEMA's National Flood Insurance Program (NFIP). The location of the project facilities within the floodplain warrants evaluation of potential flood impacts from proposed facility plans. As shown in Figure 7-1, the majority of the facilities proposed for the project alternatives are within the 100-year (i.e., 1% AEP) floodplain in the Delta—Bethany Reservoir Pumping Plant being the most notable project feature that is not. While the SCADA Fiber Route is not within the legal Delta, a significant portion of the facility footprint is within the 100-year floodplain. Figure 7-1 also depicts "Area[s] of Reduced Risk"—a FEMA designation that describes an area with a levee where the risk of being flooded is reduced, but not completely removed. FEMA does not delineate floodplains for floods smaller than the 1% AEP, such as the 2% and 10% AEP (50- and 10-year, respectively) flood events.

Delta flooding could interrupt the conveyance of water through the Delta for the SWP, the CVP, in-Delta users, the Contra Costa Water District, the cities of Antioch and Stockton, and others relying on the Delta for water supplies (Delta Stewardship Council 2020:5). Levee failures could also damage key features of the Delta ecosystem existing on the heavily altered landscape, including managed wetlands in Suisun Marsh and habitats of wintering greater sandhill cranes at Staten Island and nearby tracts. Moreover, levee failure could degrade Delta water quality if waters rush into a heavily subsided Delta island, pulling higher-salinity water (from the western Delta) into the central Delta. Because the elevations of many Delta islands are below sea level, these failures would draw salt water from San Francisco Bay and introduce additional pollutants into Delta water with flood debris, farm chemicals, and others.

Some generalizations can be made about the geographic differences in the nature of the flood threats in the various regions of the Delta, including the following.

- North and South Delta: The flood risks in both the north and south Delta are more related to the storm events in the Sacramento and San Joaquin River Basins, depending on the combination of factors including the intensity and volume of rainfall and if the temperature would be warm enough to trigger early snowmelt, adding additional volume into the channels. These conditions can increase the risk of levee failures due to scour, seepage, and slumping. For these reasons, north and south Delta receive protection from flood control systems established for the Sacramento and San Joaquin River systems. Occasionally, extended periods of snowmelt, extending into June and July, may affect north and south Delta, but the flooding effects are more localized in upstream areas.

- Flood concerns in the north Delta are particularly acute. The combined flood flows of the Morrison Stream Group, Dry Creek, the Cosumnes River, and the Mokelumne River converge and accumulate because the downstream Delta channels lack the capacity to convey the combined flow (which can be exacerbated by high tidal conditions) to the Sacramento and San Joaquin Rivers. River stages rise until levees give way or are overtopped, which occurred in 1986. During that flood event, the levees failed on McCormack-Williamson Tract, Glanville Tract, Dead Horse Island, and Tyler Island sequentially over a period of hours on the afternoon and evening of February 18, 1986, followed by a levee failure on New Hope Tract.

- West Delta: In the west Delta region, high water stages due to tides and total Delta inflow (especially from the Yolo Bypass) and high winds could result in extreme wave wash erosion, displacement of riprap, and waves overtopping the levees. Deep peat and weak foundations combined with island interiors well below sea level could contribute to the structural stresses on west Delta levees.

7.1.3 Factors That Influence Flood Risk in the Study Area

California's Central Valley, including the Delta, is a broad, gently sloping valley formed by the Sacramento and San Joaquin Rivers. The lower-lying lands along these two rivers and the Delta were once floodplains and marshlands that were regularly inundated for long periods during large, seasonal flood events before reclamation (California Department of Water Resources 2012a:1-2). The history of flood management in the Central Valley can be traced back to the mid-1800s. More than 1 million people are now living in the Central Valley floodplain where major flood events in 1983, 1986, 1995, and 1997 created cumulative flood damage estimated in excess of $3 billion (California Department of Water Resources 2012a:1-1). The Central Valley Flood Control Project management system includes levees along the major rivers and streams of the valley floor and around the islands of the Delta, a major bypass system for the Sacramento River and its tributaries, several bypass segments along the San Joaquin River, and reservoirs on almost all major rivers and streams draining to the Central Valley (California Department of Water Resources 2012a:1-3). These facilities were built and owned by different entities ranging from federal, state, and local agencies to reduce flood risk. That is, the facilities were designed for a capacity or specific purpose that would mitigate, but not entirely eliminate, flooding. Therefore, there is always flood risk in areas within the floodplain and protected by these flood management systems, which seek to reduce potential life loss and property damage. Proper land use management for floodplain and levee-protected areas, and additional mitigation actions such as flood insurance, are all integral parts of flood management.

The study area (i.e., the Delta) is formed by the confluence of the Sacramento and San Joaquin Rivers. Therefore, the flooding conditions in the Delta can be influenced by the flood management system and its operation; however, the flooding conditions in the Delta can also be influenced by eastside tributaries (i.e., the Cosumnes and Mokelumne Rivers), tidal effects, and potential sea level rise.

Flood risk is a combination of the chance of flooding and the consequence of flooding (i.e., life loss and property damages once flooding occurs), and it is not static through time. Flood risks in the study area can be influenced by many factors, including the following.

- Hydrologic conditions, such as the intensity and volume of precipitation and runoff.
- Existing flood management facilities, such as levees and bypasses.
- Levee conditions, standards, and level of compliance.
- Seismic activity.
- Land subsidence and increased hydraulic loading on a levee and its foundation.
- Sunny-day hazards, such as damage due to burrowing animals, penetrations, and vegetation.
- High water conditions, such as high tides and storm surges.
- Regional planning efforts that address flood management and emergency preparedness, response, and mitigation.

The following sections provide information about the different factors that increase flood risk in the study area.

7.1.3.1 Hydrologic Conditions

California's statewide annual precipitation is highly variable. While annual precipitation ranges between roughly 100 million and 300 million acre-feet, about 200 million acre-feet of rain and snow fall per year on average (California Department of Water Resources 2020a:53). This precipitation is generally greatest in the Sierra Nevada and north coast regions, with precipitation ranging from 36 to 160 inches per year in these areas (California Department of Water Resources 2020a:53). Conversely, some of the southern regions of the state receive less than 4 inches of precipitation per year. The geographic variation and the variability in precipitation that California receives make it challenging to manage the available runoff that can be captured in storage to meet water needs while also managing flood risk.

Annual precipitation data from California shows significant year-to-year variation. This inter-annual variability makes trend analysis difficult; an analysis of precipitation records since the 1890s shows no statistically significant trend in precipitation throughout California. Although the overall precipitation trend is generally flat over the past 120 years, the precipitation record indicates significant decadal variability giving rise to dry and wet periods. A decadal fluctuation signal has become apparent in Northern California, where winter precipitation varies with a period of 14 to 15 years (California Department of Water Resources 2020b:10). This decadal signal has increased in intensity over the twentieth century, resulting in more distinct dry and wet periods. For example, the average water year (i.e., October 1–September 30) precipitation between 1966 and 2015 was 51.8 inches (California Department of Water Resources 2020b:10). However, there are extremely dry years—such as 1976–1977 with only 19.0 inches—and extremely wet years—such as 2016–2017 with 94.7 inches—as a result of this decadal variability.

Certain large storm events can lead to high discharge events in upstream areas of the Delta tributaries (i.e., the Sacramento River, San Joaquin River, and eastside tributaries). This large increase in Delta inflows—which increases Delta WSEs—can coincide with substantial flooding in the Delta, as was the case in February 1986. In the 2 weeks prior, heavy rains saturated Northern California watersheds and contributed to high inflows into the north Delta from the Cosumnes River, Dry Creek, and the Morrison Stream Group. The inflows exceeded the conveyance capacity of north Delta channels, resulting in ponding upstream of Franklin Road. A series of levee failures ensued at Glanville Tract, McCormack-Williamson Tract, Dead Horse Island, Tyler Island, and New Hope Tract (Delta Conveyance Design and Construction Authority 2022d:Att 1-1).

7.1.3.2 Existing Flood Management Facilities

Flood management facilities (e.g., reservoirs, bypasses, levees) along the Sacramento and San Joaquin Rivers and their tributaries reduce frequency of flooding in the floodplain along these rivers. Since their construction, these facilities have helped promote public safety and prevent billions of dollars of flood-related damages (California Department of Water Resources 2017a:iii).

Human-made structures and economic activities in a floodplain will be always subject to flood risk. Flood management facilities were built with specific designed capacities and intended functions and were not built to stop all flooding. Once infrastructure is in place, an associated level of flood protection may change due to changes in hydrology under climate change and other continued development in the watershed, especially in the floodplain.

Flood management facilities could be overwhelmed and even fail if hydrologic conditions exceed designed capacities, if certain deficiencies exist, or if a combination of both elements occur. Recent examples of large-scale flood events include the February 1986 flood with damages that occurred mostly in the Sacramento Valley and the Delta, and the December 1996–January 1997 flood, during which there were five deaths and more than $300 million in damages throughout the Central Valley, including in the Delta (U.S. Army Corps of Engineers 2015:1-11).

State Plan of Flood Control

The Central Valley's flood management system consists of many reservoirs, levees, and other flood management facilities that were built by various entities over time. In 1953, structures, lands, programs, and modes of operation and maintenance were brought together in a state-federal flood protection system known as the SPFC. The SPFC facilities include approximately 1,600 miles of levee, and approximately 150 reservoirs are constructed on streams draining to the Central Valley. A group of 10 major multipurpose reservoirs play an important role in moderating Central Valley flood inflows (excluding those draining to the Tulare Lake Basin) (California Department of Water Resources 2012a:1-5). One such reservoir is Lake Oroville, which regulates the mainstem of the Feather River as part of the SRFCP and SPFC. Authorized as a multipurpose facility, operation of the Oroville facilities is dependent on hydrology and DWR's objectives. Lake Oroville stores winter and spring runoff for release to the Feather River, as necessary, for SWP and flood control operation purposes. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, diversions, and water quality.

California's CVFPB is the regulatory body for flood management in the Central Valley. DWR has flood management responsibility for its own facilities (e.g., Lake Oroville) and, as described further later, shares responsibility for operations and maintenance (O&M) for a portion of the flood management system in the Central Valley with the CVFPB.

Wat. Code Section 9110(f) defines the SPFC as follows.

> The state and federal flood control works, lands, programs, plans, policies, conditions, and mode of maintenance and operations of the Sacramento River Flood Control Project described in Section 8350, and of flood control projects in the Sacramento River and San Joaquin River watersheds authorized pursuant to Article 2 (commencing with Section 12648) of Chapter 2 of Part 6 of Division 6 for which the board or the department has provided the assurances of nonfederal cooperation to the United States, and those facilities identified in Section 8361.

The SPFC facilities are a portion of the larger flood management system in the Central Valley for which the state has special responsibilities. The SRFCP, as part of the SPFC facilities, is one of the primary flood control features on the Sacramento River system, as described in the *State Plan of Flood Control Descriptive Document* (California Department of Water Resources 2010:2-2). The SRFCP area spans from Red Bluff to the northern Delta and includes a complex system of levees, overflow weirs, drainage pumping plants, and flood bypass channels. O&M of these facilities serves a critically important role in managing floods that affect the Delta.

The channels of a flood management system convey floodwater for safe discharge based on their design capacities and profiles. The flood bypass channels (i.e., Butte Basin; Tisdale, Sutter, and Yolo bypasses) of the SRFCP are designed to convey flood flows away from the river systems when their capacities are constrained due to high runoff conditions. The Yolo Bypass is a feature of the SRFCP and is located immediately west of the metropolitan area of Sacramento and West Sacramento, extending from the Fremont Weir (upstream of the Delta) to Liberty Island (within the Delta). During high water, the diversion of water to the Yolo Bypass relieves the pressure of high flows from the Sacramento River and alleviates flood risk in the region. This function results in the Yolo Bypass flooding about once every 33 years, mostly between December and February; it is usually cleared for farming operation in the spring, but the period of inundation may be longer if necessary (Delta Stewardship Council 2020:12).

CVFPB is the nonfederal sponsor of the SRFCP and shares responsibility with DWR for O&M of these facilities. DWR is responsible for maintaining and operating some portions of the SRFCP, including the Fremont Weir, Sacramento Weir, and flood-carrying capacity of the Yolo Bypass. CVFPB also has agreements with other local maintaining agencies for remaining facilities (California Department of Water Resources 2010:5-5–5-14, 2017b:5-1). Flood control channels that are part of the SPFC (i.e., SPFC channels) are under the jurisdiction of DWR and the CVFPB. As directed by the Central Valley Flood Protection Act of 2007, DWR prepared the CVFPP as a policy plan to improve flood risk management, reduce the chance of flooding (and damages once flooding occurs), and improve public safety, preparedness, and emergency response for the Central Valley receiving protection from the SPFC. The CVFPP was first adopted by the CVFPB in 2012 and is subject to an update every 5 years. DWR analyzed channel design capacities and profiles as part the *2017 Flood System Status Report*, which was incorporated into the *2017 Central Valley Flood Protection Plan Update* (California Department of Water Resources 2017b, 2017c

The SPFC facilities are a portion of the larger flood management system in the Central Valley. The performance of SPFC facilities relies on non-SPFC federal facilities, including reservoirs—such as Shasta and Folsom Lakes—that provide substantial regulation of flows to levels that downstream SPFC facilities can accommodate as designed. On the Sacramento River, Shasta Lake regulates inflows from the Sacramento, McCloud, and Pit Rivers as well as numerous other tributaries and creeks. While not part of the SPFC, Shasta Lake—as a multipurpose reservoir—serves an important role in managing California's water supply while also providing flood control storage to help manage flood risk along the Sacramento River (California Department of Water Resources 2010:2-14). Similarly, Folsom Lake, formed by construction of Folsom Dam and managed by the Bureau of Reclamation (Reclamation), is the largest reservoir in the American River Basin and the only reservoir in the basin with designated flood control functions.

Other public and private levees, locally operated drainage systems, and other state, federal, and local facilities work in conjunction with the broader SPFC facilities. Major non-SPFC facilities that affect the performance of SPFC facilities (or provide flood risk reduction benefits to areas protected by SPFC levees) include levees that are not part of the federal projects, modifications and alterations to SPFC levees that have not been state-authorized, debris management facilities (e.g., Yuba Goldfields), and most of the reservoirs in the Central Valley (California Department of Water Resources 2017c:1-33).

Overall, the riverine system and channels in the Central Valley have been heavily modified and have limited capacity due to early reclamation development in the twentieth century (California Department of Water Resources 2010:5-2).

Flood Management Facilities in the Delta

Land uses in the Delta are primarily rural and are dominated by agriculture and open space, with several dispersed small communities, although larger population centers (i.e., Sacramento, West Sacramento, and Stockton) exist as well. Flood management facilities within the Delta primarily include levees, which often protect lands at or below sea level. Flood management in the Delta is mainly provided via reclamation districts and local flood control agencies. Flood management responsibilities in Delta areas outside areas protected by SPFC facilities are managed by a variety of local agencies, which are supported by the state's Delta Special Flood Projects Program and Delta Levees Maintenance Subventions Program (California Department of Water Resources 2012a:3-24). In addition to flood protection, Delta levees also benefit habitats and ecosystems and offer significant recreational opportunities (Delta Stewardship Council 2020:21).

About 380 miles of the total 1,100 miles of levees in the Delta are SPFC levees (Delta Stewardship Council 2017:1). SPFC levees are subject to federal levee standards and, where applicable, to DWR's *Urban Levee Design Criteria*, which requires a 200-year level of flood protection (California Department of Water Resources 2012b:7-1 to 7-50); they are also under CVFPB jurisdiction. SPFC levees in the northern Delta are part of the SRFCP and partially protect urban centers (i.e., 200-year level of flood protection)—such as Sacramento and West Sacramento—and smaller, unincorporated Delta towns (i.e., 100-year level of flood protection)—such as Clarksburg, Hood, and Courtland (California Department of Water Resources 2017b:3-3). Figure 7-2 distinguishes between the urban and nonurban levees in the northern Delta; this figure was adapted from Figure G01 in the Sacramento River Flood Flow Hydraulic Modeling—HEC-RAS 2D Technical Memorandum in Attachment A of the *Delta Conveyance Final Draft Engineering Project Report* (EPR) (Delta Conveyance Design and Construction Authority 2022e:21). In the southern Delta, the Lower San Joaquin River Flood Control Project is also part of SPFC facilities and includes levees that protect, or partially protect, urban or urbanizing communities such as Stockton, Lathrop, and Manteca (U.S. Army Corps of Engineers 1999; California Department of Water Resources 2010:2-3). The SRFCP and Lower San Joaquin River Flood Control Project also protect islands within the Delta, such as Sherman Island, Jones Tract, Upper Roberts Island, Middle Roberts Island, and Lower Roberts Island.

Most of the levees in the Delta (i.e., 720 of 1,110 miles of levees) are local non-project levees (Delta Stewardship Council 2017:7-1). Wat. Code Section 12980(e) defines these local levees in the Delta as "nonproject levee[s]" in contrast to "project levee[s]"—which are defined in Wat. Code Section 12980(f) and referred to as SPFC levees in the Delta. For consistency and clarity in this chapter, non-project levees are referred to as non-SPFC levees.

These non-SPFC levees were built by landowners or local reclamation districts to reclaim the lands for agricultural and economic development purposes. Non-SPFC levees also protect portions of the deep-water ship channels to the two major inland ports. The Stockton Deep Water Ship Channel was built in 1933 for navigation purposes and follows the San Joaquin River past Rough and Ready Island to the Port of Stockton via Stockton Channel (County of Contra Costa 2012:10-8). The Sacramento River Deep Water Ship Channel follows the Sacramento River and Cache Slough prior to entering the excavated deep-water channel that extends to the Port of Sacramento in West Sacramento. The levees on the east sides of the Sacramento River, Cache Slough, and the Sacramento River Deep Water Ship Channel are SPFC levees. The levees on the west side of the Sacramento River upstream of Rio Vista, west side of Cache Slough, and a portion of the west side of the excavated channel near Cache Slough are non-SPFC levees.

Levee inspection and maintenance for non-SPFC levees in the Delta is the responsibility of landowners or local reclamation districts. The SPFC levees in the Delta are inspected by DWR and designated local maintenance agencies according to their corresponding O&M agreements, and the findings are documented in the *Flood Control System Status Report*, which is updated every 5 years (California Department of Water Resources 2017c:2-5).

Until recently, communities protected were eligible for FEMA disaster assistance in a flooding event if their non-SPFC levees met the design guidelines in the 1983 *Flood Hazard Mitigation Plan for the Sacramento-San Joaquin Delta* (Delta HMP) developed by DWR for the Office of Emergency Services (CalOES) and approved by in negotiations between DWR and FEMA (California Wat. Code § 12984; Delta Stewardship Council 2017:ES-6). This was considered a short-term mitigation. In 2014, FEMA did not renew the Delta HMP and thus, the assistance eligibility would be for communities with levees meeting the Delta-specific PL 84-99 standards or Bulletin 192-82. Costs for improvement and frequent maintenance of non-SPFC levees can be beyond the financial capacity of property owners and local reclamation districts. The estimated state-subsidized expenditures to maintain non-SPFC Delta levees, including local matching funds, averages about $11.6 million annually (Delta Stewardship Council 2020:25). The next subsection provides additional information on applicable levee standards.

7.1.3.3 Levee Standards and Compliance

Levees are an important element of flood protection; however, levees are not constructed to withstand all hydrologic conditions. Levees are designed to accommodate specific design channel capacities or WSE profiles. Therefore, levee performance could have a strong correlation to channel performance (i.e., channel capacity). Over the last few decades, state and federal agencies have developed guidelines, standards, and permitting requirements for levees. These standards and guidelines generally establish minimum criteria for levee design and maintenance. Levee geometry standards and requirements in the Delta vary based on SPFC versus non-SPFC levees and for urban versus nonurban levees. Urban levees are those that protect an urban area, which means a developed area in which there are 10,000 residents or more (Government Code § 65007(j)). Figure 7-2 shows the distribution of urban and nonurban levees in the north Delta.

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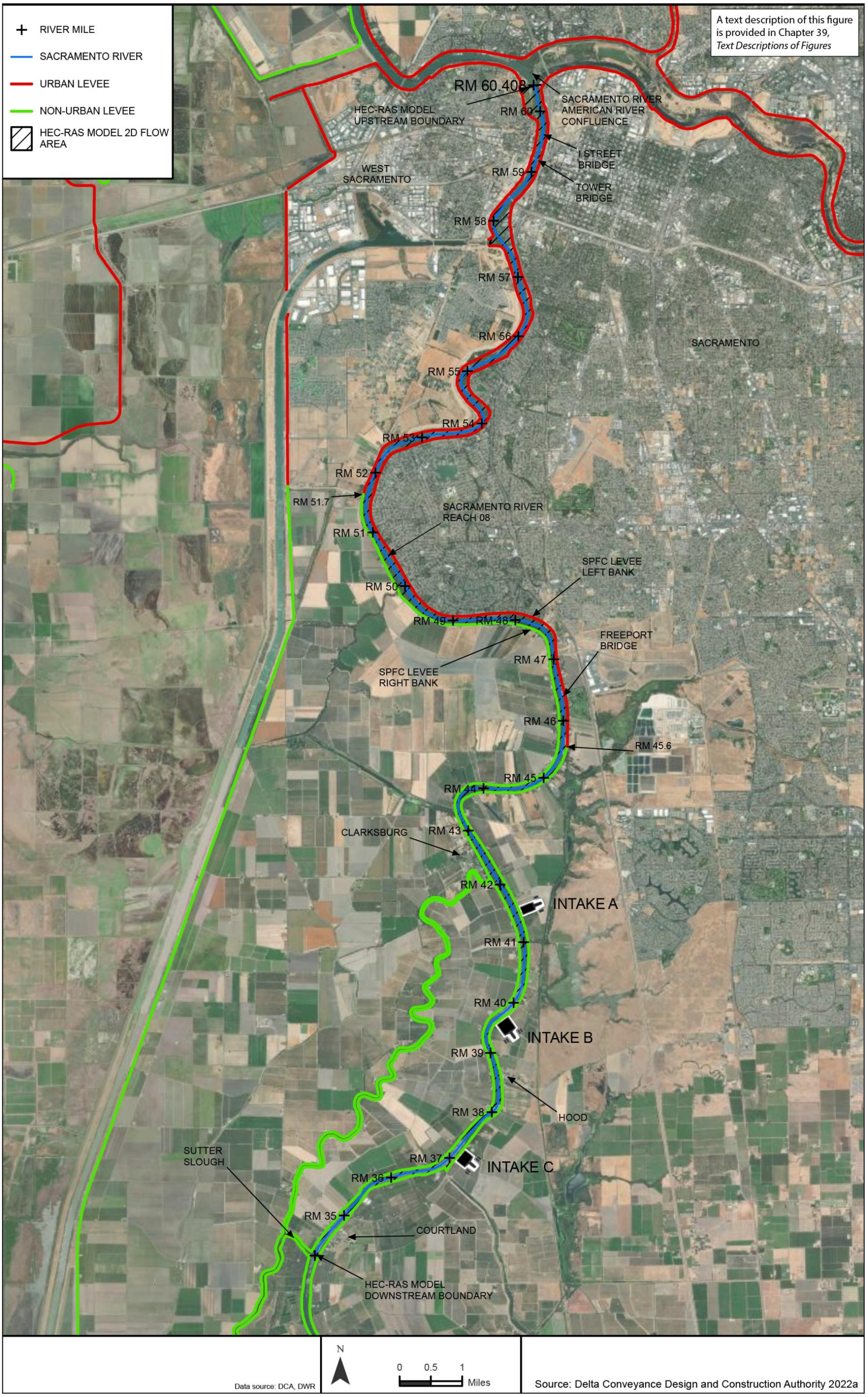

Figure 7-2 Map of the Urban and Nonurban Levees Along the Sacramento River Between the American River Confluence and Sutter Slough

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There are different design standards applicable to a Delta levee depending on the combination of its status as a SPFC facility and the area it provides protection. The relevant design standards are generally summarized below (Delta Stewardship Council 2020:16-19).

- DWR Urban Levee Design Criteria: This standard goes beyond criteria for levee height and geometric design to include requirements for freeboard, slope stability, seepage/underseepage, erosion, settlement, and seismic stability (California Department of Water Resources 2012b:7-1 to 7-50). It is intended to protect against an 0.5% AEP flood (i.e., a 200-year level of flood protection) and is the only levee standard that specifically links land uses to levee criteria. State law requires that by 2025, land use agencies cannot enter into a development agreement for a property within a flood hazard zone unless the city or county finds, based on substantial evidence in the record, that the facilities of the SPFC or other flood management facilities protect the property to the urban level of flood protection in urban and urbanizing areas or the FEMA standard of flood protection in nonurbanized areas or other conditions allowed in Government Code Section 65865.5.
- FEMA 100-year Protection: This "insurance" standard, often called the "1% annual chance flood" level of protection, provides criteria that levees must meet to protect against the flooding that is the basis for FEMA's FIRMs (44 Code of Federal Regulations § 65.10). It is often used with established USACE criteria to prescribe requirements for levee freeboard, slope stability, seepage/underseepage, erosion, and settlement. The standard generally does not address seismic stability. In communities where levees provide this level of flood protection, new developments are not required to meet federal floodproofing standards and can obtain federally guaranteed mortgages without purchasing flood insurance.
- Bulletin 192-82: Bulletin 192 was first completed by DWR in 1975 and adopted by the Legislature in 1976 as a conceptual plan to guide the formulation of projects to preserve the integrity of the Delta levee system (Wat. Code § 12225). Bulletin 192-82, its update, refined the plan and provided recommendations to the Legislature for implementation. The plan was intended to eventually have all levees within the Delta—regardless of protecting urban or agricultural areas—upgraded to a minimum configuration, thus reducing the chances for failure. However, it recognized that on a few islands, levee improvements would be uneconomical, a conclusion with which the Legislature concurred (Wat. Code § 128981(b)). Bulletin 192-82 was thus formalized to provide guidance for the Delta Levees Maintenance Subventions Program (Wat. Code § 12987) and the referenced levee standard to receive the state's financial assistance. The design standard requires a freeboard of 3.0 feet and 1.5 feet above the expected 300-year flood stage for levees protecting urban and agricultural areas, respectively. The standard also includes a requirement of 16-foot minimum crown width with a waterside slope of 1 vertical on 2 horizonal, and a landside slope of 1 vertical on 3 horizontal (California Department of Water Resources 1982:54–57). For the purposes of Delta levee maintenance, an urban area means an area in which 10% or more of the land area within the improvement project is used for residential use (Wat. Code § 12986(d)(2)). The recurrence interval of 300 years was based on the benefit-cost analysis by USACE on extreme Delta inflow and water stages as affected by high tide and wind. In areas with tidal dominated waters, the difference between a 50-year flood and a 300-year flood was about 0.5 foot (California Department of Water Resources 1982:54–57).
- PL 84-99: This is USACE's program that establishes guidelines for levee design geometry, construction, operations, and maintenance. This guidance for levee geometry implies a minimum levee height and a slope stability factor of safety but is not associated with a level of protection (such as a 100-year flood) and does not address seismic stability. The minimum geometry criteria

were not intended to become a "design standard" for non-SPFC levees, but rather a uniform procedure to establish eligibility for federal rehabilitation assistance for nonfederal flood control projects. Local maintaining agencies must apply to participate in the program and must regularly demonstrate that their levees and levee operations meet or exceed the program's requirements in order to be eligible for federally funded emergency assistance, including flood fighting support and rehabilitation of levees damaged by flooding. USACE's periodic inspection program incorporates other elements into eligibility, including presence of structure encroachments, vegetation, and rodent control programs.

PL 84-99 Delta-Specific Standards were developed for non-SPFC levees to qualify for rehabilitation under PL 84-99 and are intended to supplement the national guidelines. They were developed based on the Delta's particular organic soils and levee foundations conditions and require a freeboard of 1.5 feet above the 100-year flood stage for all islands/tracts, a minimum 16-foot crown width with a waterside slope of 1 vertical on 2 horizonal, and a landside slope of 1 vertical on 3 to 5 horizontal (depending on the levee height and depth of peat soil). These standards are not intended to establish design standards for the non-SPFC levees in the Delta, but to provide uniform procedures to be used by USACE in determining eligibility under PL 84-99. The Delta-specific PL 84-99 standard uses a 100-year hydraulic profile that is used to establish a geometric cross section similar to Bulletin 192-82 (U.S. Army Corps of Engineers 1988:9-10).

As previously mentioned, until 2014, non-SPFC levee upgrades often sought improvement to meet design guidelines established by the Delta HMP as a step towards the Delta-specific PL 84-99 or Bulletin 192-82 standards. The 2000 CALFED Bay-Delta Program Record of Decision set a goal of improving Delta levees to meet the PL 84-99 criteria, as does the Delta Protection Commission's Economic Sustainability Plan, but funding has been inadequate to attain this objective. Five Delta reclamation districts, protecting about 3% of the legal Delta's land behind about 41 miles of levees, meet or exceed the Delta-specific PL 84-99 criteria, and 24 more districts are more than halfway to improving levees to this standard (Delta Stewardship Council 2020:17).

In 2014, this agreement between FEMA and CalOES on using standards of the Delta HMP was not renewed, despite the considerable state investment in its implementation. The agreement's termination partly reflected FEMA's concern that sufficient progress had not been made toward its long-term goal of bringing levees up to the USACE Delta-specific PL 84-99 standard and the growing realization of the costs that flood disasters nationwide are imposing on the federal government. As a result, current non-SPFC levee improvements generally aim to meet Delta-specific PL 84-99 or Bulletin 192-82 standards.

7.1.3.4 Seismic Activity

The Delta's levees are threatened by the active seismic zones west of the Delta, including the San Andreas and Hayward faults. Less active faults, such as the Southern Midland Fault, underlie the Delta. A strong earthquake could damage Delta levees because of the potential for deformation or cracking of levees or the liquefaction of levee embankments and foundations during strong ground shaking. Moderate earthquakes between 1979 and 1984 damaged nearby Delta levees, and many Delta islands' levees failed during floods within a year after the 1906 San Francisco earthquake (Delta Stewardship Council 2020:7). If a levee failed on an island subsided below sea level or during high flows or if a flood were to occur soon after an earthquake, the protected area could be inundated.

The DWR Delta Risk Management Strategy Phase 1 study evaluated the performance of Delta levees under various seismic threat scenarios and analyzed potential consequences for water supply, water quality, ecosystem values, and public health and safety. The study concluded that a major earthquake of magnitude 6.7 or greater in the vicinity of the Delta Region has a 62% probability of occurring sometime between 2003 and 2032 (California Department of Water Resources 2009:2). More recent investigations suggest earthquake-induced ground shaking affecting Delta levees may be less serious but still worrisome (Delta Stewardship Council 2020:7). Although the probabilistic nature of earthquake prediction makes it difficult to quantify the timing and magnitude of seismic threats, it is important to address the threats posed by earthquakes to the Delta levee system because of the potential adverse effects of such events.

7.1.3.5 Land Subsidence

Delta island subsidence resulting from the biochemical oxidation of organic soils and wind disturbance could pose a significant threat to Delta levees. The areas that are most susceptible to subsidence are the central, western, and northern Delta, where thick organic peat layers predominate (Public Policy Institute of California 2008:9). As the landside ground elevation decreases because of subsidence, the resulting increase in elevation difference between the water surface and ground provides increased hydraulic loading on the levee and its foundation and associated risks related to seepage, piping, and slope instability. Recently, projects have been implemented in the western Delta for subsidence reversal, carbon sequestration, or both (California Department of Water Resources 2022b).

7.1.3.6 Sunny-Day Hazards

Even without an earthquake or flood, sunny-day levee failures do occasionally occur in the Delta. Generally, these failures may be the result of a combination of preexisting internal levee and foundation weaknesses caused by internal erosion of the levee and foundation over time and human interventions such as dredging or excavation at the toe of the levee (Delta Stewardship Council 2020:8). Internal erosion is often a result of seepage through the levee, which creates water pressure within the levee structure and is characterized through the formation of sand boils. Structural instability may also occur when seepage forces cause sloughing of the levee landside slope, shortening seepage paths that increase the probability of levee failure.

Other hazards that affect the performance of Delta levees include burrowing animals, encroachments, and penetrations. Burrowing animals, especially species such as beavers, ground squirrels, and owls, can weaken the structural integrity of a levee and increase the likelihood of piping. Encroachments, such as structures or farming practices on or close to the levee, can adversely affect a levee if they are not constructed or maintained in accordance with the requirements of federal, state, and local agencies. Penetrations of the levee, such as culverts or pipelines, can weaken the structural integrity of levees and lead to levee instability if the waterside opening does not have an appropriate closure device that seals the opening and prevents excessive seepage. Because of unregulated historical construction, levees also contain many hidden hazards. Interaction among the factors listed above is also common and increases the probability of levee failure.

7.1.3.7 High Water Conditions

The same hazards present during sunny-day conditions are exacerbated during high water events (e.g., winter atmospheric river storms), which are expected to increase in number and frequency under climate change conditions (Delta Stewardship Council 2021:3-17). Moreover, water levels in the Delta are influenced by the tide level at the Golden Gate Bridge. When these storms coincide with extreme winter tides (i.e., king tides), storm surges and high wind waves can cause levee failure (Maendly 2018:12–13, 46). Increased seepage is also common during these events. As sea levels rise in the future, tides and water levels will increase hydraulic stress on the levees and increase flood risk in the Delta.

7.1.3.8 Potential Climate Change Effects

Climate change has major implications for the Delta, and especially for flood risk management. The California Ocean Protection Council's (OPC) most conservative, risk-averse climate change scenario (H++) estimates 10.2 feet of sea level rise at the San Francisco tide gage by the year 2100. By 2050, rising sea levels will more than double the probability of flooding if levees are not only well-maintained, but also improved (Delta Stewardship Council 2020:10). Drainage of Delta islands will also be more difficult, impairing agriculture on which the finances of many reclamation districts rely. This projected sea level rise could be expected to be exacerbated during high water events, which are discussed in Section 7.1.3.7, *High Water Conditions*.

7.1.3.9 Regional Planning Efforts Related to Delta Flood Management

Many planning efforts addressing flood management and emergency preparedness, response, and mitigation are under way, including the following.

- *Central Valley Flood Protection Plan (CVFPP)*. The Central Valley Flood Protection Act of 2008 directed DWR to develop, and CVFPB to adopt, the CVFPP—which was first published in 2012 and updated in 2017 and 2022 (California Department of Water Resources 2012a, 2017b, 2022a). The CVFPP, developed under DWR's FloodSAFE California, established a systemwide approach to improving flood management in areas currently receiving protection from SPFC facilities (California Department of Water Resources 2012a:3-21). Following adoption of the 2012 CVFPP, DWR funded six regionally led Regional Flood Management Plans (RFMPs) that describe local and regional flood management priorities and challenges. These RFMPs also identified potential funding mechanisms and site-specific improvement needs. In the 2017 CVFPP (California Department of Water Resources 2017b), DWR refined analyses and updated flood risk estimates for the Central Valley. Without continued implementation of the recommended plan, the estimated expected annual damage for 2017 (the existing condition for the 2017 CVFPP update) is about $329 million per year in the Central Valley, with a potential 66 lives lost per year in the Sacramento River Basin and a potential 149 lives lost in the San Joaquin River Basin (California Department of Water Resources 2017b:3-35). As clarified by DWR, expected annual life loss is not a predictor of life loss for a given year but rather an indicator of potential life loss for any given year considering the full range of potential flood events and the likelihood of those occurring. CVFPP results are informative indices of life risk but do not forecast deaths expected to occur from flood events. Neither are these indicators to be used for emergency planning or other purposes. Potential life loss would require more detailed analyses and supporting data than that used in the CVFPP or its update (California Department of Water Resources 2012a:2-21, 2017b:3-35, 2017c:3-2). DWR recently released the public draft 2022 CVFPP Update in April

2022 to document the continued implementation of the State Systemwide Investment Approach with a focus on climate resilience, performance tracking, and integration and alignment with other state water management plans.

- Delta Stewardship Council's *Delta Plan*. To reduce flood risk to people, property, and state interests in the Delta, the Delta Reform Act requires that the Delta Stewardship Council's *Delta Plan* promote effective emergency response and preparedness, appropriate land use, and strategic investments in levees (Wat. Code § 85305). The Delta Reform Act also directs the Delta Stewardship Council, in consultation with CVFPB, to recommend priorities for state investments in levee operation, maintenance, and improvements in the Delta, including both SPFC and non-SPFC levees (Wat. Code § 85306). In spring 2014, the Delta Stewardship Council began developing the Delta Levees Investment Strategy, which combines risk analysis, economics, engineering, and decision-making techniques to identify funding priorities and assembled a comprehensive investment strategy for the Delta levees. In March 2020, the Delta Stewardship Council amended Chapter 7 of the *Delta Plan*, which provides an overview of flood risk in the Delta, current flood management efforts, and the most pertinent agencies and regulations.
- Sacramento-San Joaquin Delta Multi-Hazard Coordination Task Force Report. This report responds to Wat. Code Section 12994.5, which called for the task force to make recommendations to the Governor about Delta multi-hazard emergency response and recovery issues. The task force was directed to make recommendations to CalOES about creating an interagency unified command system organizational framework in accordance with the guidelines of the National Incident Management System and the Standardized Emergency Management System; coordinate development of a draft emergency preparedness and response strategy for the Delta; and develop and conduct all-hazard emergency response exercises and training in the Delta that would test or facilitate implementation of regional coordination protocols (Delta Stewardship Council 2020:39). In 2018, CalOES released the *Northern California Catastrophic Flood Response Plan*, which provides a framework outlining how local, state, and federal governments would respond and coordinate in anticipation of and following a catastrophic flood event, with emphasis on impacts on the Delta (California Governor's Office of Emergency Services 2018).
- CVP and SWP Reoperation Studies. DWR's Forecast-Coordinated Operations Program and Systems Reoperation Program address reservoir operational criteria.

State expenditures on Delta levees have greatly reduced the frequency of levee failures (Delta Stewardship Council 2017:ES-7). State funding programs for levee improvements on Delta islands and tracts vary based on location and type of levee. Since the 1980s, state funds for Delta levees are available through the Delta Levees Maintenance Subventions Program or the Delta Levees Special Flood Control Projects Program. These grant monies helped fund levee maintenance and improvements in many areas of the Delta.

During floods, DWR emergency response activities and local maintenance agencies could prevent and have prevented many potential levee failures (California Department of Water Resources 2012a:4-2 to 4-3). Therefore, the realized levee failures were often less than predicted in typical flood risk assessments.

DWR, CVFPB and USACE each play unique and critical roles in Delta flood risk management. Frequent, ongoing collaboration with other state, federal, and local agencies to improve communication and coordination is essential to meeting the Delta's flood management objectives.

7.2 Applicable Laws, Regulations, and Programs

The applicable laws, regulations, and programs considered in the assessment of project impacts on flood protection are indicated in Section 7.3.1, *Methods for Analysis*, or the impact analysis, as appropriate. Applicable laws, regulations, and programs associated with state and federal agencies that have a review or potential approval responsibility have also been considered in the development of CEQA impact thresholds or are otherwise considered in the assessment of environmental impacts. A listing of some of the agencies and their respective potential review and approval responsibilities, in addition to those under CEQA, is provided in Chapter 1, *Introduction*, Table 1-1. A listing of some of the federal agencies and their respective potential review, approval, and other responsibilities, in addition to those under NEPA, is provided in Chapter 1, Table 1-2.

7.3 Environmental Impacts

This section describes the direct and cumulative environmental impacts on flood protection that would result from project construction, operation, and maintenance. This section also describes the methods used to determine the impacts of the project, and lists the thresholds used to conclude whether an impact would be significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) potentially significant impacts are also provided.

7.3.1 Methods for Analysis

This section describes the qualitative and quantitative methods used to evaluate flood protection–related impacts of the project alternatives within the study area. These impacts would be associated with construction, operation, and maintenance of the project, and implementation of compensatory mitigation.

7.3.1.1 Process and Methods of Review for Flood Protection

As described in Chapter 3, *Description of the Proposed Project and Alternatives*, the project alternatives do not include any changes in flood control operations. Flood control operation and associated rules are under the jurisdiction of USACE. Therefore, the operations of project alternatives would have no impacts on flood protection upstream of the Delta, and the level of flood protection under project alternatives would remain the same. Since the project would not affect the Sacramento River upstream of the Delta or the San Joaquin River Basin outside of the Delta, the study area associated with flood protection focuses on the specific areas in the Delta that may be affected by project facilities—including the intakes, launch/maintenance/reception shafts, and Southern Forebay (although the Southern Forebay is applicable to Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c only).

Consistent with the evaluation of potential impacts on other resources, the qualitative and quantitative analyses discussed in this section assess the significance of project impacts in relation to existing conditions. Effects on flood protection were assessed by identifying flood risks within the study area to evaluate whether flood protection would be affected temporarily by construction or permanently by operations of permanent facilities of the project.

Many major components of project construction and facilities are underground. The assessment for potential flood protection impacts from construction and operations of permanent facilities were for aboveground facilities only. Specifically, the assessment for flood protection impacts associated with the project alternatives examined: (1) changes that may increase flooding or flood risk in the Delta, and (2) changes to the potential rate or amount of runoff that may impede or redirect localized flood flows. However, these two areas of review require different settings to accommodate the different regulatory frameworks associated with applicable flood management practices. The following subsections summarize these two areas of impact assessments, including the reasons for selecting the associated existing conditions and No Project Alternative and the resulting impacts on flood management.

Process and Method of Review for Potential Increase in Delta Flood Risks

There are many contributing factors to Delta risks of flooding, and they would continue to play a role in Delta flood risks. All project alternatives are for water supply purposes and include no changes in flood management infrastructure in the Sacramento River Basin and in the Delta, including the reservoirs of the SRFCP and CVP, and associated flood operation rules and management. Therefore, changes from project alternatives that may increase flooding or flood risk in the Delta are related to the construction and operation of the intakes on the Sacramento River, which is often the primary source of flood flow from upstream watersheds.

The intakes located along the Sacramento River where SPFC levees are present may affect the drainage of the Sacramento River flow during flooding conditions. Therefore, the preference and consistency with regulatory requirements for SPFC levees and CVFPB's jurisdiction would be followed, including the consistency with the CVFPP. The CVFPP, prepared by DWR in accordance with the Central Valley Flood Protection Act of 2008 and adopted by the CVFPB, is California's strategic blueprint to improve flood risk management in the Central Valley, and guides the state's participation in managing flood risk in areas protected by the SPFC. The CVFPP is updated every 5 years and thus, for this Draft EIR, tools and methods consistent with those for the 2022 CVFPP Update were used for evaluating the potential impacts on the SPFC facilities and their resulting flood protection.

The 2022 CVFPP Update has a 50-year planning horizon that begins in 2022 for analysis purposes and for developing assessment strategy (California Department of Water Resources 2022a). For consistency with the governing regulatory framework, the analysis for potential flood control impacts on the area protected by the SPFC should be conducted using a similar planning horizon. In other words, the portion of the impact analyses that evaluate areas protected by the SPFC uses the years 2022 and 2072 as reference years for existing conditions and the No Project Alternative, respectively. Additional detail on the data and analytical tools used to assess the impacts of the project on flood control is provided within the impact assessments below.

In addition to the increase in WSEs, effects on the localized velocity pattern changes near the intakes and the resulting erosion and scouring could also affect the SPFC levee stability. The final design of project alternatives would include detailed evaluation and measures to minimize these effects.

Process and Method of Review for Impeding or Redirecting Localized Flood Flow

Many other facilities of the project alternatives are in the flood hazard zone and thus, it is necessary to evaluate the potential impacts from these facilities on impeding or redirecting localized flood flow.

The project alternatives include design criteria to protect the facilities during flooding. As described in Chapter 3 and detailed in the EPRs (Delta Conveyance Design and Construction Authority 2022a:16, 18, 39, 47, 54, 66; 2022b:29, 42, 45-46), permanent project facilities would be designed for long-term operations, and to be protected from a 200-year flood event (i.e., 0.5% AEP) with climate-change-induced hydrology, sea level rise for 2100 conditions, freeboard criteria, and wind fetch wave run-up. These design criteria are not related to impacts on adjacent areas; however, the incorporated protection would prevent potential inundation of water conveyance structure and avoid redirected impacts.

The overall approach to flood management associated with facility construction and permanent operations includes a combination of nonstructural and structural flood risk management measures to reduce the risk of flooding during construction and operations, including at tunnel shafts. In this context, nonstructural measures could involve staging of temporary facilities or equipment, but such facilities or equipment would not significantly affect the construction footprint or on-site activities. Nonstructural measures would involve fully integrating the project construction team with existing Delta flood preparation, response, and recovery systems using methods that range from safety training to safety kits for sheltering in place, especially in the case of a levee failure (Delta Conveyance Design and Construction Authority 2022d:8-10). This would occur in coordination with reclamation districts, levee maintaining agencies, and state and federal agencies with direct responsibilities, authorities, or emergency support roles over Delta levees, including USACE, FEMA, Reclamation, CalOES, DWR, and CVFPB. During construction, measures to minimize effects on existing levees would be implemented, including avoiding or minimizing the use of existing levees as construction haul routes for the project and setbacks of project activities from existing levees that are to be determined during the design phase based on site-specific investigation and analyses.

Most construction sites contain local irrigation and drainage facilities installed by existing or previous private landowners or reclamation districts. These systems may serve parcels that would be acquired for the project and adjacent parcels. Many of these existing facilities are buried and therefore not visible on aerial photographs. Consequently, for project feature locations without site access, no further analyses can be conducted at this time. During the design phase, when the project can acquire access to specific parcels, irrigation and drainage facilities would be mapped for each site. If the facilities used by adjacent properties to move water from the existing diversion are located on a parcel to be used for a project feature, pipelines or canals would be installed to maintain service to the adjacent properties.

The intakes and associated facilities would be located in the 100-year floodplain within DWR Maintenance Area 9, Reclamation District 744, and Reclamation District 813. The temporary and permanent infrastructure would affect the flow pattern and drainage of local floodwater, which would drain to Stone Lakes Canal during flooding conditions. The project alternatives would redesign the local drainage canals that are affected and would potentially upgrade the existing pumps to maintain adequate drainage in the areas protected by levees. Therefore, no further analyses are required for impact assessment.

Structural measures for flood management and facility protection may rely on existing levees that would be improved to meet PL 84-99 standards unless the surrounding levees already meet PL 84-99 standards. Given the long duration of work at the Bouldin (central alignment) and Lower Roberts Island (eastern and Bethany Reservoir alignments) tunnel launch sites, improvements of the island perimeter levee to meet PL 84-99 geometric standards, as well as addressing any known geotechnical weaknesses, are warranted to limit long-term flood risk. The extent and types of recommended levee repairs would be refined prior to construction and in coordination with the local reclamation districts. This approach would present an improvement to existing conditions. Therefore, no additional evaluation is required. The Twin Cities Complex is one exception to this approach. A ring levee configured in compliance with PL 84-99 standards would be used for the Twin Cities Complex since it is not fully protected by perimeter levees. Therefore, a site-specific evaluation of potential impacts from the proposed facilities on flood flows in the 100-year floodplain is required using a methodology consistent with that for FEMA FIRMs.

The Southern Forebay facilities would be designed in accordance with the DSOD requirements for jurisdictional dams based on the anticipated maximum height and storage volume. The levees on Byron Tract around the Southern Forebay are maintained by Reclamation District 800 and have met PL 84-99 standards. Therefore, there will be no need for improvements to the surrounding levees or a ring levee. However, as part of the design requirements for DSOD jurisdiction dams, an overflow emergency spillway would be used in the unlikely condition that the forebay water level continued to rise above the design maximum elevation. The emergency spillway would discharge flow from the Southern Forebay into Italian Slough, which flows into Old River. The evaluation of impacts on flood protection focuses on the flow path of the emergency release per DSOD requirements and potential effects on adjacent levees and associated protected areas.

Consistent with the evaluation of potential impacts on other resources, the qualitative and quantitative analyses discussed in this section assess the significance of project impacts in relation to existing conditions. Existing conditions include existing facilities and ongoing programs that existed as of January 15, 2020 (i.e., the publication date of the Notice of Preparation). The No Project Alternative includes reasonably foreseeable changes in existing conditions (e.g., sea level rise, climate change) and changes that could be expected to occur in the year 2040 if the project were not approved.

Unique to this chapter, existing conditions and the No Project Alternative require an additional planning horizon that is different from the conditions (i.e., 2020 and 2040) previously discussed. This is done to better align with applicable flood management frameworks, in particular, the 2022 CVFPP Update, which is the long-term plan for the area protected by the SPFC (California Department of Water Resources 2022a). The 2022 CVFPP Update has a 50-year planning horizon that begins in 2022 for analysis purposes and for developing assessment strategy. Therefore, the analysis for potential flood control impacts on the area protected by the SPFC should be conducted using a similar planning horizon. To maintain consistency with the planning horizon used in the 2022 CVFPP Update, impact analyses that evaluate areas protected by the SPFC use the years 2022 and 2072 as reference years for existing conditions and the No Project Alternative, respectively.

For potential flood protection impacts on areas that do not receive protection from the SPFC (i.e., Impact FP-2), the year 2020 was used for existing conditions and the project alternatives while the year 2040 was used for the No Project Alternative—consistent with the evaluation of other resource areas in this Draft EIR. For potential flood protection impacts on areas that do receive protection from the SPFC (i.e., Impact FP-1), the year 2022 was used for existing conditions and the project alternatives while the year 2072 was used for the No Project Alternative—consistent with available flood tools and other planning efforts associated with the 2022 CVFPP Update (California Department of Water Resources 2022a). Project alternatives for each impact analysis were evaluated under the same reference year used for their respective existing conditions. That is, project alternatives for Impact FP-1 were evaluated under 2022 conditions while project alternatives for Impact FP-2 were evaluated under 2020 conditions. Table 7-1 includes a comparison of the reference years used for the existing and future conditions associated with each impact analysis in this chapter.

A more detailed description of the existing conditions, No Project Alternative, and the assumptions associated with each are included in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*. More details on the data and analytical tools are provided in later impact assessments under operations and construction.

Where appropriate, different permitting requirements for construction and operations of project alternatives were utilized to ensure compliance with flood protection regulations, which in some cases required customized analyses.

7.3.1.2 Assessing Potential Flood Protection Impacts from Construction

Construction of the project alternatives could affect: (1) WSEs of the Sacramento River between the confluence of the American River and Sutter Slough (near the proposed north Delta intakes), and (2) the depth and areal extent of the 100-year flood event at the Twin Cities Complex site.

The Southern Forebay is located on Byron Tract, an area that is already protected by levees that substantially meet the PL 84-99 criteria (Figure 7-1). Therefore, no further analysis on construction impacts on flood protection at Byron Tract was conducted

North Delta Intakes on Sacramento River (Impact FP-1)

To evaluate the potential impacts from construction of the proposed north Delta intakes on the drainage of Sacramento River flows during flood conditions, a Sacramento River hydraulic river model was prepared and used to evaluate river reaches in the Sacramento River between the American River confluence and Sutter Slough, where WSEs could potentially be affected by construction of the proposed north Delta intakes as part of the project alternatives. The upstream boundary (i.e., the confluence of the Sacramento River and American River) was selected due to its relevance as a major control point for flood management; moreover, there was no indication of additional upstream effects on WSEs beyond this upstream boundary. The downstream boundary (i.e., Sutter Slough) was selected because Sutter Slough is sufficiently downstream from the proposed north Delta intakes, and there are no significant inflows or flow splits between the American River confluence and Sutter Slough. The use of this reach for impact assessment was supported by modeled results.

The areas adjacent to this reach of the Sacramento River are protected by SPFC levees and thus are under USACE's, DWR's, and CVFPB's jurisdictions. Therefore, the best available information, tools, and evaluation methods used for project impact assessment are consistent with those for the 2022 CVFPP Update (California Department of Water Resources 2022a). The Sacramento River hydraulic river model used for project impact analysis was extracted from the full Sacramento River system model developed by DWR for use in the preparation of the 2022 CVFPP Update. This 1-D model used for the 2022 CVFPP Update was enhanced to a full 2-D steady-state Sacramento River system Hydrologic Engineering Center River Analysis System (HEC-RAS) model using new bathymetry data and light detection and ranging topography collected by DWR in 2018 and 2019 (Delta Conveyance Design and Construction Authority 2022e:3, 8–9). The CVFPB provided the flood hydrology from the 2022 CVFPP Update for use in this assessment. These profiles are similar to the flood profiles used in the 2017 CVFPP Update, based on 1997 flood hydrology with a scaling factor, but include more conservative estimates for climate-change-induced hydrology and sea level rise.

The impact assessment used model assumptions and data that are consistent with the 2022 CVFPP Update. This includes the use of existing conditions and future conditions considered in the 2022 CVFPP Update. The planning horizon for the CVFPP is 50 years; therefore, for the 2022 CVFPP Update, existing conditions are set in 2022 and future conditions in 2072. Although different from the existing (i.e., 2020) and future conditions (i.e., 2040) used for the other analysis in this chapter (i.e., Impact FP-2) and the other resource areas in the Draft EIR, the use of CVFPP existing conditions in 2022 and future conditions in 2072 are considered important to stay consistent with governing regulatory framework, and the use of best available tools and information for environmental review purposes. Correspondingly, 2022 conditions are used for existing conditions and all project alternatives to evaluate the potential impacts on WSEs of the Sacramento River from construction. The No Project Alternative scenario for this analysis assesses WSE impacts in the Sacramento River under 2072 conditions relative to existing conditions (i.e., 2022).

While no current guidance exists for use of specific climate scenarios under CEQA, per OPC, the H++ scenario, or extreme risk aversion scenario, is recommended and relevant for high-stakes, long-term decisions and for projects with a lifespan beyond 2050 that have a low risk tolerance. The 2072 conditions for the 2022 CVFPP Update include climate change conditions, reflected in hydrology and sea level rise, that are consistent to that are used for the Draft EIR's 2040 conditions for the No Project Alternative—although further in the future and with more pronounced effects. For example, the H++ sea level rise projection in 2040 is 1.8 feet, while the sea level rise projection in 2072 used by 2022 CVFPP Update is 3.7 feet. This is considered more conservative for project impact assessment. A more detailed description of the climate change and sea level rise projections for this Draft EIR can be found in Chapter 4, *Framework for the Environmental Analysis*, Chapter 30, *Climate Change*, and the 2022 CVFPP Update (California Department of Water Resources 2022a).

As previously mentioned, the modeled reach of the Sacramento River includes urban levees extending south from the American River confluence to around the town of Freeport that are for protecting Sacramento urban areas; these areas are subject to Urban Level of Flood Protection (i.e., 200-year level of flood protection) (Figure 7-2). Within the modeled reach, the remaining levees downstream of the town of Freeport are considered rural or nonurban levees that are not subject to the Urban Level of Flood Protection. Therefore, for completeness of the construction assessment for each project alternative, it is necessary to evaluate the impacts on WSEs of the Sacramento River for 100- and 200-year flood events under existing conditions (i.e., 2022). Figure 7-2 includes a map of the urban and nonurban levees along the Sacramento River between the American River confluence and Sutter Slough.

For evaluating impacts from construction of the project alternatives, the construction footprint, including cofferdams, was evaluated in the Sacramento River hydraulic river model. All WSE differences except the No Project Alternative were calculated based on the model differences between the flood event run with and without project facilities in place. The maximum WSE differences in the reach of the Sacramento River from the American River confluence to Sutter Slough for both the 100-year and 200-year flood events were used for comparative purposes. Alternatives 1, 2a, 3, 4a, and 5 were specifically modeled using the Sacramento River hydraulic river model to evaluate the impact from construction of the intakes on WSEs of the Sacramento River. Alternatives 2b, 2c, 4b, and 4c, with their smaller capacities (3,000 cfs and 4,500 cfs) and smaller footprints, were not modeled because the resulting WSE increases would be similar to or less than the corresponding alternative of the same alignment but larger capacity. After a project alternative is selected, and in consideration of any changes made to the intake configuration during design, the modeling would be reconducted to support project permitting and final design. More detailed hydraulic evaluations concerning hydraulic loading, scour, and erosion forces at the interface between the intake structures and the river terrain as a result of increased WSEs would be done as part of the final project design for construction phase and for operation phase with final installed facilities. During these evaluations, the specific size and extent of slope protection would be verified and revised, if needed. The construction impacts were only evaluated for existing conditions (i.e., 2022 conditions) but not future conditions (i.e., 2072 conditions). A more detailed description of the modeling tool and analysis are included in the Sacramento River Flood Flow Hydraulic Modeling Technical Memorandum in Attachment A of the EPR (Delta Conveyance Design and Construction Authority 2022e).

For 408 permit requirements, the assessment for potential flood protection impacts from construction was also evaluated using flood flows consistent with those used to develop the 1957 USACE Sacramento River Project Levee design profiles, which was the basis of the levee design when the SRFCP was constructed, representing the anticipated level of performance in terms of channel flow carrying capacity. The 1957 design profile assessment will be utilized by USACE and CVFPB as part of their permitting process to demonstrate that project construction would not impede the continued functions of the levees and channels as originally designed. The evaluation for the potential impacts on the 1957 levee design profile is not considered part of the CEQA analysis because the 1957 levee design profile was defined in association of a specific design flow used in the original facility construction. However, it is a necessary evaluation for the permitting process in addition to the CEQA analysis. The detail of the analysis using the 1957 levee profiles are provided in Appendix 7B, *Evaluation against U.S. Army Corps of Engineers 1957 Design Profiles*.

Additional analyses for velocity near intakes and potential risks of erosion and scouring will be performed for the final design to meet permit requirements.

Twin Cities Complex (Impact FP-2)

The Twin Cities Complex site is located on the Glanville Tract in the Mokelumne River watershed just north of the confluence of the Cosumnes River. Due to the unregulated Cosumnes River, limited Mokelumne River channel conveyance, and downstream tidal conditions, the area around the Twin Cities Complex site has a history of flooding. The potential impacts on flood extents and depths in the area surrounding the Twin Cities Complex site that could result from the construction footprint were evaluated using the north Delta hydraulic model.

The north Delta hydraulic model was first created for Sacramento County and was later applied by DWR in the McCormack-Williamson Tract Project (Delta Conveyance Design and Construction Authority 2022d:Att 3-3). This coupled 1-D/2-D HEC-RAS model incorporates topographic and bathymetric data collected by DWR between 2007 and 2016 and was applied to evaluate the effects of the construction footprint around the Twin Cities Complex site on the 1% AEP flood (Delta Conveyance Design and Construction Authority 2022d:Att 3-2).

The north Delta hydraulic model was used for this evaluation because the model was calibrated to historical flood event gage data and high-water marks for floods at this location while applied to project evaluation for the McCormack-Williamson Tract Project, which is part of the DWR's North Delta Flood Control and Ecosystem Restoration Project for floodplain restoration and flood peak reduction. When the McCormack-Williamson Tract Project is completed, the potential flood depth near the Twin Cities Complex site is expected to be lower than the existing conditions. However, the completion date for the McCormack-Williamson Tract Project is not known at this time, so analysis was conducted assuming there was no such project, which results in a conservative evaluation.

The potential impacts from construction of the project alternatives at the Twin Cities Complex were evaluated by examining the effects of the construction footprint that includes a ring levee surrounding all facilities during construction. The ring levee height was designed based on a FEMA 100-year flood depth outside of Glanville Tract within the adjacent floodway, so several feet of freeboard are available for the current analysis. Construction impacts were evaluated for existing conditions (i.e., 2020 conditions), but not future conditions (i.e., 2040 conditions). A more detailed description of the flood effect analysis for the Twin Cities Complex site can be found in the Flood Risk Management Technical Memorandum in Attachment H of the EPR (Delta Conveyance Design and Construction Authority 2022d, 2022f).

Indicators of Potential Impacts

The potential impacts from the construction of the project alternatives were evaluated based on:

- Changes in the resulting WSEs of the Sacramento River between the confluence of the American River and Sutter Slough (Impact FP-1). The increase in WSEs in the Sacramento River was used as an indicator for potential impacts on flood protection for the adjacent urban and nonurban areas.
- Changes in the extent of flooding at the proposed north Delta intakes, Southern Complex, tunnel shaft sites, or other project feature (Impact FP-2). The increase in flood depth or area was used as an indicator for potential impacts on Delta flood protection.
- Changes in the flood depth and areal extent of the 100-year flood event surrounding the Twin Cities Complex site (Impact FP-2). The increase in flood depth or area was used as an indicator for potential impacts on Delta flood protection.

Refer to Section 7.3.2, *Thresholds of Significance*, for more information about the significance criterion associated with this impact on riverine flooding from operations of the project alternatives.

7.3.1.3 Assessing Potential Flood Protection Impacts during Operations Phase

Based on the above process and methods of review, operation of the project alternatives could affect: (1) WSEs of the Sacramento River between the confluence of the American River and Sutter Slough (near the proposed north Delta intakes); (2) the depth and areal extent of the 100-year flood event at the Twin Cities Complex site; and (3) a channel (i.e., Italian Slough) and adjacent areas located downstream of the Southern Forebay Emergency Spillway. The first effect is related to the placement of north Delta intakes along the Sacramento River with SPFC levees and, therefore, the data, tools, and analyses would be consistent with the 2022 CVFPP Update. The other two are related to impeding or redirecting localized flood flow by project permanent facilities and, thus, FEMA NFIP methodology is followed. The following provides location-specific analyses.

North Delta Intakes on Sacramento River (Impact FP-1)

The tools and methods for evaluating potential impacts on WSEs of the Sacramento River between the American River confluence and Sutter Slough during operations of the project alternatives are generally the same as those described in Section 7.1.3.2, *Assessing Potential Flood Protection Impacts from Construction*, for evaluating potential impacts from construction of the proposed north Delta intakes. Therefore, the reasons and choices of tools, data, and methods are not repeated herein. infrastructure that includes the intake training walls, cylindrical tee screen structure, and log boom.

WSE differences are due to the permanent footprint of the intake facilities and are not directly related to diversions at the proposed north Delta intakes; modeling was completed without diversions occurring to provide a more conservative estimate of potential impacts. Unlike the evaluation of potential impacts from construction of the proposed north Delta intakes, the impacts during operations were evaluated for both existing conditions (i.e., 2022 conditions) and future conditions (i.e., 2072 conditions) with climate change, including corresponding hydrologic change and sea level rise. Appendix 7A, *Flood Protection 2040/2072 Analysis*, presents potential impacts on flood protection that could result from the project alternatives under future conditions.

The assessment for potential flood protection impacts during operations was also evaluated using flood flows consistent with those used to develop the 1957 USACE Sacramento River Project Levee design profiles. As previously mentioned, this analysis is expected to be used by USACE and CVFPB for permitting purposes. The detail of the analysis using the 1957 levee profile are provided in Appendix 7B.

Twin Cities Complex (Impact FP-2)

The tools and methods for evaluating potential impacts on local flood flows in the 100-year floodplain during operations of the project alternatives at the Twin Cities Complex site are the same as those described for evaluating potential impacts from construction of the permanent facilities at the Twin Cities Complex site for the central, eastern, and Bethany Reservoir alignments. Therefore, the reasons and choices of tools, data, and methods is not repeated herein. the effects of the permanent shafts and stockpile storage areas for the eastern and Bethany Reservoir alignments after the temporary ring levee is removed. The permanent stockpile for the central alignment is smaller than that of the eastern alignment and thus would have less of an effect in increasing flood depth adjacent to the facility during flooding. A more detailed description of the flood effect analysis and hydraulic model scenarios for the Twin Cities Complex site can be found in the Flood Risk Management technical manuals of the EPRs (Delta Conveyance Design and Construction Authority 2022d, 2022f).

Southern Forebay (Impact FP-2)

The Southern Forebay is located on Byron Tract—an area that is already protected by levees that substantially meet the PL 84-99 criteria. Consequently, the Southern Forebay would not include any facilities within the 100-year flood hazard area and would instead be located in an area that is considered a reduced risk (Figure 7-1). During the design phase, local irrigation and drainage facilities near the proposed Southern Forebay will be evaluated in detail for potential localized impacts from the forebay construction and operation, and associated mitigation needs, if any. If the facilities used by adjacent properties to move water from the existing diversion are located on a parcel to be used for a project feature, pipelines or canals would be installed to maintain service to the adjacent properties.

As previously mentioned, the Southern Forebay would be designed to meet the requirements of DSOD for jurisdictional dams, including an emergency spillway. The hydraulic design of the Southern Forebay Emergency Spillway would be based on controlling events, including rare emergency operation of the system (e.g., if the pumps were on and the downstream gates closed unexpectedly such as with a power outage)or uncontrolled flood flow through the conveyance system (e.g., system intake gates open accompanied by power outage during high river stage leading to uncontrolled gravity flow into the Southern Forebay). These control events are based on facility design and the resulting flow conditions will not change from existing conditions to future.

An inflow of 7,500 cfs was selected for this analysis because it represents the highest possible inflow for all project alternatives. All other project alternatives would result in lower spillway flows and lower potential hydraulic impact. Uncontrolled gravity flow through the system with the intake gates open would potentially result in a longer event but at lesser flow due to frictional head losses through the system. A qualitative analysis was conducted for the resulting flow path for assessing the potential effects on flood protection. To assess the hydraulic impact of operating the Southern Forebay Emergency Spillway on the existing levee system of Italian Slough and Old River, a 1-D model was developed of the channel and levees using HEC-RAS. The probability of the emergency spillway being operated is very low due to project operations and is assumed to be independent of hydrologic conditions. Nevertheless, two hydrologic conditions were analyzed to estimate a potential range of WSE impacts: a 100-year flood event and a mean higher high water event if the emergency spillway was used. The downstream WSE on Old River was assumed to be 10 feet for the 100-year event and 5 feet for the mean higher high water event. A range of operational scenarios were modeled to assess potential impacts on the existing levee system during a Southern Forebay spill event. Spillway releases were assumed to be equal to the project pumping capacities of 3,000, 4,500, 6,000, and 7,500 cfs over a 12-hour period. See the Southern Forebay Emergency Spillway Siting Analysis Technical Memorandum in Attachment D of the EPR for additional detail on the analysis (Delta Conveyance Design and Construction Authority 2022c).

Indicators for Potential Impacts

The potential impacts from the operations of the project alternatives were evaluated based on:

- Changes in the resulting WSEs of the Sacramento River between the confluence of the American River and Sutter Slough (Impact FP-1). The increase in WSEs in the Sacramento River was used as an indicator for potential impacts on flood protection for the adjacent urban and nonurban areas.
- Changes in the depth and areal extent of the 100-year flood event surrounding the Twin Cities Complex site (Impact FP-2). The increase in flood depth or area was used as an indicator for potential impacts on Delta flood protection.
- Increases in risk of flooding by emergency release through the Southern Forebay Emergency Spillway (Impact FP-2). The indicator is based on evaluation if the emergency releases could affect levees and associated protected area.

Refer to Section 7.3.2 for more information about the significance criterion associated with this impact on riverine flooding from operations of the project alternatives.

7.3.2 Thresholds of Significance

Based on Appendix G of the CEQA Guidelines, the impact analysis for flood protection would assume a project alternative would have a significant impact under CEQA if the project would do any of the following.

- Cause a substantial increase in WSEs of the Sacramento River between the American River confluence and Sutter Slough (Impact FP-1).

- Alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on-site or off-site or impede or redirect flood flows (Impact FP-2).

For purposes of this analysis, WSE modeling results that show less than a 0.1 foot increase in WSE would not be considered a substantial increase. Table 7-1 includes a comparison of the reference years used for the existing and future conditions associated with each impact analysis in this chapter.

Table 7-1. Comparison of Reference Years Used for Flood Protection Impact Analyses

Impact	Existing Conditions/ Project Alternatives	No Project Alternative	Notes (see Section 7.3.1.1 for more detail)
Impact FP-1: Cause a Substantial Increase in Water Surface Elevations of the Sacramento River between the American River Confluence and Sutter Slough	2022	2072	Consistent with the planning horizon used in the 2022 CVFPP Update
Impact FP-2: Alter the Existing Drainage Pattern of the Site or Area, including through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner That Would Result in Flooding On- or Off-Site or Impede or Redirect Flood Flows	2020	2040	Consistent with all other resource impact assessments in the Draft EIR

Note: For potential flood protection impacts on areas that receive protection from the SPFC in the study area (i.e., Impact FP-1), reference years were selected to maintain consistency with the planning horizon used in the 2022 CVFPP Update. For potential flood protection impacts on areas that do not receive protection from the SPFC in the study area (i.e., Impact FP-2), reference years were selected to maintain consistency with all other resource assessments in this Draft EIR.

7.3.2.1 Evaluation of Mitigation Impacts

CEQA also requires an evaluation of potential impacts caused by the mitigation measures. Following the CEQA conclusion for each impact, the chapter analyzes potential impacts associated with implementing both the Compensatory Mitigation Plan (CMP) and the other mitigation measures required to address with potential impacts caused by the project. Mitigation impacts are considered in combination with project impacts in determining the overall significance of the project. Additional information regarding the analysis of mitigation measure impacts is provided in Chapter 4, *Framework for the Environmental Analysis*.

7.3.3 Impacts and Mitigation Approaches

7.3.3.1 No Project Alternative

As described in Chapter 3, *Description of the Proposed Project and Alternatives,* CEQA Guidelines Section 15126.6 directs that an EIR evaluate a specific alternative of “no project” along with its impact. The No Project Alternative in this Draft EIR represents the circumstances under which the project (or project alternative) does not proceed and considers predictable actions, such as projects, plans, and programs, that would be predicted to occur in the foreseeable future if the Delta Conveyance Project is not constructed and operated. This includes the water-supply-related actions that would be pursued by public water agencies participating in the Delta Conveyance Project in their respective service areas. This section considers how flood protection in the Delta could change over time, discusses how other predictable actions could affect flood protection, and summarizes the modeled changes in flood protection that may occur in the project study area under the No Project Alternative.

Predictable Water-Supply Related Actions by Public Water Agencies

A list and description of actions included as part of the No Project Alternative are provided in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*. As described in Chapter 4, the No Project Alternative analyses focus on the additional water-supply-related actions public water agencies may opt to follow if the project does not occur.

Public water agencies participating in the project have been grouped into four geographic regions. The water agencies within each geographic region would likely pursue a similar suite of water supply projects under the No Project Alternative (Appendix 3C). Activities associated with the various water supply projects could temporarily alter localized drainage patterns and stream courses, resulting in changes to surface water runoff and elevations, all of which could potentially exceed the capacities of stormwater management facilities. Construction impacts are expected to be primarily associated with construction of distribution pipelines; however, construction of these facilities would not be expected to result in substantial changes to drainage patterns or increases in surface water runoff because disturbed areas would generally be returned to pre-project conditions. In addition, distribution pipelines would mostly be below-ground and would not affect drainage patterns.

It is expected that water supply facilities would be located in upland areas to the greatest extent possible and would not be situated within flood inundation zones so as not to alter existing drainage patterns. Operational activities typically include inspection, monitoring, testing, maintenance, and facility operations. These activities are not expected to affect the ability of river, stream, or drainage channels to safely pass high flow events; expose people or structures to a significant risk of loss, injury, or death involving flooding; or result in substantial changes in the rate or amount of runoff or impede or redirect flood flows. O&M activities for the water supply projects are not expected to require substantial or sustained discharge of water to existing waterbodies. Operation of desalination plants includes discharge of brine and distribution of product water. Discharge of brine is typically accomplished through isolated discharge pipes to the ocean or into injection wells and would not increase flows in rivers, streams, or drainage channels.

Future Conditions of Flood Protection in the Delta

Under the No Project Alternative, various factors contributing to Delta flood risks remain and existing levee maintenance requirements and practices in the Delta are assumed to continue. These practices include continued improvements to overcome subsidence and sea level rise with potentially substantial costs, as the usable areas within Delta islands would continue to reduce (assuming no future improvements in levee crest elevations). Implementation of projects to reverse the trend of subsidence will also continue where opportunities exist. The threat of seismic activities on Delta levees will also persist with possibly increasing chance of occurrence but without specific predictions of when and where.

The high variability of precipitation makes it difficult to detect a strong signal in future projections and is one of the least certain aspects of climate models, especially when applied at the regional level because climate models do not resolve many of the fine-scale and complex interactions that occur locally (Delta Stewardship Council 2021:3-13). Uncertainty regarding precipitation projections is greatest in the northern part of California, where most of the snowfall and rainfall in the state occurs. However, climate models do project precipitation to change under warming conditions, resulting in more frequent rainfall events and less frequent snowfall events (He et al. 2019:11). Warming air temperatures are expected to shift the timing and volume of snowmelt in the Sierra Nevada to earlier in the spring as well. Changing precipitation patterns and an earlier snowmelt would lead to shorter, more intense spring periods of river flow and freshwater discharge, consequently affecting inflows into the Delta.

Future surface water conditions are expected to change considerably when compared to existing conditions due to sea level rise and a shift in hydrologic patterns as a result of climate change. Within the study area, sea level rise conditions under the No Project Alternative could be expected to increase the duration of high-water conditions in Delta channels, decrease flood protection, and increase flood risk relative to existing conditions. The trend would be further amplified by changing hydrology and storm patterns under climate change.

Sea level rise and changes in hydrologic patterns in Delta watersheds could be expected to increase peak water levels and flooding in the Delta in the coming decades, exposing additional land to flooding in the future (Delta Stewardship Council 2021:5-6). In some parts of the Delta, the existing freeboard—while effective in reducing current flood risk—will decrease and potentially be exceeded in the future as peak water levels increase in response to climate change (assuming no future improvements in levee crest elevations).

As previously discussed in Section 7.3.1, *Methods for Analysis*, and shown in Table 7-1, two different sets of reference years are used for flood impact assessments to be consistent with corresponding regulatory frameworks. For potential flood protection impacts on areas that do receive protection from the SPFC (i.e., Impact FP-1), the year 2072 was used for the No Project Alternative, consistent with the 2022 CVFPP Update. For potential flood protection impacts related to impeding or redirecting localized flood flow (i.e., Impact FP-2), the year 2040 was used for the No Project Alternative, consistent with the evaluation of other resource areas in this Draft EIR.

The analysis for Impact FP-1 is closely related to the potential impact on Delta flood risks with hydrologic conditions and sea level rise under climate change. The changes in WSE of the Sacramento River between the American River confluence and Sutter Slough under the No Project Alternative (2072 conditions) compared to the existing conditions (2022 conditions) were evaluated using the previously mentioned Sacramento River hydraulic model with climate change hydrology and a projected sea level rise of 3.7 feet by 2072, conditions consistent with the 2022 CVFPP Update. Because of this, future WSEs under the No Project Alternative were evaluated at 2072. Under the No Project Alternative, WSEs for the 100-year flood event would increase by a maximum of 0.40 foot (river mile [RM] 45.6; see Figure 7-2 for the corresponding location) in the river reaches with urban levees and 0.60 foot (RM 37.0) in the river reaches with nonurban levees when compared to existing conditions (Table 7-2). Under the No Project Alternative, WSEs for the 200-year flood event would increase by a maximum of 0.70 foot (RM 45.6) in the river reaches with urban levees and 0.90 foot (RM 37.0) in the river reaches with nonurban levees when compared to existing conditions. As shown in Table 7-2, increases in WSEs simulated in the Sacramento River under the No Project Alternative would result in increases in flood risk in the Delta. These increases in WSEs are contributed to by increases in flood flow due to changes in hydrology and sea level rise because of climate change since the high-water stage in the Delta channels is mostly influenced by tide and storm surges.

There was no specific analysis conducted for Impact FP-2. Under the No Project Alternative for FP-2, the projected sea level rise would be up to 1.8 feet

The No Project Alternative encompasses water supply projects adopted during the early stages of development of this Draft EIR, facilities that are permitted or under construction during the early stages of development of this Draft EIR, projects that are permitted or are assumed to be constructed by 2040/2072. The above identified local and regional water supply projects could result in localized impacts on flood protection and may require mitigations before implementation. Because these projects are expected to be within the service areas of public water agencies, they would not result in additional flood protection impacts in the Delta.

7.3.3.2 Impacts of the Project Alternatives on Flood Protection

Impact FP-1: Cause a Substantial Increase in Water Surface Elevations of the Sacramento River between the American River Confluence and Sutter Slough

All Project Alternatives

All nine project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would have similar impact levels and are discussed together. This impact analysis discusses potential impacts on flood protection that could result from the project alternatives when compared to existing conditions. Because the area being evaluated for this impact (i.e., the Sacramento River between the American River confluence and Sutter Slough) receives protection from the SPFC, the project alternatives and existing conditions are both evaluated under 2022 conditions to maintain consistency with the planning horizon used in the 2022 CVFPP Update. Appendix 7A presents potential impacts on flood protection that could result from the project alternatives when compared to the No Project Alternative under future conditions. See Table 7-1 for a comparison of the reference years used for the existing and future conditions associated with each impact analysis in this chapter.

Project Construction

Intake construction would include on-bank facilities that could encroach into the existing river cross section in the Sacramento River at the northern end of the Delta and require work on the SPFC levee nearby as described in Chapter 3. During construction, a temporary levee designed to comply with California Code of Regulations Title 23 and Urban Levee Design Criteria would be built at the intake site adjacent to but landward of the existing SPFC levee. This temporary levee would provide an equivalent, or higher, level of flood protection to adjacent properties as the existing SPFC levee and allow the intake facilities to be constructed along the Sacramento River while maintaining continuous flood protection. State Route (SR) 160 would be relocated on top of the temporary levee. As excavation continues on the intake site, a new permanent SPFC levee would be constructed around the perimeter of the sedimentation basin and intake outlet channel. The new SPFC levee would extend to the existing jurisdictional levee at the north and south ends of the intake structure and would be designed to protect the site and surrounding area to flood control standards that could accommodate a 200-year flood event with sea level rise. This level of protection exceeds the requirements of both USACE and CVFPB. Following construction of the intake structure, SR 160 would be relocated to approximately its original location east of the intake structure near the Sacramento River.

To minimize encroachment of the intake structure into the river flow cross section and minimize the associated impact on flood flow WSEs, the bathymetry and riverbank configuration must accommodate construction of the intake structure and associated training walls while meeting flood criteria. Because the Sacramento River has overlapping jurisdictions across various federal and state agencies, the intake facilities would be evaluated using the CVFPB flood profiles and be designed in compliance with USACE goals to limit the rise of maximum WSEs to within the original design profile with minimal impacts, in accordance with multiple-dimensional modeling results.

Project construction would require temporary in-river cofferdam structures at the proposed north Delta intakes. The cofferdams would enable construction of the intakes and provide a contractor-selected level of construction phase flood protection within the confines of the cofferdams. The cofferdam would be placed in a configuration to reduce hydraulic impacts on the Sacramento River. Temporary measures that would be in place during certain construction sequences, such as the cofferdam or the temporary jurisdictional levee, would be removed either fully or partially after the completion of applicable construction tasks. Partially removed temporary features would not be included as part of permanent SPFC facilities. While there may be minor increases in WSE at the proposed north Delta intakes during construction, any construction would be done to limit the rise in WSEs and therefore avoid a substantial increase.

The potential impacts on WSE from the construction of the intake structures (where a cofferdam is used along the riverbank of the Sacramento River) were examined using a hydraulic model covering the Sacramento River between the American River confluence and Sutter Slough. The proposed north Delta intakes are located in a river reach of the Sacramento River with nonurban levees (100-year level of flood protection), although project construction could affect river reaches with urban levees (200-year level of flood protection) upstream that are under CVFPB's jurisdiction. Figure 7-2 includes a map of the urban and nonurban levees along the Sacramento River between the American River confluence and Sutter Slough.

Under Alternatives 1, 3, and 5, WSEs for the 100- and 200-year flood event would increase by a maximum of 0.08 foot (RM 45.6; see Figure 7-2 for the corresponding location) in the river reaches with urban levees and 0.10 foot (RM 40.0) in the river reaches with nonurban levees when compared to existing conditions (Table 7-2). Under Alternatives 2a and 4a, WSEs for the 100-year flood event would increase by a maximum of 0.10 foot (RM 47.6) in the river reaches with urban levees and 0.11 foot (RM 42.0) in the river reaches with nonurban levees when compared to existing conditions. Under Alternatives 2a and 4a, WSEs for the 200-year flood event would increase by a maximum of 0.10 foot (RM 47.6) in the river reaches with urban levees and 0.12 foot (RM 42.0) in the river reaches with nonurban levees when compared to existing conditions. Alternatives 2b, 2c, 4b, and 4c (3,000-cfs and 4,500-cfs capacity alternatives) were not modeled because WSE impacts would be similar to, or less than, Alternatives 1 and 3 (6,000-cfs capacity alternatives). Table 7-2 presents the WSE differences between the project alternatives and existing conditions in the Sacramento River during project construction that are discussed here. See the Sacramento River Flood Flow Hydraulic Modeling Technical Memorandum in Attachment A of the EPR for additional detail (Delta Conveyance Design and Construction Authority 2022e).

All increases in WSEs of the Sacramento River due to construction of the conveyance facilities are relatively small. Therefore, construction of the conveyance facilities under Alternatives 1, 2b, 2c, 3, 4b, 4c, and 5 would not substantially increase WSEs near the intakes. However, construction of the conveyance facilities under Alternatives 2a and 4a (i.e., 7,500-cfs alternatives with all three intakes) would result in increases in WSEs near the intakes that are considered significant. For a multiyear period during construction, a sheet pile cofferdam must be installed in the river to allow construction of the concrete structure at each facility. While the construction cofferdam of two intake facilities built at the same time does not significantly increase the WSE during a flood event, the concurrent construction of a third intake cofferdam (as is the case in Alternatives 2a and 4a) does raise the WSE slightly over the 0.10-foot threshold. Supported by the analyses of other alternatives, phased construction of three intakes would alleviate the significant WSE increases.

Mitigation Measure FP-1: *Phased Construction of the Proposed North Delta Intakes* would address substantial changes in Sacramento River WSEs estimated to occur during construction of Alternatives 2a and 4a.

Postconstruction Effects during Operation

The nature of the proposed north Delta intake structures requires placement along the bank of the Sacramento River, with the structure projecting into flowing water. This effectively constricts a portion of the conveyance capacity of the river along the respective length of each intake. This in turn may cause a rise in WSE upstream of the intakes. This rise in WSE is dependent on the combination of intakes used to achieve the project needs. The major features of the intake structures that affect Sacramento River hydraulics are the intake training walls and the structural elements supporting the fish screens that encroach into the river. The structure's protective log boom and debris fender pile system could also affect river hydraulics. The debris fender and log boom—provided to protect the fish screen structures from damage by floating and near surface debris—may collect debris periodically, especially during or after storm runoff.

The potential impact on WSE in the Sacramento River between the American River confluence and Sutter Slough during operation of the intake structures was examined using the same hydraulic model for assessing impacts during construction discussed in the preceding subsection. As previously discussed, the potential impact on WSEs during operations of the project alternatives are not directly related to diversions at the proposed north Delta intakes. Instead, the following discussion related to "operational" impacts evaluates the effects that are a result of the permanent facility footprint. The proposed north Delta intakes are located in a river reach of the Sacramento River with nonurban levees (100-year level of flood protection), although the permanent footprint of the intake facilities could affect river reaches with urban levees (200-year level of flood protection) upstream, which are under CVFPB jurisdiction. Figure 7-2 includes a map of the urban and nonurban levees along the Sacramento River between the American River confluence and Sutter Slough.

Under Alternatives 1 and 3, WSEs for both the 100- and 200-year flood event would increase by a maximum of 0.03 foot (RM 45.6; see Figure 7-2 for the corresponding location) in the river reaches with urban levees and 0.04 foot (RM 40.0) in the river reaches with nonurban levees when compared to existing conditions (Table 7-2). Under Alternatives 2a and 4a, WSEs for the 100-year flood event would increase by a maximum of 0.04 foot (RM 47.6) in the river reaches with urban levees and 0.05 foot (RM 40.4) in the river reaches with nonurban levees when compared to existing conditions. Under Alternatives 2a and 4a, WSEs for the 200-year flood event would increase by a maximum of 0.05 foot (RM 47.6) in the river reaches with urban levees and 0.05 foot (RM 40.4) in the river reaches with nonurban levees when compared to existing conditions. Under Alternative 5, WSEs for the 100- and 200-year flood event would increase by a maximum of 0.03 foot (RM 45.6) in the river reaches with urban levees and 0.04 foot (RM 40.4) in the river reaches with nonurban levees when compared to existing conditions. Alternatives 2b, 2c, 4b, and 4c (3,000-cfs and 4,500-cfs capacity alternatives) were not modeled since WSE impacts would be similar to, or less than, Alternatives 1 and 3 (6,000-cfs capacity alternatives). Table 7-2 presents the WSE differences between the project alternatives and existing conditions in the Sacramento River during project operations that are discussed here. See the Sacramento River Flood Flow Hydraulic Modeling HEC-RAS 2D Technical Memorandum in Attachment A of the EPR for additional detail (Delta Conveyance Design and Construction Authority 2022e).

The permanent footprint of the conveyance facilities under all project alternatives would not substantially increase WSEs of the Sacramento River near the intakes. WSE increases during project operations would be less than the WSE increases exhibited during project construction due to the removal of the sheet pile cofferdam(s) when construction is complete. While operations of the project alternatives could divert flood flows, this would not necessarily provide a beneficial flood protection effect and was not modeled in this analysis.

Table 7-2. Water Surface Elevation Differences for the Project Alternatives at Select Locations in the Sacramento River between the American River Confluence and Sutter Slough Relative to 2022 Conditions

Project Alternative and Flood Flow Scenario	River Reaches with Urban Levees, Max WSE Difference Relative to EC (feet)	River Mile of Greatest WSE Difference in Urban Levee Section	River Reaches with Nonurban Levees, Max WSE Difference Relative to EC (feet)	River Mile of Greatest WSE Difference in Nonurban Levee Section
Construction Phase				
Alternatives 1, 3, and 5				
100-year Flood Event	0.08	45.6	0.10	40.0
200-year Flood Event	0.08	45.6	0.10	40.0
Alternatives 2a and 4a				
100-year Flood Event (without mitigation)	0.10	47.6	0.11	42.0
200-year Flood Event (without mitigation)	0.10	47.6	0.12	42.0
100-year Flood Event (with mitigation)	0.08	47.6	0.08	42.0
200-year Flood Event (with mitigation)	0.08	47.6	0.09	42.0
Operations Phase (i.e., Postconstruction)				
No Project Alternative (2072)				
100-year Flood Event	0.40	45.6	0.60	37.0
200-year Flood Event	0.70	45.6	0.90	37.0
Alternatives 1, 3, and 5				
100-year Flood Event	0.03	45.6	0.04	40.0
200-year Flood Event	0.03	45.6	0.04	40.0
Alternatives 2a and 4a				
100-year Flood Event	0.04	47.6	0.05	40.4
200-year Flood Event	0.05	47.6	0.05	40.4

Source: Delta Conveyance Design and Construction Authority 2022e.

Note: Because the Sacramento River between the American River confluence and Sutter Slough is protected by the SPFC, WSE differences between the project alternatives and existing conditions were evaluated under 2022 conditions to maintain consistency with the planning horizon in the 2022 CVFPP Update. WSEs for the No Project Alternative were modeled under 2072 conditions (to maintain consistency with the CVFPP's 50-year planning horizon) before being compared to existing conditions under 2022 conditions. Alternatives 2b, 2c, 4b, and 4c (3,000-cfs and 4,500-cfs capacity alternatives) were not modeled because WSE impacts would be similar to, or less than, Alternatives 1 and 3 (6,000-cfs capacity alternatives). The results presented in the table only examine the WSE differences within the modeled reach (i.e., the Sacramento River between the American River confluence and Sutter Slough).

cfs = cubic feet per second; EC = existing conditions; WSE = water surface elevation.

CEQA Conclusion—All Project Alternatives

The intake, sedimentation basin, and outlet channel would be designed to flood control standards that could accommodate a 200-year flood event with sea level rise for year 2100 (i.e., 10.2 feet of sea level rise at the Golden Gate Bridge) as defined by DWR. The project temporary levee developed during intake construction and the new, permanent SPFC levee after project construction would provide an equivalent or higher level of flood protection to the area currently receiving protection from the existing levee near the intakes. Therefore, the impacts of the project alternatives on the degree of flood protection near the intakes would be less than significant.

The nature of the water intake structures requires their placement along the bank of the Sacramento River, with the structure projecting into the flowing water. This effectively constricts a portion of the conveyance capacity of the river along the respective length of each intake. This in turn may cause a rise in WSE in the Sacramento River between the American River confluence and Sutter Slough. This rise in WSE is dependent on the river flow rate, the combination of intakes used to achieve project needs, and the phase of construction for each intake. As shown in Table 7-2, construction of the proposed north Delta intakes during the 100- and 200-year flood events would increase WSEs between 0.08 and 0.10 foot in the river reaches with urban levees and 0.10 and 0.12 foot in the river reaches with nonurban levees of the modeled study area. Operation of the proposed north Delta intakes during the 100- and 200-year flood events would increase WSEs between 0.03 and 0.05 foot in the river reaches with urban levees and 0.04 and 0.05 foot in the river reaches with nonurban levees of the modeled study area. Currently, the facility footprint includes riprap (along the intake structure, existing levee, and river bottom interface) and slope protection that is typically sufficient to mitigate localized scour and erosion forces (Delta Conveyance Design and Construction Authority 2022a:76, App 7, App 8, App 76). More detailed hydraulic evaluations concerning hydraulic loading, scour, and erosion forces at the interface between the intake structures and the river terrain as a result of increased WSEs would be completed as part of the final project design. During these evaluations, the specific size and extent of slope protection would be verified and revised, if needed.

Construction of Alternatives 2a and 4a (i.e., 7,500-cfs alternatives with three intakes) has a potentially significant impact on WSEs during a portion of the construction phase. For a multiyear period during construction, a sheet pile cofferdam must be installed in the river to allow construction of the concrete structure at each facility. The riverside sheet pile wall of the cofferdam encroaches about 5 feet further into the river than the permanent facility, thereby increasing river velocities through the area and slightly raising WSEs due to the additional hydraulic head loss. While the construction cofferdam of two intake facilities built at the same time does not significantly increase the WSE during a flood event, the concurrent construction of a third intake cofferdam does further raise the WSE. This increase in WSE could be considered substantial when assessing flood protection impacts; therefore, based on the initial design, this impact would be considered significant.

If Alternatives 2a or 4a are selected, DWR will perform additional hydraulic modeling based on the final design, prior to construction of the intakes. If this future modeling indicates a substantial increase in WSE of the Sacramento River (greater than 0.10 foot) during the construction period of Intake A (the most upstream intake), Mitigation Measure FP-1: *Phased Construction of the Proposed North Delta Intakes* would be applied to reduce the impact to less than significant.

After implementation of Mitigation Measure FP-1: *Phased Construction of the Proposed North Delta Intakes*, Alternatives 2a and 4a—in addition to the project alternatives that did not require mitigation (i.e., Alternatives 1, 2b, 2c, 3, 4b, 4c, and 5)—would have less-than-significant impacts on the level of flood protection between the American River confluence and Sutter Slough. See the Sacramento River Flood Flow Hydraulic Modeling HEC-RAS 2D Technical Memorandum in Attachment A of the EPR for model results that support the efficacy of Mitigation Measure FP-1 and the significance determination (Delta Conveyance Design and Construction Authority 2022e).

Mitigation Measure FP-1: Phased Construction of the Proposed North Delta Intakes

DWR will delay the installation of the intake cofferdam at Intake A until the complete removal of the construction cofferdam at Intake C (or Intake B, whichever was installed first). This will delay Intake A construction approximately 2 years under Alternatives 2a and 4a. By having only two intake cofferdams installed in the river at the same time, the resulting increase in WSEs in the Sacramento River will be 0.08 foot for the 100-year flood event and 0.09 foot for the 200-year flood event and, therefore, will render the impact less than significant. The 2-year increase in the construction timeframe for the intakes will not increase the overall schedule for project construction for Alternatives 2a and 4a.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources,* does not act as mitigation for impacts on flood protection from project construction or operations, its implementation could result in impacts on flood protection.

Actions undertaken for compensatory mitigation would restore three freshwater ponds along Interstate (I-) 5, wetland, open water, and upland natural communities on Bouldin Island, and tidal wetland and channel margin restoration sites within the North Delta Arc. Compensatory mitigation would convert existing agriculture land on Bouldin Island to wetlands, riparian habitat, ponds, and grassland. For the I-5 ponds, it is proposed that the existing grasslands, riparian habitat, wetlands, and ponds would be replaced by improved grassland, wetland, riparian, and open-water habitat. Tidal wetland and channel margin habitat would be restored within the North Delta Arc. Appendix 3F describes the CMP in detail.

Channel margin enhancements associated with compensatory mitigation actions would likely occur along migration corridors that also provide a certain level of flood protection for adjacent properties. Channel margin restoration would improve channel geometry, similar to what is currently practiced by USACE and other flood management agencies when implementing levee improvements. Channel margin restoration associated with federal project levees would not be implemented on the levee but rather on benches to the waterward side of such levees, and flood conveyance would be maintained as designed. Channel margin enhancements associated with federal project levees may require permission from USACE in accordance with USACE's authority under the Rivers and Harbors Act (33 United States Code [USC] § 408) and levee vegetation policy. Any restoration activities associated with compensatory mitigation would be designed, constructed, and maintained to ensure no reduction in performance of the federal flood project.

The construction and operations of water conveyance facilities would potentially affect tidal perennial aquatic habitat and alter hydrodynamics at Georgiana Slough for migrating Chinook salmon juveniles and would potentially reduce habitat extent and possibly habitat access for delta smelt spawning. Restoration of tidal wetlands is one approach to mitigate for these impacts. Tidal wetland habitat mitigation would generally be achieved at suitable locations by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees. Where practicable and appropriate, portions of restoration sites would be raised to elevations that would support tidal marsh vegetation following levee breaching.

Depending on the location of tidal wetland restoration, it may be necessary to construct an entirely new flood control levee along portions of the project perimeter to protect adjacent properties. This new flood control levee could affect WSEs in the adjacent waterbody, although the final design would ensure that resulting WSEs do not increase be more than 0.1 foot relative to existing conditions. Any restoration activities associated with tidal wetlands would be designed, constructed, and maintained to ensure no reduction in channel performance.

Accordingly, implementation of compensatory mitigation combined with the project alternatives would not change the overall impact conclusion of less than significant.

Other Mitigation Measures

Other mitigation measures proposed would not have impacts on increased WSEs because a temporary levee would be constructed to provide equivalent or higher level of flood protection to adjacent properties as the existing SPFC levee and allow the intake facilities to be constructed along the Sacramento River while maintaining continuous flood protection. Other mitigation measures would be implemented in accordance with USACE criteria specifically to maintain flood protection and limit the rise of maximum WSEs to within the original design profile. Therefore, implementation of mitigation measures is unlikely to cause substantial increase in WSE, and there would be no impact.

Overall, increased WSE impacts for construction of compensatory mitigation and implementation of other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant for Alternatives 1, 2b, 2c, 3, 4b, 4c, and 5 and less than significant with mitigation for Alternatives 2a and 4a.

Impact FP-2: Alter the Existing Drainage Pattern of the Site or Area, including through the Alteration of the Course of a Stream or River, or Substantially Increase the Rate or Amount of Surface Runoff in a Manner That Would Result in Flooding On- or Off-Site or Impede or Redirect Flood Flows

All Project Alternatives

All nine alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would have similar impact levels and are discussed together. This impact analysis discusses potential impacts on flood protection that could result from the project alternatives when compared to existing conditions. Because the area being evaluated for this impact does not receive protection from the SPFC, the project alternatives and existing conditions are both evaluated under 2020 conditions, similar to the other resource areas in the Draft EIR. Appendix 7A presents potential impacts on flood protection that could result from the project alternatives under future conditions.

Project Construction

Construction of the earthen embankments, pumping plants, levees, tunnels, tunnel shafts, forebay, and access roads would require excavation, grading, or stockpiling at project facility sites or at temporary worksites. In addition, site grading needed to construct any of the proposed facilities has the potential to block, reroute, or temporarily detain and impound surface water in existing drainages and velocities.

All project features would be constructed to not increase peak runoff flows into adjacent storm drains, drainage ditches, rivers, or sloughs. At the proposed north Delta intakes, tunnel shafts, Southern Complex, and Bethany Complex, all water from dewatering (i.e., groundwater removal) activities and stormwater runoff would be collected, treated, and stored on-site to reduce the need for off-site water sources (Chapter 3 and Chapter 8, *Groundwater*). On-site reuse and storage would be maximized to reduce peak runoff rate from project construction sites. If additional stored water is not needed, the treated runoff flows would be released in a manner that would not increase peak flow rates in local drainage channels or rivers on-site. Dispersion facilities would be used to reduce the potential for channel erosion due to the discharge of dewatering or stormwater runoff flows. The discharge rates of water collected during construction would be relatively small compared to the capacities of most of the Delta channels where discharges would occur. Permits for the discharges would be obtained from the Regional Water Quality Control Board or the State Water Resources Control Board (State Water Board).

Shallow, localized flooding has historically occurred at the sites of the proposed north Delta intakes due to natural depressions. This flooding could be exacerbated during storm and high-water events and may be due to stormwater runoff, increased groundwater levels, or through-seepage in levee and railroad embankments.

For all intake locations, drainage and irrigation would be rerouted to accommodate the project footprint. Similar to the dewatering activities described above, project facilities would be designed to capture runoff on-site to minimize off-site impacts during construction and operation. The project alternatives include drainage and pump enhancements to ensure intake facilities would not be subject to localized flooding during operation. During construction, the local drainage at intake facility sites would be managed to minimize local flooding through installing temporary pumps if necessary to allow continued construction activities.

These temporary changes in drainage would be minimized, and in some cases avoided, by construction of new or modified drainage facilities, as described in Chapter 3. Drainage studies, as part of the final design, would be prepared for each construction location to assess the need for, and to finalize, other drainage-related design measures, such as a new on-site drainage system or new cross drainage facilities. The project alternatives would include installation of temporary drainage bypass facilities, long-term cross drainage, and replacement of existing drainage facilities that would be disrupted by construction of new facilities. These new facilities would be constructed prior to disconnecting or crossing existing drainage facilities. Locations of stockpiles and other temporary construction features were selected and refined in the design phase to minimize flow impedance under flood flow conditions.

The project alternatives would include permanent facilities within the 100-year flood hazard area; these structures—such as the intake structures and surrounding levees and Southern Complex facilities, tunnel shafts—would be designed to withstand a 200-year flood event with sea level rise and climate change hydrology for 2100 (Delta Conveyance Design and Construction Authority

2022a:66). The levee systems surrounding each Delta island along the central, eastern, and Bethany Reservoir alignments where various shafts and facilities are located provide the first line of defense against flooding during construction. The levee reliability was evaluated in terms of its compliance with PL 84-99 criteria under existing conditions (i.e., year 2020).

The Southern Complex and Bethany Complex would include large construction sites and substantial numbers of personnel and equipment; however, these sites either have adequate levee heights (Southern Complex) or are not located in the potential flood area (Bethany Complex). The two Southern Complex tunnel launch shaft sites near the northern embankment of the Southern Forebay (Southern Forebay Inlet Structure Launch Shaft and Working Shaft) are already protected by levees that substantially meet the PL 84-99 criteria, primarily on the east side of the Southern Complex. The western side of the Southern Complex would be located on higher ground. In the area protected by levees, the time to flood in the event of a catastrophic failure has been conservatively estimated as being very short (Delta Conveyance Design and Construction Authority 2022a:68). However, the chance of levee failure is relatively low, and a sudden, catastrophic structural failure is unlikely at the Southern Complex due to portions of the levee system on mineral soil foundations when compared to Bouldin and Lower Roberts Islands. Because it is an area of reduced risk, further levee improvements on Byron Tract would not be warranted as part of the comprehensive flood risk management strategy for the tunnel construction corridor (Figure 7-1).

Launch shaft sites at Bouldin Island, Lower Roberts Island, and the Twin Cities Complex site would be much larger and involve more personnel and equipment than at maintenance and reception shaft construction sites. Accordingly, DWR would improve existing levees (Bouldin Island or Lower Roberts Island) or build a ring levee (at the Twin Cities Complex site) to protect workers, facilities, and equipment at those locations. These tunnel launch shaft sites would be active worksites for a 7- to 9-year construction period. During construction, all tunnel shaft pads would be constructed to an elevation at, or slightly above, the adjacent levee height, thus providing a high ground refuge above the local 100-year flood elevation. All launch, maintenance, and reception shaft sites would enact nonstructural flood risk management measures.

Based on the flood risk evaluation, tunnel shaft sites on Bouldin Island (central alignment) and Lower Roberts Island (eastern and Bethany Reservoir alignments) would be located in a higher risk category due to the combined effects of levee geometric deficiencies and potential inundation time and depth of flooding. Therefore, levee modifications on the inland side of the island levees would be constructed prior to construction of the tunnel shafts. Use of the existing levees with improvement would result in no impacts on existing drainage flows around the islands or within the island. The total size of the construction site and postconstruction site for the Bouldin Island levee modifications would be approximately 251 acres, with an additional 90 acres for temporary levee modification access roads. The total size of the construction site and postconstruction site for the Lower Roberts Island levee modifications would be approximately 30 acres, plus an additional 37 acres for temporary levee modification access roads. To account for ongoing work by levee maintaining agencies, the extent of levee repairs would be reevaluated during the design phase and coordinated with the local levee maintaining agency. Levee modifications at Bouldin Island or Lower Roberts Island would remain in place after project construction, providing a higher level of flood protection to surrounding areas than currently exists.

Given the long duration of work at these launch shaft sites, island perimeter levee improvements to meet PL 84-99 geometric standards, as well as to address any known geotechnical weaknesses, are warranted to limit long-term flood risk. The extent and types of recommended levee repairs would be refined prior to construction and in coordination with the local reclamation districts. The levee improvements would be initiated in the early phases of project construction and may overlap to some extent with the initiation of shaft pad construction at the shaft sites. However, if critical weaknesses were identified in these levee systems, remediation would be completed before shaft sites were constructed. Ongoing and continuous levee maintenance and monitoring would be critical to reducing flood risk at the shaft sites during project construction and would be closely coordinated with the reclamation districts. It is anticipated that levee maintaining agencies would continue making levee improvements to maintain geometric standards after repairs are completed and as sea level rise can be expected to increase in the future.

The exception to this flood management approach is the ring levee for the Twin Cities Complex site, which requires a separate evaluation. As described in Chapter 3, the Twin Cities Complex would be located on the eastern portion of Glanville Tract in an upland area vulnerable to overland flow flooding from the Sacramento, Cosumnes, and Mokelumne Rivers as well as Morrison Creek. Historically, Glanville Tract has been subject to flooding along the local levees and surrounding roadways of I-5, SR 99, Twin Cities Road, and Lambert Road. Glanville Tract is not fully protected by perimeter levees as the railroad embankment on the eastern side of Glanville Tract was not designed to perform as a flood control structure but is relied upon by the reclamation district to protect Glanville Tract from backwater flooding upstream of the confluence of the Cosumnes and Mokelumne Rivers. Therefore, a ring levee would be used to protect the Twin Cities Complex in the event of a levee failure on Glanville Tract. It would be configured to minimize impedance of flood flows from nearby streams, including the Cosumnes River, and minimize the inundation effects on the surrounding land during a potential overland flooding event within Glanville Tract. The ring levee and modifications to existing drainage features would convey floodwater around the ring levee to the west side of I-5 and eventually toward Snodgrass Slough. After project construction, the ring levee at Twin Cities Complex would be deconstructed except for a portion adjacent to the reusable tunnel material (RTM) storage area.

The flood effects analysis for the Twin Cities Complex site found that the ring levee would increase the 100-year flood depth directly adjacent to the ring levee by a maximum of approximately 0.3 foot for the central and eastern alignments and 0.4 foot for the Bethany Reservoir alignment, when compared to existing conditions with approximate flood depth of 3 feet. The resulting 100-year floodplain would increase by approximately 10 acres for the central and eastern alignments and 15 acres for the Bethany Reservoir alignment. However, the flood effect is confined to an open space area north of the Twin Cities Complex site for grazing purposes that are subject to flooding under the existing conditions. The inundation would last about 2.5 days (Delta Conveyance Design and Construction Authority 2022d:Att 3-16, 2022f:Att 4). The flood depth of the narrow space between the ring levee and existing railroad embankment would increase by 3 feet with potential overtopping of the existing railroad embankment, compared to existing conditions; however, the flow volume is fairly low and the flood depth increase is mainly due to the limited space between Franklin Boulevard and the railroad embankment, and the impacts are localized to this area. Dierssen Road would be overtopped by approximately 3.5 feet under existing conditions and become unusable; the conditions remain the same under project alternatives. Modeling results show that the ring levee would not change flood depth west of I-5, south of the Twin Cities Complex site, or north of Lambert Road.

The ring levee would increase the 100-year floodplain by approximately 10 acres for the central and eastern alignments and 15 acres for the Bethany Reservoir alignment, in the open space to north of the Twin Cities Complex. However, this increase in the 100-year floodplain would affect grazing land that is mostly inundated under existing flood conditions without the project facilities as well. The depth of flow with the project would overtop Dierssen Road by approximately 3.5 feet for all alignments evaluated. However, Dierssen Road would be inundated (to the same depth with or without the project facilities) and unusable under existing flood conditions without the project facilities. After the McCormack-Williamson Tract Project is completed, the hydraulic profile would be reduced approximately 1 to 1.5 feet within the adjacent floodway, which reduces the likelihood of flooding within Glanville Tract. As a result, the overtopping of the existing railroad embankment would not occur.

The launch site associated with Byron Tract near the South Delta Pumping Plant and Southern Forebay Inlet Structure would include two shafts—the Southern Forebay Inlet Structure launch shaft and an intermediate working shaft approximately 1 mile to the north. This site would be protected by levees that substantially meet the PL 84-99 criteria, and have levees primarily only on the east side, with high ground on the west side. Although the time to flood in the event of a catastrophic failure has been conservatively estimated as being short, the chance of failure would be relatively low, and a sudden, catastrophic structural failure would be unlikely because portions of the levee system are on mineral soil foundations and substantially higher ground elevations compared to Bouldin Island and Lower Roberts Island. For these reasons, further levee improvements on Byron Tract would not be warranted as part of the comprehensive flood risk management strategy for the tunnel construction.

The DSOD is the state agency with jurisdiction over the design, construction, and safe operation of the planned Southern Forebay for Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c. The Southern Forebay would be designed in accordance with the DSOD requirements for jurisdictional dams based on the anticipated maximum embankment height and storage volume. The embankments and spillway crest elevations would be established based on interior freeboard considerations mandated by DSOD and exterior sea level rise and flood condition data provided by DWR. The embankment, outlet works, emergency spillway, and their appurtenances would be designed to protect the forebay from the 200-year flood event with sea level rise and climate change hydrology for year 2100 (i.e., 10.2 feet of sea level rise at the Golden Gate Bridge) as defined by DWR, including wave run-up and appropriate freeboard for the Southern Forebay to reduce risk of overtopping the embankment from external flooding. Riprap would be placed along the inside embankment slopes and native grasses would be planted along the outside embankment slopes for erosion protection. Seepage collectors and drainage layers would be installed within the outboard toe of the embankment. Within the Southern Forebay, internal WSEs could be higher than external WSEs; therefore, the embankments would be of adequate height to contain maximum water elevation, wave run-up, and freeboard on the interior side of the embankment (except at the emergency spillway location).

Postconstruction Effects During Operation

Shallow, localized flooding has historically occurred at the sites of the proposed north Delta intakes due to natural depressions. This flooding could be exacerbated during storm and high-water events and may be due to stormwater runoff, increased groundwater levels, or through-seepage in levee and railroad embankments.

For all intake locations, drainage and irrigation would be rerouted to accommodate the project footprint. The project alternatives include drainage and pump enhancements to ensure intake facilities would not be subject to flooding during operation.

The flood effect analysis for the Twin Cities Complex site found that the stockpile storage areas would increase the 100-year flood depth by approximately 0.1 and 0.15 foot for the eastern and Bethany Reservoir alignments, respectively, when compared to existing conditions with a flood depth of approximately 3 feet; however, the flood effect is confined to an open space area north of the Twin Cities Complex site that is subject to flooding under existing conditions with no effect on residential development and/or critical facilities (Delta Conveyance Design and Construction Authority 2022d:Att 3-16, 2022f).

The stockpile storage areas would increase the 100-year floodplain by approximately 4 acres for both the eastern and Bethany Reservoir alignments in the open space to north of the Twin Cities Complex. However, this increase in the 100-year floodplain would affect grazing land that is mostly inundated under existing flood conditions without the project facilities. The permanent stockpile for the central alignment is smaller than that of the eastern alignment and thus would have less of an effect in increasing flood depth adjacent to the facility during flooding. Modeling results show that the stockpile storage areas would not change flood depth west of I-5 or south of the Twin Cities Complex site. With the eventual completion of the McCormack-Williamson Tract Project, the hydraulic profile would be reduced approximately 1 to 1.5 feet within the adjacent floodway, which reduces the likelihood of flooding within Glanville Tract.

Permanent RTM stockpiles expected at some tunnel launch shaft sites other than the Twin Cities Complex would extend above the surrounding grades and would be planted with native grasses primarily for erosion control or to create a natural habitat area. Recommended treatments for permanent RTM stockpiles would include spreading topsoil, cross disking, and planting native grasses. As previously mentioned, the surrounding levees of these launch shaft sites would be improved to meet PL 84-99 standards and no additional analysis is required.

The Southern Forebay includes an overflow emergency spillway that would be used under the unlikely condition that the forebay water level continued to rise above the design maximum elevation. The emergency spillway would discharge flow from the Southern Forebay into Italian Slough, which flows into Old River. To accommodate this, a portion of the existing Italian Slough levee would be removed. New levees would be constructed to channelize and contain the spillway discharge flows between the outboard toe of the spillway and the existing levee along Italian Slough. The discharge channel and levees would be expected to settle and require maintenance over time. The design of the emergency spillway would accommodate the controlling event where 7,500 cfs inflow continues and the outlet structure was closed (Delta Conveyance Design and Construction Authority 2022c:1). In addition, the capacity of draining the Southern Forebay with the combined capacity of the emergency spillway and the outlet structure meets the DSOD requirements for emergency drawdown for minimizing the risk of catastrophic failure of the Southern Forebay (Delta Conveyance Design and Construction Authority 2022g:10). The discharge into Italian Slough would initially be contained within the slough’s existing levees but would, over a short distance, converge with Old River. The connection to Old River and the broader Delta waterways would allow spillway flows to be absorbed during discharge.

The potential hydraulic impact of the Southern Forebay Emergency Spillway on the existing levee system of Italian Slough and Old River was evaluated using a 1-D hydraulic model. The change in WSEs was compared between the different operational scenarios (i.e., spillway releases of 3,000, 4,500, 6,000, and 7,500 cfs) and the baseline (i.e., no spill event). The 7,500-cfs scenario exhibited the largest increases in WSEs when compared to the baseline for both the 100-year flood event and the mean higher high water event (Delta Conveyance Design and Construction Authority 2022c:Att

2-5). For the 100-year flood event, the 7,500-cfs scenario increased WSEs by 0.44 foot when compared to the baseline, with the affected area extending 2.47 miles upstream and 1.55 miles downstream of the spillway location. For the mean higher high water event, the 7,500-cfs scenario increased WSEs by 0.67 foot when compared to the baseline, with the affected area extending 2.47 miles upstream and 1.94 miles downstream of the spillway location. Although the spillway was assumed to flow for 12 hours, peak WSEs were achieved in 2 hours or less for the modeled scenarios. In the modeled scenarios, the peak WSE was located upstream of the spillway location due to backwater effects from the additional flow entering Italian Slough from the spillway. None of the scenarios analyzed resulted in overtopping levees of the main Italian Slough channel or Old River due to the releases from the Southern Forebay Emergency Spillway.

CEQA Conclusion—All Project Alternatives

The project alternatives would involve placing structures within 100-year SFHAs that would impede or redirect flood flows. The impact assessment uses a conservative approach assuming the ongoing McCormack-Williamson Tract Project is not implemented. The results show limited increases in flood depth and inundation in areas primarily used for open space/grazing that are subject to flooding under existing conditions. Therefore, the potential impacts from project alternatives would be less than significant because flooding would occur in a limited area, be of relative short duration, and would primarily affect open space/grazing uses. In the event the McCormack-Williamson Tract Project is completed, as discussed in the cumulative conditions (Section 7.3.4, *Cumulative Analysis*), potential impacts would be avoided.

Glanville Tract has historically been subject to flooding, particularly along the local levees and surrounding roadways. The McCormack-Williamson Tract Project, when completed, would reduce the hydraulic profile in the adjacent floodway by approximately 1 to 1.5 feet, which would reduce the likelihood of flooding on Glanville Tract. The conservative flood effect analysis for the Twin Cities Complex site, which is based on the assumption that the McCormack-Williamson Tract Project would not be implemented, found that the ring levee (during construction) and stockpile storage areas (during operations) for all project alternatives would increase the 100-year flood depth of 3 feet under the existing conditions by a maximum of approximately 0.4 foot and would increase the 100-year floodplain by approximately 15 acres in open space for grazing purposes only. The flood effect analysis also found that stockpile storage areas (during operations) for all project alternatives would increase the 100-year flood depth by a maximum of approximately 0.1 foot of 3 feet under the existing conditions and would increase the 100-year floodplain by approximately 4 acres in open space for grazing purposes only. Based on the limited increases in flood depth and inundated areas and the fact that the McCormack-Williamson Tract Project is being implemented, this impact would be less than significant for all project alternatives.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on flood protection from project construction or operations, its implementation could result in impacts on flood protection.

Actions undertaken for compensatory mitigation would restore three freshwater ponds along I-5, wetland, open water, and upland natural communities on Bouldin Island, and tidal wetland and channel margin restoration sites in the North Delta Arc, as described in Appendix 3F. Compensatory mitigation would convert existing agriculture land on Bouldin Island to wetlands, riparian habitat, ponds, and grassland. For the I- 5 ponds, it is proposed that the existing grasslands, riparian habitat, wetlands, and ponds would be replaced by improved grassland, wetland, riparian, and open-water habitat. Tidal wetland and channel margin habitat would be restored within the North Delta Arc. The CMP is described in detail in Appendix 3F.

Channel margin enhancements associated with compensatory mitigation actions would likely occur along migration corridors that also provide a certain level of flood protection for adjacent properties. Channel margin restoration would improve channel geometry, similar to what is currently practiced by USACE and other flood management agencies when implementing levee improvements. Channel margin restoration associated with federal project levees would not be implemented on the levee but rather on benches to the waterward side of such levees, and flood conveyance would be maintained as designed. Channel margin enhancements associated with federal project levees may require permission from USACE in accordance with USACE's authority under the Rivers and Harbors Act (33 USC § 408) and levee vegetation policy. Any restoration activities associated with compensatory mitigation would be designed, constructed, and maintained to ensure no reduction in performance of the federal flood project.

The construction and operations of water conveyance facilities would potentially affect tidal perennial aquatic habitat and alter hydrodynamics at Georgiana Slough for migrating Chinook salmon juveniles and would potentially reduce habitat extent and possibly habitat access for delta smelt spawning. Restoration of tidal wetlands is one approach to mitigate these impacts. Tidal wetland habitat mitigation will generally be achieved at suitable locations by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees. Where practicable and appropriate, portions of restoration sites will be raised to elevations that will support tidal marsh vegetation following levee breaching.

Depending on the location of tidal wetland restoration, it may be necessary to construct an entirely new flood control levee along portions of the project perimeter to protect adjacent properties. This new flood control levee could affect WSEs in the adjacent waterbody, although the final design would have a less-than-substantial increase on WSEs relative to existing conditions. Any restoration activities associated with tidal wetlands would be designed, constructed, and maintained to ensure no reduction in channel performance.

Some of the compensatory mitigation efforts would require developing temporary facilities, such as staging areas, access haul roads, work areas, and borrow sites. These facilities could involve clearing and grubbing, excavation, and other grading activities that entail soil disturbance. Unless measures are implemented to control erosion, these construction activities could result in accelerated water runoff rates. The hazard and potential impact on receiving waters of accelerated water erosion would be greatest in sloping project features, such as new and modified existing levees, particularly on the waterside.

At the Bouldin Island mitigation site, landside improvements would include the construction of a new setback levee behind and connected to the existing levee. The actual extent of earthmoving required for levee construction would vary significantly by site depending on the degree of land subsidence and the level of flood protection needed. The surface soils underlying the Bouldin Island site are organic and, therefore, subject to subsidence. The compensatory mitigation is not expected to involve construction of habitable structures or significant foundations, but some of the mitigation efforts would entail construction of up to 5 miles of new setback levees on Bouldin Island, which may be founded on soils subject to subsidence. Subsidence of the levee foundation soil of the levee itself over time could cause levee failure and unintentional flooding. However, DWR would construct these levees according to Delta standards, such as PL 84-99, and maintain them to keep pace with subsidence of the underlying foundation soils, such as by periodically adding soil material to the levee.

As with the project alternatives, construction related to the CMP would be required to gain coverage under the State Water Board Stormwater Construction General Permit, compliance with which would ensure that there would be no excessive accelerated erosion or runoff caused by the project. Construction of setback levees, foundations for water control structures, and similar features would be required to be designed and constructed in accordance with resource agency and professional engineering specifications to avoid the effects of subsidence.

Accordingly, compensatory mitigation in combination with the project alternatives would not change the overall impact conclusion, and the specific impact on localized runoff and flood protection from the project alternatives combined with the CMP would be less than significant.

Other Mitigation Measures

Some mitigation measures would involve the use of heavy equipment such as graders, excavators, dozers, and haul trucks that would have the potential to result in altering drainage patterns or increasing surface runoff. The mitigation measures with potential to result in altering drainage patterns are: Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best Management Practices to Implement Project Landscaping Plan;* CUL-1: *Prepare and Implement a Built-Environment Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. Temporary alterations in drainage patterns or surface runoff resulting from mitigation measures would be similar to construction effects of the project alternatives in certain construction areas and would contribute to drainage pattern impacts of the project alternatives. Mitigation measures would result in no increase of peak runoff flows into adjacent storm drains, drainage ditches, or rivers and sloughs. On-site reuse and storage would be maximized to reduce peak runoff rate from mitigation measures. If additional stored water is not needed, the treated runoff flows would be released in a manner that would not increase peak flow rates in local drainage channels or rivers on-site. Dispersion facilities would be used to reduce the potential for channel erosion due to the discharge of dewatering or stormwater runoff flows. The discharge rates of water would be relatively small compared to the capacities of most of the Delta channels where discharges would occur, and in accordance with applicable State Water Board permits. Therefore, implementation of other mitigation measures is unlikely to alter drainage patterns or substantially increase surface runoff, and the impact of drainage patterns would not be substantial.

Overall, the impact of altering drainage patterns from construction of compensatory mitigation and implementation of other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

7.3.4 Cumulative Analysis

The cumulative effects analysis addresses the potential for the project to act in combination with other closely related past, present, and reasonably foreseeable future projects or programs to create a cumulatively significant impact on flood risks. It is anticipated that some changes related to flood flows would take place—even assuming that future projects would be designed to avoid such impacts to the extent feasible. For this analysis, the plans, policies, and programs listed in Table 7-3 were considered. These plans, policies, and programs were selected from a compilation of past, present, and reasonably foreseeable projects included in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*.

Table 7-3. Cumulative Impacts on Flood Protection from Plans, Policies, and Programs

Program/Project	Agency	Status	Description of Program/Project	Impacts on Flood Protection
Delta Dredged Sediment Long-Term Management Strategy/Pinole Shoal Management Study	USACE	Ongoing	Maintenance and improvement of channel function, levee rehabilitation, and ecosystem restoration.	Could alter the existing drainage pattern of sediment reuse sites and directly affect flood protection.
California Water Plan Update 2018	DWR	Updated in 2018, ongoing	Provides a framework for water managers, legislators, and the public to consider options and make decisions regarding California's water future.	Could modify surface water flow patterns and indirectly affect flood protection.
Bay-Delta Water Quality Control Plan Update (Delta Outflows, Sacramento River and Delta Tributary Inflows, Cold Water Habitat and Interior Delta Flows)	State Water Board	Planning phase	Would establish flow objectives for the Sacramento River and its tributaries, Delta eastside tributaries (including the Calaveras, Cosumnes, and Mokelumne Rivers), Delta outflows, and interior Delta flows.	Could modify surface water flow patterns, increase instream flows, increase minimum Delta outflows, and indirectly affect flood protection.
Delta Flood Protection Fund	DWR	Ongoing	Provides funding to levee maintaining agencies for their use to maintain and improve critical levees in the Delta.	Could modify surface water flow patterns or alter the existing drainage pattern and indirectly affect flood protection.
North Delta Flood Control and Ecosystem Restoration Project	DWR	Ongoing	Will improve flood management and provide ecosystem benefits in the North Delta area through actions such as construction of setback levees and configuration of flood bypass areas to create quality habitat for species of concern.	Will reduce flooding and provide contiguous aquatic and floodplain habitat along the downstream portion of the Cosumnes River Preserve.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Flood Protection
McCormack-Williamson Tract Flood Control and Ecosystem Restoration Project	DWR	Ongoing	Will implement flood control improvements principally on and around McCormack-Williamson Tract in a manner that benefits aquatic and terrestrial habitats, species, and ecological processes.	Will reduce flooding and improve flood control and management.
Sacramento River Bank Protection Project	USACE	Planning phase	A long-term flood risk management project designed to enhance public safety and help protect property along the Sacramento River and its tributaries.	Could modify surface water flow patterns or alter the existing drainage pattern and indirectly affect flood protection.
Lookout Slough Tidal Habitat Restoration and Flood Improvement Project	DWR	Planning phase	Designed to be a multi-benefit project to restore approximately 3,100 acres of tidal marsh, increase flood storage and conveyance in the Yolo Bypass, increase levee resilience, and decrease flood risk.	While the project would breach and degrade an SPFC levee (i.e., Shag Slough), which would lead to hydraulic changes during flood events, it would reduce local flood risk and improve local flood control. Therefore, the project would not substantially alter the drainage pattern of the area; this effect would be less than significant.
Incidental Take Permit for Long-Term Operation of the State Water Project in the Sacramento–San Joaquin Delta 2020	CDFW	Ongoing	CDFW issued an ITP to DWR for long-term operations of the SWP.	Potential effects on flood management could be from required conservation actions and activities in the floodways (e.g., Yolo Bypass), flood control channels, or floodplain would, if necessary, be mitigated to be less than significant when implemented.
2019 National Marine Fisheries Service Biological Opinion on the Long-term Operations of the Central Valley Project and State Water Project	NMFS	Ongoing	On October 21, 2019, NMFS issued a final BiOp finding that continued operations of the CVP/SWP is not likely jeopardize several listed species, including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Southern Distinct Population Segment of North American green sturgeon, and Southern Resident killer whales.	Potential effects on flood management could be from required conservation actions and activities in the floodways (e.g., Yolo Bypass), flood control channels, or floodplain would, if necessary, be mitigated to be less than significant when implemented.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Flood Protection
2019 U.S. Fish and Wildlife Service Biological Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (Delta Smelt)	Reclamation, USFWS, and DWR	Ongoing	On October 21, 2019, USFWS delivered its BiOp to Reclamation on the effects of continued operation of the federal components of CVP and SWP on delta smelt and its designated critical habitat.	Potential effects on flood management could be from required conservation actions and activities in the floodways (e.g., Yolo Bypass), flood control channels, or floodplain would, if necessary, be mitigated to be less than significant when implemented.
Central Valley Flood Protection Plan	DWR	Ongoing	The plan lays out strategies to: prioritize the state's investment in flood management over the next 3 decades, promote multi-benefit projects, and integrate and improve ecosystem functions associated with flood risk reduction projects. The plan is updated every 5 years and is currently undergoing a 2022 update.	Implementation of the plan has improved flood risk management in the Central Valley. Implementation of the recommended plan has reduced the estimated expected annual damage and potential life loss.

BiOp = Biological Opinion; CDFW = California Department of Fish and Wildlife; CVP = Central Valley Project; DWR = California Department of Water Resources; EIS = Environmental Impact Statement; ITP = Incidental Take Permit; NMFS = National Marine Fisheries Service; SWP = State Water Project; USACE = U.S. Army Corps of Engineers; USFWS = U.S. Fish and Wildlife Service.

7.3.4.1 Cumulative Impacts of the No Project Alternative

The No Project Alternative in combination with other cumulative projects is expected to cumulatively affect flood protection. Ongoing and reasonably foreseeable future projects may affect flood protection; however, several of the projects considered in the cumulative impact analysis are being developed in accordance with project objectives to improve flood control and management (e.g., Sacramento River Bank Protection Project, McCormack-Williamson Tract Project, and Lookout Slough Tidal Habitat Restoration and Flood Improvement Project). Nevertheless, a shift in hydrologic patterns and sea level rise as a result of climate change would decrease flood protection and increase flood risk.

7.3.4.2 Cumulative Impacts of the Project Alternatives

Construction of the project alternatives could result in alterations to channel conveyance capacity, drainage patterns, the rate or amount of surface runoff, or the placement of structures within an SFHA. However, construction of temporary and permanent levees would provide an equivalent (or higher) level of flood protection for the areas where construction is occurring and increased WSEs related to constricted conveyance capacity of the Sacramento River would be similar to existing conditions. All project structures placed within a 100-year SFHA would be designed to not impede or redirect flood flows. Most of the effects associated with these impact mechanisms are restricted to the specific impact sites and therefore would not act in combination with other projects.

While most of the projects considered in the cumulative impact analysis would not affect flood control and management in the study area, several of the projects are being developed in accordance with their specific project objectives to improve flood control and management (e.g., Sacramento River Bank Protection Project, McCormack-Williamson Tract Project, and Lookout Slough Tidal

Habitat Restoration and Flood Improvement Project). The effects of other cumulative impact projects on flood protection are not known at this time. The changes due to the project alternatives would remain small, beneficial, or localized and therefore would not be cumulatively considerable relative to past, present, and reasonably foreseeable future projects.