Chapter 5 Surface Water Resources

5.1 Introduction

This chapter describes the environmental setting, general hydrologic modeling methods and results, methods of analysis, and impact analysis for surface water resources that would potentially be affected by the construction and operation of the Project. Surface water resources generally include reservoirs, rivers, and diversions, and this chapter addresses surface hydrology, water supply (diversions), and flooding.

The study area for surface water resources consists of those areas with the potential to be significantly affected by the Project and associated changes in operations. This area includes drainages in the Sites Reservoir footprint, conveyance and storage facilities for moving water to and from Sites Reservoir, Shasta Lake and the Sacramento River, Lake Oroville and the Feather River, Folsom Lake and the American River, Yolo Bypass, and the Delta. Water supply service areas and the delivery system of the CVP and SWP, including San Luis Reservoir, are also discussed. As described in Chapter 2, *Project Description and Alternatives*, the Project would not affect or result in changes in the operation of the CVP Trinity River Division facilities (including Clear Creek) and thus Trinity River resources are not discussed or analyzed further in this chapter.

The study area for flood control and management facilities includes the local drainages in the inundation area and downstream, as well as the larger flood management system along the Sacramento River and the Yolo Bypass. Other watercourses and flood storage facilities associated with northern California's flood management infrastructure, such as the Feather River (i.e., Lake Oroville and the Thermalito Complex), the American River (i.e., Folsom Dam and Lake Natoma), and San Luis Reservoir are not analyzed with respect to flooding. This is because modeling results indicate negligible increases in flow or storage at these facilities that would result in no measurable increase in the likelihood or risk of flooding (Appendix 5B, *Water Resources Modeling System*). As identified above, the Project would not affect or result in changes in the operation of the CVP Trinity River Division facilities (including Clear Creek) and thus Trinity River resources are not discussed or analyzed further in this chapter with respect to flood control and management facilities.

The analysis presented in this chapter is based on the comparison of the No Project Alternative to Alternatives 1, 2, and 3. Model runs described in this chapter of the No Project Alternative do not incorporate a climate change scenario(s). The effects of climate change on the performance of the alternatives are analyzed in Chapter 28, *Climate Change*.

Tables 5-1a and 5-1b summarize the CEQA determinations and NEPA conclusions for construction and operation impacts, respectively, between alternatives.

Table 5-1a. Summary of Construction Impacts and Mitigation Measures for Surface Water Resources

Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Impact HYDRO-1: Reduce water supply for non-Sites Storage Partner water users			
No Project	NI/NE	–	NI/NE
Alternative 1	LTS/NE	–	LTS/NE
Alternative 2	LTS/NE	–	LTS/NE
Alternative 3	LTS/NE	–	LTS/NE
Impact HYDRO-2: Substantial increase in the rate or amount of surface runoff in a manner which would result in flooding on site or off site			
No Project	NI/NE	–	NI/NE
Alternative 1	LTS/NE	–	LTS/NE
Alternative 2	LTS/NE	–	LTS/NE
Alternative 3	LTS/NE	–	LTS/NE
Impact HYDRO-3: Impede or redirect flood flows			
No Project	NI/NE	–	NI/NE
Alternative 1	LTS/NE	–	LTS/NE
Alternative 2	LTS/NE	–	LTS/NE
Alternative 3	LTS/NE	–	LTS/NE

Notes:
NI = CEQA no impact
LTS = CEQA less-than-significant impact
NE = NEPA no effect or no adverse effect

Table 5-1b. Summary of Operation Impacts and Mitigation Measures for Surface Water Resources

Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Impact HYDRO-1: Reduce water supply for non-Sites Storage Partner water users			
No Project	NI/NE	–	NI/NE
Alternative 1	LTS/NE	–	LTS/NE
Alternative 2	LTS/NE	–	LTS/NE
Alternative 3	LTS/NE	–	LTS/NE
Impact HYDRO-2: Substantial increase in the rate or amount of surface runoff in a manner which would result in flooding on site or off site			
No Project	NI/NE	-	NI/NE
Alternative 1	LTS/B	-	LTS/B
Alternative 2	LTS/B	-	LTS/B
Alternative 3	LTS/B	-	LTS/B
Impact HYDRO-3: Impede or redirect flood flows			
No Project	NI/NE	-	NI/NE

Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Alternative 1	LTS/NE	-	LTS/NE
Alternative 2	LTS/NE	-	LTS/NE
Alternative 3	LTS/NE	-	LTS/NE

Notes:
NI = CEQA determination of no impact
LTS = CEQA determination of less-than-significant impact
NE = NEPA conclusion of no effect or no adverse effect
B = NEPA conclusion of beneficial effect

5.2 Environmental Setting

The environmental setting focuses on surface water resources in the study area and considers the broader context for these resources in California. Variability and uncertainty are the dominant characteristics of California's water resources. Precipitation is the primary source of California's water supply (California Department of Water Resources 2019:1-14); however, it varies greatly on an annual and seasonal basis and by region. Most of the precipitation falls in northern California.

Water year type for the Sacramento Valley is defined based on the 40-30-30 index of estimated unimpaired runoff. Unimpaired runoff is the flow that would occur in the absence of human structures and diversions. The 40-30-30 index is the sum of 40% of the current water year's April–July runoff plus 30% of the current water year's October–March runoff plus 30% of the prior year's index, with the prior year's index having a maximum value of 10 MAF. Wet, Above Normal, Below Normal, Dry, and Critically Dry Water Years are then determined based on the value of the water year index. The estimated unimpaired runoff used in these calculations is the sum of unimpaired flow in the Sacramento River above Bend Bridge, Feather River inflow to Lake Oroville, Yuba River at Smartsville, and American River inflow to Folsom Lake.

The total volume of water the state receives can vary dramatically between Critically Dry and Wet Water Years. For example, during water year 2013, a Critically Dry Water Year, California received 103 MAF of water; during 2011, a Wet Water Year, California received 248 MAF of water (California Department of Water Resources 2019:1-4). The majority of California's precipitation occurs between November and April and most of the demand for water is during the summer months. To achieve any water supply reliability under this annual, seasonal, and regional hydrologic variability necessitates that water from precipitation in the winter and spring be stored for use in the summer and fall. Federal, state, and local agencies, as well as private entities, have therefore constructed reservoirs, aqueducts, pipelines, and water diversion facilities to capture and use the rainfall and snowmelt.

5.2.1. River and Hydrologic Systems

The river and hydrologic systems in the study area are composed of natural and artificial waterbodies. This section provides a general description of the hydrologic conditions for the natural drainages near and in the inundation area (Figure 1-3), Project conveyance systems

(Figure 1-2), and waterbodies associated with the SWP and CVP where operational changes may occur as a result of Project implementation (Figure 1-1).

5.2.1.1. Local Drainages

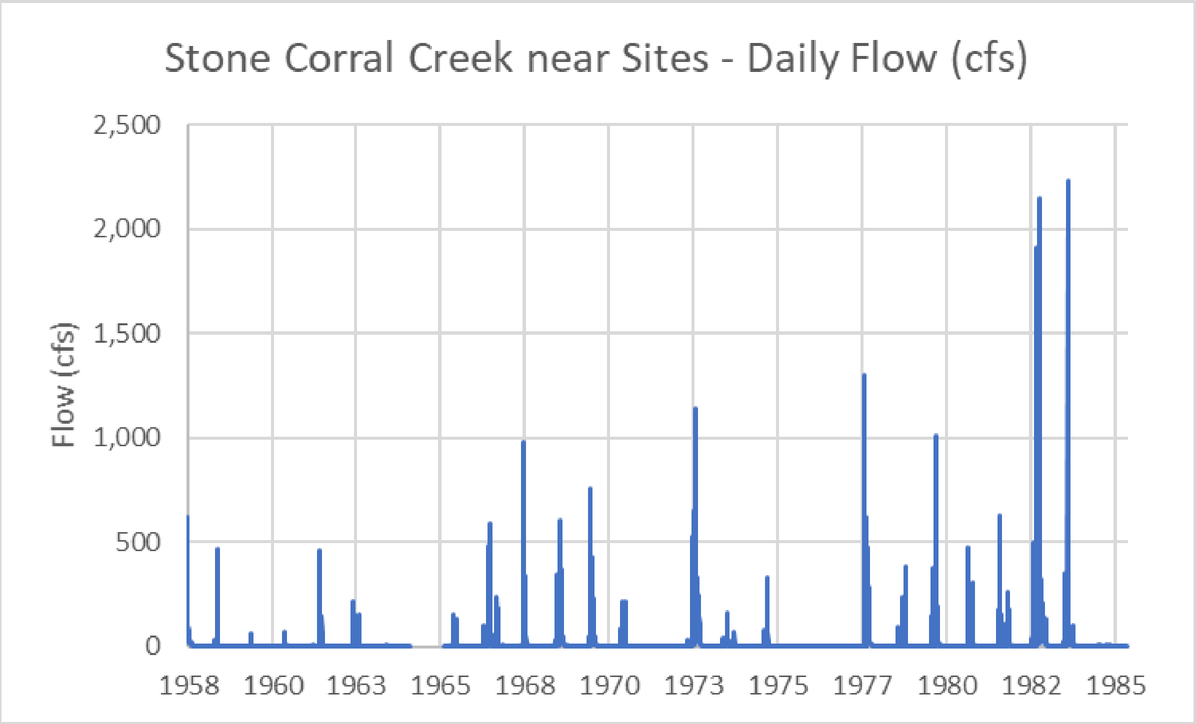
Multiple small creeks are in the vicinity of Sites Reservoir, either within the inundation area or near the inundation area. These local creeks originate in the eastside foothills of the Coast Range and drain east towards the Sacramento Valley subregion of the Central Valley. In general, these creeks are ephemeral (within and upslope of Antelope Valley) and transition to intermittent or perennial streams that frequently experience low to no flows in the summer (Chapter 7, *Fluvial Geomorphology*, Table 7-2). The creek segments on the Sacramento Valley floor have been highly altered, primarily for water conveyance and agricultural purposes.

The creek located to the north of the inundation area is Hunters Creek and the primary drainages in the inundation area are Funks Creek and Stone Corral Creek. These creeks originate at elevations below the snow line of the Coast Range and consequently do not receive cold snowmelt water. Rather, they respond rapidly to significant rainfall events, flash flooding, and substantial overland flow.

Stone Corral Creek

Stone Corral Creek has a drainage area of 38 square miles and crosses over a siphon in the TC Canal before traveling through agricultural lands. About 3 miles below the TC Canal siphon, Stone Corral Creek crosses the GCID Main Canal siphon. Although most of the water in the GCID Main Canal passes under Stone Corral Creek in the siphon, GCID can make releases to Stone Corral Creek for delivery to agricultural fields downstream. About 5.5 miles below the GCID Main Canal, Stone Corral Creek is joined by Funks Creek and then flows an additional 5.7 miles to the CBD. Antelope Creek is also tributary to Stone Corral Creek.

The U.S. Geological Survey (USGS) collected 27 years of discharge measurements in Stone Corral Creek near the community of Sites from 1958 through 1985 (Figure 5-1). The data demonstrate high variability of flow over the period of record. There were 3 years of zero flow: 1972, 1976, and 1977. Yates (1989) estimated the recurrence interval of a winter without flow at 12 to 14 years. Of the 26 years with data, 24 years had mean annual flow of less than 25 cubic feet per second (cfs). The maximum annual discharge during the period of record was 50.1 TAF in 1983. Based on the USGS data, the long-term annual average discharge through the creek is 6.7 TAF/year.



Source: U.S. Geological Survey stream gage 11390672

Figure 5-1. Mean Daily Flow in Stone Corral Creek near Sites (cfs)

Funks Creek

Funks Creek has a drainage area of 43 square miles and drains into Funks Reservoir. Below Funks Dam, Funks Creek travels 3.9 miles through agricultural fields in a combination of natural and straightened channels to where it crosses the GCID Main Canal. While the GCID Main Canal passes under Funks Creek in a siphon, GCID releases water from the canal to Funks Creek, and like Stone Corral Creek, GCID uses the downstream portions of Funks Creek as part of its conveyance system to deliver water to agricultural fields. Approximately 2 miles northeast of Maxwell and 1 mile east of Interstate 5 (I-5), Funks Creek flows into Stone Corral Creek. Grapevine Creek is tributary to Funks Creek.

There is no flow record for Funks Creek, but given the comparable size, geology, and topography of the two watersheds and their proximity to each other, Funks Creek hydrology is likely similar to Stone Corral Creek in terms of the amount and seasonality of flow. Because the Funks Creek drainage area (43 square miles) is 13% greater than the drainage area of Stone Corral Creek (38 square miles), runoff from the Funks Creek watershed is approximated here as 113% of that for Stone Corral Creek runoff. Therefore, the estimated long-term annual volume of flow for Funks Creek is 7.6 TAF and the estimated maximum flow for 1983 is 56.7 TAF.

Hunters Creek

The headwaters forks of Hunters Creek, including its north fork, originate in the uplands to the north of Antelope Valley, flow east toward the Sacramento Valley, and converge northwest of the inundation area. Hunters Creek flows in a southeasterly direction for approximately 9.0 miles until it reaches the TC Canal. Hunters Creek continues past the GCID Main Canal, is joined by several additional creeks on the valley floor, passes under I-5, and terminates in the vicinity of the CBD. The three main contributing channels to Hunters Creek on the valley floor are downstream/downslope of the locations of Saddle Dams 3, 5, and 8B.

Flood Risk

The 100-year floodplain delineations for the drainages that are near and in the inundation area are shown on Figure 5-2. Funks, Stone Corral, and Hunters Creeks are mapped within the 100-year floodplain (with inundation spreading away from the channels the further eastward into the valley the creeks go), but no other flooding hazard exists elsewhere adjacent to these creeks.

The USGS flow data and 100-year discharge estimates indicate that Stone Corral Creek has a "flashy" hydrologic regime[1]. The maximum mean daily flow on record for Stone Corral Creek was 2,230 cfs in 1983; the maximum instantaneous peak flow, 5,700 cfs, was also recorded that year (U.S. Geological Survey 2021a). The California Department of Water Resources (DWR) established the 100-year discharge for Stone Corral Creek as 7,870 cfs based on the 25 years of records (Bureau of Reclamation and California Department of Water Resources 2008:3-12). The USGS StreamStats estimate the 100-year discharge for Stone Corral Creek being slightly lower (6,590 cfs) with the mean daily discharge exceeding 215 cfs only 1% of the time and flows above 0 cfs 45% of the time (U.S. Geological Survey 2021b). Flooding occurred in the vicinity of the inundation area in February 2017 as a result of the overtopping of Stone Corral Creek. The valley floor around the community of Maxwell flooded, and two sections of I-5 just north of the city of Williams were barely passable due to floodwater encroachment. Local roadways were also closed from flooding and mudslides, and some residents voluntarily evacuated. Boils were reported on the agricultural levees stretching from Colusa to Knights Landing. The Colusa County Sheriff's Department cited flooding of local creeks as a contributor (Kalb and Opshal 2017).

As previously mentioned, there are no stream discharge data for Funks Creek and Funks Creek hydrology is considered similar to that of Stone Corral Creek. Therefore, the peak flow recurrence intervals and mean daily flow durations for Funks Creek are regarded as comparable to Stone Corral Creek.

---

[1] Flashy indicates a stream that experiences a rapid increase in flow shortly after onset of a precipitation event, and an equally rapid return to base conditions shortly after the end of the precipitation event.

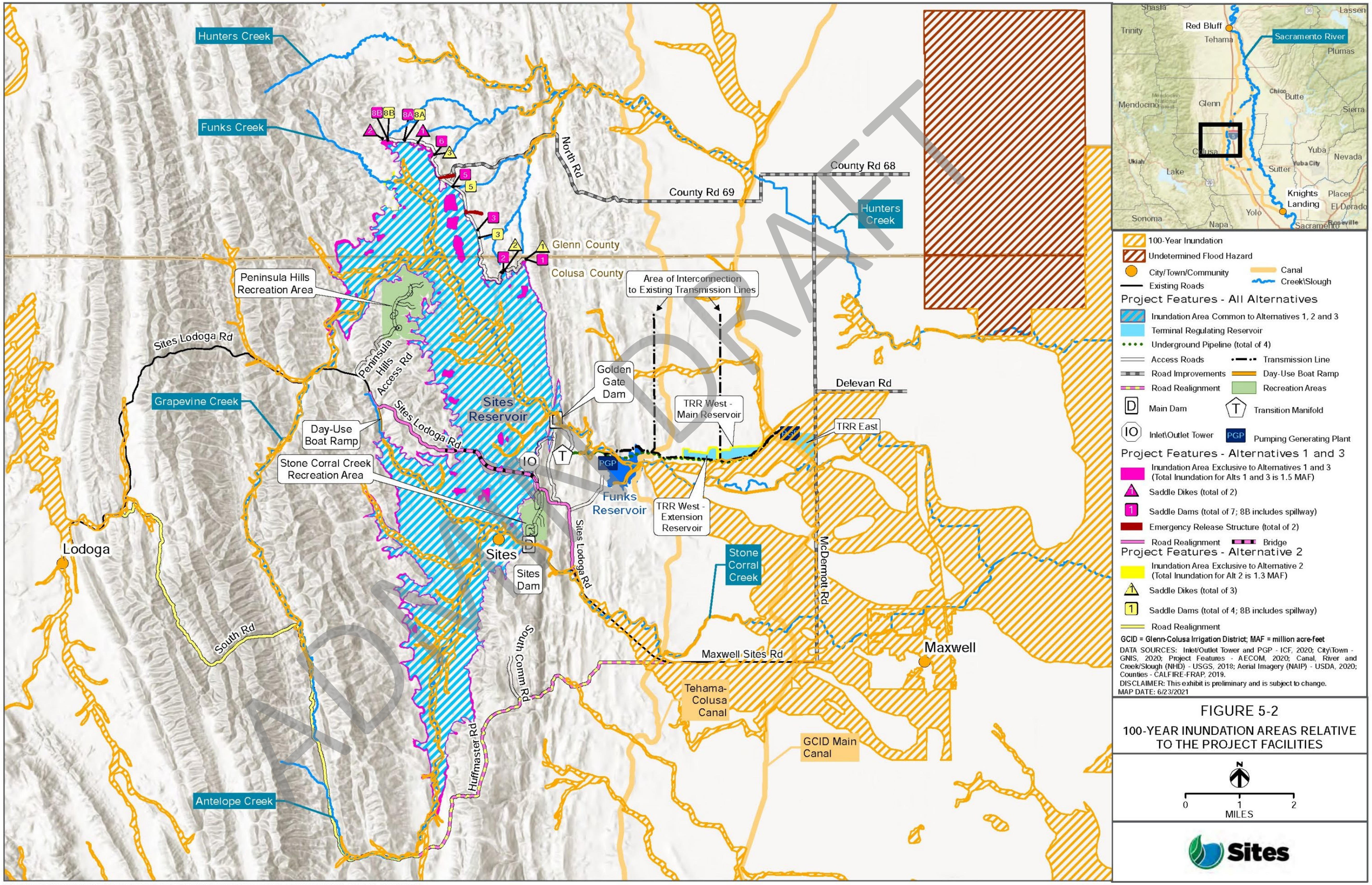


FIGURE 5-2

100-YEAR INUNDATION AREAS RELATIVE TO THE PROJECT FACILITIES

PATH: \\PDCCITRDSGIS1\PROJECTS_1\SITES_PA\00528_20\FIGURES\DOC\EIREIS\1_DEIR\01_ADEIR\GROUNDWATER\FIG5_2_SITESRESERVOIR.MXD - USER: 24991 - DATE: 6/23/2021

This page intentionally left blank

Flooding Types

The types of flooding most applicable to Funks, Stone Corral, Hunters, Grapevine, and Antelope Creeks, as well as nearby unnamed channels, are localized flooding and riverine flooding (albeit to a lesser extent). This determination is based on a review of the geology, topography, soils, and vegetation associated with the drainages in the inundation area vicinity. Localized flooding is frequently caused by severe weather cycles or a significant and often prolonged rainfall event on a relatively small drainage area (e.g., Funks, Stone Corral, Hunters, Grapevine, and Antelope Creeks). The term "flash flood" describes localized floods of significant magnitude and short duration. Riverine flooding, sometimes referred to as "slow rise" flooding, occurs when a watercourse exceeds its bankfull capacity (i.e., overbank flow), and generally results from prolonged rainfall or rainfall that is combined with already saturated soils from previous rain events. This type of flooding occurs in river systems whose tributaries may drain large geographic areas and include one or more independent river basins. The onset and duration of riverine floods may vary from a few hours to many days. The potential for riverine flooding in the inundation area vicinity is limited to the lowest reaches of Funks, Stone Corral, Hunters, Grapevine, and Antelope Creeks that are generally east of the GCID Main Canal near I-5.

5.2.1.2. Conveyance Systems

There are a number of conveyance systems in the study area that would be used to convey water from the Sacramento River to storage in Sites Reservoir, and subsequently convey releases from Sites Reservoir to the CBD, Yolo Bypass, and/or the Sacramento River. These conveyance systems are described in this section along with associated potential flood risks.

TCCA System

The TCCA operates the RBPP, TC Canal, Funks Reservoir, Corning Pumping Plant, Corning Canal, fish passage facilities, and settling basin. These facilities are held in title by Reclamation, which would retain title regardless of Project implementation. TCCA operates the TC Canal through a Joint Powers Authority composed of 17 water districts and delivers water to the service areas of those districts in Tehama, Glenn, Colusa, and northern Yolo Counties.

The RBPP was constructed on the Sacramento River adjacent to Reclamation's RBDD as part of the Fish Passage Improvement Project and includes a fish screen, canal, siphon, forebay, switchyard, and a bridge across Red Bank Creek. TCCA currently operates the four pumps in the RBPP at a total capacity of 2,000 cfs, which is in accordance with the biological opinions issued by U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) specifically for the pumping plant. The RBPP contains two additional pump bays designed for the future installation of two 250-cfs vertical axial-flow pumps, which would increase the total capacity to a maximum of 2,500 cfs. The TC Canal and the Corning Canal convey Sacramento River water south from the RBPP to irrigate approximately 150,000 acres of cropland. The TC Canal also supplies water to 20,000 acres of wildlife refuges in the Sacramento Valley.

The TC Canal is a concrete-lined channel that extends approximately 111 miles from the RBPP in Tehama County to south of Dunnigan in Yolo County. There is a regulating reservoir (i.e., Funks Reservoir) at its midpoint approximately 66 canal miles downstream of the intake. The TC Canal terminates 4 miles west of the CBD. The TC Canal has 26 automated check structures that are run by Supervisory Control and Data Acquisition and approximately 75 turnouts that are piped systems (non-canal/ditch). The automated check structures control the water surface elevation (WSE) where the canal enters (i.e., Funks Dam) and exits Funks Reservoir (check structures 16 and 17, respectively).

Funks Reservoir was created by the installation of the Funks Dam in 1976. The dam regulates flows from TC Canal and Funks Creek, and its gates are opened during large storm events to pass flood waters through the reservoir and downstream to avoid compromising the capacity and operations of the TC Canal. The initial volume of Funks Reservoir was approximately 2,200 AF, but sediment deposition that is predominately on the north and east sides has reduced the volume of usable storage in the reservoir's operating range to approximately 1,100 AF. The WSE in Funks Reservoir typically ranges from 200 to 205 feet.

GCID System

The existing GCID facilities include the Hamilton City Pump Station and forebay, Main Canal, intake and bypass channels, fish screens, head gates, gradient facility, and three siphons on the Main Canal (i.e., Walker Creek, Willow Creek, and the railroad siphon). GCID's system of canals was largely constructed in the early 1900s and conveys water to approximately 140,000 acres of irrigated lands and 22,000 acres of wildlife refuges and private wetlands in the GCID service area (Glenn-Colusa Irrigation District n.d.).

The Hamilton City Pump Station is on the Sacramento River approximately 5 miles northwest of Hamilton City (River Mile [RM] 205) and pumps water into the GCID Main Canal intake. GCID operates 10 pumps at the Hamilton City Pump Station with a total capacity of 3,000 cfs diversion. The approximately 65-mile-long GCID Main Canal is an unlined, earthen channel that delivers water between the intake at the pump station and its terminus at the CBD to the southeast near the city of Williams. There is a 1,000-cfs, gravity-fed intertie connecting GCID Main Canal and TC Canal north of Funks Reservoir and a cross tie south of the city of Williams.

The GCID Main Canal's primary irrigation season is early April through September and there is currently little to no available capacity during this period. Water delivery can occur during additional months to convey water in fall and winter to the Sacramento, Colusa, and Delevan National Wildlife Refuges, as well as to meet increased fall and winter season water demands for rice straw decomposition purposes by growers in GCID's service area.

The GCID Main Canal is typically out of service each year between early January and late February for approximately 6 weeks for maintenance. Debris that enters the intake channel, such as large trees, can block flows to the channel, get entangled at the face of the fish screen, obstruct the water control structure, or cause other disruptions to operating conditions. The debris commonly builds up during winter flood flows and is removed at the beginning of the irrigation season in late March or early April.

CBD and Knights Landing Ridge Cut

The CBD is a human-made channel designed to convey agricultural return flows and storm runoff from the Colusa Basin to the Sacramento River or the Yolo Bypass, with direction of flow controlled by the Knights Landing Outfall Gates (KLOG) near the downstream end of the CBD (Gray and Pasternack 2016:12–13). When CBD water is discharged to the Sacramento River, it enters near RM 90 at Knights Landing. The CBD is 70 miles long and crosses areas of Glenn, Colusa, and Yolo Counties; Colusa County contains the longest segment (Gray and Pasternack 2016:3). The CBD receives inflow from local creeks, including Funks and Stone Corral Creeks, and discharge and runoff from the agricultural lands in the Colusa Basin. The CBD typically conveys flood flows from November through April, and agricultural irrigation and drainage flows from May through October (Gray and Pasternack 2016:ii).

Under conditions of low water levels, CBD drains by gravity into the Sacramento River at Knights Landing; however, when the water levels in the Sacramento River at Knights Landing are too high for this gravity flow to occur or when CBD flow is too great, discharge from the CBD is routed directly to the Yolo Bypass through the Knights Landing Ridge Cut (KLRC) (Gray and Pasternack 2016 p13).

The rate of flow from the CBD into the Sacramento River through the KLOG is affected by the differential stage in the Sacramento River and in the CBD at the KLOG. The stage in the CBD at the Knights Landing Outfall depends on the operation of the KLOG (Gray and Pasternack 2016:12–13). In the irrigation season, the KLOG are closed to facilitate irrigation withdrawal; keeping the gates closed creates an upstream ponding effect.

CBD discharge to the Sacramento River was measured from 1984 through 2012 at DWR Water Data Library Station A02945 (CBD at Knights Landing) and is summarized in Table 5-2. The data presented in the setting includes entire periods of record to provide the best available information. No other data are available for this location. CBD flows measured during the flood conveyance period from November through April do not always represent full flows. CBD flow during this period may be directed to the Yolo Bypass. Flows during the agricultural irrigation and drainage period from May through October likely represent the full CBD flow being directed to the Sacramento River. The peak CBD flow during the irrigation and drainage period occurred during August and September.

Table 5-2. Summary of Daily Flow Measured in the CBD Discharging to the Sacramento River at Knights Landing between 1984 and 2012.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	0	0	0	0	0	0	0	0	0	0	0	0
Avg	256	197	79	147	310	247	369	766	889	210	609	345
Max	1,673	1,573	908	1,327	1,817	1,546	1,390	1,900	2,225	897	1,900	1,705

Source: DWR Water Data Library Station A02945

Flood Risk

Funks Reservoir

The drainage area above Funks Dam is 43 square miles. The Funks Reservoir structural height is 80 ft and its normal operating depth at the dam is 36 ft. The reservoir's spillway capacity is 22,500 cfs at an elevation of 0 ft with a crest length of 1,460 ft. Reclamation is the original owner of the reservoir and does not list flood control as a design objective of Funks Dam (Bureau of Reclamation 2021a). The reservoir is exempt from the jurisdiction of DSOD. At the time of preparation of this Final EIR/EIS there were no records of flooding or structural failure at

Funks Reservoir. There is no discharge record for Funks Creek on the California Data Exchange Center, which is administrated by DWR and compiles stream monitoring data from multiple sources (e.g., USGS). The 100-year floodplain delineations surrounding Funks Reservoir are shown on Figure 5-2. Funks Creek is mapped within the 100-year floodplain, but no other flooding hazard exists elsewhere adjacent to Funks Reservoir.

TC Canal and GCID Main Canal

The primary purpose of the TC Canal and GCID Main Canal is to provide irrigation and not flood control. The 100-year floodplain delineations for areas downstream of Sites Reservoir (including the canals) are shown on Figure 5-2 through Figure 5-5. As shown on Figure 5-2, the canals to the east of Sites Reservoir are intersected by various small drainages (e.g., Funks, Stone Corral, and Hunters Creeks as described above), but no other flooding hazard exists elsewhere adjacent to the canals. Areas with undetermined flood hazards include the national wildlife refuges, which are not subject to the Federal Emergency Management Agency (FEMA) National Flood Insurance Program regulations. As shown on Figure 5-4 and Figure 5-5, the Dunnigan Pipeline and the Walker and Willow Creeks siphon replacements would be within the 100-year floodplain.

CBD

The CBD has been designated as a floodway by the Central Valley Flood Protection Board (CVFPB). The CBD collects all drainage from the Colusa Basin watershed, which covers approximately 1,045,445 acres (1,635 square miles) (Colusa County Resource Conservation District 2012:1). The Colusa Basin encompasses the area between the Stony Creek watershed in the north and the Cache Creek watershed to the south, and between the Sacramento River in the east and the inner Coast Range foothills to the west. Various ephemeral streams drain the Coast Range foothills and have historically contributed to seasonal flooding in the Colusa Basin when combined with Sacramento River overflow (H. T. Harvey et al. 2008:1). The leveed capacity of the CBD is 20,000 cfs (California Department of Water Resources 2017a:3-3). However, even during summer conditions, some inundation of agricultural fields could occur at RM 8.9 if the WSE were to reach 25.3 feet as a result of seepage and backwater.

The KLOG are closed in the non-irrigation season during high Sacramento River events to prevent river water from flowing up the CBD. When CBD flows are high, waters are rerouted to the KLRC, which delivers overflow waters to the Yolo Bypass (Gray and Pasternack 2016:5). The CBD frequently floods in the winter (Gray and Pasternack 2016:13). While the lower drain flood waters are routed through the KLRC to the Yolo Bypass, upper drain flood waters in the shallow portion of the CBD overflow the banks. For example, the State Route 20 bridge overpass near Colusa experiences overbank flooding when discharge exceeds 2,100 cfs (Gray and Pasternack 2016:13). The highest discharge recorded at the State Route 20 bridge overpass was 23,900 cfs (February 21, 1958), while the highest discharge recorded in the lower reaches near the KLRC was over 8,500 cfs (January 17, 1978) (Gray and Pasternack 2016:13).

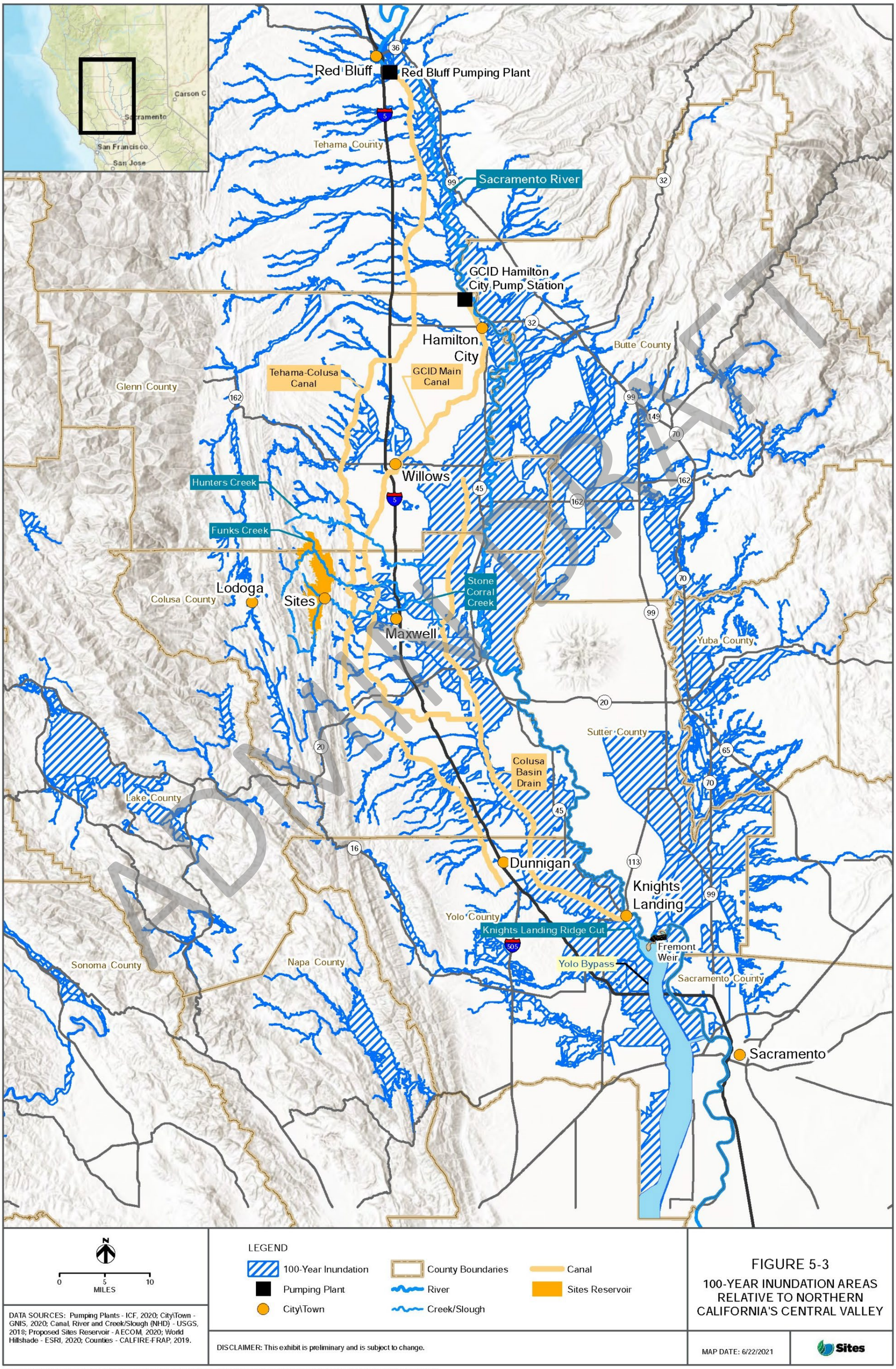
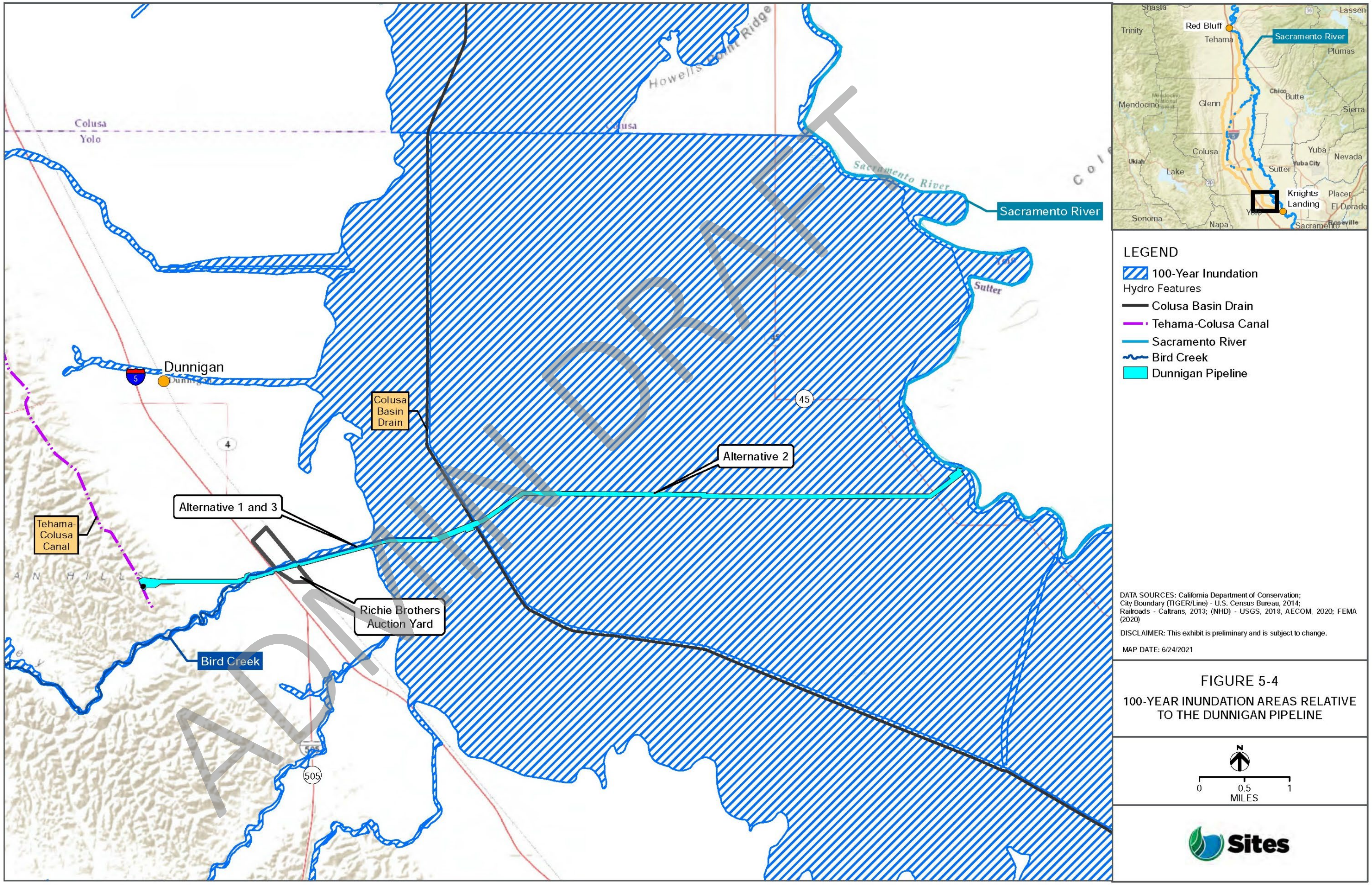


FIGURE 5-3
100-YEAR INUNDATION AREAS RELATIVE TO NORTHERN CALIFORNIA'S CENTRAL VALLEY

DATA SOURCES: Pumping Plants - ICF, 2020; City\Town - GNIS, 2020; Canal, River and Creek/Slough (NHD) - USGS, 2018; Proposed Sites Reservoir - AECOM, 2020; World Hillshade - ESRI, 2020; Counties - CALFIRE-FRAP, 2019.

DISCLAIMER: This exhibit is preliminary and is subject to change.

MAP DATE: 6/22/2021



DATA SOURCES: California Department of Conservation; City Boundary (TIGER/Line) - U.S. Census Bureau, 2014; Railroads - Caltrans, 2013; (NHD) - USGS, 2018, AECOM, 2020; FEMA (2020)

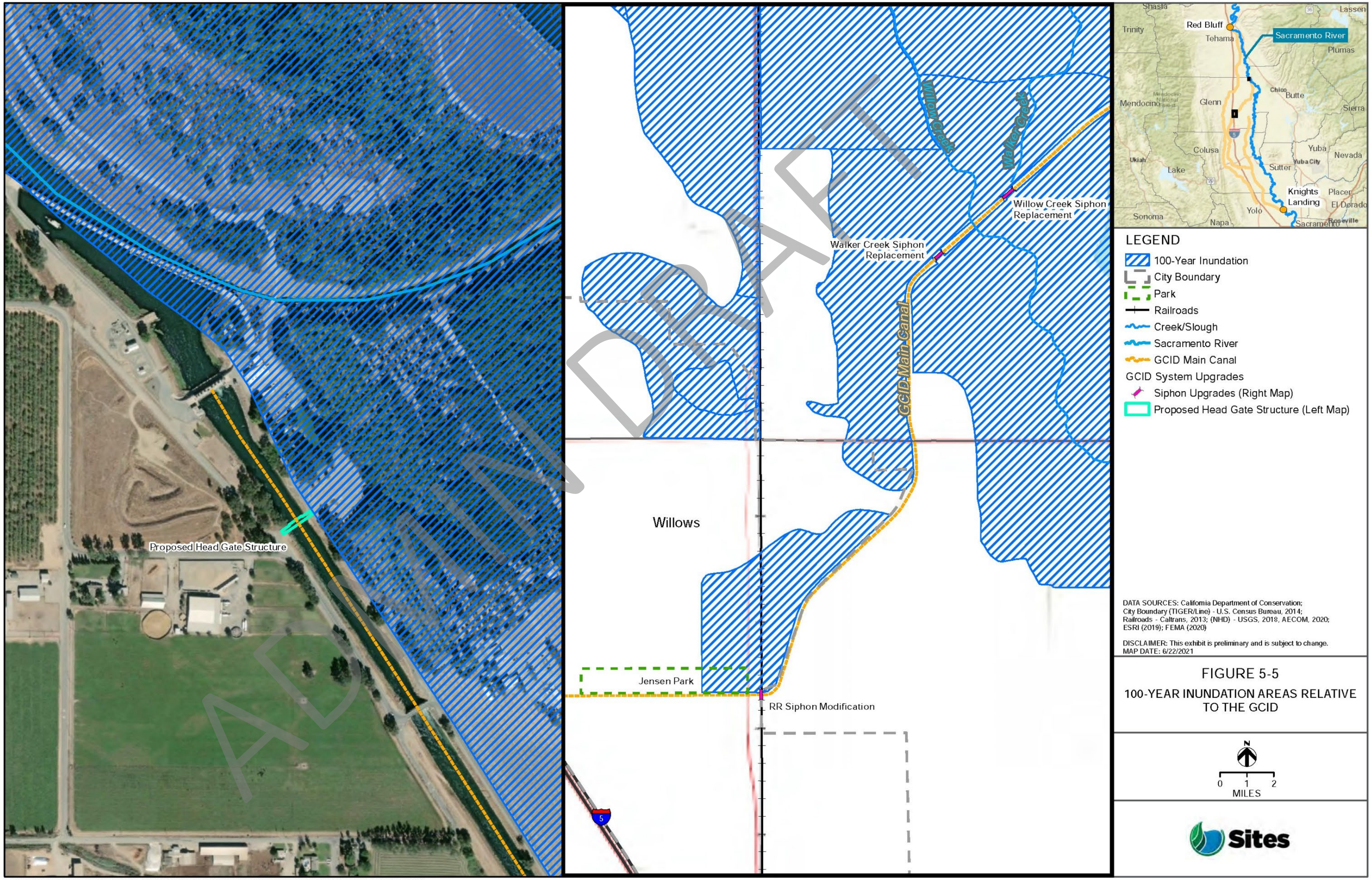
DISCLAIMER: This exhibit is preliminary and is subject to change.

MAP DATE: 6/24/2021

FIGURE 5-4

100-YEAR INUNDATION AREAS RELATIVE TO THE DUNNIGAN PIPELINE

PATH: \\PDCCITRDSGIS1\PROJECTS 1\SITES PA\00528 20\FIGURES\DOC\EIREIS\1 DEIR\01 ADEIR\GROUNDWATER\FIG5 4 SITESRESERVOIR.MXD - USER: 24991 - DATE: 6/24/2021



DATA SOURCES: California Department of Conservation;
City Boundary (TIGER/Line) - U.S. Census Bureau, 2014;
Railroads - Caltrans, 2013; (NHD) - USGS, 2018, AECOM, 2020;
ESRI (2019); FEMA (2020)

DISCLAIMER: This exhibit is preliminary and is subject to change.
MAP DATE: 6/22/2021

FIGURE 5-5

100-YEAR INUNDATION AREAS RELATIVE TO THE GCID

PATH: \\PDCCITRDSGIS1\PROJECTS 1\SITES PA\00528 20\FIGURES\DOC\EIREIS\1 DEIR\01 ADEIR\GROUNDWATER\FIG5 5 SITESRESERVOIR.MXD - USER: 24991 - DATE: 6/22/2021

This page intentionally left blank

Knights Landing Ridge Cut

Streamflows in the KLRC are based on flow conditions caused by the slide gate and flap gate settings at the outfall relative to the head difference of: (1) the stage of the gage on the CBD, which is upstream of the gates; and (2) the stage of the gage on the Sacramento River at Knights Landing, which is downstream of the gates. The KLRC conveys CBD drainage and flood flows into the Yolo Bypass several miles downstream of Fremont Weir. In addition, flood flows in the KLRC can occasionally be diminished via backwatering of the Yolo Bypass when it is at maximum conveyance capacity.

The banks on each side of the KLRC are Sacramento River Flood Control Project (SRFCP) levees. The Knights Landing Ridge Drainage District maintains the south levee upstream of the Knights Landing Outfall, and Yolo County Service Area 6 maintains the south levee downstream of the Knights Landing Outfall. Reclamation District 787 maintains the north levee upstream of the Knights Landing Outfall, and the Sacramento River Westside Levee District maintains the north levee downstream of the Knights Landing Outfall. The leveed capacity of the KLRC is 20,000 cfs (California Department of Water Resources 2017a:3-3).

During the flood events of 1986, 1997, 2006, and 2011, the stage of the Sacramento River was consistently higher than the CBD at the peak of the flood wave, resulting in no stream flow through the Knights Landing Outfall. However, at the ends of the rising and/or receding limbs of the hydrographs, there are occasions where the CBD water levels are higher than the stage in Sacramento River, resulting in stream flow through the Knights Landing Outfall (up to 1,370 cfs during the four historic floods). Based on historical record, the maximum flow through the Knights Landing Outfall is 2,220 cfs (cbec in preparation).

The 100-year floodplain delineations for the CBD and the KLRC are shown on Figure 5-3. Most of the topographically low-lying areas adjacent to the riverine areas are included within the 100-year floodplain (Figure 5-3). The KLRC is within a 100-year floodplain (Zone A) as designated by FEMA.

5.2.1.3. Sacramento River and Shasta Lake

The Sacramento River is the largest river in California. Runoff from the upper Sacramento River and its tributaries are regulated by Shasta Lake and Shasta Dam. Shasta Dam was constructed in 1945 by Reclamation and is part of the CVP. Shasta Lake has a storage capacity of approximately 4.55 MAF and captures runoff from the Sacramento, McCloud, and Pit Rivers. It has a maximum flood control storage space of 1.3 MAF. Releases from Shasta Lake are managed for protection of fish and wildlife, flood control requirements, hydropower generation, and water supply demands of CVP contractors. (Bureau of Reclamation 2014:1-3, 6-6, 6-20). Sites Reservoir would operate in conjunction with the operations of Shasta Lake, and flows in the Sacramento River downstream of Shasta Lake would be affected by Sites Reservoir diversions and releases.

During normal operations (i.e., non-emergency spill releases), Shasta Dam releases are restricted to 79,000 cfs at the tailwater of Keswick Dam and by a flood stage of 27 feet at the Sacramento River near the Bend Bridge gage. This flood stage at Bend Bridge corresponds to a discharge of just under 100,000 cfs at Shasta Dam. Shasta Dam outlet works capacity is 81,800 cfs, while the emergency spillway capacity is 186,000 cfs (Bureau of Reclamation 2021b). In 2017 and 1997, both Wet Water Years and during floods, it was reported Shasta Dam opened its top gates to release from 70,000 cfs to 79,000 cfs (Serna 2017). A FEMA report identified the 2017 flood had a 5-year recurrence interval (Solis 2017). Flood stage at Bend Bridge was exceeded in both 2017 and 1997 floods, when discharge reached 100,000 cfs and 121,000 cfs, respectively. The highest peak on record at Bend Bridge was 157,000 cfs in 1970 (National Oceanic and Atmospheric Administration 2021).

A temperature control device was installed at Shasta Dam between 1996 and 1998 to both minimize power losses and control the water temperature downstream of Shasta Lake to protect salmonids. The temperature control device has allowed for warmer water withdrawals in the spring/early summer, resulting in conservation of the deep cold-water pool for colder withdrawals in the late summer/early fall to meet downstream temperature requirements.

Keswick Reservoir was formed by the completion of Keswick Dam in 1950. It has a capacity of approximately 23.8 TAF and serves as an afterbay for releases from Shasta Dam and for discharges from the Spring Creek Power Plant.

The level of flow in the upper Sacramento River below Keswick Dam is controlled by local runoff, releases from Shasta Lake and Keswick Reservoir, transfers from the Trinity River, and groundwater accretions. The releases and transfers are determined by a suite of laws, regulations, contracts, and agreements to address demands of water users, requirements for water quality, and needs of fish populations throughout the river and the Delta. Operations are regulated by the State Water Resources Control Board (State Water Board) Decision 1641 (D-1641; March 15, 2000), which requires flow releases to meet Delta standards, and State Water Board Water Rights Order 90-5 (May 2, 1990), which requires cold-water releases to meet temperature targets at compliance points in the upper Sacramento River. Extended dry hydrologic conditions often lead to inadequate storage in Shasta Lake to provide suitable conditions for salmonids and other native fish species in the upper Sacramento River.

Downstream of Keswick Reservoir, the Sacramento River is influenced by tributary streams; diversions for agricultural, municipal, and industrial purposes; agricultural and municipal discharges; and the flood management system. The CVP is operated to meet the navigation flow requirement of 5,000 cfs at the Wilkins Slough gaging station when diversions are occurring downstream under all but the most critical water supply conditions. Flows measured at Wilkins Slough are summarized in Table 5-3. These data show that during very dry conditions, flow at Wilkins Slough may go as low as approximately 3,000 cfs. Generally, however, flows are often above what is required for this location, usually for the purpose of flood control, water quality (e.g., upstream temperatures or Delta salinity), Delta outflow, or Delta exports. The Feather River joins the Sacramento River at the community of Verona, and the American River joins at the city of Sacramento. The Sacramento River then flows south, joining with the San Joaquin River in the Delta, and out to the Pacific Ocean.

Table 5-3. Summary of Daily Flow Measured (cfs) in the Sacramento River below Wilkins Slough between 1985 and 2020.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	3,290	3,780	3,870	2,860	2,720	2,900	2,950	3,050	3,980	3,050	3,390	3,460
Avg	13,583	14,698	14,791	11,022	8,650	8,017	7,584	7,080	7,099	5,572	5,746	10,316
Max	31,600	32,600	30,300	29,800	30,200	26,700	14,600	11,300	12,600	14,400	23,700	30,700

Source: U.S. Geological Survey 2021n.

Sacramento River Flood Control Project and Flood Management

Existing flood management facilities along the Sacramento River affect its flow and operation. These facilities include dams and reservoirs, levees, and weirs. Shasta Lake collects flow in the upper Sacramento River, but many controlled and uncontrolled tributaries enter the Sacramento River downstream from this reservoir. In addition to dams and reservoirs, there are six weir structures and three flood relief structures that divert portions of flood flows to three overflow basins/bypasses: Butte Basin, Sutter Bypass, and Yolo Bypass. These weirs act as flood relief structures, allowing high flows from the Sacramento River to empty into the overflow basins and bypasses. The weirs were designed to function in a particular order (upstream to downstream), as follows: Moulton Weir, Colusa Weir, Tisdale Weir, Fremont Weir, Sacramento Weir, and Cache Creek Weir (California Department of Water Resources 2010:1). The 100-year floodplain delineations for the northern Sacramento Valley are shown on Figure 5-3. Most of the topographically low-lying areas adjacent to the riverine areas are included within the 100-year floodplain (Figure 5-3).

Multiple facilities along the Sacramento River are part of the SRFCP (authorized by Congress in 1917). The SRFCP was the major project for flood control on the Sacramento River and its tributaries. It was sponsored by The Reclamation Board of the State of California (today reauthorized as the CVFPB and was the first federal flood control project constructed outside the Mississippi River Valley [U.S. Army Corps of Engineers 2009]). The SRFCP includes levees, overflow weirs, pumping plants, and bypass channels that protect communities and agricultural lands in the Sacramento Valley and the Delta. The SRFCP extends from the Sacramento River's mouth near Collinsville in the Delta to near Chico Landing in the northern Sacramento Valley. Approximately 980 miles of levees were constructed as part of the SRFCP, providing flood protection to thousands of acres of highly productive agricultural lands, and multiple cities in the Central Valley, including Sacramento and Marysville. A large area of this regulated system includes both state- and federally authorized projects as the CVFPB has provided assurances of state cooperation to the federal government. This portion of the flood protection system is known as the State Plan of Flood Control (SPFC). The current flood risk statuses of the Sacramento River and other river systems under the jurisdiction of the SPFC, as well as the statuses of levees and flood control structures in these areas, are fully described in DWR's *2017 Flood System Status Report* (California Department of Water Resources 2017b). Key information pertaining to flood control facilities in the SRFCP is summarized in Table 5-4.

Table 5-4. Summary Flood Control Facilities and Management of the SRFCP

Reach	River Miles	Flood Control Facilities	Flood Characteristics
Red Bluff to Chico Landing	246 to 194	No levees present (U.S. Army Corps of Engineers 2002:20)	• Sacramento River naturally meanders through alluvium, and local tributaries contribute unregulated flows. • RBPP diverts water from the Sacramento River to the Corning Canal and the TC Canal at RM 243. • In-channel capacity of the river upstream of Chico Landing is 260,000 cfs. (California Department of Water Resources 2017a:3-3.)
Chico Landing to Colusa Reach	194 to 143	Constructed levees; (levees of the SRFCP begin in this reach, downstream from Ord Ferry on the west [RM 184] and downstream from RM 176 above Butte City on the east side of the river), natural overbank areas, and various flood relief structures leading into the Butte Basin.	• The Sacramento River meanders through alluvial deposits between widely spaced levees. • The largest tributary in this reach is Stony Creek; Black Butte Lake on Stony Creek is the only reservoir operated to manage flood flows in this reach. • Big Chico Creek and Mud Creek drain flood waters from the east side of the Sacramento Valley in the Chico area. • Floodwaters in the Sacramento River overbank to the east at three locations into what is referred to as the Butte Basin Overflow Area. These include the M&T (RM 190) and Three Bs flood relief structures (RM 186); Moulton Weir (RM 158); and the Colusa Weir (RM 146). • Several federal projects begin in this reach, including the SRFCP, Sacramento River Major and Minor Tributaries Project, and the Sacramento River Bank Protection Project (SRBPP). • The leveed capacity of the Sacramento River near Butte City (RM 169) is 160,000 cfs; 135,000 cfs at the Colusa Weir; and 65,000 cfs at the Butte Slough Outfall Gates at Colusa (RM 143) (California Department of Water Resources 2017a:3-3)
Colusa to Verona Reach	143 to 79	A continuation of the constructed levees	• Feather River (the largest eastern tributary to the Sacramento River), has its confluence with the Sacramento River just above Verona (RM 80). • Flood management diversions occur at the Tisdale Weir at RM 119 (where floodwaters enter into the Tisdale Bypass, which then routes water into the Sutter Bypass), and the Fremont Weir at RM 71 (where floodwaters from the Sacramento River, Sutter Bypass, and Feather River combine and flow into the Yolo Bypass). • The leveed capacity of the Sacramento River upstream of the Tisdale Bypass (from Butte Slough Outfall Gates at RM 138 to Tisdale Weir) is 66,000 cfs (California Department of Water Resources 2017a:3-3). • The leveed capacity of the Sacramento River downstream of the Tisdale Bypass (from the Tisdale Weir to the Knights Landing Outfall structure at RM 90) is 30,000 cfs (California Department of Water Resources 2017a:3-3). • The leveed capacity of the Sacramento River between the

Reach	River Miles	Flood Control Facilities	Flood Characteristics
			Knights Landing Outfall structure and the Fremont Weir is also 30,000 cfs (California Department of Water Resources 2017a:3-3).
Verona and Collinsville	79 to 0	Levees, weirs and use of Bypass	• Sacramento River flows past the city of Sacramento to the Delta. • The Yolo Bypass parallels the river reach to the west. Flows enter the Sacramento River from the Natomas Cross Canal (approximately 1 mile downstream from the Feather River confluence at RM 80). • Flows in the Yolo Bypass re-enter the river at the American River (RM 60); and at RM 14 near Rio Vista. • As the Sacramento River enters the Delta, the Georgiana Slough branches off from the mainstem Sacramento River, directing flows into the central Delta. • The one diversion point for flood management is at the Sacramento Weir (RM 63), where floodwaters are diverted from the Sacramento River through the Sacramento Bypass to the Yolo Bypass.

cfs = cubic feet per second; RBPP = Red Bluff Pumping Plant; RM = river mile; TC Canal = Tehama-Colusa Canal

The capacity of the leveed Sacramento River between Verona and Collinsville is listed in Table 5-5.

Table 5-5. Lower Sacramento River Leveed Capacity.

Segment	River Miles	Flow (cfs)
Fremont Weir to Sacramento Weir	RM 71 - RM 63	107,000 cfs
Sacramento Weir to Sutter Slough	RM 63 - RM 34	128,000 cfs
Sutter Slough to Steamboat Slough	RM 34 - RM 32	85,000 cfs
Steamboat Slough to Georgiana Slough	RM 32 - RM 26	56,500 cfs
Georgiana Slough to Yolo Bypass Junction	RM 26 - RM 14	35,900 cfs
Yolo Bypass Junction to Threemile Slough	RM 14 - RM 9	579,000 cfs
Threemile Slough to Collinsville	RM 9 - RM 0	514,000 cfs

Source: California Department of Water Resources 2017a:3-3

Annual Exceedance Probability of Flows / Peak Flows

Table 5-6 summarizes the flood characteristics of the Sacramento River reaches from Red Bluff to Verona relative to each reach's design flood capacity. Included in the table are the USGS gage station name, the number of years that maximum annual peak flows were recorded at the gage, the maximum peak and its date, the number of instances the annual peak flow exceeded the reach capacity, and the probability that a peak flow or a mean daily flow would exceed the capacity of the reach at that particular gage station site.

The probability that the annual peak flow would exceed the leveed capacity was calculated using the U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center's Statistical Software Package (HEC-SSP) for three stations: Sacramento River at Colusa, Sacramento River below Wilkins Slough, and Sacramento River at Verona. The estimation process used the B17B method and default program settings (U.S. Geological Survey 1982).

Table 5-6. Probability of Flows Exceeding Leveed Capacity, Sacramento River.

Reach	Leveed Capacity (cfs)	USGS Station	Years on Record (peak flows)	Max Peak on Record (cfs)	Number of Years Peak Exceeded Capacity	Date	Probability That Peak Flow Will Exceed Leveed Capacity in Any Given Year	Probability That Daily Average Flow Will Exceed Leveed Capacity in Any Given Year
Red Bluff to Chico Landing	260,000	Sacramento River near Red Bluff	87	291,000	2	February 28, 1940	<4%	<1%
Chico Landing to Colusa	65,000	Sacramento River at Colusa	79	51,300	0	March 4, 1983	<0.2%[a]	<1%
Colusa to Verona	30,000	Sacramento River below Wilkins Slough	81	32,700	10	February 2, 1986	<12.5%	<1%
Verona to Collinsville	107,000	Sacramento River at Verona	90	102,000	0	January 2, 1997	<0.2%[a]	<1%

Source: U.S. Geological Survey 2021c–2021j

cfs = cubic feet per second; USGS = U.S. Geological Survey

[a] While it appears that the Annual Instantaneous Peak Flow probability is less likely to exceed the leveed capacity than the Mean Daily Flow Duration, this is merely an artifact of the calculated statistics range. The USGS StreamStats Flow Duration Statistics are produced for 99 % duration to 1 % duration, whereas the USACE Frequency Curves are produced for 95 % to 0.2 %. For Sacramento River at Colusa, the leveed capacity exceeds the highest computed flow for both Flow Duration and Flow Frequency. Therefore, the likelihood of flow exceeding leveed capacity is less than the smallest computed probability in both cases.

5.2.1.4. Feather and American Rivers

The Feather and American Rivers are described because they are part of the CVP and SWP and Project operations would be integrated with operations of reservoirs on these rivers.

Lake Oroville and the Feather River

The upper Feather River watershed, extending downstream to Lake Oroville, contains numerous reservoirs and power plant diversions. The mainstem of the Feather River is regulated by Oroville Dam. The dam and its two saddle dams were completed in 1968 and formed Lake Oroville, a 3.5-MAF capacity storage reservoir with a surface area of approximately 16,000 acres at its normal maximum operating level. Water released from Lake Oroville passes through the Edward Hyatt Pumping-Generating Plant and the Thermalito Power Canal into the Thermalito Diversion Pool. At the diversion pool, water can be released through the Thermalito Diversion Dam Powerplant to the low-flow channel (LFC) of the Feather River or diverted through the Thermalito Power Canal Forebay into Thermalito Afterbay. Flows can be diverted from Thermalito Afterbay into agricultural canals to meet local Feather River service area requirements or released through the Thermalito Afterbay outlet back into the Feather River, where they combine with flows passing through the LFC to produce the high-flow channel (HFC).

Several local irrigation districts receive water from the Thermalito Afterbay during the May through August irrigation season. Major diversions on the Feather River downstream of the Thermalito Complex (which comprises Oroville Dam, Thermalito Diversion Dam, and Thermalito Afterbay outlet) include those into the Western Canal, Richvale Canal, the Pacific Gas and Electric Company Lateral, and the Sutter-Butte Canal. Feather River water is also diverted by holders of riparian water rights for agricultural and municipal uses within the Feather River and Butte Creek watersheds (U.S. Geological Survey 2010, Butte County Department of Water and Resource Conservation 2016: ES-8, 4-11, A-1, A-2).

Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, recreation, diversions, and water quality. Hydroelectric power production is scheduled within the boundaries specified by the water operations criteria. In the winter, the facilities are operated pursuant to flood control requirements specified by USACE. Pursuant to these requirements, Lake Oroville is operated to maintain up to 750,000 AF of storage space to allow for the capture of significant inflows.

DWR operations at the Thermalito Complex include planned weekly releases to accommodate water deliveries, meet Sacramento Valley in-basin demands such as Delta requirements, meet instream flow requirements in the Feather River, satisfy minimum flood management space requirements, and benefit cold-water fisheries. When Federal Energy Regulatory Commission reissues DWR’s license to operate the Thermalito Complex, DWR will likely operate consistent with the NMFS and USFWS biological opinions associated with relicensing of the Oroville Facilities Hydroelectric Project. Table 5-7 shows Feather River flow requirements in the LFC and the HFC as specified in the NMFS biological opinion (National Marine Fisheries Service 2016:371). In addition, water temperatures in the LFC and HFC will be required to meet stringent standards for protection of all life stages of the anadromous salmonids (National Marine Fisheries Service 2016:370).

Table 5-7. Summary of Feather River Flow Requirements in NMFS 2016 Biological Opinion

Feather River Reach	Minimum Flow Requirement
Low-Flow Channel	800 cfs from September 9–March 31 and 700 cfs the rest of the year

Feather River Reach	Minimum Flow Requirement
High-Flow Channel (downstream of Thermalito Afterbay)	1,000 cfs to 1,700 cfs, with the highest flows required during October–March when unimpaired runoff for the preceding April through July was >=55% of normal. Flow requirements are reduced if water surface elevation in Lake Oroville is predicted to fall below 733 feet (approximately 1.5 MAF storage)

Source: National Marine Fisheries Service 2016:51, 371

Folsom Lake and the American River

Folsom Lake is the largest reservoir in the American River watershed and has a storage capacity of approximately 1 MAF. Reclamation owns and operates Folsom Lake (formed by Folsom Dam) and Lake Natoma (formed by Nimbus Dam) as part of the CVP. Construction of Folsom Dam was completed in 1956 (Bureau of Reclamation 2021c). Releases from Folsom Lake are reregulated downstream at Lake Natoma, which has a storage capacity of 8,760 AF (Bureau of Reclamation 2021d). The American River flows 23 miles between Nimbus Dam and the confluence with the Sacramento River.

Reclamation uses Folsom Lake releases to help meet Delta salinity objectives to improve fisheries and downstream water quality. In accordance with federal and state regulatory requirements, the CVP and SWP are frequently required to release water from upstream reservoirs to maintain Delta water quality. Folsom Lake is closer to the Delta than Lake Oroville and Shasta Lake; therefore, the water generally is first released from Folsom Lake if an immediate change is needed. As water from Lake Oroville and Shasta Lake arrives in the Delta, Folsom Lake releases are reduced.

The minimum allowable flows in the lower American River are defined by State Water Board Water Right Decision 893 (D-893), which states that in the interest of fish conservation, releases should not ordinarily fall below 250 cfs between January 1 and September 15, or below 500 cfs during the rest of the calendar year. D-893 minimum flows are rarely the controlling objective of CVP operations at Nimbus Dam. Nimbus Dam releases are nearly always controlled during significant portions of a water year by flood control requirements or are coordinated with other CVP and SWP releases to meet CVP water supply and Delta operations objectives. Current flow and temperature requirements are governed by a combination of the 2017 Flow Management Standard Releases proposed by the Sacramento Area Water Forum and the 2019 NMFS biological opinion, which is further described in Chapter 11, *Aquatic Biological Resources*, and Appendix 4A, *Regulatory Requirements*.

5.2.1.5. Sutter Bypass

Sutter Bypass is approximately 20 miles long and conveys Sacramento River floodwaters along the east side of the Sacramento River from near the town of Sutter in the north to near the town of Knights Landing in the south. The southern end of the Sutter Bypass is adjacent to the southern end of the Feather River and discharges to the north side of the Sacramento River opposite the Fremont Weir, which is a main water entry point for the Yolo Bypass. The Sutter National Wildlife Refuge is located within and along the Sutter Bypass. The refuge consists of approximately 3,000 acres of riparian area on both sides of the interior of the bypass.

5.2.1.6. Yolo Bypass

The Yolo Bypass is an approximately 59,000-acre area that conveys Sacramento River floodwaters around Sacramento during times of high runoff. During high stages in the Sacramento River, water enters the Yolo Bypass from the north (over the Fremont Weir) and also from the east (via the Sacramento Weir and bypass). Diversion of the majority of the Sacramento River, Sutter Bypass, and Feather River floodwaters to the Yolo Bypass controls Sacramento River flood stages at Verona. The Yolo Basin was a natural overflow area to the west of the Sacramento River. The SRFCP modified the basin by confining the extent of overflow through a leveed bypass and allowing flood flows to enter the Yolo Bypass from the Sacramento River over the Fremont and Sacramento Weirs. Water in the bypass generally flows north to south and extends from Fremont Weir (RM 71) downstream to Liberty Island (RM 14) in the Delta. The Yolo Bypass conveys floodwaters around the Sacramento metropolitan area and reconnects them to the Sacramento River at Rio Vista. The capacity of the Yolo Bypass increases from 343,000 cfs at Fremont Weir to 500,000 cfs near the mouth of the bypass at Rio Vista (California Department of Water Resources 2017a:3-3).

As described above, during periods of high stage in the Sacramento River, flows from the CBD are also discharged through the KLRC into the Yolo Bypass. Additional flows enter the Yolo Bypass from the westside tributaries, including Cache Creek, Putah Creek, and the Willow Slough Bypass. In recent years, increased flow through the Yolo Bypass has been proposed as a means to improve fish populations through increased floodplain habitat or Delta foodweb enhancement.

During drier periods, when no water enters the bypass from the Sacramento River, flow through the bypass is greatly reduced and mostly contained in the Tule Canal in the northern part of the bypass and the Toe Drain in the southern part of the bypass. At a flow of 1,000 cfs, most of the water is retained within these drains. The area of inundation at this flow is 4,100 acres (Section 5.A.A.4.3.3.4 and Table 5.A.A.4-1 in California Department of Water Resources and Bureau of Reclamation 2016).

Daily average flow in the Yolo Bypass is extremely variable (Table 5-8), especially in the winter when flows have varied from less than 30 cfs of local drainage to 367,000 cfs of storm flow. During the July through October dry season, flow through the bypass has remained below 1,000 cfs and averaged 20–200 cfs.

Table 5-8. Summary of Daily Flow Measured (cfs) in the Yolo Bypass near Woodland between 1986 and 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	7	28	28	19	14	11	11	11	10	3	4	5
Avg	18,719	24,967	19,301	8,997	2,513	595	63	71	208	21	49	3,397
Max	299,000	367,000	215,000	106,000	65,500	18,900	621	636	750	63	1,150	93,100

Source: U.S. Geological Survey 2021n.

Yolo Bypass Inundation and Flood Risk

The Yolo Bypass floods approximately once every 3 years, generally during the winter months (Bureau of Reclamation and California Department of Water Resources 2019:4-6). The flood season can occasionally be longer, depending on the temporal hydrologic variability and extremes of the inflow sources. The 100-year floodplain delineations for the Yolo Bypass are shown on Figure 5-3. Most of the topographically low-lying areas adjacent to the riverine areas are included within the 100-year floodplain (Figure 5-3).

At the Fremont Weir, the likelihood of maximum annual instantaneous flows exceeding the Yolo Bypass capacity (343,000 cfs) is between 1% and 2% as computed through the Central Valley Flood Protection Plan by DWR in 2016 (Bureau of Reclamation and California Department of Water Resources 2019:4-7). The maximum of the mean daily flows on record at Fremont Weir occurred in 1955 and was 256,000 cfs (U.S. Geological Survey 2021k). USGS stopped recording discharge at Fremont Weir in 1975. Near the city of Woodland, the USGS recorded 70 years of annual maximum instantaneous peak flows between 1942 and 2019. The maximum peak flow on record near Woodland is 374,000 cfs and occurred on February 20, 1986 (U.S. Geological Survey 2021l). The second highest peak flow was 357,000 cfs and occurred on January 3, 1997. The capacity of the Yolo Bypass at Woodland is likely between 343,000 cfs and 500,000 cfs. At the time of preparation of this Final EIR/EIS there were no reports of flooding and its capacity is likely greater than the maximum peak flow on record. According to USGS StreamStats, the mean daily flow at the Yolo Bypass near Woodland exceeded 96,000 cfs 1% of the time on record (U.S. Geological Survey 2021m).

5.2.1.7. Delta and Suisun Marsh

The Delta, located east of San Francisco Bay, includes integrated channels and islands at the confluence of the Sacramento and San Joaquin Rivers. The Delta is a natural floodplain that covers 738,000 acres and drains approximately 40% of the state (California Department of Water Resources 1995:1). Inflows to the Delta occur primarily from the Sacramento River system and Yolo Bypass, the San Joaquin River, and other eastside tributaries such as the Mokelumne, Calaveras, and Cosumnes Rivers. In most years, approximately 76% of water enters the Delta from the Sacramento River, approximately 15% enters from the San Joaquin River, and approximately 5% enters from the eastside tributaries, with the remainder coming from Delta precipitation (California Department of Water Resources 1995:19). The Delta is tidally influenced; rise and fall varies from less than 1 foot in the eastern Delta to more than 5 feet in the western Delta (California Department of Water Resources 1995:21).

There are multiple structures in the Delta that affect flow and water quality, and the main structures are the Suisun Marsh Salinity Control Gates, Delta Cross Channel gates, and the southern Delta temporary barriers. The Suisun Marsh Salinity Control Gates are used to reduce salinity in Suisun Marsh. The Delta Cross Channel gates allow relatively high quality Sacramento River water to enter the southern Delta when the Suisun Marsh Salinity Control Gates do not need to be closed for high flows and fish protection. The southern Delta temporary barriers raise water levels for agricultural diversions and reduce fish migration down Old River.

Water quality in the Delta is highly variable and strongly influenced by seawater intrusion into the western and central portions of the Delta during periods of low Delta outflow, which may be attributed to low Delta inflows and/or high volumes of export pumping at the CVP and SWP facilities. The position of “X2” is one indicator of the extent of seawater intrusion; it is defined as the distance from the Golden Gate Bridge in river kilometers to the location where near-bottom salinity is 2 parts per thousand. The location of X2 is important to both aquatic life and water supply beneficial uses. In addition to seawater intrusion, Delta water quality is also affected by the water quality and volume of river inflows, tidal flows, agricultural diversions, drainage flows, wastewater discharges, and groundwater accretions.

There are multiple regulations affecting flow through the Delta. For example, the State Water Board Bay-Delta Plan (2018) includes flow and water quality regulations to benefit fish and wildlife, municipal and industrial use, and agriculture. These include Delta export constraints and inflow, outflow, and salinity objectives (including February–June X2 requirements). The 2019 USFWS Biological Opinion and 2020 DWR Incidental Take Permit include additional operational regulations that affect Delta flows including management of reverse flow in Old and Middle Rivers toward the export pumps, modified operation of the Delta Cross Channel gates for fish protection, San Joaquin River inflow to export ratio requirements, fall X2 requirements, and additional Delta outflow. These regulations often limit Delta exports by the SWP and CVP directly or indirectly as the SWP and CVP facilities are operated to comply with the requirements. To meet the Delta water quality requirements and water rights requirements of users located upstream of the Delta, the CVP and SWP are operated in a coordinated manner in accordance with the Coordinated Operation Agreement (Appendix 4A).

Delta Flood Risk

The present hydrogeomorphic regime of the Delta is a function of the intensity of water management in each of the tributary rivers, local farming practices, intra- and inter-Delta water transfers, and an extensive human-made levee system. Channel alignments are largely fixed by artificial levees and erosion control measures. Flooding, except when artificial levees break, no longer occurs on most islands and tracts (Northwest Hydraulic Consultants 2006:7). Instead, flow and sediment remain confined to the existing channel network. Upstream water diversions for municipalities and agriculture reduce the amount of flow entering the Delta and the amount of sediment transported to the Delta. In addition, conveyance of water within and out of the Delta alters flow directions and affects sedimentation, erosion rates, and erosion patterns. The levee system in the Delta restricts flow to a network of human-made and natural channels that reduce flood events and inhibit the accumulation of soils on the Delta islands.

5.2.1.8. San Luis Reservoir

When permitted by water rights, the CVP and SWP can store Delta exports in San Luis Reservoir when there is no immediate demand for the water. CVP water is conveyed via the Delta-Mendota Canal and SWP water is conveyed via the California Aqueduct to the O’Neill Pumping Plant, which lifts the CVP water into the O’Neill Forebay. The William R. Gianelli Pumping-Generating Plant lifts water from O`Neill Forebay and discharges it into San Luis Reservoir. Total San Luis Reservoir capacity is approximately 2.03 MAF, with approximately 1.06 MAF used by the SWP and 0.97 MAF used by the CVP. Under wet conditions, Delta exports can be limited by San Luis Reservoir capacity.

Water generally is diverted into San Luis Reservoir from late fall through early spring when irrigation water demands of CVP and SWP water users are low. By April or May, demands from CVP and SWP water users located south of the Delta usually exceed the pumping rate at the CVP Jones Pumping Plant and the SWP Banks Pumping Plant in the southern Delta, and the stored water is released.

SWP water is released from San Luis Reservoir by gravity into the San Luis Canal for continued conveyance to the Dos Amigos Pumping Plant, where it is lifted more than 100 feet to permit gravity flow to the end of the San Luis Canal at Kettleman City. The SWP California Aqueduct continues downstream of Kettleman City to convey SWP water to the southern San Joaquin Valley, central coast, and southern California. SWP water from the California Aqueduct can also flow through O`Neill Forebay directly into the San Luis Canal instead of being pumped into San Luis Reservoir, especially during irrigation season when water demands are high.

CVP water from San Luis Reservoir can be moved south through either the San Luis Canal or through the Delta-Mendota Canal, which ends at the Mendota Pool. The CVP San Luis Reservoir water can also be diverted at the Pacheco Pumping Plant to be conveyed through the Pacheco Conduit westward into Santa Clara and San Benito Counties.

5.2.2. Water Supply and Service Areas

The CVP and SWP supply water to multiple users throughout the state. The water supplied by Sites Reservoir would serve various Storage Partners, as described below, including those who are also members of the CVP and SWP. This section describes the types of water recipients of the CVP, SWP and Sites Reservoir.

5.2.2.1. CVP

Reclamation provides CVP water to several types of water users within the approved places and purposes of use of CVP water rights. Some CVP water supplies federal and state wildlife refuges that were identified in the Central Valley Project Improvement Act under Public Law 102-575, Title 34. The main recipients of CVP water are identified in Table 5-9.

Table 5-9. Types and Examples of CVP Water Recipients

Type	Examples
Water users who had water rights prior to construction of CVP facilities.	
Sacramento River settlement contractors	The largest Sacramento River settlement contractors include Anderson-Cottonwood Irrigation District, GCID, Natomas Central Mutual Water Company, Reclamation District 108, and Sutter Mutual Water Company
South-of-Delta exchange and settlement contractors	South-of-Delta exchange and settlement contractors divert water from the San Joaquin River, including Mendota Pool, with the largest contractor being Central California Irrigation District
CVP Contractors	
North of Delta	Contractors who receive water from Shasta Lake, the Sacramento River, the Trinity River, Black Butte Reservoir, CBD, Corning Canal, TC Canal, and American River municipal and industrial contracts.
Delta	Contra Costa Water District

South of Delta	Contractors who divert from the Delta-Mendota Canal, Mendota Pool, Cross Valley Canal, as well as the San Felipe Division, and the West San Joaquin Division, with Westlands Water District holding the largest contract. Friant Division and eastside water users are also south of the Delta, but they do not receive Delta exports.

Source: Bureau of Reclamation 2016
GCID = Glenn-Colusa Irrigation District

The CVP water districts served by the TC Canal include Kirkwood, Orland-Artois, Glide, Kanawha, Holthouse, 4-M, Glenn Valley, LaGrande, Davis, Westside, Myers-Marsh, Cortina, Colusa County, and Dunnigan Water Districts. GCID also periodically takes water from the TC Canal.

5.2.2.2. SWP

DWR provides several types of SWP water. The majority of SWP water is Table A water, which represents the maximum volume of water that is allocated and delivered for SWP water supply contracts. Other types of SWP water include Article 21, Article 56 (carryover), and turnback pool water. Article 21 water is offered to SWP contractors for short periods when there is excess water available for export that cannot be stored. Article 56 water is Table A water carried over to the next year. Turnback pool water is Table A water that exceeded a SWP contractor's needs and was sold to another SWP contractor. The volume of Article 21, Article 56, and turnback pool water available is small compared to Table A contract water (California Department of Water Resources 2020:17).

Average annual delivery of Table A water during 2009–2018 was estimated to be 1,871 thousand acre-feet per year (TAF/yr), about 45% of the maximum Table A contract amount of 4,173 TAF/yr (California Department of Water Resources 2020:16-17). Total estimated SWP deliveries during this time (i.e., including Article 21 water, Article 56 water, and turnback pool water) averaged 1,963 TAF/yr. There are large fluctuations in SWP deliveries, with the total volume ranging from 477 TAF/yr to 3,410 TAF/yr during 2009–2018.

DWR also delivers water to settlement agreement users in the Feather River Service Area (FRSA) that had senior water rights prior to construction of the SWP facilities on the Feather River. This water is not part of the Table A contracts.

SWP Table A includes contracts with water users in the Feather River Area (separate from the settlement agreement users), San Francisco Bay area, San Joaquin Valley, central coast, and southern California. The largest Table A contract volumes belong to Kern County Water Agency (983 TAF) and Metropolitan Water District of Southern California (1,912 TAF) (California Department of Water Resources 2020:17).

5.2.2.3. Storage Partners

Table 5-10 lists the Sites Reservoir Storage Partners as of the writing of this Final EIR/EIS. Most of the Storage Partners receive either CVP or SWP water. Storage Partners that receive CVP water are almost all located north of the Delta and receive water via the TC Canal or are Sacramento River settlement contractors. Storage Partners that receive SWP water are mostly located in southern California, but also include the City of American Canyon (which receives water via the North Bay Aqueduct), Zone 7 Water Agency (which receives water via the South Bay Aqueduct), and the Santa Clara Valley Water District (which receives SWP water via the South Bay Aqueduct and CVP water from San Luis Reservoir). Some Storage Partners receive water indirectly from the SWP. For example, Irvine Ranch Water District receives water from the Municipal Water District of Orange County, which purchases water from the Metropolitan Water District of Southern California (Irvine Ranch Water District 2021).

Table 5-10. Storage Partner Summary Table

Storage Partner	Location (relative to Delta, county)	CVP/SWP Contractor [a]	Service Area	Municipal and Industrial Provider?
City of American Canyon	North of the Delta, Napa County	SWP	30 square miles	Y
Antelope Valley-East Kern Water Agency	South of the Delta, Los Angeles, Kern, and Ventura Counties	SWP	2,400 square miles	Y
Carter Mutual Water Company	North of the Delta, Colusa County	CVP	3 square miles	Y
Coachella Valley Water District	South of the Delta, Riverside, Imperial, and San Diego Counties	SWP	1,000 square miles	Y
Colusa County	North of the Delta, Colusa County	CVP	Unknown	Y
Colusa County Water District	North of the Delta, Colusa County	CVP	72 square miles	Y
Cortina Water District	North of the Delta, Colusa County	CVP	1 square mile	N
Davis Water District	North of the Delta, Colusa County	CVP	3 square miles	Y
Desert Water Agency	South of the Delta, Riverside County	SWP	195 square miles	Y
Dunnigan Water District	North of the Delta, Yolo County	CVP	15.6 square miles	Y
Glenn-Colusa Irrigation District	North of the Delta, Glenn and Colusa Counties	CVP	273 square miles	N
Irvine Ranch Water District	South of the Delta, Orange County	Neither	181 square miles	Y
La Grande Water District	North of the Delta, Colusa County	CVP	2 square miles	Y
Metropolitan Water District of Southern California	South of the Delta, Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura Counties	SWP	5,200 square miles	Y
Reclamation District 108	North of the Delta, Yolo and Colusa Counties	CVP	75 square miles	N
Rosedale Rio Bravo	South of the Delta, Kern County	SWP [c]	69 square	N

Storage Partner	Location (relative to Delta, county)	CVP/SWP Contractor [a]	Service Area	Municipal and Industrial Provider?
Water Storage District			miles	
San Bernardino Valley Municipal Water District	South of the Delta, San Bernardino County	SWP	353 square miles	Y
San Gorgonio Pass Water Agency	South of the Delta, Riverside and San Bernardino Counties	SWP	225 square miles	Y
Santa Clara Valley Water District	South of the Delta, Santa Clara County	CVP and SWP	1,300 square miles	Y
Santa Clarita Valley Water District (formerly Castaic Lake)	South of the Delta, Los Angeles County	SWP	195 square miles	Y
Westside Water District	North of the Delta, Colusa County	CVP	24 square miles	Y
Wheeler Ridge-Maricopa Water Storage District	South of the Delta, Kern County	SWP [b]	230 square miles	N
Zone 7 Water Agency	West of the Delta, Alameda and Contra Costa Counties	SWP	~75 square miles	Y

CVP = Central Valley Project; SWP = State Water Project
Table Notes:
[a] California Department of Water Resources 2020:17 and Bureau of Reclamation 2016.
[b] Members of the Kern County Water Agency.

5.3 Hydrologic Modeling Methods

Descriptions of changes in reservoir storage, stream flow downstream of the reservoirs, diversions, and Delta flows are presented to provide a basis for understanding changes in system hydrology. Hydrologic effects specific to particular environmental resources (e.g., water quality, aquatic resources) are addressed in the chapters associated with each resource. For example, changes in surface water storage in the CVP and SWP reservoirs could affect recreational opportunities under the action alternatives as compared to the No Project Alternative. Changes in surface water storage are presented in this chapter as part of the description of surface water resources, but evaluation of model results as they specifically pertain to the recreation analysis are presented in Chapter 16, *Recreation Resources*. Specific changes related to other resources are likewise considered in their respective chapters. This chapter utilizes CALSIM II results to explain changes in system hydrology and to evaluate changes in water supply and flood risk.

CALSIM II is the primary model used to evaluate Project effects, with inputs including water demands, hydrology, facilities, water management, regulatory standards, and operational criteria assumptions. CALSIM simulates the operations of the SWP and CVP, resulting in output information including projected storage conditions, river flows, Delta inflows and outflows, and diversions including Delta exports. CALSIM II includes an 82-year modified historical hydrology (water years 1922–2003) developed jointly by DWR and Reclamation to account for hydrologic variability among water years.

CALSIM II represents the best available planning model for CVP and SWP system operations and has been used in previous system-wide evaluations of CVP and SWP operations (Bureau of Reclamation 2015). CALSIM uses hydrologic conditions for water years 1922–2003, but water operation protocols are based on current conditions. Appendix 5A1, *Model Assumptions*, contains a detailed description of the model assumptions used for all alternatives. These assumptions represent recent conditions for land use, regulations that affect water operations, water demands, and infrastructure. CALSIM is a monthly model because it would be difficult to develop all the daily inputs needed to simulate daily California water operations for 1922–2003. As described in Appendix 5A6, *Model Limitations and Improvements*, components of the model most relevant to Sites operation have been improved to better represent daily conditions. Accurate representation of daily variability in river flows and weir spills is necessary to evaluate Sites Reservoir diversion criteria. Through review and calibration to historical data, CALSIM representation of daily flows between Sacramento River at Red Bluff and Sacramento River at Freeport has been improved.

The results from CALSIM are intended to be compared and are not predictive or represent exact conditions under operational requirements. The CALSIM results from the Project simulations are compared to the results of the simulation for the No Project Alternative to determine the incremental effects of the Project. The results from a single simulation do not necessarily represent the exact operations for a specific month or year but reflect long-term trends. Use of the model in a comparative manner helps reduce the effects of possible model inaccuracies that may be associated with simplifying model procedures and assumptions such as the use of a monthly time step and operations that may not always match real-time operations.

The operational decisions modeled in CALSIM II (e.g., determining the flow needed to meet a salinity standard in the Delta) are on a monthly time step and in practice there are operational responses to changes that are on a sub-monthly timescale. Results for an individual parameter are either a monthly average or an end-of-month condition. As a monthly model, CALSIM does not fully capture real-time operational decisions that may deviate from standard operations due to extreme conditions such as drought or decisions that are affected by variations in flow within a month. During storm events, peak flows, weir spills, and diversions may vary considerably during a month, and such variations are not captured in the model. CALSIM was used in conjunction with the Upper Sacramento River Daily Operations Model (USRDOM) and associated tools to improve the accuracy of the CALSIM simulation of flows that depend on daily variations in flow and operational decisions.

USRDOM simulates daily flow and storage conditions in the Sacramento River from Shasta Lake to Knights Landing and CBD including the Project conveyance and storage features. USRDOM utilizes results from CALSIM II to evaluate the impacts of changing diversions, in-basin use and Delta operations under projected conditions. It couples the monthly operational decisions in CALSIM II to a simulation of the associated sub-monthly operational response at Shasta Lake depending on the inflows. USRDOM is particularly useful in verifying the CALSIM II simulated river conditions and the availability of excess flows to fill the Sites Reservoir under the capacity and operational constraints of the intakes at Red Bluff and Hamilton City.

CALSIM and USRDOM were used iteratively to develop a set of monthly CALSIM results that would be compatible with daily operations for Sites Reservoir diversions. Because USRDOM requires inputs on a daily timestep, the monthly inputs and outputs of the CALSIM II model are downscaled to a daily timestep for use in USRDOM.

CALSIM II output, as well as the ancillary USRDOM output, is also used by a variety of other assessment models as described throughout this document, and summarized in Appendix 1A, *Introduction to Appendices and Models*. With the information generated from these models, the water storage, deliveries, flows, water quality, geomorphology, and potential fish effects can be compared for the different alternatives.

CALSIM methods and results are described in detail in Appendix 5A, *Surface Water Resources Modeling of Alternatives*, and Appendix 5B, *Water Resources Modeling System*, along with its sub-appendices. Appendix 5C, *Upper Sacramento River Daily River Flow and Operations Model*, contains a description of the USRDOM model and summary of results.

5.4 Hydrologic Modeling Results

Many different hydrologic models were used to evaluate the potential environmental effects of the Project. This chapter focuses primarily on the results from the CALSIM II hydrologic model and CBD hydraulic modeling. Results from other models are described in the chapters where they are most pertinent. A full list of models and flow charts showing the interrelationships between the models are presented in Appendix 1A. This chapter provides modeling results for the operation of Alternative 1A and Alternative 1B, which are both considered under Alternative 1. These model results represent two different operation options under Alternative 1 as a result of the different participation for Reclamation.

5.4.1. CALSIM

5.4.1.1. Summary of General Changes in Hydrology

CALSIM results were used to estimate changes in hydrology that would be associated with the Project. These modeled changes in hydrology were used to inform the impact evaluation for multiple resources. The CALSIM results were also used to generate model input for other models specific to particular resources. This subsection describes the general hydrologic effects simulated by CALSIM.

Operation of Sites Reservoir would have direct effects on flow in the Sacramento River below the points of diversion (RBPP and GCID Main Canal upstream of Hamilton City) and below the points of Sites discharge (Sacramento River discharge for Alternative 2, CBD outlet for

Alternatives 1 and 3, and downstream end of Yolo Bypass for all three alternatives). These direct effects include diversion to and release from Sites Reservoir storage for use by Storage Partners.

Operation of Sites Reservoir also could affect storage in Shasta Lake, Lake Oroville, and Folsom Lake, and the flows below these reservoirs through the following mechanisms:

- **Shasta Lake and Lake Oroville Exchanges.** Exchanges could increase storage in these reservoirs in the spring and early summer for later use. Exchanges with Shasta Lake would support cold-water pool management, fall flow stability, and spring pulse flow actions. Sites Reservoir releases for south-of-Delta export would occur from July through November. However, in exchanges, Sites Reservoir water could be released outside of the July through November period (e.g., April through June). To initiate an exchange, Sites Reservoir water would be released to meet CVP or SWP obligations. Water would be retained in Shasta Lake or Lake Oroville for release later in the summer or fall for the benefit of Storage Partners. Any exchanged water remaining in CVP or SWP reservoirs would be subject to spill. Exchanges would be targeted to where they would be most beneficial.
- **CVP Operational Flexibility Water (Op Flex Water).** Reclamation’s storage in Sites Reservoir is assumed to be used for operational flexibility, or “Op Flex Water.” The volume of Op Flex Water would depend on the level of Reclamation participation in the Project (7% for Alternative 1B and 25% for Alternative 3). The primary objectives of Op Flex Water releases from Sites Reservoir are to improve CVP contractor water supply, water supply to wildlife refuges, anadromous fish populations, or Delta water quality. To meet some of these objectives, Op Flex Water would replace water that would have been released from Shasta or Folsom Lakes.
- **Operational Adjustments.** The addition of Sites Reservoir and potential alteration of storage in some reservoirs may result in additional small adjustments in the coordinated operation of CVP and SWP facilities to meet demands and water quality criteria.
- **Real-Time Exchanges with Storage Partners.** These in-lieu exchanges between Sites Reservoir releases and flow in the Sacramento River would occur when Sites Reservoir releases were used to meet local Storage Partner demands (Sacramento River Settlement Contractors, Reclamation, or, most likely, GCID) that normally would be met through diversions from the Sacramento River. The water that is not diverted would remain in the Sacramento River for use by downstream Storage Partners.

Tables 5-11 through 5-29 provide a summary of the changes in hydrology expected to occur as a result of Alternatives 1, 2, and 3 relative to the No Project Alternative as evaluated by CALSIM. These results were selected to show what may be expected under a range of hydrologic conditions by showing average storage and discharge for Critically Dry and Wet Water Years. Other metrics are used for individual resources to represent conditions specific to them (e.g., WSE for recreation). Results for other water year types are generally, but not always, intermediate between those for Critically Dry and Wet Water Years. Appendices 5B1 through 5B4 provide more detail on modeled results for other water year types.

Most of the summary tables presented below show storage or discharge for the No Project Alternative followed by the percent change or the difference associated with Alternative 1, 2, or 3. However, for those storage and discharge values associated with Sites Reservoir operations (Tables 5-17 through 5-20), the values shown for Alternatives 1, 2, and 3 are not presented in terms of percent change, but rather in terms of either flow or storage. These tables follow a general hydrologic, north to south order, starting with Shasta Lake, proceeding down the Sacramento River, adding Sites diversions and releases along the way, receiving flows from the Feather and American Rivers, and then flowing into and out of the Delta.

Due to exchanges (Alternatives 1, 2, and 3) and Op Flex Water (Alternative 1B and 3), the Project could allow storage in Shasta Lake to increase slightly, with more increases expected during Critically Dry Water Years than Wet Water Years (Table 5-11). Releases from Shasta Lake are not expected to be greatly affected by Alternatives 1, 2, and 3, but due to exchanges and Op Flex Water, some changes are expected during Critically Dry Water Years including decreases in spring reservoir releases (particularly during April through June), which allows for small increases in storage (particularly during June through September), and subsequent increases in reservoir releases (particularly August through October) (Table 5-12).

At Red Bluff, diversions at the RBPP under the No Project Alternative represent diversions for agriculture, and increases in diversions associated with the alternatives indicate diversions for storage in Sites Reservoir. Increases in diversions at the RBPP are expected to occur with Alternatives 1, 2, and 3 for diversions to Sites storage, particularly during January through March of Wet Water Years (Table 5-13). Diversions to storage are an example of where Critically Dry Water Years and Wet Water Years do not represent the full range of results because diversions are greatest during January through March of Above Normal Water Years (Appendix 5B). Downstream of Red Bluff, Sacramento River flows would be somewhat reduced due to the increase in winter and spring diversions to Sites storage. Changes in Shasta Lake releases also are apparent in the flows downstream of Red Bluff, including the increases in flow during August through October of Critically Dry Water Years (Table 5-14).

The diversion pattern at Hamilton City for storage in Sites Reservoir and flow effects downstream of Hamilton City near Wilkins Slough (Tables 5-15 and 5-16) are similar to what occurs due to the RBPP diversions, except the winter diversions at Hamilton City would be smaller than at RBPP. In addition, downstream of Hamilton City there would be substantial increases in flow relative to the No Project Alternative during July through October of Critically Dry Water Years. These are due to Sites water being used in-lieu of diversions into GCID Main Canal, as well as increased releases from Shasta Lake.

For Alternatives 1, 2, and 3, average storage levels in Sites Reservoir are expected to be greater than 1 MAF during wet conditions but drop below 235 TAF during the fall of Critically Dry Water Years (Table 5-17). Most releases from Sites Reservoir would be made during dry conditions (e.g., results for Critically Dry Water Years are shown in Table 5-18). Sites releases provide another example where Critically Dry and Wet Water Years do not represent the full range of results; under Alternatives 1, 2, and 3, depleted reservoir storage would cause Sites Reservoir releases to be lower on average during Critically Dry Water Years than Dry Water Years. This depletion is greatest for Alternative 3 because there is a tendency for reservoir storage to be used more actively, resulting in lower storage during some Critically Dry Water Years. Under Alternative 3 (and to a lesser degree under Alternative 1B), CVP Op Flex Water results in increased releases during Above Normal and Below Normal Water Years compared to the other alternatives. More detailed results for all water year types are in Appendix 5B.

Sites Reservoir releases to the Sacramento River (either through CBD via the Dunnigan Pipeline or directly from the Dunnigan Pipeline) are expected to be greatest during dry conditions, with average releases of approximately 350–580 cfs during June through August of Critically Dry Water Years (Table 5-19), with releases reaching a maximum of 1,000 cfs during some months (Chapter 2). Releases to the Sacramento River would be somewhat higher during Dry Water Years than Critically Dry Water Years due to greater storage in Sites Reservoir, with average releases of approximately 560–830 cfs during June through August (Table 5-19), and releases persisting at higher levels through November relative to Critically Dry Water Years.

Sites Reservoir releases to Yolo Bypass would be greater during Wet Water Years than during Critically Dry Water Years (Table 5-20), with releases reaching 380–446 cfs during August and September of Wet Water Years. Percent change in total Yolo Bypass flows is expected to be large during August through October because, during this time, Sites would be releasing habitat water to the Yolo Bypass, and existing Yolo Bypass flows are generally low during these months (Table 5-21). Small percent reductions in Yolo Bypass flows are expected during the rainy season as a result of the diversions to Sites Reservoir storage (Table 5-21).

Changes to storage in Lake Oroville are expected to be minimal, with small increases in storage in the summer and fall of Critically Dry Water Years associated with Sites Reservoir exchanges (Table 5-22). The exchanges may enable reduction in SWP releases from Lake Oroville in June and July, thereby allowing water to be retained longer in Lake Oroville and resulting in more water released during the late summer and fall as can be seen in the CALSIM results for Critically Dry Water Years (Table 5-23).

Effects on the American River are expected to be small, although some increases and decreases in Folsom Lake storage and American River flows may occur during Critically Dry Water Years (Tables 5-24 and 5-25). Some of the larger changes in the American River are likely modeling artifacts that are not expected to occur during real-time operations.

The main effect of Alternatives 1, 2, and 3 on flow near the downstream end of the Sacramento River at Freeport is an increase in flow of 6%–16% during July through October in Critically Dry Water Years (Table 5-26), with small percent reductions in flow (0%–2%) during wetter months (November–April).

In the Delta, the effects of diversions to Sites storage, Sites releases to the Sacramento River, Sites releases to the Yolo Bypass, and small operational changes for Shasta Lake, Lake Oroville, and Folsom Lake would combine to produce small percentage reductions in Delta outflow during the wetter months but would allow increases in Delta outflow during drier months, particularly during Critically Dry Water Years and during August and September (Table 5-27). The increases in Delta outflow would be due to the Yolo Bypass habitat flows and increases in carriage water.

The Project would allow substantial increases in exports during the summer and early fall of Critically Dry Water Years (Table 5-28). These greater exports could result in more storage in San Luis Reservoir, the main receiving reservoir for Delta exports (Table 5-29), although these exports would eventually be released from San Luis Reservoir for water supply purposes.

Table 5-11. Simulated Shasta Lake Storage: No Project Alternative (TAF) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	1,779	1,743	1,893	2,592	2,769	2,989	3,061	2,884	2,552	2,192	1,943	1,896
Alt 1A	1	2	2	2	1	1	2	2	3	4	3	2
Alt 1B	2	2	2	2	2	1	2	2	4	5	4	3
Alt 2	1	2	2	2	1	1	1	2	3	4	3	2
Alt 3	6	6	6	4	4	3	3	4	6	8	7	7
Average for Wet Water Years												
NPA	3,178	3,161	3,242	3,457	3,583	3,854	4,349	4,489	4,377	3,944	3,567	3,294
Alt 1A	0	0	0	0	1	0	0	0	0	0	0	0
Alt 1B	0	0	0	0	0	0	0	0	0	0	0	0
Alt 2	0	0	0	0	1	0	0	0	0	0	0	0
Alt 3	0	0	0	0	0	0	0	0	0	0	0	0

Alt = Alternative, NPA = No Project Alternative, TAF = thousand acre-feet
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-12. Simulated Sacramento River Flow at Bend Bridge: No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	6,020	6,137	6,291	6,027	6,411	6,189	5,587	8,813	10,137	10,284	8,160	4,860
Alt 1A	3	-1	-1	-1	1	0	-5	-2	-4	0	6	7
Alt 1B	3	-1	-1	0	2	3	-5	-3	-5	-1	5	7
Alt 2	3	-1	-1	0	2	0	-2	-3	-4	0	6	7
Alt 3	5	-1	1	0	1	4	-2	-6	-5	-2	5	5
Average for Wet Water Years												
NPA	8,647	9,518	13,102	28,285	31,759	24,312	14,434	12,772	10,789	13,481	11,634	10,954
Alt 1A	0	0	0	0	-1	1	0	0	0	0	0	0
Alt 1B	0	0	0	0	-1	1	0	1	0	0	0	-1
Alt 2	0	0	0	0	-1	1	0	0	0	0	0	0
Alt 3	0	0	0	1	-1	1	0	1	0	0	0	-1

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-13. Simulated Sacramento River Diversion at Red Bluff: No Project Alternative (cfs) and Change in cfs between No Project and Alternatives 1, 2, and 3 (cfs, Not Percent Change)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	67	17	0	0	7	26	60	90	127	144	113	44
Alt 1A	-9	0	0	177	242	206	1	1	2	2	2	10
Alt 1B	-2	0	0	177	248	206	3	-26	-8	-13	4	11
Alt 2	-2	0	0	177	247	206	1	1	2	2	2	10
Alt 3	-4	0	0	177	241	207	-2	-22	1	-3	2	17
Average for Wet Water Years												
NPA	153	14	0	0	0	20	193	666	1,105	1,277	1,010	250
Alt 1A	-15	241	432	863	892	559	303	123	0	-1	-17	7
Alt 1B	-15	274	418	1,043	867	595	302	123	0	-7	-17	4
Alt 2	-15	238	424	854	775	433	303	123	0	-1	-17	7
Alt 3	-14	275	377	1,059	1,178	734	349	124	1	-6	-16	5

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-14. Simulated Flow in Sacramento River below Red Bluff Pumping Plant: No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	5,959	6,146	6,401	6,114	6,501	6,236	5,565	8,734	10,013	10,140	8,047	4,817
Alt 1A	3	-1	-1	-3	-2	-4	-5	-2	-4	0	6	7
Alt 1B	3	-1	-1	-3	-2	0	-5	-3	-5	-1	6	7
Alt 2	3	-1	-1	-3	-2	-3	-2	-3	-4	0	6	6
Alt 3	5	-1	1	-3	-2	0	-2	-5	-6	-2	5	5
Average for Wet Water Years												
NPA	8,503	9,567	13,296	28,911	32,286	24,605	14,443	12,152	9,697	12,206	10,624	10,705
Alt 1A	0	-3	-3	-3	-4	-1	-2	-1	0	0	0	0
Alt 1B	0	-3	-3	-4	-3	-1	-2	0	0	0	0	-1
Alt 2	0	-3	-3	-3	-3	0	-2	-1	0	0	0	0
Alt 3	0	-3	-3	-3	-4	-2	-3	0	0	0	0	-1

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-15. Simulated Hamilton City Diversion: No Project Alternative (cfs) and Change in cfs between No Project and Alternatives 1, 2, and 3 (cfs, Not Percent Change)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	484	615	163	89	64	62	512	2,133	2,412	2,295	1,801	528
Alt 1A	-15	-8	2	44	2	32	-2	-18	-313	-451	-398	-102
Alt 1B	-18	-3	1	45	2	32	-2	-34	-367	-474	-397	-75
Alt 2	-18	-10	1	44	2	32	-2	-18	-313	-447	-309	-83
Alt 3	-16	-5	-1	43	2	32	-24	-204	-329	-523	-155	-40
Average for Wet Water Years												
NPA	575	696	225	78	64	22	400	2,121	2,247	2,590	2,189	621
Alt 1A	44	-8	-2	335	406	200	372	111	9	-11	1	33
Alt 1B	45	12	41	373	440	231	372	104	5	-8	-6	92
Alt 2	44	-8	-4	318	305	184	371	109	8	-11	1	33
Alt 3	45	12	37	442	600	312	441	101	5	-8	-6	92

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-16. Simulated Sacramento River Flow downstream of Hamilton City near Wilkins Slough: No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	5,065	5,218	7,800	7,769	8,347	8,323	5,741	4,460	4,918	5,011	4,445	4,051
Alt 1A	4	-1	-1	-3	-1	-3	-5	-4	-1	9	20	10
Alt 1B	4	-1	0	-3	-1	-1	-5	-4	-2	8	18	9
Alt 2	4	-1	-1	-3	-1	-3	-2	-6	-1	8	17	9
Alt 3	6	-1	1	-3	-1	0	-2	-6	-4	6	13	6
Average for Wet Water Years												
NPA	7,880	9,114	12,874	21,395	22,104	19,956	16,386	10,690	6,777	7,060	6,134	10,255
Alt 1A	-1	-2	-1	-1	-1	-1	-2	-2	0	0	0	0
Alt 1B	0	-3	-1	-2	0	-2	-2	0	0	0	-1	-2
Alt 2	-1	-2	-1	-1	-1	-1	-2	-2	0	0	0	0
Alt 3	0	-3	-1	-2	-1	-1	-3	0	0	0	-1	-2

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative

Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-17. Simulated Sites Reservoir Storage for All Alternatives (TAF)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	213	205	204	515	529	541	508	470	405	336	275	234
Alt 1B	183	175	175	473	488	499	471	433	366	295	235	198
Alt 2	162	154	152	438	453	465	438	403	341	273	215	179
Alt 3	139	133	132	385	400	412	384	338	278	208	167	153
Average for Wet Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	1,321	1,336	1,365	1,272	1,346	1,392	1,427	1,434	1,425	1,412	1,378	1,345
Alt 1B	1,299	1,318	1,348	1,246	1,319	1,369	1,405	1,412	1,403	1,388	1,351	1,322
Alt 2	1,119	1,134	1,162	1,090	1,151	1,189	1,224	1,231	1,223	1,211	1,177	1,144
Alt 3	1,270	1,289	1,316	1,166	1,266	1,329	1,371	1,378	1,369	1,354	1,318	1,289

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative; TAF = thousand acre-feet
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-18. Simulated Sites Reservoir Release for All Alternatives (cfs)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	318	129	27	0	1	41	515	550	1,013	1,052	923	647
Alt 1B	229	117	24	0	1	41	430	566	1,054	1,081	917	573
Alt 2	257	133	44	0	0	27	419	521	960	1,042	885	558
Alt 3	211	106	26	0	0	27	437	701	942	1,079	619	193
Average for Dry Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	949	576	33	0	0	9	87	113	841	1,330	1,456	1,037
Alt 1B	938	466	33	0	0	9	269	492	953	1,307	1,352	1,035
Alt 2	918	515	42	0	0	9	87	112	817	1,307	1,443	989
Alt 3	779	292	30	0	0	9	232	795	1,447	1,496	1,267	903
Average of All Water Year Types												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	520	211	23	0	0	10	107	115	377	576	794	658

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1B	488	195	22	0	0	10	138	253	566	606	736	606
Alt 2	519	198	28	0	0	7	92	110	363	576	800	654
Alt 3	417	157	20	0	0	7	138	348	796	937	841	536
Average for Wet Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	373	0	0	1	0	1	10	8	30	48	425	476
Alt 1B	337	0	0	0	0	1	10	8	30	87	451	482
Alt 2	381	0	0	1	0	1	10	8	30	48	425	494
Alt 3	289	0	0	1	0	1	10	7	29	86	450	466

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-19. Simulated Sites Reservoir Release to Sacramento River (Release to Dunnigan Pipeline minus Release to Yolo Bypass) for All Alternatives (cfs)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	227	106	20	0	0	0	337	334	577	539	452	487
Alt 1B	181	102	20	0	0	0	271	330	577	548	451	445
Alt 2	212	109	35	0	0	0	262	332	565	535	357	367
Alt 3	167	91	19	0	0	0	256	332	524	530	390	128
Average for Dry Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	752	472	28	0	0	0	2	0	662	826	649	752
Alt 1B	749	396	29	0	0	0	114	61	654	817	655	735
Alt 2	692	428	34	0	0	0	2	0	642	809	658	696
Alt 3	605	253	25	0	0	0	81	225	619	794	567	630
Average of All Water Year Types												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	267	170	18	0	0	0	50	49	248	355	278	314
Alt 1B	259	164	17	0	0	0	65	62	299	334	257	285
Alt 2	252	160	21	0	0	0	39	49	241	357	269	286
Alt 3	216	134	15	0	0	0	63	98	295	345	247	212
Average for Wet Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	0	0	0	0	0	0	0	0	0	2	0	32
Alt 1B	0	0	0	0	0	0	0	0	0	41	20	59
Alt 2	0	0	0	0	0	0	0	0	0	2	0	32
Alt 3	0	0	0	0	0	0	0	0	0	41	20	59

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-20. Simulated Sites Reservoir Release to Yolo Bypass for All Alternatives (cfs)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	38	0	0	0	0	0	0	0	0	0	48	14
Alt 1B	0	0	0	0	0	0	0	0	0	0	49	12
Alt 2	0	0	0	0	0	0	0	0	0	0	182	63
Alt 3	0	0	0	0	0	0	0	0	0	0	41	0
Average for Wet Water Years												
NPA	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1A	371	0	0	0	0	0	0	0	0	0	380	428
Alt 1B	335	0	0	0	0	0	0	0	0	0	380	408
Alt 2	380	0	0	0	0	0	0	0	0	0	380	446
Alt 3	288	0	0	0	0	0	0	0	0	0	380	392

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-21. Simulated Total Yolo Bypass Flow: No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	41	22	349	387	600	343	107	68	64	48	54	69
Alt 1A	79	1	-1	-5	-6	-3	0	0	0	0	77	18
Alt 1B	0	0	-1	-5	-6	-3	0	0	0	0	79	15
Alt 2	1	1	-1	-5	-6	-3	0	0	0	0	291	71
Alt 3	0	0	-1	-5	-6	-3	0	0	0	0	66	0
Average for Wet Water Years												
NPA	86	595	5,269	28,589	35,823	21,201	6,960	642	169	48	143	80
Alt 1A	361	-5	-3	-3	-3	-1	-3	-11	0	0	230	416
Alt 1B	325	-8	-4	-3	-3	-1	-3	-11	0	0	230	400
Alt 2	370	-5	-4	-3	-3	0	-3	-11	0	0	230	436
Alt 3	277	-7	-3	-3	-4	-1	-4	-11	0	0	230	386

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-22. Simulated Lake Oroville Storage: No Project Alternative (TAF) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	872	862	918	1,443	1,549	1,689	1,712	1,666	1,421	1,138	977	930
Alt 1A	2	1	1	0	0	0	0	0	2	3	2	2
Alt 1B	2	1	1	0	0	0	0	0	2	3	2	2
Alt 2	1	1	1	0	0	0	0	0	2	3	2	2
Alt 3	1	1	1	0	0	0	0	0	2	2	1	1
Average for Wet Water Years												
NPA	2,473	2,439	2,452	2,617	2,854	2,945	3,305	3,508	3,488	3,192	2,965	2,639
Alt 1A	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1B	0	-1	0	0	0	0	0	0	0	0	0	0
Alt 2	0	0	0	0	0	0	0	0	0	0	0	0
Alt 3	0	0	0	0	0	0	0	0	0	0	0	0

Alt = Alternative, NPA = No Project Alternative, TAF = thousand acre-feet
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-23. Simulated Feather River Flow at Mouth: No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	1,418	1,290	1,786	3,145	2,912	2,777	3,018	2,467	3,855	3,396	2,265	1,835
Alt 1A	6	7	0	0	0	0	0	0	-12	-3	10	1
Alt 1B	3	7	0	0	0	0	0	-1	-12	-3	9	2
Alt 2	4	7	0	0	0	0	0	0	-12	-2	10	1
Alt 3	-3	7	0	0	0	0	0	-1	-10	-1	12	2
Average for Wet Water Years												
NPA	4,071	3,641	8,056	22,041	25,901	24,098	16,346	14,468	10,472	7,361	5,694	8,240
Alt 1A	0	0	-1	0	0	0	0	0	0	0	0	1
Alt 1B	0	0	-1	0	0	0	0	0	0	0	1	2
Alt 2	0	0	-1	0	0	0	0	0	0	0	0	1
Alt 3	0	0	-1	0	0	0	0	0	0	0	1	2

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative

Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-24. Simulated Folsom Lake Storage: No Project Alternative (TAF) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	306	324	402	425	433	484	505	521	494	425	354	325
Alt 1A	3	2	2	0	-1	-1	0	0	0	0	3	3
Alt 1B	3	1	1	1	-1	-1	-1	0	0	0	2	3
Alt 2	4	3	2	0	-1	-1	1	1	1	1	4	4
Alt 3	2	0	0	-2	-3	-2	0	-1	-1	-1	2	2
Average for Wet Water Years												
NPA	649	544	539	567	567	751	897	966	951	864	745	693
Alt 1A	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1B	0	0	0	0	0	0	0	0	0	0	0	-1
Alt 2	0	0	0	0	0	0	0	0	0	0	0	0
Alt 3	0	0	-1	0	0	0	0	0	0	0	0	0

Alt = Alternative, NPA = No Project Alternative, TAF = thousand acre-feet
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-25. Simulated American River Flow at H Street: No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	674	596	521	943	1,039	882	1,089	879	835	970	1,130	681
Alt 1A	0	9	1	0	10	-2	0	-7	0	4	-14	0
Alt 1B	0	10	1	-1	9	1	4	-8	1	1	-13	0
Alt 2	1	11	1	0	10	-5	-10	3	0	1	-13	0
Alt 3	0	13	0	-1	7	-1	-12	2	4	1	-17	0
Average for Wet Water Years												
NPA	1,501	4,076	3,897	8,708	9,142	5,534	5,236	6,775	4,691	2,947	2,693	1,802
Alt 1A	0	0	0	0	0	0	0	0	0	0	0	0
Alt 1B	0	-1	0	0	0	0	0	0	0	-1	0	2
Alt 2	0	0	0	0	0	0	0	0	0	0	0	0
Alt 3	-1	0	0	0	0	0	0	0	0	0	0	1

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-26. Simulated Sacramento River Flow at Freeport: No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	7,376	7,740	12,374	13,524	16,675	13,611	11,501	8,743	10,621	10,249	8,751	7,051
Alt 1A	7	3	0	-2	0	-2	0	1	0	9	16	13
Alt 1B	6	3	0	-2	0	0	0	1	0	9	15	12
Alt 2	7	3	0	-2	0	-2	0	1	0	9	14	11
Alt 3	6	3	1	-1	0	0	0	1	0	8	12	6
Average for Wet Water Years												
NPA	14,038	18,156	25,908	48,604	56,569	49,188	40,251	33,461	23,936	19,381	16,536	21,337
Alt 1A	0	-1	-1	-1	-1	-1	-1	0	0	0	0	0
Alt 1B	0	-2	-1	-1	-1	-1	-1	0	0	0	0	1
Alt 2	0	-1	-1	-1	-1	0	-1	0	0	0	0	1
Alt 3	0	-1	-1	-1	-1	-1	-1	0	0	0	0	0

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative
Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-27. Simulated Delta Outflow: No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	4,514	3,749	8,423	10,372	13,481	11,136	9,525	5,686	5,397	4,020	3,536	3,000
Alt 1A	-3	2	-1	-3	0	-3	0	1	0	2	5	6
Alt 1B	-3	2	-1	-3	0	-3	0	1	0	3	5	6
Alt 2	-3	1	-1	-3	0	-3	0	1	0	2	8	7
Alt 3	-3	2	-1	-2	-1	-3	0	1	0	2	3	3
Average for Wet Water Years												
NPA	8,744	11,731	26,384	84,727	100,499	79,534	54,518	38,005	23,349	11,768	7,348	13,004
Alt 1A	2	-2	-2	-1	-2	0	-1	-1	0	0	5	3
Alt 1B	2	-3	-2	-2	-1	-1	-1	0	0	0	5	3
Alt 2	2	-2	-2	-1	-1	0	-1	-1	0	0	5	3
Alt 3	0	-3	-2	-2	-2	-1	-1	0	0	0	5	3

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative

Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-28. Simulated Delta Exports (Banks and Jones): No Project Alternative (cfs) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	3,501	4,731	5,720	5,604	6,048	3,742	1,725	2,243	2,138	2,486	3,258	3,740
Alt 1A	19	3	2	1	0	1	0	0	0	34	37	19
Alt 1B	17	3	2	1	0	7	-1	0	-1	30	36	18
Alt 2	17	3	1	1	0	2	0	0	0	32	33	16
Alt 3	15	2	3	0	0	8	0	0	-3	27	28	9
Average for Wet Water Years												
NPA	7,862	11,150	10,444	8,526	9,658	8,323	6,773	6,643	7,809	10,640	9,701	10,105
Alt 1A	2	0	0	0	0	-1	0	0	0	0	0	0
Alt 1B	2	0	0	0	0	-1	-1	0	0	0	0	0
Alt 2	1	0	0	0	0	-1	0	0	0	0	0	0
Alt 3	2	0	0	0	0	-1	-2	0	0	0	0	0

Alt = Alternative, cfs = cubic feet per second, NPA = No Project Alternative

Positive value for change indicates that the value for the alternative is greater than the NPA value.

Table 5-29. Simulated San Luis Reservoir Storage: No Project Alternative (TAF) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Average for Critically Dry Water Years												
NPA	362	533	765	1,119	1,321	1,404	1,320	1,188	912	596	397	346
Alt 1A	4	2	2	-1	0	0	0	0	0	0	1	0
Alt 1B	4	2	2	0	0	2	2	2	1	1	2	1
Alt 2	2	1	1	0	0	0	0	0	0	0	0	-1
Alt 3	3	2	2	3	3	3	3	3	2	2	1	1
Average for Wet Water Years												
NPA	774	1,052	1,389	1,407	1,629	1,788	1,787	1,636	1,289	974	720	742
Alt 1A	1	1	1	1	1	0	0	0	0	0	0	0
Alt 1B	1	1	1	1	1	0	0	0	0	0	1	0
Alt 2	1	1	1	1	1	0	0	0	0	0	0	0
Alt 3	2	1	1	2	2	1	1	0	0	0	0	0

Alt = Alternative, NPA = No Project Alternative, TAF = thousand acre-feet

Positive value for change indicates that the value for the alternative is greater than the NPA value.

5.4.1.2. Summary of Water Supply Delivery Results

CALSIM results were used to estimate Sites water deliveries to Storage Partners, as well as regular system deliveries to CVP and SWP contractors. Summaries of these water supply deliveries are provided in Tables 5-30 and 5-31. Results are shown for the average deliveries (in TAF/year) of all years in the 82-year simulation period as well as the average for all Dry and Critically Dry Water Years (Table 5-30). These metrics are informative for understanding overall average water supply as well as water supply during drier conditions when additional water supply is most beneficial. Water transfers between Storage Partners are added to the deliveries received by the recipient, not the seller.

Overall total Sites deliveries are estimated to average between about 160 TAF/yr and 170 TAF/yr, with Dry and Critically Dry Water Year averages ranging between about 300 TAF/yr and 310 TAF/yr, depending on alternative.

Table 5-30 shows how reservoir size and CVP participation would affect deliveries. To evaluate the effect of reservoir size on water supplies, Alternative 1A (reservoir capacity of 1.5 MAF) can be compared to Alternative 2 (reservoir capacity of 1.3 MAF). Neither of these alternatives includes CVP participation. Total Sites deliveries are more affected by reservoir size during Dry and Critically Dry Water Years. The 1.5-MAF reservoir provides total Sites deliveries that are about 25 TAF/yr greater than the 1.3-MAF reservoir (312 TAF versus 299 TAF/yr).

The effects of CVP participation in the Project can be seen by comparing Alternative 1A (no participation) to Alternative 1B (some CVP participation) and Alternative 3 (more CVP participation). (Note that small incidental changes in CVP deliveries are combined with the Op Flex values, so values presented for Alternatives 1A and 2 are not quite equal to zero). Under Alternative 3, increases in CVP deliveries from Sites storage (CVP Op Flex) would cause some reduction in other Sites deliveries, primarily due to greater reservoir storage allocated to CVP purposes. CVP participation is also associated with a small reduction in total Sites deliveries, with greater reduction associated with greater CVP participation (Alternative 3). On average, CVP operational flexibility would result in more active use of Sites Reservoir, particularly due to increased releases during Above Normal and Below Normal Water Years (Appendix 5B and Table 5-18), which sometimes would decrease storage and water supply during Critically Dry Water Years, but on average would increase yield (releases) from the Sites Reservoir. This increased yield would help contribute toward environmental objectives (e.g., storage in Shasta Lake) and is not apparent in Table 5-30, which focuses on deliveries.

Table 5-30. Simulated Sites Water Supply Deliveries

Deliveries (TAF/year) (change from No Project Alternative conditions)	**Alternative 1A**		**Alternative 1B**		**Alternative 2**		**Alternative 3**	
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD)		**1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD)**		**1.3 MAF Reservoir Dunnigan Pipeline (outlet to Sacramento River)**		**1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD)**	
	All	**Mean of Dry and Critically Dry Water Years**	**All**	**Mean of Dry and Critically Dry Water Years**	**All**	**Mean of Dry and Critically Dry Water Years**	**All**	**Mean of Dry and Critically Dry Water Years**
Total Sites Deliveries to Storage Partners	114	268	109	254	107	250	90	205
North of Delta	24	47	23	44	23	43	21	37
South of Delta	89	221	85	210	84	206	70	168
CVP Operational Flexibility	1	2	7	14	1	2	22	60
Sub-Total Supplemental Deliveries for Water Supply	115	270	116	269	108	251	112	266
Refuge Water Supply	19	32	18	29	19	33	16	28
North of Delta	4	5	4	5	4	5	4	5
South of Delta	14	26	14	24	15	28	12	23
Yolo Bypass Habitat Water Supply	36	10	34	9	40	14	32	10
Total Sites Deliveries	169	312	168	307	167	299	161	303
% of Total Sites Deliveries								
Deliveries to Storage Partners - North of Delta	14%	15%	14%	14%	14%	15%	13%	12%
Deliveries to Storage Partners - South of Delta	53%	71%	51%	68%	50%	69%	43%	55%
CVP Deliveries - Operational Flexibility (Op Flex)	0%	1%	4%	5%	1%	1%	14%	20%
Refuge Water Supply	11%	10%	11%	10%	12%	11%	10%	9%
Yolo Bypass Habitat Water Supply	21%	3%	20%	3%	24%	5%	20%	3%

Deliveries (TAF/year) (change from No Project Alternative conditions)	Alternative 1A		Alternative 1B		Alternative 2		Alternative 3	
	1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD)		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD)		1.3 MAF Reservoir Dunnigan Pipeline (outlet to Sacramento River)		1.5 MAF Reservoir Dunnigan Pipeline (outlet to CBD)	
	All	**Mean of Dry and Critically Dry Water Years**	**All**	**Mean of Dry and Critically Dry Water Years**	**All**	**Mean of Dry and Critically Dry Water Years**	**All**	**Mean of Dry and Critically Dry Water Years**
Consideration of Incidental Change to CVP and SWP Deliveries								
Incidental Change to SWP Deliveries	5	4	0	0	4	4	-4	12
Total Authority, CVP Op Flex, and Incidental Changes in SWP Deliveries	174	315	168	307	171	303	157	315

Notes: CBD = Colusa Basin Drain, CVP = Central Valley Project, MAF = million acre-feet, SWP = State Water Project, TAF = thousand acre-feet

Table 5-31 provides more information about the incidental changes to CVP and SWP deliveries. The values under the No Project Alternative are provided to put the incidental changes in context; the changes are broken down by north of Delta versus south of Delta and SWP versus CVP. The CVP values include increases due to CVP Op Flex Water. These SWP and CVP deliveries are further subdivided into hydrologic regions and different types of CVP and SWP uses (e.g., settlement/exchange contractors, refuges, municipal, agricultural, FRSA) in Appendix 5B. All decreases in water supply would be negligible relative to total deliveries and in consideration of model limitations. On average, total CVP and SWP deliveries would remain basically unchanged or increase with Alternatives 1, 2, and 3, with greater increases expected in association with CVP participation, particularly with Alternative 3.

Table 5-31. Simulated CVP and SWP Water Supply Deliveries: No Project Alternative (TAF) and Alternatives 1, 2, and 3 Minus No Project (TAF)

Alternative	North of Delta Total SWP	North of Delta Total CVP	South of Delta Total SWP	South of Delta Total CVP
Average of Dry and Critically Dry Water Years				
NPA	82	515	1,405	708
Alternative 1A	0	3	4	2
Alternative 1B	0	4	1	13
Alternative 2	0	3	4	1
Alternative 3	0	10	12	52
Average of All Water Year Types				
NPA	100	626	2,431	1304
Alternative 1A	0	0	5	3
Alternative 1B	0	0	1	9
Alternative 2	0	0	4	3
Alternative 3	0	3	-4	21

CVP = Central Valley Project; NPA = No Project Alternative; SWP = State Water Project; TAF = thousand acre-feet
Note: There are small differences in the calculation of CVP and SWP deliveries between the reports used to generate this table and Table 5-30. This table provides breakdown of CVP and SWP deliveries, but the calculated total changes in deliveries in Table 5-30 are slightly more accurate.

5.4.1.3. CALSIM Flood Metrics Comparison

Table 5-32 compares the CALSIM II modeled flood flows for the No Project Alternative and Alternatives 1, 2, and 3 at key diversion and return locations across the affected area. The flood metrics are maximum monthly average and monthly average exceeded 10% of the time. Daily flows and peak flows were not modeled in CALSIM II. The design capacity for each Sacramento River reach is listed so that the reader may compare increases in monthly flood flows to the flood capacity of the reach. Months shown in the table are those with the highest flow for each parameter, regardless of whether the highest flow is for the No Project Alternative or Alternatives 1, 2, and 3.

Table 5-32. CALSIM II Modeled Flood Flows

CALSIM II Model Station Sacramento River Flow at Bend Bridge	Location Relative to Project Elements Between Shasta Lake Outflow and First Diversion to Sites (Red Bluff)	Capacity (cfs)	Flood Flows Metric	Month	CALSIM II Modeled Flows (cfs)					Difference from NPA (cfs)			
					NPA	Alt 1A	Alt 1B	Alt 2	Alt 3	Alt 1A	Alt 1B	Alt 2	Alt 3
Sacramento River Flow at Bend Bridge	Between Shasta Lake outflow and first diversion to Sites (Red Bluff)	98,000 (approx.)	Max Monthly Ave	Feb	84,431	84,432	84,432	84,432	84,433	1	1	1	2
			Monthly Ave Flow Exceeded 10% of the Time	Feb	43,639	43,639	43,955	43,639	44,228	0	316	0	590
Red Bluff Diversion	First diversion to Sites (serving TC Canal)	2,530	Max Monthly Ave	Apr	717	2,250	2,250	2,250	2,250	1,533	1,533	1,533	1,533
			Monthly Ave Flow Exceeded 10% of the Time	Feb	0	2,121	2,121	2,121	2,121	2,121	2,121	2,121	2,121
Sacramento River Flow below Red Bluff Diversion Dam	Between first diversion to Sites (Red Bluff) and second diversion to Sites (GCID Main Canal)	260,000	Max Monthly Ave	Feb	85,876	85,127	85,877	85,151	84,013	-749	1	-725	-1,863
			Monthly Ave Flow Exceeded 10% of the Time	Feb	44,180	42,935	42,935	42,935	43,931	-1,246	-1,246	-1,246	-250
Hamilton City Diversion	Second diversion to Sites (GCID Main Canal)	3,000	Max Monthly Ave	May	2,397	3,000	3,000	3,000	3,000	603	603	603	603
			Monthly Ave Flow Exceeded 10% of the Time	Jun	2,710	2,677	2,677	2,677	2,617	-33	-33	-33	-94
Sacramento River near Wilkins Slough	Between second diversion to Sites (GCID Main Canal) and Sites return (CBD)	30,000	Max Monthly Ave	Feb	27,776	27,751	27,776	27,751	27,782	-26	0	-26	6
			Monthly Ave Flow Exceeded 10% of the Time	Feb	26,657	26,630	26,618	26,632	26,620	-27	-39	-25	-37

CALSIM II Model Station Sacramento River Flow at Bend Bridge	Location Relative to Project Elements Between Shasta Lake Outflow and First Diversion to Sites (Red Bluff)	Capacity (cfs)	Flood Flows Metric	CALSIM II Modeled Flows (cfs)						Difference from NPA (cfs)			
				Month	NPA	Alt 1A	Alt 1B	Alt 2	Alt 3	Alt 1A	Alt 1B	Alt 2	Alt 3
Colusa Basin Drain above Dunnigan Pipeline	Between Sites return (TC Canal) and CBD return to Sacramento River	2,100	Max Monthly Ave	Jan	2,838	2,849	2,849	2,849	2,849	10	10	10	10
			Monthly Ave Flow Exceeded 10% of the Time	Apr	1,742	1,747	1,747	1,747	1,747	4	4	4	4
Sacramento River below Colusa Basin Drain	Between CBD return and Yolo Bypass	30,000	Max Monthly Ave	Feb	27,811	27,786	27,811	27,786	27,817	-26	0	-26	6
			Monthly Ave Flow Exceeded 10% of the Time	Feb	26,691	26,664	26,653	26,666	26,655	-27	-38	-25	-36
Flow through Yolo Bypass	Below Fremont Weir	343,000	Max Monthly Ave	Feb	130,590	130,574	130,544	130,574	130,547	-16	-46	-17	-43
			Monthly Ave Flow Exceeded 10% of the Time	Feb	47,664	44,861	44,860	45,769	44,856	-2,803	-2,804	-1,895	-2,808

CBD = Colusa Basin Drain; cfs = cubic feet per second; GCID = Glenn-Colusa Irrigation District; NPA = No Project Alternative; TC Canal = Tehama-Colusa Canal

5.4.2. CBD Hydraulic Modeling

A one-dimensional (1D) Hydrologic Engineering Center River Analysis System (HEC-RAS) hydraulic model was used to simulate current conditions in the CBD and assess changes to the WSE caused by a release of 1,000 cfs from the Dunnigan Pipeline into the CBD under Alternatives 1 and 3.

The model results indicate that for a low-flow condition in the CBD, KLOG causes backwater with a flat WSE (almost zero water surface slope) up to RM 25 near Balsdon Weir (Jacobs 2020:4, Figure E1). The 1,000-cfs Sites Reservoir release during these conditions would increase CBD WSEs by a maximum of 1.54 feet. The WSE increases would be highest upstream of the Sites release location to Balsdon Weir; and the WSE would dissipate upstream of the weir. The WSE increases would taper off downstream of the Sites Reservoir release location to KLOG, and the WSE would converge at the KLOG.

The 1,000-cfs release during a high-flow condition of 1,700 cfs in CBD (Jacobs 2020:5, Figure E2) still would have a maximum WSE increase of 1.54 feet but would taper off upstream at a faster rate because of the higher slope of the water surface. The lowest elevation along the toe of west berm profile at RM 8.9 was determined to be the lowest field elevation of 25.3 feet, North American Vertical Datum of 1988 (NAVD 88). This elevation was considered critical in this analysis for assessing WSE effects because if the CBD WSE exceeds this elevation, flooding in this field can result because of seepage and backwater.

Using the simulated proposed conditions stage results, Jacobs (2020) identified the periods when WSEs would exceed the critical elevation of 25.3 feet, NAVD 88 at RM 8.9 and computed the quantity and timing of when Sites Reservoir volumes could be conveyed to Sacramento River with a constant flow rate of 1,000 cfs. In brief, the 1,000-cfs Sites Reservoir release could be conveyed without causing WSE effects primarily during April through July and in October. In August and September, the CBD carries high flows resulting from rice field agricultural drainage and often does not have capacity to convey reservoir releases of 1,000 cfs.

5.5 Methods of Analysis

The evaluation of environmental impacts on surface water resources is both quantitative (using and interpreting modeling results) and qualitative (using information about local hydrological conditions to establish context and impact mechanisms). The following sections outline the processes used in the determination of impacts on surface water resources associated with construction and operation of the Project.

5.5.1. Construction

Construction impacts are evaluated qualitatively based on the physical characteristics of the locations where construction would occur, including slope and soil type. Where appropriate, the impact analysis is combined for Alternatives 1, 2, and 3 depending on the impact being evaluated or the associated Project components. The Authority will implement the following BMPs, which are described in Appendix 2D, *Best Management Practices, Management Plans, and Technical Studies*. These BMPs, which are based on regulations and industry and discipline standards, are considered part of the Project and are incorporated into the analysis of potential construction impacts:

- BMP-1, Conformance with Applicable Design Standards and Building Codes, includes a broad range of civil and geotechnical engineering and seismic design studies and design measures.
- BMP-12, Development and Implementation of Stormwater Pollution Prevention Plan(s) (SWPPP) and Obtainment of Coverage under Stormwater Construction General Permit (Stormwater and Non-stormwater), requires a suite of measures to control soil erosion and sediment, stormwater and non-stormwater runoff, and "housekeeping" considerations (e.g., construction materials stockpiles, waste management).
- BMP-15, Performance of Site-Specific Drainage Evaluations, Design, and Implementation, requires evaluation of local drainage features during final Project design and incorporation of necessary design features (e.g., low impact development practices, bioswales, infiltration basins) to result in equivalent functioning of existing drainage system.
- BMP-3, Completion of Pre-Construction Geotechnical Evaluations and Data Reports, requires geotechnical testing, data collection, and reporting necessary to describe expected construction conditions and provide design and construction recommendations.

The Authority has also incorporated the preparation of an Initial Sites Reservoir Fill Plan (Section 2D.2) into the Project that would be reviewed by DSOD to identify needs during the initial filling of the reservoir.

As described in Section 2.5.3.1, *Geotechnical Investigations*, the Authority will conduct geotechnical studies (e.g., reservoir rim study, seismic fault study) to provide Project-specific recommendations for the engineering and final design of all facilities. These studies will be conducted once property is purchased or access granted. The impact analysis assumes the Project would be designed and constructed in accordance with the following standards, criteria, and regulations, as described in BMP-1:

- All facilities would be designed to meet a wide variety of seismic design criteria, such as the California Building Standards Code regulations for structures and transmission lines, the International Building Code for structural design, the seismic design for railway structures, and the seismic provisions for structural steel buildings.
- The main dams, saddle dams, saddle dikes, I/O Works, and TRR East embankment or TRR West would be designed to conform with Project-specific geotechnical design recommendations and seismic design criteria (e.g., DSOD Drawdown Criteria, IBC Structural Design Criteria, various USACE concrete and structure criteria, and various Reclamation design standards) such that dam embankments, foundations, abutments, and appurtenant facilities would be stable under design conditions of construction and reservoir operation including seismic.
- TRR East would be designed to meet both DSOD and Reclamation design criteria because of its height of embankment, whereas TRR West would be designed to meet only

Reclamation design criteria because it would be constructed through excavation rather than an embankment.

- Roads and the bridge would be designed to meet national, state, and county standards. In addition, the bridge would be designed to meet California Department of Transportation (Caltrans) Seismic Design Criteria, including its no collapse criteria (California Department of Transportation 2020:3-1–3-4). The bridge's earthen fill prisms would be designed to meet Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Caltrans Seismic Design Criteria, and Caltrans California Amendments to the AASHTO LRFD Bridge Design Specifications.

5.5.2. Operation

Potential water supply effects associated with the Project were evaluated using results from CALSIM, which are described in Section 5.4, *Hydrologic Modeling Results*. Potential flooding effects were evaluated using CALSIM II results, which are also described in Section 5.4. Operational impacts of Alternatives 1, 2, and 3 on flooding were evaluated quantitatively and qualitatively using the modeled results, as described above. In addition, the analysis of dam failure and emergency releases relies on the following information: previous studies conducted for the 2017 Draft EIR/EIS; design standards and design criteria described in Chapter 2 and Appendix 2D; and BMP-25, Preparation of an Emergency Action Plan for Reservoir Operations. Specifically, consistent with California Water Code sections 6160, 6161, and 6002.5, BMP-25 requires that an Emergency Action Plan be prepared and submitted to the Governor's Office of Emergency Services (CalOES) for Project construction and operation. The Emergency Action Plan would comply with Senate Bill 92 and CalOES's Emergency Action Plan requirements. The Emergency Action Plan would include, but may not be limited to, emergency notification flowcharts, notification procedures, inundation maps, and a variety of other important emergency response protocols for notifying downstream entities if an emergency release is anticipated. The Emergency Action Plan would address potential and actual emergency conditions and any uncontrolled release of water, including emergency release of water. These plans are typically reviewed annually and periodically tested through tabletop and functional exercises and drills.

5.5.3. Thresholds of Significance

An impact on surface water resources would be considered significant if the Project would do any of the following.

- Reduce water supply for non-Sites Storage Partner water users.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would:
    - Substantially increase the rate or amount of surface runoff in a manner which would result in flooding on site or off site.
    - Impede or redirect flood flows.

5.6 Impact Analysis and Mitigation Measures

Impact HYDRO-1: Reduce water supply for non-Sites Storage Partner water users

This impact evaluation considers whether construction and operation of Sites Reservoir would reduce the amount of water available to other water users, including the overall incidental effects of the Project on water available for diversion, export, or groundwater pumping. Water supply effects are considered differently in other chapters. For example, Chapter 8, *Groundwater Resources*, focuses on whether groundwater supplies would be affected, which partially overlaps with this discussion. Chapter 26, *Public Services and Utilities*, assesses whether there would be sufficient supplies available to serve the Project, whereas this chapter addresses the effects of construction and operation of the Project on other water supply users.

No Project

Under the No Project Alternative, the operations of the existing TC Canal, RBPP, and GCID Main Canal would continue, and Sites Reservoir would not be constructed or operated. Existing water supply would not be affected and water supply users would continue to receive diversions from the RBPP and GCID Main Canal pursuant to existing water rights and regulatory requirements.

Significance Determination

The No Project Alternative would not reduce water supply for other water users because no new facilities would be constructed and operated. There would be no impact/no effect.

Alternatives 1, 2, and 3

Construction

The estimated volume of water needed for construction is estimated to be between 1.12 and 1.43 million gallons per day for a period of 4 to 4.5 years over the total construction period (6 years). This is approximately 1.3 to 1.6 TAF/year. A summary of expected construction water use is provided in Table 5-33.

Table 5-33. Summary of Expected Construction Water Use for Alternatives 1, 2, and 3

Location/Project Component	Source	Expected Volume Needed (Gallons per day)	Expected Duration
Sites Reservoir and Related Facilities (including Roads and Recreation areas)	Groundwater and Surface Water	750,000 to 1,000,000	4 years
GCID System Upgrades Regulating Reservoirs and Conveyance Complex	Surface Water	350,000 to 400,000	4.5 years
Conveyance to Sacramento River (Dunnigan Pipeline)	Surface Water, Groundwater or water captured during dewatering	20,000 to 30,000	4.5 years

GCID = Glenn-Colusa Irrigation District

This water would be obtained either through acquisition of property with wells or through acquisition of water from nearby local water purveyors (ditches, canals, and wells) and possibly local landowners (wells). As identified in Chapter 8, there is sufficient groundwater supply to provide this water during the construction period without affecting yield from other wells.

Operation

Operations of Sites Reservoir would be integrated with existing CVP water operations and regulations for Alternatives 1, 2, and 3. CVP and SWP water service contractors who are not settlement, exchange, or FRSA contractors are the most likely water users to be affected by changes in operations and changes in the movement of water through the Delta. However, the purpose of Sites Reservoir would be to increase water supply and the movement of water from Sites Reservoir through the Delta would only be allowed if regulatory conditions permitted and other conditions (e.g., pumping and storage capacity) allowed increased exports. Sites exports would be junior to exports for CVP and SWP contract purposes. CALSIM results indicate the consequences of integrating Sites Reservoir operations with existing operations in the Central Valley (see Section 5.4).

The effects of the Project on CVP and SWP water supply as estimated by CALSIM are shown in Table 5-31 for north-of-Delta and south-of-Delta CVP and SWP water users for Dry and Critically Dry Water Years and the average of all water years. Further breakdown of these results is shown in Appendix 5B. All decreases in water supply modeled for Alternatives 1, 2, and 3 are considered negligible. On average, CVP and SWP deliveries are expected to increase with Alternatives 1, 2, and 3, with greater increases expected in association with CVP participation, particularly with Alternative 3.

Operation of Alternative 1, 2, or 3 would require new or modified water rights, water supply, and operating agreements to accommodate the supplies identified by the modeled simulations. Implementation of Alternative 1, 2, or 3 would require authorization from State Water Board, Division of Water Rights (State Water Board Division) in the form of a permit to divert and store water that would eventually be perfected to a license. The Authority is currently coordinating with the State Water Board Division related to water rights filings to support the Sites Reservoir and operation. Once filed, the State Water Board Division would provide public notice of the application which would provide an opportunity for public review. The process allows for the filing of protests based on perceived injury to legal users of water or based on environmental impacts. Protests are subsequently resolved through a variety of means that may include final resolution in a hearing. Any permit issued by the State Water Board would include terms and conditions, as determined appropriate by the State Water Board in authorizing Alternative 1, 2, or 3. Given the above, any right(s) and agreement(s) as part of Alternative 1, 2, or 3 would be formulated to protect existing beneficial uses associated with existing water rights.

CEQA Significance Determination and Mitigation Measures

Construction and operation of Alternative 1, 2, or 3 would not substantially reduce water supply to other water users. This impact would be less than significant.

NEPA Conclusion

Project effects would be the same as described above for CEQA. Construction and operation of Alternative 1, 2, or 3 would not substantially reduce water supply to other water users as compared to the No Project Alternative. Adverse effects would not occur to water supply for other water users.

Impact HYDRO-2: Substantial increase in the rate or amount of surface runoff in a manner which would result in flooding on site or off site

No Project

The No Project Alternative represents the continuation of the 2020 baseline conditions in the study area. Current flood control infrastructure, as well as existing routine operations and maintenance activities would continue, and there would be no change in the flood control regimes. Unimpeded flooding in the creeks in the vicinity of Sites Reservoir (e.g., Stone Corral Creek) would continue to pose a flood hazard to downstream reaches.

Significance Determination

The No Project Alternative would not result in substantial increases in the rate or amount of surface runoff in a manner which would result in flooding on site or off site because no new facilities would be constructed and operated. There would be no impact/no effect.

Alternatives 1, 2, and 3

Construction

Sites Reservoir, the Funks Reservoir and TRRs and PGPs, administration and operations building, maintenance and storage buildings, Dunnigan Pipeline, Sacramento River discharge, and new roads (including the South Road under Alternative 2 only) represent new facilities with the potential to alter existing drainage patterns and characteristics. The increase in impervious surfaces associated with construction activities is discussed under Impact FLV-1 in Chapter 7. Streamflow present in Funks or Stone Corral Creeks would be contained behind coffer dams and localized flooding in these creeks would be avoided during construction. Streamflow in the channels associated with construction of the South Road for Alternative 2 would be contained in a similar manner.

Construction activities would not increase the rate or amount of surface runoff in a manner which would result in flooding on site or off site. On Funks Creek at the Golden Gate Dam construction site, flow would be routed through a temporary pipe underneath the construction site and then re-enter the Funks Creek channel downstream. The coffer dam would provide enough residence time for settling of sediment to occur for typical flows in Funks Creek[2]. On Stone Corral Creek at the Sites Dam construction site, flow would be routed through a permanent tunnel underneath the construction site (which would later be used as the dam outlet pipe) and

---

[2] Note that the anticipated volume that would need to be stored for a 33-hour 100-year storm event on Funks Creek is approximately 5,900 AF.

then re-enter the Stone Corral Creek channel downstream[3]. Construction equipment used during these construction activities would not increase the rate or amount of surface runoff in a manner which would result in flooding on site or off site. Furthermore, implementation of BMP-15 would ensure that post-Project conditions will result in equivalent functioning of the existing drainage system, and implementation would incorporate measures for drainage feature stability (e.g., drainage systems and practices that mimic natural processes to infiltrate and recharge, such as green infrastructure, low impact development practices, bioswales, infiltration basins); incorporate relocation plans (for canals, ditches, wells, and other existing infrastructure); and incorporate other modifications to manage localized runoff amounts and/or patterns as part of Alternative 1, 2, or 3. Lastly, BMP-12 would control soil erosion and sediment and stormwater and non-stormwater runoff.

Operation

Table 5-34 shows the percent change between the No Project Alternative and Alternatives 1, 2, and 3 for maximum monthly average and the monthly 10% exceedance flow, as modeled at various locations in the system. Excluding the RBPP and GCID Main Canal at Hamilton City diversions, the percent changes in maximum monthly average range from an increase of less than 0.4% to a decrease of less than 2.5% when compared to the No Project Alternative (Table 5-34). For monthly 10% exceedance flows, the percent change ranges from an increase of less than 1.4% to a decrease of approximately 6% when compared to the No Project Alternative, depending on the location (Table 5-34). Identified reductions in in-channel flow would reduce the potential for flooding, while the identified increases in flow would be minor. The largest percent increase in flow (1.35%) is in the Sacramento River at Bend Bridge under Alternative 3, where the modeled increase in February monthly average flow exceeded 10% of the time is 590 cfs relative to the No Project Alternative, but the discharge (44,228 cfs) would be well below the capacity (98,000 cfs) of the river at Bend Bridge. In brief, these percent differences are minor when considered in the context of the larger system and would not represent a substantial increase in the amount or rate of runoff that would result in flooding.

Table 5-34. Percent Change between the No Project Alternative and Alternatives 1, 2, and 3

CALSIM II Model Station	Flood Flows Metric	% Difference from NPA				
		Month	Alt 1A	Alt 1B	Alt 2	Alt 3
Sacramento River Flow at Bend Bridge	Max Monthly Ave	Feb	0.00%	0.00%	0.00%	0.00%
	Monthly Ave Flow Exceeded 10% of the Time	Feb	0.00%	0.72%	0.00%	1.35%
Sacramento River Flow	Max Monthly Ave	Feb	-0.87%	0.00%	-0.84%	-2.17%
	Monthly Ave Flow	Feb	-2.82%	-2.82%	-2.82%	-0.57%

---

[3] The anticipated volume that would need to be stored for a 33-hour 100-year storm event on Stone Corral Creek is 3,500 AF. Assuming a coffer dam can be constructed to impound 1,940 AF of storage during the first year of construction, the Sites Dam outlet would be required to have release capabilities of up to 2,500 cfs to prevent the coffer dam from overtopping. The outlet tunnel with two 84-inch-diameter fixed cone valves would accommodate these releases, and an energy dissipating chamber would reduce the velocity of the water released to approximately 33 feet per second.

CALSIM II Model Station	Flood Flows Metric	% Difference from NPA				
		Month	Alt 1A	Alt 1B	Alt 2	Alt 3
below Red Bluff Diversion Dam	Exceeded 10% of the Time					
Sacramento River near Wilkins Slough	Max Monthly Ave	Feb	-0.09%	0.00%	-0.09%	0.02%
	Monthly Ave Flow Exceeded 10% of the Time	Feb	-0.10%	-0.15%	-0.10%	-0.14%
Colusa Basin Drain above Dunnigan Pipeline	Max Monthly Ave	Jan	0.36%	0.36%	0.36%	0.36%
	Monthly Ave Flow Exceeded 10% of the Time	Apr	0.24%	0.24%	0.24%	0.24%
Sacramento River below Colusa Basin Drain	Max Monthly Ave	Feb	-0.09%	0.00%	-0.09%	0.02%
	Monthly Ave Flow Exceeded 10% of the Time	Feb	-0.10%	-0.14%	-0.10%	-0.14%
Flow through Yolo Bypass	Max Monthly Ave	Feb	-0.01%	-0.04%	-0.01%	-0.03%
	Monthly Ave Flow Exceeded 10% of the Time	Feb	-5.88%	-5.88%	-3.98%	-5.89%

Alt = Alternative, NPA = No Project Alternative
Values in table based on CALSIM results

Besides minor decreases in flood flows on the Sacramento River, a flood protection benefit would also be provided for the areas downstream of Sites Reservoir (specifically on the floodplains of Stone Corral Creek where flooding has historically occurred). As described in the Water Storage Investment Program application (Sites Project Authority 2017), direct flood control benefits would be provided in the Stone Corral Creek and Funks Creek watersheds (including the community of Maxwell) by reducing the size of the floodplain within the region. It is estimated that the Project would reduce the 100-year floodplain by approximately 10,000 acres, representing a 9% reduction. In addition to increasing the level of protection in the Funks Creek and Stone Corral Creek watersheds, a 100-year level of protection would also be achieved for approximately 4,025 acres in the Colusa Basin located east of I-5.

<u>*CEQA Significance Determination and Mitigation Measures*</u>

Construction of Alternative 1, 2, or 3 would not substantially increase flooding on site or off site. Construction sequencing and use of coffer dams and bypass flow mechanisms would ensure that localized flooding during construction would be avoided. Construction of Alternatives 1, 2, and 3 would not substantially increase the rate or amount of surface runoff in a manner that would result in flooding on or off site and impacts would be less than significant.

Diversions under Alternatives 1, 2, and 3 would only occur under higher flow regimes in the Sacramento River. Operational impacts on the flood control regime of the greater Sacramento River system are expected to be minimal and result in mostly decreases in monthly average flow and the existing flood volume. Alternatives 1, 2, and 3 would result in a direct reduction in runoff from the Stone Corral Creek and Funks Creek watersheds and associated historic flooding downstream, including the community of Maxwell. Operation of Alternatives 1, 2, and 3 would not substantially increase the rate or amount of surface runoff in a manner that would result in flooding on or off site and impacts would be less than significant.

NEPA Conclusion

Construction and operation effects for Alternatives 1, 2, and 3 would be the same as those described above for CEQA. Project alternatives would not substantially increase flooding on site or off site as compared to the No Project Alternative. In addition, the Project would provide direct flood control benefits within the Stone Corral Creek and Funks Creek watersheds by reducing the size of the floodplain within the region. Construction effects of Alternatives 1, 2, and 3 would not be adverse and operation effects of Alternatives 1, 2, and 3 would be beneficial.

Impact HYDRO-3: Impede or redirect flood flows

No Project

The No Project Alternative represents the continuation of the 2020 baseline conditions in the study area. Current flood control conditions, as well as existing routine operations and maintenance activities would continue, and there would be no change in the flood control regimes.

Significance Determination

The No Project Alternative would not result in the impediment or redirection of flood flows because no new facilities would be constructed and operated. There would be no impact/no effect.

Alternatives 1, 2, and 3

This section addresses potential impacts associated with impediment or redirection of flood flows as a result of operation of Alternatives 1, 2, or 3. Impact mechanisms related to redirection of flood flows during construction and related impacts are similar to those discussed above under Impact HYDRO-2 and therefore are addressed under that impact.

Operation

Dam Failure

Under Alternatives 1, 2, and 3, Sites Reservoir dams would be designed and constructed pursuant to conservative guidelines and criteria required by DSOD that are designed to prevent failure (BMP-1). The designs would incorporate multiple lines of defense or design redundancy as required to meet design standards. The known faults, geologic structures, and seismic activity of the area would be considered in the final design of the main dams, saddle dams, and saddle dikes, which would be designed to conform with all applicable design criteria. The main dams, saddle dams, and saddle dikes would also be designed to accommodate the maximum predicted fault offset (Chapter 12, *Geology and Soils*, Table 12-6). The dams would be designed to ensure the dam embankment is not impaired by extensive cracking, crest settlement, or excessive deformation in critical zones, and the design would limit seismic deformation to 5 feet.

Furthermore, monitoring equipment and tools, including strong motion seismic detectors, piezometers, settlement points, and seepage weirs, would be permanently installed at each dam site, and strong motion seismic detectors would be installed at center crests, abutments, and toes of Golden Gate Dam and Sites Dam. These procedures would provide early warning signs of potential dam failure.

In the unlikely event that surface fault rupture (or other means of structural compromise, including inadequate construction and acts of vandalism or terrorism) resulted in partial or complete dam failure, it could cause widespread flooding to property and people in the region downstream of the dams to the Sacramento River. Flood maps would be developed in accordance with the CalOES, along with evacuation plans for areas within the inundation area. Previous analysis indicated that the peak outflow from a breach of Sites Reservoir with a capacity of 1.8 MAF could be estimated at 2,078,000 cfs, and that the flood wave would move east through the foothills, fanning out to the relatively flat terrain of the Sacramento Valley before reaching the community of Maxwell and I-5. The estimated flow velocity at Maxwell and I-5 would be 4.5 feet per second and the maximum depth would be 10 feet. The flood wave would then continue approximately 13 miles east to the town of Colusa and the Sacramento River. The flood wave would then be impeded by the west levee of the Sacramento River, and the flood would reach a depth of 22 feet (upslope of the Sacramento River levee) (California Department of Water Resources 2005:4). The peak outflow of a breach from a 1.5-MAF reservoir would be less than 2,078,000 cfs and the flood map developed in accordance with the CalOES would describe and illustrate the anticipated outflow.

The I/O Works, tunnel, and pipelines in the Antelope Valley and foothills would be located near or on known faults, and surface fault rupture could damage these facilities. Damage to these facilities could cause flooding along Funks and Stone Corral Creeks. Additional geotechnical information will be incorporated into the Project design as further studies are conducted (Section 2.5.3.1, *Geotechnical Investigations*; BMP-3), such as a seismic fault study to minimize fault crossings. As with the dams and dikes, these facilities would be designed to meet all applicable design criteria to protect against seismic events (BMP-1). Furthermore, the power and supervisory controls required to operate the I/O Works and other appurtenances would be designed to remain fully operable following a seismic event, which would enable operators to shut down facilities as needed.

Finally, consistent with California Water Code sections 6160, 6161, and 6002.5, an Emergency Action Plan would be prepared and submitted to CalOES for Project construction and operation (BMP-25). The Emergency Action Plan would comply with CA Senate Bill 92 and CalOES's Emergency Action Plan requirements. The Emergency Action Plan would include, but may not be limited to, emergency notification flowcharts, notification procedures, inundation maps, and protocols for notifying downstream entities if an emergency release is anticipated.

Reservoir Emergency Releases

As an offstream reservoir, Sites Reservoir would be filled by controlled diversions from the Sacramento River and would receive relatively little inflow from the local creeks. In general, Sites Reservoir would fill to its highest operating levels by spring to early summer, and then would be drawn down during summer. The maximum normal operating water elevation for the

1.5-MAF reservoir is 498 feet above mean sea level. The current design includes a spillway crest elevation at 504 feet above mean sea level, which would allow for storage of the entire probable maximum flood (PMF) from Funks and Stone Corral Creeks in the reservoir above the normal operating water elevation.

By the time the rainy season begins (i.e., when a 100-year flood could occur), the reservoir would have more than enough capacity to handle typical storm events from the local creeks, even at full operating capacity. Emergency spill releases would only have the potential to occur during years of very heavy precipitation when the Sites Reservoir is already at capacity and a localized storm in the Sites Reservoir watershed creates a significant rise in the reservoir's WSE. Emergency spill releases could also occur under a scenario of over-pumping to storage. The probability of an event requiring emergency spills remains very small because inflow is controlled through pumping. Diversions to Sites Reservoir would not occur once the reservoir reaches a stage that is near capacity and additional precipitation events are forecasted to occur. Further, should water diversions continue in a highly unlikely scenario, the Authority would be able to prepare for any necessary flood warnings to the public downstream of the reservoir (BMP-25). Finally, the drainage area contributing to the Sites Reservoir is considered low elevation and therefore rarely contains accumulating snow during the winter. Thus, there is no potential for additional water volume from snowmelt or rain-on-snow hydrological events.

As described in the *Emergency Release* subsection of Section 2.5.2.1, the reservoir would be designed to meet DSOD drawdown requirements including:

- ability to reduce the depth of water in the reservoir by 10% of the reservoir depth within 7 days. Reservoir depth is defined as the elevation difference between the maximum normal operating water elevation and the top of dead pool elevation.
- ability to drain the reservoir to dead pool within 90 to 120 days.

Under all alternatives, the reservoir would be designed to release emergency drawdown flows into Stone Corral Creek and Funks Creek and emergency spills at Saddle Dam 8B to the Hunters Creek watershed. As previously stated, detailed flood mapping would be developed in accordance with California Water Code. Stone Corral Creek is the only creek in the vicinity of Sites Reservoir with stream gage data, but based on the size, geology, topography, and proximity of Funks Creek and the forks of Hunters Creek, these creeks are comparable to Stone Corral Creek. The hydrology of Funks Creek and Hunters Creek is likely similar to Stone Corral Creek hydrology in terms of peak flow recurrence intervals and mean daily flow durations. The 100-year discharge for Stone Corral is established as 7,870 cfs[4] based on 25 years of flow data (Bureau of Reclamation and California Department of Water Resources 2008:3-12) . The maximum mean daily flow on record from the USGS gage station 11390672 Stone Corral Creek, near Sites, was 2,230 cfs. This flow was recorded in 1983 and the maximum instantaneous peak flow on record was 5,700 cfs, which occurred in the same year. This flow event created downstream flooding in the community of Maxwell.

---

[4] The USGS StreamStats estimate the 100-year discharge for Stone Corral slightly lower at 6,590 cfs with the mean daily discharge exceeding 215 cfs only 1% of the time and flows above 0 cfs 45% of the time (U.S. Geological Survey 2021b).

The Saddle Dam 8B spillway will only function under an overtopping emergency scenario and will accommodate flows of up to about 3,900 cfs into the Hunters Creek watershed. The maximum emergency spill flows into Hunters Creek (the maximum Project diversion rate or the PMF flow of approximately 3,900 cfs) would be slightly more than the 1-in-200 year flood event of 3,850 cfs for Hunters Creek (U.S. Geological Survey 2022). The Stone Corral Creek emergency drawdown release could be approximately 4,700 cfs from Sites Dam. This flow would be slightly less than the 1-in-25 year flood event of approximately 5,000 cfs at Stone Corral Creek near Sites USGS gage station (U.S. Geological Survey 2021b). Both of these emergency release volumes would cause some amount of downstream flooding, the extent of which would be more amplified in the Stone Corral Creek watershed.

Emergency drawdown would also be released into Funks Reservoir (9,000 cfs) and TRR East or TRR West (7,000 cfs) via the I/O Works and pipelines before ultimately being discharged into Funks Creek. These emergency releases would cause some amount of downstream flooding in Funks Creek. TRR West (under Alternative 2) is not adjacent to Funks Creek; therefore, the area between TRR West and Funks Creek would be flooded (Rude pers. comm.). Flow allocation between the two reservoir outlets, Sites Dam outlet and the I/O Works, is currently being assessed and is subject to change during design.

CBD Flood Impacts

Sites releases to the CBD would be controlled by operations and would not inundate, as a result of overtopping, seepage, or reverse flows, the existing agricultural fields adjacent to the CBD. No flooding in the CBD area is anticipated as a result of operation of Alternative 1, 2, or 3. Sites releases potentially could be directed to the Yolo Bypass instead of the Sacramento River from August through October.

CEQA Significance Determination and Mitigation Measures

The probability of dam failure and subsequent impacts is low as a result of incorporation of design criteria and construction practices, post-construction monitoring, and avoidance or minimizing of fault crossings. The probability of the emergency release event occurring is remote because inflow would be controlled primarily through pumping for offstream storage reservoirs. The reservoir would be operated to avoid overtopping, seepage, or flooding into adjacent lands as a result of releases into the CBD. Accordingly, Alternatives 1, 2, and 3 would have a less-than-significant impact with regards to flooding and impediment or redirection of flood flows.

NEPA Conclusion

Operation effects for Alternative 1, 2, or 3 would be the same as those described above for CEQA. Project alternatives would incorporate design criteria and construction practices, post-construction monitoring, and avoidance or minimizing of fault crossings and operate through pumping for offstream storage. Project alternatives would not impede or redirect flood flows as compared to the No Project Alternative. The operation of Alternative 1, 2, or 3 would not have an adverse effect on flooding and impediment or redirection of flood flows.

5.7 References

5.7.1. Printed References

Bureau of Reclamation. 2014. Shasta Lake *Water Resources Investigation Final Environmental Impact Statement*. Available: https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=1915. Accessed: May 28, 2021.

Bureau of Reclamation. 2015. *Coordinated Long Term Operation of the CVP and SWP EIS*, Appendix 5A *CalSim II and DSM2 Modeling*.

Bureau of Reclamation. 2016. *Central Valley Project (CVP) Water Contractors*. Available: https://www.usbr.gov/mp/cvp-water/docs/latest-water-contractors.pdf. Accessed: November 25, 2020.

Bureau of Reclamation. 2021a. *Projects & Facilities, Dams. Funks Dam Details*. Available: https://www.usbr.gov/projects/index.php?id=139

Bureau of Reclamation. 2021b. *Projects & Facilities, Dams. Shasta Dam Details*. Available: https://www.usbr.gov/projects/index.php?id=241

Bureau of Reclamation. 2021c. *Projects & Facilities, Dams. Folsom Dam Details*. Available: https://www.usbr.gov/projects/index.php?id=74. Accessed: May 28, 2021.

Bureau of Reclamation. 2021d. *Projects & Facilities, Dams. Nimbus Dam Overview*. Available: https://www.usbr.gov/projects/index.php?id=222. Accessed: May 28, 2021.

Bureau of Reclamation and California Department of Water Resources. 2008. *North-of-the-Delta Off-Stream Storage Investigation: Plan Formulation Report*. Prepared for Reclamation by URS Corporation under Contract 06CS204097A. 353pp. Available: http://s3-us-west-2.amazonaws.com/ucldc-nuxeo-ref-media/6a8b0fb3-c504-48cc-86f4-623d280d0ee0. Date accessed: April 17, 2021.

Bureau of Reclamation and California Department of Water Resources. 2019. *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project, Final Environmental Impact Statement/Environmental Impact Report*. State Clearinghouse # 2013032004. May.

Butte County Department of Water and Resource Conservation. 2016. Butte County Water Inventory Analysis. Final Report. June 2016. Available: http://buttecounty.granicus.com/MetaViewer.php?view_id=2&clip_id=341&meta_id=57394. Accessed: May 28, 2021.

California Department of Transportation. 2020. Seismic Design Criteria. Version 2.0.

California Department of Water Resources. 1995. Delta Atlas. Available: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_ waterfix/exhibits/exhibit3/rdeir_sdeis_comments/RECIRC_2646_ATT%203.pdf. Accessed: May 28, 2021.

California Department of Water Resources. 2005. North of Delta Offstream Storage Investigations, Sites Reservoir Inundation Analysis.

California Department of Water Resources. 2010. *Fact Sheet, Sacramento River Flood Control Project Weirs and Flood Relief Structures*. Last revised: Unknown. Available: http://www.rd108.org/wp-content/uploads/2015/07/WeirsReliefStructures.pdf. Accessed: January 21, 2021.

California Department of Water Resources and Bureau of Reclamation. 2016. California WaterFix Biological Assessment, Appendix 5A–Attachment 4: Yolo Bypass Floodplain Hydraulics. July.

California Department of Water Resources. 2017a. *State Plan of Flood Control Descriptive Document Update*. August. Last revised: Unknown. Available at: https://cawaterlibrary.net/wp-content/uploads/2017/10/CVFPP-SPFC-DescriptiveDoc-Aug2017-compiled.pdf. Accessed: January 21, 2021.

California Department of Water Resources. 2017b. *2017 Flood System Status Report*. August. Last revised: Unknown. Available at: https://cawaterlibrary.net/document/2017-flood-system-status-report/. Accessed: January 21, 2021.

California Department of Water Resources. 2019. California Water Plan Update 2018. Available: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/Final/California-Water-Plan-Update-2018.pdf. Accessed: May 28, 2021.

California Department of Water Resources. 2020. The Final State Water Project Delivery Capability Report 2019. August 26, 2020. Available: https://data.cnra.ca.gov/dataset/state-water-project-delivery-capability-report-dcr-2019/resource/119da5c5-1c47-4142-8896-334628ca61cd. Accessed: February 9, 2021.

cbec. In preparation. Draft Technical Memorandum: Historic Flow Analysis (14-1036–Knights Landing Outfall Gates Fish Exclusion Project).

Colusa County Resource Conservation District. 2012. *Colusa Basin Watershed Management Plan*. December. Last revised: Unknown. https://www.sacramentoriver.org/forum/lib/library/docs/Colusa_Basin_Watershed_Management_Plan_(2012).pdf. Accessed: January 22, 2021.

Glenn-Colusa Irrigation District. n.d. GCID Fact sheet. Available: https://912afe62-5b11-482e-8c47-c2358db4f96b.filesusr.com/ugd/c88b6b_b5394b07da4d40a280cb0795b19469d9.pdf?index=true. Accessed: February 4, 2021.

Gray, A.B. and Pasternack, G.B. 2016. Colusa Basin Drainage Area Fluvial Sediments: Dynamics, Environmental Impacts and Recommendations for Future Monitoring of The Colusa Basin Suspended Sediment Project. (SWAMP-MR-RB5-2016-0002.) Prepared for Central Valley Regional Water Quality Control Board, Sacramento, CA. Last revised: Unknown. Available: https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/reglrpts/r5_cbds_reg_mar2016.pdf. Accessed: October 28, 2020.

H. T. Harvey & Associates, G. Mathias Kondolf, Geomorph, and Blankinship & Associates. 2008. *Colusa Basin Watershed Assessment*. Prepared for Colusa County Resource Conservation District. December.

Irvine Ranch Water District. 2021. Water Supply & Reliability. Available: https://www.irwd.com/services/water-supply-reliability#:~:text=IRWD's%20drinking%20water%20comes%20from,geographic%20location%20within%20the%20District.&text=into%20the%20future.-,IRWD's%20drinking%20water%20comes%20from%20two%20primary,local%20groundwater%20and%20imported%20water. Accessed: May 28, 2021.

Jacobs. 2020. *Colusa Basin Drain Hydraulic Modeling, Final Technical Memorandum*. Prepared for Henry Luu, Sites Program Management Team. August 28, 2020.

Kalb, L. and R. Opshal. 2017. Town of Maxwell floods as worry about Oroville Dam shifts to creeks and canals. *The Sacramento Bee*. Available: https://www.sacbee.com/news/weather/article133701629.html

National Marine Fisheries Service. 2016. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for Relicensing the Oroville Facilities Hydroelectric Project, Butte County California (FERC Project No. 2100-134). (Oroville Facilities Biological Opinion). Available: https://repository.library.noaa.gov/view/noaa/27563. Accessed: May 17, 2021.

National Oceanographic and Atmospheric Administration. 2021. California Nevada River Forecast Center. Sacramento River–Bend Bridge. Available: https://www.cnrfc.noaa.gov/graphicalRVF.php?id=BDBC1

Northwest Hydraulic Consultants. 2006. *North Delta Sedimentation Study*. March. West Sacramento, CA. Prepared for California Department of Water Resources.

Serna, J. 2017. Shasta Dam makes history as water flows from top gates for first time in 20 years. Los Angeles Times. Available: https://www.latimes.com/local/lanow/la-me-shasta-reservoir-water-release-20170223-story.html

Sites Project Authority. 2017. Water Storage Investment Program Application: Physical Benefits Tab–Attachment 1: Flood Control Benefits. August. 2017.

Solis, N. 2017. Shasta County agencies preparing flooding scenarios. Redding Record Searchlight. Available: https://www.latimes.com/local/lanow/la-me-shasta-reservoir-water-release-20170223-story.html

State Water Resources Control Board. 2018. *Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary*. December 12. Available: https://www.waterboards.ca.gov/plans_policies/docs/2018wqcp.pdf. Accessed: January 12, 2021.

U.S. Army Corps of Engineers. 2002. Sacramento and San Joaquin River Basins Comprehensive Study, Technical Studies Documentation. Sacramento District. December.

U.S. Army Corps of Engineers. 2009. *Sacramento River Flood Control Project (SRFCP)*. Sacramento District.

U.S. Geological Survey. 1982. Guidelines for Determining Flood Flow Frequency. Bulletin #17B of the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data. Available: https://water.usgs.gov/osw/bulletin17b/dl_flow.pdf Accessed: June 2021.

U.S. Geological Survey. 2010. Annual Data Report, Basin Schematic. Available: https://ca.water.usgs.gov/data/waterdata/Schematics2010/lake.oroville.pdf. Accessed: May 28, 2021.

U.S. Geological Survey. 2021a. National Water Information System, Peak Streamflow for the Nation. Stream gage 11390672 Stone Corral C Nr Sites CA. Available: https://nwis.waterdata.usgs.gov/nwis/peak?site_no=11390672&agency_cd=USGS&format=html Accessed: February 2021.

U.S. Geological Survey. 2021b. StreamStats, Data-Collection Station Report. Station 11390672 Stone Corral C Nr Sites CA. Available: https://streamstatsags.cr.usgs.gov/gagepages/html/11390672.htm Accessed: February 2021.

U.S. Geological Survey. 2021c. StreamStats, Data-Collection Station Report. Station 11378000 SACRAMENTO R NR RED BLUFF CA. Available: https://streamstatsags.cr.usgs.gov/gagepages/html/11378000.htm Accessed: February 2021.

U.S. Geological Survey. 2021d. National Water Information System, Peak Streamflow for the Nation. Stream gage 11378000 SACRAMENTO R NR RED BLUFF CA. Available: https://nwis.waterdata.usgs.gov/nwis/peak/?site_no=11378000 Accessed: February 2021.

U.S. Geological Survey. 2021e. StreamStats, Data-Collection Station Report. Station 11389500 SACRAMENTO R A COLUSA CA. Available: https://streamstatsags.cr.usgs.gov/gagepages/html/11389500.htm Accessed: February 2021.

U.S. Geological Survey. 2021f. National Water Information System, Peak Streamflow for the Nation. Stream gage 11389500 SACRAMENTO R A COLUSA CA. Available: https://nwis.waterdata.usgs.gov/usa/nwis/peak/?site_no=11389500 Accessed: February 2021.

U.S. Geological Survey. 2021g. StreamStats, Data-Collection Station Report. Station 11390500 SACRAMENTO R BL WILKINS SLOUGH NR GRIMES CA. Available: https://streamstatsags.cr.usgs.gov/gagepages/html/11390500.htm#325 Accessed: February 2021.

U.S. Geological Survey. 2021h. National Water Information System, Peak Streamflow for the Nation. Stream gage 11390500 SACRAMENTO R BL WILKINS SLOUGH NR GRIMES CA. Available: https://nwis.waterdata.usgs.gov/nwis/peak/?site_no=11390500 Accessed: February 2021.

U.S. Geological Survey. 2021i. StreamStats, Data-Collection Station Report. Station 11425500 SACRAMENTO R A VERONA CA. Available: https://streamstatsags.cr.usgs.gov/gagepages/html/11425500.htm Accessed: February 2021.

U.S. Geological Survey. 2021j. National Water Information System, Peak Streamflow for the Nation. Stream gage 11425500 SACRAMENTO R A VERONA CA. Available: https://nwis.waterdata.usgs.gov/nwis/peak?site_no=11453000&agency_cd=USGS&format=html Accessed: February 2021.

U.S. Geological Survey. 2021k. National Water Information System, Mean Daily Discharge. Stream gage 11391021 FREMONT WEIR SPILL TO YOLO BYPASS NR VERONA CA. Available: https://nwis.waterdata.usgs.gov/nwis/dv?cb_00060=on&format=html&site_no=11391021&referred_module=sw&period=&begin_date=1947-01-01&end_date=1975-09-29 Accessed: February 2021.

U.S. Geological Survey. 2021l. National Water Information System, Peak Streamflow for the Nation. Stream gage 11453000 YOLO BYPASS NR WOODLAND CA. Available: https://nwis.waterdata.usgs.gov/nwis/peak?site_no=11425500&agency_cd=USGS&format=html Accessed: February 2021.

U.S. Geological Survey. 2021m. StreamStats, Data-Collection Station Report. Station 11453000 YOLO BYPASS NR WOODLAND CA. Available: https://streamstatsags.cr.usgs.gov/gagepages/html/11453000.htm Accessed: February 2021.

U.S. Geological Survey. 2021n. National Water Information System. Available: https://waterdata.usgs.gov/nwis. Data for flow in the Sacramento River below Wilkins Slough and the Yolo Bypass near Woodland accessed May 6, 2021.

U.S. Geological Survey. 2022. *StreamStats*, Peak-Flow Statistics Flow Report [2012 5113 Region 1 North Coast].

Yates, Eugene B. 1989. *Water Quality and Supply on Cortina Rancheria, Colusa County, California*. U.S. Geological Survey Water-Resources Investigations Report 89-4004.

5.7.2. Personal Communications

Rude, Pete. Civil Engineer. Jacobs. April 23, 2021—Smartsheet response re: TRR West emergency releases to Nicole Williams, Project Manager, ICF, Sacramento, CA.