4 Hydrology, Hydraulics, and Flood Control

This chapter addresses the water resources within the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Project) area and describes potential effects of Project implementation on those resources. Water resources include hydrology, hydraulics, and flood control. The analysis provided in this chapter includes a description of existing environmental conditions; methods used to assess environmental effects; potential direct, indirect, and cumulative impacts of Project implementation; and mitigation measures recommended to avoid or minimize adverse effects under National Environmental Policy Act (NEPA) and significant impacts under California Environmental Quality Act (CEQA). Federal, State of California (State), and local regulations that pertain to flood control, hydraulics, and hydrology are summarized.

4.1 Environmental Setting/Affected Environment

This section presents the environmental setting for hydrology, hydraulics, and flood control in the Project area.

4.1.1 Hydrology and Hydraulics

The Project area for hydrology and hydraulics consists of the Sacramento River from Shasta Dam to Rio Vista, the Yolo Bypass, and the Sacramento-San Joaquin Delta (Delta) in the vicinity of Cache Slough (Figure 4-1). These areas are described below.

4.1.1.1 Sacramento River

The Sacramento River has been divided into two reaches, one above the Fremont Weir, and one below the Fremont Weir. These two reaches are discussed separately because they are affected by the proposed project differently.

4.1.1.1.1 Sacramento River from Shasta Dam to Fremont Weir

Flows in the 65-mile Shasta Dam to Red Bluff (River Mile [RM] 244) reach of the Sacramento River are regulated by Shasta Dam and are reregulated downstream at Keswick Dam (RM 302), as shown in Figure 4-1. In this reach, flows are influenced by tributary inflow. Major west-side tributaries to the Sacramento River in this reach include Clear and Cottonwood creeks. Major east-side tributaries to the Sacramento River in this reach include Battle, Bear, Churn, Cow, and Paynes creeks.

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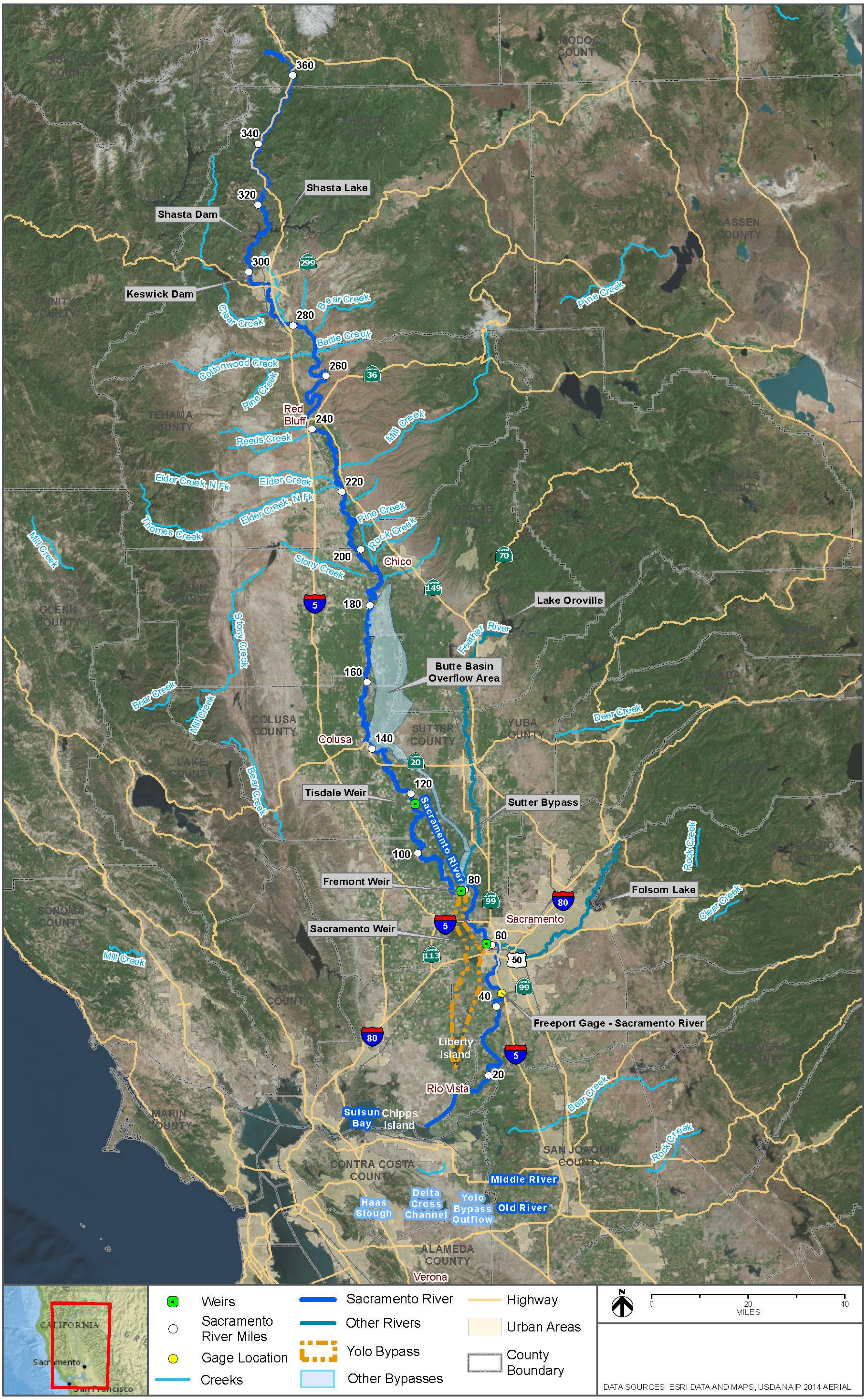

Figure 4-1. Sacramento River and Tributaries

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The Sacramento River enters the Sacramento Valley about five miles north of Red Bluff. From Red Bluff to Chico Landing (52 miles), the river receives flows from Antelope, Mill, Deer, Big Chico, Rock, and Pine creeks on the east side and Thomes, Elder, Reeds, and Red Bank creeks on the west side. From Chico Landing to Colusa (50 miles), the Sacramento River meanders through alluvial deposits between widely spaced levees. Stony Creek is the only major tributary in this segment of the river. No tributaries enter the Sacramento River between Stony Creek and its confluence with the Feather River.

Floodwaters in the Sacramento River overflow the east bank at three sites in a reach referred to by the State as the Butte Basin Overflow Area. In this river reach, several Federal projects begin, including the Sacramento River Flood Control Project (SRFCP), Sacramento River Major and Minor Tributaries Project, and Sacramento River Bank Protection Project. Levees of the SRFCP begin in this reach, downstream from Ord Ferry on the west (RM 184) and from RM 176 above Butte City on the east side of the river.

Shasta Lake is operated to meet a flow requirement in the Sacramento River at Wilkins Slough near Grimes (RM 125), also known as the Navigation Control Point. Downstream from Wilkins Slough, the Feather River, the largest east-side tributary to the Sacramento River, enters the river just above Verona. Between Wilkins Slough and Verona, floodwater is diverted at two places in this segment of the river—Tisdale Weir into the Tisdale Bypass and Fremont Weir into the Yolo Bypass. The bypass system routes floodwater away from the mainstem Sacramento River to discharge into the Delta near Rio Vista.

4.1.1.1.2 Sacramento River from the Fremont Weir to Rio Vista

The portion of the Sacramento River within the Project area begins at Fremont Weir near Verona and extends to just upstream of Rio Vista near RM 12.

Below Verona, the Sacramento River flows 79 miles to the Delta, passing the City of Sacramento and Freeport. The Yolo Bypass parallels this river reach to the west. Flows enter the Sacramento River reach at various points. First, flows from the Natomas Cross Canal enter the Sacramento River approximately one mile downstream from the mouth of the Feather River. The American River flows into the Sacramento River in the City of Sacramento. When Sacramento River system flood flows are the highest, a portion of the flow is diverted into the Yolo Bypass at Sacramento Weir, about three miles upstream from the American River confluence near downtown Sacramento. At the downstream end, Yolo Bypass flows reenter the Sacramento River near Rio Vista. As the river enters the Delta, Georgiana Slough branches off from the mainstem of the Sacramento River, routing a portion of the flow into the central Delta.

Regulated flows in the Sacramento River below the Yolo Bypass based on 2017 reservoir operations and system conditions were evaluated as a part of the 2017 CVFPP Update (DWR 2016a). Table 4-1 shows the annual exceedance probability (AEP) of flows in the Sacramento River at Freeport, as computed through the CVFPP. AEP is the likelihood of flows being higher than a specified flow rate in a given year. A flow with a 0.01 AEP has a one percent likelihood of being exceeded in any given year.

Table 4-1. Annual Exceedance Probability of Sacramento River Flows at Freeport

Annual Exceedance Probability --	Maximum Annual Instantaneous Flow (cfs)
0.900	138,015
0.800	160,247
0.667	188,063
0.500	225,074
0.429	242,946
0.200	334,361
0.100	433,108
0.040	518,692
0.020	549,885
0.010	595,563
0.005	659,195
0.002	847,077

Source: 2017 No Project Regulated Flow Frequency Curve for SAC41, evaluated for CVFPP Update (DWR 2016a).
Key: cfs = cubic feet per second

4.1.1.2 Yolo Bypass

The Yolo Bypass is a leveed floodway on the west side of the Sacramento River between Verona and Rio Vista. The bypass flows generally north to south and extends from Fremont Weir (RM 83) downstream to Liberty Island (RM 14) in the Delta.

During high stages in the Sacramento River, water enters the Yolo Bypass from the north over Fremont Weir and from the east via the Sacramento Weir and bypass. Flows are then conveyed south around the City of West Sacramento. During periods of high stage in the Sacramento River, flows from the Colusa Basin are also discharged through the Knights Landing Ridge Cut to the Yolo Bypass. Additional flows enter the Yolo Bypass from the west-side tributaries, including Cache Creek, Putah Creek, and the Willow Slough Bypass. Flood waters reenter the Sacramento River through Cache Slough, upstream from Rio Vista. Liberty Island is the southern outlet of the Yolo Bypass.

The Yolo Bypass floods approximately once every three years, generally during the winter months of December, January, and February. However, the flood season can occasionally be longer. For example, in 1998, water entered the bypass in June (United States Department of the Interior, Bureau of Reclamation [Reclamation] 2014). During the irrigation season, non-flood waters exit the bypass primarily through the east levee Toe Drain, a riparian channel running along the eastern edge of the bypass.

Regulated Fremont Weir flows based on 2017 reservoir operations and system conditions were evaluated as a part of CVFPP. Table 4-2 shows the AEP of instantaneous flows at Fremont Weir as computed by the CVFPP.

Table 4-2. Annual Exceedance Probability of Regulated Peak Flows into Yolo Bypass at Fremont Weir.

Annual Exceedance Probability --	Maximum Annual Instantaneous Flow (cfs)
0.900	36,043
0.800	42,309
0.667	60,228
0.500	89,189
0.429	100,879
0.200	158,580
0.100	217,221
0.040	297,720
0.020	336,440
0.010	351,801
0.005	363,896
0.002	402,613

Source: 2017 No Project Regulated Flow Frequency Curve for SAC14a, evaluated for CVFPP Update (DWR, 2016a).
Key: cfs = cubic feet per second

4.1.2 Flood Management

This section describes major features of the flood management system in the Project area, including reservoirs, levees, weirs, and bypasses. Flows within the Project area are regulated by Shasta Lake, Lake Oroville, and Folsom Lake.

Releases from Shasta, Folsom, and Oroville dams often are made for flood management. Releases for flood management occur either after a storm event to maintain the prescribed vacant flood space in the reservoir or in the fall, beginning in early October, to reach the prescribed vacant flood space. During a storm event, releases for flood management occur either over the dam spillways during large events or through river outlets for smaller events.

4.1.2.1 Shasta Lake

Shasta Dam is a curved, gravity-type, concrete structure that rises 533 feet above the streambed, with a total height above the foundation of 602 feet. The dam has a crest width of about 41 feet and a length of 3,460 feet. Shasta Lake has a storage capacity of 4,550,000 acre-feet and a water surface area at full pool of 29,600 acres. Maximum seasonal flood management storage space in Shasta Lake is 1.3 million acre-feet. Releases from Shasta Dam can be made through the power plant, over the spillway, or through the river outlets. The power plant has a maximum release capacity of nearly 20,000 cubic feet per second (cfs), the river outlets can release a maximum of 81,800 cfs at full pool, and the maximum release over the drum-gated spillway is 186,000 cfs (Reclamation 2014).

4.1.2.2 Lake Oroville

The primary flood management feature of the Feather River Basin is Lake Oroville, with a flood management reservation volume of 750,000 acre-feet. Lake Oroville releases are used to help maintain flows below the maximum flood flow of 150,000 cfs on the Feather River and, in conjunction with New Bullards Bar Reservoir on the Yuba River, to maintain flows below the maximum flood flow of 300,000 cfs at the Yuba River confluence. Levees line the Feather River from the City of Oroville (RM 63) to its confluence with the Sacramento River (Reclamation 2014).

4.1.2.3 Folsom Lake

The lower American River is primarily protected from flooding by Folsom Dam. The Folsom Lake flood management reservation volume is variable, ranging from 400,000 to 670,000 acre-feet. The target maximum release on the American River is 115,000 cfs due to the leveed capacity along the lower American River. The American River is leveed on the north bank from Carmichael Bluffs to its confluence with the Sacramento River, and on the south bank from Sunrise Boulevard Bridge (RM 19) to its confluence with the Sacramento River (Reclamation 2014).

4.1.2.4 Sacramento River

Flood management facilities along the Sacramento River and in the Delta include the levees, weirs, and bypasses of the upper and lower Butte Basin and the levees, weirs, and bypasses of the Sacramento River between Colusa and Collinsville. The levees, weirs, and bypasses are features of the SRFCP, which began operation in the 1930s and was significantly expanded in the 1950s. The following section describes reaches of the Sacramento River in terms of their flood management features.

4.1.2.4.1 Lower Butte Basin

When Sacramento River flows exceed between 90,000 and 100,000 cfs at Ord Ferry, water flows naturally over the banks of the river into the Butte Basin. In addition to the Sacramento River overbank flows at Ord Ferry, the basin receives inflow over Colusa and Moulton weirs and from tributary streams draining from the northeast, principally Cherokee Canal and Butte Creek. Outflows from the Butte Basin move through the Sutter Bypass when the Sacramento River stage is high or through the Butte Slough Outfall Gates (RM 139) into the Sacramento River when the river stage is low (Reclamation 2014).

4.1.2.4.2 Sacramento River from Colusa to Verona

The Sacramento River flows through the 64 miles between Colusa (RM 143) and Verona (RM 79). The levee system continues along both sides of this river reach. The levee spacing (or channel width), east to west, is wider between the upstream sections, from RM 176 to RM 143 at Colusa, than the levee spacing downstream from Colusa. The Feather River, the largest east-side tributary to the Sacramento River, enters the river just above Verona. Flood management diversions in this segment of the river occur at Tisdale Weir and Fremont Weir.

4.1.2.4.3 Sacramento River from Verona to the Delta

Below Verona, the Sacramento River flows 79 miles to Collinsville, at the mouth of the Delta, passing the City of Sacramento along the way. The Yolo Bypass parallels this river reach to the west. Flows enter this river reach at various points. First, flows from the Natomas Cross Canal enter the Sacramento River approximately one mile downstream from the mouth of the Feather River (RM 80). The American River (RM 60), the southernmost major Sacramento River tributary, enters the river at the City of Sacramento. Flows in the Yolo Bypass reenter the river near Rio Vista (RM 12). As the river enters the Delta, Georgiana Slough branches off from the mainstem Sacramento River, routing flows into the central Delta. The one diversion point for flood management is at Sacramento Weir, where floodwaters are diverted from the Sacramento River through the Sacramento Bypass to the Yolo Bypass under the highest flow conditions.

4.1.2.5 Yolo Bypass

Flood management facilities along the Yolo Bypass include Fremont Weir at the northern end of the bypass, levees on either side of the bypass, and the bypass itself, which conveys floodwaters from the Sacramento, American, and Feather rivers away from West Sacramento.

- From Fremont Weir to the Knights Landing Ridge Cut, the design capacity of the Yolo Bypass is 343,000 cfs. The west levee is about two miles long and intended to reduce flood risk to adjacent agricultural land. The Knights Landing Ridge Cut, with a design capacity of 20,000 cfs, enters the west side of the Yolo Bypass along this reach (California Department of Water Resources [DWR] 2010).
- The design capacity of the Yolo Bypass increases to 362,000 cfs from the Knights Landing Ridge Cut to Cache Creek (DWR 2010).
- From Cache Creek to the Sacramento Bypass, the design capacity of the Yolo Bypass is 343,000 cfs, with six feet of freeboard. The west levee is about 6.4 miles long and is intended to reduce flood risk to agricultural land in Reclamation District (RD) 2035 and Woodland. Maintenance of the levee is conducted by RD 2035. The east levee is about 6.1 miles long and reduces flood risk to adjacent agricultural land. Maintenance of the east levee is conducted by RD 1600. Design inflow to the Yolo Bypass from the Sacramento Bypass is 112,000 cfs (DWR 2010).
- From the Sacramento Bypass to Putah Creek, the design capacity of the Yolo Bypass is 480,000 cfs, with six feet of freeboard. The west levee is about 5.2 miles long. Willow Slough Bypass, with a design flow of 6,000 cfs, enters the Yolo Bypass within this reach. The east levee is about seven miles long and is intended to reduce flood risk to West Sacramento. The west levee of the bypass is maintained by RD 900 and DWR, and the east levee is maintained by RD 900. The Yolo Basin Wetlands are located within this reach and lie over the bypass channel. The Yolo Basin Wetlands, part of the larger Yolo Bypass Wildlife Area, provide about 3,700 acres of wildlife habitat, including permanent wetlands, seasonal wetlands, grassland/uplands, and riparian woodland. The California Department of Fish and Wildlife operates and maintains the Yolo Bypass Wildlife Area in accordance with the United States Army Corps of Engineers (USACE) requirements.
- From Putah Creek to the Miner Slough, the Yolo Bypass has a design capacity of 500,000 cfs; from Miner Slough to the Sacramento River, the design capacity is 500,000 cfs. The

design freeboard from Putah Creek to the Sacramento River is six feet. The west levee begins about seven miles downstream from Putah Creek and extends about 13 miles to the Sacramento River in the Delta, near Rio Vista. Along this reach, Cache Slough and Lindsey Slough enter the Yolo Bypass. The levee is intended to reduce flood risk to adjacent agricultural land. Maintenance is conducted by RD 536, RD 2060, RD 2098, and RD 2068. The east levee extends about 23 miles to the Sacramento River. Along this reach, Miner Slough has a design inflow of 10,000 cfs from a series of Delta sloughs that are distributary from the Sacramento River. When it was constructed in 1963, the Sacramento Deep Water Ship Channel narrowed the channel of the Yolo Bypass and impacted the design profile. The west levee of the ship channel replaced a portion of the left levee of the Yolo Bypass (DWR 2010).

- Liberty Island, Little Holland Tract, Prospect Island, Little Egbert Tract, and other lands surrounded by private levees lie within the bypass near its southern end. The levees, generally limited in height, restrict low flows in the Yolo Bypass but overtop during high flows. Levees on Liberty Island and a portion of Little Holland Tract failed due to high Yolo Bypass flows in 1995 and 1998, and the lands have remained flooded since that time (DWR 2010).

4.2 Regulatory Setting

This section provides the regulatory setting for flood control, hydraulics, and hydrology, including potentially relevant Federal, State, and local requirements.

4.2.1 Federal Plans, Policies, and Regulations

This section discusses the Federal authorizations for Federal flood protection projects in the Project area. While each authorization covers one major project, such as the SRFCP, projects were generally implemented over time through construction of various segments of the projects. Some levees are physically disconnected from the larger system and were constructed to provide local benefits, while others were constructed to provide system benefits.

While the purpose of this section is to show the Federal authorizations, statements on each project's features are included. The statements were extracted from the congressional authorizations and their supporting USACE Chief of Engineers Reports.

4.2.1.1 Sacramento River Flood Control Project

The SRFCP is the core of the flood protection system along the Sacramento River and its tributaries. About 980 miles of levees are included in the SRFCP. Portions of these levees were originally constructed by local interests and were either included directly in the SRFCP without modification or modified to meet USACE project standards. The SRFCP was originally authorized by the Flood Control Act of 1917 and subsequently modified and extended by the Flood Control Acts of 1928, 1937, and 1941. The State adopted and authorized the SRFCP in 1953 by adding Section 12648 to the California Water Commission (CWC) regulations. Assurances of cooperation were provided in the 1953 Memorandum of Understanding (MOU) (USACE and The Reclamation Board 1953).

4.2.1.1.1 Flood Control Act of 1917

Public Law 64-367 (64th Congress) is the Flood Control Act of 1917. The authorized flood control project was in accordance with plans contained in the California Debris Commission (predecessor of the Reclamation Board) report submitted on August 10, 1910 and printed as United States House Document (HD) 81 (62nd Congress), as modified by the California Debris Commission report submitted on February 8, 1913, and printed in Rivers and Harbors Committee Document No. 5 (63rd Congress). The 1913 document provides for the rectification and enlargement of river channels and the construction of weirs (Hagwood 1981).

4.2.1.1.2 Flood Control Act of 1928

Public Law 70-391 (70th Congress) is the Flood Control Act of 1928. The 1928 act modified the Flood Control Act of 1917 in accordance with the California Debris Commission report submitted on May 1, 1924 and printed in United States Senate Document (SD) 23 (69th Congress). Major changes made by the act include the following:

- Elimination of reclamation works in Butte Basin
- Construction of a weir above Colusa
- Elimination of two of the four proposed cutoffs in the stretch of river between Colusa and the mouth of the Feather River
- Use of the existing Tisdale Weir instead of construction of a new weir
- Relocation of certain levee lines on the Feather River and in the Yolo Bypass
- Construction of settling basin at the mouth of Cache Creek
- Designation of three sloughs in the Delta to be left open instead of closed
- Increase in levee cross-section dimensions
- Conclusion that San Joaquin Valley flood problems are different from those of the Sacramento Valley, and flood control in the San Joaquin Valley should be considered in a separate report, if deemed advisable
- Assignment of some maintenance responsibility to Federal government (maintenance of enlarged channels, weirs, and certain gages)
- Increase in the flood control project cost
- Change of the cost share between the Federal government and non-Federal interests
- Establishment of design capacities to be maintained (Hagwood 1981)

4.2.1.1.3 Rivers and Harbors Act of 1937

Public Law 75-392 (75th Congress) is the Rivers and Harbors Act of 1937. The prior 1917 and 1928 Flood Control Acts were modified in accordance with a Senate Commerce Committee Document (75th Congress). The document concluded that maintenance by the Federal government was not consistent with policies of the Flood Control Act of 1936 (Public Law 74-738, 74th Congress). Additional work was required on revetment for eroding levees, and the flood control project cost was adjusted. Requirements were added for local interests to provide rights-of-way and hold the Federal government harmless from damage claims (Hagwood 1981).

4.2.1.1.4 Flood Control Act of 1941

Public Law 77-228 (77th Congress) is the Flood Control Act of 1941. The 1941 act modified previous acts in accordance with HD 205 (77th Congress). The act authorized Federal expenditures for completion of the Project and required the following local cooperation:

- Furnish all rights-of-way, including railway, highway, and all other utility modifications
- Hold and save the United States free from damage claims
- Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army (Hagwood 1981)

Construction of the SRFCP began in 1918 and continued for decades. By 1944, the flood control project was regarded as being about 90 percent complete (Hagwood 1981). The plan for completing the flood control project was presented in the November 30, 1953, *MOU Respecting the Sacramento River Flood Control Project* between USACE and The Reclamation Board (USACE and The Reclamation Board 1953). This MOU included levee construction standards for river project levees and bypass levees and outlined maintenance responsibilities. The plan specified no difference in levee standards for urban versus agricultural levees. By 1961, the flood control project was essentially completed (Kelley 1989).

Some documents refer to the flood control project from these authorizations as the “Old” SRFCP.

4.2.1.2 Sacramento River and Major and Minor Tributaries Project

The Sacramento River and Major and Minor Tributaries Project was initially authorized by the Federal government in the Flood Control Act of 1944 (Public Law 78-534, 78th Congress) and was further amended by the Flood Control Act of 1950 (Public Law 81-516, 81st Congress). The Project was a modification and extension of the SRFCP and was to supplement reservoir storage by reducing flooding potential to certain areas along the Sacramento River. Authorizing legislation by the State of California is contained in Section 12648 of the CWC regulations. Assurances of cooperation were provided in the 1953 MOU (USACE and The Reclamation Board 1953).

The Project provided for levee construction and/or channel enlargement of the following minor tributaries of the Sacramento River: Chico Creek, Mud Creek, and Sandy Gulch; Butte and Little Chico creeks; Cherokee Canal; and Elder and Deer creeks (Tehama County). In addition, the Project also included revetment of levees for the Sutter, Tisdale, Sacramento, and Yolo bypasses. Minor tributary improvements were to reduce flood risk to about 80,000 acres of agricultural land important to the economy of the region and to the City of Chico and other smaller communities. Bypass levee revetment features of the Project were to reduce flood risk to floodplain lands adjacent to the bypasses and to decrease requirements for levee repairs under emergency conditions (USACE 1999).

4.2.1.3 American River Flood Control Project

The American River Flood Control Project was authorized by the Federal government in the Flood Control Act of 1954 to reduce flood risk along the lower American River. Authorizing legislation by the State of California is contained in Section 12648.1 of the CWC regulations. The Project was constructed in 1958 by USACE and includes approximately eight miles of levee along the north bank of the American River between Carmichael Bluffs and the terminus of the SRFCP levee near the State Fairgrounds. It also includes about 10 miles of levee along the south bank of the American River from the confluence with the Sacramento River to Mayhew drain (DWR 2010).

4.2.1.4 Sacramento River – Chico Landing to Red Bluff

The Sacramento River Project for bank protection and channel improvements from Chico Landing to Red Bluff was authorized by the Flood Control Act of 1958 (Public Law 85-500, 85th Congress). Authorizing legislation by the State of California is contained in Section 12648.2 of the CWC regulations. The Project was authorized in accordance with recommendations by the USACE Chief of Engineers in HD 272 (84th Congress). The Project was a modification and extension of the SRFCP and was to increase bank protection along the Sacramento River from Chico Landing to Red Bluff and lower portions of its principal tributaries to reduce flood risk with discharges modified by Shasta Dam and Black Butte Dam. Black Butte Dam was planned to be constructed soon after this Project was completed. The area encompassed by this Project included the Sacramento River from Chico Landing to Red Bluff and lower portions of Antelope, Mill, Deer, Pine, Elder, Thomes, and Stony creeks (USACE 1999).

4.2.1.5 Oroville Project

Federal participation in the construction of Oroville Dam was authorized by the Flood Control Act of 1958 (Section 204 of Public Law 85-500, 85th Congress). The Federal interest was flood control provided by the flood control storage reservation of 750,000 acre-feet. This authorization also included the non-State Plan of Flood Control New Bullards Bar and the Marysville Dam (not constructed at the time of this report). Authorizing legislation by the State of California is contained in Sections 12648 and 12649 of the CWC regulations, though these sections refer only to a project that would accomplish the same flood control purposes as proposed by the Table Mountain Dam (DWR 2010).

4.2.1.6 Sacramento River Bank Protection Project

Erosion presents a serious ongoing threat to the SRFCP levee system. The Sacramento River Bank Protection Project was authorized by Section 203 of the Flood Control Act of 1960 (Public Law 86-645, 74 Statute 498), supplemented by Section 202 of the River Basin Monetary Authorization Act of 1974 (Public Law 93-252, 88 Statute 49), as amended by Section 3031 of the Water Resources Development Act of 2007, and further supplemented by Section 140 of Public Law 97-377 (96 Statute 1916). Its intent was to preserve the integrity of the SRFCP levee system. Section 12649.1 of the CWC regulations provides the State authorization for the Project.

The first and second phases authorized construction of 915,000 linear feet of bank protection work. Construction of the first phase began in June 1965. The second phase of construction was authorized in 1974, and USACE began investigation of the third phase in the mid-1990s (DWR 2010).

4.2.1.7 Sacramento River Bank Protection Project, First Phase Mitigation

Environmental mitigation for the impacts of the first phase of the Sacramento River Bank Protection Project was authorized by Congress in 1986 and included a post-project mitigation program involving the purchase, protection, and revegetation of 260 acres (DWR 2010). The authorized mitigation for Phase 1 is complete (USACE 2014).

4.2.1.8 Snagging and Clearing Projects

The Continuing Authorities Program allows USACE to respond to a variety of flood problems without obtaining specific congressional authorization for each project. Section 208 of the 1954 Flood Control Act, as amended, allows work to remove accumulated snags and other debris and to clear and straighten stream channels. Section 12656.7 of the CWC regulations provides the State authorization for these types of projects. Three snag removal and stream clearing projects in the Sacramento River Basin include the following:

- Adin Project – A flood control project was authorized by the Federal government for Ash and Dry creeks at Adin in Modoc County in the Flood Control Act of 1937 and modified by the Flood Control Act of 1954. Ash and Dry creeks are tributary streams to the Pit River above Shasta Dam. This project was intended to reduce local flood risk (DWR 2010).
- Salt Creek Project – The Salt Creek Project was authorized by Section 2 of the Flood Control Act of 1937, as amended by Section 208 of the Flood Control Act of 1954. Salt Creek is a tributary stream that joins the Sacramento River one mile below Keswick Dam. This project was intended to reduce local flood risk (DWR 2010).
- McClure Creek Project – The McClure Creek Project was authorized by Section 2 of the Flood Control Act of 1937, as amended by Section 208 of the Flood Control Act of 1954. Salt Creek is a tributary stream that joins the Sacramento River below Tehama. This project was intended to reduce local flood risk (DWR 2010).

4.2.1.9 FEMA 60.3(d) (3) – Floodway Requirement

The Federal Emergency Management Agency's (FEMA's) floodplain management criteria for flood-prone areas prohibits encroachments (including fill, new construction, substantial improvements, and other development) within the adopted regulatory floodway. Developments within FEMA floodways must demonstrate that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of 100-year flows.

No regulatory floodways have been defined or adopted for the Yolo Bypass or the Sacramento River. The FEMA floodway requirement states that until a regulatory floodway is designated, no new construction, substantial improvements, or other development shall be permitted unless it is demonstrated that proposed development will not increase the water surface elevation (WSE) of the one-percent-annual-chance base flood more than one foot at any point within the community.

4.2.1.10 Water Control Manual Flood Management Requirements

Pursuant to the Flood Control Act of 1944, Shasta Dam, Oroville Dam, and Folsom Dam are subject to regulations from the respective Water Control and Reservoir Regulation Manuals.

4.2.1.10.1 Shasta Dam

The Shasta Dam Water Control Manual (USACE 1977) establishes flood control regulations for Shasta Dam. According to the Shasta Dam Flood Control Diagram (USACE 1977), releases from Shasta are operated so that downstream flows do not exceed 79,000 cfs at Keswick or 100,000 cfs at Bend Bridge.

4.2.1.10.2 Oroville Dam

The Oroville Dam Reservoir Regulation Manual (USACE 1970) establishes flood control regulations for Lake Oroville. Pursuant to the Flood Control Act of 1958, DWR entered into an agreement with USACE providing for operation of the Project during floods as a Federal Energy Regulatory Commission licensing condition. Per USACE requirements outlined in the Reservoir Regulation Manual, Lake Oroville is operated to maintain a 750,000 acre-feet flood control reservation below gross pool and 150,000 acre-feet of surcharge storage space during the flood season. Reservoir releases are limited to a maximum of 150,000 cfs until the reservoir reaches 10 feet above the ungated spillway lip. Flows are also limited to achieve a maximum flow of 300,000 cfs below the Feather-Yuba confluence.

4.2.1.10.3 Folsom Dam

The 1987 Folsom Dam Water Control Manual (USACE 1987) establishes the flood control regulations for Folsom Dam. The flood control diagram was updated in 2003 (Sacramento Area Flood Control Agency 2003). USACE and Reclamation are in the process of updating the Folsom Dam Water Control Manual, but the update is not complete as of June 2017.

4.2.2 State Plans, Policies, and Regulations

This section discusses the State plans, policies, and regulations for State flood protection projects in the Project area. Applicable State plans, policies, and regulations related to minimum flows for water rights and water quality standards are described in Chapter 5, *Surface Water Supply*.

4.2.2.1 Central Valley Flood Protection Plan

The Central Valley Flood Protection Plan (CVFPP) is a strategic and long-range plan for improving flood risk management in the Central Valley. Prepared by DWR in accordance with the Central Valley Flood Protection Act of 2008 (and adopted by the Central Valley Flood Protection Board in June 2012, the CVFPP guides the State’s participation in managing flood risk in areas protected by the State Plan of Flood Control (SPFC). The adopted CVFPP describes the State Systemwide Investment Approach (SSIA) for sustainable, integrated flood management in areas protected by SPFC facilities.

The CVFPP includes a program to protect existing urban areas with populations greater than 10,000 to achieve protection against a 0.5 percent chance event, including in-place fixes such as levee raises, flood walls, levee strengthening, and levee setbacks, depending on the level of adjacent development. The CVFPP also includes a program for small communities under 10,000 for flood protection using nonstructural improvements, levee improvements, ring levees, training levees, or floodwalls to preserve development opportunities without providing urban flood protection. Improvements for rural-agricultural areas are less extensive than improvements for urban and small communities and would be focused on maintaining levee elevations and access roads, easements, and levee improvements, including setbacks where feasible.

Implementation of some flood improvements began in 2007 when bond funding provided a down payment toward SPFC improvements and extensive evaluations of SPFC facilities that were later included in the CVFPP. Since 2007, approximately 220 miles of urban and 100 miles of non-urban SPFC levees have been repaired, rehabilitated, or improved (DWR 2016a).

The CVFPP proposes system improvements, defined as physical actions or improvements with the potential to benefit large portions of the flood management system and improve the overall function and performance of the SPFC in managing large floods that affect urban, small community, and rural-agricultural areas. An important category of system improvement projects is bypass capacity expansion, which includes modifications to weirs, bypass systems, hydraulic structures, and easements. Bypass capacity could be increased by modifying existing weirs and bypasses.

The CVFPP states that the ultimate configuration of system improvement projects would be known only after future feasibility studies have explored the potential magnitude and extent of hydraulic improvements within the system (DWR 2012).

4.2.2.1.1 Central Valley Flood Protection Plan Update

The *Draft 2017 CVFPP Update* includes refinements to the SSIA that were identified through ongoing flood management planning and coordination with Federal and local partners to improve flood protection in the Central Valley (DWR 2016a).

Since 2012, DWR has completed the Sacramento River Basin-Wide Feasibility Study (BWFS) and San Joaquin River BWFS, and recommended several system improvement projects for detailed study (DWR 2016b and 2017). These refined system improvements are identified in the 2017 CVFPP Update (DWR 2016a)

The CVFPP also identified potential improvements for the weir and bypass system, including a 1.5-mile expansion of Upper Elkhorn Basin and a 3,500-foot levee setback along the Lower Elkhorn Basin.

4.2.3 Regional and Local Plans, Policies, and Regulations

4.2.3.1 Lower Sacramento/Delta North Regional Flood Management Plan

The *Regional Flood Management Plan for the Lower Sacramento/Delta North Region* is the regional follow-on to the 2012 *Central Valley Flood Protection Plan* and is being developed at the local and regional level with partial funding from DWR. The *Regional Flood Management Plan* establishes the flood management vision for the region and identifies a list of regional actions including improvements to existing flood management facilities. Proposed improvements were generally evaluated at pre-feasibility levels, with preliminary engineering, costs, and financing improvements completed for the majority of the proposed projects. DWR will consider these regional improvements in their basin-wide feasibility studies, assessing their consistency with refined system improvements and other aspects of the SSIA.

Other applicable regional and local plans, policies, and regulations related to minimum flows for water rights and water quality standards are described in Chapter 5 and public safety hazards in Chapter 11.

4.3 Environmental Consequences

This section describes the environmental consequences associated with the Project alternatives and the No Action Alternative. This section presents the assessment methods used to analyze the effects on flood control, hydraulics, and hydrology; the thresholds of significance that determine the significance of effects; and the potential environmental consequences and mitigation measures as they relate to each Project alternative. Detailed descriptions of the alternatives evaluated in this section are provided in Chapter 2, *Description of Alternatives*.

4.3.1 Methods for Analysis

An overview of the methods used in the analysis of the potential effects for hydrology, hydraulics and flood control is presented in the following discussion.

4.3.1.1 Models Used

Several models were used to evaluate the effects of the project alternatives on flood control, hydraulics, and hydrology.

4.3.1.1.1 HEC-RAS

The 1-dimensional Central Valley Floodplain Evaluation and Delineation (CVFED) Hydrologic Engineering Center River Analysis System (HEC-RAS) hydraulic model of the SRFCP (DWR 2014) was used to evaluate changes in peak WSE throughout the Yolo Bypass and the Sacramento River.

The CVFED HEC-RAS model geometry was modified to represent assumed future hydraulic features for each of the alternatives. Hydrology was scaled down from the Central Valley Hydrology Study's (CVHS) 1997 storm pattern to represent a storm with a peak flow at Fremont Weir close to 343,000 cfs, the capacity of the Yolo Bypass. The resulting hydrograph was routed through the HEC-RAS model to find peak WSE. Resulting peak WSE from the alternatives were compared against the resulting peak WSE from existing geometry. HEC-RAS model simulations were developed assuming current sea level rise for existing conditions. A simulation of the No Action Alternative, assuming future sea level rise, was also developed to allow comparison against the HEC-RAS model simulation for existing conditions. Alternatives 1, 4, 5, and 6 were each run for one simulation, assuming current sea level rise, for comparison against the HEC-RAS model simulation for existing conditions.

The main model limitation of the HEC-RAS model is the level of detail of its geometry, particularly at low flows. Results are averaged across cross-sections and represent the floodplain in more coarse spatial detail than the two-dimensional TUFLOW model, discussed below and in Section 4.4.1.1.2. The HEC-RAS model is calibrated to represent peak WSE during flood flows and is not calibrated to represent low flows.

4.3.1.1.2 TUFLOW

TUFLOW is a finite difference two-dimensional hydrodynamic modeling engine used to simulate the hydraulics within the Yolo Bypass. The two-dimensional capabilities of the engine allow for the comparison of the spatial distribution of flow, velocity, and depth, with or without assumed future hydraulic features. The Yolo Bypass application of the TUFLOW model extends along the Sacramento River from RM 118 to RM 12 near Rio Vista and includes the entire Yolo Bypass. Historic flows from the year 1997 to 2012 were simulated for several channel and weir configurations on a five- to 10-second timestep as a part of the initial alternatives evaluation (see Appendix D, *Hydrodynamic Modeling Report*).

The two-dimensional TUFLOW model is more spatially detailed than the HEC-RAS model and is calibrated for low flows as well as high flows.

4.3.1.1.3 CalSim II

CalSim II is the application of the Water Resources Integrated Modeling System software to the Central Valley Project (CVP) and State Water Project (SWP). This application was jointly developed by Reclamation and DWR for planning studies relating to CVP/SWP operations. The primary purpose of CalSim II is to evaluate the water supply reliability of the CVP and SWP at current and/or future levels of development (e.g., 2005, 2030), with and without various assumed future facilities and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta and CVP/SWP exports to the San Francisco Bay Area, San Joaquin Valley, Central Coast, and Southern California. CalSim II models a complex and extensive set of regulatory standards and operations criteria. Descriptions of both are contained in Appendix E, *CalSim II Modeling*.

CalSim II typically simulates system operations for an 82-year-period using a monthly timestep. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed level of development (e.g., 2030, 2070). The historical flow record of October 1921 to September 2003, adjusted for the influences of land use changes and upstream flow regulation, is used to represent the possible range of water supply conditions. Major Central Valley rivers, reservoirs, and CVP/SWP facilities are represented by a network of arcs and nodes. CalSim II uses a mass balance approach to route water through this network. Simulated flows are mean flows for the month; reservoir storage volumes correspond to end-of-month storage.

The hydrologic analysis conducted for this Draft Environmental Impact Statement (EIS)/Environmental Impact Report (EIR) modified the standard historically based CalSim II input hydrology to represent 2030 and 2070-level climate change based on the CWC Climate Change Water Storage Investment Program modeling (CWC 2016). Additionally, the CalSim II used for this analysis includes representation of 2030 and 2070-level sea level rise to ensure Delta water quality operations are consistent with expected conditions. While the 2030 hydrology scenarios include existing infrastructure, the 2070 hydrology scenarios also assume reasonably foreseeable actions that could occur in the Project area in the future and do not rely on approval or implementation of the Project, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. These reasonably foreseeable actions, in addition to changes in regulatory conditions and water supply demands, would result in differences in flows on the Sacramento River and in the Delta between existing conditions and the No Action Alternative. Possible changes include the following:

- Implementation of the California WaterFix Project
- Full implementation of the Grassland Bypass Project
- Implementation of the South Bay Aqueduct Improvement and Enlargement Project
- San Joaquin River Restoration Program full restoration flows

Although CalSim II is the best available tool for simulating system-wide operations, the model also contains simplifying assumptions in its representation of the real system. CalSim II's predictive capability is limited and cannot be readily applied to hourly, daily, or weekly timesteps for hydrologic conditions. The model, however, is useful for comparing the relative effects of alternative facilities and operations within the CVP/SWP system on a monthly timestep. Modeling of the existing conditions and comparable level of development alternatives assumes a 2030 hydrology and sea level rise with existing infrastructure and regulatory conditions. Modeling of the No Action Alternative and comparable level of development alternatives assumes a 2070 hydrology and sea level rise and reasonably foreseeable infrastructure and regulatory conditions.

A general external review of the methodology, software, and applications of CalSim II was conducted in 2003 (Close et al. 2003). An external review of the San Joaquin River Valley CalSim II model also was conducted (Ford et al. 2006). Several limitations of the CalSim II models were identified in these external reviews. The main limitations of the CalSim II models are as follows:

- Model uses a monthly timestep.
- Accuracy of the inflow hydrology is uncertain for current conditions and future conditions with climate change.
- Model lacks a fully explicit groundwater representation.

In addition, Reclamation, DWR, and external reviewers have identified the need for a comprehensive error and uncertainty analysis for various aspects of the CalSim II model. DWR conducted the CalSim II Model Sensitivity Analysis Study (DWR 2005), and Reclamation has completed a similar sensitivity and uncertainty analysis for the San Joaquin River basin (Reclamation and DWR 2006).

Despite these limitations, monthly CalSim II model results remain useful for comparative purposes. It is important to differentiate between "absolute" or "predictive" modeling applications and "comparative" applications. In absolute applications, the model is run once to predict a future outcome. Errors or assumptions in formulation, system representation, data, or operational criteria all contribute to total error or uncertainty in model results. In comparative applications, the model is run twice, once to represent a base condition (no-action) and a second time with a specific change (action) to assess the change in the outcome because of the input change. In the comparative mode (the mode used for this Draft EIS/EIR), the difference between the two simulations is of principal importance. Most potential errors or uncertainties affecting the “no-action” simulation also affect the “action” simulation in a similar manner. As a result, the effect of errors and uncertainties on the difference between the simulations is reduced. However, not all limitations are fully eliminated by the comparative analysis approach. Small differences between the alternatives and the bases of comparison are not considered to be indicative of an effect of the alternative.

4.3.1.2 Changes in Flows over Fremont Weir into the Yolo Bypass

All the action alternatives include operation of a new gated notch (or notches) at Fremont Weir, as described in Chapter 2, *Description of Alternatives*. The long-term flow patterns into the Yolo Bypass would change based upon the magnitude of flows in the Sacramento River at Fremont Weir, the changes to gate operations, and the changes to the dimensions and elevations of the gates at Fremont Weir, as evaluated quantitatively using CalSim II model output. Assumptions used in the CalSim II model are described in Appendix E, *CalSim II Modeling*.

The flood control effect of changing the long-term flow patterns into the Yolo Bypass was evaluated by comparing the number of times the monthly average flow exceeded 136,869 cfs in the CalSim II results for each of the alternatives. 136,869 cfs represents the maximum existing conditions modeled monthly average flow of 136,869 cfs at Fremont Weir. The maximum existing conditions modeled monthly average flow was chosen as a threshold for high flows because any increase in occurrences in the highest monthly flow would likely correspond with a change in the highest sub-monthly peak flows.

Any change in occurrences of flows above the specified threshold was selected since that is within the ability of a stream gage to measure flows reliably; the USGS rates gages as “Excellent” rating indicates that about 95 percent of the daily discharges are within 5 percent of the true value (USGS 2006).

4.3.1.3 Changes in Sacramento River Flows at Freeport

All the action alternatives include operation of a new gated notch (or notches) at Fremont Weir, as described in Chapter 2, *Description of Alternatives*, which would affect flows into the Sacramento River downstream from Fremont Weir at Freeport. Historical data were available for the Sacramento River at Freeport, allowing for a flood-frequency analysis of historical flows.

The long-term flow patterns into the Sacramento River would change based upon the magnitude of flows in the Sacramento River at Fremont Weir, the changes to gate operations, and the changes to the dimensions and elevations of the gates at Fremont Weir, as evaluated quantitatively using CalSim II model output. Assumptions used in the CalSim II model are described in Appendix E, *CalSim II Modeling*.

The flood control effect of changing the long-term flow patterns into the Sacramento River below Freeport was evaluated by comparing the number of times the monthly average flow exceeded 72,231 cfs in the CalSim II results for each of the alternatives. 72,231 cfs represents the maximum existing conditions modeled monthly average flow of 72,231 cfs at Freeport. The maximum existing conditions modeled monthly average flow was chosen as a threshold for high flows because any increase in the highest monthly flow would likely correspond with a change in high sub-monthly peak flows.

4.3.1.4 100-Year Flood Hazard area

Results from the HEC-RAS and CalSim II models were used to assess changes in the 100-year flood hazard area. CalSim II results were used to assess changes in the peak flow exceedance. HEC-RAS results were compared to determine whether the altered peak flows would exceed the bypass capacity and whether increases in maximum water surface elevation within the bypass would occur for the existing peak flow. Since the HEC-RAS model is calibrated to represent WSE at high flows, a comparison of peak WSE is a suitable use of the model.

The differences in preliminary TUFLOW results of similar alternatives were used to confirm the possible range of changes in flood flows for all the EIS/EIR alternatives. For the highest historic flood flow routed in TUFLOW, which occurred during the 1997 event, TUFLOW indicated that some portions of the bypass experienced increases in maximum WSE between 0.02 and 0.05 feet for the alternatives relative to the existing conditions hydrodynamic model, as described in Appendix D, *Hydrodynamic Modeling Report*. This agrees with the general range of changes in WSE between alternatives as modeled in HEC-RAS.

The analyses discussed in Section 4.4.2 do not include graphical comparisons of the 100-year flood hazard area because the flows would remain limited to the bypass and WSE would remain similar under high flows.

4.3.2 Thresholds of Significance – CEQA

A significant effect on the environment means “a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the Project.” (State CEQA Guidelines, Section 15382). The following thresholds of significance were developed based on the guidance provided in Appendix G of the CEQA Guidelines and modified based on thresholds used in the environmental documents for other projects in the region (e.g., the California WaterFix, Shasta Lake Water Resources Investigation). These thresholds also encompass the factors considered under NEPA to determine the context and the intensity of its impacts.

An alternative would result in a significant impact under CEQA on hydrology, hydraulics, and flood control if, relative to existing conditions, it would increase the frequency or severity of damaging flood flows, as indicated by the following:

- Increase the number of occurrences of monthly flows above 136,869 cfs in the Yolo Bypass (136,869 corresponds to the maximum modeled existing conditions monthly flow) in more than one year. The analysis compares the increase in number of occurrences, rather than the magnitude of change, because peak flow magnitudes cannot be characterized on a monthly timestep. Monthly flows were used to assess effects due to the reliance on CalSim II and its monthly timestep to simulate the long-term effects of the project on hydrology and flood control.
- Increase the number of occurrences of monthly flows above 72,231 cfs in the Sacramento River at Freeport (72,231 cfs corresponds to the maximum modeled existing conditions monthly flow) in more than one year. See rationale for using monthly averages above.

- Place housing or other structures within a 100-year flood hazard area as mapped on a Federal flood hazard boundary or Flood Insurance Rate Map or other flood hazard delineation map
- Place structures that would impede or redirect flood flows within a 100-year flood hazard area

As described in Section 4.3.1.4, the Project is not expected to impede or redirect flood flows within the 100-year flood hazard area; flows would remain within the Yolo Bypass.

Effects are determined by comparing against two baselines. For CEQA, the baseline is existing conditions, and for NEPA, the baseline is the No Action alternative, discussed in further detail in Section 4.3.3.1. The No Action Alternative includes future effects such as sea level rise and climate change; existing conditions does not.

4.3.3 Effects and Mitigation Measures

This section provides an evaluation of the direct and indirect effects on flood control, hydraulics, and hydrology from implementing the Project alternatives. This analysis is organized by Project alternative, with specific impact topics numbered sequentially under each alternative.

4.3.3.1 No Action Alternative

Under the No Action Alternative, no additional actions would be taken to increase seasonal floodplain inundation in the lower Sacramento River Basin or to improve fish passage throughout the Yolo Bypass. The Yolo Bypass would continue to be inundated during overtopping events at Fremont Weir. However, additional flows could not pass Fremont Weir when the Sacramento River elevation is below Fremont Weir. Therefore, there would be no construction-related impacts on flood control, hydraulics, and hydrology.

The No Action Alternative assumes reasonably foreseeable actions that could occur in the Project area in the future and do not rely on approval or implementation of the Project, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. These reasonably foreseeable actions, in addition to changes in regulatory conditions and water supply demands, would result in differences in flows in the Sacramento River and in the Delta between existing conditions and the No Action Alternative. Possible changes that could affect flood management (and are included in the modeling) include the following:

- Sea level rise and climate change beyond that in the existing condition;
- Implementation of the California WaterFix Project;
- Full implementation of the Grassland Bypass Project;
- Implementation of the South Bay Aqueduct Improvement and Enlargement Project; and
- San Joaquin River Restoration Program full restoration flows

4.3.3.1.1 Impact HYD-1: Change in occurrence of flows exceeding the maximum existing conditions monthly flow from the Sacramento River into the Yolo Bypass

The CalSim II modeling uses a monthly time step, which is inappropriate for flood control analysis. However, modeling results for the CalSim II period of record indicate that existing conditions flows from Fremont weir into the Yolo Bypass would be less than 136,869 cfs in all years. With additional 2070 assumed climate change, modeling results for the CalSim II period of record indicate that No Action Alternative monthly flows at Fremont Weir greater than 136,869 cfs (the maximum existing conditions monthly flow) would occur in 2 months out of the simulation period. Therefore, the No Action Alternative would increase the number of occurrences of flow above the maximum existing conditions flow, relative to the existing conditions scenario.

CEQA Conclusion

The effect of the No Action Alternative on flows from the Sacramento River into the Yolo Bypass would be **significant** relative to existing conditions because long-term changes in future flow patterns due to climate change, sea level rise, and implementation of the California WaterFix Project would increase the number of occurrences of flows exceeding the maximum existing conditions monthly flow in the Sacramento River at Fremont Weir. However, mitigation is not necessary for the No Action Alternative. The impact would remain **significant and unavoidable**.

4.3.3.1.2 Impact HYD-2: Change in occurrence of flows exceeding the maximum existing conditions monthly flow in the Sacramento River at Freeport

The CalSim II modeling uses a monthly time step, which is inappropriate for flood control analysis. However, modeling results for the CalSim II period of record indicate that existing conditions flows in the Sacramento River at Freeport would be less than 72,231 cfs in all years. With additional 2070 assumed climate change, modeling results for the CalSim II period of record indicate that No Action Alternative monthly flows at Freeport greater than 72,231 cfs (the maximum existing conditions monthly flow) would occur in 2 months out of the simulation period. Therefore, the No Action Alternative would increase the number of occurrences of flow above the maximum existing conditions flow, relative to the existing conditions scenario.

CEQA Conclusion

The effect of the No Action Alternative on flows in the Sacramento River at Freeport would be **significant** relative to existing conditions because long-term changes in future flow patterns due to climate change, sea level rise, and implementation of the California WaterFix Project would increase the number of occurrences of flows exceeding the maximum existing conditions monthly flow in the Sacramento River at Freeport. However, mitigation is not necessary for the No Action Alternative. The impact would remain **significant and unavoidable**.

4.3.3.1.3 Impact HYD-3: Change in 100-year flood hazard area

The No Action Alternative would not locate any new housing or new structures within the 100-year floodplain. In addition, the No Action Alternative would not impede or redirect flood flows within the existing flood hazard area. The physical configuration of Fremont Weir and the channel geometry within the Yolo Bypass would not be altered under the No Action Alternative. However, the No Action Alternative would have higher WSE and a greater inundated area within the Yolo Bypass relative to existing conditions due to future operational changes caused by sea level rise, climate change, and implementation of the California WaterFix Project. In general, TUFLOW and HEC-RAS model results and sensitivity analyses indicate that flows up to the weir capacity, in addition to inflows from bypass tributaries, would remain within the leveed portion of the Yolo Bypass.

Figures 4-2 through 4-6 present the resulting modeled increase in inundated area under future conditions (pink) relative to existing conditions (blue) for 1,000 to 12,000 cfs flows into the Yolo Bypass. The effects of sea level rise on inundated area are greater at lower flows and relatively smaller under higher flows. For example, the inundated area on Figure 4-6 shows a greater increase for the No Action Alternative relative to existing conditions at a 1,000 cfs flow than the increase in inundated area at a 12,000 cfs flow on Figure 4-2.

CEQA Conclusion

The effect of the No Action Alternative on the 100-year flood hazard area would be **less than significant** because no changes would occur to bypass channel geometry, and peak flood flows would not be impeded or redirected.

4.3.3.2 Alternative 1: East Side Gated Notch

Alternative 1, East Side Gated Notch, would allow increased flow from the Sacramento River to enter the Yolo Bypass through a gated notch on the east side of Fremont Weir. The invert of the new notch would be at an elevation of 14 feet, which is approximately 18 feet below the existing Fremont Weir crest. Alternative 1 would allow up to 6,000 cfs to flow through the notch during periods when the river stage is not high enough to go over the crest of Fremont Weir to provide open channel flow for adult fish passage. See Section 2.4 for more details on the alternative features.

Under Alternative 1, larger areas within the bypass would be inundated at low flows. Flood flows would remain limited to the leveed portion of the bypass. Alternative 1 would not locate any new housing or new structures within the 100-year flood hazard area.

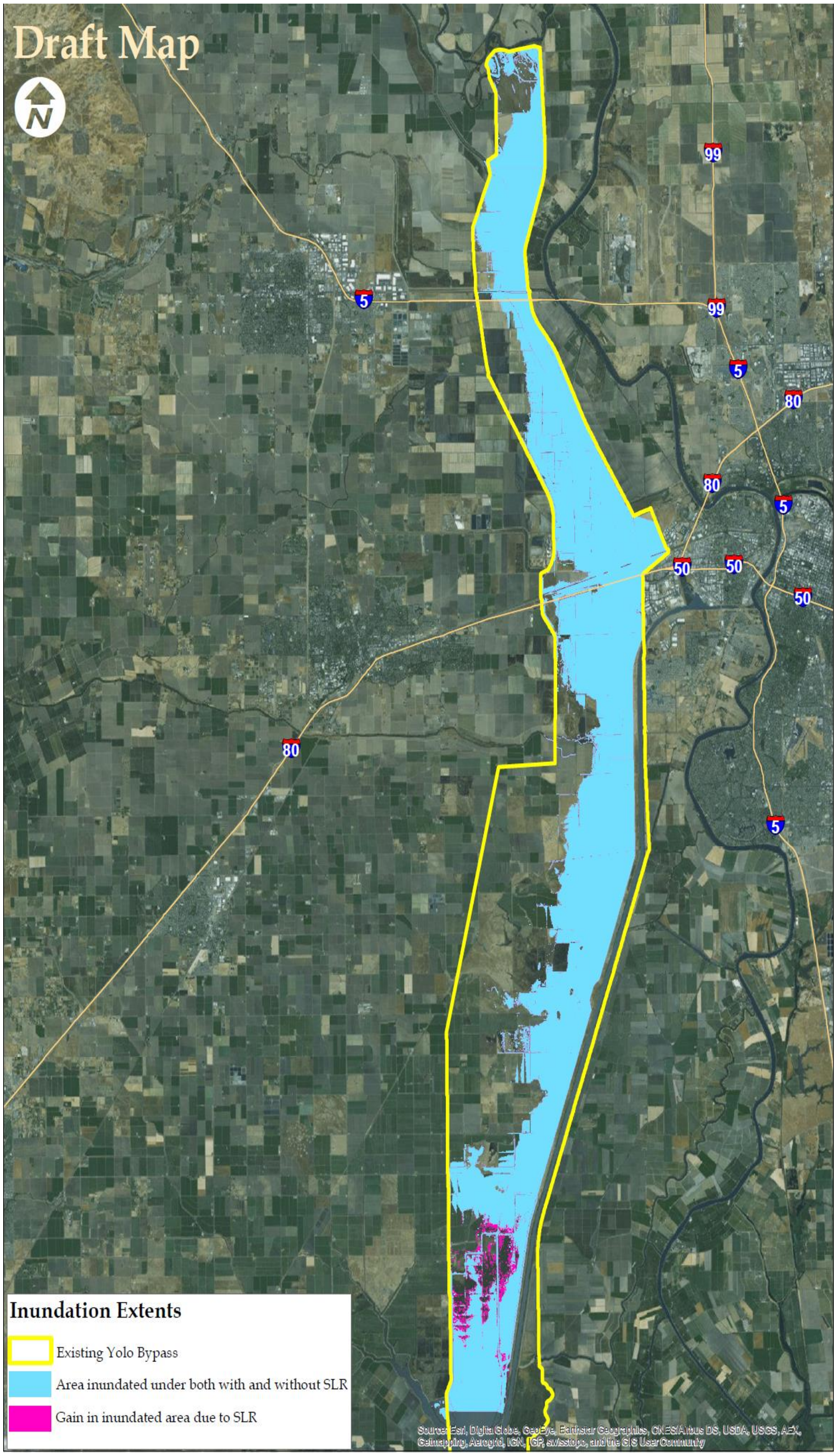

Figure 4-2. Inundation Increase at 12,000 cfs under Future Condition with Sea Level Rise (i.e., No Action Alternative) versus Existing Conditions

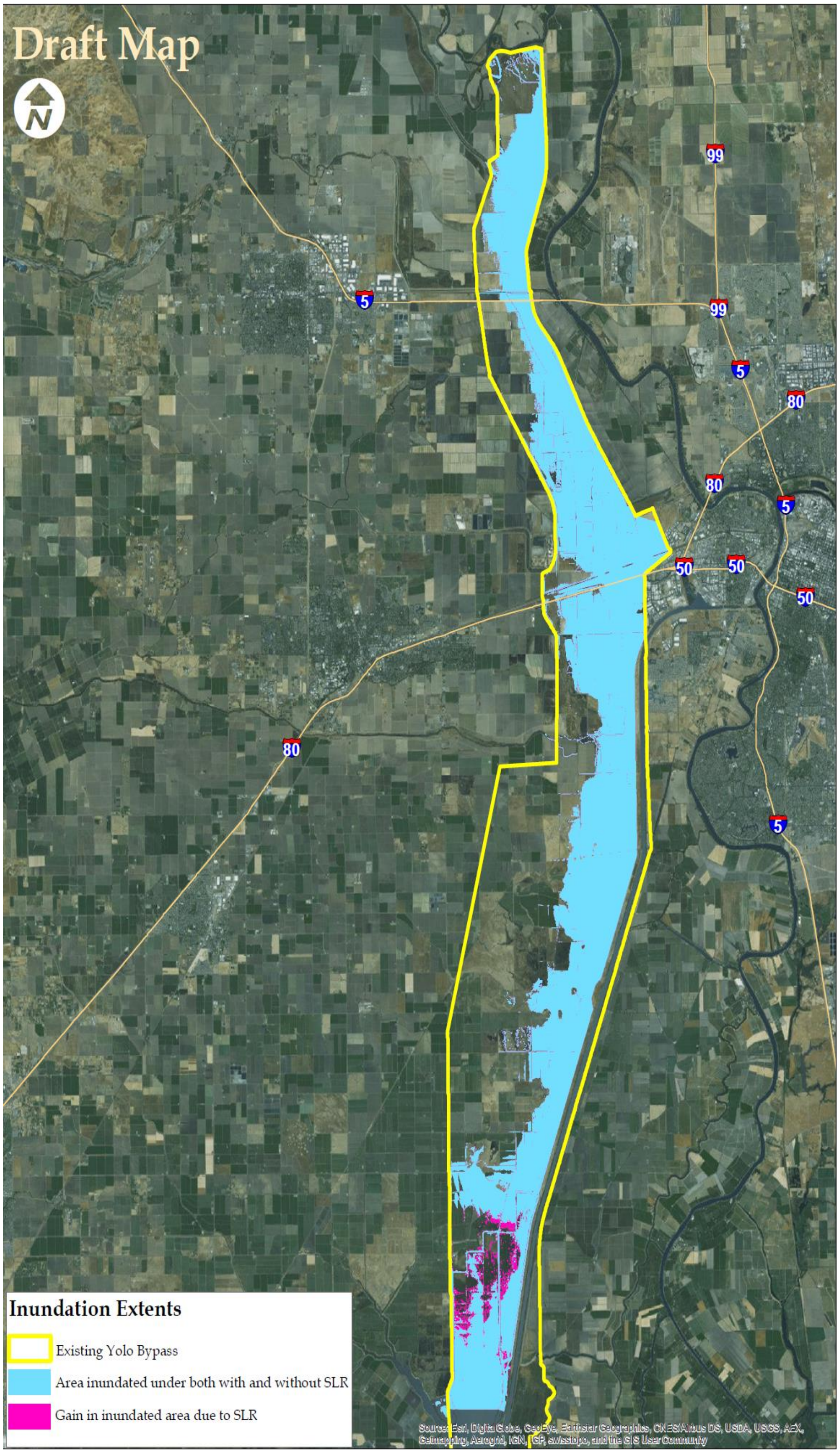

Figure 4-3. Inundation Increase at 9,000 cfs under Future Condition with Sea Level Rise (No Action Alternative) versus Existing Conditions

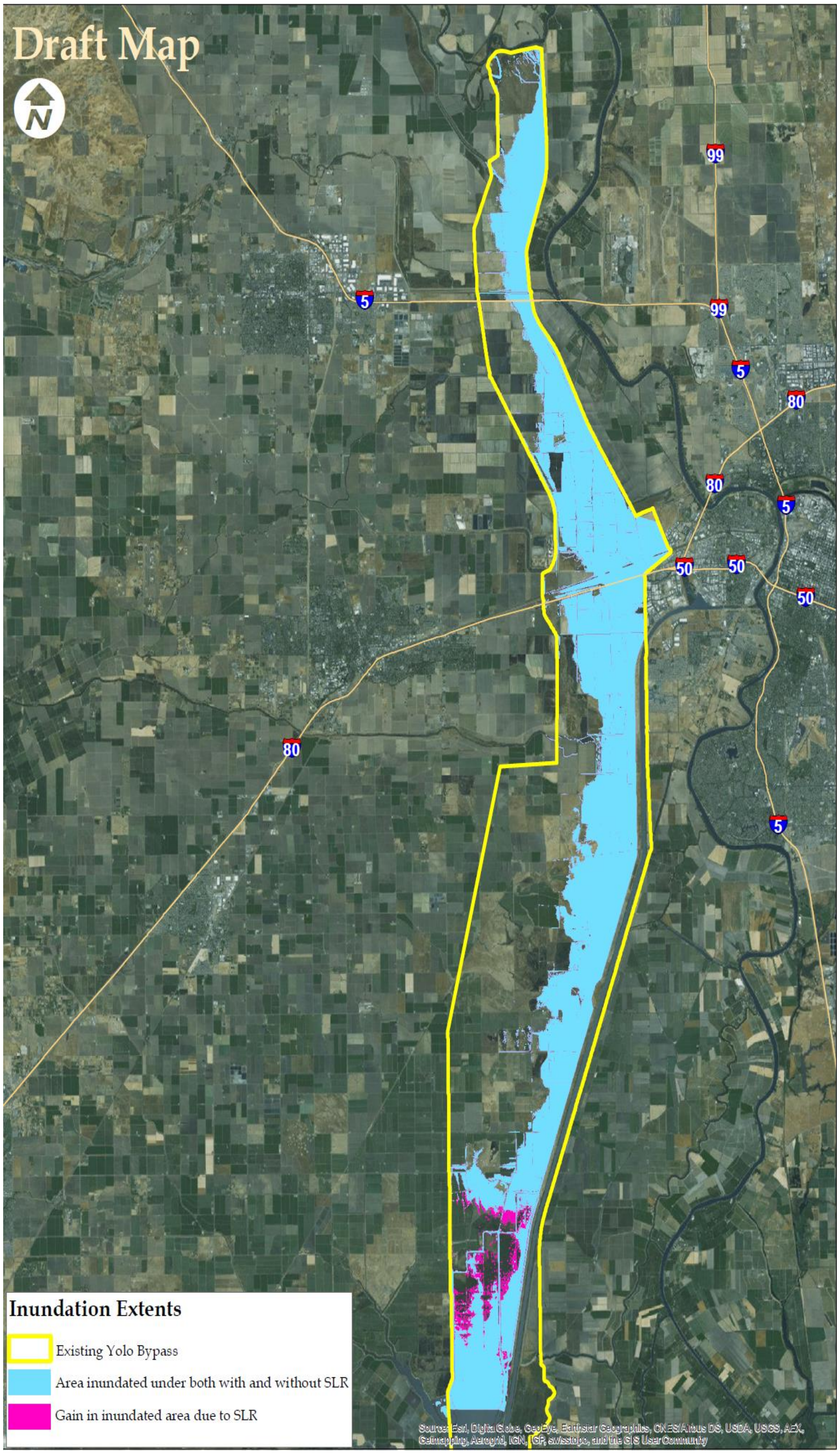

Figure 4-4. Inundation Increase at 6,000 cfs under Future Condition with Sea Level Rise versus Existing Conditions (No Action Alternative)

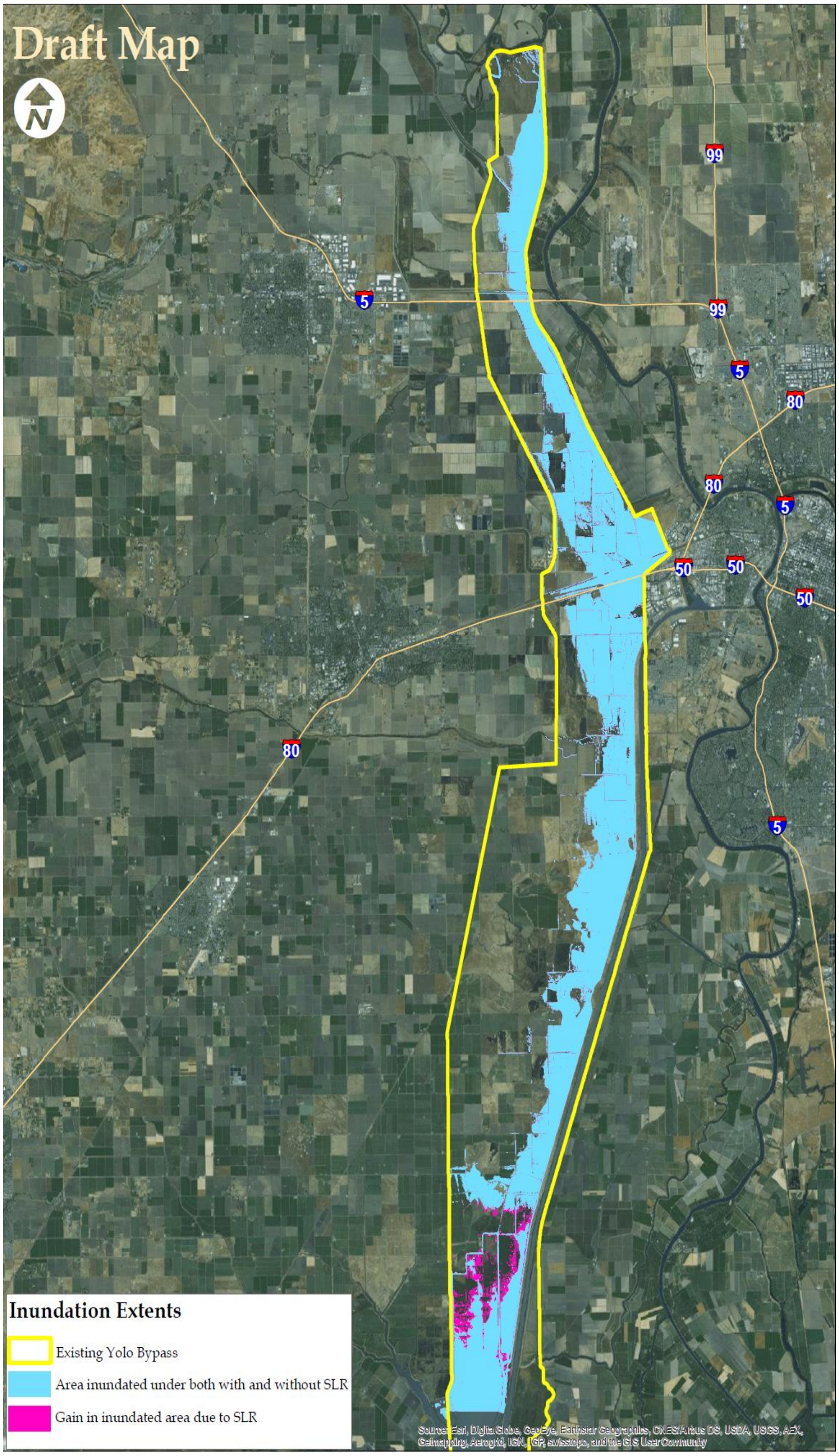

Figure 4-5. Inundation Increase at 3,000 cfs under Future Condition with Sea Level Rise versus Existing Conditions (No Action Alternative)

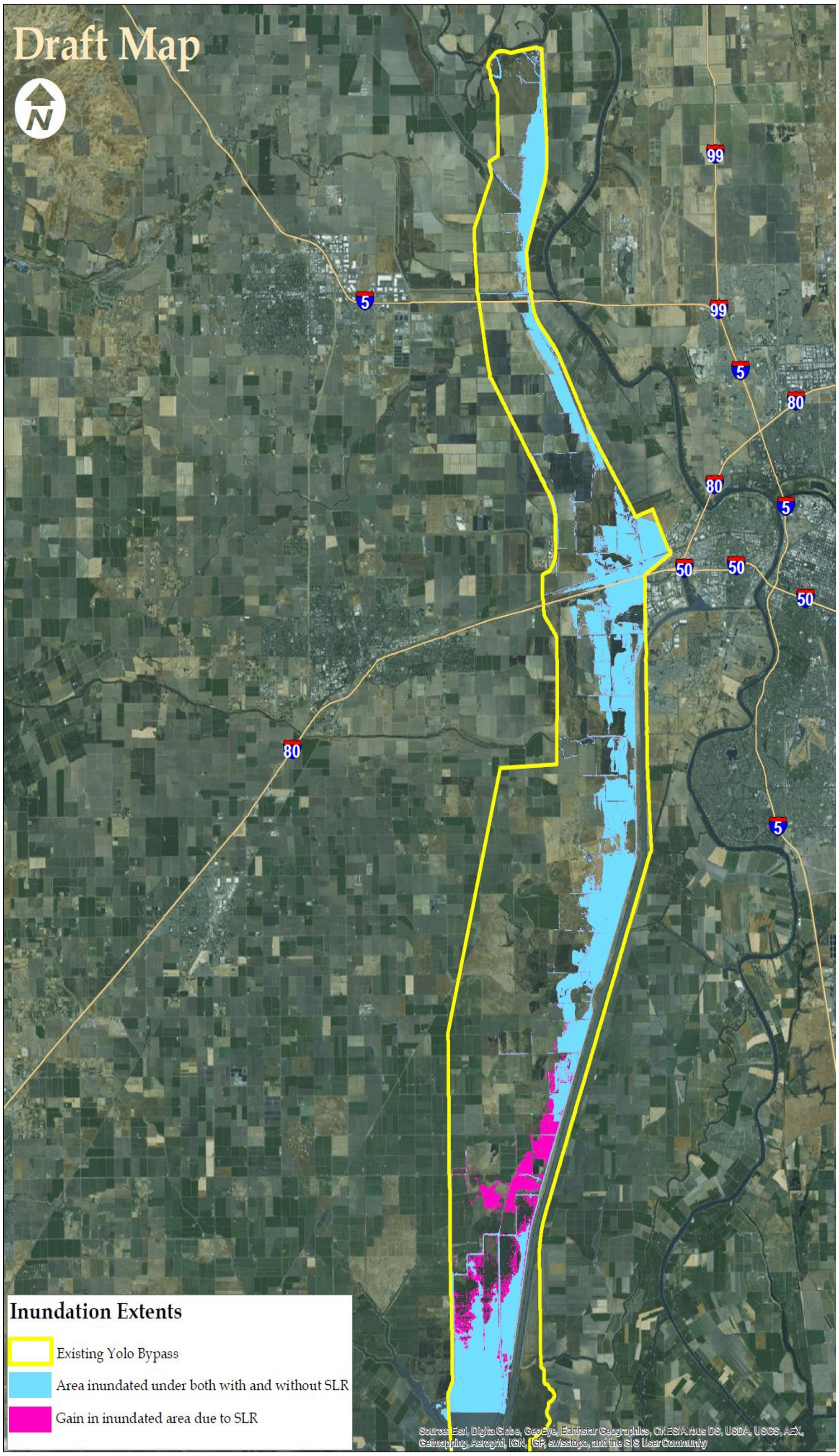

Figure 4-6. Inundation Increase at 1,000 cfs under Future Condition with Sea Level Rise versus Existing Conditions (No Action Alternative)