4.3 HYDROLOGY, WATER QUALITY, AND RIVER GEOMORPHOLOGY

This section addresses hydrology, water quality, and river geomorphology in the study area for the proposed project. As described in Chapter 3, "Description of the Proposed Project," the study area for this proposed project occurs between RM 174 and RM 202, which generally corresponds to the study area addressed in the hydrologic analysis contained in this section of the Draft EIR. Potential effects on aquatic species are addressed in Section 4.4, "Biological Resources."

4.3.1 ENVIRONMENTAL SETTING

SOURCES OF INFORMATION

The evaluation of hydrology, water quality, and river geomorphology for this Draft EIR is based largely on review of the following documents:

- *Hydraulic Analysis of Riparian Habitat Conservation on the Sacramento River from Princeton to Beehive Bend–Hydraulic Modeling of the Sacramento River from RM 163 to RM 176*. Prepared by Ayres Associates in 2003. (http://www.sacramentoriverportal.org/beehive_bend/ayres_report.htm)

- *Hydraulic Modeling of Proposed Restoration Activities of the Butte Basin Reach of the Sacramento River from RM 174 to RM 194*. Prepared by Ayres Associates in 2001. (http://www.watershedportal.org/viewDoc_html?did=1512).

- *Two-dimensional Hydraulic Modeling of the Upper Sacramento River from RM 194.0 to RM 202.0; Including Riparian Restoration, Revised Setback Levee, and East Levee Removal*. Prepared by Ayres Associates in 2002. (http://www.sacramentoriverportal.org/modeling/levee_index.htm)

- *Final environmental assessment for proposed restoration activities on the Sacramento River National Wildlife Refuge (Ryan, Ohm, Haleakala, Pine Creek, Kaiser, Phelan Island, Koehnen, Hartley Island, and Stone Units)*. Prepared by Jones & Stokes for USFWS in 2002. (http://pacific.fws.gov/planning/draft/docs/CA/sacriver/SRNWR_EA.pdf)

- *Sacramento and San Joaquin River Basins California Comprehensive Study*. Interim report. Prepared by USACE and The Reclamation Board in 2002.

- *SRCA Forum Handbook*, prepared in 2003. (http://www.sacramentoriver.ca.gov/publications/handbook/handbook.html)

These resources are cited throughout this section and corresponding references are included in Chapter 11, "References and Personal Communications." Review of relevant sections of the CALFED Final PEIS/EIR included reviews of Section 5.1, "Water Supply and Water Management;" Section 5.2, "Bay-Delta Hydrodynamics and Riverine Hydraulics;" and Section 5.3, "Water Quality."

REGIONAL CONTEXT

The Sacramento River Valley encompasses an area of more than 26,300 square miles in the northern portion of the Central Valley. The Sacramento River basin encompasses large and smaller sub-basins. Major sub-basins include the McCloud River, Pit River, Goose Lake and the Cascade Range in the north. Major sub-basins of the Sierra Nevada include the Feather River and the American River in the east. Smaller sub-basins include the Coast Range and Klamath Mountains in the west, and the Bay-Delta in the south. The Sacramento River joins the San Joaquin River in the Bay-Delta near Pittsburg in Contra Costa County. The combined waters from these two river systems flow into Suisun Bay, through the Carquinez Strait, into San Pablo Bay and San Francisco Bay, and to the Pacific Ocean.

The Sacramento River is the largest river in the state. It has an average annual runoff of 22.4 million acre-feet (MAF) and yields 35% of the state's developed water supply. Upper Sacramento River flows are largely controlled by the Central Valley Project (CVP) storage and diversion facilities operated by the U.S. Bureau of Reclamation (Reclamation) and local irrigation districts. Shasta Dam, located upstream of Redding, is the dominant reservoir on the mainstem Sacramento River, and its operations exert considerable influence over stream flow patterns in the river (described below).

In its historic condition, the Sacramento Valley was composed of extensive perennial grasslands, riparian woodlands, and marshes. The Sacramento River and other primary waterways often would flood in winter and early spring, recharging wetlands and depositing fertile sediments on the floodplain that is now valued for agriculture. The Sacramento River within the project area is characterized by a meandering channel with a broad alluvial floodplain. Upstream reaches are characterized by confined canyons, and lower reaches are characterized by natural levees separating the river from extensive flood basins.

The natural physical and biological processes of erosion, deposition, and riparian succession along the Sacramento River have generally been modified by humans throughout the period of recent development since about 1850. Construction of Shasta Dam (completed in 1944) 9 miles north of Redding resulted in a substantial reduction in winter flood flows and an increase in summer stream flows. Past efforts to reclaim floodplain areas for agricultural production and flood protection involved clearing of riparian areas, stabilization of stream banks, and construction of levees and other flood protection structures.

PROJECT STUDY AREA SETTING

Hydrology

Stream flow patterns in the Sacramento River reflect a combination of natural runoff events and operational controls (DWR 1994). Annual average precipitation in the entire basin is 36 inches and varies considerably from approximately 20 inches in the valley floor falling nearly exclusively as rain, and ranging from 40 to 60 inches annually as rain and snow at higher elevations in the mountains (CALFED 2000b). In general, natural Sacramento River stream flow patterns are distinctly seasonal; however, managed reservoir releases have altered the natural flows as depicted in Table 4.3-1. The typical water year (starting October 1) begins with low natural runoff flows, reduced reservoir releases as the agricultural irrigation season ends, and minimum reservoir storage levels (CALFED 2000b). With the return of winter rains, the highest flows and increased probability of overbank flooding events occurs during the winter rainfall months of January and February. Flows decrease slightly in late winter before peak periods of mountain snowmelt that occur in spring. Flows are muted in spring compared to historical unimpaired flows as the natural runoff is retained to fill the reservoirs to their normal summer operating pool levels. Flows then increase through the summer as reservoirs are lowered (primarily Shasta Lake) for hydropower production and to meet the agricultural demands of the Sacramento Valley and Central Valley Project operational demands and requirements.

Table 4.3-1 shows descriptive statistical flow parameters (i.e., minimum, average, and maximum) for two gauging stations that are located in the study area (Hamilton City and Ord Ferry). These measured stream flows are considered representative of the range of flow conditions in the study area.

Sacramento River Flows and Flood Control Operations

This subsection provides an overview of the flow patterns on the Sacramento River and flood control structures and operations to protect communities, agriculture and other commercial operations.

The Sacramento River has a design flow capacity of 160,000 cubic feet per second (cfs) just downstream of the project area (USACE and The Reclamation Board 2002). Table 4.3-1 depicts average monthly flows on the Sacramento River at the Hamilton City and Ord Ferry gauging stations from 2001 through 2004.

Shasta Dam provides flood protection to the communities of Redding, Anderson, Red Bluff, and Tehama, as well as the agricultural lands, industrial developments, and communities downstream along the Sacramento River. Private levees or low berms, and USACE *project levees* limit the area of flooding in both urban and agricultural areas. Nevertheless, small communities and portions of larger communities continue to be at risk of flooding along portions of the river and tributaries. Shasta Dam is operated for an objective release of 79,000 cfs at Redding and 100,000 cfs at Bend Bridge in Red Bluff. Flows greater than 36,000 cfs begin to cause flooding in Redding (USACE and The Reclamation Board 2002).

Table 4.3-1
Average Mean, Maximum, and Minimum Monthly Flows (cfs) on the Sacramento River

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Hamilton City												
Mean	5,624	5,683	15,695	18,395	19,590	14,263	8,325	11,303	10,961	11,777	8,299	6,909
Maximum	6,736	6,450	20,661	29,779	41,324	23,698	13,320	22,575	12,857	12,182	8,984	7,790
Minimum	4,550	4,888	6,462	7,881	8,697	8,885	5,437	7,099	9,087	10,838	7,701	5,831
Sacramento River at Ord Ferry												
Mean	5,832	5,797	18,382	21,252	20,659	16,589	9,728	12,357	11,243	11,819	8,961	7,559
Maximum	6,889	7,023	22,345	34,487	42,752	27,485	14,336	24,200	13,411	12,632	9,563	8,349
Minimum	5,221	4,777	11,996	8,608	10,471	10,361	5,816	7,855	9,349	10,737	8,200	6,269

Source: DWR 2005

Tributaries entering the Sacramento River from the west, including Clear, Cottonwood, Elder, Thomes, and Stony Creeks, drain runoff from the Coastal Mountain range. Cottonwood Creek provides the most significant amount of inflow to the Sacramento River in this region. Tributaries from the east that drain runoff from the Cascade and Sierra Nevada mountain ranges include the Cow, Bear, Battle, Paynes, Antelope, Mill, Deer, Rock, Big Chico, and Butte Creeks. Most of the tributaries are unregulated and can contribute high flood flows to the Sacramento River (USACE and The Reclamation Board 2002).

The maximum historical flows from Keswick Dam to Red Bluff are predominantly a result of uncontrolled local drainage. The 2,500-square mile uncontrolled drainage area between Keswick Dam and Bend Bridge can produce flows well in excess of the design channel capacity of 100,000 cfs. These high-magnitude flows can occur very rapidly, requiring release changes from Keswick Dam based on official flow forecasts and complicated by the 8- to 12-hour travel time between Keswick Dam and Bend Bridge (USACE and The Reclamation Board 2002). As described above, the measured flows at Red Bluff and Colusa reflect the range of conditions in the study area.

The Sacramento River Flood Control Project

The SRFCP was conceived in 1911 and constructed by USACE downstream of the project area. At that time, 80% of the proposed 500 miles of river and bypass levees had already been completed under private and municipal levee systems begun in the 1850s (Kelley 1989). Along the Sacramento River, the SRFCP consists of setback levees beginning near the town of Ord on the west side and just north of the Butte/Glenn County line on the east. The west bank project levee runs upstream to approximately RM 184. The east bank project levee extends only as far upstream as RM 176. The Reclamation Board is responsible for maintenance of the SRFCP. The responsibility is passed on to the local reclamation and levee districts or to the DWR where no such district exists. The bank protection project consists of the rock revetment of about 160 miles of banks and levees, installed to ensure the security of the flood control system (SRCA Forum 2003). Additional levees maintained by the Reclamation Board in conjunction with local reclamation districts extend upstream of the USACE project levees.

The Chico Landing to Red Bluff Project, authorized in 1958, extends and modifies the SRFCP. This project, sponsored by The Reclamation Board, provides for bank protection (erosion protection) and incidental channel modifications along 50 miles of the Sacramento River between Chico Landing and Red Bluff. In this reach, which includes the Chico Landing Subreach, 21.5 miles of bank protection have been installed to hold the river in place and limit meandering of the channel (USACE and The Reclamation Board 2002).

The historical and specific bank protection efforts applied in the project area at Pine Creek, Capay, and Dead Man's Reach are not described in this Draft EIR; however, bank protection has been applied to eroding banks or repaired in a number of locations in the project area under USACE PL 84-99 emergency authority (Luster, pers. comm., 2005).

Behind the present day SRFCP levees, access to the Sacramento River floodplains and flood basins is limited by the overflow weirs (Moulton, Colusa, Tisdale, Fremont, and Sacramento) and bypasses (Sutter, Yolo, and Butte Basin), described below.

Butte Basin Overflow Area

The Butte Basin lies to the east of the Sacramento River and extends from the Butte Slough outfall gates near Meridian (RM 138) to Big Chico Creek near Chico Landing (RM 194) (see Exhibit 3-2). The Butte Basin Overflow Area is an essential element of the flood management system for the Sacramento River. Flood flows are diverted out of the Sacramento River into the Butte Basin and Sutter Bypass via several designated overflow areas (i.e., low points along the east side of the river) that allow high flood flows to exit from the Sacramento River channel. Overflow into the Butte Basin reduces the peak discharge and stage between the main levees of the SRFCP. The reduction of discharge and stage in the river is necessary to prevent the overtopping and subsequent failure of the flood control project levees downstream. The Sutter Bypass, in turn, conveys flows to the lower Sacramento River region at the Fremont Weir near the confluence with the Feather River and into the Sacramento River and the Yolo Bypass (USACE and The Reclamation Board 2002). The Yolo Bypass (59,000 acres), Sutter Bypass (15,000 acres) and Butte Basin provide access to broad, inundated floodplain habitat during wet years.

At high stages water flows from the Sacramento River into the Butte Basin at two locations in the project area: the 3B's natural overflow site is located immediately upstream of Dead Man's Reach at RM 186.5, and the M&T Bend Flood Relief Structure (FRS) is located between Capay and Dead Man's Reach at RM 191 (see Exhibit 3-2). Downstream of the project area, additional flood flows are diverted out of the Sacramento River into the Butte Basin and Sutter Bypass via the Goose Lake FRS, and the Moulton, Colusa, and Tisdale Weirs.

Sacramento River Bank Protection Project

The Sacramento River Bank Protection Project (SRBPP) was originally authorized under the Flood Control Act of 1960 (PL 86-645). Its purpose is to protect the levees and flood control facilities on the Sacramento River from the Bay-Delta at Collinsville at RM 0 to Chico Landing at RM 194 and includes the lower reaches of the American River (RM 0 to RM 23), Feather River (RM 0 to RM 61), Yuba River (RM 0 to RM 11), and Bear River (RM 0 to RM 17), as well as portions of Three Mile, Steamboat, Sutter, Miner, Georgianna, Elk, and Cache Sloughs. The SRBPP was created in 1959 and initiated by USACE in 1963 as a means of protecting the SRFCP levees. The SRBPP is an ongoing project subject to Congressional reauthorization. Construction activities authorized to date by the SRBPP account for approximately 152 miles of river bank revetment.

Water Quality

Surface Water Quality

Designated beneficial uses for the Sacramento River and all tributaries from Shasta Dam, upstream of the project area, to the Colusa Basin Drain, downstream of the project area, include:

- municipal, industrial, and agricultural supply;
- power generation;
- contact and non-contact recreation;
- cold-water fish habitat, migration, and spawning;
- warm-water fish habitat, migration, and spawning;
- wildlife habitat; and
- navigation.

The U.S. Geological Survey (USGS) completed an evaluation of water quality conditions of the Sacramento River upstream of the project area at Red Bluff as a component of an overall analysis of conditions in the Sacramento River watershed (USGS 2000). The evaluation indicated that the Sacramento River at Red Bluff generally has excellent water quality that is very low in contaminants.

Table 4.3-2 shows a summary of average concentrations from monthly water samples for conventional physical and inorganic chemical constituents measured in the Sacramento River at Red Bluff from February 1996 through April 1998 (USGS 2000). Red Bluff is approximately 55 miles north (upstream) of the study area and while changes in water quality are likely to occur as water flows downstream, this is the best available information to characterize water quality at the project area. In general, the data indicate that the river is low in total dissolved solids (TDS) as indicated by measurements of conductivity (EC), total hardness, and specific cations and anions. The water has neutral pH, moderate alkalinity, and adequate dissolved oxygen (DO) levels for aquatic organisms. The water from the river is also generally low in nutrients (e.g., nitrogen and phosphorus) that can cause nuisance algae and aquatic vascular plant growth. Trace metal content is low in the river. Although mercury is routinely detected, the concentration has not exceeded ambient California Toxics Rule (CTR) criteria (see below for description of CTR). Pesticides have been detected in the Sacramento River; however, with the exception of the drinking water standard for carbofuran, there are no applicable regulatory criteria established for the pesticides that have been detected. DFG has established guidance values for aquatic life chronic criteria (i.e., four-day-average) applicable to the organophosphate pesticides diazinon and chlorpyrifos. The DFG guidance values and other reference dose values for aquatic life or human health hazards that have been established for many pesticides are generally indicative of the lowest concentrations at which toxic effects have been detected. The average concentration of diazinon in the Sacramento River does not exceed the DFG guidance level of 50 nanograms per liter (ng/L) (DFG 2000).

Table 4.3-2
Summary of Conventional Water Quality Constituents in the Sacramento River at Red Bluff, 1996–1998

Constituent (Units)	Water Quality Objective	Average Measurement
Conventional Physical and Chemical Constituents		
Temperature	<2.5°F [a]	11.5°C
EC (µS/cm)	—	116
DO (mg/L)	7.0 [b]	10.7
DO Saturation (%)	85 [b]	99
pH (standard units)	6.5 to 8.5 [c]	7.8
Alkalinity (mg/L $CaCO_3$)	—	48.3
Total Hardness (mg/L $CaCO_3$)	—	46.6
Suspended Sediment (mg/L)	—	38.8
Calcium (mg/L)	narrative [d]	10.3
Magnesium (mg/L)	—	5.0
Sodium (mg/L)	—	5.8
Potassium (mg/L)	—	1.1
Chloride (mg/L)	500 [e]	2.4
Sulfate (mg/L)	500 [e]	4.5

Table 4.3-2
Summary of Conventional Water Quality Constituents in the Sacramento River at Red Bluff, 1996–1998

Constituent (Units)	Water Quality Objective	Average Measurement
Silica (mg/L)	—	20.5
NO_2+NO_3 (mg/L N)	NO_3<10 [f]	0.12
Total Phosphorus (mg/L P)	—	0.0477
Trace Metals		
Arsenic (µg/L)	50 [g]	1.0
Chromium (µg/L)	180 [g]	1.0
Copper (µg/L)	5.1 [g]	1.6
Mercury (µg/L)	0.050 [h]	0.0045
Nickel (µg/L)	52 [g]	1.2
Zinc (µg/L)	120 [g]	2.3
Organic Pesticides		
Molinate (ng/L)	13,000 [i]	<60
Simazine (ng/L)	3,400 [j]	<22
Carbofuran (ng/L)	40,000 [e], 500 [i]	<31
Diazinon (ng/L)	51 [k]	<28
Carbaryl (ng/L)	700 [j]	<41
Thiobencarb (ng/L)	1,000 [a]	<38
Chlorpyrifos (ng/L)	14 [k]	<25
Methidathion (ng/L)		<38

Notes:
$CaCO_3$ = calcium carbonate
mg/L = milligrams per liter
µg/L = micrograms per liter
MRL = method reporting limit
µS/cm = microsiemens per centimeter
ng/L = nanograms per liter
NO_2 = nitrogen dioxide (nitrate)
NO_3 = nitrogen trioxide (nitrite)

[a] Regional Water Board (formerly called the Regional Water Quality Control Board) Basin Plan (Basin Plan) water quality objective for allowable change from controllable factors
[b] Basin Plan water quality objective
[c] Basin Plan water quality objective; <0.5 allowable change from controllable factors
[d] Basin Plan narrative objective: water shall not contain constituent in concentrations that would cause nuisance or adversely affect beneficial uses
[e] Secondary drinking water maximum contaminant level (MCL)
[f] Primary drinking water maximum contaminant level (MCL)
[g] CTR aquatic life criteria for four-day average dissolved concentration
[h] CTR human health maximum criteria total recoverable concentration
[i] DFG hazard assessment value
[j] U.S. Environmental Protection Agency Integrated Risk Information System reference dose for drinking water quality
[k] DFG aquatic life guidance value for four-day average concentration

Source: Constituent measurements from USGS 2000.

The Sacramento River was also evaluated from 1997 through 2003 as part of DWR's Sacramento River Watershed Program (SRWP) and during varying periods for programs coordinating with the SRWP (Larry Walker Associates 2004). Results indicated that some samples collected from throughout the Sacramento River watershed in 2002–2003 caused toxicity to test organisms; the causes of observed toxicity at these locations has not yet been determined. As a result of these data, the Sacramento River is included on the federal Clean Water Act (CWA) Section 303(d) list of impaired waters for unknown toxicity. The Central Valley Regional Board (formerly called Central Valley Regional Water Quality Control Board) is required to develop a total maximum daily load (TMDL) for the specific pollutants in waterways on the 303(d) list. The Central Valley Regional Board has listed the TMDL for "unknown toxicity" as a low priority (Central Valley Regional Board 2002).

Geomorphology

The geomorphology of the Sacramento River varies throughout the region. From the base of Mount Shasta for about 75 miles downstream to near elevation 300 near the town of Red Bluff, the river is generally constrained from moving laterally by erosion-resistant volcanic and sedimentary formations. The river in this area, the Sacramento Canyon, is generally narrow and deep, and the floodplain is similarly narrow. From here, the river emerges onto the broad alluvial floodplain of the Sacramento Valley. For the next 100 river miles or so, the Sacramento River historically meandered freely across a wide (1.5 to 4 miles) floodplain (SRCA Forum 2003). By eroding and depositing sediment, the river migrated across deep alluvial soils from the Red Bluff area to the area near Colusa (USACE and The Reclamation Board 2002; Luster, pers. comm., 2005).

The reach of the Sacramento River that includes the project area is predominately a meandering single-thread channel bordered by setback levees. This reach of the river has become less sinuous since 1896. This has been attributed to chute cutoffs promoted by the clearing of riparian forests and to natural variation over time (USGS 1977, SRCA Forum 2003). Meander scars of unknown age located in the 100-year meander belt indicate a high degree of sinuosity in at least portions of the channel in the relatively recent past (SRCA Forum 2003).[1]

While riparian forest vegetation is generally believed to protect riverbanks from erosion, few studies have quantified the effect of riparian vegetation versus other cover types on rates of river channel migration. Recently, Micheli et al. (2004) compared migration rates and bank erodibilities between 1949 and 1997 for reaches of the Sacramento River between Red Bluff and Colusa. The study compared reaches bordered by riparian forest versus agriculture and showed that agricultural floodplains are 80–150% more erodible than riparian forest floodplains. Larsen et al. (2002a) simulated river migration at river miles 185 to 201 using a channel migration model that is based on mathematical–physical algorithms for flow and sediment transport. The model is based on physical processes to accommodate changes in input variables and thus predicts the consequences of conditions—such as flow regime changes or bank stabilization measures—that have not existed in the past. The model predicted that between 1997 and 2072, the river at Capay (RM 193-194) is projected to move away from the restoration area and at Dead Man's Reach (RM 186) it is projected to be fairly stable. These studies show that advances in the understanding of long term river meander processes in the Sacramento River are underway (Micheli et al. 2004 and Larsen et al. 2002); however; there is still a great deal of uncertainty in the prediction and modeling of the rate, extent, and specific configuration of complex, long-term meander processes.

The USACE has been stabilizing the channel in the vicinity of the Butte Basin flood relief structures with a series of bank protection installations as part of its flood control responsibilities. Because changes in channel alignment in this area (particularly chute cut-offs of meander loops) could potentially lower channel elevation, it was thought that this would result in less flow into Butte Sink via the flood relief structures, and more flow down the leveed river corridor. Recent studies indicate however, that change in channel elevation is insignificant in altering the flow split between Butte Basin and the main channel of the Sacramento River at higher flows. These studies show that excessive flows would enter the leveed reach regardless of channel alignment (Ayres 1997).

Downstream of the project area, SRFCP levees were constructed along the Sacramento River and its tributaries to prevent the flooding of nearby communities. The levees were designed to confine flows to a relatively narrow channel that would efficiently convey sediment through the system, thereby reducing the dredging necessary to maintain navigation. Today, the Sacramento River downstream of the project area is a leveed and largely straightened channel. The river does not meander as it did historically, but generally conveys flows downstream

[1] The *100-year meander belt* is the combination of all channel locations between 1896 and 1991. It is the area along the river that has experienced channel movement in the relative immediate past. Refer to Chapter 3, "Description of the Proposed Project," for further discussion of this topic.

and into overflow bypass channels, as needed. The banks are routinely managed, but they are prone to erosive forces, especially on outside curves.

Geology and Soils

The project area is in the Sacramento Valley, which constitutes the northernmost third of the Great Valley physiographic province of California—a large, northwest-trending structural trough filled with a tremendously thick layer of sediment ranging in age from Jurassic to Holocene (Bailey 1966). The SRNWR properties exist on and incorporate several types of level, nearly level, and gently sloping alluvial landforms; including floodplains, natural levees, paleochannels, and sloughs, that are composed of sediments deposited by the Sacramento River system (Jennings and Strand 1960, Saucedo and Wagner 1992, Strand 1962). More recent deposits lie on top of older formations and include terrace deposits (including the Modesto Formation), paleochannel deposits, alluvial fans, meander belt deposits, basin, and marsh deposits (SRCA Forum 2003). The terrace deposits of the Modesto Formation flank the river in stair steps away from channel. These deposits tend to erode at a lower rate than the other younger deposits and tend to form higher, more consolidated banks along the river, referred to as geologic control (SRCA Forum 2003). In general, the sediments that comprise the surficial portions of these landforms are of Holocene age and consist of gravel, sand, silt, and minor amounts of clay.

Overlying Holocene alluvial deposits are the relatively young and predominantly coarse- and moderately coarse-textured soils of the Columbia, Gianella, Horst, and Laugenour series (Gowans 1967, Begg 1968, TNC 2001). Soils of the Columbia, Gianella, and Horst series occupy the majority of land area in the project area. These soils typically consist of very deep, well drained sands, loamy sands, sandy loams, loams, and silt loams formed from mixed alluvium. Soils of the Laugenour series occur only in the Dead Man's Reach Unit; they are texturally similar to the soils of the Columbia, Gianella, and Horst series, but differ in that they are poorly drained. Riverwash (i.e., recently deposited alluvium) also occupies substantial portions of the project area. Surface runoff in the project area is slow and the hazard of erosion is slight.

The setback levees of the SRFCP are generally built along the Modesto Formation, along the west side of the river. On the east side, however, the levees lie well within the paleochannel deposits.

4.3.2 Regulatory Setting

This section includes applicable laws and regulations for flood safety and water quality that are identified as part of the due diligence process and that could apply to any type of project located in the study area. Those laws and regulations applicable to this proposed project are addressed in the environmental impact section, below.

Flood Safety

The primary facilities for controlling flood damages in the Sacramento River system are reservoirs providing flood storage and levees along channels. Also important in preventing flood damages are coordinated preparations for flood fighting and emergency planning, including evacuation. Several federal, state, and local agencies have responsibilities for different aspects of operations and maintenance of flood control facilities and for emergency response. The roles of these entities are summarized below.

The flood control facilities on the Sacramento River are part of the joint federal/state SRFCP. The USACE, in conjunction with the State, developed a flood control plan for the Sacramento River as part of the SRFCP, which included levee construction, channel improvements, and reservoir flood storage.

The Sacramento River levees were constructed by USACE as part of the SRFCP. These project levees are within an easement obtained by the State through the Sacramento-San Joaquin Drainage District. USACE participates in the flood operation of the river and levee system through the development of flood release schedules. Additionally, construction and repair of the existing levees along the Sacramento River has been undertaken by

USACE over the years as part of its ongoing efforts to improve the regional protections provided by the SRFCP. Project levees in California must meet the standards for design and construction specified by the USACE as discussed in Engineering Manual 1110-2-1913 (USACE 2000).

The Reclamation Board enforces appropriate standards for the maintenance and protection of flood control facilities in the Central Valley. The Reclamation Board must approve any activity that may affect *project works*, to ensure that the activity maintains the integrity and safety of flood control project levees and floodways and is consistent with the flood control plans adopted by The Reclamation Board and the State legislature. Project works are the components of a flood control project in The Reclamation Board's jurisdiction that the board or the legislature has approved or adopted. Project works include levees, bank protection projects, weirs, pumping plants, floodways, and any other related flood control works or rights-of-way that have been constructed using state or federal funds. Project works also include flood control plans. Rules promulgated in Title 23 of the California Code of Regulations (CCR Title 23, Division 1, Article 8 [Sections 111 through 137]) regulate the modification and construction of levees to ensure public safety. The rules state that existing levees may not be excavated or left partially excavated during the flood season. The flood season for the Sacramento River is November 1 through April 15.

Levee operation and maintenance are overseen by DWR, which inspects the levees and issues a biannual report. The report covers the general condition of the levee, vegetation control, rodent control, and flood preparedness.

The National Weather Service (NWS), Reclamation, and DWR jointly operate the California-Nevada River Forecast Center (CNRFC), which disseminates climatological information and river flow forecasts. Coordination between the CNRFC and entities operating major flood control reservoirs in the state ensures that the CNRFC has necessary information on current and proposed reservoir outflows to allow the NWS to forecast river stages. In addition, DWR and NWS jointly operate the State-Federal Flood Operations Center (Flood Operations Center), which gathers flood information and disseminates it to emergency operations personnel and the public. This agency also coordinates activities of the different flood control agencies and provides data necessary for the informed operation of the reservoirs.

The State Office of Emergency Services (OES) coordinates both state and federal resources in response to flood emergencies. The local offices of emergency services coordinate all local emergency operations. These could include evacuating the floodplain, obtaining state assistance with a flood fight, and implementing recovery actions following a flood. The local office of emergency services in the project area receives its information from the Flood Operations Center and, to some extent, directly from the dam operators.

During floods, the project levees must be continually patrolled so that the functioning of the levee system can be assessed and immediate emergency actions initiated if a defect is detected. Forecasts issued by the Flood Operations Center are the primary notification received by local levee districts for the need to patrol the levees. If levee defects are found that are beyond the capability of the responsible levee district to manage, it will request assistance from the State and USACE. Such requests are coordinated through the State OES system.

SACRAMENTO AND SAN JOAQUIN RIVER BASINS CALIFORNIA COMPREHENSIVE STUDY

The Sacramento and San Joaquin River Basins California Comprehensive Study (Comprehensive Study) was a joint effort by The Reclamation Board and USACE, in coordination with federal, state, and local agencies, groups, and organizations in the Central Valley. The Comprehensive Study was not a regulatory program per se, but consistency with its goals and objectives is important for any project affecting flood control in the Sacramento and San Joaquin River basins. Responding to the flood events in the 1980s and 1990s, the State Legislature and Congress directed USACE to develop a comprehensive plan for flood damage reduction and environmental restoration purposes for the Sacramento and San Joaquin River basins. This effort was conducted in cooperation with The Reclamation Board.

In December 2002, an interim report was released by the Comprehensive Study team (USACE and The Reclamation Board 2002). The report identified the Comprehensive Study as an approach to developing projects in the future to reduce damages from flooding and restore the ecosystem in the Sacramento-San Joaquin River basins. As described in the report, the Comprehensive Study has three parts: (1) a set of principles to guide future projects, (2) an approach to develop projects with consideration for system wide effects, and (3) an organization to consistently apply the guiding principles in maintaining the flood management system and developing future projects.

The Comprehensive Study has proposed a set of guiding principles to govern implementation of projects that propose modifying the Sacramento or San Joaquin River flood control systems. These principles have been developed to ensure that projects proposed to be implemented are consistent with the objectives established by USACE and The Reclamation Board. The following are the Comprehensive Study's guiding principles:

- recognize that public safety is the primary purpose of the flood management system;
- promote effective floodplain management;
- promote agriculture and open space protection;
- avoid hydraulic and hydrologic impacts;
- plan system conveyance capacity that is compatible with all intended uses;
- provide for sediment continuity;
- use an ecosystem approach to restore and sustain the health, productivity, and diversity of the floodplain corridors;
- optimize use of existing facilities;
- integrate with the CALFED Program and other programs; and
- promote multi-purpose projects to improve flood management and ecosystem restoration.

The proposed project lies at the junction of the upper and middle Sacramento River regions of the Comprehensive Study.

WATER QUALITY

The quality of surface water and groundwater resources in the state is protected under various state and federal laws, including the state Porter-Cologne Water Quality Control Act and the CWA. The U.S. Environmental Protection Agency (EPA) has generally authorized the State Water Board (formerly called the State Water Resources Control Board) and the nine associated Regional Boards to administer all surface water and groundwater quality regulations in the state. Both the EPA and the State Water Board generally provide oversight, while the Regional Boards have primary responsibility for implementation and enforcement. The Central Valley Regional Water Board is responsible for enforcing these regulations in the project area.

Water Quality Control Plan and Applicable Water Quality Criteria

Pursuant to the Porter-Cologne Water Quality Control Act, the Regional Water Board prepares and updates a water-quality control plan (Basin Plan) every three years that identifies water quality protection policies and procedures. The Basin Plan describes the officially designated beneficial uses for specific surface water and groundwater resources and the enforceable water quality objectives necessary to protect those beneficial uses.

The Basin Plan includes numerical and narrative water quality objectives for physical and chemical water quality constituents. Constituents for which numerical objectives are set include temperature; DO; turbidity; pH (i.e., acidity); TDS; electrical conductivity (EC); bacterial content; and various specific ions, trace metals, and synthetic organic compounds. Narrative objectives are set for parameters such as suspended solids, biostimulatory substances (e.g., nitrogen and phosphorus) (i.e., nutrients), oils and grease, color, taste, odor, and aquatic toxicity. The primary mechanism that the Regional Water Board uses to ensure conformance with Basin Plan water quality objectives and implementation policies and procedures is to issue waste discharge requirements (WDRs) for projects that may discharge wastes to land or water. WDRs specify terms and conditions that must be followed during the implementation and operation of a project.

In addition, the CTR is a separate regulatory instrument that prescribes aquatic life and human health protection criteria for trace metals and organic compounds. Federal and state drinking water quality standards regulate the quality of treated municipal drinking water supplies delivered to users.

Clean Water Act, Section 303(d)

The Regional Water Board administers Section 303(d) of the CWA, which requires each state to maintain a list of water bodies in which physical and/or chemical aspects of water quality are limited or impaired by the presence of pollutants. Section 303(d) requires preparation of a total maximum daily load (TMDL) program for waters identified as impaired. The TMDL is a quantitative assessment of the pollutant sources, contaminant loads, assimilative capacity of the water body for the specific contaminants, and allocation of specific load reduction targets that are necessary to ensure compliance with the water quality standards.

Clean Water Act, Section 401

Section 401(a)(1) of the CWA specifies that any applicant for a federal license or permit to conduct any activity that may result in any discharge into navigable waters shall provide the federal licensing or permitting agency a certification that any such discharge will comply with the applicable provision of Sections 301, 302, 303, 306, and 307 of the CWA. The Regional Water Board administers the Section 401 program with the intent of prescribing measures for the applicant’s project that are necessary to avoid, minimize, or mitigate adverse impacts on water quality and ecosystems.

Waste Discharge Requirements and National Pollutant Discharge Elimination System Permits

The State Water Board and Central Valley Regional Water Board regulate discharges of waste to land and into waters of the state (i.e., surface water or groundwater) through WDRs, which are authorized under the state Porter-Cologne Water Quality Control Act, and through National Pollutant Discharge Elimination System (NPDES) permits, which are authorized under Section 402 of the CWA.

A Regional Water Board NPDES stormwater permit for general construction activity applies to general ground-disturbing construction activity greater than one acre. Before construction of such projects, applicants must submit to the Regional Water Board a Notice of Intent (NOI) to discharge stormwater and must prepare a Storm Water Pollution Prevention Plan (SWPPP). A SWPPP generally describes proposed construction activities, receiving waters, stormwater discharge locations, best management practices (BMPs) that will be used to reduce project construction effects on receiving water quality, and the BMP inspection and monitoring methods. A number of *good housekeeping* BMPs are also generally included in a SWPPP to control waste discharges during the dry months. An appropriate selection of post-construction permanent pollution control and treatment measures must also be considered for implementation where necessary to prevent long-term water quality impairment.

The Regional Water Board administers a general WDR process for low-threat discharges from construction dewatering activities that discharge to surface waters (i.e., removal of accumulated water during excavation). An NOI is required before the activity, and the general order contains a set of standard terms and conditions for compliance with discharge prohibitions, specific effluent and receiving water limitations, solids disposal activities, water quality monitoring protocols, and applicable water quality criteria. The Regional Water Board can also issue waivers to WDRs for low-threat discharges if the wastes would not be discharged directly into water and would not be exposed to stormwater runoff that could enter surface waters.

Other Regulations for Water Quality Protection

The following other regulations related to water quality conditions are described in other sections of this Draft EIR:

- **CWA, Section 404.** Under Section 404, USACE regulates and issues permits for activities that involve the discharge of dredged or fill materials into "waters of the United States," including wetlands. See Section 4.4, "Biological Resources."

- **Section 1600 et seq. of the California Fish and Game Code.** All diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream, or lake in California that supports wildlife resources is subject to regulation by DFG, pursuant to Sections 1600 through 1603 of the California Fish and Game Code. See Section 4.4, "Biological Resources."

These regulatory programs typically impose specific measures to reduce water quality impacts on wetlands and aquatic habitat. Local grading and erosion control ordinances may also apply.

4.3.3 ENVIRONMENTAL IMPACTS

THRESHOLDS OF SIGNIFICANCE

These significance thresholds are based on relevant provisions of CEQA, the State CEQA Guidelines, environmental questions in Appendix G of the Guidelines, and significance criteria used in other relevant environmental compliance documents for similar projects.

The proposed habitat restoration project would be considered to have a significant effect on the hydrologic environment or on water quality if it would:

- Result in a significant change in the river's tendency to meander such that people, structures, or flood control infrastructure are significantly threatened;

- Cause an increase in the flood stage (i.e., water surface elevation) that would pose a significant risk to people, structures, or the operation of flood control infrastructure;

- Expose people, structures, or flood control infrastructure to a significant increase in the risk of flood hazard from the 100-year flood;

- Result in a substantial degradation of surface water or ground water quality such that it would violate criteria or objectives identified in the Central Valley Regional Water Board Basin Plan, or otherwise substantially degrade water quality to the detriment of beneficial uses;

- Result in a substantial depletion of groundwater supplies or interfere with groundwater recharge such that a net deficit in aquifer volume or a lowering of the local groundwater table level would occur;

- Result in a substantial alteration of the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in a substantial increase in erosion or siltation;

- Result in a substantial increase in sediment in the Sacramento River; or

- Result in a substantial alteration of water temperatures in the Sacramento River.

ANALYSIS METHODOLOGY

Both quantitative and qualitative methods were used to assess the potential impacts of the proposed project on hydrology, water quality and geomorphology. Because of the availability of appropriate hydraulic models, quantitative methods were used to assess the proposed project-related changes to local and downstream flood hydrology and, combined with qualitative methods, changes to geomorphic processes.

Project Modeling

The potential hydraulic effects of modifying the vegetation on nine individual properties (located between RM 163 and RM 202) slated for restoration, including the project sites being evaluated in this Draft EIR, have been quantitatively estimated through a number of modeling efforts conducted by Ayres Associates. The linear extent of the modeling encompasses the proposed project study area (RM 176 to RM 202) and includes an additional 13 miles south of the Chico Landing Subreach (as described in Chapter 3, “Description of the Proposed Project”). One of these modeling efforts (Ayres 2002) was related to preparation of the *Final Environmental Assessment for Proposed Restoration Activities on the Sacramento River National Wildlife Refuge* (USFWS 2002), while two other studies were conducted for TNC with broader purposes (Ayres 2001 and 2003). The modeling studies and Web sites are identified at the front of this section.

To assess effects of riparian habitat restoration in the project area along the Sacramento River where it is confined by flood control project levees, Ayres Associates used a one-dimensional model (Ayres 2003). Modeling was conducted for the Beehive Bend Subreach of the river (RM 176 to RM 163); this subreach includes the Stone and Hartley Island restoration units (USFWS 2002). (As described in Chapter 3, “Description of the Proposed Project,” the three SRNWR units that contain the restoration project sites addressed in this Draft EIR are located generally in the middle of the Chico Landing Subreach [RM 178 to RM 206]. Beehive Bend is the next subreach to the south.) The one-dimensional model was calibrated to the peak 1998 flow of 151,000 cfs but was run for the design flow of 150,000 cfs. For further information on the assumptions included in this model, refer to Ayres (2003).

To assess potential restoration effects on river hydraulics upstream of the project flood control levees, Ayres Associates used two-dimensional modeling (Ayres 2001 and 2002). The first effort (Ayres 2001) modeled surface water elevation and velocity changes in the river between RM 194, south of Hamilton City, and RM 174, at Glenn. The modeling included a maximum riparian forest land use conversion on three properties totaling 1,215 acres owned by TNC. These properties were referred to as the Kaiser, Phelan and Koehnen units in the modeling report. Two of these units, Kaiser and Koehnen, encompass the Capay and Dead Man’s Reach Units with a total approximately 809 acres. The second and most recent modeling effort (Ayres 2002) addressed anticipated vegetation changes between RM 202 and RM 184. The anticipated vegetation changes on the Pine Creek project site (approximately 21 acres) were included in the modeling along with several other units totaling approximately 622 acres (including the Pine Creek Unit). The hydraulic modeling using the two-dimensional models was conducted using a Sacramento River flow of 195,000 cfs, the magnitude of the flood that occurred in 1995 and for which adequate calibration data were available. Flows lower than the modeled 195,000 cfs would be expected to have similar incremental increases over current conditions but would not be expected to exceed the results derived from using 195,000 cfs.

These previous modeling efforts are accurate and representative for use in evaluating the effects of the proposed project because they included the project sites; furthermore, the models fully addressed the potential range of effects that would occur following restoration of riparian habitat. No substantial changes in natural flood hydrology, basin-wide reservoir and flood control operations, channel geomorphological characteristics of the study area, or restoration of the properties (including those project sites included in the proposed project), have occurred that would invalidate the results of these previous modeling efforts. Use of the existing models, which include additional units and an overall substantially greater area (approximately 1,007 additional acres or 55% additional land area) than the sum of the acreages of the Pine Creek, Capay, and Dead Man’s Reach Units allows for a very conservative quantitative analysis of a full restoration scenario of the project area. Changes associated with only the three project sites included in this analysis would likely be much less notable.

Existing models used for large-scale, planning level examinations of the river's hydraulics, such as the USACE Comprehensive Study, would not have been detailed enough to evaluate the specific changes of each area Ayres Associates has modeled. The model results presented below are more detailed than those of the Comprehensive Study model and are sufficient for an investigation of project feasibility.

Addressing Uncertainties

Project condition hydraulic modeling relies on the formulation of reasonable assumptions and, most importantly, calibration efforts to accurately reflect the existing conditions and consequences of future management. The use of different assumptions in modeling may lead to conclusions that overestimate or underestimate the impact or benefits of implementing the proposed project. The hydraulic modeling was conducted with steady-state conditions (i.e., evaluation of unchanging model parameters to reflect the assumption of a single set of field conditions) and calibration involved assigning generalized *roughness values* to existing and restored surfaces. Wherever possible, model input variables were calibrated against actual field data such as high water marks collected by DWR during high flow events. Also wherever possible, local residents were contacted and closely involved in model calibration efforts. Local residents provided important calibration data such as aerial photographs of their lands taken during and following flood events that show debris lines left at high water marks. These efforts ensured the best possible reflection of current conditions within the models to allow for the most accurate representation of future conditions resulting from the project.

While changes in the channel and stage elevations resulting from natural geomorphic processes (e.g., sediment transport, meander migration, and chute cutoffs) are not captured in the model and may affect the accuracy at small, localized areas, net changes throughout the entire modeled area are expected to be relatively accurate and therefore potential inaccuracies in the model are considered inconsequential in terms of hydraulic analyses for the overall modeled areas. The models also used the most conservative roughness coefficients for all restored units based on conditions described below for all vegetation types. These conditions would represent the worst-case scenario (i.e., conditions that could potentially result in the highest probability for increased flood stage to occur).

Based on monitoring data collected over a 15 year period at 106 long-term monitoring sites, relationships were developed between site characteristics and resulting vegetation communities (TNC 2003a and b). These relationships were used to develop the most realistic planting plan that could be expected within a restoration site. In other words, an area that is very likely to become denser forest is modeled as such. Likewise, an area that will likely remain less dense is modeled as such. This approach precludes the need for future maintenance of these sites and provides the most conservative approach to analysis with hydraulic models.

IMPACT ANALYSIS

IMPACT 4.3-a **Changes in Flood Hydrology.** *The proposed project would have the potential to change downstream and local flood hydrology on the Sacramento River by increasing vegetation densities on the floodplain. Modeling results predicted that downstream and local changes in flood stage elevations varied from localized increases up to 1 foot to decreases up to 0.5 foot. This does not represent an increase that would pose a significant risk to people, structures, or the operation of flood control infrastructure and does not violate existing regulations for risk to flood control infrastructure. Changes in elevation resulting from this project are likely to be less than indicated by the model because the model was used previously to evaluate effects from restoration of properties totaling approximately 1,800 acres, and the proposed project total acreage is approximately 836 acres, which represents about 46% less land area than what was previously evaluated. The changes in downstream and local flood hydrology would be* ***less than significant****.*

The proposed action would restore agricultural fields and orchards to riparian communities that would include grassland, savannah, and woody vegetation. Some areas would have stands of riparian vegetation denser than current vegetative conditions. Such changes could cause changes in the velocity of flood flows that may inundate the revegetated areas. When flow velocity decreases as a result of increased friction (i.e., roughness), the water surface elevation may rise. Potential changes in water surface elevations were evaluated in the hydraulic modeling described above using conservative assumptions of projected vegetation densities in the restoration areas and existing floodplain corridor at the modeled peak flows. However, while the entire Dead Man's Reach Unit was originally modeled assuming projected vegetation densities equal to full riparian forest, the proposed restoration plan consists of a mosaic of communities including approximately 6% of total acreage in grassland, 54% in savannah, and 40% in woody vegetation. The restoration plan for the Pine Creek project site consists of riparian forest which is consistent with the habitat assumptions used in the modeling. The restoration plan for the Capay project site consists of a mosaic of forest, grassland and savannah, which is also very similar to the habitat assumptions used in the modeling.

The Ayres (2003) report summarized the results of the one-dimensional hydraulic modeling for RM 176 to RM 163 (within the flood control project levees). The output of the modeling effort included water surface profiles resulting from three different sets of land uses, or conditions, in the modeled area. These modeled conditions (and respective water surface profiles) were: *existing conditions*, *conditions with maximum restoration*, and *conditions assumed for proposed restoration activities on SRNWR properties* (including nine units that were considered for habitat restoration) described in the 2002 environmental assessment prepared for that project (USFWS 2002). Development of the existing conditions run was necessary to establish a baseline for comparison of other conditions.

A maximum restoration condition was developed first and compared to the baseline condition. This run was developed as a sensitivity analysis to evaluate the effects of full woody riparian vegetation in the refuge units. A *revised restoration conditions* run was conducted that assumed habitat restoration on the properties. This revised run represents the proposed project with its mosaic of riparian habitats based on relationships developed with long term monitoring. The modeling report shows the predicted changes in water surface elevations for the modeled subreach (Beehive Bend), which includes areas of both increased and decreased flood stage. Minor increases generally occur upstream of new vegetation areas as a result of reduced velocity and creation of a backwater effect. However, water surface elevation is actually reduced in some areas where conditions assume restoration of riparian habitat.

The modeling results indicate that implementation of riparian habitat restoration projects would increase water surface elevation during a design flood no more than 0.5 foot. This does not represent an increase that would pose a significant risk to people, structures, or the operation of flood control infrastructure and does not violate existing regulations for risk to flood control infrastructure. The Ayres modeling reports provide further detail. Additionally, any actual changes are likely to be much less noteworthy with the much smaller area of land proposed to be restored under the proposed project. Therefore, no adverse effects are anticipated from habitat restoration under the proposed project downstream of the upper end of the flood control project levees (beginning on the west bank levee at approximately RM 184 and the east bank levee at RM 176 and continuing southward) as a result of the small, localized increases in water surface elevation (Ayres 2003). Because of the confining nature of the flood control levees in this section of the river, the vegetation change would not substantially increase the area inundated by the modeled flows.

As with the modeling described above, hydraulic characteristics were predicted for both existing land use conditions and future conditions (2002 proposed restoration activities) with changes in vegetation using two separate two-dimensional modeling efforts (Ayres 2001 and 2002). The future conditions modeling included vegetation changes anticipated on SRNWR units from RM 174 to RM 202. The models were calibrated to flows recorded during high water conditions in 1995, with peak flows of 195,000 cfs at the Colusa gauge. The results of the two-dimensional modeling effort completed in November 2001 (Ayres 2001) indicate that vegetation changes proposed for the Phelan Island and Koehnen (encompasses Dead Man's Reach) Units would have minimal effect on surface water elevations at high flows. Elevation increases of up to 0.3 foot were predicted in the vicinity of Koehnen and increases of up to 0.9 foot were predicted at the upstream edge of Phelan Island. Increases of up to 0.5 foot were predicted on the western edge of Phelan Island and up to 0.4 foot on the eastern edge (Ayres 2001). Ayres Associates looked specifically at the water surface elevation increase at the M&T Bend FRS. The minimal increase of 0.1 foot is not expected to affect the flow splits from the main river into the Butte Basin.

The modeling conducted for TNC in the vicinity of Hamilton City provides the most recent and accurate prediction of changes in hydraulics related to proposed vegetation changes at the Pine Creek Unit (encompasses the 21-acre Pine Creek project site) and Kaiser Unit (now called Capay) (Ayres 2002). This modeling, completed in January 2002, anticipates that flood flow elevations upstream of the Pine Creek Unit and upstream of State Highway 32 would decrease as much as 0.5 foot with the change in vegetation. The model indicates surface water elevation increases of up to 1.0 foot within the Kaiser Unit (Capay) and up to 0.4 foot at the eastern edge of the model at the levee downstream of Big Chico Creek. A maximum increase of 1.0 foot is predicted for the western edge of the modeled area, immediately west of the Kaiser Unit (Capay) (Ayres 2002). Based on these water profiles and known elevations of the banks, levees and other topographic features in this stretch of the river, no significant loss of freeboard is anticipated at the modeled flood flows. The modeled peak flow represents significant flooding throughout the basin, although similar conditions have been experienced three times since 1986. For floods with more frequent recurrence intervals (e.g., 2-year and 10-year events) and correspondingly lower peak flows, the expected maximum rise in water surface elevation would be smaller than for the event modeled, and the magnitude of impacts would be smaller. Additionally, changes in surface water elevations at all locations are expected to be less because the total area proposed for restoration at the project sites (project versus modeled) is much smaller than that assumed for the model.

The proposed project-induced rises in surface water elevation during flooding conditions would not substantially increase the area inundated by flood flows. The existing bank and levee elevations in the stretch of river modeled are sufficient to contain the predicted elevation increases (Ayres 2001 and 2002). Therefore, this impact is considered less than significant.

IMPACT 4.3-b

Changes in Geomorphic Processes. *Increasing vegetation densities on the floodplain would alter velocities in the existing floodway in the project area, possibly changing sediment transport, channel scouring, and meander migration. Any changes in velocities would be too small to significantly affect channel hydraulics or lead to erosive forces that could affect this already dynamic system. Also, bank stabilization efforts by others that may include placement of riprap would not be affected by the proposed project. The changes in geomorphic processes resulting from restoration activities would be* ***less than significant****.*

Erosion and deposition patterns in the river and floodplain would not be expected to change substantially as a result of the proposed project. The project-related changes in vegetation in the portion of the river modeled with a one-dimensional model (RM 163 to RM 176) are not expected to significantly affect river velocities. At the modeled flow, velocity changes are expected to be less than 1 foot per second (Ayres 2003). This minor change would not substantially alter bank erosion or bottom scouring adjacent to the upstream restoration tracts.

The results of the two-dimensional modeling (Ayres 2001 and 2002) indicate that the proposed restoration of all properties would not significantly alter flow velocities in the Sacramento River channel or overbank flooded areas. Velocities of less than 5 feet per second are predicted in most floodplain areas, and velocity increases are expected to be at or below 3 feet per second throughout the modeled area. Therefore, no significant increase in floodplain scour and erosion are anticipated related to restoration of riparian habitat in the project area.

Natural geomorphic processes of sediment transport, bank scour, and point bar formation currently exist in this dynamic and meandering river. The proposed increases in vegetation densities on the floodplain are relatively small and are not expected to substantially alter the way the system currently functions. Additionally, primary geomorphic channel forming processes are most prevalent at bankfull stage (1.5- to 2-year reoccurrence interval) flows. When flood stages rise above bankfull levels, erosive forces in channels are typically decreased as flows spill onto the floodplain resulting in energy dissipation. All of the proposed restoration activities would be expected to occur on the floodplain above the bankfull stage elevation, thus decreasing any affects that may result from these activities. Habitat restoration would not be expected to substantially encroach on the active flow area of the channel below bankfull elevation because routine high flow velocities greatly limit the extent, age, and height of vegetation growth that is possible.

Also, the restoration of native riparian habitat in the project area on lands that once supported a naturally functioning riverine ecosystem is considered beneficial for reducing the direct and indirect adverse effects of erosion and sediment deposition in the river. Minor changes in geomorphic processes resulting from restoration activities would be less than significant.

IMPACT 4.3-c — Temporary Effects on Water Quality Associated with Proposed Project Implementation. *Implementation of the project would be accomplished through the use of standard agricultural practices already being used throughout the study area. These activities would include orchard removal, disking, seeding, planting, and temporary herbicide use. Irrigation system modification and expansion would include standard trench and backfill techniques. Ground-disturbing activities associated with proposed project implementation are not expected to cause soil erosion and/or sedimentation of local drainages or the Sacramento River channel. Temporary effects on water quality associated with proposed project implementation would be* ***less than significant****.*

Land-disturbing construction activities for the proposed project would be minimal because habitat restoration efforts would primarily involve planting operations entailing minimal tillage or grading. In orchard areas where trees are removed, native vegetation would be replanted directly following site preparation (see Chapter 3, “Description of the Proposed Project”) to prevent the possibility of severe erosion from disturbed, unprotected land.

The Regional Water Board administers the NPDES stormwater permit program for non-agricultural general construction activities that disturb more than 1 acre. Activities associated with implementation of the proposed project would not involve ground disturbances like those associated with general construction projects as defined by the Regional Water Board. In general, proposed project implementation activities would occur during the dry season and standard agricultural grading and erosion control practices would be followed to avoid and minimize potential discharges of contaminated runoff from the disturbed areas. If TNC later determines that project disturbances, beyond typical agricultural type disturbances, would occur that exceed 1 acre, the authorization to conduct the work under an NPDES stormwater permit would be obtained from the Regional Water Board. Therefore, temporary effects on water quality associated with implementation of the proposed project are considered less than significant.

IMPACT 4.3-d — Long-Term Effects on Water Quality and Water Temperature in the Sacramento River. *Runoff of potentially hazardous materials related to past agricultural activities would be reduced compared to current levels as many of the existing agricultural areas use pesticides and experience flooding. These materials could be transported downstream when the project area becomes inundated during flood events and could contaminate flood water and adversely affect river water quality. Pesticides are not anticipated to be used once restored native vegetation is established. Long-term effects on water quality associated with proposed project implementation would be* ***beneficial****. Furthermore, re-establishing native riparian habitat would have no discernible effect on water temperature, and may actually have a moderating effect.*

Inundation of agricultural areas could cause transport of pesticide or hazardous waste residues that are present as a result of historical agricultural land uses. Before acquisition of the SRNWR units, the USFWS conducted hazardous waste investigations that indicated a minimal likelihood of hazardous waste contamination at the properties, including the units that contain the restoration project sites that are the subject of this Draft EIR (USFWS 1989). The runoff of pesticides would be reduced compared to current levels because many of the existing agricultural areas experience flooding and pesticides would not be used for restoration of riparian areas.

The long-term removal of agricultural lands that currently have pesticide applications is considered a beneficial effect of the proposed project.

Changes in water temperatures are not expected to result from the proposed restoration activities. In the long-term, mature riparian forest could provide additional shading of the river resulting in potential beneficial effects on water temperature. The cessation of applications of pesticides in the project area and the re-establishment of native riparian habitat is anticipated to result in a beneficial effect to water quality and no discernible effect to water temperature, respectively.

IMPACT 4.3-e	Change in Water Demand and Available Water Supply. *Over the long term, the proposed project would result in a decrease in the use of groundwater for irrigation. This decrease in water demand is considered a* ***beneficial*** *effect.*

The proposed project would remove land from irrigated agricultural use. Habitat restoration activities would require irrigation for the first 3 years until the native vegetation becomes established. Once established, vegetation in the restored project area would not require continued irrigation and all wells would be properly decommissioned according to DWR specifications (filled and capped) resulting in less long-term demand for irrigation water. The decommissioning of wells would also prevent infiltration of floodwater into an uncapped well that could otherwise contaminate the local groundwater aquifer surrounding the well with surface contaminants carried in flood flows. Additionally, ceasing agricultural practices in the project area would benefit adjacent and downstream agricultural lands by allowing groundwater levels to recharge via habitat restoration practices that improve the natural hydrology of these lands. Therefore, implementation of the proposed project would result in long-term changes in water demand and available supply that would be beneficial.

4.3.4 MITIGATION MEASURES

No mitigation is required for impacts to hydrology, water quality, or geomorphology.