3.2 Flood Control and Geomorphic Conditions

3.2.1 Introduction

This section analyzes the proposed project's potential impacts related to flood control and geomorphic conditions. It describes existing conditions in the study area and summarizes the overall Federal, state, and local regulatory framework for flood control and geomorphic conditions, and it analyzes the potential for the proposed project to affect these resources.

3.2.2 Existing Conditions

This section defines the study area for flood control and geomorphic conditions and discusses the existing conditions in the study area.

The study area is approximately 8 miles of the Feather River starting upstream of the project area (i.e., OWA D-Unit) inlet weir (River Mile [RM] 60) to approximately 0.5 mile downstream of the dredge tailings (RM 54). The study area is larger in aerial coverage than the project area, and includes the bed and banks of the Feather River upstream and downstream of the project area as well as the area affected by construction (i.e., the construction footprint) and the changes in inundation (Figure 2-1).

3.2.2.1 Flood Control

Sacramento River Flood Control Project

The Sacramento River Flood Control Project includes approximately 980 miles of levees, overflow weirs, pumping plants, and bypass channels that protect communities and agricultural lands in the Sacramento Valley and the Sacramento-San Joaquin River Delta. The levees adjacent to the west bank of the Feather River (Feather River West Levee [FRWL]) in the study area vicinity are Federal levees maintained by California Department of Water Resources (DWR) and local reclamation districts. The berms adjacent to the east bank, where the proposed project would occur, are non-Federal levees and do not protect lives or property from flooding damage.

Flooding

The study area is within the Sutter Basin, which is bounded by the Sutter Bypass to the west and south, the Feather River to the east and south, and the Thermalito Afterbay to the north. The flood concerns and channel capacity of the Feather River in the study area are discussed below.

Past and Present Flood Concerns

Flooding was historically, and still is, a concern in study area. Historical floods occurred on the Feather and Yuba Rivers in the early 1800s, 1825–26, 1849–50, 1852–53, 1861–62, 1867, 1875, 1881, 1890, and 1907. Floods were also recorded in 1909, 1914, 1937, 1940, 1955, 1964, and 1970. The floods of record occurred in December 1937, December 1955, December 1964, February 1986, January 1995, and January 1997. The floods of record corresponded with storm events that ranged from 20-year events to >100-year events and resulted in loss of human lives and thousands of acres damaged, as well as hundreds of thousands of dollars in damages (County of Butte 2007:81).

However, substantial flood risk-reduction measures have been made in the area since documentation of flooding began, and flood events since the construction of Oroville Dam in1968 were determined to be the most relevant for describing the current flood risk in the study area. Major floods have occurred in the study area since construction of the Oroville Dam. Floods in 1986, 1995, 1997, and 2006 resulted in breaches of the dikes surrounding the project area (HDR 2016). The study area, as well as the Feather River system as a whole, is susceptible to three types of floods: levee failure/overtopping and resultant riverine (slow rise) flooding, localized flooding, and dam failure inundation. These flood types are described below.

Levee Failure/Overtopping and Riverine Flooding

Major storm events can produce high flows throughout the Feather River system, most of which is considered vulnerable to flooding from levee failure and/or overtopping. Flood risk reduction from high river flows is achieved primarily by a system of levees and earthen embankments, supplemented with flood storage at the Oroville Dam and the New Bullards Bar Dam. Approximately 41 miles of levees protect the Feather River and surrounding lands from flooding. The levees and earthen embankments also provide protection for the area against flooding from the Yuba and Bear Rivers.

Riverine flooding, which occurs when a watercourse exceeds its bankfull capacity or when a levee is overtopped and/or compromised, is typically the result of prolonged rainfall, or rainfall that is combined with soils saturated from previous rain events. This type of flooding occurs in river systems whose tributaries may drain large geographic areas and may include one or more independent river basins. The onset and duration of riverine floods varies from a few hours to many days. The amount of flood runoff is directly affected by the amount, intensity, and distribution of precipitation; the amount of soil moisture; seasonal variation in vegetation; snow depth; and the water-resistance of a surface from urbanization. Slow-rise flooding is a well-established and potentially large-scale threat to the Feather River, particularly downstream of the study area. (AMEC 2007:45.)

The maximum amount of inundation that could occur if a levee in the vicinity of the study area were to fail or overtop in the study area or immediately downstream is unknown. Inundation amounts downstream of the study area are typically greater than 3 feet (ranging up to a maximum of 25 feet). (California Department of Water Resources 2011.)

Inundation depths in the project area are currently variable and depend on the magnitude of the associated flood event. Interestingly, the initial floodwaters in OWA D-Unit are currently derived from a backwater effect in the southern (i.e., downstream) portion of the unit. Floodwaters typically overtop the interior channel network and spread out over their associated floodplains at flows greater than 43,000 cubic feet per second (cfs). (Peterson Brustad 2015.)

The 2008 Sutter County General Plan Update Technical Background Report (TBR) identifies flood protection studies that have been completed or are in progress and whose recommendations may affect flood protection and FEMA flood mapping within the region (County of Sutter 2008:5.5-2,5.5-3). The Upper Feather River Floodplain Mapping Study is the most relevant to the proposed project. The FEMA-delineated flood zones in the study area are described below.

Localized Flooding

Localized flooding refers to flooding on the interior (landward side) of the levee system, as opposed to flooding from the river to the interior. Localized flooding problems often are caused by storm drain system overload, severe weather, or an unusually heavy amount of rainfall. Flooding from these intense weather events typically occurs in areas with increased runoff from impervious surfaces that is associated with urbanization, development, and inadequate storm drainage systems. The term *flash flood* describes localized floods of great magnitude and short duration. In contrast to riverine flooding, flash floods are usually caused by heavy rainfall on a relatively small drainage area (AMEC 2007:45). This type of precipitation typically occurs in winter and spring. Because the project area is in a floodplain with a disturbed but natural surface, localized flooding is less of a hazard than riverine flooding (described below) and is therefore not a significant concern for the proposed project.

Dam Failure Inundation

In addition to levee failure or overtopping, there is a potential for flooding in the study area from dam failure. There are 10 large dams in the greater region that are all under the jurisdiction of DWR's Division of Safety of Dams and have the potential to cause significant flooding if they were to fail. At the time of preparation of this document, there have been no dam failures within or affecting the study area. These dams are operated by various entities and serve several purposes, including flood control, water supply, and fisheries.

All area dams have performed well during past floods, but the region remains at risk for failure because of the variability in the ownership, ages, and conditions of the dams. As a result, there is potential for adverse effects on public safety and property in the region (AMEC 2007:45). In Butte County, the failure of the Lake Almanor Dam (located on the North Fork of the Feather River in the Almanor Basin), the Lake Oroville Dam, or the Thermalito Afterbay Dam would lead to catastrophic flooding in the study area.

Channel Capacity (Feather River)

DWR has estimated the Feather River channel capacity from Oroville to its confluence with the Yuba River to be 210,000 cfs; 300,000 cfs from the confluence with the Yuba River to the Bear River; and 320,000 cfs from the confluence with the Bear River to the Yolo Bypass (U.S. Army Corps of Engineers 2002a:20; California Department of Water Resources 2010:3–6).

The maximum allowed release criterion for Oroville Dam is 160,000 cfs because of channel limitations of the Feather River near the Yuba River and below the Bear River. Oroville Dam flood operations are defined by the release schedule provided in the operations manual (U.S. Army Corps of Engineers 1970). Operations are not to exceed the forecast flow upstream and downstream of the Yuba River. The structure of the release gates can allow controlled releases of up to 250,000 cfs. Emergency spillway design capacity of Oroville Dam would allow up to an additional 629,000 cfs of uncontrolled release (City of Biggs 1998:6-5, 6-6).

DWR has estimated that a 200-year storm event would require releases of 170,000 cfs from Oroville Dam and that a 500-year storm event would require releases of 250,000 cfs. In the event that conditions require unusually high release rates (in excess of 150,000 cfs), DWR would notify local jurisdictions and emergency response agencies. Additionally, flows would be increased incrementally to allow evacuation if determined necessary. (City of Biggs 1998:6-5, 6-6.)

The Feather River can generate more than 300,000 cfs during large flood events. Unlike much of the Sacramento River, the levees along the Feather River are set back from the channel, forming wide floodways. Prior to construction of the flood management system, the Feather River historically overflowed toward the west during major flood events, mingling with floodflows in the Sutter Basin (U.S. Army Corps of Engineers 2002b:95,96). Mean annual flow calculations for locations along the Feather River are presented in Chapter 3.3, *Hydrology and Water Quality* (Table 3.3-1).

Water Surface Elevations

The 100-year and 200-year water surface elevation (WSE) profiles developed for a separate project on the Feather River were compared to the 1957 U.S. Army Corps of Engineers (USACE) design profile and top of levee profile. The modeling results indicate that the existing FRWL has sufficient freeboard for 100-year and 200-year events, which are frequently lower than the 1957 USACE design profile. The modeling effort's upstream terminus was RM 60, just upstream of the Thermalito Afterbay. (Peterson Brustad 2010.)

Federal Emergency Management Agency Mapping Efforts

The proposed project falls within the area mapped as a 100-year floodplain (Zone A) by the Federal Emergency Management Agency (FEMA) (Federal Emergency Management Agency 2016).

3.2.2.2 Geomorphic Conditions

Geomorphic Setting of Feather River

In geologic history, the Feather River migrated frequently and freely within its meander belt. Prior to Euroamerican settlement, the mainstem Feather River and its tributaries along the valley floor would naturally overtop their banks at regular cycles and flood the adjacent lands, replenishing and depositing sediments. Despite overbank sediment deposition, these flood basins have maintained a low topographic profile, which suggests that the flood basins are subsiding at a rate equal to or greater than overbank deposition (Gilbert 1917; Water Engineering & Technology 1990:34; Water Engineering & Technology 1989 as cited in Water Engineering & Technology 1990:34; Harvey 1988 as cited in Water Engineering & Technology 1990:34). These floodplains have historically provided crucial fluvial geomorphic roles for the Feather River; the flow loss to the flood basins causes the river to downsize in the downstream direction in the lower reaches (Water Engineering & Technology 1990:35).

The geomorphic history of the Feather River has been substantially affected by hydraulic mining over the last century[1], the clearing of riparian vegetation, and the construction of levees and upstream dams for flood control and water supply. Prior to the onset of mining, the Feather River was similar to the Sacramento River upstream of Colusa. The rapid introduction of mining debris resulted in extensive shoaling of bendways and a reduction in channel sinuosity. The initial pulse or

[1] It is estimated that between 1848 and 1909, nearly 44% of the total of some 1,555,000,000 cubic yards of gold-bearing material mined by the hydraulic method was washed into the Yuba River (Hagwood 1981 as cited in Water Engineering & Technology 1990:22). In addition to this 685 million cubic yards of material that entered the Yuba River, 100 million cubic yards of sediment were washed into the upper Feather River and 255 million cubic yards entered the Bear River. Consequently, the Feather River has been affected by mining debris from all three sources, with the greatest effects from the influx of sediment from the Yuba River (Water Engineering & Technology 1990:22).

surge of mining sediment was very fine-grained, silt-dominated material (referred to as *slickens*), which was followed by quartz-dominated sands and gravels. Channel infilling from mining debris resulted in a dramatic decrease in channel capacity on the Feather River, which led to extensive flooding and overbank deposition onto urban areas and agricultural lands. The Feather River has subsequently degraded into these sediments, and the channel banks are presently composed of hydraulic mining debris.

If degradation continues, coarse-grained, non-cohesive pre-mining sediments will be exposed, which would result in decreased channel stability. The segment of the Feather River upstream of Marysville is substantially different from the lower Feather River because the upper Feather River did not receive the tremendous sediment influx introduced by hydraulic and dredge mining. Although hydraulic mining did occur on the upper Feather River, the amount of material introduced was significantly less than that on the Yuba River (Water Engineering & Technology 1990:xix; 1991:137–139). Please refer to Section 3.4, *Geology, Seismicity, Soils, Minerals, and Paleontological Resources*, for a description of sedimentology in the study area.

Reach-Specific Information

From RM 54 to RM 61, the Feather River flows through gold mining dredge spoils. The channel banks are generally composed of the spoils, which are dominated by sand- to cobble-sized sediment. The river has been controlled within linear spoils piles, which abut the river for several miles. As a result, sinuosity is low in this uppermost reach where the project area is located (Water Engineering & Technology 1991:139,140).

The observations of low sinuosity were recently verified by cbec (2015), who described the study area reach as a gravel/cobble bed river with banks comprised of armored gravel/cobble dredge tailings. The cohesive and erosion-resistant Modesto formation deposits are found along the banks within the downstream portions of the study reach. cbec staff also observed fining of bed material from the upstream to the downstream extent with armoring of bed material throughout the study area reach.

Channel Incision

Thalweg profiles for the upper Feather River are shown in Figure 6.8 of the 1991 geomorphic analysis and bank protection alternatives study by Water Engineering & Technology (1991:155), which incorporates data from 1909 and 1964 surveys. The profiles illustrate a significant degradational trend during this time period, which is expected as channel incision into hydraulic mining debris has been documented (Meade 1982 as cited in Water Engineering & Technology 1990: 80). The profiles show the greatest amount degradation downstream from the study area. The Feather River has not degraded in the study area because of the sediment supply that is maintained by lateral erosion of the dredge spoils that border the channel. In addition, flow regulation has affected the rate of incision. Because only infrequent flows can entrain coarser material, channel incision into the debris is relatively slow. Farther downstream, the lower reaches of the Feather River have degraded because of the presence of finer materials (Water Engineering & Technology 1991:150–156).

The technical memorandum prepared by cbec (2015) incorporated 1909, 1999, and 2010 thalweg surveys and describes similar findings. Specifically, cbec's analysis concluded that between 1909 and 1999, the river thalweg degraded an average of 6.5 feet and most degradation occurred just downstream of the Fish Barrier Dam (refer to Section 3.3.2.1 for a description of the waterbodies and system of facilities known as the Oroville-Thermalito Complex). In addition, cbec (2015) noted that between 1999 and 2010, the bed profile remained relatively unchanged except for localized erosion and deposition.

Sinuosity, Channel Migration, and Bank Failure

Migration rates in the upper Feather River below Oroville Dam and the study area are highly variable, reflecting the heterogeneity of materials present, and the range and stages of channel bend development (Harvey 1988 as cited in Water Engineering & Technology 1990:150). Although lateral migration has occurred in Feather River below Oroville Dam and the study area, the levee and bank setback is sufficient to keep the threat of direct erosion threat very low (Water Engineering & Technology 1991:139,140).

According to cbec's 2015 bankline analysis, there have generally been little to no planform changes following dam construction in the low flow reach upstream of the Thermalito Afterbay outfall, where stable armored dredge tailings and bed material confine river movement. This finding suggests that the low flow reach is transport-limited (i.e., its ability to entrain sediment is limited by hydrology) and that lateral movement into dredge tailings may not be a source of sediment to downstream reaches. The downstream fining sequence observed in the high flow reach downstream of the Thermalito Afterbay outfall likely indicates that tailings along the river banks are serving as a sediment source during high flow events. Although there has been little change to the channel planform in recent years, it is likely that high flow events that inundate the unvegetated tailings along the upper bank of the Feather River allow sediment to be mobilized on these slopes. (cbec 2015.)

The cross-sectional analysis conducted by cbec (2015) indicated a varying degree of morphological change that was dependent upon the location of the cross section relative to the erodibility of the bed and bank material, even though there were minimal changes in the thalweg profile as described above.

OWA D-Unit Geomorphology

According to cbec, the project area floodplain contains a mix of vegetated lowlands and historic dredge tailings. Most of the dredge tailings served as source material for construction of the Oroville Dam. The remnant dredge tailings in the project area are comprised of gravel and cobbles with a fine sand matrix. This matrix was not observed by cbec on the surface of the tailing piles near the river banks, which indicates that the fine sediment on the surface of the riverbank tailings has been mobilized and transported to downstream reaches during high flow events. (cbec 2015.)

3.2.3 Regulatory Setting

Refer to Chapter 3.3, *Hydrology and Water Quality*, for additional regulatory setting information this is applicable to flood control and geomorphic conditions.

3.2.3.1 Federal

Rivers and Harbors Appropriation Act of 1899

The River and Harbors Appropriation Act of 1899 addresses activities that involve the construction of dams, bridges, dikes, and other structures across any navigable water, or that place obstructions to navigation outside established Federal lines and excavate from or deposit material in such waters. Such activities require permits from USACE.

Section 14

Section 14 (33 U.S. Code [USC] 408) requires approval from the USACE Chief of Engineers, or designee, for alterations to certain public works, including Federal project levees, so long as the alteration would not be injurious to the public interest and does not impair the usefulness of the work. Section 408 alterations would include actions that could change the hydraulic capacity of the floodway or change the authorized geometry of the Federal project levees. SBFCA is seeking approval under 33 USC Section 408, supported by the Environmental Assessment prepared for this document under NEPA.

Upon receipt of permission from USACE under Section 408, the Central Valley Flood Protection Board will issue an Encroachment Permit for the project.

National Flood Insurance Program

The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 were intended to reduce the need for large, publicly funded flood risk management structures and disaster relief by restricting development on floodplains. FEMA administers the National Flood Insurance Program (NFIP) to subsidize flood insurance to communities that comply with FEMA regulations limiting development in floodplains. FEMA issues Flood Insurance Rate Maps for communities participating in the NFIP. These maps delineate flood hazard zones in the community. These maps are designed for flood insurance purposes only and do not necessarily show all areas subject to flooding. The maps designate lands likely to be inundated during a 100-year storm event and elevations of the base flood. They also depict areas between the limits affected by 100-year and 500-year events and areas of minimal flooding. These maps often are used to establish building pad elevations to protect new development from flooding effects.

Requirements for Federal Emergency Management Agency Certification

For guidance on floodplain management and floodplain hazard identification, communities turn to FEMA guidelines, as defined in 44 Code of Federal Regulations (CFR) 59 through 77. In order for a levee to be recognized by FEMA under the NFIP, the community must provide evidence demonstrating that adequate design and operation and maintenance systems are in place to provide reasonable assurance that protection from the base flood (1% or 100-year flood) exists. These specific requirements are outlined in 44 CFR 65.10, Mapping of Areas Protected by Levee Systems.

Executive Order 11988 Floodplain Management

Executive Order 11988 addresses floodplain issues related to public safety, conservation, and economics. The order generally requires Federal agencies constructing, permitting, or funding actions meet the following requirements.

- Avoid incompatible floodplain development.
- Be consistent with the standards and criteria of the NFIP.
- Restore and preserve natural and beneficial floodplain values.

3.2.3.2 State

Central Valley Flood Protection Plan

According to California Government Code Sections 65302.9 and 65860.1, every jurisdiction in the Sacramento-San Joaquin Valley is required to update its general plan and zoning ordinance in a manner consistent with the Central Valley Flood Protection Plan (CVPPP) within 24 months after the CVFPP's adoption[2], which occurred on June 29, 2012. In addition, the locations of the state and local flood management facilities, locations of flood hazard zones, and the properties located in these areas must be mapped and consistent with the CVFPP.

The proposed project is intended to be consistent with the CVFPP, as the state seeks to continue to work with SBFCA to develop and implement multi-benefit projects.

3.2.3.3 Local

Butte County General Plan

Both the Water Resources Element and the Health and Safety Element of the Butte County General Plan 2030 contain goals and policies relevant to flood control (County of Butte 2012). These goals and policies focus on minimizing risk and property damage from flooding, protection of surface water and groundwater resources and quality, and management of stormwater runoff.

Water Resources Element

Goal W-6 Improve streambank stability and protect riparian resources.

- **Policy W-P6.1** Any alteration of natural channels for flood control shall retain and protect riparian vegetation to the extent possible while still accomplishing the goal of providing flood control. Where removing existing riparian vegetation is unavoidable, the alteration shall allow for reestablishment of vegetation without compromising the floodflow capacity.
- **Policy W-P6.2** Where streambanks are already unstable, as demonstrated by erosion or landslides along banks, tree collapse, or severe in-channel sedimentation, proponents of new development projects shall prepare a hydraulic and/or geomorphic assessment of on-site and downstream drainageways that are affected by project area runoff.

Health and Safety Element

Goal HS-2 Protect people and property from flood risk.

- **Policy HS-P2.1** The County supports the efforts of regional, State and Federal agencies to improve flood management facilities along the Sacramento River while conserving the riparian habitat of the river.
- **Policy HS-P2.2** The County supports the efforts of private landowners and public agencies to maintain existing flood management facilities.
- **Policy HS-P2.3** The County supports the Flood Mitigation Plan and the Flooding Mitigation Action Plan in the Butte County Multi-Jurisdictional All-Hazard Pre-Disaster Mitigation Plan (MHMP).
- **Policy HS-P2.4** Development projects on lands within the 100-year flood zone, as identified on the most current available maps from FEMA (the most current available map at the time of the

[2] The Public Draft of the CVFPP was completed in December 2011.

publication of General Plan 2030 is shown on Figure HS-1), shall be allowed only if the applicant demonstrates that it will not:

a. Create danger to life and property due to increased flood heights or velocities caused by excavation, fill, roads and intended use.

b. Create difficult emergency vehicle access in times of flood.

c. Create a safety hazard due to the height, velocity, duration, rate of rise and sediment transport of the flood waters expected at the site.

d. Create excessive costs in providing governmental services during and after flood conditions, including maintenance and repair of public facilities.

e. Interfere with the existing water conveyance capacity of the floodway.

f. Substantially increase erosion and/or sedimentation.

g. Require significant storage of material or any substantial grading or substantial placement of fill that is not approved by the County through a development agreement, discretionary permit, or other discretionary entitlement; a ministerial permit that would result in the construction of a new residence; or a tentative map or parcel map.

h. Conflict with the provisions of the applicable requirements of Government Code Sections 65865.5, 65962 or 66474.5.

- **Policy HS-P2.5** The lowest floor of any new construction or substantial improvement within Flood Zones A, AE, AH and shaded Zone X, as shown in Figure HS-1 or the most current maps available from FEMA, shall be elevated 1 foot or more above the 100-year flood elevation. (County Flood Ordinance Sec. 26-22). Within urban or urbanizing areas, as defined in Government Code 65007, the lowest floor of any new construction or substantial improvements shall be elevated a minimum of 1 foot above the 200-year flood elevation.
- **Policy HS-P2.6** After General Plan 2030 and the Zoning Ordinance are amended to be consistent with the Central Valley Flood Protection Plan, scheduled for adoption in July 2012, the County shall make specific findings prior to approval of a development agreement, subdivision or discretionary permit or other discretionary entitlement, or any ministerial permit that would result in the construction of a new residence. The County shall make findings that it has imposed conditions that will protect the property to the urban level of flood protection, as defined in Government Code Section 65007, in urban and urbanizing areas, or to the national Federal Emergency Management Agency standard of flood protection in nonurbanized areas.

Goal HS-3 Prevent and reduce flooding.

- **Policy HS-P3.1** Watersheds shall be managed to minimize flooding by minimizing impermeable surfaces, retaining or detaining stormwater and controlling erosion.
- **Policy HS-P3.2** Applicants for new development projects shall provide plans detailing existing drainage conditions and specifying how runoff will be detained or retained on-site and/or conveyed to the nearest drainage facility and shall provide that there shall be no increase in the peak flow runoff to said channel or facility.
- **Policy HS-P3.3** All development projects shall include stormwater control measures and site design features that prevent any increase in the peak flow runoff to existing drainage facilities.
- **Policy HS-P3.4** Developers shall pay their fair share for construction of off-site drainage improvements necessitated by their projects.

Goal HS-4 Reduce risks from levee failure.

- **Policy HS-P4.1** The County supports the efforts of regional, State or Federal agencies to study levee stability throughout the county, particularly levees that were designed and constructed to provide a minimum 100-year level of protection.

- **Policy HS-P4.2** The County supports the efforts of levee owners and regional, State, or Federal agencies to design and reconstruct levees that do not meet flood protection standards (200-year for urban or urbanizing areas, 100-year for all other areas) to bring them into compliance with adopted State and/or Federal standards.
- **Policy HS-P4.3** New development proposals in levee inundation areas shall consider risk from failure of these levees.

Butte County Ordinance

The delineation of flood boundaries and adoption of County ordinances regulating development within identified floodplains/floodways are the basic flood management tools that the County uses to identify flood hazards and implement its own flood management program. FEMA's flood mapping program is a critical component of these efforts. A County ordinance adopted in March 1983 enforced flood hazard prevention, as set forth in Article IV in Chapter 26 of the Butte County Code. The Code assigns authority for enforcement of County flood hazard prevention policy to the floodplain administrator, in this case the Director of Development Services. The Code relies on FEMA and Flood Insurance Studies (FIS) data, although other studies may supplement these data if the floodplain administrator recommends it and the Board of Supervisors approves it. The Flood Hazard Prevention Ordinance appoints the Department of Development Services to review all applications for new construction or subdivisions within flood hazard areas. The ordinance's basic requirement, in order to reduce flood hazards, is that the lowest floor of any new construction or substantial improvement within Flood Zones A, AE, AH, and shaded Zone X be elevated 1 foot or more above the regulatory flood elevation. Also, it must be shown that development within the floodplain will not raise the existing flood level. There are other criteria for building in flood hazard areas, including flood-proofing nonresidential structures and designing structures to withstand hydrostatic pressures and hydrodynamic loads.

In areas subject to flooding that are proposed for subdivision, the County is required to ensure that:

- All such proposed developments are consistent with the need to minimize flood damage,
- Subdivisions and parcel maps must, as a condition of approval, establish regulatory flood elevations and note same on final maps prior to recordation of the final map,
- Adequate drainage is provided to reduce exposure to flood hazards.
- All public utilities and facilities are located so as to minimize or eliminate flood damage.

Butte County Multi-Jurisdictional All-Hazard Pre-Disaster Mitigation Plan

The County's principal emergency response plan is the Butte County Multi-Jurisdictional All-Hazard Pre-Disaster Mitigation Plan (Butte County MHMP), adopted in March 2007 (County of Butte 2007). The purpose of the plan is to meet the requirements of the Disaster Mitigation Act and thereby maintain continued eligibility for certain hazard mitigation (or disaster loss reduction) programs from FEMA. The plan lays out the strategy that will enable Butte County to become less vulnerable to future disaster losses. The plan reviews the County's capabilities with regard to reducing impacts of natural hazards (e.g., flooding, dam failure) and identifies recommended action items to reduce vulnerability to these hazards. The most relevant section of the plan with respect to flood control issues is the Flooding Mitigation Action Plan. The Flooding Mitigation Action Plan contains a description of flood hazards, a risk assessment, plans and programs to address the hazards, and mitigation goals and strategies for each jurisdiction in Butte County. The main goal of the Butte

County MHMP pertaining to flood control is to protect infrastructure and agriculture from long-term risks of flood; this goal is to be achieved by implementation of the Flooding Mitigation Action Plan.

Butte County Flood Mitigation Plan

The County established the Butte County Flood Mitigation Plan to provide guidance to agencies that protect life, property, and livestock; are involved in land use planning; administer FEMA's NFIP; and respond to flood emergencies in Butte County (Wood Rodgers 2006).

3.2.4 Environmental Effects

This section describes the modeling efforts used to partially inform the impact analysis for flood control and geomorphic conditions. This section also discusses the potential impacts of the proposed project on flood control and geomorphic conditions in the context of State CEQA Guidelines Appendix G checklist items and professional judgement. Modeling efforts completed by both cbec (2015) and HDR (2016) were partly relied on for the determination of impacts. A brief summary of the HDR (2016) modeling is presented below.

3.2.4.1 HDR (2016) Modeling Effort for the Study Area

Hydraulic model simulations were conducted by PBI (Appendix A in HDR 2016) for with-project conditions using Peterson Brustad's TUFLOW model for the 2-year (Figure 2-3), 100-year (Figure 2-4), 200-year, and 1957 design flow events (Appendix 3.2-A).

2-Year Results

Hydraulic modeling results for the 2-year, with-project scenario indicate that backwater from the Feather River flowing into the study area via the proposed new permanent connection and creating approximately 150 acres of new 2-year shallow floodplain habitat. The proposed fish barrier berm (located in the southern part of the study area) effectively prevents water from entering the Pit 2 southern pond from the north. The simulation also shows water from the Feather River backing up into the Pit 2 pond via the low flow outlet spillway channel. (HDR 2016) (Appendix 3.2-A).

HDR's (2016) hydraulic summary table summarizes the peak flow, shear stresses, velocities, and water surface elevations at the new permanent connection for the 2-year flow event (with-project conditions). No stage reduction in the Feather River would occur during the 2-year flow event.

100-Year and 200-Year Results

Hydraulic modeling results for the 100-year and 200-year scenarios indicate that once flows in the Feather River main channel reach roughly 43,000 cfs, water begins to flow into the study area through the existing outflow weir. When flows in the main channel reach approximately 60,000 cfs, water begins to spill into the study area through the existing rock gabion inflow weir.

Hydraulic modeling results for the 100-year and 200-year scenarios show water spilling into the study area via the proposed rock gabion inflow weir once flows in the Feather River reach approximately 70,000 cfs. A peak flow of approximately 7,000–15,000 cfs is diverted through the new rock gabion inflow weir, which results in a maximum stage reduction of 0.3 feet and 0.7 feet in the main channel of the Feather River for the 100-year and 200-year events, respectfully.

The modeling results show very little change in the extents of inundation in the study area for both the 100-year and 200-year events because under existing conditions, water already fully inundates the study area due to the existing inflow and outflow weirs.

The model simulations show about a 0.5-feet increase in stage in the main channel of the Feather River near the location of the existing outflow weir. However, this section of the main channel is separated from the FRWL by a large existing berm and One Mile pond; results indicate that water surface elevations adjacent to the FRWL do not increase as a result of the 100-year and 200-year with-project condition. In addition, there are no significant downstream WSEL impacts shown beyond RM 56, which is within the relative extents of the proposed project.

HDR's (2016) hydraulic summary table (Appendix 3.2-A) summarizes the peak flows, shear stresses, velocities, and water surface elevations over the inflow weir and outflow weir for the 100-year and 200-year flow events (with-project conditions). Maximum stage reduction in the Feather River would be on the order of approximately 0.3 feet for the 100-year flow event and 0.7 feet for the 200-year flow event.

1957 Design Flow Results

Similar to the 100-year and 200-year scenarios, hydraulic modeling results for the with-project 1957 design flow scenario show little changes in the extent of inundation. A peak flow of roughly 39,000 cfs is conveyed into the project area via the new rock gabion inflow weir which results in a maximum stage reduction of 0.5 feet in the main channel of the Feather River. It should be noted, however, that overtopping of the perimeter berms that surround the study area occurs in many different places during the simulated 1957 design flow event.

Also similar to the 100-year and 200-year scenarios, the model simulations show a 0.5-feet increase in stage in the main channel of the Feather River near the location of the existing outflow weir. However, this section of the main channel is separated from the FRWL by a large existing berm and pond and the results show that water surface elevations adjacent to the FRWL do not increase as a result of the 1957 design flow with-project condition. In addition, there are no downstream WSEL impacts shown beyond RM 56.

HDR's (2106) hydraulic summary table (Appendix 3.2-A) summarizes the peak flows, shear stresses, velocities, and water surface elevations over the new rock gabion inflow weir and outflow weir for the 1957 design flow event (with-project conditions). Maximum stage reduction in the Feather River would be approximately 0.5 feet for the 1957 design flow event.

3.2.4.2 CEQA Checklist

a. Substantially alter 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 substantial erosion or siltation onsite or offsite?

b. Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding onsite or offsite?

Impact FC-1: Change in Stream Energy and Modification of Floodplain Scour/Deposition (beneficial for vegetation management and hydraulic improvements; no impact for recreational features)

The discussion below is applicable to checklist items *a* and *b*.

OWA D-Unit (Project Area)

The extent of floodplain inundation would remain similar to existing conditions under high flows. However, for flows less than the 100-year event that entered the project area, there is potential for both scour of, and deposition onto, the floodplain. These geomorphic processes are normal and essential for floodplain maintenance. Based on the modeling effort completed for the proposed project, specifically anticipated increases in flow velocity and shear stress within the project area floodplain, altered flow velocities and shear stresses within the project area would not pose a significant risk of channel scouring or associated channel avulsion within the study area. The highest velocities would occur in the immediate vicinity of the new rock gabion inflow weir and the outflow weir, where the structures would be engineered to withstand the increased velocities associated with higher flow events. Small increases in velocity through the project area have the potential to winnow fines from the coarse matrix, but this would most likely be limited due to fine sediment availability and habitat enhancements (grading and planting of native riparian vegetation) within the project area that also have the benefit of slowing flow velocities and stabilizing surface sediments. Deposition of smaller materials (sand, silt, and clay) would most likely be confined to the new rock gabion inflow weir and outflow weir areas and would be spatially variable elsewhere.

Part of the project area is currently isolated from the Feather River. One of the primary goals of the proposed project is to improve the existing OWA weir system to re-engage the historic floodplain at various flow regimes to the Feather River and provide numerous benefits via floodplain connectivity; the most relevant benefit for flood control and geomorphic conditions would be the increase in the frequency and duration of low flow inundation.

Geomorphic processes are spatially and temporally variable throughout a typical floodplain environment. Therefore, determining the exact locations of expected geomorphic change is difficult. The anticipated benefits to flood control and geomorphic conditions will be determined over the course of the project through a stringent monitoring effort. The proposed monitoring elements are described in Section 2.3.6. The proposed project would have an overall beneficial effect related to alteration of the existing drainage patterns within the project area.

Feather River

The proposed project would minimally affect the hydraulics, and therefore the geomorphology of the Feather River relative to current conditions based on the modeling efforts completed for the proposed project that pertain to anticipated changes in stream power of the river. Anticipated reductions in stream power on the Feather River between the new rock gabion inflow weir and the outflow weir may help slow river armoring without further diminishing the supply of sediment from the dredge tailings. The proposed project would have an overall beneficial effect related to alteration of the existing drainage patterns within the Feather River.

Vegetation Management: The impact discussion above is applicable to proposed vegetation management activities because they would result in the beneficial effects of reduced flow velocities and more stable surface sediments.

Hydraulic Improvements: The impact discussion above would be most applicable to hydraulic improvements because these activities would allow for the increase in inundation of the study area.

Recreation Features: The impact discussion above is not entirely applicable to recreation feature implementation. Recreation feature implementation would not significantly alter the geomorphic processes within the project area or the Feather River.

c. Place housing 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?

The proposed project would not involve the construction of houses. There would be no impact.

d. Place within a 100-year flood hazard area structures that would impede or redirect floodflows?

Impact FC-2: Change in Water Surface Elevations and Flood Safety Attributable to Project Design (beneficial for hydraulic improvements; no impact for vegetation management and recreational features)

OWA D-Unit (Project Area)

The proposed project would involve the placement of structures associated with recreation features (i.e., a concrete pad for the existing portable restroom facilities, vehicular bridge and two footbridges) within the 100-year flood hazard area. The hydraulic improvements would also place inflow and outflow structures within the banks of the Feather River. The proposed project is meant to increase the frequency and duration of flooding within the study area. The existing inflow/outflow weir system only allows flooding into the study area when flows in the main channel are approximately 43,000 cfs. Degrading the berm along the eastern boundary would allow backwater to enter and flood the project area at events lower than 43,000 cfs. The area of inundation would increase for the lower (i.e., 2-year) flood events. However, the area of inundation would not change for the higher (i.e., 100-year or 200-year) events because the area is already fully inundated under existing conditions. The proposed project would have an overall beneficial effect related to impeding floodflows or redirecting floodflows within the project area.

Feather River

As described above in Section 3.2.4.1, *HDR (2016) Modeling Effort for the Study Area*, the upstream, local, and downstream water surface levels in the Feather River would not be affected by vegetation management, hydraulic improvement, or recreation feature implementation. The reduction in flood stage on the Feather River under the higher flow regimes as a result of the proposed project is considered beneficial.

The proposed project would not change the geometry (planform) of the Feather River and therefore would not cause significant changes to water flow in the river or cause negative hydraulic effects upstream or downstream of the study area reach. Therefore, the proposed project would have a beneficial effect related to impeding floodflows or redirecting floodflows on the Feather River.

Vegetation Management: The impact discussion above is not entirely applicable to vegetation management activities. Vegetation management activities would not significantly alter water surface elevations within the project area or the Feather River.

Hydraulic Improvements: The impact discussion above would be most applicable to hydraulic improvements because they would allow for the increase in inundation of the study area and slight decreases in stage in the Feather River.

Recreation Features: The impact discussion above is not entirely applicable to recreation feature implementation. Recreation feature implementation would not significantly alter water surface elevations within the project area or the Feather River.

e. Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?

Impact FC-3: Change the potential for failure of levee, dam, or instream structure (beneficial for hydraulic improvements; no impact for vegetation management and recreational features)

The proposed project would serve to decrease the existing potential for failure of any levee, dam, or instream structure. No people or structures would be exposed to a significant risk of loss, injury, or death involving flooding. Therefore, this impact is considered beneficial.

f. Contribute to inundation by seiche, tsunami, or mudflow?

The proposed project would slightly alter the riverbank contours of the Feather River at several locations within the study area, but would not involve alterations that would increase the susceptibility of surrounding communities to inundation by seiches, tsunamis, or mudflows. Therefore, there would be no impact.