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EXAMPLE 6: IN-DELTA STORAGE PROJECT

GEOMORPHOLOGY AND SOILS

Construction-related Impacts

Loss of Farmland
Prime farmland would be taken out of use where it is present in the area of the reservoir and its appurtenances (SCS 1992).

Operation and Maintenance-Related Impacts

Seismic Impacts
Structures at the site are susceptible to seismic disturbance by earthquakes on nearby faults. Victoria Island lies in an area of moderate seismicity (Biggar and Wong 1992). Since 1861, six earthquakes with magnitudes between 5.3 and 6 have occurred in eastern Contra Costa County (Wong and Biggar 1989). Two of these occurred in 1980 on the northwest-trending Marsh Creek-Greenville Fault (Jennings 1994), resulting in about four miles of surface rupture (Bolt et al. 1981) along a portion of the fault about 11 miles southwest of Victoria Island (Wagner et al. 1990). According to recent estimates (Peterson et al. 1996; WGNCEP 1996), the Greenville Fault is capable of a magnitude 6.9 earthquake.

The north-trending Vaqueros faults (comprising the Brentwood, Kellogg, Vaqueros, Davis, and Camino Diablo Faults) are northeast of the Greenville/Marsh Creek fault, and approximately 7 miles southeast of Victoria Island. Of these, the Brentwood fault is capable of a magnitude 6 earthquake (CCWD 1993). Although focal mechanisms of low-level seismicity in the vicinity of the Vaqueros faults suggest that strain east of the Greenville fault system is being released by earthquakes along north-trending faults, there is no geomorphic evidence that surface rupture has occurred along the Vaqueros faults in Holocene time (Biggar and Wong 1992). The MCE on either the Greenville or the Brentwood fault could generate estimated peak horizontal ground accelerations at Victoria Island of 0.15 g or more (after Carey 1992) and the duration of ground shaking at the surface could last from 12 to 20 seconds (CCWD 1993).

The Great Valley thrust fault extends along the west side of the Sacramento and San Joaquin Valleys. In this area, the shallowly dipping, several-mile-wide fault plane approaches to within 3 miles of the southwest corner of Victoria Island. Studies by WGNCEP (1996) indicate that the Great Valley thrust fault in this area has the capability of producing a magnitude 6.7 earthquake. Peak horizontal ground accelerations at Victoria Island due to such an earthquake are estimated to be approximately 0.4 to 0.5 g (after Carey 1992).

Because of the relatively shallow depth and small size of the reservoir proposed for Victoria Island, the probability of reservoir-triggered seismicity (RTS) at this site is low. If RTS were to occur, the most probable activity would be earthquake sequences composed of small-magnitude events occurring after water level fluctuations in the reservoir or possibly at the initial filling.

The delta levees are susceptible to catastrophic failure due to earthquake-induced liquefaction (Finch 1992; Volpe et al. 1992). Liquefiable sand is widespread beneath the levee systems on most of the major Delta islands. The sandy levee sections common to levees of many of the islands, including those of Victoria Island and of Woodward Island immediately to the north, add to their susceptibility to earthquake-induced levee damage (Finch 1992). In a 1992 study of liquefaction probabilities along the Mokelumne Aqueduct, the highest liquefaction probability (99 percent over the next 30 years) was determined for a levee on Woodward Island (Volpe et al. 1992). Similar liquefaction probabilities may apply to the Victoria Island levees because of similarities in levee construction and proximity to seismogenic faults.

4.7 MITIGATION STRATEGIES

Impacts on soil erosion from construction and operation are common to all examples. The impacts may be minimized by implementing a comprehensive soil erosion control and restoration plan. The plan should contain measures directed toward controlling short-term and long-term erosion and sedimentation effects and to generally restore pre-project topography, water resources, soils, and vegetation in areas affected by construction activities.

Important farmland taken out of use due to the filling of a reservoir or construction associated with reservoirs and associated facilities cannot be mitigated. Appropriate documentation of the change in service would have to be filed with the National Resource Conservation Service.

The potential seismic impact to the reservoir and associated facilities may be mitigated by designing the facilities and other structures, including the upgraded levees, to meet the potential seismic accelerations. Strong-motion studies of the site using maximum-likelihood earthquakes on nearby faults could refine the structure design parameters on the basis of site geology and its effect upon surface movement.

New References Cited

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General comments on the Reservoir report impacts

The seismic impacts discussions in Sections 4.2.2, 4.3.2, 4.4.2, 4.5.2, and 4.6.2, include discussions of the characteristics of the faults in the example reservoir areas. This information may be more appropriately placed in an "affected environment/existing conditions" section.

Section 4.2.1: loss of farmland is identified as a construction-related impact and should be included in Section 4.2.2, which would be consistent with the other sections.

Section 4.2.2, 4th Para.: Define reservoir-triggered seismicity. How can a reservoir trigger a seismic event?

These comments also apply to the In-Delta storage example write-up.

GEOMORPHOLOGY AND SOILS

1.1.1 Significance Criteria

The methodology used to develop proposed thresholds for geomorphologic and soil resources and seismic impacts include the following:

Thresholds should be qualitative;
Thresholds should be applicable to anticipated actions and the study area;
Threshold subjects should be consolidated when possible; and
Thresholds apply only to adverse impacts.

Proposed significance threshold criteria include the following:

Removal, filling, grading, or disturbance of soils;
Releases of toxic substances from soils or sediments;
Adverse changes in rates of sedimentation and erosion;
Adverse changes in soil drainage;
Increased potential for soil or sediment erosion by wind, waves, or currents;
Increased potential for erosion and mass failure-induced landslides;
Increased potential for seismic activity or vulnerability of structures to seismic events;
Disruption of natural or favorable soil profiles and horizons;
Increased potential for damage from geological hazards; and
Impacts upon any soils on lands classified as prime or unique farmlands.

2.0 INTRODUCTION

Surface water storage is an element common to each alternative under consideration for the CALFED Bay-Delta Program (Program). This technical report evaluates the potential consequences and mitigation strategies for several surface water storage options that have the potential to contribute to the Program objective of improving water management for beneficial uses of the Bay-Delta system. While specific reservoir projects have not been identified as part of the Program alternatives, specific reservoir storage capacities and component configurations relative to existing project facilities have been proposed. Storage capacity described within the alternatives varies from 1 million acre feet to 3 million acre feet (MAF), while facility configurations vary from on-stream to off-stream storage, with locations both north and south of the delta. Since no actual sites have been selected for inclusion in the alternatives, five example reservoir sites, representative of the general sizes and geographic locations described in the alternatives, were chosen for analysis to evaluate potential impacts from surface water impoundment.

Significance criteria are established to satisfy the California Environmental Quality Act (CEQA) requirement to determine the threshold at which impact magnitudes constitute significant impacts. Although the CEQA statutes and guidelines define a ?significant effect on the environment as a substantial, or potentially substantial, adverse change in the environment,? neither CEQA nor the CEQA guidelines establish mandatory thresholds or levels at which an adverse impact is considered significant. Thus CEQA allows the lead agency discretion in the selection, use, and application of significance criteria that are appropriate for the setting and circumstance of each project.

The National Environmental Policy Act (NEPA) does not have the same mandatory finding of significance as does CEQA, but NEPA does discuss how the significance of impacts can be defined in terms of context and intensity. The general nature of the planning and the range of settings and impacts involved with the Program dictate the use of qualitative thresholds of significance at this programmatic stage.

3.0 PROJECT DESCRIPTIONS

Specific sites were used to better focus information about potential impacts and mitigation measures. The reader is reminded however, that these sites are presented merely as examples to illustrate the types of impacts and mitigation measures associated with construction, operation and maintenance of storage reservoirs consistent with the requirements for surface storage and facility configurations contained within the alternatives. The inclusion of an example project does not indicate an endorsement of that project by CALFED. Project descriptions are taken from individual Facility Descriptions and Updated Cost Estimates prepared by the CALFED Storage and Conveyance Refinement Team (CALFED 1997a-1997g).

3.1 EXAMPLE 1: SITES/COLUSA RESERVOIR PROJECT

The Sites/Colusa Reservoir is an example of an off-stream north of Delta storage project that would be filled primarily through diversions of winter and spring surplus flows pumped from the Sacramento River. Minor additional runoff contributions from local drainage are anticipated. This project could provide long-term storage, which would increase the reliability of water supplies during drought conditions. The Tehama-Colusa Canal (T-C Canal) and the Glenn-Colusa Irrigation District Canal are the main existing conduits that could be utilized for filling the reservoir. Enlargement and extension of the T-C Canal and construction of an additional new diversion from the Sacramento River into the T-C Canal, the Chico Landing Intertie, are also components of this project. Water would be delivered to the Sites/Colusa reservoir through the enlarged T-C Canal via the proposed Logan Forebay and Pumping Generating Plant.

3.1.1 Location

The Sites/Colusa Reservoir would be located within northern Colusa County and southern Glenn County, about 10 miles west of Maxwell across the drainages of Stone Corral, Hunters, Logan, and Funks Creeks. The area is rural in nature and very sparsely populated. The small community of Sites and a road near Stonyford are within the reservoir inundation area.

3.1.2 Project Components

Reservoir

The reservoir would be formed by constructing four large dams across the major drainages and several smaller saddle dams along the low divides between drainages. The large dams include a 294-foot high dam on Stone Corral Creek (Sites Dam), a 302-foot high dam on Funks Creek (Golden Gate Dam), a 282-foot high dam spanning Hunters Creek (Hunters Dam), and a 272-foot high dam across Logan Creek (Logan Dam). These dams would be zoned earth embankment types with crest elevations of 541 feet above mean sea level (MSL) and crest widths of 40 feet. Four saddle dams ranging from 71 to 260 feet in height would be required along Logan Ridge and five saddle dams ranging from 11 to 130 feet in height would be required along the northern boundary of the reservoir.

The maximum operating water surface elevation would be at 532 feet above MSL and would inundate approximately 29,600 acres. Total storage capacity for the Sites/Colusa Reservoir would be 3.3 MAF.

Tehama-Colusa Canal Enlargement and Expansion

Existing Canal Configuration

The existing canal is 111 miles long, extending from the Red Bluff Diversion Dam on the Sacramento River in the north to Bird Creek in Yolo County in the south. The capacity of the canal at Red Bluff is 2,530 cubic feet per second (csf), diminishing to 1,700 csf at the terminus. Funks Reservoir, at about mile 67 of the canal and about five miles west of the town of Maxwell in Colusa County, is the only regulating facility for the canal. The T-C Canal Enlargement would increase the capacity of the canal from Red Bluff to Funks Reservoir.

The Red Bluff Diversion Dam creates the necessary hydraulic head to divert water from the Sacramento River into the T-C Canal. The Diversion Dam consists of eleven, 60-foot wide concrete overflow weir sections, a 60-foot wide concrete sluiceway, the headworks to the T-C Canal, fishways at both abutments of the dam, and low earth dikes on each abutment.

The T-C Canal Fish Screens and Bypass Facilities allow water to be diverted from the Sacramento River while minimizing harm to fish that may be present. The fish are prevented from entering the canal by slowly rotating drums placed diagonally across a settling basin, then collected into bypass pipes and returned to the center of the Sacramento River downstream of the dam.

Eight individual reaches, identified by major drainage or creek crossings at each end, divide the existing T-C Canal. The T-C Canal Enlargement would involve the northern end of the existing canal and include five of the eight reaches, while the T-C Canal Extension would involve the remaining three reaches south of Funks Reservoir. The extension project also includes extending the T-C Canal from its present terminus into southern Yolo County.

Proposed Canal Configurations

There are two potential configurations for increasing the capacity of the existing canal Õ the existing canal structure could be enlarged; or a parallel canal adjacent to the existing canal could be constructed. Both options would require increasing the capacity of the intake structure from the Red Bluff Diversion Dam with an equal increase in the capacity of the fish screens. Additionally, a 21-mile extension of the canal is part of the project.

Enlarged Canal Configuration

This option would increase the capacity of the five canal reaches between the Red Bluff Diversion Dam and Funks Reservoir to 5,000 csf by enlarging the existing canal structure. The T-C Canal intake facility would be enlarged to a total capacity of 5,000 csf and the existing fish screening facility would be expanded accordingly. The expansion would require excavation and lining of the existing canal, enlargement of 24 siphons, construction of 58 road crossings, and establishment of one check structure with each reach.

Parallel Canal Configuration

This option would increase the capacity of the canal to at least 5,000 cfs for all eight reaches. In this configuration a separate canal would be constructed parallel to the existing canal with a capacity of 3,500 csf. The parallel canal would require an additional 500 feet of right-of-way adjacent to the existing canal. The expanded right-of-way would allow sufficient distance between the canals for construction and maintenance activities. The T-C Canal intake facility and fish screens would be enlarged similarly to that required for the Enlarged Canal Configuration. In addition, a separate intake structure would be constructed for the parallel canal.

T-C Canal Extension

The canal extension from its present terminus at Bird Creek to the proposed Lake Berryessa Winters Pumping-Generating Plant would add approximately 21 miles to the total length of the canal. The extension section would be concrete-lined with a capacity of 5,000 cfs, and would include construction of siphons, check structures, bridges, overchutes, and culverts. The extension would require a new 300-foot right-of-way and new crossings would include Oat Creek, Cache Creek, and Highway 16.

Chico Landing Intertie

The Chico Landing Intertie would connect the Sacramento River south of Hamilton City to the existing T-C Canal just south of Greenwood. The Intertie would provide an alternate means of diverting water from the river to the new reservoir. The Intertie would consist of approximately 10 miles of concrete-lined canals, three pumping plants, and a screened diversion on the Sacramento River. The Chico Landing Intertie has a design capacity of 5,000 cfs.

The diversion facility would be composed of twenty-four, 32-foot bays and two, 24-foot bays with 2, 6-foot by 8-foot slide gates per bay and would include fish screens designed to meet the California Department of Fish and Game velocity limits.

All of the canal reaches would have the following common dimensions õ concrete-lined trapezoidal sections with 1.5:1 side slopes and a bottom width of 60 feet. The canal would be constructed in both cut and fill. The proposed canal alignment would cross several existing facilities. It would cross the Glenn-Colusa Canal and the Southern Pacific Railroad in inverted siphons. The alignment also would include nine irrigation ditch crossings and nine county road crossings. The required right-of-way width is 350 feet.

Logan Conveyance System

The proposed conveyance system from the T-C Canal to the Sites/Colusa Reservoir would be located approximately four miles south of Willows and nine miles north of the existing Funks Reservoir. The system would include the following features:

Logan Forebay, a 400 acre feet impoundment formed by a low earth dam on Logan Creek immediately west of the T-C Canal;

Logan Pumping-Generating Plant, located at the base of Logan Dam, which would lift water a maximum of 322 feet into the Sites/Colusa Reservoir; and

Logan Canal, a 5,000 cfs capacity, 1.7 mile long canal connecting Logan Forebay to the Logan Pumping-Generating Plant.

The Logan Pumping-Generating Plant would have a capacity of 5,000 cfs and would serve both inflow and outflow requirements for the Sites/Colusa Reservoir. An open chute-type spillway with an uncontrolled crest (ungated) with a capacity of 2,500 cfs would discharge from the reservoir into Hunters Creek. The small spillway would be adequate to handle the maximum probable project flood because of the large water surface area compared to the small, relatively dry tributary drainage area.

Outlet works facilities for Sites/Colusa Reservoir would include outlets at Logan Dam and Golden Gate Dam. The outlet at Logan Dam would contain the penstock for the Logan Pumping-Generating Plant and would be used both to fill Sites/Colusa Reservoir and to make releases into Logan Forebay. The outlet at Golden Gate Dam would be used only to help during an emergency evacuation. Department of Water and Power (DWR), Division of Safety and Dams requires that during an emergency evacuation, 10 percent of the maximum water depth must be released in 10 days. This equates to an estimated release capacity of 44,000 cfs or 22,000 cfs at each outlet works facility.

3.2 EXAMPLE 2: THOMES-NEWVILLE RESERVOIR PROJECT

The Thomes-Newville Reservoir Project, an example of an off-stream north of Delta storage reservoir, would function as storage for available flows from Thomes Creek, North Fork Stony Creek, and Stony Creek, as well as for surplus flows from the Sacramento River. This project could increase the water supply opportunities and contribute to the reliability of water supplies during drought conditions. Facilities associated with the project include Newville and Tehenn Reservoirs located on North Fork Stony Creek, a diversion facility from Thomes Creek to Newville Reservoir, a two-way conveyance facility from Tehenn Reservoir to the existing Black Butte Reservoir on the mainstem of Stony Creek, and a two-way conveyance canal facility from the Tehama-Colusa Canal to Black Butte Reservoir. The Thomes-Newville Reservoir Project would have a storage capacity of 3.08 MAF.

There would be four water sources for the Thomes-Newville Reservoir Project. Flows from the North Fork Stony Creek would discharge directly into the proposed reservoir. Thomes Creek flows would be diverted from Thomes Creek and conveyed to the reservoir by a gravity canal. Mainstem Stony Creek flows would be conveyed from Black Butte Reservoir to Newville Reservoir via Tehenn Canal, Tehenn Pumping-Generating Plant, Tehenn Reservoir, and Newville Pumping-Generating Plant. Sacramento River flows would be diverted into the Tehama-Colusa Canal and conveyed into Black Butte Reservoir via Sour Grass Canal and Sour Grass Pumping-Generating Plant. From Black Butte Reservoir, the Sacramento River water would be conveyed to Newville Reservoir via the Tehenn Canal and

Reservoir.

3.2.1 Location

The Thomes-Newville Reservoir Project would be located approximately 25 miles west of Orland on the North Fork of Stony Creek in Glenn County. Three storage facilities, built between 1909 and 1970 as part of the Orland Project, are located on Stony Creek. The East Park Reservoir was constructed in 1909 in the upper watershed followed by Stony Gorge Reservoir, constructed in 1928, and Black Butte Reservoir further downstream, completed in 1970. The Black Butte Reservoir now serves as the main regulating facility for the distribution system of the Orland Project. The Thomes-Newville Reservoir Project would be located approximately 10 miles upstream of the Black Butte Dam.

The area is sparsely populated with relatively few structures. Approximately eight miles of public roads exist within the inundation area of Newville Reservoir. The Paskenta-Round Valley Road, a paved two-lane county road, passes through the north end of the reservoir and another county road crosses northwestward through the reservoir from the dam site to Paskenta-Round Valley Road. These roads would be relocated and upgraded to current county standards. Total length of new road construction would be approximately 10 miles.

3.2.2 Project Components

Reservoir

The Newville Reservoir would have a storage capacity of 3.08 MAF and would be impounded by one main dam (Newville Dam) across North Fork Stony Creek and 10 saddle dams located on Rocky Ridge on the eastern and northern boundaries of the reservoir. The main dam would be an earthfill embankment structure, rising 400 feet above the existing streambed to an elevation of 1,000 feet above MSL. The dam crest length would be approximately 3,200 feet. The proposed reservoir would have a normal pool elevation of 980 feet above MSL and a surface area of 16,700 acres.

Spillway and Inlet-Outlet Works

The spillway would have a maximum capacity of 35,700 cfs and would be located 200 feet west of the right dam abutment. The spillway would consist of two submerged radial gates in a rectangular reinforced concrete-lined channel. The gates would be 20 feet wide by 30 feet high. The sill of the gates would be at an elevation of 930 feet above MSL. The emergency spillway, with a capacity of 8,000 cfs, would consist of two 20-foot long uncontrolled weirs, each at an elevation of 985 feet above MSL. The gated spillway and the emergency spillway would discharge into a common concrete lined tailrace and stilling basin.

The inlet-outlet works for the Newville Reservoir would have a capacity of 5,000 cfs to convey water pumped into the reservoir and to facilitate releases from the reservoir. The primary features of the inlet-outlet works would be a 2,100-foot long tunnel through the right abutment of the dam and a sloping intake conduit with nine evenly spaced levels of inlets between the minimum and normal pool elevations. The emergency release requirement of the proposed reservoir would be 32,000 cfs. This release would be made through the gated spillway and the inlet-outlet works of the dam.

Newville Pumping-Generating Plant

The plant would be located at the toe of the Newville Dam to lift water from Tehenn Reservoir into Newville Reservoir and to generate power from releases from Newville Reservoir into Tehenn Reservoir. The plant would have a total capacity of 5,000 cfs.

Thomes Creek Diversion Structure and Canal

The diversion structure would be located in Thomes Creek, approximately nine miles upstream of the town of Paskenta and would consist of a conventional concrete gravity dam. The dam crest would be about 90 feet above the existing streambed at an elevation of 1,050 feet above MSL. A 500-foot wide overflow section with a crest elevation of 1,035 feet above MSL would be located on the left abutment. Two additional 20-foot wide and 50-foot high radial gates located in the right abutment could pass up to 41,000 cfs. The sill of the gates would be located 25 feet above the original streambed. These gates would be opened to allow flood flows to pass and flush accumulated sediment out of the diversion pool. During most of the winter, the gates would be closed so water could be diverted to Newville Reservoir.

A concrete-lined canal would convey water 13,000 feet from Thomes Creek to Newville Reservoir. The canal would be 30 feet wide and 16.5 feet deep with a capacity of 10,000 cfs.

Tehenn Reservoir

Tehenn Reservoir would be formed by constructing Tehenn Dam immediately downstream of Newville Dam across the North Fork Stony Creek. The reservoir would back water to the Newville Pumping-Generating Plant located at the base of Newville Dam, where the pumping-generating plant would lift the water into Newville Reservoir. Tehenn Dam would rise 112 feet above the original streambed and would have a crest length of 2,500 feet. Tehenn Reservoir would be capable of storing 32,500 acre feet at normal pool elevation of 610 feet above MSL.

The spillway for Tehenn Reservoir would be a concrete-lined ungated chute-type on the left abutment of the dam with a capacity of 50,000 cfs. The chute would extend 1,300 feet, ending in a concrete stilling basin. The spillway crest length would be 250 feet. The inlet-outlet works for Tehenn Dam would consist of a steel-lined concrete conduit under the left abutment with a capacity of 5,000 cfs.

Tehenn Pumping-Generating Plant

The Tehenn Pumping-Generating Plant would lift water from Black Butte Reservoir and the Tehenn Canal into Tehenn Reservoir and also would generate power by releasing water from Tehenn Reservoir to Black Butte Reservoir. The plant would have a total capacity of 5,000 cfs.

Tehenn Canal

Tehenn Canal would deliver a maximum flow of 5,000 cfs in either direction between Black Butte Reservoir and Tehenn Pumping-Generating Plant. It would be approximately five miles long, roughly following the natural channel of North Fork Stony Creek and would require a maximum cut of 120 feet.

Black Butte Pumping-Generating Plant

The Black Butte Pumping-Generating Plant would lift water from the Black Butte Canal into Black Butte Reservoir and would generate power from releases from Black Butte Reservoir to the Black Butte Canal. The plant would be located just downstream of the existing Black Butte Dam and would be connected to the dam inlet-outlet works by a new 1,800-foot tunnel. The pumping-generating plant would have a capacity of 5,000 cfs.

Black Butte Canal

The Black Butte Canal would be a two-way conveyance facility connecting the Black Butte Pumping-Generating Plant and Black Butte Reservoir with the Sour Grass Pumping-Generating Plant. The concrete-lined canal would have a capacity of 5,000 cfs and would be approximately 4.5 miles long between the Black Butte and Sour Grass Pumping-Generating Plants. Near Black Butte, the canal would require a maximum cut of approximately 190 feet.

Sour Grass Pumping-Generating Plant

The Sour Grass Pumping-Generating Plant would lift flow into the Black Butte Canal during pumping operations and would generate power during release operations from Black Butte Reservoir. The pumping-generating plant would have a capacity of 5,000 cfs. Releases made through this plant and the Black Butte Pumping-Generating Plant would be used to supply supplemental water from storage in Newville Reservoir for use in the Tehama-Colusa Canal.

Sour Grass Canal

The Sour Grass Canal would convey water in either direction between the Tehama-Colusa Canal and the Sour Grass Pumping-Generating Plant. The concrete-lined canal would have a capacity of 5,000 cfs and a total length of approximately 4.5 miles, generally following the alignment of Sour Grass Creek.

3.3 EXAMPLE 3: WEST SAN JOAQUIN VALLEY RESERVOIR PROJECT

The West San Joaquin Valley (WSJV) Reservoir Project is an example of an off-stream storage project south of the Sacramento-San Joaquin Delta. This reservoir would be adjacent to the existing San Luis Reservoir and would be connected with the California Aqueduct so that excess Delta flows could be conveyed to and stored within the reservoir. The primary purpose of the WSJV Reservoir would be to reduce the frequency and magnitude of water shortages for water users dependent on the Delta by increasing the reliability of available supplies. This type of additional off-stream storage in association with the California Aqueduct could increase the water supply reliability of the State Water Project (SWP) and the Central Valley Project (CVP). The additional storage provided also could add flexibility to the SWP and CVP delivery systems and permit shifting Delta diversions toward months with fewer Delta impacts.

The project would consist of a storage reservoir, pumping-generating plants, and conveyance canals. The existing Los Banos Reservoir would be modified for use as a regulating facility for the WSJV Reservoir. The existing Los Banos Retention Dam, originally constructed to protect the California Aqueduct from flood flows carried by Los Banos Creek, would be improved to accommodate the proposed pumped-storage operations of the WSJV Reservoir. The project would store available flows diverted from the Delta at the SWP?s Banks Pumping Plant and, possibly, the CVP?s Tracy Pumping Plant. Water diverted from the delta would be conveyed to the existing Los Banos Reservoir through SWP?s California Aqueduct or CVP?s Delta Mendota Canal, then pumped to the WSJV Reservoir for storage. Water stored in the WSJV Reservoir would be released into Los Banos Reservoir and the California Aqueduct through a series of pumping-generating facilities. The new reservoir would operate similarly to the San Luis Reservoir facilities.

3.3.1 Location

The WSJV Reservoir Project would be located in Merced County approximately six miles west of the California Aqueduct and 80 miles south of the Sacramento-San Joaquin Delta. The main dam would be constructed in a narrow canyon on Los Banos Creek. The Los Banos Valley, extending several miles upstream of the dam site, would form the reservoir inundation area. The area is rural in nature with scattered ranches. The existing San Luis and Los Banos Reservoirs are located immediately downstream of the project site

Construction of the WSJV Reservoir Project would require the relocation or reconstruction of 12.5 miles of roads and the construction of approximately 20 miles of new roads for recreation and facility access. Additional relocations include approximately 50 residences, a 500kV transmission line, two crude oil pipelines, and a natural gas pipeline.

3.3.2 Project Components

Reservoir

The reservoir would be formed by the construction of a zoned earthfill dam, rising 436 feet above the streambed of Los Banos Creek. The crest of the dam, at 806 feet above MSL, would be 40 feet wide and 2,160 feet long. At normal pool, the surface elevation of the reservoir would be at 786 feet above MSL and would have a surface area of approximately 13,810 acres. Total storage capacity for the WSJV Reservoir would be 2.03 MAF.

Several saddle dams would be required to achieve the proposed storage capacity. Salt Creek Saddle Dam would be located about 2.5 miles southeast of the primary dam site. This dam would be a rolled earthfill embankment dam with a crest width of 40 feet, length of 4,500 feet and height of 253 feet. A 36-inch diameter steel outlet conduit would be placed along the bed of Salt Creek to divert the stream during construction and for stream releases during normal reservoir operations.

Harper Lane and San Carlos Saddle Dams would be located at the northwest and southeast corners of the reservoir, respectively. The Harper Lane Saddle Dam would be a zoned earthfill dam with a crest height of 78 feet and a length of 900 feet. Billie Wright Road would be relocated along the 40-foot wide dam crest. San Carlos Saddle Dam would be a zoned earthfill embankment structure with a crest height of 81 feet and a length of 650 feet. A 600-foot long, 20-foot high dike would be required at a saddle location approximately 900 feet to the west. These two sections would be joined as one continuous embankment with a total length of 1,250 feet.

Spillway and Inlet-Outlet Works

Both the spillway and the emergency outlet works would be located on the left abutment of the dam. The spillway inlet would be an ungated, 30-foot diameter spillway tunnel extending approximately 14,480 feet to a concrete-lined open chute section that would extend about 340 feet to a stilling basin. The inlet-outlet works for the project would be designed to transfer up to 4,650 cfs between WSJV Reservoir and the pumping-generating plant during generating operations, and up to 3,500 cfs during pumping operations. This facility also would have the capacity to release 16,000 cfs during emergency drawdown. The main features of the inlet-outlet works would be a free-standing intake tower with an overall height of 308 feet, a concrete-lined pressure tunnel with a full-length steel liner, and the pumping-generating plant penstocks.

The emergency outlet works would be designed to evacuate 10 percent of the maximum reservoir depth in 10 days for a peak drawdown capacity of 26,000 cfs. This flow would be passed through the emergency outlet portion of the spillway, with a capacity of 10,000 cfs

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and through two bypasses in the inlet-outlet works with a combined capacity of 16,000 cfs.

Los Banos Detention Dam and Reservoir

The existing detention dam is a zoned earthfill embankment with a height of 167 feet and a crest length of 1,370 feet. Several modifications would be required to facilitate the proposed pumped-storage operation for WSJV Reservoir. The existing upstream shell of the Los Banos Detention Dam has insufficient permeability to be free-draining under drawdown rates anticipated for the proposed pumping-storage option. Replacement of the existing shell material with more pervious material would be necessary. Additionally, the existing spillway would be supplemented with a new spillway located on the right abutment of the Los Banos Detention Dam. Maximum release capacity would be 17,600 cfs and would be sized to meet the maximum discharge resulting from an emergency drawdown of WSJV Reservoir. Construction of new inlet-outlet works also are anticipated.

Conveyance Facilities

Two conveyance channels, capable of transferring water in either direction, would be required to move water from the California Aqueduct to the WSJV Reservoir. Both channels would be capable of carrying 3,500 cfs in pumping mode. In generating mode, Channel 1 would be capable of carrying 4,650 cfs while Channel 2 would carry 5,800 cfs.

Channel 1, located between the Los Banos Detention Dam and California Aqueduct, would be concrete-lined and approximately one mile in length. Primary features would include an outlet culvert at Los Banos Creek, an emergency drawdown channel, confluence facility, turnout structure for the aqueduct, a bridge crossing for both Interstate 5 and Canyon Creek, and various animal crossings. The freeway bridge would be 100 feet wide and 240 feet long. Channel 2, between the WSJV Reservoir and the Los Banos Reservoir, would be unlined and approximately 1.4 miles long.

Pumping-Generating Plants

Two pumping-generating plants would be constructed as part of this project. Plant 1 would convey water from the California Aqueduct to the Los Banos Reservoir. Maximum plant power requirements in pumping mode would be about 54 megawatts (MW) with a maximum flow of 4,500 cfs. The maximum plant generation would be about 50 MW with a maximum flow of 5,800 cfs.

Plant 2 would lift water from the Los Banos Reservoir to the WSJV Reservoir and would recover energy during WSJV Reservoir releases. The reversible units in this facility would require a maximum of 174 MW in pumping mode with a maximum flow of 4,500 cfs. Maximum plant generation would be 167 MW with a maximum flow of 5,800 cfs.

3.4 EXAMPLE 4: MONTGOMERY RESERVOIR PROJECT

The Montgomery Reservoir is an example of an off-stream south of Delta storage project in the San Joaquin Valley that would be used to store and reregulate available water from Lake McClure and/or surplus flows on the Merced River and flood control on Dry Creek. The Montgomery Reservoir could help develop conservation storage in the San Joaquin Valley, which could potentially develop additional water supplies for agricultural and environmental uses on the San Joaquin River.

The project would include a storage reservoir and dam, a pumping plant, a two-way conveyance canal, and a discharge pipeline. The project would store available excess flows diverted from the Merced River. Water diverted would be conveyed through an expansion of the existing North Side Canal. The canal would be modified from a one-way to a two-way canal to facilitate conveyance to and from Montgomery Reservoir. This two-way conveyance facility from Merced Falls Reservoir to Montgomery Reservoir would convey up to 2,000 cfs by gravity to Montgomery Reservoir from October through March and about 1,000 cfs to Merced Falls Reservoir from April through September. Montgomery Reservoir potentially could contribute to the regulation of flows from the American, Sacramento, and Stanislaus Rivers and provide an additional source to serve local demands.

3.4.1 Location

The Montgomery Reservoir would be located in northeastern Merced County approximately 60 miles southeast of the Sacramento-San Joaquin Delta. The project dam would be located on Dry Creek approximately 16 miles above the confluence with the Merced River near the town of Snelling. The dam site is within the Merced Irrigation District (MID) service area. Through operation of the New Exchequer Dam, MID supplies approximately 570,000 acre-feet of water per year for municipal and agricultural uses. The project area is rural in nature and sparsely populated. Relocation would be required for County Road 59J, a telephone line, and approximately 4.5 miles of additional roads, including portions of Olsen Road and Fields Road that would be inundated.

3.4.2 Project Components

Existing Facilities

Montgomery Reservoir would be located about 10 miles west of New Exchequer Dam. Owned and operated by MID, New Exchequer Dam is located on the Merced River and impounds Lake McClure. Approximately eight miles downstream of New Exchequer Dam is McSwain Dam and roughly one mile further downstream from McSwain Dam is the Merced Falls Diversion Dam. MID uses Merced Falls Diversion Dam to divert water into the North Side Canal. Snelling Dam is located about three miles downstream of Merced Falls Diversion Dam and is used by MID to divert water into the Main Canal, serving areas south of the Merced River.

Montgomery Reservoir

Montgomery Reservoir would be formed by constructing a zoned earthfill dam with a height of 101 feet above the original streambed of Dry Creek. The dam crest would be 30 feet wide at an elevation of 336 feet above MSL. The reservoir would have a surface water elevation of 325 feet above MSL and a surface area of approximately 8,050 acres. Total storage capacity would be 240,000 acre-feet. Depending on reservoir configuration, the project could inundate up to 8,100 acres. According to the 1961 Reclamation feasibility-level design, eight saddle dams of various lengths and heights also would be required; further details regarding these dams were not included in the feasibility design.

Spillway, Pumping Plant, and Outlet Works

The spillway would be a glory hole-type with an inlet elevation of 329 feet above MSL and an outlet elevation of 310 feet above MSL. The spillway maximum design capacity is 1,000 csf and would be located on the left side of the main embankment dam, draining into an unnamed tributary of Dry Creek. A pumping plant would be required on the discharge pipeline to pump water from Montgomery Reservoir to the North Side Canal. The capacity of this pumping plant would be 1,000 cfs.

The Outlet Works would be located near the center of the dam and would discharge water into Dry Creek with a maximum outlet capacity of 5,200 csf at an elevation of 237 feet above MSL. The maximum outlet capacity is capable of releasing the emergency evacuation volume of approximately 3,650 cfs as defined by DWR, Division of Safety of Dams.

Conveyance Facilities

The existing North Side Canal would be expanded from a one-way gravity canal to a two-way canal to deliver water to the proposed reservoir. The total length of the expansion would be approximately 30,000 feet from the Merced Falls Diversion Dam to the outlet at the proposed reservoir. A new discharge pipeline with 1,000 cfs capacity would be constructed from the pumping plant at the base of the embankment dam, extending approximately 15,000 feet to the North Side Canal. The discharge pipeline would deliver water from the proposed reservoir back to the North Side Canal. Water delivered to the North Side Canal could flow in either direction from the connection point with the pipeline.

The Main Canal Pipeline would be constructed to connect the North Side Canal with the Main Canal. This pipeline would be approximately 4,000 feet long and cross beneath the Merced River. The Main Canal Pipeline would facilitate delivery of Montgomery Reservoir water to MID users south of the Merced River, thereby reducing diversions from the Merced River to the Main Canal at Snelling Diversion Dam. For the purposes of this report, an adequate right of way width, sufficient for construction and maintenance of all canals and pipelines, was determined to be 300 feet.

3.5 EXAMPLE 5: LOS VAQUEROS RESERVOIR ENLARGEMENT PROJECT

The Los Vaqueros Reservoir Enlargement Project is an example of a modification to an existing off-stream south of Delta facility to accommodate increased storage. The Los Vaqueros Reservoir is currently under construction by Contra Costa Water District for water quality and emergency storage purposes. The Enlargement Project would increase storage capacity from 100,000 acre feet to 1.06 MAF. The Los Vaqueros Dam, currently being constructed, would be removed to build a larger earthfill dam. In addition to the larger dam, the project facilities would include the Kellogg Forebay, pumping-generating plants, and conveyance facilities.

A larger capacity would enable storage of excess Delta flow pumped at Banks Pumping Plant. The stored water would be released for needs in the California Aqueduct and to offset Delta diversions during environmentally critical periods. Enlargement of this off-stream storage facility could increase water supply reliability of the SWP and CVP and could increase flexibility of Delta export operations for both projects.

Available Delta flows would be pumped from Clifton Court Forebay, first to Kellogg Forebay, and then into the enlarged reservoir via the Los Vaqueros Pumping-Generating Plant. Storage releases also would generate energy at the Plant. The Tuway Canal would convey water in either direction between Kellogg Forebay and the California Aqueduct.

3.5.1 Project Location

The Los Vaqueros Reservoir Enlargement Project would be located in Contra Costa County on the eastern slope of the Coast Range. The current construction site is located about 11 miles south of Antioch and seven miles northwest of the Clifton Court Forebay. The total project lands to be acquired would be approximately 7,000 acres.

3.5.2 Project Components

Reservoir

The enlarged Los Vaqueros Reservoir would be formed by removal of the dam currently under construction and replacement with a main dam built across Kellogg Creek. Construction also would include four saddle dams. The reservoir would have a water surface elevation of 780 feet above MSL, a surface area of 4,830 acres, and a storage capacity of 1.065 MAF. The main dam would be a zoned earth embankment structure with a crest elevation of 800 feet above MSL, a height of 505 feet above the streambed, and a crest length of 2,700 feet.

Spillway and Inlet-Outlet Works

The enlarged Los Vaqueros Reservoir and Dam would have a 2,200-foot long concrete-lined, chute-type spillway structure located on the right abutment. The inlet-outlet works would have three functions õ to enable rapid release of reservoir storage during emergencies; provide a choice of reservoir depths during normal operational releases; and provide a means to pump water into the reservoir. It would consist of three concrete- and steel-lined pressure tunnels of varying levels with a normal operating capacity of 5,000 cfs and an emergency capacity of 11,800 cfs to meet the release requirements of DWR?s Division of Safety and Dams. Both the spillway and the river outlet works facilities could safely pass the maximum probable flood flow.

Kellogg Forebay

Kellogg Forebay would serve as a transfer facility between the Kellogg Pumping Plant and the Los Vaqueros Pumping-Generating Plant. It would be formed by a dam on Kellogg Creek and one saddle dam. The main dam, located approximately 1.5 miles south of Camino Diablo Road and approximately three miles downstream of the Los Vaqueros Dam, would be a zoned earthen embankment. The dam would be 90 feet in height with a crest elevation of 260 feet above MSL. The Kellogg Forebay would have a normal water surface elevation of 244 feet above MSL, a surface area of 124 acres, and a storage capacity of 4,270 acre feet.

In addition, the main Kellogg Forebay Dam would have a 340-foot long concrete-lined, chute-type spillway structure located on the right abutment. The outlet works would have a maximum release capacity of 45 cfs designed to meet the emergency release requirements of DWR?s Division of Safety and Dam. Both the spillway and the outlet works could safely pass the maximum probable flood flow.

Conveyance Facilities

The conveyance facilities would consist of the Los Vaqueros Pipeline, the Los Vaqueros Pumping-Generating Plant, the Tuway Canal, a widened North San Joaquin Intake Channel, the Kellogg Pumping Plant, and the Kellogg Pumping Plant Discharge Facility.

The Los Vaqueros Pipeline would be located between the Los Vaqueros Reservoir and the Los Vaqueros Pumping-Generating Plant. This 5,000 cfs capacity pipeline would consist of nine 11,000-foot long, 144-inch diameter pipes and would convey water to and from the enlarged reservoir. The 5,000 cfs capacity Los Vaqueros Pumping-Generating Plant would be located at Kellogg Forebay. The Plant would lift water from the forebay to Los Vaqueros Reservoir through the Los Vaqueros Pipeline. The pumping plant also would generate power from storage releases from Los Vaqueros Reservoir to Kellogg Forebay.

Tuway Canal would connect Kellogg Forebay to the California Aqueduct. It would convey water pumped by the existing Harvey O. Banks Delta Pumping Plant or by the proposed Kellogg Pumping Plant to Kellogg Forebay. The canal would be a 4.5 mile long concrete-lined structure and have a capacity to carry 5,000 cfs in either direction. Tuway Canal would have a top width of 135 feet, a bottom width of 60 feet, and a depth of 25 feet from the normal operating water surface level. The canal would include a 2,900-foot long siphon structure consisting of six, 23-foot by 23-foot concrete boxes. The canal right-of-way would consist of 410 acres.

The North San Joaquin Intake Channel conveys water from Clifton Court Forebay to Harvey O. Banks Pumping Plant. The intake channel would be widened to increase its capacity from 10,900 cfs to 15,900 cfs. The 2-mile long channel would have a top width of 304 feet, a bottom width of 120 feet, and a depth of 46 feet from the normal operating water surface elevation.

The Kellogg Pumping Plant would be located near the top of the North San Joaquin Intake Channel on the north side of Harvey O. Banks Pumping Plant. The pumping plant would lift water from the enlarged intake channel into the Tuway Canal. The plant would have a capacity of 5,000 cfs. The Kellogg Pumping Plant Discharge Facility would have a capacity of 5,000 cfs and would consist of nine 3,200-foot long, 144-inch diameter pipelines, a 1,000-foot long canal, and three, 25-foot by 55-foot radial gates.

During reservoir filling operations, the Kellogg Pumping Plant would pump water from the North San Joaquin Intake Channel leading to Harvey O. Banks Pumping Plant, into the Tuway Canal. Tuway Canal, which can convey flows in either direction, would transport the pumped Delta water to Kellogg Forebay. From the forebay, water would be pumped through the Los Vaqueros Pipeline into the enlarged Los Vaqueros Reservoir.

Water released from the enlarged Los Vaqueros Reservoir would pass through the Los Vaqueros Pipeline, through the turbines of the Los Vaqueros Pumping-Generating Plant and into Kellogg Forebay. The enlarged reservoir also would have a connection to Contra Costa Water District?s existing pipeline. Kellogg Forebay water would be released to the Tuway Canal and flow by gravity to the California Aqueduct.

4.0 GEOMORPHOLOGY AND SOILS

4.1 IMPACTS COMMON TO ALL EXAMPLE SITES

4.1.1 Construction-related Impacts

Sedimentation and Soil Compaction
Construction of the dam and associated facilities potentially could result in increased sedimentation to existing drainages. Additionally, compaction of soil by heavy equipment during construction would temporarily affect the physical characteristics of the soil.

4.1.2 Operation and Maintenance-related Impacts

Increased Erosion Potential
Reservoir inundation would result in erosion at the water?s edge due to wave action and bank slumping from shoreline soil saturation and water erosion. Wind erosion on denuded slopes would take place in the water fluctuation zone of the proposed reservoir.

4.2 EXAMPLE 1: SITES/COLUSA RESERVOIR PROJECT

4.2.1 Construction-related Impacts

Loss of Farmland
Important farmland, including prime farmland, unique farmland, and farmland of statewide importance would be taken out of use where it is present in the area of the reservoir and its appurtenances, and along the Tehama-Colusa Canal, its extension, and the Chico Landing Intertie (FMMP 1994, 1996b).

4.2.2 Operation and Maintenance-related Impacts

Increased Landslide Potential
The potential of landsliding in the northeastward-dipping strata surrounding the reservoir may be increased as a result of saturation of the strata as the reservoir is filled. Such landsliding could be seismically triggered by earthquakes.

Seismic Impacts
Structures at the reservoir site and along the canal and intertie are susceptible to seismic disturbance by earthquakes on nearby faults. Studies by DWR (1980) at the Thomes-Newville site about 20 miles north of the Sites/Colusa Reservoir site show the Sites/Colusa site to lie in an area of low to moderate seismicity. The largest measured quake in the vicinity between 1928 and 1980 was about 31 miles away, near the Willows Fault, and had a magnitude of 4.7. The Stony Creek Fault lies 8 to 10 miles west of the reservoir site and has been assigned a maximum credible earthquake of magnitude 6.5. Most recent movement on the Stony Creek Fault is between 30,000 and 130,000 years before present (Late Quaternary according to Jennings [1994]).

Studies by the Working Group on Northern California Earthquake Potential (WGNCEP 1996) indicate that the Great Valley thrust fault system along the west side of the Sacramento Valley and close to the proposed reservoir and canal has the capability of producing earthquakes ranging up to magnitude 6.7. Historical earthquakes have occurred along this thrust system with magnitudes as high as 7 and modified Mercalli intensities as high as 9 (Wong et al. 1988).

The Tehama-Colusa Canal runs close to the Dunnigan Hills Fault (Jennings 1994). The fault exhibits seismic activity (Wong et al. 1988), and its geomorphic expression suggests

Holocene activity (Jennings 1994, WGNCEP 1996). About 20 miles south of Dunnigan, the proposed canal extension crosses the East Valley and West Valley Faults, but most recent movement on these faults is judged to be pre-Quaternary (Jennings 1994) and therefore not considered a seismic hazard.

Reservoir-triggered seismicity (RTS) could occur at this site due to the large size and depth of the reservoir. If RTS were to occur, the most probable activity would be earthquake sequences composed of small-magnitude events occurring after water level fluctuations in the reservoir or possibly at the initial filling. The largest RTS earthquake would not exceed the maximum credible earthquake (MCE) already assigned to faults considered significant to the reservoir.

4.3 EXAMPLE 2: THOMES-NEWVILLE RESERVOIR PROJECT

4.3.1 Construction-related Impacts

Sedimentation and Soil Compaction
Steep-sloped cuts for the relocated roads and water transport facilities would increase the potential for landslides due to slope steepening.

4.3.2 Operation and Maintenance-related Impacts

Increased Downstream Sedimentation
After the facility has been constructed, the downstream geomorphology of Thomes Creek would be significantly changed by the diversion of approximately 97 percent of the Thomes Creek flow (CALFED SCRT 1997) into the Thomes-Newville Reservoir. The resulting lack of carrying capacity in the downstream creek bed would result in siltation of the channel, especially at the confluence of steep tributary streams.

Although the reservoir would impound almost all of the sediment supplied to it by Thomes Creek and the North Fork of Stony Creek, the reservoir is sufficiently large compared to the rate of sediment delivery. Thus sedimentation of the reservoir is not considered to be a problem (DWR 1980). Because Black Butte Reservoir already exists as a sediment trap immediately downstream of the proposed reservoir, Thomes-Newville Reservoir would serve to impound sediment that otherwise would be deposited in Black Butte Reservoir and therefore would cause no adverse sedimentation effects on Stony Creek below Black Butte Reservoir.

Loss of Farmland
Prime farmland in the vicinity of Newville (FMMP 1996b) would be taken out of use when the reservoir is constructed and filled.

Increased Landslide Potential
The potential of landsliding in the northeastward-dipping strata surrounding the reservoir may be increased as a result of saturation of the strata as the reservoir is filled. Such landsliding could be seismically triggered.

Seismic Impacts
Structures at the site are susceptible to seismic disturbance by earthquakes on nearby faults. According to the DWR (1980), the site lies in an area of low to moderate seismicity. The largest measured quake in the vicinity between 1928 and 1980 was about 31 miles away, near the Willows Fault, and had a magnitude of 4.7. The Stony Creek Fault lies about 3.5 miles west of the site and has been assigned a maximum credible earthquake of magnitude 6.5, with an estimated maximum ground acceleration at the site of 0.55 g. Most recent movement on the Stony Creek Fault is between 30,000 and 130,000 years before present (Late Quaternary according to Jennings [1994]). Studies by WGNCEP (1996) indicate that the Great Valley thrust fault system along the west side of the Sacramento and San Joaquin Valleys and close to the reservoir location has the capability of producing a magnitude 6.7 earthquake.

RTS could occur at this site due to the size and depth of the reservoir. If RTS were to occur, the most probable activity would be earthquake sequences composed of small-magnitude events occurring after water level fluctuations in the reservoir or possibly at the initial filling. The largest RTS earthquake will not exceed the MCE already assigned to faults considered significant to the reservoir.

4.4 EXAMPLE 3: WEST SAN JOAQUIN VALLEY RESERVOIR PROJECT

4.4.1 Construction-related Impacts

No additional impacts associated with construction have been identified.

4.4.2 Operation and Maintenance-related Impacts

Increased Landslide Potential
The potential of landsliding in the northeastward-dipping strata surrounding the reservoir may be increased as a result of saturation of the strata as the reservoir is filled. Such landsliding could be seismically triggered.

Seismic Impacts
Structures at the site are susceptible to seismic disturbance by earthquakes on nearby faults. The fault shown to have the greatest potential impact upon the site is the Ortigalita Fault, an active fault (Jennings 1994) that runs through the western part of the proposed reservoir about 2.6 miles southwest of the proposed sites for Los Banos Grande (LBG) Dam and the Salt Creek Saddle (SCS) Dam (DWR 1990). The fault is seismogenic (LaForge and Lee 1982), exhibits mainly right-lateral strike-slip movement (Anderson et al. 1982a), and is capable of a magnitude 6.9 earthquake (Petersen et al. 1996; WGNCEP 1996). Calculations

using a design earthquake of magnitude 6.75 on this fault showed that the earthquake would produce a peak horizontal acceleration at the LBG and SCS dam sites of about 0.6 g and that the duration of accelerations in excess of $0.05 g would be about 23 seconds (DWR 1990). The peak horizontal acceleration at the Harper Lane Saddle (HLS) Dam site at the north end of the proposed reservoir and 1,500 feet northeast of the Ortigalita Fault was determined to be about 0.7 g.

Several smaller faults have been mapped within a few miles east of the Ortigalita Fault. These include the Los Banos Creek Fault, the O?Neill Fault, and the postulated San Joaquin Fault. The Los Banos Creek segment of the Ortigalita Fault lies within the footprint of the proposed WSJV Reservoir about 2.2 miles southwest of the proposed LBG Dam site and passes through the foundation of the site of the HLS Dam at the north end of the proposed WSJV Reservoir. An MCE of magnitude 4.6 on the Los Banos Creek Fault could generate peak horizontal ground accelerations at the LBG and SCS dam sites of about 0.2 g (DWR 1990). The O?Neill Fault and the San Joaquin Fault are considered to be pre-Holocene (DWR 1990) or Late Quaternary (Jennings 1994) in age and are not considered to pose a seismic threat to the proposed facilities.

The Great Valley thrust fault extends along the west side of the Sacramento and San Joaquin Valleys. In the vicinity of the proposed reservoir , the Great Valley thrust fault is represented by a distinct homoclinal segment that is bounded by the San Joaquin Fault on the northeast, the Ortigalita fault on the southwest, and bedding slip on the O?Neill fault zone. Studies by WGNCEP (1996) indicate that the Great Valley thrust fault in this area has the capability of producing a magnitude 6.6 earthquake.

RTS should be evaluated at the proposed WSJV Reservoir. Studies of seismicity associated with the filling and operation of San Luis Reservoir, located immediately north of the proposed WSJV Reservoir, suggest that a ?fairly good? case could be made for RTS at that site (Anderson et al. 1982b), although other investigators classify San Luis Reservoir as a questionable RTS case (Wong and Strandberg 1996). If RTS were to occur, the most probable activity would be earthquake sequences composed of small-magnitude events occurring after water level fluctuations in the reservoir or possibly at the initial filling. The largest RTS earthquake would not exceed the MCE already assigned to faults considered significant to the reservoir. Note that groundwater flow from the reservoir to the underlying Ortigalita fault zone may trigger additional seismicity on the fault zone.

4.5 EXAMPLE 4: MONTGOMERY RESERVOIR PROJECT

4.5.1 Construction-related Impacts

No additional impacts associated with construction have been identified.

4.5.2 Operation and Maintenance-related Impacts

Loss of Farmland
Prime farmland is located near the center of the proposed reservoir (FMMP 1996c) and would be taken out of use when this reservoir is constructed and filled.

Increased Erosion Potential
After the facility has been constructed, the downstream geomorphology of Dry Creek may be significantly changed if the majority or all of the Dry Creek flow is impounded in the reservoir. The resulting lack of carrying capacity in the downstream creek bed would result in siltation of the channel. Conversely, early planning documents indicated that natural and ephemeral streams would be used to convey releases and spill flows (Guillen 1997). If the release and spill volumes imposed upon these streams significantly exceed the flow capabilities of these streams, significant erosion and channel modification would take place. Because the reservoir would impound almost all of the sediment supplied to it by Dry Creek, any water released to the natural streams below the dam would be sediment-starved and would tend to erode the streambed below the dam.

Seismic Impacts
Structures at the site are susceptible to seismic disturbance by earthquakes on the nearby Foothill Fault System. Although the most recent movement on most of the faults composing this system is pre-Quaternary, studies of faults in the Bear Mountains and Melones Fault Zones about 20 miles north of the proposed reservoir show the latest movement on these faults to be Late Quaternary and perhaps Holocene in age (Jennings 1994). The maximum magnitude earthquake on the Foothills Fault System is estimated to be 6.5 magnitude (CDMG 1996; WGNCEP 1996). The probability of significant reservoir-induced seismicity is low because of the small size and shallow depth of the reservoir (CALFED 1997).

4.6 EXAMPLE 5: LOS VAQUEROS RESERVOIR ENLARGEMENT PROJECT

4.6.1 Construction-related Impacts

No additional impacts associated with construction have been identified.

4.6.2 Operation and Maintenance-related Impacts

Loss of Farmland
No prime farmland, unique farmland, and or farmland of statewide importance would be taken out of use by construction of the dam and its ancillary facilities or by filling the reservoir (FMMP 1996a).

Increased Erosion Potential
After the facility has been constructed, the downstream geomorphology of Kellogg Creek may be significantly changed by sedimentation or scouring. ~~Reservoir inundation would~~

~~result in erosion at the water?s edge due to wave action, wind erosion on denuded slopes in the water fluctuation zone, and bank slumping from shoreline soil saturation and water erosion.~~

Increased Landslide Potential
The potential of landsliding in the northeastward-dipping strata surrounding the enlarged reservoir may be increased as a result of saturation of the strata as the reservoir is filled. Such landsliding could be seismically triggered as well, possibly leading to overtopping of the dam by landslide-created waves or by displacement of the reservoir water by a rapidly-moving slide block.

Seismic Impacts
Structures at the site are susceptible to seismic disturbance by earthquakes on nearby faults. The reservoir site lies in an area of moderate seismicity (Biggar and Wong 1992). Since 1861, six earthquakes of magnitudes between 5.3 and 6 have occurred in eastern Contra Costa County (Wong and Biggar 1989). Two of these occurred in 1980 on the northwest-trending Marsh Creek-Greenville Fault, which lies 0.5 to 1.5 miles west of the proposed reservoir (Wagner et al. 1990). The 1980 earthquakes caused surface rupture for about four miles (Jennings 1994) along the portion of the fault adjacent to the proposed reservoir (Bolt et al. 1981). According to recent estimates (Person et al. 1996; WGNCEP 1996), the Greenville Fault is capable of a magnitude 6.9 earthquake. The potential for triggering seismicity on the Marsh Creek-Greenville Fault Zone due to groundwater flow from the reservoir to the fault zone will be increased due to the high maximum pool elevation (780 feet) of the water in the enlarged proposed reservoir.

The north-trending Vaqueros faults (comprising the Brentwood, Kellogg, Vaqueros, Davis, and Camino Diablo Faults) lie immediately adjacent to the east and north of the dam site. Of these, the Brentwood fault passes within 700 feet of the dam and is capable of a magnitude 6 earthquake (CCWD 1993). Focal mechanisms of low-level seismicity in the vicinity of the Vaqueros faults suggest that strain east of the Greenville fault system is being released by earthquakes along north-trending faults, but there is no geomorphic evidence that surface rupture has occurred along the Vaqueros faults in Holocene time (Biggar and Wong 1992). MCE on either the Greenville or the Brentwood fault could generate peak horizontal ground accelerations of about 0.4 g and the duration of ground shaking at the surface could last from 12 to 20 seconds (CCWD 1993).

The Great Valley thrust fault extends along the west side of the Sacramento and San Joaquin Valleys. In this area, the shallowly dipping fault plane appears to underlie the reservoir site, extending to the east approximately 10 miles. Studies by WGNCEP (1996) indicate that the Great Valley thrust fault in the vicinity of the proposed reservoir has the capability of producing a magnitude 6.7 earthquake.

RTS at this site has been studied for reservoir volumes ranging from 100,000 to 244,000 acre feet (Wong and Strandberg 1996). The study concluded that the conditional probability of RTS occurring was 14 to 15 percent, and that if RTS were to occur, the most probable activity would ~~would~~ be earthquake sequences composed of small-magnitude events occurring after water level fluctuations in the reservoir or possibly at the initial filling. The largest RTS earthquake wouldl ~~will~~ not exceed the MCE already assigned to faults considered significant to the reservoir. The larger size of the proposed enlarged reservoir evaluated here would~~will~~ increase the probability of occurrence of RTS but would~~will~~ not increase the magnitude of the maximum RTS earthquake. Note that the potential for triggering seismicity on the Marsh-Creek-Greenville Fault Zone due to groundwater flow from the reservoir to the fault zone would~~will~~ be increased due to the high maximum pool elevation (780 feet) of the water in the proposed enlarged reservoir.

4.7 MITIGATION STRATEGIES

Erosion

Impacts on soil erosion from construction and operation are common to all examples. The impacts may be minimized by implementing a comprehensive soil erosion control and restoration plan. The plan should contain measures directed toward controlling short-term and long-term erosion and sedimentation effects and to generally restore pre-project topography, water resources, soils, and vegetation in areas affected by construction activities.

Loss of farmland

Important farmland taken out of use due to the filling of a reservoir or construction associated with reservoirs and associated facilities cannot be mitigated. Appropriate documentation of the change in service would have to be filed with the National Resource Conservation Service.

Landsliding

Landsliding may be minimized by inventorying potential landslide areas that could impact the reservoir and its facilities, determining which of these areas may be susceptible to triggering by saturation from the reservoir, seismic effects, or other natural causes, and then implementing best management practices for landslide control as required.

Seismic Effects

The potential seismic impact to the reservoir and facilities may be mitigated by designing the dam and other structures to meet the potential seismic accelerations. Strong-motion studies of the site using maximum-likelihood earthquakes on nearby faults could refine the structure design parameters on the basis of site geology and its effect upon surface movement. Use of best management practices for landslide control will minimize the effects of seismic triggering of potential or existing slides.

The impacts of RTS can be minimized by operating a reservoir in a manner that minimizes RTS, and monitoring seismicity with one or more locally installed high-sensitivity seismographs so reservoir operations can be refined should RTS be detected.

Sedimentation

The decrease in flow in Thomes Creek and consequent downstream sedimentation cannot be mitigated.

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