APPENDIX C
VEGETATION RESOURCES IN ECOLOGICAL ZONES

Vegetation resources in the project area are located in two ecological zones: San Joaquin River and East San Joaquin Basin. These zones are shown in Figure 3.5-1 and fully described in Section 3.5.1.

C.1 San Joaquin River Ecological Zone

This ecological zone is divided into four units, two of which will be potentially impacted by proposed pulse flows (CALFED 1998). The proposed project area does not include areas downstream of the San Joaquin River near Vernalis. The San Joaquin River between Friant Dam and the Mendota Pool in many years has no water, and the Mendota Pool is where some water input for the pulse flows could occur for the San Joaquin River. Therefore, the potentially affected ecological zones within the San Joaquin unit include the Vernalis Station to Merced Ecological unit, and the Merced River to Mendota Pool ecological unit. Both relevant ecological units will be treated as one because riparian vegetation is similar.

The San Joaquin River flows out of the southern Sierra Nevada foothills into the Central Valley at Friant Dam (river mile [RM] 267.5). Due to proposed project alternatives, the assessment of potential project effects is restricted to upstream of the San Joaquin River near Vernalis (RM 73) to the Mendota Pool (RM 205). Water diversion prevents the river from flowing until the Delta-Mendota Canal drains into the river at the Mendota Pool. In extremely wet water years, the Kings River is diverted north and drains into the San Joaquin River at Mendota Pool through the Fresno Slough. Twenty five miles downstream of the Mendota Pool, the Arroyo Canal (RM 182) de-waters the San Joaquin River until Bear Creek drains into it (RM 135.6). The combined effects of agriculture, levees, burning, urbanization and flow regulation have reduced riparian vegetation along California's third largest river to a shattered remnant of its former extent.

At Mendota Pool there is a 21-acre parcel on the east bank that has been reduced to a thicket of willows and exotic species in under 15 years. In 1984, the same stand had a canopy of cottonwoods that has since been burned.

Five miles downstream of Mendota Pool, riparian vegetation is continuous but is only one tree wide. On some point bars, riparian vegetation has been allowed to remain, but there are no valley oaks and few Fremont cottonwoods. Riparian vegetation is almost exclusively individual mature black willow trees, with an occasional pocket of cottonwoods. Where vegetation has not been completely removed to facilitate floodwater conveyance, it has encroached into the bankfull channel. Upstream of Firebaugh (RM 196), riparian vegetation reaches its widest point since Mendota Pool, yet at the downstream end of town near the sewage treatment facilities riparian vegetation is reduced to one tree width.

Between RM 192 and RM 190 riparian vegetation has been cleared, and mostly narrowleaf or arroyo willow resprouted. There is no continuity between riparian stands and the vegetation is sparse. Mature black willow trees have been left for their windbreak value only. Downstream of where the Arroyo Canal diverts the San Joaquin River (RM 181-182) and again dewaters the channel, the river corridor is devoid of any perceptible riparian vegetation, and grasses are all that remain.

From RM 181 to Fremont Ford (Valley Grasslands State Park), riparian vegetation consists of a line of black willow trees and grasses. This is the only region of the project area that has great valley grasslands.

At RM 171, some agriculture groundwater recharge creates ponds in the San Joaquin River channel. At the Sand Slough control structure (RM 168.7) flow is returned to the San Joaquin River, resulting in riparian vegetation with a much different character. Upstream of Sand Slough, the riparian vegetation has been cleared for ease of floodwater conveyance. Downstream of Sand Slough, riparian vegetation has not been cleared and is encroaching into the bankfull channel. Some meander lobes downstream of Sand Slough have been skimmed for gravel deposits; however, where riparian vegetation has been allowed to persist on abandoned oxbows, Fremont cottonwoods, valley oaks, and both tree and shrub form willows grow in multiple age classes with multistoried canopies.

Between RM 151-136, the river flows through several wildlife refuges. The floodway is wide but the lack of water results in riparian vegetation that is mostly grass and occasionally individual valley oaks. Because of a high soil pH and texture in this area great valley grasslands dominate riparian vegetation, and few riparian hardwoods are able to grow.

Where Bear Creek flows into the San Joaquin River, the discharge is roughly doubled, and riparian vegetation takes on a form that is consistent throughout the rest of the riparian corridor. Downstream of the Merced River confluence (RM 118.3), relic stands of valley oak border the floodway, narrowleaf willow grows in thickets within the floodway, and scroll bars are more evident. Where Orestimba Creek flows into the San Joaquin River upstream of Crows Landing (RM 109), a relic valley oak woodland with cottonwoods emerging over the oak canopy remains, and the delta deposit formed by Orestimba Creek is encroached with narrowleaf willow. In areas close to the channel, where frequently flooded agricultural land has been left fallow (RM 112, RM 108), riparian vegetation has begun to regenerate. Over the next two decades it is likely that a dense willow stand will cover them. Below the Merced River confluence, river migration is evident on aerial photographs. Migration could potentially introduce large woody debris into the channel, create fresh cut banks on the outside of meander bends, and deposit sediments on bars and floodplains creating new seed beds.

From the Merced River confluence to the San Joaquin River near Vernalis (RM 73), there are many remnant sloughs and oxbow channels. In many areas around sloughs, vegetation has been cleared; however, where sloughs fall within the Army Corp of Engineers designated floodway, forests of

willows box elders, cottonwoods and valley oaks remain. The sloughs have created islands where relic valley oak stands and cottonwoods persist. The vegetation is continuous and structural diversity varies from a multistoried canopy with 100 percent closure and a well developed understory to dense willow thickets. Over the long term, large stands (>5 acres) are in decline, and the interior of these large riparian tracts is often dying. There is no replacement of individual trees when they die.

Summary

Human disturbance, hydrology and fluvial geomorphic processes affect riparian vegetation. Currently riparian vegetation in the San Joaquin Basin is fragmented and reduced to a band often no more than a tree wide on either side of a river. Changes in river stage and land use practices could elicit a quantifiable response from vegetation. Pulse flow timing, frequency, magnitude and duration within the San Joaquin River and each tributary, combined with each species different annual life history strategy, could facilitate some natural regeneration and recovery.

C.2 East San Joaquin Basin Ecological Zone

All of the San Joaquin Rivers major tributaries are located in the East San Joaquin Basin Ecological Zone (CALFED 1998). As is more fully discussed in the aquatic resources section, this zone is divided into three ecological units, the Stanislaus, Tuolumne and Merced, which are characterized by the rivers that flow through them.

C.2.1 Stanislaus River Ecological Unit

With the closure of New Melones Dam on the Stanislaus River in 1980, the U.S. Army Corp of Engineers purchased and created a wider floodway corridor downstream of the dam. Because of this wider floodway, the Stanislaus River has the widest riparian corridor and the greatest quantity of vegetation compared to the other ecological units. However, narrowleaf willow has encroached into the low water channel. The proposed project will affect riparian vegetation downstream of Goodwin Dam (RM 58) to the river's confluence with the San Joaquin (RM 0). Between RM 36 and RM 40 the Stanislaus River's channel bed undergoes a transition from a gravelbed to sandbed. White alders grow along the bankfull channel in the gravelbedded reach and this changes to box elder in the sand bedded reach.

The effects of flow regulation are most notable on this river. Narrowleaf willow has encroached within the active channel to the low water margin throughout the entire river corridor from Knight's Ferry to the confluence with the San Joaquin. The youngest vegetation along the whole river is exclusively narrowleaf willow and box elder. On unvegetated sites only narrowleaf willow regenerates, while box elder is regenerating in the dense willow thickets due to its shade tolerance. Urbanization and agriculture are two human disturbances that have had the greatest effects on riparian vegetation reduction on the Stanislaus River. Urban development has decreased riparian

vegetation width through the city of Riverbank and Ripon (but not to the extent that the Tuolumne River suffers through Modesto). Removal of riparian vegetation for agriculture probably has caused most significant reduction in riparian vegetation coverage and diversity along the channel downstream of Knight's Ferry.

The net result of the designated floodway corridor, agriculture, flow regulation, and urban development has resulted in a riparian corridor that is wider than the other San Joaquin tributaries, but one that does not have a high species diversity, and suffers from extreme riparian vegetation encroachment into the low water channel.

The area around the confluence (RM 0) is comparable to a lush jungle contained between two levees. Three age classes of Fremont cottonwood stands are visible ranging from 10 to 75 years old. White mulberry is common in these older stands. Caswell State Park (RM 2.5- 8.5) is considered the best remaining example of great valley cottonwood and valley oaks forests still in existence. Vegetation patterns are distinct within the riparian forests at Caswell State Park. At the center of Caswell there is a stand of valley oak growing in a stellate pattern with each arm of the star being mature Fremont cottonwood stands. Riparian stands are so evolved at Caswell State Park that *Clematis* and grape lianas drape from the canopy to the ground and there is 100 percent canopy closure in many areas.

Where Caswell Park ends (RM 8.5), cottonwood and valley oak sharply decrease and are fragmented due to agricultural encroachment. Riparian vegetation is characteristic of agriculturally affected reaches: one tree width on either side of the channel. Where relic, senescent stands do occur, they are confined to pre-regulation floodplains and terraces, and are surrounded by a sea of narrowleaf willow. Narrowleaf willow is regenerating on point bar deposits within the active channel, which prevents these deposits from mobilizing during high flows.

Urban encroachment through the city of Ripon (RM 13.5-16) has reduced riparian vegetation along the channel. Riparian vegetation is contiguous with other large (> 5 acres) stands downstream. Although riparian vegetation is wider than one tree, the densest vegetation is along the low water channel margin and is limited to 125 feet in width. Upstream of Ripon, the riparian corridor is narrow but contiguous, and the dominant species is narrowleaf willow. An occasional box elder emerges, and a few pockets of valley oak remain beyond a dense band of mature narrowleaf willow.

Between Ripon and Oakdale, the combined effects of urbanization, agriculture, gravel mining and flow regulation are most pronounced. At RM 28 an old orchard has been left fallow on the left bank. The old fallow orchard is imbedded in a degenerating forest with many gaps and a few large cottonwoods and valley oaks; however, narrowleaf willow is the only plant regenerating in the orchard. By RM 30 riparian vegetation is mostly narrow leaf willow with an occasional strip of overhanging valley oaks. Although narrowleaf encroachment continues to dominate riparian vegetation, there are a few mature or senescent Fremont cottonwoods and valley oaks. At RM 39 an inchannel gravel mining pits cleared virtually all of the original cottonwoods, valley oaks, and

willows from the area around the mine. The inchannel gravel mine now has narrowleaf willow growing along the levees, and the levee has failed with the inchannel pit now taking the majority of flow from the channel. The main channel below the levee breach has been almost completely filled in with narrowleaf willow.

From Oakdale to Knight's Ferry, almost pure stands of narrowleaf willow line the low water channel, and giant reed infestations are common for the first time upstream of the Stanislaus River's confluence with the San Joaquin River. In this reach, mature and senescent vegetation has been cleared or burned. Urban development in Oakdale has reduced the riparian vegetation to one or two trees in width. Upstream of Oakdale the riparian corridor begins to widen, but it is not densely vegetated like areas near the confluence. At Knight's Ferry, for the first time since near the confluence, there is a large (>15 acre) riparian stand consisting of senescent cottonwoods with a few valley oaks.

Above Knights Ferry (RM 53), the river becomes confined in a gorge eroded by the river through a basalt lava flow. The character of the Stanislaus River from this point upstream to Goodwin Dam (RM 58) is unique. From the covered bridge at RM 54.5, riparian vegetation is restricted to small cracks and hollows in the bedrock, and is predominately arroyo willow and white alder. Narrow leaf willow encroachment occurs as soon as the river emerges from the basalt gorge and the banks become alluvial.

C.2.2 Tuolumne River Ecological Unit

The Tuolumne river is 52 miles long between La Grange Dam (RM 52) and the confluence with the San Joaquin River (RM 0). The Tuolumne River's channel bed changes from gravel dominated to sandbedded between RM 24 and RM 30, and a change in gradient also occurs in this reach. Because of the shift in substrate and gradient, white alder grades into box elder in the gravelbed to sandbed transition reach. The Tuolumne River is the only ecological unit within the project area with a major metropolitan city along its banks (Modesto). Downstream of Modesto, the river is confined between levees and agricultural activities. Upstream of Modesto, the river is affected by urban development, gravel mining, and agriculture.

From the confluence with the San Joaquin River to RM 12 there are few large (>5 acres) stands of riparian vegetation, with only a small percentage of these relic stands being valley oak. Over the past few decades, bank riprap has created a trapezoidal channel preventing channel migration and natural riparian regeneration that typically accompanies channel migration. Riparian regeneration that has occurred in this area is limited to pockets in the riprap, or on the upper edge of levees. Agriculture has eliminated any extensive riparian vegetation cover, and has reduced existing vegetation to one tree width through much of this area. Relic valley oak and cottonwood stands remain around old

oxbow channels and represent the greatest cover and structural diversity between the city of Modesto and the river's confluence with the San Joaquin River.

From RM 12 to 19.5, riparian vegetation is most affected by urban development associated with the growth of Modesto. Riparian vegetation consists of small (<2 acres) dense bands of narrowleaf willow, interspersed with senescent Fremont cottonwoods. Occasionally a valley oak delineates the break in slope between urban development and the active channel. A confined channel with no active meandering has allowed narrowleaf willow to form a dense band down to the low water channel. Relic stands of cottonwood and black willow have been burned or are degraded by human disturbance. Tuolumne River Regional Park, through the City of Modesto, has the largest stand of valley oaks; however, recent plantings do not include native tree species, and park management prevents any natural regeneration. Another effect of increasing urban development is that exotic plant species are common throughout the river corridor.

Upstream of Modesto to the city of Waterford (RM 19–31.6) there are few large stands (>5 acres) of valley oaks and cottonwoods, and regeneration is prevented by continual human activities and the change in flow regime by the New Don Pedro Project. Upstream from the city of Modesto RM 24-34), aggregate extraction adjacent to the channel and inchannel has left many solitary valley oaks or cottonwoods surrounded by exotic plants leading to decreased native hardwoods regeneration and diminished habitat quality.

Between RM 34 and 52 riparian vegetation exists along the channel and in hollows created by dredger tailings. Turlock Reservoir State Park (RM 37) preserves some of the best riparian vegetation structure and species composition along the entire river. Because of the park's location adjacent to the Tuolumne River it floods often. This flooding, in combination with mowing and exotic species removal, help facilitate the regeneration and maintenance of the park. The location and the size of the state park is excellent because it preserves a large relic stand (> 5 acres) and will be a productive seed source for future restoration efforts between La Grange Dam and Waterford. In fact, the riparian corridor along the Tuolumne River near La Grange (RM 40-46) enjoys the most extensive vegetation coverage of anywhere on the Tuolumne River. Except in the hollows between dredger tailing piles, riparian vegetation is predominately willow shrubs that create a dense thicket within the bankfull channel, and a few isolated relic stands of senescent cottonwoods and valley oaks. In a few areas along this reach, cattle grazing has eliminated riparian regeneration and denuded the banks. The most recent riparian plant regeneration has occurred in the dredger tailing hollows, because groundwater is close and the effects of grazing are minimized. The understory and gaps within relic Fremont cottonwood and valley oak stands are being invaded by tree of heaven and giant reed. Upstream of the town of La Grange, the Tuolumne River is confined to a bedrock valley similar to the Stanislaus; riparian vegetation persists in hollows and cracks along the valley walls and does not cover any area greater than 5 acres.

C.2.3 Merced River Ecological Unit

The proposed project will affect the riparian vegetation along the Merced River between the confluence with the San Joaquin River (RM 0) and Merced Falls (RM 55). The gravelbed to sandbedded channel transition occurs between RM 25 and 30, and there is again a transition from white alder to box elder where this occurs. Riparian vegetation grows in a narrow band along the river due to the combined effects of flow regulation and agriculture. Where there are large riparian vegetation stands (>5 acres), they are old, intensively managed, and senescent. These senescent "islands" are linked together by a band of vegetation seldom more than a tree wide. Exotics have proliferated and benefited by the altered flow regime and human disturbance. Native hardwood species are dwindling, incapable of competing against the exotic species and human encroachment.

Near the confluence of the Merced with the San Joaquin River, there are many shallow depressions left by previous channel migration, creating a diverse topography that is frequently inundated. However, only valley grassland stands currently grow. George Hatfield Park (RM 1-2) contains the largest relic riparian stand in this lower portion of the river, a relic stand of valley oak surrounded by agricultural activities. The reduction in spring flows combined with the park's mowing, has prevented any younger age classes of riparian vegetation or species from establishing within the park.

For the next 20 river miles upstream of George Hatfield Park, riparian vegetation is discontinuous. A few declining relic stands are connected by sporadically occurring narrowleaf willow shrubs and black willow trees. Agriculture has cleared all riparian vegetation to the upper edge of the bankfull channel, leaving discontinuous riparian vegetation with 100 to 500 feet gaps between individual trees. Just upstream of RM 11 for almost 2000 feet, there is no riparian vegetation except for a few spotty narrowleaf willows; riprap and agriculture have replaced vegetation. A vital seed source remains where native riparian vegetation has been left intact at the outside of meander bends. Unfortunately, when these declining relic stands die they will be replaced with grasslands. Currently there has been no visible valley oak or cottonwood regeneration, and what little regeneration that has occurred is restricted to two species: box elder and narrowleaf willow. Regeneration is confined to a narrow band no more than 100 feet in width, while older valley oak stands are isolated on terraces surrounded by agriculture.

McConnel State Park (RM 23.1) is a relic stand of valley oaks on the right bank of the Merced River. This park contains an old meander bend that pinched off leaving behind an oxbow with relic, pre-dam riparian vegetation. Sycamores, cottonwoods, and valley oaks form a closed canopy with connections between the different hardwood species. This is the first location of George Hatfield Park (RM 4) with a similar canopy structure. Between McConnel State Park and George Hatfield there are no sizable (>5 acre) stands with closed canopy and mixed hardwood species (i.e., not just a few valley oaks surrounded by grasses). Upstream of McConnel State Park, riparian vegetation returns to a single tree width and valley oaks remain in the middle of grape fields, hinting at riparian vegetation's previous extent.

The gravel bed to sand bed transition occurs around RM 26, and the oxbows tend to get bigger upstream of the channel bed substrate transition. Large stands of giant reed are established in the gravel bedded zone, and inchannel gravel mining has left the riparian vegetation fragmented and with no suitable area to regenerate. Dry Creek enters the Merced at RM 31.9, and there is a well developed mixed willow stand below the creeks confluence.

Above the Dry Creek confluence to Merced Falls (RM 32 to RM 55), riparian vegetation reaches its greatest width and has some of the highest species and structural diversity of anywhere along the Merced River. Below Snelling (RM 41), young trees are establishing on surfaces that are currently functioning as floodplains. Upstream of Snelling to Merced Falls, riparian vegetation has only been able to regenerate and establish in the hollows between dredger tailings.

Upstream of Dry Creek, riparian vegetation encroachment into the active channel is far more obvious. While the riparian corridor is generally wider through this reach, it is also more encroached and scrubby, with no tree species forming identifiable stands. There is some riparian regeneration apparent on 1993 aerial photographs, but the channel is still encroached. The regeneration probably occurred two decades ago, making the vegetation mature with no age class diversity.