SECTIONSIX

GROUNDWATER RESOURCES

The focus of this section is on groundwater resources in the San Joaquin Valley, since this portion of the project area is the one most likely to be affected by the action alternatives. Conveyance of drainwater to the Ocean and/or the Delta is also addressed.

6.1 AFFECTED ENVIRONMENT

The San Joaquin River basin has been identified as containing 26 groundwater basins with 9 of the basins classified as significant sources of groundwater. The total area of the 9 groundwater basins is approximately 13,700 square miles, of which the San Joaquin Valley alone comprises about 13,500 square miles. The California Department of Water Resources (DWR) estimates an annual overdraft of approximately 205,000 AF of groundwater. This overdrafting of groundwater has caused ground subsidence since the mid-1920s. By 1970, 5,200 square miles of the valley were affected and maximum subsidence exceeded 28 feet in an area west of Mendota. Much of this area is now served by the Central Valley Project’s San Luis Unit.

Irrigated agriculture has altered both groundwater flow and quality. Significant portions of the groundwater in the study area exceed the CWA’s recommended TDS concentration. The dissolved solids content of the groundwater averages about 500 ppm, but ranges from 64 to 10,700 ppm. Calcium, magnesium, sodium, bicarbonates, Se, sulfates, and chlorides are all present in significant quantities.

Figures 6-1 through 6-4 show the distribution of TDS, Se, molybdenum, and boron in shallow groundwater in the project area. These maps were developed from groundwater quality measurements taken from shallow wells located throughout the San Joaquin Valley using geostatistical analysis methods described in Appendix C2.

The highest groundwater salinity and Se concentrations occur in areas of the highest native soil salinity. Harradine (1950) characterized western San Joaquin Valley soils in the 1940s. Alluvial fan soils are derived from the Diablo Range of the California Coast Range, which borders the study area to the west. The Diablo Range consists of an exposed Cretaceous and upper Jurassic marine core assemblage overlain by and juxtaposed with Cretaceous and Tertiary marine and continental deposits. The soils in the basin trough at the eastern edge of the study area are of mixed origin; Sierra Nevada igneous and metamorphic rocks and Diablo Range sediments. Soils are generally coarse-grained in the upper- and middle-alluvial fan areas and fine-grained in the lower alluvial fan and basin trough areas.

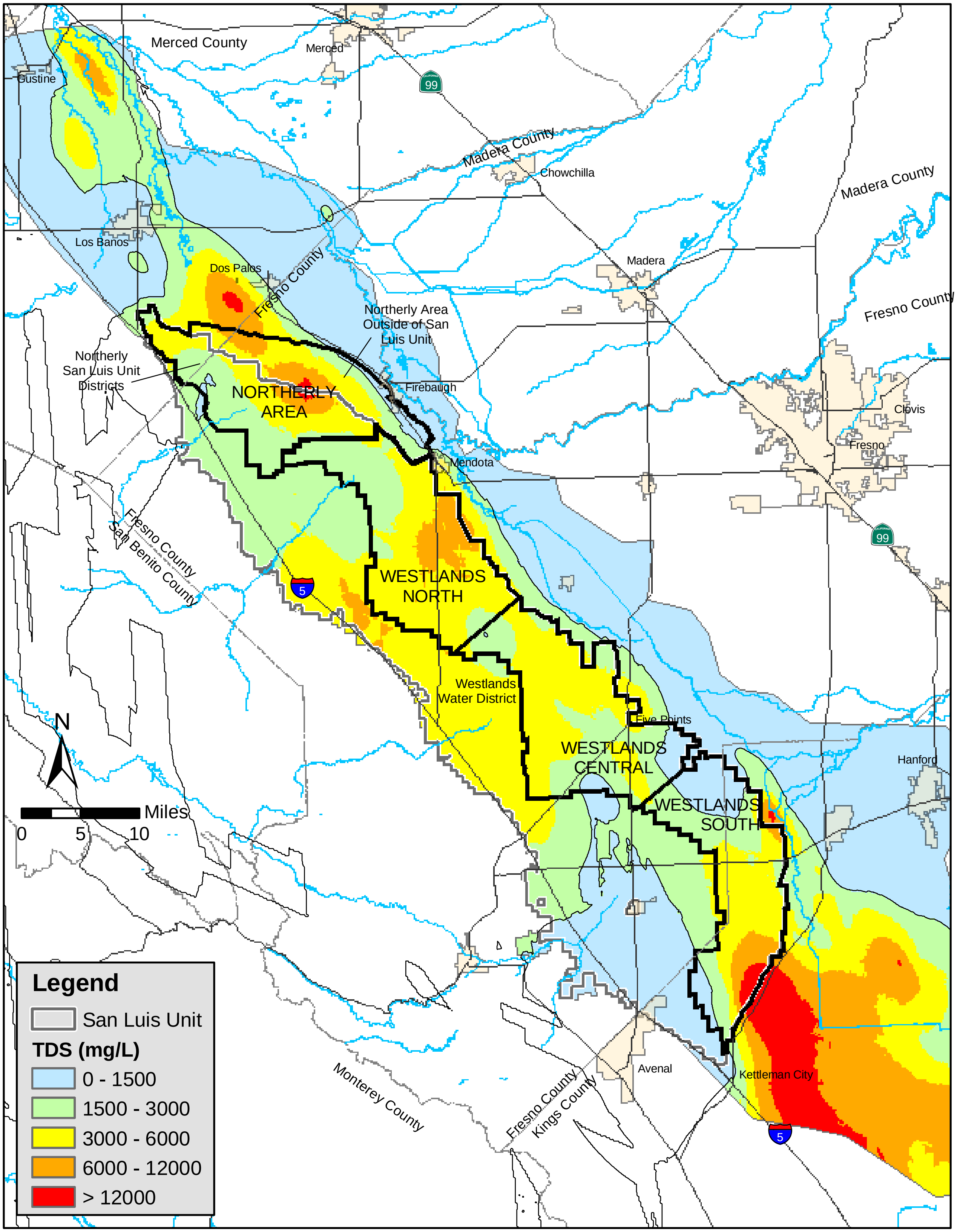
In the western San Joaquin Valley, soil salinity problems and inadequate drainage have limited agricultural production for more than a century, making some lands unusable as far back as the 1880s and 1890s. Irrigation of grains with water from the San Joaquin and Kings rivers in the 1880s and 1870s led to rising water tables, increased soil salinity and removal of some land from production. Many of the soils are naturally saline and high in clay content, which restricts drainage.

Soil salts in the study area contain calcium, sulfate, sodium, magnesium and inorganic carbon. Prior to irrigation, soils contained sodium, magnesium, sulfate evaporite salts such as thenardite (sodium sulfate), mirabolite (sodium sulfate) and bloedite (magnesium, sodium sulfate) (Presser et al. 1990) and calcium sulfate (gypsum) and calcium carbonate. Irrigation dissolves the more soluble evaporite salts and substantial amounts of calcite (calcium carbonate) and gypsum (calcium sulfate) remain in irrigated soils (e.g., Tanji et al. 1977). Presser et al. (1990) reported Se concentrations ranging from 1 to 25 ppm in these evaporite salts present in the saline and seleniferous geological formations in the Diablo Range and in unirrigated soils. In contrast, Deverel and Fujii (1988) reported that Se is probably not present in gypsum. Irrigation of saline soils dissolved soluble soil salts and Se and moved them to the groundwater. Subsequent rises in the groundwater table further increased groundwater salinity and Se concentrations (Deverel and Fujii 1988; Deverel and Fio 1991).

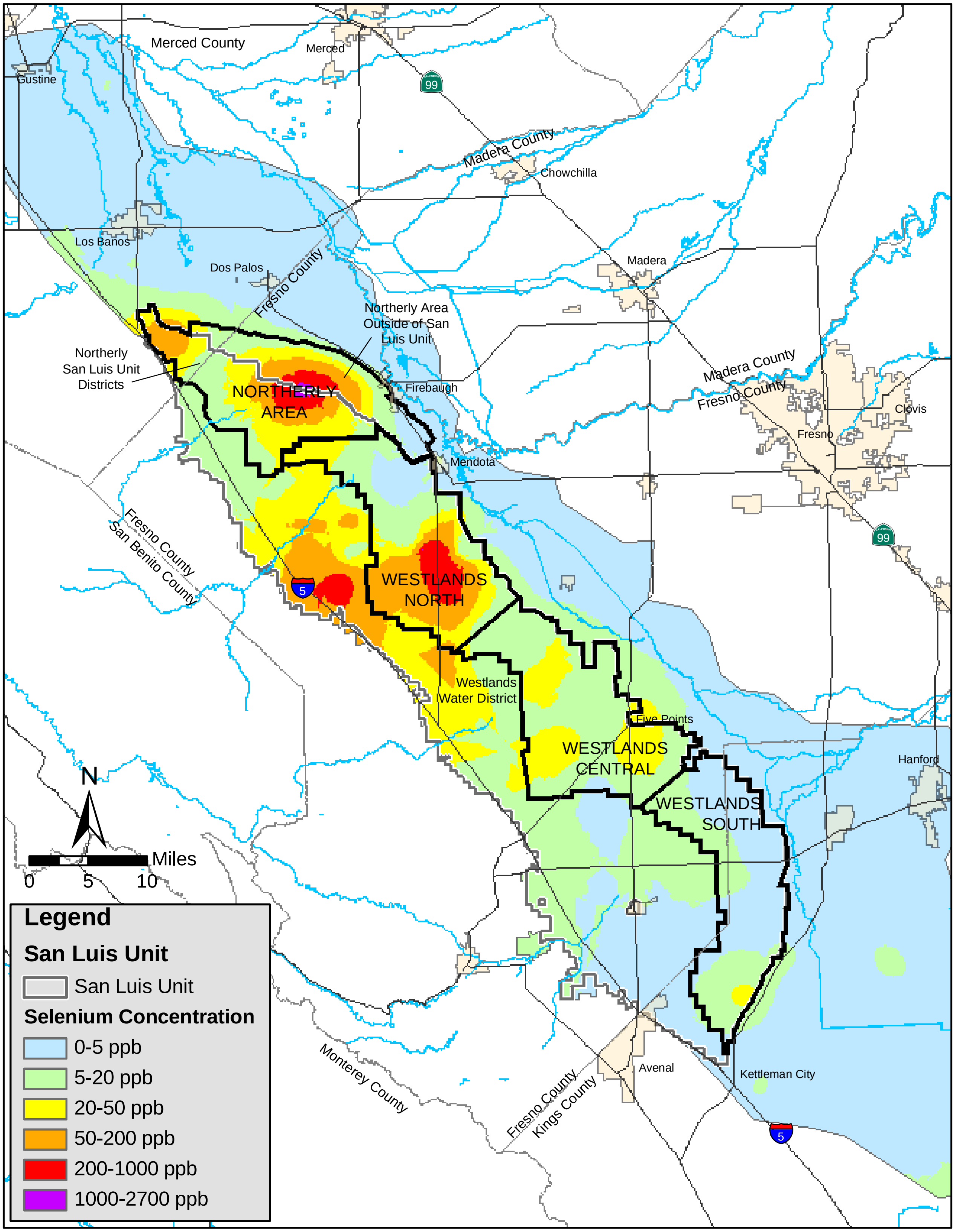
Percolation of irrigation water past crop roots, pumping of groundwater from deep wells, and imported surface water used for irrigation have combined to create large downward hydraulic-head gradients. As a result, the soil salts and Se in the irrigation water are leaching from the unsaturated soil zone and increase salt and Se concentrations in the groundwater. However, drinking water wells are typically over 300 feet deep and several layers of aquifers and clay lenses lie between the upper levels affected by irrigation and the drinking water aquifer.

A USGS report (Dubrovsky and Deverel 1989) indicated that irrigation had affected the upper 20 to 200 feet of the saturated groundwater zone. This poor quality groundwater zone is moving downward in response to recharge from above the water table and pumping from deep wells. In 1994 Belitz and Phillips estimated the downward velocity of the poor quality groundwater at about 0.6 foot/year, which suggests that most of the regions groundwater would be affected within 200 to 930 years. Based on an analysis of groundwater quality in subregions, Quinn et al. (1990) estimated that the useable average life of the aquifer in Westlands was from 110 to 114 years.

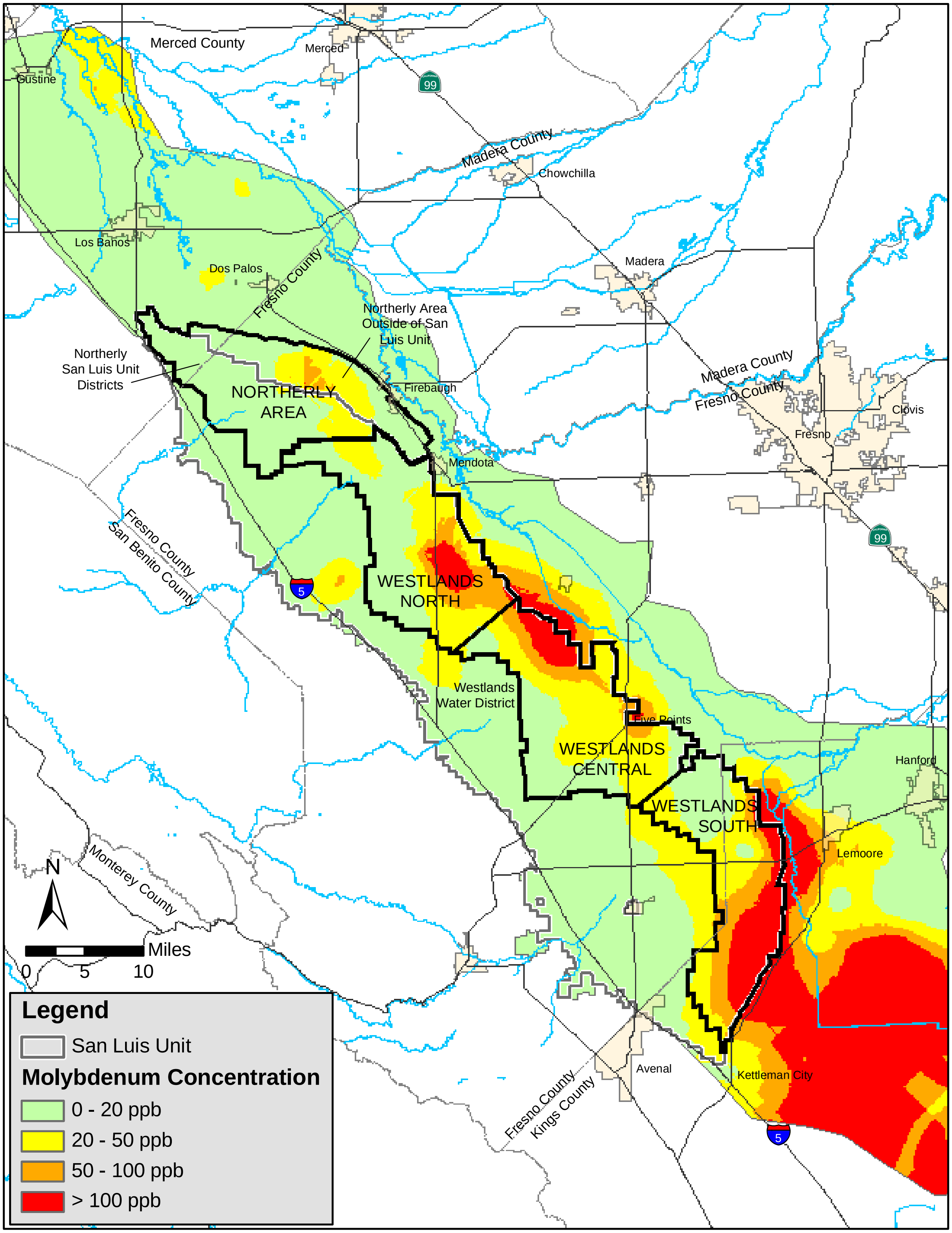
Ken Schmidt and Associates (pers. comm., 2002) indicated that eastward movement of saline groundwater affects the quality of pumped water in the semiconfined zone near Mendota and Fresno Slough. They describe a front of saline water parallel to Fresno Slough as the result of groundwater flowing downward and westward from the western San Joaquin Valley, which appears to have affected City of Mendota wells. For example, water quality data for City of Mendota well number 5 indicate increasing trends in salinity in the late 1990s.



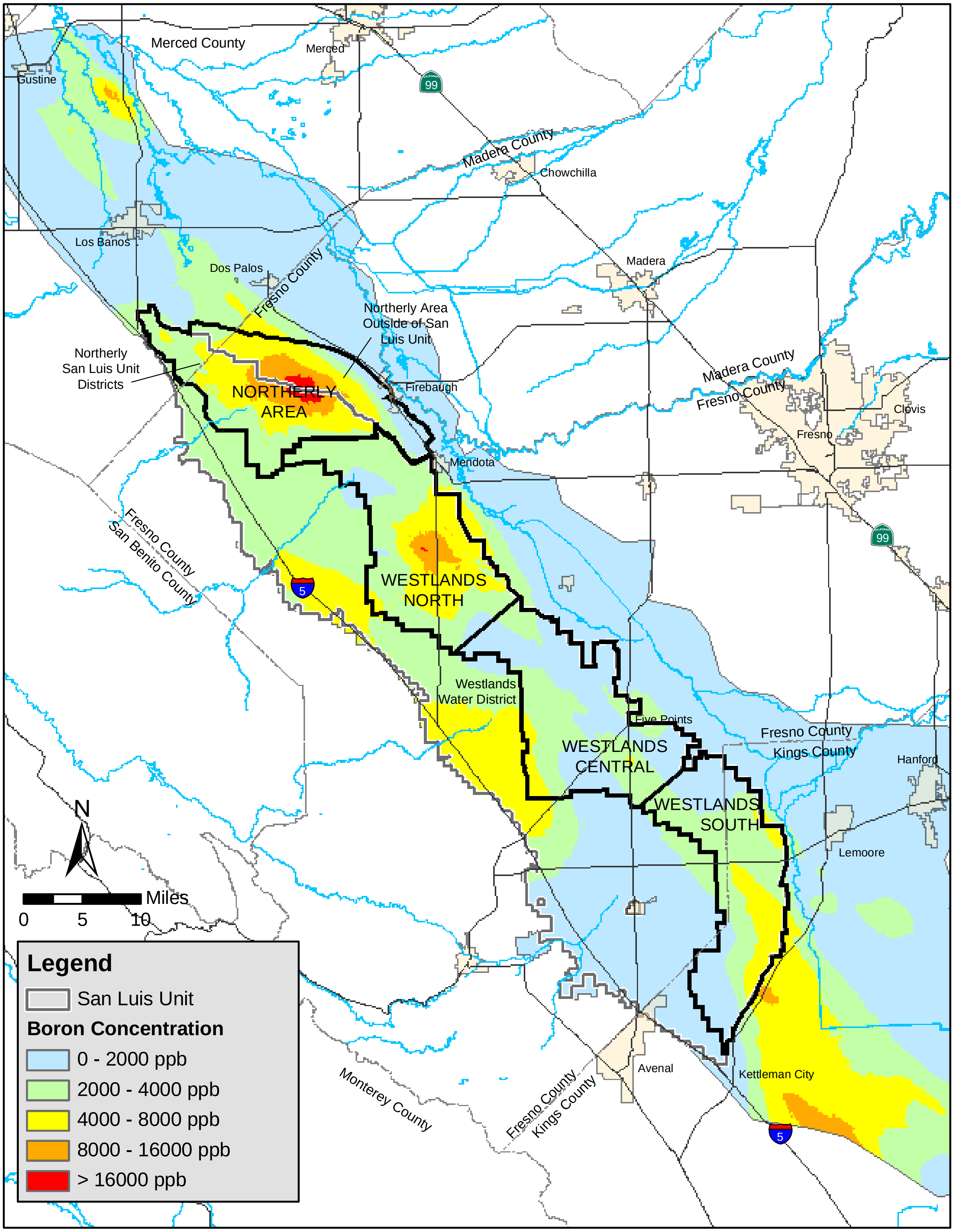
San Luis Drainage Feature Re-evaluation	Total Dissolved Solids In Shallow Groundwater	Figure 6-1
17324004		



San Luis Drainage Feature Re-evaluation	Selenium Concentration In Shallow Groundwater	Figure 6-2
17324004		



San Luis Drainage Feature Re-evaluation	Molybdenum Concentration In Shallow Groundwater	Figure 6-3
17324004		



San Luis Drainage Feature Re-evaluation	Boron Concentration In Shallow Groundwater	Figure 6-4
17324004		

In the western San Joaquin Valley, the groundwater system is divided into a lower confined zone and upper semiconfined zone, separated by the Corcoran Clay (Figure 6-5). The water table is located within the semiconfined zone. In the upslope areas, the water table is typically located several hundred feet below land surface. In contrast, most downslope areas are underlain by a shallow water table within 7 feet of land surface (Belitz and Heimes 1990).

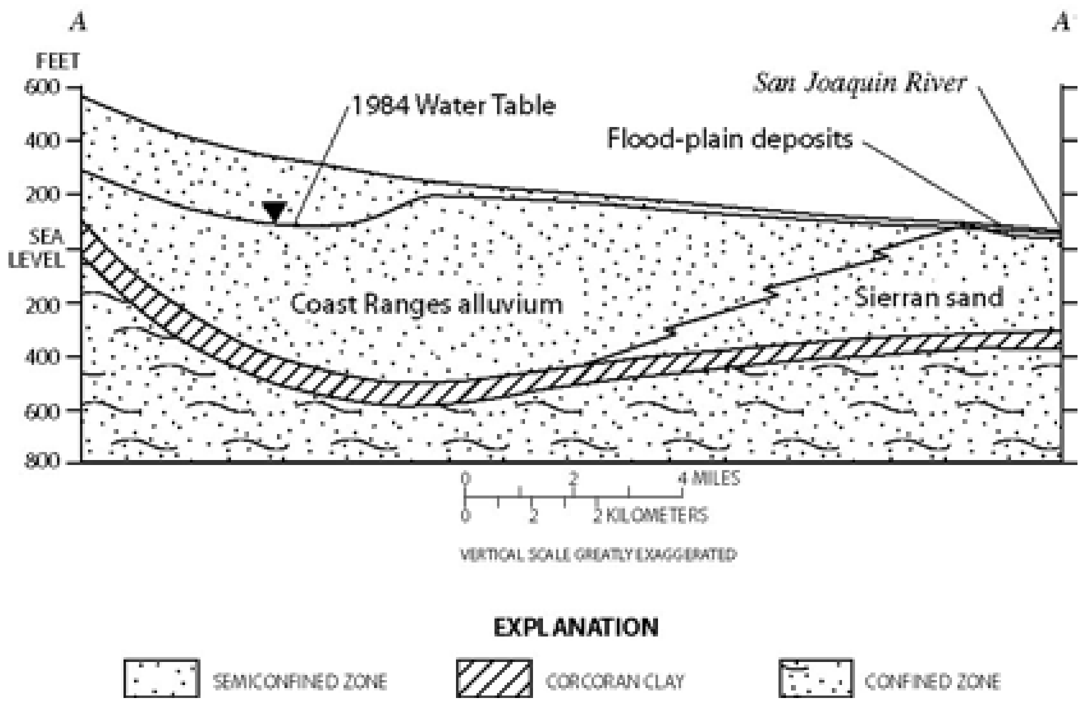


Figure 6-5 Geohydrologic Section of Western San Joaquin Valley (modified from Belitz and Heimes 1990)

Under natural conditions, the shallow water table existed in areas along the valley floor and adjacent to the San Joaquin River. Groundwater recharge occurred primarily by infiltration of runoff in Coast Range streams. Groundwater discharge was primarily by evapotranspiration and seepage to the San Joaquin River.

During the past 40 years, recharge increased dramatically as a result of imported irrigation water. Irrigated agriculture has altered both groundwater flow and quality. Percolation of irrigation water past crop roots, pumpage of groundwater from deep wells, and imported surface water used for irrigation have combined to create large downward hydraulic-head gradients. The salts in the irrigation water, and soil salts leached from the unsaturated zone, increased salt and Se concentrations in groundwater (Dubrovsky and Deverel 1989). In low-lying areas of the valley, and where the water table is within 7 feet of land surface, evaporation from the shallow water table further increased salt and Se concentrations.

Irrigation recharge increases groundwater storage and causes the water table to rise. Groundwater movement is primarily downward resulting from the combined response to deep percolation of irrigation water and pumpage from deep water supply wells. From a drainage study areawide perspective, much more water moves in the vertical direction than horizontally, and groundwater level and quality impacts in any given field occur primarily as the result of irrigation of the field. Current hydrologic understanding of the system indicates that irrigation of upslope lands is generally not a significant source of dissolved constituents to drainwater collected in the downslope drainage-impaired area. In fact, the low water transmitting properties of the aquifer materials and low horizontal hydraulic gradients indicate groundwater movement is fairly slow.

Drainage systems remove groundwater and prevent water logging and salt accumulation in the root zone. Continued recharge without drainage would increase the area underlain by the shallow water table and continue soil and groundwater salinization.

6.2 ENVIRONMENTAL CONSEQUENCES

This section evaluates water table rise and its related effects on bare soil evaporation, the area underlain by shallow water table, groundwater salinity, and drinking water supplies.

6.2.1 Evaluation Criteria

The water-table rise is the primary groundwater effect, which produces several related effects.

- **Bare soil evaporation.** Evaporation from the shallow water table can cause salinity increases in groundwater and soil (Deverel and Fujii 1988). The analysis tools reliably estimate evaporation rates in the range between 0.0 to 0.4 foot/year (Belitz, Phillips, and Gronberg 1993). Evaporation rate increases of 0.1 foot/year or greater were considered to be a significant adverse effect, and evaporation rate increases less than about 0.05 foot/year is considered not significant.
- **Undrained area underlain by shallow water table.** As the water table rises, the area underlain by the shallow water table expands. Drainage systems are used to manage shallow water table conditions and root zone salinity. Belitz, Phillips, and Gronberg (1993) utilized a large amount of soil moisture, soil tension, and hydraulic conductivity data for Panoche clay loam, the predominant western San Joaquin Valley soil, and concluded that bare-soil evaporation is significant when the water table is within 7 feet of land surface. The groundwater-flow model can be utilized to reliably estimate water-table depth at the scale of individual water districts. Therefore, a 10-square-mile or greater increase in undrained area underlain by a water table within 7 feet of land surface was considered to be a significant adverse effect, and area changes less than several square miles are considered not significant.
- **Groundwater salinity.** Groundwater salinity can increase as a result of increased evaporation from the shallow water table. Groundwater salinity changes affect drainwater quality. Both measured groundwater salinity increases, as inferred from repeat wellwater samples collected in 1984 and 2002, and simulated changes in groundwater salinity under representative conditions were considered. An estimated 10 percent increase in groundwater salinity was considered to be a significant adverse effect. Detailed calculations of localized groundwater salinity increases beneath evaporation basins proposed for the In-Valley Disposal Alternative are described in Appendix E1.

- **Drinking water supplies.** An estimated 5 percent increase in any contaminant was considered to be a significant adverse effect. Less than 5 percent was considered not significant.

6.2.2 Methodology and Assumptions

HydroFocus, Inc. used two models to evaluate effects on groundwater resources: a regional groundwater flow model and a geochemical model. A regional groundwater-flow model was employed to estimate changes in groundwater storage and water table depths. The geochemical model was utilized to simulate soil-salinity reactions that probably occur in western San Joaquin Valley soils, and in Appendix E2 the results are compared to parallel calculations used to analyze the relationships among drainage and root zone salinity, crop yields, crop revenues, and drainage quantity and quality changes. Additionally, shallow groundwater samples were collected as a part of this study from wells sampled in 1984 by the USGS to assess dissolved solids, Se, boron, molybdenum, and other trace element concentrations. This chemical data provided an empirical assessment of the constituent concentration changes in groundwater during the past 18 years. A detailed description of the sampling methods, analytical results, and interpretation of the geochemical interrelationships is provided in Appendix E3.

A transient, three-dimensional, finite-difference groundwater-flow model was utilized to estimate changes in water-table depth and its consequences to bare-soil evaporation, area affected by a water table within 7 feet of land surface, and groundwater salinity. The USGS developed the model for the San Joaquin Valley Drainage Program. The model represents about 212,500 acres of the approximately 604,000-acre Westlands Water District (about 36 percent), and about 88,000 acres of the 97,400-acre Grassland Drainage Area (GDA) (90 percent); the model represents 72 percent (34,600 acres) of the currently 48,000-acre drained area within the GDA.

The model utilizes mean annual recharge and pumpage data to project long-term changes in annual water-table depth. It employs a linear function to calculate evaporation from the shallow water table. The evaporation rate is zero when the water table is at or more than 7 feet below land surface, and a maximum evaporation rate of 1 foot/year is simulated for water-table depths 4 feet and less below the land surface. The linear relation of evaporation and shallow groundwater depth is described by Belitz, Phillips, and Gronberg (1993) and is based on the analysis of western San Joaquin Valley soils data. Over the entire depth interval of 0 to 7 feet, evaporation from the shallow groundwater is governed by an exponential function of depth to the water table. For water table depths between 7 and 4 feet below land surface, the exponential function can be approximated by the linear function employed in the model. For water table depths less than 4 feet, the model substantially underestimates evaporation of shallow groundwater. However, Belitz, Phillips, and Gronberg (1993) determined that groundwater was rarely shallower than 4 feet. For example, the model predicts shallow groundwater evaporation rates of 0, 0.14, 0.3, and 0.4 foot for water table depths of 7, 6, 5, and 4 feet, respectively.

HydroFocus, Inc. (1998) evaluated model-projected groundwater levels and drainflow during the period 1989–97. They updated boundary conditions, recharge, and pumpage data and concluded updated model results are acceptable to evaluate long-term changes in water-table depth.

In the western San Joaquin Valley, soil and groundwater salinity varies spatially (Fujii, Deverel, and Hatfield 1988; Corwin, Rhoades, and Vaughan 1996; Corwin et al. 1999; Deverel et al.

1984; Deverel and Gallanthine 1989), which limited the ability to establish historical and present-day salinity values and project future salinity changes under different management alternatives. Geochemical analyses and recent groundwater sample data were utilized to provide insight into anticipated groundwater quality changes over time. In August 2002, shallow wells installed by the Bureau of Reclamation during the 1960s, 1970s, and 1980s were sampled to depths of 18 to 30 feet. Although many of the previously sampled wells no longer exist or have been replaced, 20 wells were successfully located and sampled. The samples were analyzed for TDS, alkalinity, chloride, sulfate, Se, molybdenum, arsenic, aluminum, barium, beryllium, cadmium, chromium, calcium, magnesium, sodium, potassium, copper, iron, manganese, and silica. A detailed description of the sampling methods, analytical results, and interpretation of the geochemical interrelationships is provided in Appendix E3.

The current analysis considered an Out-of-Valley scenario, whereby drainwater is exported for discharge at several locations, and an In-Valley scenario (with and without land retirement components), where drainwater is treated and managed within the San Joaquin Valley. The Out-of-Valley scenario considers drainwater discharge at one of two possible Delta locations (Chipps Island or Carquinez Strait) and a Pacific Ocean location (Point Estero). Simulated groundwater effects from these alternatives were compared to the No Action Alternative and existing conditions. Assumptions for the No Action, Out-of-Valley, and In-Valley scenarios are summarized below.

No Action Alternative

For the No Action Alternative, the following hydrologic conditions were simulated[1]:

- Irrigation system improvements and practices on farmed lands in the GDA and Westlands remain the same as existing conditions. Existing recharge rates were estimated using information from Table 5 in the *Source Control Memorandum* (URS 2002)[2].
- In Westlands, simulated annual groundwater pumping is maintained constant at 175,000 AF/year, which is equal to the average private supply reported in *Westlands' Water Needs Assessment*[3] (Reclamation 2003). The distribution of semiconfined and confined zone pumping within Westlands was weighted based on the pumping rates reported by Belitz et al. (1993).

---

[1] See Appendix E-4 ("Simulated Groundwater Use and Water Table Recharge Rates in Westlands Water District, San Luis Drainage Feature Re-Evaluation') for a complete description of recharge and pumpage distributions selected for the model area.

[2] In the Northerly Area, the reported existing condition recharge rates were increased 0.04 foot/year to include seepage from unlined canals. Under the action alternatives, seepage reduction measures reduce seepage.

[3] Because the model represents only a portion of Westlands, simulated pumpage is less than 175,000 AF/yr. The analysis of well location and metered pumpage data indicated about 20 percent of the annual local supply (35,000 AF/year) is represented by the model. This pumpage is distributed as follows: 55 percent within the area having a shallow water table within 10 feet of land surface, 20 percent within the area having a shallow water table between 10 and 20 feet of land surface, and 25 percent within the area having a water table greater than 20 feet below land surface. Pumpage is discontinued in retired lands, and the discontinued pumpage is redistributed to the remaining active lands to maintain a constant local supply of 175,000 AF/yr (35,000 AF/year in the model). Hence, land retirement can modify the relationship between pumpage and water table depth.

- In 2002, about 48,000 acres were drained within the GDA and a substantial portion of the drainwater was discharged to the San Joaquin River through the Grassland Bypass Project. After 2009, when the Grassland Bypass Project agreement ends, it is assumed that drainwater is no longer discharged to the river, but instead managed within the GDA. In contrast, Westlands has not discharged agricultural drainwater for more than 15 years, and the No Action Alternative simulated continued undrained conditions in Westlands.
- Under No Action, 65,000 acres would be retired in Westlands.
  - Without a drainage option, 38,000 acres within Westlands would be retired from irrigated agriculture as follows: 8,600 acres retired in 2002, 20,000 acres retired by 2003, and 9,400 acres retired in 2004. The retired lands were randomly distributed throughout the drainage problem area. When land is permanently retired, irrigation ceases and consequently groundwater pumpage and surface-water deliveries are discontinued. The surface water is reallocated to other farmed lands within the district. The reallocated surface water was assumed to displace surface-water supplies that would be purchased from other entities. Hence, pumpage and irrigation recharge beneath active agricultural lands is not altered as a result of land retirement and the surface-water reallocation.
  - Without a drainage option, 27,000 acres would be retired through the Westlands land acquisition program as follows: 6,480 acres in 2002, 14,040 acres in 2003, and 6,480 acres in 2004. The acquired lands were randomly distributed throughout the drainage problem area. The acquired lands are not permitted to irrigate with CVP water and, therefore, deep percolation throughout Westlands is substantially reduced. The acquired lands can practice dryland farming or irrigate with a non-CVP water supply (for example, groundwater, drainwater, transfer, and so forth). Ten percent of the land area (6,500 acres) was assumed to be irrigated; the actual area and distribution of irrigated lands can vary from year to year. The average water supply is assumed to be 50 percent surface water and 50 percent groundwater.
- In 2002, about 3,000 acres of land are retired under the Britz settlement. During the period 2003 through 2005, about 34,100 acres of land would be retired under the Sumner Peck Ranch et al. settlement. It was assumed these lands are retired over a 3-year period at a rate of about 11,370 acres per year. The retired lands were randomly distributed throughout the area defined by the plaintiffs' parcels during a 3-year period. Irrigation ceases on these lands and consequently groundwater pumpage and surface-water deliveries are discontinued. The surface water is reallocated to other farmed lands within the district, and the reallocated surface water was assumed to displace surface-water supplies that would be purchased from other entities.
- As of 2002, 2,091 acres of land had been permanently retired under the CVPIA land retirement program. The remaining 4,909 acres are assumed to be retired at a rate of 981 acres per year during 2003, 2004, 2005, 2006, and 2007. The future retired lands were randomly distributed throughout the CVPIA land retirement project area. Irrigation ceases on these lands and consequently groundwater pumpage and surface-water deliveries are discontinued. The surface water is reallocated to other farmed lands within the district, and the reallocated surface water was assumed to displace surface-water supplies that would be purchased from other entities.

- No new shallow groundwater management projects are implemented.
- In the GDA, drainwater recycling continues at current levels and the planned 3,000-acre In-Valley/GDA reuse facility begins operations in 2005. In its present-day condition (2004), the In-Valley reuse facility can reduce the drainage discharge requirement by 7,200 AF. No new seepage reduction, drainwater recycling, or drainage reuse projects are implemented. After 2009, when the Grassland Bypass Project San Luis Drainage use agreement with Reclamation ends, all drainwater remains within the GDA. It was assumed that the In-Valley/GDA facility continues operation after 2009, but without a disposal outlet for the drainwater produced, drainage system sump flows would remain within the GDA. The GDA facility would reduce drainage by 15 percent, and the 15,400 AF of uncontrolled discharge would no longer be managed under the Grassland Bypass Project San Luis Drainage use agreement. The leaching fraction (27 percent) continues to contribute to deep percolation beneath the GDA facility (about 1 foot/year).

In-Valley Disposal Alternatives

The In-Valley Disposal Alternative utilizes similar irrigation and groundwater management options as the Out-of-Valley Disposal Alternatives; however, treatment facilities and evaporation basins are used to manage the drainwater within the San Joaquin Valley. In addition, land retirement alternatives were evaluated to determine the potential environmental effects to variations on the In-Valley Disposal Alternative that included land retirement. Based on the screening of many land retirement combinations, three scenarios were selected to become alternatives for analysis[4]. The following simulated hydrologic conditions are common to all four variations of the In-Valley Disposal Alternative:

- Existing recharge rates were estimated using information from Table 5 *Source Control Memorandum* (URS 2002)[5]. Moderate reductions in deep percolation were assumed to occur by 2005 due to increased irrigation efficiencies; the simulated deep percolation reductions continue through 2050. The efficiency improvements reduce average deep percolation by 0.10 foot/year in the Westlands areas located upslope to the drainage-impaired area, and by 0.10 foot/year in the Northerly Area.
- In the GDA, seepage reduction projects decrease water-table recharge by 4,200 AF/year.
- In Westlands, simulated annual groundwater pumping is maintained constant at 175,000 AF/year, which is equal to the average private supply reported in *Westlands' Water Needs Assessment*[6] (Reclamation 2003). The distribution of semiconfined and confined zone

[4] The four In-Valley Disposal Alternatives are: In-Valley, In-Valley with land retirement based on groundwater quality considerations, In-Valley with land retirement based on water needs, and In-Valley with retirement of all drainage-impaired lands.

[5] See Appendix E-4 ("Simulated Groundwater Use and Water Table Recharge Rates in Westlands Water District, San Luis Drainage Feature Re-Evaluation') for a complete description of recharge and pumpage distributions selected for the model area.

[6] Because the model represents only a portion of Westlands, simulated pumpage is less than 175,000 AF/yr. The analysis of well location and metered pumpage data provided by Westlands indicated that about 20 percent of the annual local supply (35,000 AF/year) is represented by the model. This pumpage is distributed within the model area representing Westlands as follows: 55 percent within the area having a shallow water table within 10 feet of land surface, 20 percent within area having a shallow water table between 10 and 20 feet of land surface, and 25 percent

pumping within Westlands was weighted based on the pumping rates reported by Belitz et al. (1993).

- Regional drainwater recycling continues in the GDA and is implemented in Westlands. Drainwater recycling displaces surface-water supplies and, therefore, does not affect the irrigation recharge rate. However, recycling increases irrigation-water salinity.
- In 2002, about 3,000 acres of land are retired under the Britz settlement. During the period 2003 through 2005, about 34,100 acres of land would be retired under the Sumner Peck Ranch et al. settlement. It was assumed these lands are retired over the 3-year period at a rate of about 11,370 acres per year. The retired lands were randomly distributed throughout the area defined by the plaintiffs' parcels during the 3-year period. In 2005, about 10,000 acres in the Northerly Area are retired in Broadview Water District. Irrigation ceases on the lands and, consequently, groundwater pumpage and surface-water deliveries are discontinued. In Westlands, the surface water is reallocated to other farmed lands within the district, and the reallocated surface water was assumed to displace surface-water supplies that would be purchased from other entities.
- As of 2002, 2,091 acres of land had been permanently retired under the CVPIA land retirement program. The remaining 4,904 acres were assumed to be retired at a rate of 981 acres per year during 2003, 2004, 2005, 2006, and 2007. The future retired lands were randomly distributed throughout the CVPIA land retirement project area. Irrigation ceases on these lands and, consequently, groundwater pumpage and surface-water deliveries are discontinued. The surface water is reallocated to other farmed lands within Westlands, and the reallocated surface water was assumed to displace surface-water supplies that would be purchased from other entities.
- The 65,000 acres of retired and acquired lands within Westlands under the No Action Alternative would be returned to irrigated agricultural production.

New drainage systems include both conventional and "shallow" designs. It was assumed that 25 percent of the Westlands drainage systems and 10 percent of the new GDA drainage systems would be operated to manage shallow groundwater conditions. The shallow conductance term is presumably 2.7 times greater than the conventional conductance term. In the conventional systems, the mean drain lateral depth is 7.5 feet below land surface; whereas, the shallow drain lateral systems have a mean drain lateral depth of 4.5 feet below land surface.

- In Westlands, the drainage systems are located within the 298,000-acre drainage-impaired area. In the GDA, the 6,000 acres of new drainage systems are randomly located within presently undrained portions of the 81,000-acre drainage-impaired area. New drainage systems were implemented in the model by instantaneously activating drainage systems in all the appropriate model cells in 2005. However, only those cells having a simulated water table above the drain lateral elevation actually produced drainage.

---

within area having a water table greater than 20 feet below land surface. Pumpage is discontinued in retired lands, and the discontinued pumpage is redistributed to the remaining active lands to maintain a constant local supply of 175,000 AF/yr (35,000 AF/year in the model). Hence, land retirement can modify the relationship between pumpage and water table depth.

- Reuse and treatment facilities begin operation in 2005. Irrigation recharge beneath the reuse fields was assumed to be 1 foot/year, but this water is assumed to be captured by drainage systems. It was assumed that 30 percent[7] of this recharge (0.30 foot/year) potentially percolates past the drainage systems and increases groundwater storage. The direct application of drainwater increases salt loads in irrigation water applied to these lands.
- Evaporation basins are required to reduce drainwater volume. The basin bottoms are to be constructed using natural clay liners from native soils to reduce permeability below 1 foot/year. Basin leakage under gravity drainage was assumed to equal the maximum clay liner permeability (1 foot/year). Mineral precipitation, pH, and microbial sludge development effects were estimated on reducing basin bottom sediment seepage over time. However, variability in hydraulic conductivity measurements from San Joaquin Valley pond sediments is difficult to quantify with a lack of reliable field measurements (Grismer and McCullough-Sanden 1987). Therefore, the possible effects were bracketed by simulating groundwater concentrations for 0, 25, 50, and 90 percent reductions in seepage rates. These hydraulic conductivity reductions were simulated as occurring within the first 5 years of basin operation.

The following unique hydrologic conditions are simulated for the In-Valley Disposal Alternative:

- In 2005, 110,900 acres of new subsurface drainage systems are gradually installed within Westlands.
- About 19,000 acres of reuse and treatment facilities begin operation in 2005.
- At most, about 3,300 acres of evaporation basins are required to reduce drainwater volume.

The following unique hydrologic conditions are simulated for the In-Valley Disposal/ Groundwater Quality Land Retirement Alternative[8]:

- During the period 2002 through 2004, 58,850 acres of land are retired during the 3-year period as follows: 12,950 acres in 2002, 30,600 acres in 2003, and 15,300 acres in 2004.
- In 2005, 90,200 acres of new subsurface drainage systems are gradually installed within Westlands.
- About 16,700 acres of reuse and treatment facilities begin operation in 2005.
- At most, about 2,900 acres of evaporation basins are required to reduce drainwater volume.

The following unique hydrologic conditions are simulated for the In-Valley Disposal/Water Needs Retirement Alternative[9]:

---

[7] The 30-percent deep percolation past drains is considered conservative because, under present pumping rates, the potentiometric surface is rising, and we would expect the vertical gradients to diminish over time thereby reducing the potential deep percolation rate. Furthermore, from a regional perspective the reuse areas are small in area relative to the study area, and therefore the contribution of deep percolation past drains to groundwater storage will be negligible.

[8] The Groundwater Quality Land Retirement component retires all the lands in Westlands with Se concentration greater than 50 ppb in the shallow groundwater and lands acquired by Westlands (that could be brought into production with drainage service).

- During the period 2002 through 2004, 97,200 acres of land are retired during the 3-year period as follows: 21,400 acres in 2002, 50,500 acres in 2003, and 25,300 acres in 2004.
- In 2005, 47,100 acres of new subsurface drainage systems are gradually installed within Westlands.
- About 12,500 acres of reuse and treatment facilities begin operation in 2005.
- At most, about 2,200 acres of evaporation basins are required to reduce drainwater volume.
- The following hydrologic conditions are simulated for the In-Valley Disposal/Drainage-Impaired Area Retirement Alternative[10].
- During the period 2002 through 2004, 254,400 acres of land are retired during the 3-year period as follows: 56,000 acres in 2002, 132,300 acres in 2003, and 66,100 acres in 2004.
- No drainage systems are installed within Westlands.
- About 7,500 acres of reuse and treatment facilities begin operation in 2005.
- At most, about 1,300 acres of evaporation basins are required to reduce drainwater volume.

Out-of-Valley Disposal Alternatives

The Out-of-Valley Disposal Alternatives plan for drainwater transport and disposal at one of three discharge points: two in the Delta (Chipps Island and Carquinez Strait) and one in the Pacific Ocean (Point Estero). From a groundwater resource perspective, potential environmental effects are approximately the same regardless of the discharge point selected. Hence, estimated effects are essentially identical for all three potential Out-of-Valley Disposal Alternatives. For these alternatives, the following hydrologic conditions were simulated:

- Existing recharge rates were estimated using information from Table 5 of the *Source Control Memorandum* (URS 2002). Moderate reductions in deep percolation were assumed to occur by 2005 due to seepage reduction measures increased irrigation efficiencies; the simulated deep percolation reductions continue through 2050. The efficiency improvements reduce average deep percolation by 0.10 foot/year in the Westlands areas located upslope to the drainage-impaired area, and by 0.10 foot/year in the Northerly Area.
- In Westlands, simulated annual groundwater pumping is maintained constant at 175,000 AF/year, which is equal to the average private supply reported in *Westlands' Water Needs Assessment* (Reclamation 2003). The distribution of semiconfined and confined zone pumping within Westlands was weighted based on the pumping rates reported by Belitz et al. (1993).

---

[9] The Water Needs Land Retirement Alternative would retire enough lands to meet the internal water use needs of the San Luis Unit. It would include lands with Se concentrations greater than 20 ppb in Westlands, and lands acquired by Westlands (that could be brought into production with drainage service).

[10] The Drainage-Impaired Area Land Retirement Alternative would retire all of the drainage-impaired lands in Westlands – approximately 298,000 acres. The Northerly Area (non-Westlands) is excluded from land retirement, except for 10,000 acres in Broadview Water District.

- In 2005, 115,800 acres of new subsurface drainage systems are gradually installed within Westlands, and 6,000 acres of new drainage systems are gradually installed in the GDA. In Westlands, the drainage systems are located within the 298,000-acre drainage-impaired area. In the GDA, the new drainage systems are located within presently undrained portions of the 81,000-acre drainage-impaired area. New drainage systems were implemented in the model by instantaneously activating drainage systems in all the appropriate model cells in 2005. However, only those cells having a simulated water table above the mean drain lateral elevation actually simulate drainage.
- New drainage systems include both conventional and “shallow” designs. It was assumed 25 percent of the Westlands drainage systems and 10 percent of the new GDA drainage systems would be operated to manage shallow groundwater conditions. The shallow designs maintain the water table at shallower depths, which allows for increased cropwater use of the water table.
- Drain conductance incorporates the effective conductivity of the drain/soil system and drain lateral density. Soil textures are generally finer-grained, and the corresponding effective conductivity values are presumably lower in Westlands relative to the GDA. An average conductivity for the drain/soil system of 250 feet/year was assumed for the GDA, and an average value of 80 feet/year was assumed for Westlands (Fio 1994). The new drainage systems include both conventional and “shallow” designs. Laterals are spaced about 400 feet apart in the conventional systems and 150 feet apart in the shallow systems. Hence, the shallow conductance term is presumably 2.7 times greater than the conventional conductance term. In the conventional systems, the drain lateral depths range from 7 to 8 feet below land surface (mean drain lateral depth of 7.5 feet below land surface), whereas the shallow drain lateral systems are installed from 4 to 5 feet below land surface (mean drain lateral depth of 4.5 feet below land surface).
- The 65,000 acres of retired and acquired lands within Westlands under the No Action Alternative would be returned to irrigated agricultural production.
- In 2002, about 3,000 acres of land are retired under the Britz settlement. During the period 2003 through 2005, about 34,100 acres of land would be retired under the Sumner Peck Ranch et al. settlement. It was assumed these lands are retired over the 3-year period at a rate of about 11,370 acres per year. The retired lands were randomly distributed throughout the area defined by the plaintiffs’ parcels during the 3-year period. In 2005, about 10,000 acres in the Northerly Area are retired in Broadview Water District. Irrigation ceases on these lands and consequently groundwater pumpage and surface-water deliveries are discontinued. In Westlands, the surface water is reallocated to other farmed lands within the district, and the reallocated surface water was assumed to displace surface-water supplies that would be purchased from other entities.
- As of 2002, 2,091 acres of land had been permanently retired under the CVPIA land retirement program. The remaining 4,904 acres assumed to be retired at a rate of 981 acres per year during 2003, 2004, 2005, 2006, and 2007. The future retired lands were randomly distributed throughout the CVPIA land retirement project area. Irrigation ceases on these lands and consequently groundwater pumpage and surface-water deliveries are discontinued. The surface water is reallocated to other farmed lands within the district, and the reallocated

surface water was assumed to displace surface-water supplies that would be purchased from other entities.

- In the GDA, seepage reduction projects decrease water-table recharge by 4,200 AF/year.
- Regional drainwater recycling continues in the GDA and is implemented in Westlands. Drainwater recycling displaces surface-water supplies and, therefore, does not affect the irrigation recharge rate. However, recycling increases irrigation-water salinity.
- About 19,000 acres of drainage reuse projects begin operation in 2005[11]. The leaching fraction was assumed to be 27 percent (1 foot/year), but the intent is for drainage systems to capture this water. It was assumed that 30 percent[12] of the deep percolation (0.30 foot/year) potentially percolates past the drainage systems and increases groundwater storage. The direct application of drainwater increases salt loads in irrigation water applied to these lands.

6.2.3 No Action Alternative

Under the No Action Alternative, groundwater changes are affected primarily by (1) the cessation of drainage discharge within the GDA after 2009 and (2) 109,100 acres of land retired in Westlands. Without drainage in the GDA, the average simulated water table beneath the drainage-impaired area rises 3 feet during the 49-year simulation period. In contrast, land retirement in Westlands lowers the water table beneath the lands retired. On the average, the simulated water table beneath the Westlands drainage problem area decreased by 4.3 feet. The bare-soil evaporation and area criteria are summarized in Table 6-1.

[11] Reuse facility construction will probably occur in phases, which was not represented in the model. The phasing should not significantly change the overall results.

[12] The 30 percent deep percolation past drains is considered conservative because, under present pumping rates, the potentiometric surface is rising, and the vertical gradients would be expected to diminish over time, thereby reducing the potential deep percolation rate. Furthermore, from a regional perspective the reuse areas are small in area relative to the study area and, therefore, the contribution of deep percolation past drains to groundwater storage will be negligible.

Table 6-1
Summary of Bare-Soil Evaporation and Shallow Water Table Area Criteria

Bare-Soil Evaporation (feet/year)						
	GDA		Westlands		Region	
Condition	**2001**	**49-year simulation period**	**2001**	**49-year simulation period**	**2001**	**49-year simulation period**
Existing	0.19	NA	0.18	NA	0.19	NA
No Action	0.19	0.39	0.18	0.30	0.19	0.35
In-Valley	0.19	0.13	0.18	0.09	0.19	0.11
In-Valley/Water Quality Land Retirement	0.19	0.13	0.18	0.11	0.19	0.12
In-Valley/Water Needs Land Retirement	0.19	0.12	0.18	0.10	0.19	0.12
In-Valley/Drainage-Impaired Area Land Retirement	0.19	0.12	0.18	0.10	0.19	0.12
Out-of-Valley	0.19	0.13	0.18	0.09	0.19	0.11
Undrained Area Underlain by Water Table Within 7 Feet of Land Surface (square miles)						
Existing	69	NA	261	NA	330	NA
No Action	69	74	261	212	330	286
In-Valley	69	57	261	68	330	125
In-Valley/Water Quality Land Retirement	69	51	261	30	330	81
In-Valley/Water Needs Land Retirement	69	50	261	22	330	72
In-Valley/Drainage-Impaired Area Land Retirement	69	49	261	11	330	60
Out-of-Valley	69	57	261	68	330	122

NA = Not applicable

The No Action Alternative (and other alternatives with a land retirement component) assumes that surface water reallocated from retired lands decreases the need for surface water purchased from other entities. If this assumption becomes invalid, and land retirement has the effect of increasing the overall surface-water supply to irrigated lands, it would reduce the demand for groundwater. The subsequent pumping decrease, combined with continued water table recharge, would result in an increased rate of water table rise, thereby increasing the bare-soil evaporation rate and area affected by the shallow water table.

6.2.3.1 Bare-Soil Evaporation

In the GDA, under existing conditions[13] the simulated evaporation rate is 0.19 foot/year, and under the No Action Alternative the simulated evaporation rate increases from 0.19 to 0.39 foot/year (a net increase of 0.20 foot/year). In Westlands, the simulated evaporation rate under existing conditions is 0.18 foot/year, and under the No Action Alternative the simulated evaporation rate increases from 0.18 to 0.30 foot/year (a net increase of 0.12 foot/year). From a regional perspective, the simulated existing condition evaporation rate is 0.19 foot/year, and under the No Action Alternative the evaporation rate increases to 0.35 foot/year. By the end of the simulation period, the evaporation rate under the No Action Alternative is 0.16 foot/year greater than existing conditions, which exceeds the significance criteria of 0.10 foot/year. The

[13] Existing conditions represent conditions prior to alternative implementation.

No Action Alternative has adverse effects on bare-soil evaporation relative to existing conditions.

6.2.3.2 Undrained Area Affected by Shallow Water Table

In the GDA, under existing conditions[13] the simulated undrained area underlain by a water table within 7 feet of land surface is 69 square miles, and under the No Action Alternative the undrained area underlain by the shallow water table increased to 74 square miles (a net increase of 5 square miles). In Westlands, under existing conditions the simulated area underlain by a shallow water table is 261 square miles, and under the No Action Alternative the area decreased from 261 to 212 square miles. From a regional perspective, under existing conditions the simulated undrained area underlain by the shallow water table within 7 feet of land surface is 330 square miles, and under the No Action Alternative the area decreased to 286 square miles (a net decrease of 44 square miles). The No Action Alternative therefore has a beneficial effect on the area affected by the shallow water table relative to existing water table conditions in the western San Joaquin Valley.

6.2.3.3 Groundwater Salinity

Under the No Action Alternative, increased bare-soil evaporation without drainage to remove salts would increase soil and groundwater salinity. In the GDA, without the Grassland Bypass Project San Luis Drainage use agreement, recycling and reuse would increase the salinity of the applied irrigation water and increase soil and groundwater salinity levels. For example, HydroFocus estimated a 10 percent groundwater salinity increase in the GDA after 9 years of conditions similar to the No Action Alternative (Reclamation 2001c, Appendix D). If undiluted drainwater is applied directly, especially under undrained conditions, the expected salinity increase is more dramatic. For example, HydroFocus' calculations indicated that irrigation with undiluted drainwater caused soil salinity to more than double under undrained conditions. The above salinity increases under the No Action Alternative were considered significant adverse effects.

In Westlands, it was determined that constituent concentration levels measured in 2002 monitoring well samples were not statistically different from similar samples collected in 1984. The analysis focused on possible changes in boron, molybdenum, Se, and salinity (as represented by electrical conductivity). Groundwater levels in the sampled wells were significantly deeper during the 2002 sampling relative to the 1984 sampling. Irrigation activity clearly influences local groundwater levels. For wells surrounded by fallow or partially fallow land, average water levels were over 3 feet deeper in 2002 than 1984; and, for wells surrounded by cropped land, average groundwater levels were 0.2 foot deeper in 2002 than 1984. Reduced regional recharge rates owing to land fallowing, and regional groundwater pumping activities probably caused the water level decline. The lower water levels decreased evaporation rates and its corresponding evaporative concentration effects on dissolved solids. Furthermore, concentration decreases in wells surrounded by cropped areas may be the result of the downward displacement of shallow, poor quality water by relatively higher quality irrigation water. The No Action Alternative probably has a beneficial effect on groundwater salinity because land retirement increases the depth to water and possible dilution effects from higher quality irrigation water in cropped areas.

The No Action Alternative, therefore, provides a beneficial effect relative to existing groundwater salinity conditions in the western San Joaquin Valley.

6.2.3.4 Drinking Water Supplies

For the No Action Alternative, concentrations of most contaminants are expected to continue to increase. Even though the contamination would take 100 to 400 years to travel to the wells, the migration toward drinking water sources would continue. A Se forecasting study by the USGS mentions “drainage alone cannot alleviate the salt and Se buildup in the San Joaquin Valley, at least within a century” (Luoma and Presser 2000).

The majority of municipal drinking water wells in the area of the Drain extract their water from deep aquifers, which are protected by the thick, low permeability Corcoran clay layer and, thus, are less vulnerable to any of the action alternatives. Most likely, practices that alter the quality or quantity of the shallow groundwater would not have a significant effect on the sub-Corcoran aquifer for a century or more. However, composite wells screened above and below the Corcoran clay represent an increase risk for dissolved constituents to penetrate the clay and enter the sub-Corcoran aquifer system.

In the western San Joaquin Valley, most municipal drinking water wells are less vulnerable than shallow groundwater. In the case of City of Mendota’s Well No. 5, water quality data indicate increasing salinity trends in the late 1990s, which may be attributed to eastward movement of shallow, saline groundwater.

However, changes to the No Action Alternative to include large-scale land retirement would have no significant effect compared to existing conditions. If drainage service is not provided and irrigation continues, high salinity groundwater effects to wells may increase. Relative to existing conditions, the increased salinity trends under the No Action Alternative are considered an adverse effect.

6.2.4 In-Valley Disposal Alternative

In the GDA, under the In-Valley Disposal Alternative the average simulated water table decreased 0.4 foot during the 2001-2050 simulation period. Beneath Westlands, the average net simulated water-table decrease was 3.6 feet.

6.2.4.1 Bare-Soil Evaporation

In the GDA, under the In-Valley Disposal Alternative the simulated evaporation rate decreases from 0.19 foot/year to 0.13 foot/year (a net decrease of 0.06 foot/year). In Westlands, the simulated evaporation rate decreased from 0.18 foot/year to 0.09 foot/year (a net decrease of 0.09 foot/year). From a regional perspective, the evaporation rate decreases from 0.19 to 0.11 foot/year (a net decrease of 0.08 foot/year relative to existing conditions). Relative to the No Action Alternative, the simulated evaporation rate is 0.24 foot/year less under the In-Valley Disposal Alternative. The In-Valley Disposal Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.

6.2.4.2 Undrained Area Affected by Shallow Water Table

In the GDA, the simulated undrained area underlain by the shallow water table under the In-Valley Disposal Alternative decreased from 69 square miles to 57 square miles (a net decrease of 12 square miles). In Westlands, the simulated undrained area underlain by the shallow water table decreased from 261 to 68 square miles (a net decrease of 193 square miles). From a regional perspective, the undrained area underlain by the shallow water table decreased from 330 to 125 square miles (a net decrease of 205 square miles). By the end of the simulation period, the In-Valley Disposal Alternative reduced the undrained area underlain by a shallow water table by 161 square miles relative to the No Action Alternative, and 205 square miles less than existing conditions. The In-Valley Disposal Alternative, therefore, produces a significant beneficial effect relative to the No Action Alternative and existing water table conditions.

6.2.4.3 Groundwater Salinity

Under the In-Valley Disposal Alternative, soil and groundwater salinity can increase in the drainage study area as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. For example, groundwater salinity was estimated to increase from 5.9 to 6.1 deciSiemens per meter (dS/m) after 9 years of conditions similar to the In-Valley Disposal Alternative (a net increase of about 3 percent). The In-Valley Disposal Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions.

Beneath the **reuse facilities**, where undiluted drainwater is applied directly to crops, the expected salinity increase is more dramatic. For example, salinity calculations for fields within the GDA indicated that irrigation with undiluted drainwater caused groundwater salinity to increase by more than 40 percent. Although these salinity increases represent significant adverse effects, they are limited to relatively small areas and are reversible. Affected soils could be reclaimed and saline shallow groundwater removed if an alternative means of salt disposal becomes available.

Beneath the **evaporation basins**, where the concentrations of dissolved constituents in drainwater have been increased by evaporation, the basin water can leak slowly into the underlying groundwater system. The concentration increases depend on the quality of the drainwater received and the groundwater underlying the basins. For the three proposed basins (Northerly Area, Westlands North, and Westlands Central) and an assumed seepage rate of 1 foot/year, 10- to 21-fold salinity increases are simulated for the 0- to 10-foot depth interval of the saturated groundwater system. Large amounts of salts precipitate within the 0- to 10-foot depth, which reduces salinity effects to deeper groundwater. For example, simulated salinity changes range from 5 to 6.5-fold increases in the 10- to 40-foot depth interval. Substantial boron and molybdenum concentration increases are also simulated. For boron and molybdenum, the greatest concentration increase is simulated for the 0- to 10-foot depth interval (2- to almost 5-fold increase in boron concentrations, and 8- to 17-fold increase in molybdenum concentrations). For Se, simulated concentrations decreased 1.3- to 2.4-fold. Although the salinity, boron, and molybdenum concentration increases can represent significant adverse effects, they are limited to relatively small areas. For lower seepage rates (0, 25, and 50 percent reductions) some degradation of the groundwater quality occurs for all simulated depths. For the 90 percent seepage-rate reduction, only the groundwater quality in the upper 10 feet of sediment is degraded.

Using the groundwater-flow model results, horizontal groundwater velocities were estimated at about 500 feet/year in the upper 50 feet of the saturated zone for the 1-foot/year seepage rate. Therefore, in 44 years groundwater with high salinity and constituent concentrations could travel about 20,000 feet downgradient from the evaporation basins. Results suggested significant water level increases could affect crop root zone salinity within 3,500 feet of the evaporation basins. These numbers represent maximum velocities and distances, as reduced seepage rates would decrease groundwater velocities and net lateral movement. Furthermore, interceptor drains and vertical cut-off walls could be constructed to limit net lateral groundwater movement.

6.2.4.4 Drinking Water Supplies

Drainwater recycling, which would happen under any of the action alternatives, would blend drainwater with freshwater supplies to a salinity level that is acceptable for use on commercial crops in the reuse facilities. The use of the recycled water could affect the salinity of shallow groundwater throughout the drainage study area. This increase could affect Mendota’s drinking water wells because their drinking water wells are under the influence of groundwater above the confining layer. However, the distance from the sites would make the effect on the wells not significant. The use of recycled drainwater would not regularly affect other communities that draw their water from the deep aquifer wells, protected from shallow groundwater, unless well-aided contamination occurs. The effect is not significant.

For the In-Valley Disposal Alternative where drainwater is disposed of in San Joaquin Valley, evaporation basins would be a necessary element to the recycling and treatment process. Evaporation basins could affect the San Joaquin groundwater system if the impaired water seeps through the basin lining. However, the proposed evaporation basins would be located where underlying groundwater is not potable and not considered to be a source of drinking water. The distance between the proposed basins and the City of Mendota’s drinking water wells is approximately 12 miles. Water and dissolved constituents could move from the basins towards the nearest municipal wells. However, the rate of movement is slow and the wells would be unaffected for generations, well beyond the expected life of these facilities. Furthermore, the saltwater would disperse as it moves towards the wells, which would lower the salinity of the plume. Groundwater monitoring wells would be established near the basins.

Therefore, the San Joaquin Valley’s drinking water supplies would not be significantly affected by the In-Valley Disposal Alternative. Compared to the No Action Alternative and existing conditions, the In-Valley Disposal Alternative would have a beneficial effect on drinking water quality due to a reduction in drainage volume/flow.

6.2.5 In-Valley/Groundwater Quality Land Retirement Alternative

In the GDA, under the In-Valley/Groundwater Quality Land Retirement Alternative the average simulated water table decreased 4.1 feet during the 2001–2050 simulation period. Beneath Westlands, the average net simulated water-table decrease was 8.2 feet.

6.2.5.1 Bare-Soil Evaporation

In the GDA, under the In-Valley/Groundwater Quality Land Retirement Alternative the simulated evaporation rate decreases from 0.19 to 0.13 foot/year (a net decrease of 0.06

foot/year). In Westlands, the simulated evaporation rate decreased from 0.18 to 0.11 foot/year (a net decrease of 0.07 foot/year). From a regional perspective, the evaporation rate decreases from 0.19 to 0.12 foot/year (a net decrease of 0.07 foot/year relative to existing conditions). Relative to the No Action Alternative, the simulated evaporation rate is 0.23 foot/year less under the In-Valley/Groundwater Quality Land Retirement Alternative. The In-Valley/Groundwater Quality Land Retirement Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.

6.2.5.2 Undrained Area Affected by Shallow Water Table

In the GDA, the simulated undrained area underlain by the shallow water table under the In-Valley/Groundwater Quality Land Retirement Alternative decreased from 69 to 51 square miles (a net decrease of 18 square miles). In Westlands, the simulated undrained area underlain by the shallow water table decreased from 261 to 30 square miles (a net decrease of 231 square miles). From a regional perspective, the undrained area underlain by the shallow water table decreased from 330 to 81 square miles (a net decrease of 249 square miles). By the end of the simulation period, the In-Valley/Groundwater Quality Land Retirement Alternative reduced the undrained area underlain by a shallow water table by 205 square miles relative to the No Action Alternative, and 249 square miles less than existing conditions. The In-Valley/Groundwater Quality Land Retirement Alternative, therefore, produces a significant beneficial effect relative to the No Action Alternative and the existing water-table conditions.

6.2.5.3 Groundwater Salinity

Under the In-Valley/Groundwater Quality Land Retirement Alternative, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. The In-Valley/Groundwater Quality Land Retirement Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions.

Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the expected salinity increase is more dramatic. Although the salinity increases represent significant adverse effects, they are limited to relatively small areas and are reversible.

Beneath the proposed evaporation basins, and with an assumed seepage rate of 1 foot/year, 10- to 21-fold salinity increases are simulated for the 0- to 10-foot depth interval of the saturated groundwater system. Large amounts of salts precipitate within the 0- to 10-foot depth, which reduces salinity effects to deeper groundwater. Substantial molybdenum and boron concentration increases are also simulated. For boron and molybdenum, the greatest concentration increase is simulated for the 0- to 10-foot depth interval (2- to almost 5-fold increase in boron concentrations and 8- to 17-fold increase in molybdenum concentrations). For Se, simulated concentrations decreased 1.3- to 2.4-fold. Although the salinity, boron, and molybdenum concentration increases can represent localized significant adverse effects, they are limited to relatively small areas.

For the 1-foot/year seepage rate, horizontal groundwater velocities were estimated at about 500 feet/year in the upper 50 feet of the saturated zone. Therefore, in 44 years groundwater with high salinity and constituent concentrations could travel about 20,000 feet downgradient from the basins. Results suggested significant water level increases could affect crop root zone salinity within 3,500 feet of the evaporation basins. These numbers represent maximum velocities and distances, as reduced seepage rates would decrease groundwater velocities and net lateral movement. Furthermore, interceptor drains and vertical cut-off walls could be constructed to limit net lateral groundwater movement.

6.2.5.4 Drinking Water Supplies

Since the closest drinking water supply wells are approximately 12 miles away, the effects from the In-Valley/Groundwater Quality Land Retirement Alternative would not be significant (see Section 6.2.4.4). This alternative incorporates land retirement similar to No Action as well as In-Valley treatment, which would reduce drainage flow. Therefore, this alternative would produce a beneficial effect on drinking water supply relative to the No Action Alternative and existing conditions.

6.2.6 In-Valley/Water Needs Land Retirement Alternative

In the GDA, under the In-Valley/Water Needs Land Retirement Alternative the average simulated water table decreased 4.3 feet during the 2001–2050 simulation period. Beneath Westlands, the average net simulated water-table decrease was 10.4 feet.

6.2.6.1 Bare-Soil Evaporation

In the GDA, under the In-Valley/Water Needs Land Retirement Alternative the simulated evaporation rate decreases from 0.19 to 0.12 foot/year (a net decrease of 0.07 foot/year). In Westlands, the simulated evaporation rate decreased from 0.18 to 0.10 foot/year (a net decrease of 0.08 foot/year). From a regional perspective, the evaporation rate decreases from 0.19 to 0.12 foot/year (a net decrease of 0.07 foot/year relative to existing conditions). Relative to the No Action Alternative, the simulated evaporation rate is 0.23 foot/year less under the In-Valley/Water Needs Land Retirement Alternative. The In-Valley/Water Needs Land Retirement Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.

6.2.6.2 Undrained Area Affected by Shallow Water Table

In the GDA, the simulated undrained area underlain by the shallow water table under the In-Valley/Water Needs Land Retirement Alternative decreased from 69 to 50 square miles (a net decrease of 19 square miles). In Westlands the simulated undrained area underlain by the shallow water table decreased from 261 to 22 square miles (a net decrease of 239 square miles). From a regional perspective, the undrained area underlain by the shallow water table decreased from 330 to 72 square miles (a net decrease of 258 square miles). By the end of the simulation period, the In-Valley/Water Needs Land Retirement Alternative reduced the undrained area underlain by a shallow water table by 214 square miles relative to the No Action Alternative, and 258 square miles less than existing conditions. The In-Valley/Water Needs Land Retirement Alternative, therefore, produces a significant beneficial effect relative to the No Action Alternative and the existing water table conditions.

6.2.6.3 Groundwater Salinity

Under the In-Valley/Water Needs Land Retirement Alternative, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. The In-Valley/Water Needs Land Retirement Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions.

Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the expected salinity increase is more dramatic. Although the salinity increases represent significant adverse effects, they are limited to relatively small areas and are reversible.

Beneath the evaporation basins, for the proposed basins and an assumed seepage rate of 1 foot/year, 10- to 21-fold salinity increases are simulated for the 0- to 10-foot depth interval of the saturated groundwater system. Large amounts of salts precipitate within the 0- to 10-foot depth, which reduces salinity effects to deeper groundwater. Substantial molybdenum and boron concentration increases are also simulated. For boron and molybdenum, the greatest concentration increase is simulated for the 0- to 10-foot depth interval (2- to almost 5-fold increase in boron concentrations and 8- to 17-fold increase in molybdenum concentrations). For Se, simulated concentrations decreased 1.3- to 2.4-fold. Although the salinity, boron, and molybdenum concentration increases can represent significant adverse effects, they are limited to relatively small areas.

For the 1-foot/year seepage rate, horizontal groundwater velocities were estimated at about 500 feet/year in the upper 50 feet of the saturated zone. Therefore, in 44 years groundwater with high salinity and constituent concentrations could travel about 20,000 feet downgradient from the evaporation basins. Results suggested significant water-level increases could affect crop root zone salinity within 3,500 feet of the evaporation basins. These numbers represent maximum velocities and distances, as reduced seepage rates would decrease groundwater velocities and net lateral movement. Furthermore, interceptor drains and vertical cut-off walls could be constructed to limit net lateral groundwater movement.

6.2.6.4 Drinking Water Supplies

Since the closest drinking water supply wells are approximately 12 miles away and saltwater would likely disperse as it moved towards the wells, the effects from the In-Valley/Water Needs Land Retirement Alternative would not be significant (see Section 6.2.4.4). This alternative incorporates 193,956 acres of land retirement, which would further reduce drainage flow. Therefore, this alternative would produce a beneficial effect on drinking water supply relative to the No Action Alternative and existing conditions.

6.2.7 In-Valley/Drainage-Impaired Area Land Retirement Alternative

In the GDA, under the In-Valley/Drainage-Impaired Area Land Retirement Alternative the average simulated water table decreased 4.4 feet during the 2001–2050 simulation period. Beneath Westlands, the average net simulated water-table decrease was 17.6 feet.

6.2.7.1 Bare-Soil Evaporation

In the GDA, under the In-Valley/Drainage-Impaired Area Land Retirement Alternative the simulated evaporation rate decreases from 0.19 to 0.12 foot/year (a net decrease of 0.07 foot/year). In Westlands, the simulated evaporation rate decreased from 0.18 to 0.10 foot/year (a net decrease of 0.08 foot/year). From a regional perspective, the evaporation rate decreases from 0.19 to 0.12 foot/year (a net decrease of 0.07 foot/year relative to existing conditions). Relative to the No Action Alternative, the simulated evaporation rate is 0.23 foot/year less under the In-Valley/Drainage-Impaired Area Land Retirement Alternative. The In-Valley/Drainage-Impaired Area Land Retirement Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.

6.2.7.2 Undrained Area Affected by Shallow Water Table

In the GDA, the simulated undrained area underlain by the shallow water table under the In-Valley/Drainage-Impaired Area Land Retirement Alternative decreased from 69 square miles to 49 square miles (a net decrease of 20 square miles). In Westlands the simulated undrained area underlain by the shallow water table decreased from 261 to 11 square miles (a net decrease of 250 square miles). From a regional perspective, the undrained area underlain by the shallow water table decreased from 330 to 60 square miles (a net decrease of 270 square miles). By the end of the simulation period, the In-Valley/Drainage-Impaired Area Land Retirement Alternative reduced the undrained area underlain by a shallow water table by 226 square miles relative to the No Action Alternative, and 270 square miles less than existing conditions. The In-Valley/Drainage-Impaired Area Land Retirement Alternative, therefore, produces a significant beneficial effect relative to the No Action Alternative and the existing water table conditions.

6.2.7.3 Groundwater Salinity

Under the In-Valley Disposal Alternative, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. The In-Valley Disposal Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions.

Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the expected salinity increase is more dramatic. Although the salinity increases represent significant adverse effects, they are limited to relatively small areas and are reversible.

Beneath the evaporation basins, for the proposed basins and an assumed seepage rate of 1 foot/year, 10- to 21-fold salinity increases are simulated for the 0- to 10-foot depth interval of the saturated groundwater system. Large amounts of salts precipitate within the 0- to 10-foot depth, which reduces salinity effects to deeper groundwater. Substantial molybdenum and boron concentration increases are also simulated. For boron and molybdenum, the greatest concentration increase is simulated for the 0- to 10-foot depth interval (2- to almost 5-fold increase in boron concentrations and 8- to 17-fold increase in molybdenum concentrations). For Se, simulated concentrations decreased 1.3- to 2.4-fold. Although the salinity, boron, and molybdenum concentration increases can represent significant adverse effects, they are limited to relatively small areas.

For the 1-foot/year seepage rate, horizontal groundwater velocities were estimated at about 500 feet/year in the upper 50 feet of the saturated zone. Therefore, in 44 years groundwater with high salinity and constituent concentrations could travel about 20,000 feet downgradient from the basins. Results suggested significant water level increases could affect crop root zone salinity within 3,500 feet of the evaporation basins. These numbers represent maximum velocities and distances, as reduced seepage rates would decrease groundwater velocities and net lateral movement. Furthermore, interceptor drains and vertical cut-off walls could be constructed to limit net lateral groundwater movement.

6.2.7.4 Drinking Water Supplies

Since the closest drinking water supply wells are approximately 12 miles away, the effects from the In-Valley/Drainage-Impaired Land Retirement Alternative would not be significant. This alternative incorporates 308,000 acres of land retirement, which would reduce drainage flow. Therefore, this alternative would produce a significant beneficial effect on drinking water supply relative to the No Action Alternative and existing conditions.

6.2.8 Ocean Disposal Alternative

The Ocean Disposal Alternative is one of three Out-of-Valley Disposal Alternatives. Under the Ocean Disposal Alternative, the average water-table elevation decreased beneath the GDA drainage service area 0.4 foot during the 2001–2050 simulation. Beneath the Westlands drainage service area, the average water-table elevation decreased 3.6 foot.

6.2.8.1 Bare-Soil Evaporation

In the GDA, under the Ocean Disposal Alternative the simulated evaporation rate decreases from 0.19 to 0.13 foot/year (a net decrease of 0.06 foot/year). In Westlands, the simulated evaporation rate increased from 0.18 to 0.09 foot/year (a net decrease of 0.09 foot/year). From a regional perspective, the evaporation rate decreases from 0.19 to 0.11 foot/year. Relative to the No Action Alternative, the simulated evaporation rate is 0.24 foot/year less under the Ocean Disposal Alternative. The Ocean Disposal Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.

6.2.8.2 Undrained Area Affected by Shallow Water Table

In the GDA, the simulated undrained area underlain by the shallow water table decreased from 69 to 57 square miles (a net decrease of 12 square miles). In Westlands, the simulated undrained area underlain by the shallow water table decreased from 261 to 68 square miles (a net decrease of 193 square miles). Relative to existing conditions, the Ocean Disposal Alternative decreased the undrained area underlain by a shallow water table by 205 square miles and is, therefore, considered to have a beneficial effect. Relative to the No Action Alternative, the Ocean Disposal Alternative decreased the undrained area underlain by a shallow water table by 161 square miles and is, therefore, considered to have a significant beneficial effect.

6.2.8.3 Groundwater Salinity

Under the Ocean Disposal Alternative, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. For example, groundwater salinity was estimated to increase from 5.9 to 6.1 dS/m after 9 years of drainwater recycling in the GDA (a net increase of about 3 percent) (Reclamation 2001, Appendix D). The Ocean Disposal Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions.

Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the expected salinity increase is more dramatic. For example, salinity calculations for fields within the GDA indicated that irrigation with undiluted drainwater caused groundwater salinity to increase by more than 40 percent. Although these salinity increases represent significant adverse effects, they are limited to relatively small areas and are reversible. Affected soils could be reclaimed and saline shallow groundwater removed if an alternative means of salt disposal becomes available.

6.2.8.4 Drinking Water Supplies

In general, disposal of drainwater to the ocean would result in no significant effect to drinking water supplies. Ocean water is not currently utilized for drinking water, although it is considered a potential future source. At the present time, the Ocean Disposal Alternative poses no significant adverse effect to drinking water supplies outside of the San Joaquin Valley.

If drainwater is transported off site, it would mean a 4,200 AF/year reduction in groundwater recharge in the valley. The reduced recharge rate would decrease the rate the shallow water table rises, and exporting the drainwater reduces salt loads to groundwater. Reducing the salt load would decrease the rate of increase in salinity concentrations in shallow groundwater. Since most communities obtain their drinking water from below the Corcoran clay layer, the effect of reduced recharge and salt load should not affect deepwater drinking water sources. The City of Mendota may benefit as the reduced salt loads may decrease the rate of impairment of their drinking water well source. Reducing recharge may decrease vertical gradients between shallow and deep aquifer systems, and increase the time of travel between the water table and deeper aquifer systems. Overall, the effect on most communities is not significant.

A positive aspect of disposing drainwater outside the San Joaquin Valley is the avoidance of evaporation basins. Eliminating the need for evaporation basins alleviates the potential for adverse effects from basin leakage and the need for groundwater monitoring wells.

Although evaporation basins would be avoided, seepage of the contaminated drainwater during its transport to the ocean must be considered. The 175 miles of buried pipeline from the San Luis Unit to the ocean should have very minimal seepage loss, and the effect is not significant.

6.2.9 Delta-Chipps Island Disposal Alternative

Under the Delta-Chipps Island Disposal Alternative, the average water-table elevation decreased beneath the GDA drainage service area 0.4 foot. Beneath the Westlands drainage service area, the average water-table elevation decreased 3.6 feet.

6.2.9.1 Bare-Soil Evaporation

In the GDA, under the Delta-Chipps Island Disposal Alternative the simulated evaporation rate decreases from 0.19 to 0.13 foot/year (a net decrease of 0.06 foot/year). In Westlands, the simulated evaporation rate decreased from 0.18 to 0.09 foot/year (a net decrease of 0.09 foot/year). From a regional perspective, the evaporation rate decreases from 0.19 to 0.11 foot/year. Relative to the No Action Alternative, the simulated evaporation rate is 0.24 foot/year less under the Ocean Disposal Alternative. The Ocean Disposal Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.

6.2.9.2 Undrained Area Affected by Shallow Water Table

In the GDA, the simulated undrained area underlain by the shallow water table decreased from 69 to 57 square miles (a net decrease of 12 square miles). In Westlands, the simulated undrained area underlain by the shallow water table decreased from 261 to 68 square miles (a net decrease of 193 square miles). Relative to existing conditions, the Delta-Chipps Island Disposal Alternative decreased the undrained area underlain by a shallow water table by 205 square miles and is, therefore, considered having a beneficial effect. Relative to the No Action Alternative, the Delta-Chipps Island Disposal Alternative decreased the undrained area underlain by a shallow water table by 161 square miles and is, therefore, considered to have a significant beneficial effect.

6.2.9.3 Groundwater salinity

Under the Out-of-Valley Disposal Alternatives, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. For example, groundwater salinity was estimated to increase from 5.9 to 6.1 dS/m after 9 years of drainwater recycling in the GDA (a net increase of about 3 percent) (Reclamation 2001, Appendix D). The Delta-Chipps Island Disposal Alternative is, therefore, considered to have a significant beneficial effect on groundwater salinity relative to the No Action Alternative.

Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the expected salinity increase is more dramatic. For example, salinity calculations for fields within the GDA indicated that irrigation with undiluted drainwater caused groundwater salinity to increase by more than 40 percent. Although these salinity increases represent significant adverse effects, they are limited to relatively small areas and are not irreversible. Affected soils could be reclaimed and saline shallow groundwater removed if an alternative means of salt disposal becomes available.

6.2.9.4 Drinking Water Supplies

Groundwater effects resulting from the Delta-Chipps Island Disposal Alternative are minimal. Water districts bordering the Delta do not have many drinking water wells due to seawater intrusion concerns. Therefore, the possibility of other contaminants such as Se reaching the already nonpotable groundwater is not a major consideration. A number of drinking water wells exist in Contra Costa County, though most wells here are for emergency and standby purposes only (DHS Water Quality CD). The wells are located far enough away that the horizontal and vertical distance is sufficient to protect the wells from drainwater, so no significant adverse effect occurs.

This alternative would result in the same reduction of groundwater recharge as that discussed under the Ocean Disposal Alternative. The alternative would have no significant effect to most communities. Mendota may experience a beneficial effect.

With this alternative, seepage of the contaminated drainwater during its transport to the ocean must also be considered. The Delta-Chipps Island Disposal Alternative would include 107.6 miles of pipeline and concrete-lined canal outside of the San Joaquin Valley to transport the drainwater to the Delta. With proper lining of the canal, seepage would be minimized, and the effect is not significant.

6.2.10 Delta-Carquinez Strait Disposal Alternative

Under the Delta-Carquinez Strait Disposal Alternative, the average water-table elevation decreased beneath the GDA drainage service area 0.4 foot. Beneath the Westlands drainage service area, the average water-table elevation decreased 3.6 foot.

6.2.10.1 Bare-Soil Evaporation

In the GDA, under the Delta-Carquinez Strait Disposal Alternative the simulated evaporation rate decreases from 0.19 to 0.13 foot/year (a net decrease of 0.06 foot/year). In Westlands, the simulated evaporation rate decreased from 0.18 to 0.09 foot/year (a net decrease of 0.09 foot/year). From a regional perspective, the evaporation rate decreases from 0.19 to 0.11 foot/year. Relative to the No Action Alternative, the simulated evaporation rate is 0.24 foot/year less under the Delta-Carquinez Strait Disposal Alternative. The Delta-Carquinez Strait Disposal Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.

6.2.10.2 Undrained Area Affected by Shallow Water Table

In the GDA, the simulated undrained area underlain by the shallow water table decreased from 69 to 57 square miles (a net increase of 12 square miles). In Westlands, the simulated undrained area underlain by the shallow water table decreased from 261 to 68 square miles (a net decrease of 193 square miles). Relative to existing conditions, the Delta-Carquinez Strait Disposal Alternative decreased the undrained area underlain by a shallow water table by 205 square miles and is, therefore, considered to have a beneficial effect. Relative to the No Action Alternative, the Delta-Carquinez Strait Disposal Alternative decreased the undrained area underlain by a shallow water table by 161 square miles and is, therefore, considered to have a significant beneficial effect.

6.2.10.3 Groundwater Salinity

Under the Out-of-Valley Disposal Alternatives, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. For example, groundwater salinity was estimated to increase from 5.9 to 6.1 dS/m after 9 years of drainwater recycling in the GDA (a net increase of about 3 percent) (Reclamation

2001, Appendix D). The Delta-Carquinez Strait Disposal Alternative is, therefore, considered to have a significant beneficial effect on groundwater salinity relative to the No Action Alternative.

Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the expected salinity increase is more dramatic. For example, salinity calculations for fields within the GDA indicated that irrigation with undiluted drainwater caused groundwater salinity to increase by more than 40 percent. Although these salinity increases represent significant adverse effects, they are limited to relatively small areas and are not irreversible. Affected soils could be reclaimed and saline shallow groundwater removed if an alternative means of salt disposal becomes available.

6.2.10.4 Drinking Water Supplies

Disposing drainwater to Carquinez Strait in the Delta poses a minimal threat to subsurface drinking water supplies near the Delta. As mentioned above, the nearest drinking water wells are sufficiently far enough away, both horizontally and vertically, that the sources would be protected for centuries. At Carquinez Strait, the water is more saline and the depth of the estuary water is much greater than at Chipps Island. Thus, the drainwater is more likely to mix and dilute at Carquinez Strait. Furthermore, as Carquinez Strait is much further downstream from Chipps Island, and less likely to mix with Delta water, this alternative is preferable to the Delta-Chipps Island Disposal Alternative from a drinking water perspective. As with the Delta-Chipps Island Disposal Alternative, the percentage of drainwater that could eventually seep into the ground is quite low, and the lining of existing unlined conveyance facilities is proposed.

This alternative would result in the same reduction of groundwater recharge as that discussed under the Ocean Disposal Alternative. This alternative would have no significant effect to most communities. Mendota may experience a beneficial effect.

This out-of-valley conveyance pipeline and canal would total 125 miles. Seepage loss along the way is expected to be minimal. The effect is not significant.

6.2.11 Cumulative Effects

Cumulative effects can occur when project effects are insignificant on their own, but when combined with other incremental effects from other projects in the region, the combined effects can become significant. The analysis summarized below in Section 6.2.12 (Environmental Effects Summary) indicates the action alternatives benefit bare-soil evaporation and undrained area affected by shallow-water table, but do not significantly affect groundwater salinity. Irrigation recharge within both the project and adjacent areas contributes to ongoing regional increases in water table elevation (i.e., bare-soil evaporation and undrained area affected by shallow-water table), and groundwater and soil salinity (Belitz, Philips, and Gronberg 1993). For the period 1991–97, DWR reported an average increase to the area (underlain by a water table within 10 feet of land surface) of 20,000 acres per year (DWR 2000). The San Joaquin Valley Drainage Implementation Program (1998) reported that in 1990 alone, almost 1.5 million tons of salt were imported and deposited into western San Joaquin Valley soils and water. The water table rise and salinization of soil and groundwater is a significant regional problem associated with irrigated agriculture, and the incremental effects of the action alternatives are not cumulatively significant. In other words, the effects do not exacerbate the regional problems.

6.2.12 Environmental Effects Summary

The following sections and tables summarize the evaluation of effects relative to the No Action Alternative and existing conditions.

6.2.12.1 No Action Alternative

- By the end of the simulation period, the evaporation rate under the No Action Alternative is 0.16 foot/year greater than simulated under existing conditions, which is greater than the criteria of 0.10 foot/year. The No Action Alternative, therefore, has an adverse effect on bare soil evaporation relative to existing conditions.
- By the end of the simulation period, the undrained area underlain by the shallow water table decreases 44 square miles under the No Action Alternative relative to existing conditions (2001). The No Action Alternative, therefore, has a beneficial effect relative to existing water table conditions (2001) in the western San Joaquin Valley.
- Under the No Action Alternative, increased bare-soil evaporation without drainage to remove salts would increase soil and groundwater salinity. In the GDA, a 10 percent groundwater salinity increase is estimated for the GDA after 9 years of conditions similar to the No Action Alternative. In Westlands, constituent concentration levels measured in monitoring well samples have not changed during the period 1984 to 2002, and land retirement and possible dilution of shallow groundwater by irrigation water in cropped areas have a beneficial effect on groundwater salinity.
- Under the No Action Alternative, concentrations of most contaminants in raw groundwater are expected to continue to increase as the contaminants continue to migrate toward wells. This is an adverse effect on drinking water supplies.

6.2.12.2 In-Valley Disposal Alternative

- Under the In-Valley Disposal Alternative, by the end of the simulation period the evaporation rate is 0.08 foot/year less than existing conditions and 0.24 foot/year less than the No Action Alternative. The In-Valley Disposal Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.
- Under the In-Valley Disposal Alternative, by the end of the simulation period the undrained area underlain by the shallow water table decreases by 161 square miles relative to the No Action Alternative, and the affected area is 205 square miles less than existing conditions. The In-Valley Disposal Alternative, therefore, produces a significant beneficial effect relative to existing conditions and the No Action Alternative.
- Groundwater salinity was estimated to increase from 5.9 to 6.1 dS/m after 9 years of conditions similar to the In-Valley Disposal Alternative (a net increase of about 3 percent). The In-Valley Disposal Alternative is, therefore, considered to have no effect on groundwater salinity relative to the No Action Alternative and existing conditions. Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the groundwater salinity is expected to increase by more than 40 percent. Beneath the evaporation ponds, where concentrated drainwater can leak slowly into the underlying groundwater system, salinity and dissolved constituent concentrations (salinity, molybdenum, and boron) substantially increase

in shallow groundwater. These significant adverse effects are limited to relatively small areas and are reversible.

- Under the In-Valley Disposal Alternative, blended water would affect the salinity of shallow groundwater throughout the San Joaquin Valley. This change would potentially affect specific wells located above the confining layer, but the distance to the wells would make the effect not significant. It has only a minimal effect on the majority of other drinking water sources that draw their water from the deep aquifer wells. The evaporation basins would be located where the underlying groundwater is not potable and is not considered a source of drinking water. The effect of a reduction in drainage flow is beneficial.

6.2.12.3 In-Valley/Groundwater Quality Land Retirement Alternative

- Under the In-Valley/Groundwater Quality Land Retirement Alternative, by the end of the simulation period the evaporation rate is 0.07 foot/year less than existing conditions and 0.23 foot/year less than the No Action Alternative. The In-Valley/Groundwater Quality Land Retirement Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.
- Under the In-Valley/Groundwater Quality Land Retirement Alternative, by the end of the simulation period the undrained area underlain by the shallow water table decreases by 205 square miles relative to the No Action Alternative, and the affected area is 249 square miles less than existing conditions. The In-Valley/Groundwater Quality Land Retirement Alternative, therefore, produces a significant beneficial effect relative to existing conditions and the No Action Alternative.
- Groundwater salinity was estimated to increase from 5.9 to 6.1 dS/m after 9 years of conditions similar to the In-Valley Disposal Alternative (a net increase of about 3 percent). The In-Valley/Groundwater Quality Land Retirement Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions. Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the groundwater salinity is expected to increase by more than 40 percent. Beneath the evaporation basins, where concentrated drainwater can leak slowly into the underlying groundwater system, salinity and dissolved constituent concentrations (salinity, molybdenum, and boron) substantially increase in shallow groundwater. These significant adverse effects are limited to relatively small areas and are reversible.
- Under the In-Valley/Groundwater Quality Land Retirement Alternative, blended water would affect the salinity of shallow groundwater throughout the San Joaquin Valley. This change would potentially affect specific wells located above the confining layer; however, it would have only a minimal effect on the majority of other drinking water sources. The adverse effect is not significant.
- This alternative includes land retirement as well as treatment, which would reduce the drainwater flow and produce a beneficial effect on drinking water supply relative to existing conditions and the No Action Alternative.

6.2.12.4 In-Valley/Water Needs Land Retirement Alternative

- Under the In-Valley/Water Needs Land Retirement Alternative, by the end of the simulation period the evaporation rate is 0.07 foot/year less than existing conditions and 0.23 foot/year less than the No Action Alternative. The In-Valley/Water Needs Land Retirement Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.
- Under the In-Valley/Water Needs Land Retirement Alternative, by the end of the simulation period the undrained area underlain by the shallow water table decreases by 214 square miles relative to the No Action Alternative, and the affected area is 258 square miles less than existing conditions. The In-Valley/Water Needs Land Retirement Alternative, therefore, produces a significant beneficial effect relative to existing conditions and the No Action Alternative.
- Groundwater salinity was estimated to increase from 5.9 to 6.1 dS/m after 9 years of conditions similar to the In-Valley Disposal Alternative (a net increase of about 3 percent). The In-Valley/Water Needs Land Retirement Alternative is, therefore, considered to have no effect on groundwater salinity relative to the No Action Alternative and existing conditions. Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the groundwater salinity is expected to increase by more than 40 percent. Beneath the evaporation basins, where concentrated drainwater can leak slowly into the underlying groundwater system, salinity and dissolved constituent concentrations (salinity, molybdenum, and boron) substantially increase in shallow groundwater. These significant adverse effects are limited to relatively small areas and are reversible.
- Under the In-Valley/Water Needs Land Retirement Alternative, blended water would affect the salinity of shallow groundwater throughout the San Joaquin Valley. This change would potentially affect specific wells located above the confining layer; however, it would have only a minimal effect to the majority of other drinking water sources. The effect is not significant.
- This alternative includes additional land retirement as well as treatment, which would reduce the drainage flow and produce a beneficial effect on drinking water supply relative to existing conditions and the No Action Alternative.

6.2.12.5 In-Valley/Drainage-Impaired Area Land Retirement Alternative

- Under the In-Valley/Drainage-Impaired Area Land Retirement Alternative, by the end of the simulation period the evaporation rate is 0.07 foot/year less than existing conditions and 0.23 foot/year less than the No Action Alternative. The In-Valley/Drainage-Impaired Area Land Retirement Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.
- Under the In-Valley/Drainage-Impaired Area Land Retirement Alternative, by the end of the simulation period the undrained area underlain by the shallow water table decreases by 226 square miles relative to the No Action Alternative, and the affected area is 270 square miles less than existing conditions. The In-Valley/Drainage-Impaired Area Land Retirement Alternative, therefore, produces a significant beneficial effect relative to existing conditions and the No Action Alternative.

- Groundwater salinity was estimated to increase from 5.9 to 6.1 dS/m after 9 years of conditions similar to the In-Valley Disposal Alternative (a net increase of about 3 percent). The In-Valley/Drainage-Impaired Area Land Retirement Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions. Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the groundwater salinity is expected to increase by more than 40 percent. Beneath the evaporation basins, where concentrated drainwater can leak slowly into the underlying groundwater system, salinity and dissolved constituent concentrations (salinity, molybdenum, and boron) substantially increase in shallow groundwater. These significant adverse effects are limited to relatively small areas and are reversible.
- Under the In-Valley/Drainage-Impaired Area Land Retirement Alternative, blended water would affect the salinity of shallow groundwater throughout the San Joaquin Valley. This change would potentially affect specific wells located above the confining layer; however, it would have only a minimal effect on the majority of other drinking water sources. The effect is not significant.
- This alternative includes additional land retirement as well as treatment, which would reduce the flow and produce a significant beneficial effect on drinking water supply relative to existing conditions and the No Action Alternative.

6.2.12.6 Ocean Disposal Alternative

- Under the Ocean Disposal Alternative, by the end of the simulation period the evaporation rate is 0.08 foot/year less than for existing conditions and 0.24 foot/year less than the No Action Alternative. The Ocean Disposal Alternative, therefore, has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.
- Relative to existing conditions, the Ocean Disposal Alternative decreases the undrained area underlain by a shallow water table by 205 square miles and is considered to have a significant beneficial effect. Relative to the No Action Alternative, the Ocean Disposal Alternative decreased the undrained area underlain by a shallow water table by 161 square miles and is considered to have a significant beneficial effect.
- Under the Ocean Disposal Alternative, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. The Ocean Disposal Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions. Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the groundwater salinity is expected to increase by more than 40 percent. These significant adverse effects are limited to relatively small areas and are reversible.
- The removal of contaminated drainwater from the system would greatly reduce the salt loading in the valley. Reducing the amount of drainwater that recharges the shallow groundwater would slow the transport of contaminated groundwater further down the water column into the deep aquifer protecting drinking water sources. The beneficial effect is not significant.

6.2.12.7 Delta-Chipps Island Disposal Alternative

- Under the Delta-Chipps Island Disposal Alternative, by the end of the simulation period the evaporation rate is 0.08 foot/year less than for existing conditions and 0.24 foot/year less than the No Action Alternative. The Delta-Chipps Island Disposal Alternative has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.
- Relative to existing conditions, the Delta-Chipps Island Disposal Alternative decreased the undrained area underlain by a shallow water table by 205 square miles and is considered to have a significant beneficial effect. Relative to the No Action Alternative, the Delta-Chipps Island Disposal Alternative decreased the undrained area underlain by a shallow water table by 161 square miles and is considered to have a significant beneficial effect.
- Under the Delta-Chipps Island Disposal Alternative, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. The Delta-Chipps Island Disposal Alternative is, therefore, considered to have no effect on groundwater salinity relative to the No Action Alternative and existing conditions. Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the groundwater salinity is expected to increase by more than 40 percent. These significant adverse effects are limited to relatively small areas and are reversible.
- The removal of contaminated drainwater from the system would greatly reduce the salt loading in the valley. Reducing the amount of drainwater that recharges the shallow groundwater would slow the transport of contaminated groundwater further down the water column into the deep aquifer protecting drinking water sources. The beneficial effect is not significant.

6.2.12.8 Delta-Carquinez Strait Disposal Alternative

- Under the Delta-Carquinez Strait Disposal Alternative, by the end of the simulation period the evaporation rate is 0.08 foot/year less than for existing conditions and 0.24 foot/year less than the No Action Alternative. The Delta-Carquinez Strait Disposal Alternative has a beneficial effect relative to existing conditions and a significant beneficial effect relative to the No Action Alternative.
- Relative to existing conditions, the Delta-Carquinez Strait Disposal Alternative decreased the undrained area underlain by a shallow water table by 205 square miles and is considered to have a significant beneficial effect. Relative to the No Action Alternative, the Delta-Carquinez Strait Disposal Alternative decreased the undrained area underlain by a shallow water table by 161 square miles and is considered to have a significant beneficial effect.
- Under the Delta-Carquinez Strait Disposal Alternative, soil and groundwater salinity can increase as a result of drainwater recycling, but the increase would be less than estimated for the No Action Alternative. The Delta-Carquinez Strait Disposal Alternative is, therefore, considered to have no significant effect on groundwater salinity relative to the No Action Alternative and existing conditions. Beneath the reuse facilities, where undiluted drainwater is applied directly to crops, the groundwater salinity is expected to increase by more than 40 percent. These significant adverse effects are limited to relatively small areas and are reversible.

- The removal of contaminated drainwater from the system would greatly reduce the salt loading in the valley. Reducing the amount of drainwater that recharges the shallow groundwater would slow the transport of contaminated groundwater further down the water column into the deep aquifer protecting drinking water sources. The beneficial effect is not significant.

Tables 6-2 through 6-9 summarize the effects of the No Action and action alternatives on groundwater resources.

Table 6-2
Summary Comparison of Effects of No Action Alternative

Affected Resource and Area of Potential Effect	No Action Alternative Compared to Existing Conditions
Bare-Soil Evaporation	Rate increases 0.16 foot/year. Adverse effect.
Undrained Area Affected by Shallow-Water Table	Area decreases 44 square miles. Beneficial effect.
Groundwater Salinity	Ten percent increase. Adverse effect in GDA. Land retirement and possible dilution of shallow groundwater would have a beneficial effect in Westlands.
Drinking Water Supplies	Contaminants in groundwater would continue to migrate toward wells. However, since land retirement is included in No Action, it would provide a beneficial effect.

Table 6-3
Summary Comparison of Effects of In-Valley Disposal Alternative

Affected Resource and Area of Potential Effect	In-Valley Disposal Compared to No Action	In-Valley Disposal Compared to Existing Conditions
Bare-Soil Evaporation	Rate decreases 0.24 foot/year. Significant beneficial effect.	Rate decreases 0.08 foot/year. Beneficial effect.
Undrained Area Affected by Shallow-Water Table	Area decreases 161 square miles. Significant beneficial effect.	Area decreases 205 square miles. Beneficial effect.
Groundwater Salinity	Increase of 3 percent. No significant effect.	Increase of 3 percent. No effect.
Drinking Water Supplies	No significant effect to drinking water sources. Reduction in drainwater would slow contamination of drinking water sources. Beneficial effect.	Minimal effect to drinking water sources. Reduction in drainwater would slow contamination of drinking water sources. Beneficial effect.

Table 6-4
Summary Comparison of Effects of In-Valley/Groundwater Quality Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Groundwater Quality Land Retirement Alternative Compared to No Action	In-Valley/Groundwater Quality Land Retirement Alternative Compared to Existing Conditions
Bare-Soil Evaporation	Rate decreases 0.23 foot/year. Significant beneficial effect.	Rate decreases 0.07 foot/year. Beneficial effect.
Undrained Area Affected by Shallow-Water Table	Area decreases 205 square miles. Significant beneficial effect.	Area decreases 249 square miles. Beneficial effect.
Groundwater Salinity	Increase of 3 percent. No significant effect.	Increase of 3 percent. No effect.
Drinking Water Supplies	No significant effect to drinking water sources. Reduction in drainwater would slow contamination of drinking water sources. Beneficial effect.	Minimal effect to drinking water sources. Reduction in drainwater would slow contamination of drinking water sources. Beneficial effect.

Table 6-5
Summary Comparison of Effects of In-Valley/Water Needs Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Water Needs Land Retirement Alternative Compared to No Action	In-Valley/Water Needs Land Retirement Alternative Compared to Existing Conditions
Bare-Soil Evaporation	Rate decreases 0.23 foot/year. Significant beneficial effect.	Rate decreases 0.07 foot/year. Beneficial effect.
Undrained Area Affected by Shallow-Water Table	Area decreases 214 square miles. Significant beneficial effect.	Area decreases 258 square miles. Beneficial effect.
Groundwater Salinity	Increase of 3 percent. No significant effect.	Increase of 3 percent. No effect.
Drinking Water Supplies	No significant effect to drinking water sources. Reduction in drainwater would slow contamination of drinking water sources. Beneficial effect.	Minimal effect to drinking water sources. Reduction in drainwater would slow contamination of drinking water sources. Beneficial effect.

Table 6-6
Summary Comparison of Effects of
In-Valley/Drainage-Impaired Area Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Drainage-Impaired Area Land Retirement Alternative Compared to No Action	In-Valley/Drainage-Impaired Area Land Retirement Alternative Compared to Existing Conditions
Bare-Soil Evaporation	Rate decreases 0.23 foot/year. Significant beneficial effect.	Rate decreases 0.07 foot/year. Beneficial effect.
Undrained Area Affected by Shallow-Water Table	Area decreases 226 square miles. Significant beneficial effect.	Area decreases 270 square miles. Beneficial effect.
Groundwater Salinity	Increase of 3 percent. No significant effect.	Increase of 3 percent. No effect.
Drinking Water Supplies	No significant effect to drinking water sources. Large reduction in drainwater would slow contamination of drinking water sources. Significant beneficial effect.	Minimal effect to drinking water sources. Large reduction in drainwater would slow contamination of drinking water sources. Major beneficial effect.

Table 6-7
Summary Comparison of Effects of Ocean Disposal Alternative

Affected Resource and Area of Potential Effect	Ocean Disposal Compared to No Action	Ocean Disposal Compared to Existing Conditions
Bare-Soil Evaporation	Rate decreases 0.24 foot/year. Significant beneficial effect.	Rate decreases 0.08 foot/year. Beneficial effect.
Undrained Area Affected by Shallow-Water Table	Area decreases 161 square miles. Significant beneficial effect.	Area decreases 215 square miles. Beneficial effect.
Groundwater Salinity	Slight increase. No significant effect.	Slight increase. No effect.
Drinking Water Supplies	No significant effects to drinking water sources. Reducing drainwater recharge would slow the transport of contaminated groundwater toward drinking wells. Beneficial effect.	No significant effects to drinking water sources. Reducing drainwater recharge would slow the transport of contaminated groundwater toward drinking wells. Beneficial effect.

Table 6-8
Summary Comparison of Effects of Delta-Chipps Island Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Chipps Island Disposal Compared to No Action	Delta-Chipps Island Disposal Compared to Existing Conditions
Bare-Soil Evaporation	Rate decreases 0.24 foot/year. Significant beneficial effect.	Rate decreases 0.08 foot/year. Beneficial effect.
Undrained Area Affected by Shallow-Water Table	Area decreases 161 square miles. Significant beneficial effect.	Area decreases 215 square miles. Beneficial effect.
Groundwater Salinity	Slight increase. No significant effect.	Slight increase. No effect.
Drinking Water Supplies	No significant effects to drinking water sources. Reducing drainwater recharge would slow the transport of contaminated groundwater toward drinking wells. Beneficial effect.	No significant effects to drinking water sources. Reducing drainwater recharge would slow the transport of contaminated groundwater toward drinking wells. Beneficial effect.

Table 6-9
Summary Comparison of Effects of Delta-Carquinez Strait Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Carquinez Strait Disposal Compared to No Action	Delta-Carquinez Strait Disposal Compared to Existing Conditions
Bare-Soil Evaporation	Rate decreases 0.24 foot/year. Significant beneficial effect.	Rate decreases 0.08 foot/year. Beneficial effect.
Undrained Area Affected by Shallow-Water Table	Area decreases 161 square miles. Significant beneficial effect.	Area decreases 215 square miles. Beneficial effect.
Groundwater Salinity	Slight increase. No significant effect.	Slight increase. No effect.
Drinking Water Supplies	No significant effects to drinking water sources. Reducing drainwater recharge would slow the transport of contaminated groundwater toward drinking wells. Beneficial effect.	No significant effects to drinking water sources. Reducing drainwater recharge would slow the transport of contaminated groundwater toward drinking wells. Beneficial effect.

6.2.13 Mitigation Recommendations

When appropriate, the following mitigation measures could be put in place to ensure project features do not degrade groundwater supplies.

- Evaporation basins should be constructed in such a way that seepage through the liner or joints is minimized, which will help to ensure that the poor quality water in the basins does not leach into the groundwater system. Monitoring wells are part of facility design.
- The disposal pipeline should be constructed from materials that minimize seepage from the line. Joints on the pipeline should be constructed to be as leak resistant as possible.
- Valves to stop pipeline flow should be placed at all major water crossings and in key groundwater recharge areas.
- Inspection and testing should be completed to assure the pipeline's structural integrity.
- Monitoring for leaks at major system facilities should be completed on a routine basis for the project life.
- Appropriate measures must be taken to ensure pipeline corrosion is mitigated.
- Flow monitoring should be completed at both the beginning and near the outlet of the transport pipes to ensure significant leaks are not occurring in the pipe.

SECTIONSEVEN

BIOLOGICAL RESOURCES

This Section provides an overview of the biological communities and special-status species that occur in the study area, and identifies potential biological effects associated with each alternative. General habitat types (vegetation communities) that could be affected by proposed facilities and activities, and characteristic plants and animals that could occur in each habitat type are briefly described. Also described are special-status vertebrate, invertebrate, and plant species that could be affected by implementation of the action alternatives. Both direct and indirect effects are addressed, as well as cumulative effects.

The assessment of biological effects is based on best available information. Intensive biological field surveys have not yet been completed. Detailed facility designs, site selections, operating plans, and construction schedules are still being developed or refined. In most cases, approximate locations of major project features and associated biological data are mapped at a scale of 1:24000. Associated habitat types are coarsely mapped at 1:100000. As detailed designs are formalized, focused on-site field surveys will be completed where appropriate to accurately inventory and map sensitive habitats and species occurrences.

7.1 AFFECTED ENVIRONMENT

The major terrestrial and aquatic habitat types that may be affected by project construction or operation are listed below. Habitat types generally follow the Mayer and Laudenslayer (1988) classification system described and mapped in the *California Wildlife Habitat Relationship System Database* (CDFG 1999) and the *California Gap Analysis Project* (CDFG 1998). Several uncommon habitat types (e.g., sensitive native plant communities) described in the *California Natural Diversity Database* (CNDDB; CDFG 2003) are also identified. Special-status species that may be affected by project construction and/or operation are described in Section 7.1.3 below.

7.1.1 Terrestrial Resources

- **Agricultural Lands (CRP, OVN).** Agricultural land includes active, temporarily fallowed, and retired croplands (CRP), and orchards/vineyards (OVN). Agricultural lands are the dominant vegetation cover type in the San Joaquin Valley and also are found along all pipeline routes. CRP in the San Joaquin Valley is generally concentrated along the central, flatter portion of the valley, with OVN extending into the western foothills. The mix of crops varies from year to year depending on economic factors and predicted water supplies. Cotton and row vegetables typically have been the dominant crops. In 2002, the crop mix included cotton (34 percent), row crops (30 percent), fallow (13 percent), orchard/vineyard (11 percent), small grains (10 percent), alfalfa (2 percent), and pasture (<1 percent). Harvesting practices, crop selections, the proximity and amount of nearby undisturbed vegetation, and the types of food and foraging cover provided by the crops all affect the value of agricultural land as wildlife habitat. Some row and grain crops provide foraging habitat for hawks and migrating and wintering waterfowl.

  Retired land, for project purposes, refers to formerly irrigated and temporarily fallowed agricultural land that has been converted to nonirrigated uses because irrigation water is no longer available or permitted. Newly retired lands may be dryland farmed (e.g., winter wheat, barley), grazed (typically sheep), or left fallow.

- **Alkali Desert Scrub (ASC),** also **San Joaquin Saltbush** or **Chenopod Scrub.** Relict stands of this shrub-dominated habitat type are widely scattered throughout the San Joaquin Valley, but are more commonly found in Tulare Basin, south of the project area. ASC occurs in areas characterized by impeded drainage with fine-textured, alkaline, or saline soils. Vegetation is generally dominated by salt-tolerant shrub and subshrub species such as perennial saltbush, iodine bush, alkali blite, and goldenbush, but also could include forbs and grasses such as alkali heath, alkali weed, pickleweed, alkali sacaton, and saltgrass. Wildlife species associated with ASC are specifically adapted to its open, sparsely vegetated, dry conditions and include several special-status species.

- **Annual and Perennial Grasslands (AGS, PGS).** These habitat types occur throughout the San Joaquin Valley and along the proposed pipeline routes, mostly on level plains to gently rolling foothills at elevations immediately higher than or surrounding areas of VRI and ASC habitat types. AGS is comprised primarily of introduced annual grasses and forbs such as wild oats, ripgut brome, soft chess, and barley. Habitat value is variable, depending largely on current management and grazing history. The PGS habitat type is typically associated with moist, lightly grazed relict areas within AGS-dominated landscapes and is quite rare. Characteristic native PGS species include purple needlegrass and alkali sacaton.

  Grassland habitats are important foraging areas for a large number of species, including hawks and swallows, mourning doves, loggerhead shrike, coyotes, and badgers. The habitat type supports large populations of small prey species, such as deer mice, pocket gophers, voles, and ground squirrels. Birds such as killdeer, ring-necked pheasant, western meadowlark, western kingbird, and horned lark nest in grassland habitats. Common reptiles and amphibians of grassland habitats include western fence lizard, common kingsnake, western rattlesnake, common garter snake, and western toad. An extensive list of terrestrial special-status species are also associated with the grassland habitat types.

Vernal pool communities, shallow depressions filled with water from winter storms that subsequently dry up during spring or early summer, are a rare and protected form of wetland found only within grassland habitats. See Section 7.1.2.

- **Chamise-Redshank Chaparral (CRC).** Within the study area, CRC occurs in very limited areas along the Ocean Disposal Alternative pipeline route. Mature CRC is generally single-layered with little or no herbaceous understory. Shrub canopies frequently overlap and often form a nearly impenetrable thicket. Depending on climatic and geographic conditions, this habitat type may consist of nearly pure stands of chamise or redshank, a mixture of both, or occur with other shrubs. The purest stands of chamise occur on xeric, south-facing slopes. On more moist sites, toyon, sugar sumac, poison oak, spiny redberry, and California buckthorn are common associates with chamise. Common redshank associates are sugar bush, laurelleaf sumac, and ceanothus.
- **Coastal Oak Woodland (COW).** This forest habitat type is extremely variable, ranging from dense, closed-canopy woodlands in mesic sites to savannah-like in drier sites. The overstory consists of deciduous and evergreen hardwoods (mostly oaks up to 70 feet tall) sometimes mixed with scattered conifers. A shrub understory commonly is scattered among the trees, but may also form nearly impenetrable thickets. In the closed canopy sites the understory may range from lush shade-tolerant shrubs, ferns, and herbs to sparse cover with a thick carpet of litter. In open woodland sites, the understory is more typically grassland, sometimes with scattered shrubs.
- **Coastal Scrub (CSC).** Within the study area, the CSC habitat type occurs within 50 miles of the ocean at elevations ranging from sea level to 3,000 feet. CSC intergrades with coastal dune and coastal AGS habitat types at lower elevations and with COW, CRC, and AGS at higher elevation inland sites. Low to moderate-sized shrubs up to 7 feet in height with an herbaceous understory typify the CSC habitat type. Canopy cover usually approaches 100 percent, although bare areas are sometimes present. Dominant vegetation includes California sagebrush, black sage, and California buckwheat. Common wildlife species occurring in CSC include western fence lizard, California quail, Heerman's kangaroo rat, grey fox, coyote, and mule deer.
- **Montane Riparian (MRI).** Within the study area, the MRI habitat type occurs only at higher elevations in mountainous terrain associated with the Ocean Disposal Alternative pipeline route. Because it typically is found along high gradient mountain streams with narrow floodplains, MRI vegetation generally is confined to narrow bands along the water's edge and to low terraces and gravel bars within the channel. Vegetation is variable and often structurally diverse, frequently occurring as a dense, continuous, multilayered grove of broadleaved, deciduous trees with a dense shrub layer of willows, alders, buttonbush, mulefat, and poison oak. Along small streams and seeps, the overstory can be comprised entirely of shrub species. All riparian habitats have an exceptionally high wildlife value. Typical wildlife species that frequent the streamside vegetation include riparian obligate migratory birds (Wilson's warbler, yellow warbler, and many more), bats, shrews, California red-legged frog, western grey squirrel, and deer. Also see VRI below.
- **Ruderal Vegetation.** This common habitat type is always associated with disturbed lands. It can occur as large areas (e.g., abandoned croplands) or as small inclusions within other terrestrial communities. In the study area, it is most typically associated with road and utility

rights-of-way (ROWs), field borders, ditch ROWs, and abandoned fields. Vegetation usually consists of scattered native and nonnative shrubs, generally with nonnative herbaceous species dominating the understory. Habitat value is typically low for most terrestrial wildlife species, although the interconnecting matrix of ruderal vegetation associated with farm roads, field margins, irrigation ditches, and fencelines in the San Joaquin Valley provides wildlife movement corridors in the otherwise agriculture-dominated landscape. (Note: While this habitat type is described here, it does not occur as mappable units in the digital vegetation map used in the analysis of effects.)

- **Urban (URB).** The URB habitat type consists of developed residential, commercial, and industrial areas, typically with permanent structures. In the study area, mappable areas of URB range from individual farmsteads to residential subdivisions to cities and towns. Five types of vegetative structure characterize the URB habitat type: *Tree Grove*, *Street Strip*, *Shade Tree/Lawn*, *Lawn*, and *Shrub*. Species composition varies with planting design and climate but always includes a mixture of native and exotic plant species. Within the URB habitat type, both natives and exotics are valuable, with exotic species providing a source of additional wildlife foods such as fruits and berries.
- **Valley Foothill Riparian (VRI).** This habitat type is found in valleys and bottomlands bordered by sloping alluvial fans, slightly dissected terraces, lower foothills, and coastal plains. It is generally associated with low velocity rivers and streams (RIV), floodplains, and gentle topography. In the study area, major VRI habitats are associated with the San Joaquin and Salinas rivers and major tributary streams both inside and outside of the San Joaquin Valley. Dominant tree species include Freemont cottonwood, California sycamore, valley oak, white alder, boxelder, and Oregon ash. Common shrubs include wild grape, wild rose, California blackberry, blue elderberry, poison oak, buttonbrush, and willows. The herbaceous layer may include sedges, rushes, grasses, miner’s lettuce, Douglas sagewort, poison hemlock, and hoary nettle. All VRI habitats have exceptionally high wildlife value. A large number of riparian obligate migratory birds forage and nest in the VRI habitat type, as well as a long list of common and frequently observed birds, reptiles, amphibians, and mammals and numerous special-status species.
- **Valley Oak Woodland (VOW).** The VOW habitat type occurs along the lower flanks of Coast Range valleys from sea level to 2,540 feet in elevation, and subsequently occurs along the Ocean Disposal Alternative aqueduct route. VOW is comprised mostly of deciduous, broad-leaved species such as valley oak, western sycamore, interior live oak, box elder, and black walnut and varies from savanna-like to forest-like, with partially closed canopies. Valley oaks ranging in height from 50 to 115 feet typically dominate the canopies; however, digger pine and coast live oak are associated with VOW along the Coast Range. Valley oak stands with little or no grazing tend to develop a partial shrub layer of bird-disseminated species, such as poison oak, toyon, and coffeeberry. The shrub layer is best developed along natural drainages, becoming insignificant in the uplands with more open stands of oaks. Ground cover generally consists of a well-developed carpet of nonnative annual grasses and forbs such as ripgut grass, wild oats, rye grasses, Italian ryegrass, filarees, brome grasses, wild oats, fiddlenecks, needlegrasses, and melic grasses. VOW is considered a sensitive natural community.

7.1.2 Aquatic and Wetland Resources

The major aquatic and wetland habitat types that are found in the study area and may be affected by project construction and/or operation include:

- **Estuarine (EST).** In the study area, estuarine habitat refers to the Bay-Delta. EST occurs in semienclosed coastal waters where tidal seawater is diluted by inflowing freshwater. EST includes the open-water portion of the estuary as well as periodically and permanently flooded shallows. The mixture of ocean- and freshwater forms a salinity gradient that varies spatially and temporally. The salinity gradient determines the distribution of species in the estuarine system. Salinity levels within the Bay-Delta estuary are controlled by the tides, freshwater inflows, and Delta pumping. The Bay-Delta estuary supports a number of important resident freshwater fish and invertebrate species and is also used as a migration corridor and rearing area for several species of special-status anadromous fish.
- **Marine (MAR).** For this project, MAR habitat refers to the Pacific Ocean and adjacent beaches and coastal dunes. A diverse assemblage of species rely on marine habitats, including whales, sea turtles, sea otters, fish, pelagic birds, and invertebrates.
- **Riverine (RIV).** Riverine habitats consist of perennial or intermittently flowing rivers and streams. The Salinas River and the San Joaquin River with its major tributaries and sloughs are the major RIV habitats in the study area. In addition, numerous small and intermittent streams occur along proposed pipeline corridors. RIV habitats commonly are associated with adjacent riparian and wetland habitat types (VRI, MRI, FEW) and are valuable to wildlife as well as aquatic species for cover, foraging, and travel corridors.
- **Saline Emergent Wetland (SEW).** Saline emergent wetlands are common along the margins of bays, lagoons, and estuaries in areas of regular tidal inundation. Vegetation cover is composed mostly of perennial grasslike plants and forbs and is generally complete except where creeks or ponds exist. Component plants typically are present in zones or patches relating to elevational gradients. Species found in lower, more saline, sites include cordgrasses, pickleweed, and California sea blight. Typical species of more brackish, higher elevation sites include bird’s beak, saltmarsh dodder, bulrushes, and slender cattail. SEW provides habitat for a variety of bird, mammal, reptile, and amphibian species. Common birds include saltmarsh yellowthroat, song sparrow, Virginia rail, and a variety of migrating or breeding shorebirds, herons, egrets, and waterfowl. Raccoon, opossum, skunk, and coyote forage along the edges. *Northern Coastal Salt Marsh* is a rare type of SEW potentially found in the study area. It is distributed along much of the California coast and the western Delta region.
- **Freshwater Emergent Wetland (FEW).** Freshwater emergent wetlands are among the most productive wildlife habitats in California, providing food, cover, and water for over 160 species of birds, and numerous species of mammals, reptiles, and amphibians (Mayer and Laudenslayer 1988). Common plant species found in FEW habitats include big leaf sedge, baltic rush, and redroot nutgrass around the upper margins; saltgrass in more alkali sites; and common cattail, bulrushes, and arrowhead in the wetter sites. *Coastal Brackish Marsh* is a rare type of FEW community that typically occurs in the interior of coastal bays and estuaries where freshwater and saltwater intermix and salinities change with the tides. This rare community is well developed at Suisun Bay at the mouth of the Delta and occurs in the

general vicinity of the Delta Disposal Alternatives' pipelines near Chipp's Island and Carquinez Strait.

- **Vernal Pools.** Vernal pools are a rare and protected form of seasonal FEW found only within grassland habitats. The pools are shallow depressions filled with water from winter storms that subsequently dry up during spring or early summer. A unique assemblage of special-status plant and invertebrate species is associated with the ephemeral pools, with the salinity, alkalinity, and the length of time that water persists generally determining plant species composition. Within the general study area, vernal pool occurrences are concentrated east of the San Joaquin River, but may also be encountered along the Ocean and Bay-Delta Disposal Alternatives aqueduct routes.
- **Canals and Drains.** Unlined canals and drains provide marginal wetland and aquatic habitat throughout large areas of the study area. The quality of this habitat varies depending on the degree and frequency of maintenance, water quality, habitat type of adjacent lands, consistency of flows, and other factors. Some reaches of delivery canals and drains contain emergent and aquatic plants such as bulrushes, cattails, and pondweeds, as well as undesirable invasives such as perennial pepperweed. Larger canals and drains may support warmwater fisheries. Common fish species potentially present in canal fisheries include largemouth and striped bass, threadfin shad, Sacramento blackfish, bluegill, white catfish, black bullhead, black crappie, green sunfish, carp, goldfish, and mosquitofish.
- **Evaporation Basins.** In the San Joaquin Valley, evaporation basins refer to intensively managed, highly saline, shallow, manmade ponds ranging from 25 to nearly 2,000 acres in size. Only seven active pond operations, totaling about 4,700 acres, currently are permitted by the State to operate in the valley, with the majority located in Tulare Basin. Harsh conditions within the ponds limit biological diversity, but production of some aquatic food-chain organisms, such as widgeongrass, water boatmen, midges, brine flies, and brine shrimp is often quite high and primary production may be substantially higher than in most natural aquatic systems. This abundant and available food resource attracts waterfowl and other birds, exposing them to contaminants (specifically selenium [Se]) that are bioaccumulated in the food chain.

7.1.3 Special-Status Species

Early in the planning process, the Service provided lists of special-status species that may occur in areas potentially affected by the action alternatives. A list of special-status marine mammals and anadromous fish potentially affected by the action alternatives was obtained from NOAA Fisheries (formerly the National Marine Fisheries Service). A list of State-listed special-status species was obtained from CDFG websites and other relevant documents.

The Service's initial list, dated December 4, 2001, was based on a project study area that included the San Luis Unit service area (Westlands and the Northerly Area) and a narrow corridor leading to the Delta. The initial list later was expanded to include additional potential pipeline routes for the Ocean and Delta Disposal Alternatives. The expanded list of species, dated June 3, 2002, later was shortened (with Service concurrence) when several of the potential pipeline route variations were eliminated from further consideration. Subsequent refinements to the siting and alignment of proposed features further reduced the area potentially affected by the various action alternatives, resulting in the Service's current species list dated June 3, 2003.

When the Federal and State agency lists were combined, a total of 85 animals, fish, invertebrates, and plants were identified as having the potential to be affected by the action alternatives. Only those species listed as *Threatened* or *Endangered* under the Federal Endangered Species Act (ESA) and California Endangered Species Act (CESA), and species classified as *Proposed for Listing* or *Candidate for Listing* under the above laws were evaluated. The combined list of species is presented in Appendix F, Table F-1.

An extensive list of additional species, including Federal *Species of Concern*, State-listed *Species of Special Concern*, California Natural Heritage Program *List 1B* and *List 2* plants, and a number of species afforded protection under other California conservation laws and regulations are not individually identified or addressed in this Section but are identified in Appendix F, Table F-2. Potential project effects to these additional species will be evaluated when preconstruction biological surveys are performed for the identified proposed action. At that time, implementation of possible conservation measures for the additional species will be considered, if occurrences or suitable habitats are verified.

Following an initial assessment of the 85 listed species, Reclamation biologists concluded that areas of potential occurrence for many of the species fell outside the “footprint” of possible construction or operational effects of the action alternatives. Based on an extensive literature review of the known ranges and habitat requirements of each species, consultations with species experts, and an evaluation of recent occurrence records (CDFG 2003), it was subsequently determined that all but 28 of the remaining identified species could be eliminated from further evaluation because (1) suitable habitat is no longer thought to be present and (2) the absence of recent occurrence records in the areas being evaluated was highly indicative that the species no longer is present.

The 28 species likely to be present, or that may occasionally utilize available suitable habitat, in areas that would be affected by construction or operation of the action alternatives are presented in Table 7-1.

Table 7-1
Federally and State-Listed Species That May Occur in Areas Potentially Affected by Action Alternatives

Listed species	Federal Status	State Status	Biology	Primary Habitat
American peregrine falcon *(Falco peregrinus anatum)*	--	E/CFP[1]	Rare breeder and uncommon winter visitor. Nests and roosts on protected ledges of high cliffs, also high towers, tall bridges, and buildings. Nest/roost locations typically are associated with rivers, lakes, or marshes that support large populations of avian prey. Has been observed foraging at evaporation basins in Tulare Basin, but no nesting records in the study area.	CRP, AGS, RIV, FEW, SEW, VRI, VOW
Bald eagle *(Haliaeetus leucocephalus)*	T	E/CFP	Along coastal areas, large permanent waterbodies, and free-flowing rivers; preys on fish, waterbirds, and small mammals, but also scavenges opportunistically. Requires large, mature trees or snags near water for nest sites or hunting/day perches. Roosts communally in winter in dense, sheltered, remote conifer stands in proximity to feeding sites.	COW, VRI
California black rail *Laterallus jamaicensis coturniculus)*	--	T/CFP	Coastal and interior salt, brackish, and freshwater marshes dominated by pickleweed or bulrushes, but usually tidal sloughs with tall emergent vegetation along channels.	SEW, FEW
California clapper rail *(Rallus longirostris obsoletus)*	E	E/CFP	Tidal salt and brackish marshes and sloughs with abundant small channels and dense vegetation	SEW
California least tern *(Sterna antillarum browni)*	E	E/CFP	Generally breeds along coast in large nesting colonies, dive to capture fish and macroinvertebrates	CSC
California red-legged frog *(Rana aurora draytonii)*	T	CSC	Deep still or slow-moving permanent and semipermanent freshwater to fresh-brackish aquatic habitats with dense emergent and submergent vegetation and riparian species along the edges; may estivate in rodent burrows or cracks in nearby upland grasslands or shrublands. CRITICAL HABITAT proposed April 13, 2004.	AGS, VRI
California tiger salamander *(Ambystoma californiense)*	T[2]	CSC	Larvae require predator-free small ponds, stock ponds, vernal pools in grasslands and oak woodlands; rodent burrows, crevices, cracks in dried soil are used for cover and summer dormancy. CRITICAL HABITAT proposed August 10, 2004.	AGS, VOW

Table 7-1 (continued)
Federally and State-Listed Species That May Occur in Areas Potentially Affected by Action Alternatives

Listed species	Federal Status	State Status	Biology	Primary Habitat
Chinook salmon (Central Valley Spring-run *(Oncorhynchus tshawytscha)*	T	T	Anadromous. Spawns in deeper water than most salmon, preferring main river channels above the saltwater limit. Designated CRITICAL HABITAT currently vacated[3].	RIV, EST
Chinook salmon (Central Valley Fall/Late Fall-run) *(Oncorhynchus tshawytscha)*	FC	CSC	Anadromous. Spawns in Sacramento River tributaries, migrating through the Bay-Delta estuary.	RIV, EST
Chinook salmon (Sacramento Winter-run) *(Oncorhynchus tshawytscha)*	E	E	Anadromous. Spawns only in the Sacramento River, migrating through the Bay-Delta estuary. Includes designated CRITICAL HABITAT.	RIV, EST
Conservancy fairy shrimp *(Branchinecta conservation)*	E	--	Large, deep, turbid clay-bottomed vernal pools in annual grasslands. Includes designated CRITICAL HABITAT.	AGS
Delta smelt *(Hypomesus transpacificus)*	T	T	Breeds and migrates in the Bay-Delta estuary and lower San Joaquin River in areas with dense aquatic vegetation. Includes designated CRITICAL HABITAT.	RIV
Giant kangaroo rat *(Dipydomys ingens)*	E	E	Requires flat, uncultivated, sparsely vegetated areas with soils consisting of dry, sandy loams for burrowing.	AGS, ASC
Giant garter snake *(Thamnophis gigas)*	T	T	Sloughs, unmaintained earth-lined canals, and other small vegetated waterways with adequate small fish and amphibian prey; requires grassy banks and emergent vegetation for basking and areas of high ground protected from flooding to overwinter.	FEW, VRI
Greater sandhill crane *(Grus canadensis tabida)*	--	T/CFP	Migrant and winter resident in the San Joaquin Valley; forages in large flocks in grasslands, recently plowed or harvested croplands, and wetlands for waste grains, invertebrates, insects, and other small prey. Avoids saline waters.	AGS,CRP, FEW
Green sturgeon *(Acipenser medirostris)*	FC	CSC	Breeds and migrates through the Bay-Delta estuary. Anadromous, spending most time in brackish and saltwater. Spawns in dead-end sloughs, channel edges, inshore areas over sandy, rocky, or vegetated substrates.	EST

Table 7-1 (continued)
Federally and State-Listed Species That May Occur in Areas Potentially Affected by Action Alternatives

Listed species	Federal Status	State Status	Biology	Primary Habitat
Longhorn fairy shrimp *(Branchinecta longiantenna)*	E	--	Small, clear pools in sandstone rock outcrops or clear to moderately turbid clay- or grass-bottomed pools. Includes designated CRITICAL HABITAT.	AGS
Salt marsh harvest mouse *(Reithrodontomys raviventris)*	E	E/CFP	Mid- to higher-elevation salt and brackish tidal marshes with dense perennial pickleweed and associated low-growing salt-tolerant shrubs and herbaceous vegetation; most frequent in dense, continuous vegetation cover with infrequent, brief flooding.	SEW
San Joaquin kit fox *(Vulpes macrotis mutica)*	E	T	Alkali desert scrub, annual grasslands, open savannah, and borders of agricultural areas; may forage in adjacent agricultural habitat.	AGS, ASC, CRP, VOW
San Joaquin woolly threads *(Monolopia congdonii)*	E	--	Annual herb occurring in nonnative grassland and saltbush scrub vegetation types. Blooms Feb-May.	AGS, DSC
Steelhead (Central Valley ESU) *(Oncorhynchus mykiss iredeus)*	T	--	Occurs in the Sacramento Basin, San Joaquin River up to the Merced, and the Bay-Delta estuary, spawning in cool flowing streams with cobble substrates. Designated CRITICAL HABITAT currently vacated[3].	RIV, EST
Steelhead (South Central California ESU) *(Oncorhynchus mykiss iredeus)*	T	CSC	Spawns in fall/winter in coolwater coastal streams with gravel or cobble bottoms. Designated CRITICAL HABITAT currently vacated[3].	Coastal RIV
Swainson's hawk *(Buteo swainsoni)*	--	T	Nests in open woodlands, small groves, or isolated trees, typically selecting mature valley oaks or cottonwoods in or near riparian habitat and adjacent (within 10 miles) to suitable foraging areas; forages for small rodents, ground squirrels, rabbits, reptiles, and amphibians in large, open grasslands, irrigated pastures, and hay/grain fields. Breeds late March to late August, with peak activity late May through July. Winters in South America.	AGS, CRP, VRI
Tidewater goby *(Eucyclogobius newberryi)*	E	CSC	Generally limited to the southern and central coast. Occurs in the lower reaches of small freshwater coastal streams, including shallow brackish estuaries and lagoons. Can range up to 1,2 miles upstream from the mouth.	Coastal RIV, SEW

Table 7-1 (concluded)
Federally and State-Listed Species That May Occur in Areas Potentially Affected by Action Alternatives

Listed species	Federal Status	State Status	Biology	Primary Habitat
Vernal pool fairy shrimp *(Branchinecta lynchi)*	T	--	Vernal pools or sandstone rock outcrop pools. Includes designated CRITICAL HABITAT.	AGS
Vernal pool tadpole shrimp (*Lepidurus packardi)*	E	--	Vernal pools and ephemeral stock ponds. Includes designated CRITICAL HABITAT.	AGS
Western burrowing owl *(Athene cunicularia hypugaea)*	--	CSC[4]	Nests and roosts in level, open, dry, heavily grazed or low grassland or shrubland vegetation where existing burrow sites are available.	AGS, CRP
Western yellow-billed cuckoo *(Coccyzus americanus occidentalis*)	FC	E	Nests and forages in dense cottonwood-willow riparian forest. Uncommon migrant not known to nest in the study area. Riparian obligate.	VRI

Notes:

[1]CFP—California fully protected species.

[2]Central California Distinct Population Segment listed as Threatened August 4, 2004.

[3]Designated CRITICAL HABITAT vacated by court decree April 30, 2002.

[4]Petitioned for listing as State-threatened or -endangered in April 8, 2003; petition rejected February 5, 2004. Species remains protected under California Fish and Game Code §3503.5—Protection of Raptors.

E – Endangered; T – Threatened; PT - Proposed Threatened; CSC – California Species of Special Concern; FC - Candidate (Federal); "—" - Not Listed; AGS – Annual Grassland; COW – Coastal Oak Woodland; CRP – Croplands; CSC – Coastal Scrub; ASC – Desert Scrub; FEW – Freshwater Emergent Wetland; MAR – Marine; RIV – Riverine; SEW – Saltwater Emergent Wetland; VRI – Valley Foothill Riparian; ESU – Evolutionarily Significant Unit

7.2 ENVIRONMENTAL CONSEQUENCES

Each alternative was evaluated at an appraisal level of detail to identify potential short-term and permanent biological effects that could result from project construction and operation. This appraisal-level analysis focused on general habitat types and vegetation communities, although for individual *special-status species*, potential species-level effects were identified and qualitatively evaluated. Using this broad scale of analysis, it was assumed that if a project feature or activity affected a mappable area of a given general habitat type or vegetation community, the wildlife that commonly is found in that habitat could also be affected.

For most proposed facilities or project-related activities, this appraisal-level analysis presents a "worst-case" scenario of potential effects. In reality, not all mapped vegetation units contain uniformly occupied or suitable habitats. As a result, potential effects frequently will be avoided by utilizing previously disturbed inclusions or unoccupied areas within the mapped units or by scheduling activities to coincide with periods when direct effects can be minimized.

No intensive biological or botanical field surveys were performed to locate or quantify site-specific occurrences of species, populations, or occupied habitats. Species-focused surveys will be completed for the preferred alternative when facility designs and site selections are finalized.

Toxicological effects of Se bioaccumulation on biological resources are analyzed in detail separately in Section 8.

7.2.1 Evaluation Criteria

The following evaluation criteria were used to determine the significance of effects to terrestrial biological resources, aquatic and wetland resources, and special-status species.

7.2.1.1 Terrestrial Resources

Project effects to terrestrial biological resources are considered significant if they result in:

- Substantial loss, degradation, or contamination of natural communities that provide habitat for terrestrial wildlife species or are recognized for scientific, recreational, ecological, or commercial importance (e.g., riparian areas, native grasslands, oak woodlands)
- Substantial adverse effects on natural communities or habitats that are specifically recognized as biologically significant in local, State, or Federal policies, statutes, or regulations
- Substantial interference or disruption to natural wildlife movement corridors used by resident or migratory wildlife
- Fragmentation or isolation of important terrestrial wildlife habitats
- Direct mortality, significant reduction in local population size, or lowered reproductive success of individual terrestrial species such that abundance is substantially affected

7.2.1.2 Aquatic and Wetland Resources

The following evaluation criteria for determining significant effects to aquatic resources, including wetland and marine resources, are based on accepted standards and guidelines for protecting aquatic and wetland-dependent species and their habitats. Adverse effects to aquatic or wetland resources are considered significant if project construction or operation results in:

- Filling, draining, or other loss or degradation of existing freshwater or saline wetlands.
- Changes in wetland habitat resulting in adverse effects to nesting migratory birds.
- Substantial adverse effects to aquatic or wetland-dependent species, natural communities, or habitats that are specifically recognized as biologically significant in local, State, or Federal policies, statutes, or regulations.
- Interference with the migratory movements of native fish species.
- Alteration of historic stream channel characteristics or hydrology that would result in substantial erosion, siltation, downstream flooding, or degradation of aquatic habitats.

7.2.1.3 Special-Status Species

Significant effects to Federally or State-listed special-status species would occur if project construction or operation results in the any of the following:

- Reduction of a listed species' numbers because of direct or indirect mortality or because of project-related stresses that lead to alterations of behavior, reproductive success, or survival. Any take of a listed species is considered a significant effect.
- Temporary or permanent loss, disturbance, or fragmentation of species' habitat, including movement, migration, and dispersal routes that could result in increased mortality or lowered reproductive success.
- Permanent loss or significant degradation of any designated critical habitat, protected breeding area, or sensitive coastal, pelagic, or benthic habitat.
- Direct or indirect effects on a population of candidate or sensitive species, or its habitat, that would contribute to or result in Federal or State listing of the species.

7.2.2 Assessment Methods (Modeling, Evaluation Methods, and Assumptions)

For the purpose of this NEPA analysis, agricultural crop information from 2002 was considered representative of existing conditions for facility sites and retired lands.

7.2.2.1 Terrestrial Resources

Relevant information about potentially affected terrestrial habitat types (vegetation communities) and associated wildlife species was developed from reviews of biological databases and literature, including an extensive collection of earlier project-related documents and reports. The terrestrial habitat types described in this report are based on the classification system described in *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988) and digitally mapped in the *California Gap Analysis Project* (CDFG 1998). The Gap Analysis digitally mapped all commonly occurring habitat types at a scale of 1:100,000 with minimum mapping units (polygons) of approximately 250 acres. Occurrences of several uncommon plant communities, as described by Holland (1986), were digitally mapped at 1:24000 scale based on locations provided in the CNDDB (CDFG 2003).

Biological effects to each mapped terrestrial habitat type were evaluated using Geographic Information System (GIS) analysis. Each alternative's major facilities were digitally mapped at 1:24000 scale on U.S. Geological Survey (USGS) digital topographic base maps and then related to the 1:100,000 scale habitat type coverage. Major nonlinear project facilities (reuse facilities, evaporation basins, treatment facilities) were represented by map polygons that were sized, shaped, and sited using a variety of appraisal-level criteria. Linear project features (conveyance pipelines and canals) assumed a 75-foot temporary construction corridor for all pipelines and a 100-foot construction corridor for canals. Once constructed, permanent ROW widths for the linear features were assumed to be 30 feet and 100 feet, respectively. Using this method and scale, potential effects were assessed at the habitat type level.

This appraisal-level approach assumes that actions that affect identifiable areas of habitat would also have the potential to affect species that would occur in that habitat type; that is, if an area that can be characterized as a specific habitat type is adversely affected, its associated plants and animals would also be affected. Using this method, a coarse quantitative estimate of the amount of each habitat type affected by construction and operation of project features was determined.

7.2.2.2 Aquatic and Wetland Resources

Riverine and wetland habitat types that could be affected by project construction and operation include rivers, intermittent and perennial streams, wetlands (freshwater and saline) , vernal pools, and existing agricultural canals and drains. Marine and estuarine habitat types could also be affected, but are unique to the Ocean and Delta Disposal Alternatives, respectively.

For all alternatives, the same type of GIS analysis described in Section 7.2.2.1 was also used to evaluate potential project effects to aquatic and wetland habitat types. Affected hydrologic features were identified from 1:24000-scale topographic base maps and, in some areas, similarly scaled recent aerial photography. A reconnaissance-level field verification of proposed facility locations and alignments for each alternative was also completed.

For all stream crossings (most being small and intermittent streams), an average disturbance area of 0.1 acre was assumed. For wetland areas of mappable size, the distances traversed by the linear feature were approximated using GIS measurements.

Water quality models for the Delta and Ocean Disposal Alternative discharges were developed to quantify the mixing and dilution that would occur in the vicinity of each discharge site. Results of near-field models provide information about dispersion and dilution of the discharge plumes in the immediate vicinity of each outfall site. Far-field analyses provide estimates of Se and TDS concentrations at more distant points. See Section 5.2.2 for more information on the water quality models. An evaluation of the potential biological effects of Se concentrations in receiving waters and sediment is presented separately in Section 8.

7.2.2.3 Special-Status Species

Lists of Federally and State-listed special-status species that could occur in areas affected by each alternative were obtained from the Service, NOAA-Fisheries, and CDFG.

To determine the potential for significant effects to special-status species, each species' habitat requirements, breeding biology, seasonal movements, occurrence records, and distribution information was compiled from a review of current literature, consultations with Service and CDFG biologists and other local and regional species experts, and analysis of data from the CNDDB (CDFG 2003) and the *California Wildlife Habitat Relationships System Database* (CDFG 1999). GIS map overlays were then used to relate the mapped locations of proposed facilities to documented occurrences, historic ranges, critical habitats, and/or general habitat types preferred by each listed species. Based on the literature reviews, consultations, and GIS analysis, the likelihood of each species occurring within 2 miles of proposed facility locations and alignments was evaluated and a qualitative effects determination was made. An evaluation of the potential biological effects of Se bioaccumulation on special-status species under each alternative is presented separately in Section 8.

No intensive on-site habitat assessments or site-specific species-focused presence/absence surveys were conducted for any of the alternatives. Once feasibility designs for a preferred alternative have been completed, intensive field surveys would be conducted for all project components.

7.2.3 No Action Alternative

7.2.3.1 Terrestrial Resources

No significant construction-related effects would be expected under the No Action Alternative. Consistent with the definition of No Action to exclude unplanned or speculative projects, it is assumed that no new on-farm drainwater collection systems or disposal facilities would be constructed. Grassland Area Farmers would not complete the unfunded expansion of the Panoche reuse facility. Instead, they would continue to operate the existing 3,100 developed acres of the planned 4,000-acre facility at its current influent capacity of 9,100 AF/yr. No similar regional facilities would be developed.

Under the No Action Alternative a total of 109,100 acres of irrigated and temporarily fallowed croplands would be permanently retired, including 65,000 acres under the Westlands settlement (see Section 2.2.1.2); 34,100 acres under the Sumner-Peck settlement; 7,000 acres under the CVPIA Retirement Program (including 2,091 acres already retired); and 3,006 acres already retired under the Britz settlement. Vegetation on these lands has not yet been thoroughly inventoried so current ground cover, vegetation conditions, and habitat values are unknown. Retired lands remaining under private or district ownership would be dryland farmed and grazed, or portions would be left temporarily fallowed. CVPIA Land Retirement Program lands presumably would continue to be managed to provide wildlife habitat or to be compatible with wildlife use under the present CVPIA program. A comprehensive long-term land management plan for the Westlands settlement lands has not yet been developed. Under the No Action Alternative, no valley-wide strategy is currently in place for coordinating management of the retired lands and, other than the CVPIA program, no current mechanism would provide for future development of wildlife habitat improvements or long-term habitat management.

Retired agricultural lands converted to nonirrigated crops would continue to be periodically disturbed for cultivation and harvesting and, therefore, would not develop significant wildlife value. Production of small grains (wheat, barley) on dryland sites, though, could provide improved food and cover over existing conditions, but wildlife benefits would depend on location, parcel size, adjoining habitats, and management. Fallowed, abandoned, or grazed lands could be invaded to varying degrees by noxious weeds or other undesirable species. Some of the retired lands would continue to act as salt sinks, collecting and concentrating salts until they support limited vegetation and offer little wildlife habitat value. Some salt sink areas, depending on habitat characteristics, could provide an exposure risk for Se bioaccumulation for some species; however, the extent or likelihood of such effects has not been investigated. Retired lands occurring in large contiguous blocks would provide higher terrestrial habitat value than parcels in small, scattered, and isolated tracts. In general, in the absence of any long-term program to develop and manage retired lands for wildlife habitat under the No Action Alternative, the effect to terrestrial resources from anticipated long-term changes in vegetation and cropping patterns would be only a slightly beneficial effect. The long-term potential for minimally managed lands to increase the spread of noxious weeds, however, would be an adverse effect.

7.2.3.2 Aquatic and Wetland Resources

Under the No Action Alternative, no large (regional) drainwater collection or treatment/disposal facilities would be developed and no new surface-water impoundments (e.g., regulating reservoirs, evaporation basins) would be constructed as part of any drainage control program. Without large-scale construction projects, no aquatic or wetland habitat would be lost or disturbed. No existing natural wetlands would be drained or filled, and no natural stream channels or other waterways would be crossed or altered. No migratory movements of native fish would be temporarily or permanently blocked.

Under the No Action Alternative, irrigation water freed up from planned or scheduled land retirements would be reallocated to other agricultural lands and would not be made available for aquatic or wetland habitat improvement.

Grassland Area Farmers would be forced to discontinue use of the northern 28 miles of the San Luis Drain to discharge GDA drainwater to Mud Slough and the San Joaquin River after December 2009. Without continued use of the Drain, substantial environmental benefits to area waterways and wetlands derived from the Grassland Bypass Project since 1996 would cease and future anticipated benefits from the planned full implementation of the Grassland Bypass Project would not occur.

With discontinued use of the concrete-lined Drain segment, 28 miles of aquatic habitat would be eliminated, and any fish species present in the substantially dewatered segment would be lost or would need to be salvaged and relocated. However, because the Drain and associated canals provide only marginal artificial habitat, loss of this canal fishery would not be considered adverse.

Without the Grassland Bypass Project discharges, year-round flow in Mud Slough would decrease substantially after December 2009. This flow reduction would generally be considered an adverse effect, but the associated improvement in water quality of the receiving waters could result in a minor improvement in aquatic habitat conditions. The improvement in Mud Slough aquatic habitat, however, would vary depending on prevailing rainfall, seasonal conditions, and the amount of uncontrolled agricultural drainage that would continue to contribute to the flow. If unmanaged drainage flows of poor quality were to enter Mud Slough or other wetland channels, aquatic habitat conditions would degrade.

The Grassland Bypass Project currently prevents uncontrolled lateral seepage of Se-contaminated drainwater and limits occasional overtopping of surface runoff (during prolonged wet periods and storm events) into a number of canals and laterals used for wildlife refuge water supplies in the Grasslands region (see the Grassland Bypass Project Final EIS, p. 6-22 [Reclamation 2001c]). See Section 8.2.3 for a discussion of Se-related effects under the No Action Alternative.

7.2.3.3 Special-Status Species

No substantial adverse effects to special-status species are anticipated under the No Action Alternative.

No new regional collection facilities would be constructed or put into operation through 2061. Without collection facilities, no new regional drainwater disposal facilities such as treatment plants, reuse facilities, evaporation facilities, or other costly technologies would be developed. On-farm source control measures, on the other hand, would undoubtedly expand over the 50-year period, but would have little direct effect on special-status species.

Changes in crop production could affect the character, quality, and pattern of terrestrial habitat provided by agricultural lands as farmers in drainage-impaired areas convert to more salt-tolerant crop mixes. However, no identified special-status species are known to utilize existing irrigated crop types exclusively and, thus, none would be significantly affected by any wide-scale conversions to more salt-tolerant irrigated crops. Lands converted to dryland farming would continue to be disturbed during cultivation and harvesting, and, therefore, would not develop significant wildlife value.

The amount of agricultural land removed from production (retired, temporarily fallowed, or abandoned) would continue to increase as additional drainage-impaired lands lose productivity and become uneconomical to farm. Under the No Action Alternative, planned land retirements would increase to as much as 109,100 acres by 2061, an increase of 88,600 acres over existing conditions. A portion of these lands would act as salt sinks, collecting and concentrating salts until they support little vegetation or possess little wildlife habitat value. Other abandoned lands would revert in varying degrees to undesirable invasive species. This conversion of irrigated lands to other uses would progress in a scattered, uncoordinated manner depending on site-specific conditions and individual circumstances. There would be no program of planned placement of abandoned lands into alternative uses or for managing lands removed from production. However, individual farmers could manage the retired lands for dryland farming, grazing, and other agricultural uses not dependent upon CVP water sources. Portions of the 65,000 acres of land acquired by Westlands could be irrigated with groundwater or non-CVP water sources. As a result, the overall potential benefits to special-status species from alternative land use are not expected to be important.

7.2.4 In-Valley Disposal Alternative

The current evaluation of potential effects to biological resources from construction and operation of the In-Valley Disposal Alternative is based on *appraisal-level* designs and conceptual operating plans. At present, only very general site plans for the major facilities and conveyance alignments have been completed. Detailed facility operating plans, construction schedules, and specifications for permanent structures (buildings, maintenance yards, roads, berms, fences, pump facilities, powerlines, etc.) are not yet available. As currently proposed, 44,106 acres would be permanently retired under the In-Valley Disposal Alternative, approximately 14,700 of which would be utilized for project facilities.

7.2.4.1 Terrestrial Resources

Construction of the initial phase of the In-Valley Disposal Alternative’s major facilities is expected to take approximately 5 years, with full and complete implementation not expected to occur for a decade or more. A range of temporary and permanent effects to existing terrestrial biological resources would result from construction and operation of the drainwater collection system, interfacility conveyance systems and pumping stations, 16 reuse facilities, 4 treatment/evaporation facilities, and the permanent conversion of irrigated parcels to nonirrigated uses following retirement. Terrestrial resources would also be affected by permanent retirement of 44,106 acres (in total) of irrigated lands. Development of required evaporation basin mitigation sites (potentially including construction of new wetlands, and restoration or enhancement of existing sites) would permanently convert an as-yet-undetermined amount of terrestrial habitat to seasonal and permanent wetland habitats.

Currently (2002), approximately 70 percent of the acreage comprising proposed facility sites and retirement lands is planted in cotton and vegetable row crops, or has been fallowed. The remainder of the proposed sites is predominantly small grain crops, with approximately 5 percent being alfalfa or pasture grasses.

Construction Effects

As proposed, all major In-Valley facilities would be constructed on active or fallowed agricultural lands or on permanently retired croplands, settlement lands, or other previously disturbed agricultural parcels (e.g., farm roads, ditches, canal ROWs, fencelines, field borders, etc.). These agricultural and ruderal habitats are common both locally and regionally. In general, the majority of affected parcels is considered to have low habitat value (e.g., cotton fields, vegetable crops) when compared to natural vegetation types or agricultural crops such as alfalfa or irrigated pasture. During construction, broad-ranging foraging species and other mobile terrestrial wildlife species would disperse to adjoining parcels of similar habitat. Less mobile species, including some nesting/burrowing species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys to locate potential occurrences of nest trees, roosts, den sites, and preferred foraging areas, and subsequent implementation of appropriate conservation measures and construction practices, potential effects to common terrestrial biological resources from construction of In-Valley Disposal Alternative facilities are not expected to be significant.

Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of the In-Valley Disposal Alternative facilities could introduce or spread noxious weeds. However, Reclamation routinely requires implementation of appropriate construction procedures and construction site management to reduce establishment of undesirable species; therefore, effects would not be significant.

Reuse Areas. Staged development of the 16 reuse areas would affect up to 19,000 acres, most of which is currently (2002) dominated by cotton and row crops. In general, effects to common terrestrial species from construction of the required reuse areas are not expected to be significant. Construction activities required to initially develop typical reuse sites would be similar to farming activities that historically took place at the sites. Initial development would include surface contouring and leveling; installation of irrigation systems and associated subsurface drains, sumps, and buried collectors; clearing or turning under of existing crops; initial planting of selected salt-tolerant species; and similar site preparation activities. These activities, like the previous farming practices, would result in minor or temporary effects to common terrestrial species that are adapted to the San Joaquin Valley’s intensively managed agricultural landscape. For any portions of reuse facilities that would be located on already retired, abandoned, or fallowed parcels, construction would remove ruderal vegetation, nonirrigated cover crops, or residual vegetation from earlier farm use.

Evaporation Basins. Four general areas, totaling approximately 6,200 acres, have been evaluated as suitable sites for constructing proposed evaporation basins. The completed basins, requiring up to 3,290 acres when fully operational, would occupy portions of each of the four areas. Because the precise size and siting of each facility are not yet known, effects to existing vegetation have not been precisely quantified. Currently (2002), the four sites are dominated by wheat and alfalfa (approximately 30 percent each), cotton (20 percent), and fallowed land (10 percent).

Staged construction of the proposed basins would take place over a number of years. Construction would include permanent removal of all existing commercial crops and ruderal vegetation, berm/embankment construction, leveling and compaction of soil substrates, installation of pipelines and control structures, and construction of any required permanent aboveground structures (buildings, access roads, equipment yards, fences, etc.). Terrestrial wildlife would be displaced to adjacent parcels during construction; however, unlike the reuse areas where some form of vegetative cover would be restored, displaced wildlife would not return once construction has ended. The effect of permanently clearing 3,290 acres of various crops will depend to a large extent on the location of the facility relative to nearest native or natural habitat and on its immediate surrounding vegetation. However, because agricultural lands are common both locally and regionally and typically have limited habitat value, conversion of the 3,290 acres of agricultural lands to evaporation basins would not be considered a significant loss of terrestrial habitat.

Future construction activity would occur when individual evaporation basin cells within each evaporation basin facility are closed at the end of their functional life. Cell closures would require capping, contouring, revegetating, and long-term monitoring of the closed cells to ensure that seeps and surface-water ponding will not create future Se exposure hazards. Material for capping closed cells would likely be obtained from adjacent lands. Any borrow areas would be surveyed prior to excavation to evaluate potential effects to biological resources and appropriate environmental compliance documentation would be completed. Following excavation, all borrow areas and temporary haul roads would be contoured and revegetated, and monitored to assure revegetation has been successful. Because appropriate environmental compliance documentation, site restoration, and monitoring activities would take place, future construction activities associated with closure of basin cells would not be expected to significantly affect common terrestrial species.

Conveyance/Collection Systems. Construction of the In-Valley Disposal Alternative's linear network of 71 miles of interfacility conveyance pipelines, 1,000+ miles of buried collection lines, and associated sumps, pumps and controls could result in widely distributed, but generally temporary effects to terrestrial species. These potential effects are not expected to be significant. Both the conveyance system and the entire collection network would be installed as buried pipelines (as opposed to open canals). Construction would take place in narrow linear corridors entirely within the agricultural heart of the valley and generally would be limited to previously disturbed road, canal, and railroad ROWs or the perimeters of agricultural fields. In this previously disturbed, topographically flat, and easily accessed landscape, pipeline construction (trench excavation, pipe placement, and backfilling) would be expected to move quickly, with only minor and temporary disturbances to terrestrial wildlife resources.

Treatment Facilities. Construction of the In-Valley Disposal Alternative's proposed RO and biological treatment facilities would also occur entirely on active or former agricultural lands, or other previously disturbed agricultural parcels. Construction of the 8 facilities would permanently remove existing vegetation from the sites, resulting in the permanent loss of approximately 14 acres of agricultural habitat in total. Because agricultural habitats are common both locally and regionally, construction of these small facilities would not be considered a significant effect.

Retired Lands. A total of 44,106 acres of active and fallowed agricultural land would be acquired and permanently retired under the In-Valley Disposal Alternative, an increase of 23,588 acres over current (2002) conditions, but 65,000 acres less than would be expected over the next 50 years under No Action.

A portion of the 44,106 acres of retired land would be developed for project purposes (reuse areas, evaporation basins, evaporation basin mitigation) and 7,000 acres of the total would be separately acquired and managed under the CVPIA Land Retirement Program to provide wildlife habitat (outside the scope of this project).

For project planning purposes, it is assumed that approximately one-third of the remaining retired land would be converted to nonirrigated forage crops suitable for grazing sheep and two-thirds would be dryland farmed. Activities associated with these anticipated changes in use may include disking or turning under the existing irrigated crops or cover, planting new vegetation (if appropriate), controlling weeds, and possibly removing or relocating existing infrastructure as deemed necessary by the owners. These typical farm activities could result in minor or temporary effects to common terrestrial species, most of which are adapted to the intensively managed agricultural landscape. In general, construction effects associated with the In-Valley Disposal Alternative's retired lands are not expected to be significant.

Potential biological effects to terrestrial species from long-term *operation* of the retired lands for grazing or dryland farming are discussed in the following section.

Operation Effects

Detailed operating plans and implementation schedules for the In-Valley Disposal Alternative's major facilities and retirement lands have not yet been completed. Subsequently, the following evaluation of potential operational effects to terrestrial resources is based on conceptual operating plans.

See Sections 7.2.4.2 and 7.2.4.3 for discussion of operational effects to aquatic/wetland resources and special-status species.

Reuse Areas. From a local or regional perspective, long-term operation of the 16 reuse facilities, totaling 19,000 acres when phased construction is completed, would not significantly alter the overall quantity of agricultural habitat from a local or regional perspective. Terrestrial habitats currently provided by existing agricultural crops and ruderal land would permanently change to predominantly salt-tolerant pasture grasses. Each reuse facility's day-to-day operations would be similar to the common farming activities that already take place throughout the project area. The mix of salt-tolerant vegetation that would be planted and maintained at the facilities would continue to provide marginal cover and foraging habitat similar in value to other managed agricultural lands in the San Joaquin Valley. It is assumed that any marginal loss of terrestrial habitat value that might result from conversion of the reuse sites from prior agricultural uses would be offset by the more diverse regional mix of forage and cover provided by substantial acreages of land that would be retired and converted to dryland crops (e.g., barley, wheat) and sheep pasture, and by CVPIA Land Retirement Program restoration tracts.

See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Evaporation Basins. The In-Valley Disposal Alternative's four evaporation facilities would be located adjacent to, or surrounded by, existing croplands, reuse areas, and/or retired lands. The sites would be intensively managed to prevent establishment of terrestrial, emergent, or riparian vegetation and, thus, would be minimally attractive to most terrestrial wildlife species. A permanent loss of agricultural and ruderal habitat would occur on the four disjunct sites (totaling 3,290 acres) following construction of evaporation and treatment facilities. The loss of terrestrial habitat that would result from permanent conversion of the sites from prior agricultural use to use as evaporation basins would be compensated by the more diverse habitat provided by the adjoining or surrounding, reuse areas or retired (dryland farmed or grazed) parcels.

See Section 8.2.2.1 for an evaluation of potential effects to terrestrial biological resources due to elevated Se concentrations at the evaporation basins.

Conveyance/Collection Systems. Normal day-to-day operation and maintenance of the network of buried pipelines, sumps, pumps, and controls that comprise the collection and conveyance system is not expected to have a significant effect on common terrestrial wildlife species or their habitats.

Treatment Facilities. Operation of the proposed RO facilities and biological treatment plants would have no direct significant effects on terrestrial wildlife species. All of the treatment facilities would be located adjacent to proposed evaporation basin facilities on formerly active, fallowed, or retired agricultural lands. Because of the small size of the enclosed facilities, effects to terrestrial species from facility noise, daily vehicle traffic, and lighting would not be significant. Waste residues from the biotreatment facilities would be hauled to approved waste disposal sites located in the valley.

Retired Lands. A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat. For planning purposes, it is assumed that the remaining retired lands not used for project facilities and ROWs would convert to dryland farming, summer fallowing, or sheep grazing. In any given year it is anticipated that approximately one-half of the dryland-farmed acreage would be fallowed to conserve soil moisture. Except for the CVPIA program lands, none of the retired lands under the SLDFR project would be specifically managed to develop wildlife habitat or to provide long-term wildlife benefits.

Any retired agricultural lands converted to nonirrigated crops would continue to periodically be disturbed for cultivation and harvesting and, therefore, would not typically develop significant wildlife value. Production of small grains (wheat, barley) would provide a degree of improvement over most existing irrigated crops, but actual wildlife benefits would depend on location, parcel size, adjacent habitats, and management. Similarly, grazed lands managed under a rotation could provide a desirable mix of vegetation cover, offering better forage and cover than previous irrigated crops; however, significant wildlife benefits would not be guaranteed. Actual benefits would depend on adjacent crop types and access corridors, grazing intensity, rotation cycles, presence of sheepdogs, etc.

Fallowed, abandoned, or improperly grazed lands could quickly be invaded by noxious weeds and undesirable invasive species; however, Reclamation routinely requires all lessees/operators to incorporate a weed management program into their operations. Consequently, the effect would not be significant. Some low-lying retired lands would continue to act as salt sinks, collecting and concentrating salts until they support limited vegetation and offer little wildlife habitat value.

In general, in the absence of any long-term program or funding mechanism to specifically develop and manage the retired lands under the In-Valley Disposal Alternative to significantly improve wildlife habitat, the effect to terrestrial wildlife from anticipated long-term changes in vegetation and cropping patterns is assumed to be only slightly beneficial, resulting in no significant effect.

7.2.4.2 Aquatic and Wetland Resources

Construction Effects

All of the In-Valley Disposal Alternative's major facilities would be constructed on active or fallowed agricultural lands or on permanently retired croplands, settlement lands, or other previously disturbed agricultural parcels (e.g., farm roads, ditches, canal ROWs, fencelines, field borders, etc.). Because facility construction would focus on upland sites, construction effects to aquatic and wetland resources would likely be limited to existing agricultural ditches, drainageways, and swales.

Reuse Areas and Evaporation Basins. Construction of the proposed reuse facilities and evaporation basins would be unlikely to result in the permanent loss or disturbance of any natural aquatic or wetland habitats. These facilities would be located on upland sites comprised of large tracts of active or retired agricultural lands. Where feasible, existing hydrologic features (canals, ditches) could be incorporated into the facility's site plan.

As a precaution, each reuse and evaporation basin site would be surveyed prior to construction to identify any unmapped natural and human-made hydrologic features and floodways (if any) that might also be present at the sites. Although unlikely, any permanent loss of jurisdictional wetlands could be mitigated, resulting in no significant effects.

The eventual scheduled closures and capping of individual evaporation basin cells could destroy a limited number of waterbird nests and eggs. While every effort would be made to discourage shorebird nesting at project evaporation basins, some nesting attempts would still be successful. Effects could be mitigated by excavating and removing sediments, contouring, capping, revegetating, and monitoring of the sites to ensure that seeps and surface-water ponding would not create future Se exposure hazards. If appropriate closure and postclosure procedures are followed, including timing of the closures to avoid nesting periods, effects to aquatic and wetland species from closures of the individual basin cells should not be significant.

Conveyance/Collection System. No significant effects to aquatic and wetland resources are anticipated to occur as a result of construction of collection and conveyance facilities. Construction of the extensive network of buried collection pipelines and associated sumps, pumps, and controls would result in widely distributed, but generally temporary effects. As proposed, the entire collection system would be constructed as buried pipelines (as opposed to open canals). Following pipeline installation, any affected waterway would immediately be restored to preconstruction profiles and revegetated. Construction would take place in narrow linear corridors entirely within the agricultural heart of the valley and generally would be limited to previously disturbed road, canal, and railroad ROWs or the perimeters of agricultural fields.

Stream crossings in this agricultural environment typically would be limited to existing ditches and canals. In this topographically flat agricultural landscape, pipeline construction (trench excavation, pipe placement, and backfilling) would move quickly, with minor and temporary disturbances at the few anticipated aquatic and wetland sites that might be encountered.

Operation Effects

Reuse Areas. The 19,000 acres of proposed reuse areas would be designed and operated to sustain long-term production and maintenance of selected salt-tolerant crops. Typical operations would be very similar to the farming activities that historically took place at the sites and throughout the project area. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Evaporation Basins. Operation of the In-Valley Disposal Alternative's 3,290 acres of intensively managed hypersaline evaporation basins would result in a number of potential adverse effects to aquatic or wetland-dependent species that would utilize the basins. Possible effects not specifically related to Se exposure could include salt encrustations on feathers of wintering waterbirds, increased predation and more rapid spread of avian diseases due to crowding, direct mortality from human/equipment activity, and stress-related reductions in the health and vigor of breeding, migrating, and wintering birds from hazing. These significant adverse effects could be controlled with adequate monitoring combined with responsive management actions, and could likely be further reduced with the availability of nearby alternative habitat. Effects not fully mitigated would be considered unavoidable adverse effects. See Section 8.2.4.2 for an evaluation of the potential effects of Se bioaccumulation to aquatic and wetland species at the evaporation basins.

Treatment Facilities. Operation of the proposed RO and biological treatment plants would have no direct significant effects on aquatic and wetland resources. All treatment facilities would be located near proposed evaporation facilities on active, fallowed, or retired agricultural lands. No open water (i.e., holding basins, equalization ponds, etc.) would be present at any of the treatment plants. Because of the small size of the facilities, effects to aquatic and wetland species from facility noise, daily vehicle traffic, and lighting would not be significant. Effluents from all of the treatment facilities would be closely monitored to assure operating criteria are being met, and contingency plans for temporarily shutting down the facilities would be in place if effluent quality problems were to occur. Waste residues from the biotreatment facilities would be hauled to approved waste disposal sites located in the valley.

Conveyance/Collection Systems. Once constructed, operation of the buried collection and conveyance pipelines would have no significant effects on existing aquatic and wetland resources.

7.2.4.3 Special-Status Species

Based on an extensive literature review, consultation with species experts, reconnaissance surveys in the general vicinities of proposed facility sites and pipeline alignments, and an evaluation of recent occurrence records (CDFG 2003), it was determined that 17 listed species could occur in areas affected by construction or operation of the In-Valley Disposal Alternative. The 68 remaining species (from the list of 85 compiled by the Service, NOAA Fisheries, and CDFG covering all action alternatives; see Appendix F, Table F-1) were eliminated from further consideration under this alternative because (1) areas of potential occurrence were associated with other action alternatives or fell well outside the "footprint" of anticipated construction and operational effects of the In-Valley Disposal Alternative, (2) suitable habitat no longer was thought to be present in the areas being evaluated, or (3) the absence of recent occurrence records was highly indicative that the species no longer is present in the areas being evaluated. Table 7-2 identifies the 17 listed special-status species that could be present or occasionally utilize suitable habitat in areas potentially affected by the In-Valley Disposal Alternative. For Federally listed species for which a "may adversely affect" determination was made, Reclamation has completed consultation with the Service under Section 7 of the ESA that identified measures to avoid or minimize potential effects (Appendix M2). The Service will require preconstruction surveys for those species that may be affected by the selected alternative. At present, species-focused endangered species biological surveys have not yet been completed on any proposed construction sites or pipeline alignments.

Table 7-2
Special-Status Species That May Be Affected by the In-Valley Disposal Alternative

Common Name	Scientific Name	Federal Status	State Status	Effect
San Joaquin kit fox	*Vulpes macrotis mutica*	E	T	May have significant effect; mitigation feasible
Swainson's hawk	*Buteo swainsoni*	--	T	May have significant effect; mitigation feasible
California least tern	*Sterna antillarum browni*	E	E/CFP	May have significant effect; mitigation feasible
American peregrine falcon	*Falco peregrinus anatum*	--	E/CFP[1]	May have significant effect; mitigation feasible
Greater sandhill crane	*Grus canadensis tabida*	--	T/CFP	No significant effect
Bald eagle	*Haliaeetus leucocephalus*	T	E/CFP	May have significant effect; mitigation feasible
California black rail	*Laterallus jamaicensis coturniculus*	--	T/CFP	May have significant effect; mitigation feasible
Western burrowing owl	*Athene cunicularia hypugaea*	-	SC[2]	May have significant effect; mitigation feasible
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	--	E	May have significant effect; mitigation feasible
Giant garter snake	*Thamnophis gigas*	T	T	May have significant effect; mitigation feasible
California red-legged frog	*Rana aurora draytonii*	T	SC	May have significant effect; mitigation feasible
Chinook salmon (Central Valley Spring-run)[3]	*Oncorhynchus tshawytscha*	T	T	No significant effect
Chinook salmon (Central Valley Fall/Late Fall-run	*Oncorhynchus tshawytscha*	FC	SC	No significant effect
Chinook salmon (Sacramento Winter-run)[4]	*Oncorhynchus tshawytscha*	E	E	No significant effect
Steelhead (Central Valley)[3]	*Oncorhynchus mykiss*	T	--	No significant effect
Delta smelt[4]	*Hypomesus transpacificus*	T	T	No significant effect
Green sturgeon	*Acipenser medirostris*	FC	SC	No significant effect

Notes:

[1]CFP--California fully protected species.
[2]Formally petitioned for listing as State-threatened or -endangered in April 8, 2003; petition rejected February 5, 2004. Species remains protected under California Fish and Game Code §3503.5—Protection of Raptors.
[3]Designated Critical Habitat within this alternative's "footprint" of potential project effects vacated April 30, 2002.
[4]Listing includes designated Critical Habitat within this alternative's "footprint" of potential project effects.
E – Endangered; T – Threatened; PT - Proposed Threatened; CSC – California Species of Special Concern; FC - Candidate (Federal); "—" - Not Listed; AGS – Annual Grassland; COW – Coastal Oak Woodland; CRP – Croplands; CSC – Coastal Scrub; ASC – Desert Scrub; FEW – Freshwater Emergent Wetland; MAR – Marine; RIV – Riverine; SEW – Saltwater Emergent Wetland; VRI – Valley Foothill Riparian; ESU – Evolutionarily Significant Unit

Construction Effects

The probability of adversely affecting any listed species during construction of In-Valley Disposal Alternative facilities would be quite small with completion of preconstruction biological surveys and implementation of recommended or required species-directed protocols and avoidance measures. These measures could reduce the effects to not significant.

Construction of the reuse facilities, evaporation basins, treatment facilities, and collection system would occur on active, fallowed, or retired agricultural lands, greatly reducing the potential to adversely affect any of the listed species. No construction is expected to take place in riparian corridors or within mapped emergent wetlands, and it is unlikely that roost sites or nest trees would be disturbed. For most broad-ranging species that forage in agricultural and ruderal lands, construction disturbances would be minor and temporary.

San Joaquin kit fox territories could extend into proposed reuse area sites and collection system alignments, but kit fox dens would be unlikely in the intensively managed agricultural areas where the major construction activity would occur. Kit fox use of agricultural lands typically is limited to the edges of the valley floor within 2 miles of natural grassland and shrubland vegetation. Significant effects to this species could occur as a result of construction activities associated with development and installation of the facilities; however, with preconstruction surveys to identify potential kit fox activity and implementation of approved conservation and avoidance measures, it is anticipated that effects could be reduced to not significant.

Swainson's hawks are known to nest along the San Joaquin River (and occasionally in isolated individual trees or small stands) and forage for insects, birds, and other small prey in adjacent agricultural lands up to several miles from nest and roost sites. Swainson's hawks could also forage at or near some construction sites, but would likely utilize adjacent areas while construction activities are ongoing. Significant effects to Swainson's hawks could occur during construction activities; however, with preconstruction surveys and implementation of established guidelines for construction near nests, it is anticipated that effects could be reduced to not significant.

Wintering **greater sandhill cranes** are known to forage over broad areas of the agricultural valley floor for insects, worms, seeds, and grains on recently disked or harvested grain fields, rice or corn stubble, shortgrass grasslands, and open wetlands. Cranes may be attracted to disturbed ground at this alternative's expansive construction sites (e.g., evaporation basins, reuse areas), opportunistically utilizing the sites during hours when construction activity stops each day, and foraging in other fields when construction activity resumes. No significant effects to greater sandhill cranes are expected to occur due to construction activities associated with development and installation of the facilities.

Western burrowing owls occur year-round in the San Joaquin Valley and have been observed nesting in small colonies along earthen canal banks and other sparsely vegetated disturbed sites. Construction of portions of the collection system in and adjacent to the San Luis Drain ROW could significantly affect colonies of western burrowing owls known to nest among the broken or shifted concrete slabs that comprise the abandoned conveyance structure. However, with completion of burrowing owl surveys to determine precise locations of the colonies, and implementation of approved avoidance measures and development of a burrowing owl management plan for the Drain ROW segments, it is anticipated that significant effects from construction could effectively be avoided.

The **bald eagle, American peregrine falcon, California black rail**, and **western yellow-billed cuckoo** could be significantly affected by construction activities at proposed construction sites but effects would be mitigated to not significant if preconstruction surveys are completed and approved avoidance measures are implemented. **Bald eagles** are occasionally observed wintering in the San Joaquin Valley, where they typically are found foraging over major rivers, reservoirs, and wetlands. **American peregrine falcons** are incidental winter visitors and have been observed on very rare occasions foraging for waterbirds at refuges, waterfowl areas, and other wetlands, including evaporation basins. **California black rails** have been observed year-round in densely vegetated emergent wetlands. **Western yellow-billed cuckoos** typically are restricted to thick riparian vegetation, typically willows

The **giant garter snake** is found in a variety of permanent aquatic environments including marshes, sloughs, ponds, low gradient streams, and other waterways and agricultural wetlands, such as poorly maintained irrigation and drainage canals. Construction of the collection system may require crossing a small number of permanently watered, poorly maintained irrigation and drainage canals; however, construction in major permanent waterways and wetlands is not anticipated. Significant effects to giant garter snakes could occur due to construction activities; however, with preconstruction surveys and implementation of approved avoidance measures, as necessary, effects would be reduced to not significant.

The California **red-legged frog** may occur in quiet pools of streams, marshes, and ponds within areas potentially disturbed by the In-Valley Disposal Alternative. However, the species has not been recently documented within areas potentially affected by proposed facilities and no proposed Critical Habitat would be affected. While significant effects could occur, if necessary, species-directed biological surveys and implementation of approved avoidance and conservation measures would reduce effects to not significant.

None of the listed **Chinook salmon** or **steelhead ESUs**, **Delta smelt**, or **green sturgeon** would be affected by construction activities associated with In-Valley Disposal Alternative features or facilities and no Critical Habitats would be adversely modified during construction.

<u>**Operation Effects**</u>

None of the listed species would be significantly affected by operation of the collection system or treatment facilities or the anticipated noise, lighting, vehicle traffic, or equipment use that would be associated with facility operations. No mappable units of native or sensitive terrestrial habitat types, as identified in the CNDDB (CDFG 2003), would be affected by the In-Valley Disposal Alternative features. Potential effects to special-status species as a result of Se bioaccumulation are discussed in Section 8.2.4.3.

The **San Joaquin kit fox** would likely forage at the proposed reuse areas, favoring sites located nearest the eastern edges of the project in close proximity to preferred grassland and shrubland habitats. Foraging kit fox would be less likely to utilize other reuse sites that are more isolated within the agricultural landscape. Retirement of large contiguous tracts of cropland in the vicinity of the reuse areas, however, could create travel corridors to the interior sites, expanding potential kit fox foraging areas to eventually include the majority of the reuse areas. Portions of the reuse facilities planted in salt-tolerant grasses, grain crops, or permanent pasture could develop a substantial prey base of common dietary items such as insects, ground-nesting birds, and small mammals. Intensively cropped portions of the reuse facilities would likely support less abundant prey than the areas planted in cover or pasture crops, or nearby nonirrigated parcels and refuge lands. Sparsely vegetated grazed lands and the perimeters of wheat or barley fields also could provide attractive foraging areas. Day-to-day operation of farm equipment and farming infrastructure at the reuse facilities and retired lands would be similar to the common farming activities that already take place throughout the project area and subsequently would not be expected to increase kit fox mortality over current conditions. No significant effects to this species are expected to occur as a result of operation.

While the **Swainson's hawk** and **greater sandhill crane** would also be attracted to grasslands, irrigated pasture, and other suitable croplands (including retired lands converted to dryland farming or grazing land), reuse areas also would provide attractive foraging habitat with an abundance of seeds, grains, worms, insects, and small mammals. No significant effects to these species are expected to occur as a result of operation.

Potential risks to the **San Joaquin kit fox, Swainson's hawk** and **greater sandhill crane** associated with Se exposure at reuse areas are addressed in Section 8.2.4.3.

Following initial construction or development, **western burrowing owls** occupying the San Luis Drain ROW and other sparsely vegetated disturbed sites within the project area could be significantly affected by subsequent facility operation or maintenance. With appropriate operating rules and conservation measures included in a proposed burrowing owl management plan that could be developed for this alternative, the effect could be reduced to not significant. Retired parcels operated as grazing lands could develop into large areas of potential burrowing owl habitat; however, as currently proposed, operation of the reuse areas as intensively irrigated croplands with large areas of persistent vegetation and uniform groundcover would prevent development of suitable burrowing owl nesting habitat and would provide generally unsuitable foraging habitat. No significant effects to this species are expected to occur as a result of operation.

The **giant garter snake and California red-legged frog** would not be adversely affected by operation or maintenance of any of this alternative's facilities. These species, however, could indirectly benefit from a general improvement in water quality in Mud Slough and other Grasslands area delivery channels, wetlands, and waterways that would result from full implementation of this alternative. No significant effects to these species are expected to occur as a result of operation.

7.2.5 In-Valley/Groundwater Quality Land Retirement Alternative

The In-Valley/Groundwater Quality Land Retirement Alternative is a variation of the In-Valley Disposal Alternative described in Section 7.2.4. The overall project "footprint," the types of project facilities, and the types of project effects described for In-Valley Disposal Alternative remain the same. However, the retirement and conversion of an *additional* 48,486 acres to nonirrigated agricultural and grazing use would reduce the required size of this alternative's evaporation basins and reuse areas, resulting in a slight reduction in biological effects.

7.2.5.1 Terrestrial Resources

Construction of the In-Valley/Groundwater Quality Land Retirement Alternative's major facilities is expected to take approximately 5 years, with full implementation not expected to occur for a decade or more. A range of temporary and permanent effects to existing terrestrial biological resources would result from construction and operation of the drainwater collection system, interfacility conveyance systems and pumping stations, 16 reuse facilities, 4 treatment/evaporation facilities, and the permanent conversion of irrigated parcels to nonirrigated uses following retirement. Terrestrial resources would also be affected by permanent retirement of 92,592 acres (in total) of irrigated lands and by development of required evaporation basin mitigation sites (potentially including construction of new wetlands and restoration or enhancement of existing sites) would permanently convert an as-yet-undetermined area of terrestrial habitat to seasonal and permanent wetland habitats.

Currently (2002), approximately 70 percent of the acreage comprising proposed facility sites and retirement lands is planted in cotton and vegetable row crops, or has been fallowed. The remainder of the proposed sites is predominantly small grain crops, with approximately 5 percent being alfalfa or pasture grasses.

Construction Effects

The construction effects on terrestrial resources, with the exception of minor acreage changes described below, are similar to the effects described in Section 7.2.4.1 for the In-Valley Disposal Alternative. However, with preconstruction biological surveys to locate potential occurrences of nest trees, roosts, or den sites, and subsequent implementation of appropriate conservation measures and construction practices, effects to common terrestrial biological resources from construction of In-Valley/Groundwater Quality Land Retirement Alternative facilities would not be significant.

Reuse Areas. Staged development of the 16 reuse areas would disturb up to 16,700 acres, most of which is currently dominated by cotton and row crops. Construction effects on reuse areas would be similar to the In-Valley Disposal Alternative described in Section 7.2.4.1.

Evaporation Basins. Staged construction of the proposed evaporation facilities (totaling 2,890 acres when fully operational) would result in similar construction-related effects to terrestrial biological resources as described for the In-Valley Disposal Alternative in Section 7.2.4.1. Because agricultural lands are common both locally and regionally and have limited habitat value, conversion of the 2,890 acres of agricultural lands to evaporation basins would not be considered a significant loss of terrestrial habitat. In addition, because appropriate site restoration and monitoring activities would take place, construction activities associated with closure of basin elements would not be expected to significantly affect common terrestrial species.

Conveyance/Collection Systems. Construction effects of the In-Valley/Groundwater Quality Land Retirement Alternative would be similar to the In-Valley Disposal Alternative described in Section 7.2.4.1.

Treatment Facilities. Construction of the In-Valley/Groundwater Quality Land Retirement Alternative's proposed RO and biological treatment facilities would result in the permanent loss of approximately 12 acres of agricultural habitat and would be similar to the effects described in Section 7.2.4.1 for the In-Valley Disposal Alternative.

Retired Lands. A total of 92,592 acres of active and fallowed agricultural land would be acquired and permanently retired under the In-Valley/Groundwater Quality Land Retirement Alternative, an increase of 72,074 acres over current (2002) conditions, but 16,514 acres less than would be expected over the next 50 years under No Action.

A portion of the 92,592 acres of retired land would be developed for project purposes (reuse areas, evaporation basins, evaporation basin mitigation), and 7,000 acres of the total would be acquired and managed under the CVPIA Land Retirement Program to provide wildlife habitat (outside the scope of this project).

As currently proposed, one-third of the remaining land would initially be planted with nonirrigated forage crops suitable for grazing sheep and two-thirds would be prepared to facilitate dryland farming. Initial development would be designed not only to attract potential lessees/operators, but to protect the soil and help prevent the spread of noxious weeds until lessees/operators are found. These initial efforts may include disking or turning under the existing irrigated crops or cover, planting new vegetation (if appropriate), controlling weeds, and possibly removing or relocating existing infrastructure as deemed necessary. These typical farm activities would result in minor or temporary effects to common terrestrial species, most of which are adapted to the intensively managed agricultural landscape. In general, the biological effects to terrestrial species that would result from these initial construction and capital improvements would not be significant.

Potential biological effects to terrestrial species from long-term operation of the retired lands for grazing or dryland farming are discussed in the following section.

Operation Effects

Detailed operating plans and development schedules for the In-Valley/Groundwater Quality Land Retirement Alternative's major facilities and retirement lands have not yet been completed. Subsequently, the following evaluation of potential operational effects to terrestrial resources is based on conceptual operating plans. See Sections 7.2.5.2 and 7.2.5.3 for discussion of operational effects to aquatic/wetland resources and special-status species.

Reuse Areas. Long-term operation of the 16 reuse facilities, totaling 16,700 acres when phased construction is completed, would not significantly alter the overall quantity of agricultural habitat from a local or regional perspective. A permanent change in land use would occur from current agricultural and ruderal habitats to predominantly salt-tolerant pasture grasses. Each facility's day-to-day operations would be similar to the common farming activities that already take place throughout the project area. The mix of salt-tolerant vegetation that would be planted and maintained at the facilities would continue to provide marginal cover and foraging habitat similar in value to other managed agricultural lands in the San Joaquin Valley. Any marginal loss of terrestrial habitat for most commonly occurring terrestrial species that might result from conversion from prior agricultural uses would be offset by the more diverse regional mix of forage and cover provided by the addition of substantial acreages of retired land converted to dryland crops (e.g., barley, wheat) and sheep pasture, and by CVPIA Land Retirement Program revegetation parcels. No significant effects are anticipated. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Evaporation Basins. The In-Valley/Groundwater Quality Land Retirement Alternative's four evaporation facilities would be located adjacent to, or surrounded by, existing croplands, reuse areas, and/or retired lands and would not be concentrated in any one part of the project area. The sites would be intensively managed to prevent establishment of upland, emergent, or riparian vegetation and, thus, would not be attractive to terrestrial wildlife. A permanent loss of agricultural and ruderal habitat on the four disjunct sites (totaling 2,902 acres) would occur following construction of evaporation and treatment facilities. The loss of terrestrial habitat that would result from permanent conversion of the sites from prior agricultural use to evaporation basin use would be compensated by the more diverse habitat provided by the adjoining or surrounding, reuse areas or retired (dryland farmed or grazed) parcels. No significant effects are anticipated. See Section 8.2.2.1 for an evaluation of potential effects to terrestrial biological resources due to elevated Se concentrations at the evaporation basins.

Conveyance/Collection Systems. Operation of the network of buried pipelines, sumps, pumps, and controls that comprise the collection and conveyance systems would be similar to that described for the In-Valley Disposal Alternative in Section 7.2.4.1.

Treatment Facilities. Operation of the proposed RO facilities and biological treatment plants would be similar to that described for the In-Valley Disposal Alternative in Section 7.2.4.1.

Retired Lands. A total of 92,592 acres of active and fallowed agricultural land would be acquired and permanently retired under the In-Valley/Groundwater Quality Land Retirement Alternative, an increase of 72,074 acres over current (2002) conditions would occur, but 16,514 acres less than would be expected over the next 50 years under No Action. Vegetation on these lands has not yet been thoroughly inventoried so current ground cover, vegetation conditions, and habitat value is unknown. A portion of the 92,592 acres of retired land would be developed for project purposes (reuse areas, evaporation basins, evaporation basin mitigation) and 7,000 acres of the total would be acquired and managed under the CVPIA Land Retirement Program to provide wildlife benefits. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing.

As currently proposed, operational effects would be similar to that described for the In-Valley Disposal Alternative in Section 7.2.4.1.

7.2.5.2 Aquatic and Wetland Resources

<u>Construction Effects</u>

All of the In-Valley/Groundwater Quality Land Retirement Alternative's major facilities would be constructed on active or fallowed agricultural lands or on permanently retired croplands, settlement lands, or other previously disturbed agricultural parcels (e.g., farm roads, ditches, canal ROWs, fencelines, field borders, etc.). Because facility construction is focused toward upland sites, construction effects to aquatic and wetland resources would likely be limited to disturbances to existing agricultural ditches, drainageways, and swales.

Reuse Areas and Evaporation Basins. Construction of the proposed reuse facilities and evaporation basins could result in a significant loss of natural aquatic or wetland habitat, and construction effects on aquatic and wetland resources would be similar to the In-Valley Disposal Alternative described in Section 7.2.4.2.

Conveyance/Collection System. Installation of conveyance system pipelines at stream crossings, agricultural waterways, or other wetland habitats (if any) would be completed using procedures that minimize effects. Following pipeline installation, affected waterways would immediately be restored to preconstruction profiles and revegetated. Similarly to the In-Valley Disposal Alternative, no significant effects to aquatic and wetland resources are anticipated to occur as a result of construction of collection and conveyance facilities.

Operation Effects

Reuse Areas. The 16,700 acres of proposed reuse areas would be designed and operated to sustain long-term production and maintenance of selected salt-tolerant crops. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Evaporation Basins. Effects are similar to those described in Section 7.2.4.1; significant effects that can be substantially mitigated, with remaining effects, if any, considered unavoidable.

Treatment Facilities. Operation of the four proposed RO and biological treatment plants would have no direct significant effects on aquatic and wetland resources and is similar to the description of the In-Valley Disposal Alternative in Section 7.2.4.2.

Conveyance/Collection Systems. Once constructed, operation of the buried collection and conveyance pipelines would have no significant effects on existing aquatic and wetland resources.

7.2.5.3 Special-Status Species

Based on an extensive literature review, consultation with species experts, reconnaissance surveys in the general vicinities of proposed facility sites and pipeline alignments, and an evaluation of recent occurrence records (CDFG 2003), it was determined that 16 listed species could occur in areas affected by construction or operation of the In-Valley/Groundwater Quality Land Retirement Alternative. The 69 remaining species (from the list of 85 compiled by the Service, NOAA Fisheries, and CDFG covering all action alternatives; see Appendix F, Table F-1) were eliminated from further consideration under this alternative because (1) areas of potential occurrence were associated with other action alternatives or fell well outside the "footprint" of anticipated construction and operational effects of the In-Valley/Groundwater Quality Land Retirement Alternative, (2) suitable habitat no longer was thought to be present in the areas being evaluated, or (3) the absence of recent occurrence records was highly indicative that the species no longer is present in the areas being evaluated. Table 7-2 in Section 7.2.4.3 identifies the 16 listed special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by this alternative. Reclamation has completed consultation with the Service for species with determinations of "may adversely affect" under Section 7 of the ESA that identified measures to avoid or minimize potential effects to special-status species.

At present, species-focused endangered species biological surveys have not yet been completed on any proposed construction sites or pipeline alignments.

Construction Effects

The probability of adversely affecting any listed species during construction of In-Valley/Groundwater Quality Land Retirement Alternative facilities would be quite small with completion of preconstruction biological surveys and implementation of accepted species-directed protocols and avoidance measures.

Construction of the reuse facilities, evaporation basins, treatment facilities, and collection system would occur on active, fallowed, or retired agricultural lands, greatly reducing the potential to adversely affect any of the listed species. No construction is expected to take place in riparian corridors or within mapped emergent wetlands, and no roost sites or nest trees would likely be disturbed.

For broad-ranging species that forage in agricultural and ruderal lands, construction disturbances would typically be minor and temporary. Any permanent loss of existing agricultural and ruderal foraging areas generally would not be considered significant because these habitats are common both locally and regionally. Furthermore, any permanent losses of existing irrigated crop foraging areas would be compensated for by additional diversity provided by the potentially large parcels of retired lands that would be managed for dryland grain production and sheep pasture.

Construction effects on the San Joaquin kit fox, Swainson’s hawks, greater sandhill cranes, western burrowing owls, bald eagle, American peregrine falcon, California black rail, western yellow-billed cuckoo, giant garter snake, and California red-legged frog would be the same as described in Section 7.2.4.3 for the In-Valley Disposal Alternative.

None of the listed **Chinook salmon** or **steelhead ESUs**, **Delta smelt**, or **green sturgeon** would be affected by construction activities associated with In-Valley/Groundwater Quality Land Retirement Alternative features or facilities and no Critical Habitats would be adversely modified during construction.

Operation Effects

Similarly to the In-Valley Disposal Alternative, none of the listed species would be significantly affected by operation of the collection system or treatment facilities or the anticipated noise, lighting, vehicle traffic, or equipment use that would be associated with facility operation. No mappable units of native or sensitive terrestrial habitat types, as identified in the CNDDB (CDFG 2003), would be affected by the In-Valley/Groundwater Quality Land Retirement Alternative features. Potential effects to special-status species as a result of Se bioaccumulation are discussed in Section 8.2.4.3.

7.2.6 In-Valley/Water Needs Land Retirement Alternative

The In-Valley/Water Needs Land Retirement Alternative is a variation of the In-Valley/ Groundwater Quality Land Retirement Alternative described in Section 7.2.5. The types of project facilities and the types of project effects described for the In-Valley/Groundwater Quality Land Retirement Alternative are very similar. The In-Valley/Water Needs Land Retirement

Alternative, however, would retire and convert an additional 101,364 acres of irrigated and fallowed lands to nonirrigated agricultural use and grazing land, reducing the required size of this alternative's evaporation basins and reuse areas, and resulting in a general reduction in biological effects.

7.2.6.1 Terrestrial Resources

Construction of the In-Valley/Water Needs Land Retirement Alternative's major facilities is expected to take approximately 5 years, with full implementation not expected to occur for a decade or more. A range of temporary and permanent effects to existing terrestrial biological resources would result from construction and operation of the drainwater collection system, interfacility conveyance systems and pumping stations, 16 reuse facilities, 4 treatment evaporation facilities, and the permanent conversion of irrigated parcels to nonirrigated uses following retirement. Terrestrial resources would also be affected by permanent retirement of 193,956 acres (in total) of irrigated lands and by development of required evaporation basin mitigation sites (potentially including construction of new wetlands and restoration or enhancement of existing sites) would permanently convert an as-yet-undetermined area of terrestrial habitat to seasonal and permanent wetland habitats.

Currently (2002), approximately 70 percent of the acreage comprising proposed facility sites and retirement lands is planted in cotton and vegetable row crops, or has been fallowed. The remainder of the proposed sites is predominantly small grain crops, with approximately 5 percent being alfalfa or pasture grasses.

Construction Effects

The construction effects on terrestrial resources, with the exception of minor acreage changes described below, are similar to the effects described in Section 7.2.4.1. However, with preconstruction biological surveys to locate potential occurrences of nest trees, roosts, or den sites, and subsequent implementation of appropriate conservation measures and construction practices, effects to common terrestrial biological resources from construction of this alternative's facilities would not be significant.

Reuse Areas. Staged development of the 16 reuse areas would disturb up to 12,500 acres, most of which is currently dominated by cotton and row crops. Construction effects on reuse areas would be similar to the In-Valley Disposal Alternative described in Section 7.2.4.1 and are not significant.

Evaporation Basins. Staged construction of the proposed evaporation facilities (totaling 2,150 acres when fully operational) would result in similar construction-related effects to terrestrial biological resources as described for the In-Valley Disposal Alternative in Section 7.2.4.1. Because agricultural lands are common both locally and regionally and have limited habitat value, conversion of the 2,150 acres of agricultural lands to evaporation basins would not be considered a significant loss of terrestrial habitat. In addition, because appropriate site restoration and monitoring activities would take place, construction activities associated with closure of basin elements would not be expected to significantly affect common terrestrial species.

Conveyance/Collection Systems. Construction effects of the In-Valley/Water Needs Land Retirement Alternative would be similar to the In-Valley Disposal Alternative described in Section 7.2.4.1.

Treatment Facilities. Construction of the In-Valley/Water Needs Land Retirement Alternative's proposed RO and biological treatment facilities would result in the permanent loss of approximately 9 acres of agricultural habitat and would be similar to the effects described in Section 7.2.4.1 for the In-Valley Disposal Alternative and are not significant.

Retired Lands. A total of 193,956 acres of active and fallowed agricultural land would be acquired and permanently retired under the In-Valley/Water Needs Land Retirement Alternative, an increase of 173,438 acres over current (2002) conditions, and 84,850 acres more than would be expected over the next 50 years under No Action.

A portion of the 193,956 acres of retired land would be developed for project purposes (reuse areas, evaporation basins, evaporation basin mitigation) and 7,000 acres of the total would be acquired and managed under the CVPIA Land Retirement Program to provide wildlife habitat (outside the scope of this project).

As currently proposed, one-third of the remaining land would initially be planted with nonirrigated forage suitable for grazing sheep and two-thirds would be prepared to facilitate dryland farming. Initial development would be designed not only to attract potential lessees/operators, but to protect the soil and help prevent the spread of noxious weeds until lessees/operators are found. These initial efforts would include disking or turning under the existing irrigated crops or cover, planting new vegetation (if appropriate), controlling weeds, and possibly removing or relocating existing infrastructure. These typical farm activities would result in minor or temporary effects to common terrestrial species, most of which are well adapted to the San Joaquin Valley's intensively managed agricultural landscape. In general, the biological effects to terrestrial species that would result from these initial construction and capital improvements would not be significant.

Potential biological effects to terrestrial species from long-term operation of the retired lands for grazing or dryland farming are discussed in the following section.

Operation Effects

Detailed operating plans and development schedules for the In-Valley/Water Needs Land Retirement Alternative's major facilities have not yet been completed. Subsequently, the following evaluation of potential operational effects to terrestrial resources is based on conceptual operating plans.

Reuse Areas. Long-term operation of the 16 reuse facilities, totaling 12,500 acres when phased construction is completed, would not significantly alter the overall quantity of agricultural habitat from a local or regional perspective. A permanent change in agricultural and ruderal habitats would occur to predominantly salt-tolerant pasture grasses. Each facility's day-to-day operations would be similar to the common farming activities that already take place throughout the project area. The mix of salt-tolerant vegetation that would be planted and maintained at the facilities would continue to provide marginal cover and foraging habitat similar in value to other managed agricultural lands in the San Joaquin Valley. Any marginal loss of terrestrial habitat value that might result from conversion from prior agricultural uses would be offset by the more diverse regional mix of forage and cover provided by substantial acreages of retired land converted to dryland crops (e.g., barley, wheat) and sheep pasture, and by CVPIA Land Retirement Program revegetated parcels. No significant effects are anticipated. See

Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Evaporation Basins. The In-Valley/Water Needs Land Retirement Alternative's four evaporation facilities would be located adjacent to, or surrounded by, existing croplands, proposed reuse areas, and/or retired lands and would not be concentrated in any one part of the project area. The sites would be intensively managed to prevent establishment of upland, emergent, or riparian vegetation and, thus, would not be attractive to terrestrial wildlife. A permanent loss of agricultural and ruderal habitat would occur on 4 disjunct sites (totaling 2,159 acres), following construction of evaporation and treatment facilities. The loss of terrestrial habitat that would result from permanent conversion of the sites from prior agricultural use to evaporation basin use would be compensated by the more diverse habitat that would be provided by the adjoining or surrounding, reuse areas or retired (dryland farmed or grazed) parcels and the effects are not significant. See Section 8.2.2.1 for an evaluation of potential effects to terrestrial biological resources due to elevated Se concentrations at the evaporation basins.

Conveyance/Collection Systems. Operation of the network of buried pipelines, sumps, pumps, and controls that comprise the collection and conveyance systems would be similar to the In-Valley Disposal Alternative described in Section 7.2.4.1. The effects are not significant.

Treatment Facilities. Operation of the proposed RO facilities and biological treatment plants would be similar to that described for the In-Valley Disposal Alternative in Section 7.2.4.1. The effects are not significant.

Retired Lands. A total of 193,956 acres of active and fallowed agricultural land would be acquired and permanently retired under the In-Valley/Water Needs Land Retirement Alternative, an increase of 173,438 acres over current (2002) conditions, and 84,850 acres more than would be expected over the next 50 years under No Action. Vegetation on these lands has not yet been thoroughly inventoried so current ground cover, vegetation conditions, and habitat value are unknown. A portion of the 193,956 acres of retired land would be developed for project purposes (reuse areas, evaporation basins, evaporation basin mitigation) and 7,000 acres of the total would be acquired and managed under the CVPIA Land Retirement Program to provide wildlife benefits. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. Minor to significant increases/decreases in habitat value would result, depending on location, season, existing vegetation, and affected species. Any significant net reduction in the amount of higher-valued (for wildlife) agricultural crops could result in localized unavoidable significant adverse effects for some foraging species.

As currently proposed, operational effects would be similar to those described for the In-Valley Disposal Alternative in Section 7.2.4.1 and are not significant.

7.2.6.2 Aquatic and Wetland Resources

Construction Effects

All of the In-Valley/Water Needs Land Retirement Alternative's major facilities would be constructed on active or fallowed agricultural lands or on permanently retired croplands, settlement lands, or other previously disturbed agricultural parcels (e.g., farm roads, ditches, canal ROWs, fencelines, field borders, etc.). Because facility construction is focused toward upland sites, construction effects to aquatic and wetland resources would likely be limited to disturbances to existing agricultural ditches, drainageways, and swales.

Reuse Areas and Evaporation Basins. Construction of the proposed reuse facilities and evaporation basins could result in a significant loss of natural aquatic or wetland habitat, and construction effects would be similar to the In-Valley Disposal Alterative described in Section 7.2.4.2. These effects can be mitigated to not significant.

Conveyance/Collection System. Installation of conveyance system pipelines at stream crossings, agricultural waterways, or other wetland habitats (if any) would be completed using procedures that minimize effects. Following pipeline installation, affected waterways would immediately be restored to preconstruction profiles and revegetated. Similarly to the In-Valley Disposal Alternative, no significant effects to aquatic and wetland resources are anticipated to occur as a result of construction of collection and conveyance facilities.

Operation Effects

Reuse Areas. The 12,500 acres of proposed reuse areas would be designed and operated to sustain long-term production and maintenance of selected salt-tolerant crops. Typical reuse area operations would be very similar to the farming activities that historically took place at the sites and throughout the project area. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Evaporation Basins. Significant adverse effects could be substantially mitigated. However, any effects not mitigated would be unavoidable as described in Section 7.2.4.2.

Treatment Facilities. Operation of the four proposed RO and biological treatment plants would have no direct significant effects on aquatic and wetland resources and is similar to the description of the In-Valley Disposal Alternative in Section 7.2.4.2.

Conveyance/Collection Systems. Once constructed, operation of the buried collection and conveyance pipelines would have no significant effects on existing aquatic and wetland resources.

7.2.6.3 Special-Status Species

Based on an extensive literature review, consultation with species experts, reconnaissance surveys in the general vicinities of proposed facility sites and pipeline alignments, and an evaluation of recent occurrence records (CDFG 2003), it was determined that only 16 listed species could occur in areas affected by construction or operation of the In-Valley/Water Needs Land Retirement Alternative. The 69 remaining species (from the list of 85 compiled from the Service, NOAA Fisheries, and CDFG covering all action alternatives; see Appendix F, Table F-1) were eliminated from further consideration because (1) areas of potential occurrence were associated with other action alternatives or fell well outside the "footprint" of anticipated construction and operational effects of this alternative, (2) suitable habitat no longer was thought to be present in the areas being evaluated, or (3) the absence of recent occurrence records was highly indicative that the species no longer is present in the areas being evaluated. Table 7-2 in Section 7.2.4.2 identifies the 16 listed special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by this alternative. Reclamation has completed consultation with the Service for species with determinations of "may adversely affect" under Section 7 of the ESA that identified measures to avoid or minimize potential effects to special-status species. At present, species-focused endangered species biological surveys have not yet been completed on any proposed construction sites or pipeline alignments.

Construction Effects

As described in Section 7.2.4.3, significant effects to some listed species could occur. The probability of adversely affecting any listed species during construction of In-Valley/Water Needs Land Retirement Alternative facilities would be quite small with completion of preconstruction biological surveys and implementation of accepted species-directed protocols and avoidance measures. These measures could reduce the effects to not significant.

Construction of the reuse facilities, evaporation basins, treatment facilities, and collection system would occur on active, fallowed, or retired agricultural lands, greatly reducing the potential to adversely affect any of the listed species. No construction is expected to take place in riparian corridors or within mapped emergent wetlands, and no roost sites or nest trees would likely be disturbed.

For broad-ranging species that forage in agricultural and ruderal lands, construction disturbances would typically be minor and temporary. Any permanent loss of existing agricultural and ruderal foraging areas generally would not be considered significant because these habitats are common both locally and regionally. Furthermore, any permanent losses of existing irrigated crop foraging areas would be compensated for by additional diversity provided by the potentially large parcels of retired lands that would be managed for dryland grain production and sheep pasture.

Construction effects on the San Joaquin kit fox, Swainson's hawk, greater sandhill crane, western burrowing owl, bald eagle, American peregrine falcon, California black rail, western yellow-billed cuckoo, giant garter snake, and California red-legged frog would be the same as described in Section 7.2.4.3 for the In-Valley Disposal Alternative. Significant effects can be mitigated to not significant.

None of the listed **Chinook salmon** or **steelhead ESUs**, **Delta smelt**, or **green sturgeon** would be affected by construction activities associated with In-Valley/Water Needs Land Retirement Alternative features or facilities and no Critical Habitats would be adversely modified during construction.

Operation Effects

Similarly to the In-Valley Disposal Alternative, none of the listed species would be significantly affected by operation of the collection system or treatment facilities or the anticipated noise, lighting, vehicle traffic, or equipment use that would be associated with facility operation. No mappable units of native or sensitive terrestrial habitat types, as identified in the CNDDB (CDFG 2003), would be affected by the In-Valley/Water Needs Land Retirement Alternative features. Potential effects to special-status species as a result of Se bioaccumulation are discussed in Section 8.2.4.3.

7.2.7 In-Valley/Drainage-Impaired Area Land Retirement Alternative

The In-Valley/Drainage-Impaired Area Land Retirement Alternative is a variation of the other Land Retirement Alternatives evaluated in Sections 7.2.6 and 7.2.5 and the In-Valley Disposal Alternative evaluated in Section 7.2.4. The overall project "footprint," however, increases substantially with the proposed retirement of 308,000 acres of irrigated land. With this large land retirement program, though, the need for evaporation basins, reuse areas, treatment capacity, and collection/conveyance systems would be significantly reduced, resulting in a general reduction in biological effects.

7.2.7.1 Terrestrial Resources

Construction of the In-Valley/Drainage-Impaired Area Land Retirement Alternative's major facilities is expected to take approximately 5 years, with full implementation not expected to occur for a decade or more. A range of temporary and permanent effects to existing terrestrial biological resources would result from expansion of existing Northerly Area drainwater collection systems, limited construction of new conveyance pipelines, expansion of existing Northerly Area reuse capacity, and construction of a single Northerly Area evaporation facility with associated RO and biological treatment plants. Terrestrial resources would also be affected by permanent retirement of 308,000 acres (in total) of irrigated lands and by development of required evaporation basin mitigation sites (potentially including construction of new wetlands and restoration or enhancement of existing sites) would permanently convert an as-yet-undetermined area of terrestrial habitat to seasonal and permanent wetland habitats.

Currently (2002), approximately 70 percent of the acreage comprising proposed facility sites and retirement lands is planted in cotton and vegetable row crops, or has been fallowed. The remainder of the proposed sites is predominantly small grain crops, with approximately 5 percent being alfalfa or pasture grasses.

<u>Construction Effects</u>

The construction effects on terrestrial resources, with the exception of minor acreage changes described below, are similar to the effects described in Section 7.2.4.1 for the In-Valley Disposal Alternative. With preconstruction biological surveys to locate potential occurrences of nest trees, roosts, or den sites, and subsequent implementation of appropriate conservation measures and construction practices, effects to common terrestrial biological resources from construction of this alternative's facilities would not be significant.

Reuse Areas. Planned reuse area development would be limited to expansion of the existing 4,000-acre Panoche Reuse Facility (i.e., Grassland Bypass Project) to 7,500 acres. The expansion would disturb 3,500 acres, most of which is currently dominated by cotton and row crops. Construction effects on reuse areas would be similar to the In-Valley Disposal Alternative described in Section 7.2.4.1.

Evaporation Basins. Staged construction of the proposed evaporation facility (totaling 1,270 acres when fully operational) would result in similar construction-related effects to terrestrial biological resources as described for the In-Valley Disposal Alternative in Section 7.2.4.1.

Conveyance/Collection Systems. Construction of the In-Valley/Drainage-Impaired Area Land Retirement Alternative's 1.1-mile conveyance pipeline and the expanded collection system with its associated sumps, pumps, and controls would result in generally temporary and minor effects to terrestrial species. Construction effects of the conveyance/collection system on terrestrial resources would be similar to those described for the In-Valley Disposal Alternative in Section 7.2.4.1.

Treatment Facilities. Construction of the In-Valley/Drainage-Impaired Area Land Retirement Alternative's single RO and biological treatment facilities would be similar to the effects described in Section 7.2.4.1 for the In-Valley Disposal Alternative.

Retired Lands. A total of 308,000 acres of active and fallowed agricultural land would be acquired and permanently retired under the In-Valley/Drainage-Impaired Area Land Retirement Alternative, an increase of 287,482 acres over current (2002) conditions, and 198,894 acres more than would be expected over the next 50 years under No Action.

All of the lands are located in Westlands, except for 10,000 acres in the Northerly Area. None is targeted for project facilities–although using selected sites for development of evaporation basin mitigation wetlands has not been investigated. Approximately 7,000 acres of the total would be separately acquired and managed under the CVPIA Land Retirement Program to provide wildlife habitat (outside the scope of this project).

As currently proposed, one-third of the available retired land would initially be planted with nonirrigated forage crops suitable for grazing sheep and two-thirds would be prepared to facilitate dryland farming. Initial development would be designed not only to attract potential lessees/operators, but to protect the soil and help prevent the spread of noxious weeds until lessees/operators are found. These initial efforts may include disking or turning under the existing irrigated crops or cover, planting new vegetation (if appropriate), controlling weeds, and possibly removing or relocating existing infrastructure as deemed necessary. These typical farm activities would result in minor or temporary effects to common terrestrial species, most of which are adapted to the intensively managed agricultural landscape. In general, the biological effects to terrestrial species that would result from these initial construction and capital improvements would not be significant.

Potential biological effects to terrestrial species from long-term operation of the retired lands for grazing or dryland farming are discussed in the following section.

<u>Operation Effects</u>

Detailed operating plans and development schedules for the In-Valley/Drainage-Impaired Area Land Retirement Alternative's major facilities and retirement lands have not yet been completed. Subsequently, the following evaluation of potential operational effects to terrestrial resources is based on conceptual operating plans.

It is anticipated that with appropriate planning, monitoring, and management, operation of this alternative's major facilities would not significantly affect common terrestrial wildlife resources. (See Sections 7.2.7.2 and 7.2.7.3 for discussion of operational effects to aquatic/wetland resources and special-status species.)

Reuse Area. Long-term operation of the reuse facility, totaling 7,500 acres when phased construction is completed, would not significantly alter the overall quantity of agricultural habitat from a local or regional perspective. A permanent change in agricultural and ruderal habitats would occur to predominantly salt-tolerant pasture grasses. The facility's day-to-day operation would be similar to the common farming activities that already take place throughout the project area. The mix of salt-tolerant vegetation that would be planted and maintained at the facility would continue to provide marginal cover and foraging habitat similar in value to other managed agricultural lands in the San Joaquin Valley. Any marginal loss of terrestrial habitat value that might result from conversion from prior agricultural uses would be offset by the more diverse regional mix of forage and cover provided by substantial acreages of retired land converted to dryland crops (e.g., barley, wheat) and sheep pasture, and by CVPIA Land Retirement Program restoration tracts. No significant effects are anticipated. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Evaporation Basin. The In-Valley/Drainage-Impaired Area Land Retirement Alternative's evaporation facility would be located adjacent to existing croplands and the proposed reuse area. The site would be intensively managed to prevent establishment of upland, emergent, or riparian vegetation and, thus, would not be attractive to terrestrial wildlife. A permanent loss of agricultural and ruderal habitat would occur at the 1,275-acre evaporation and treatment facility. The loss of terrestrial habitat value that would result from permanent conversion of the site from prior agricultural use to evaporation basin use would be offset by the more diverse habitat that would be provided by the reuse area and nearby retired (dryland farmed or grazed) parcels. See Section 8.2.2.1 for an evaluation of potential effects to terrestrial biological resources due to elevated Se concentrations at the evaporation basins.

Conveyance/Collection Systems. Operation of the network of buried pipelines, sumps, pumps, and controls that comprise the collection and conveyance systems would be similar to that described for the In-Valley Disposal Alternative in Section 7.2.4.1.

Treatment Facilities. Operation of the proposed RO and biological treatment plants would be similar to that described for the In-Valley Disposal Alternative in Section 7.2.4.1.

Retired Lands. A total of 308,000 acres of active and fallowed agricultural land would be acquired and permanently retired under the In-Valley/Drainage-Impaired Area Land Retirement Alternative, an increase of 287,482 acres over current (2002) conditions and 198,894 acres more than would be expected over the next 50 years under No Action. Vegetation on these lands has not yet been thoroughly inventoried so current ground cover, vegetation conditions, and habitat value are unknown.

All of the lands are located in Westlands, except for 10,000 acres in the Northerly Area. None is targeted for project facilities–although using selected sites for development of evaporation basin mitigation wetlands has not been investigated. Approximately 7,000 acres of the total would be managed under the CVPIA Land Retirement Program to provide wildlife habitat (outside the scope of this project), and about 8,779 would be used for project facilities and ROWs. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. Minor to significant increases/decreases in habitat value would result, depending on location, season, existing vegetation, and affected species. Any significant net reduction in the amount of higher-valued (for wildlife) agricultural crops could result in localized unavoidable adverse effects for some foraging species.

As currently proposed, operational effects would be similar to those described for the In-Valley Disposal Alternative in Section 7.2.4.1.

7.2.7.2 Aquatic and Wetland Resources

Construction Effects

All of the In-Valley/Drainage-Impaired Area Land Retirement Alternative's major facilities would be constructed on active or fallowed agricultural lands or on permanently retired croplands or other previously disturbed agricultural parcels (e.g., farm roads, ditches, canal ROWs, fencelines, field borders, etc.). Because facility construction is focused toward upland sites, construction effects to aquatic and wetland resources would likely be limited to disturbances to existing agricultural ditches, drainageways, and swales.

Reuse Area and Evaporation Basin. Construction of the proposed reuse facility and evaporation basin could result in a significant loss of natural aquatic or wetland habitat, and construction effects on aquatic and wetland resources would be similar to the In-Valley Disposal Alternative described in Section 7.2.4.2.

Conveyance/Collection System. Installation of conveyance system pipelines at stream crossings, agricultural waterways, or other wetland habitats (if any) would be completed using procedures that minimize effects. Following pipeline installation, affected waterways would immediately be restored to preconstruction profiles and revegetated. Similarly to the In-Valley Disposal Alternative, no significant effects to aquatic and wetland resources are anticipated to occur as a result of construction of collection and conveyance facilities.

Operation Effects

Reuse Area. The 7,500-acre reuse area would be designed and operated to sustain long-term production and maintenance of selected salt-tolerant crops. Typical reuse area operations would be very similar to the farming activities that historically took place throughout the project area. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Evaporation Basin. As described in Section 7.2.4.2, significant adverse effects could be substantially mitigated. However, any remaining effects would be unavoidable.

Treatment Facilities. Operation of the proposed RO and biological treatment plants would have no direct significant effect on aquatic and wetland resources and is similar to the description of the In-Valley Disposal Alternative in Section 7.2.4.2.

Conveyance/Collection Systems. Once constructed, operation of the buried collection and conveyance pipelines would have no significant effects on existing aquatic and wetland resources. Operation of this alternative's Delta-Mendota Canal Sumps to intercept Se-contaminated drainwater before it enters the canal in the Firebaugh vicinity would reduce the Se load entering the canal and the San Joaquin River downstream at Mendota Pool.

7.2.7.3 Special-Status Species

Based on an extensive literature review, consultation with species experts, reconnaissance surveys in the general vicinities of proposed facility sites and pipeline alignments, and an evaluation of recent occurrence records (CDFG 2003), it was determined that 16 listed species could occur in areas affected by construction or operation of the In-Valley/Drainage-Impaired Area Land Retirement Alternative. The 69 remaining species (from the list of 85 compiled from the Service, NOAA Fisheries, and CDFG covering all action alternatives; see Appendix F, Table F-1) were eliminated from further consideration under this alternative because (1) areas of potential occurrence were associated with other action alternatives or fell well outside the “footprint” of anticipated construction and operational effects of this alternative, (2) suitable habitat no longer was thought to be present in the areas being evaluated, or (3) the absence of recent occurrence records was highly indicative that the species no longer is present in the areas being evaluated. Table 7-2 in Section 7.2.4.3 identifies the 16 listed special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by this alternative. Reclamation has completed consultation with the Service for species with determinations of “may adversely affect” under Section 7 of the ESA that identified measures to avoid or minimize potential effects to special-status species. At present, species-focused endangered species biological surveys have not yet been completed on any proposed construction sites or pipeline alignments.

Construction Effects

The probability of adversely affecting any listed species during construction of In-Valley/Drainage-Impaired Area Land Retirement Alternative facilities would be quite small with completion of preconstruction biological surveys and implementation of accepted species-directed protocols and avoidance measures are fully implemented.

Construction of the reuse facility, evaporation basin, treatment facilities, and collection system would occur on active, fallowed, or retired agricultural lands, greatly reducing the potential to adversely affect any of the listed species. No construction is expected to take place in riparian corridors or within mapped emergent wetlands, and no roost sites or nest trees would likely be disturbed.

For broad-ranging species that forage in agricultural and ruderal lands, construction disturbances would typically be minor and temporary. Any permanent loss of existing agricultural and ruderal foraging areas generally would not be considered significant because these habitats are common both locally and regionally. Furthermore, any permanent losses of existing irrigated crops would be compensated for by additional diversity provided by the large, frequently contiguous, parcels of retired lands that would be managed for dryland grain production and sheep pasture.

Construction effects on the San Joaquin kit fox, Swainson’s hawks, greater sandhill cranes, western burrowing owls, bald eagle, American peregrine falcon, California black rail, western yellow-billed cuckoo, giant garter snake, and California red-legged frog would be the same as described in Section 7.2.4.3 for the In-Valley Disposal Alternative.

None of the listed **Chinook salmon** or **steelhead ESUs**, **Delta smelt**, or **green sturgeon** would be affected by construction activities associated with In-Valley/Drainage-Impaired Area Land Retirement Alternative features or facilities and no Critical Habitats would be adversely modified during construction.

Operation Effects

Similarly to the In-Valley Disposal Alternative, none of the listed species would be significantly affected by operation of the collection system or treatment facility or the minimal noise, lighting, vehicle traffic, or equipment use that would be associated with facility operation. No mappable units of native or sensitive terrestrial habitat types, as identified in the CNDDB (CDFG 2003), would be affected by the In-Valley/Drainage-Impaired Area Land Retirement Alternative features. Potential effects to special-status species as a result of Se bioaccumulation are discussed in Section 8.2.4.3.

7.2.8 Ocean Disposal Alternative

Evaluation of potential effects to biological resources from construction and operation of the Ocean Disposal Alternative is based on *appraisal-level* designs and specifications. At present, only general site plans for the major facilities and conveyance alignments have been completed. Detailed specifications for this alternative's major facilities, permanent structures (buildings, tunnel portals, maintenance yards, roads, berms, fences, pump facilities, powerlines, etc.), construction schedules, and facility operating plans are not yet available.

7.2.8.1 Terrestrial Resources

The Ocean Disposal Alternative would include both "in-valley" and "out-of-valley" components. Implementation would affect large areas of active and retired agricultural lands in the San Joaquin Valley, as well as previously disturbed and natural sites extending westward along the proposed aqueduct corridor to the Pacific Ocean. Potential effects could result from construction and operation of the 213-mile aqueduct and its associated tunnels and undersea outfall, the drainwater collection and conveyance systems, 16 reuse facilities, and numerous pump stations. No evaporation basins or treatment facilities would be constructed and no mitigation wetlands would be required.

Construction Effects

Although final site selections and facility designs have not yet been completed, it is anticipated that all of the major "in-valley" components of the Ocean Disposal Alternative (collection systems, reuse facilities, and the "in-valley" pumping plants, conveyance system, and aqueduct segment east of I-5) would be constructed on active or temporarily fallowed agricultural lands or on permanently retired croplands, settlement lands, or other previously disturbed agricultural parcels (e.g., farm roads, ditches, canal ROWs, fencelines, field borders, etc.). These agricultural parcels are common both locally and regionally and generally are considered to have low habitat value compared to natural vegetation types. The "out-of-valley" aqueduct segment, tunnels and pumping plants would generally traverse previously disturbed transportation and utility ROWs, croplands, and urban land.

During construction, mobile terrestrial wildlife species would disperse to adjoining areas of similar habitat. Less mobile species, including a number of nesting and burrowing/denning species, could be killed or displaced during construction. With completion of preconstruction botanical and biological surveys to identify sites or resources that may warrant special consideration, and subsequent implementation of approved conservation measures and appropriate construction practices, effects to common terrestrial species from construction of Ocean Disposal facilities are not expected to be significant.

Surface disturbances associated with construction and operation of the Ocean Disposal Alternative facilities could introduce or spread noxious weeds and other undesirable vegetation. However, Reclamation routinely requires appropriate weed control procedures and construction site management; therefore, effects are not expected to be significant.

Reuse Areas. Staged development of the 16 reuse areas would require surface disturbance of up to 19,000 acres, most of which would take place on active cropland. Activities required to initially develop typical reuse sites would be similar to farming activities that historically took place at the sites. Development would include surface contouring and leveling; installation of irrigation systems, subsurface drains, sumps, and buried collectors; initial planting, clearing, or turning under of existing crops; and similar site preparation activities. These activities, like the previous farming practices, could result in minor or temporary effects to the common terrestrial species that have adapted to the valley's intensively managed agricultural landscape. For reuse facilities that would be located in whole or in part on already retired, abandoned, or fallowed parcels, construction would remove ruderal vegetation, nonirrigated cover crops, or residual vegetation from earlier farm use.

Collection/Conveyance. Construction of the Ocean Disposal Alternative's extensive linear network of 1,000+ miles of buried collection pipelines and associated sumps, pumps and controls could result in widely distributed, but generally minor and temporary effects to terrestrial species. As currently proposed, the entire collection system would be constructed as buried pipelines (as opposed to open canals). Construction would take place in narrow linear corridors entirely within the agricultural heart of the valley and generally would be limited to previously disturbed road, canal, and railroad ROWs or the perimeters of agricultural fields. In this previously disturbed, topographically flat, and easily accessible landscape, pipeline construction (trench excavation, pipe placement, and backfilling) would move quickly, with generally minor and temporary disturbance to terrestrial wildlife resources.

Ocean Aqueduct. Construction of the 211-mile aqueduct would disturb approximately 2,000 acres, assuming a 75-foot construction corridor. Most of the alignment would follow existing highway, railroad, and powerline ROWs, effectively minimizing potential construction-related effects to undisturbed or sensitive terrestrial communities. More than 70 percent of the pipeline corridor would traverse cropland, vineyard, and urban habitats. Approximately 25 percent would cross grazed annual grassland and scattered woodland habitat types. The remaining 5 percent, comprised mainly of stream crossings and other wetland and aquatic habitat types, is addressed in Section 7.2.8.2. All pumping plants would be located within the aqueduct corridor in close proximity to road ROWs, typically on cropland or grazed grasslands. An unspecified amount of terrestrial habitat would also be disturbed for temporary access/haul roads, equipment staging areas, and for disposal of excavated materials from tunnel boring and pipeline construction. With preconstruction botanical and biological surveys, approved construction techniques, and appropriate site restoration, it is anticipated that effects to common terrestrial resources from construction of the aqueduct could be reduced to not significant.

Retired Lands. A total of 44,106 acres of active and fallowed agricultural land would be acquired and permanently retired under the Ocean Disposal Alternative, an increase of 23,588 acres over current (2002) conditions, but 65,000 acres less than would be expected over the next 50 years under No Action. None of these lands have been thoroughly inventoried so current ground cover, vegetation conditions, and habitat values are unknown.

A portion of the 44,106 acres of retired land would be developed for project purposes (reuse areas, treatment facilities), and 7,000 acres of the total would be separately acquired and managed under the CVPIA Land Retirement Program to provide wildlife habitat (outside the scope of this project). For planning purposes, it is assumed that one-third of the remaining land would be planted with nonirrigated forage suitable for grazing sheep and two-thirds would be dryland farmed. Initial activities on the retired parcels would include disking or turning under the existing irrigated crops or cover, planting new vegetation (if appropriate), controlling weeds, and possibly removing or relocating existing infrastructure. These typical farm activities could result in minor or temporary effects to common terrestrial species, many of which are well adapted to the valley's intensively managed agricultural landscape. In general, construction effects associated with the Ocean Disposal Alternative's retired lands are not expected to be significant.

Potential biological effects to terrestrial species from long-term *operation* of the retired lands for grazing or dryland farming are discussed in the following section.

Operation Effects

Facility site plans, detailed design specifications, and development schedules are not yet available. Subsequently, this evaluation of potential operational effects is based on a conceptual operating plan.

Reuse Areas. Operation of the 16 reuse facilities, totaling 19,000 acres when phased construction is completed, would not significantly alter the overall quantity or availability of terrestrial habitat from a local or regional perspective. A permanent change in agricultural and ruderal habitats would occur to predominantly salt-tolerant pasture grasses. Typical reuse area operations would be very similar to the farming activities that historically took place at the sites and throughout the project area. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Collection/Conveyance and Aqueduct. Operation of the Ocean Disposal Alternative's buried aqueduct, tunnels, pumping plants, and buried collection system would have no significant effects on terrestrial species or habitats under normal operating conditions. All pumping plants associated with the aqueduct would be enclosed in buildings and would create no significant effects from noise, traffic, and lighting.

Retired Lands. A total of 44,106 acres of active and fallowed agricultural land would be acquired and permanently retired under the Ocean Disposal Alternative, an increase of 23,588 acres over current (2002) conditions, but 65,000 acres less than would be expected over the next 50 years under No Action. Vegetation on these lands has not yet been thoroughly inventoried so current ground cover, vegetation conditions, and habitat value is unknown. A portion of the 44,106 acres of retired land would be developed for project purposes (e.g., reuse areas), and 7,000 acres of the total would be separately acquired and managed under the CVPIA Land Retirement Program to provide wildlife benefits.

As currently proposed, one-third of the remaining land would be operated as grazing land for sheep and two-thirds would be dryland farmed. It is assumed that in any given year, approximately one-half of the farmed acreage would be fallowed. None of the land would be specifically managed to develop wildlife habitat or to provide long-term wildlife benefits.

Any retired agricultural lands converted to nonirrigated crops would continue to periodically be disturbed for cultivation and harvesting and, therefore, would not typically develop significant wildlife value. Production of small grains (wheat, barley) would at least provide a degree of improvement over existing irrigated crops, but would depend on location, parcel size, adjacent habitats, and management. Similarly, grazed lands could provide a desirable mix of vegetation cover, offering better forage and cover than previous irrigated crops.

Fallowed, abandoned, or heavily grazed lands could quickly be invaded by noxious weeds and undesirable invasive species; however, it is anticipated that existing coordinated weed control programs would expand to include any newly retired lands. Some of the retired lands would continue to act as salt sinks, collecting and concentrating salts until they support limited vegetation, and offer little wildlife habitat value.

In general, in the absence of any long-term program or funding mechanism to develop and manage the retired lands under the Ocean Disposal Alternative to significantly improve wildlife habitat, the effect to terrestrial resources from anticipated long-term changes in vegetation and cropping patterns would be only slightly beneficial, resulting in no significant beneficial effect.

7.2.8.2 Aquatic and Wetland Resources

Construction Effects

Construction of the Ocean Disposal Alternative would result in temporary and permanent effects to aquatic and wetland habitat types. Construction would include the 16 reuse facilities (totaling 19,000 acres), the in-valley and out-of-valley segments of the aqueduct, undersea outfall, 6 tunnel portals, 10 pumping plants, and the collection system. No treatment facilities or evaporation basins would be constructed as part of the Ocean Disposal Alternative.

Reuse Areas. Staged development of the reuse facilities is not expected to substantially affect aquatic and wetland resources. Because the facilities would be located on active or retired agricultural lands, significant construction effects to aquatic, riparian, or wetland habitat types would be unlikely. Based on an appraisal-level reconnaissance, few, if any, natural stream channels traverse the sites (hydrologic features are typically shallow swales, irrigation ditches, or agricultural drainageways) and no substantial wetlands were identified. No significant effects to aquatic and wetland resources are anticipated to occur as a result of development of the reuse areas.

Collection/Conveyance. Construction of the extensive network of buried collection pipelines and associated sumps, pumps, and controls would result in widely distributed, but generally temporary effects. As proposed, the entire collection system would be constructed as buried pipelines (as opposed to open canals). Construction would take place in narrow linear corridors entirely within the agricultural heart of the valley and generally would be limited to previously disturbed road, canal, and railroad ROWs or the perimeters of agricultural fields. Stream crossings in this environment typically would involve existing ditches and canals. In this topographically flat agricultural landscape, pipeline construction (trench excavation, pipe placement, and backfilling) would move quickly, with minor and temporary disturbances at the few anticipated aquatic and wetland sites that might be encountered. No significant effects to aquatic and wetland resources are anticipated to occur as a result of construction of collection and conveyance facilities.

Ocean Aqueduct. Effects to aquatic and wetland resources from construction of the 211-mile buried ocean aqueduct would also be widely distributed, but largely temporary. Based on an appraisal-level analysis of 1:24000 scale USGS topographic maps and limited reconnaissance-level ground truthing, the aqueduct corridor would cross 102 intermittent and permanent stream channels, the vast majority being small ephemeral drainages. Major stream crossings would include the Salinas River, Paso Robles Creek, Estrella River, and Cholame Creek. Most of the crossings would be located near existing bridge crossings or road culverts since the majority of the pipeline alignment would follow existing highway, railroad, and powerline ROWs. Construction corridors would be narrowed to a minimum width necessary to complete the crossing; however, assuming a 75-foot construction corridor, an average of 0.1 acre of aquatic habitat/riparian habitat would be disturbed at each crossing. All crossings would be restored to original contours and revegetated following construction. Pumping plants would be located and designed to avoid effects to aquatic and wetland habitats.

At present, detailed alignments have not been determined; however, once final conveyance alignments and related facility locations have been selected, preconstruction wetland delineations, pursuant to Section 401/404 of the Clean Water Act, would be completed on all wetlands, stream crossings, adjacent riparian habitat, and other waters of the United States likely to be affected by aqueduct construction.

No pipeline or facility construction would begin until the Section 401/404 discharge permits are obtained from the USACE and Streambed Alteration Agreements are obtained from the State. The permit/agreement application(s) would identify all affected sites and specify measures that would be taken to avoid or mitigate adverse effects. Construction activities taking place in delineated wetland areas and/or stream channel crossings would follow site-specific and general BMPs. If, because of individual site conditions, it is determined that a net loss of wetland habitat values cannot be avoided, replacement habitat would be developed at ratios specified in the permit.

All temporary facilities (temporary access/haul roads, equipment staging areas, and disposal sites for excavated spoil from tunnel boring and pipeline construction) would be designed and sited to avoid effects to streams, wetlands, and other sensitive habitats and would be stabilized, recontoured, and revegetated to protect downstream/downslope aquatic resources.

Significant effects to aquatic and wetland resources could occur as a result of construction of the aqueduct, but these effects could be avoided or mitigated by the measures described above so that effects would be reduced to not significant.

Ocean Outfall. Construction activity associated with installation of the 1.44-mile-long ocean outfall (comprised of a 0.73-mile buried pipe segment, 0.71-mile suspended pipe segment, and diffuser) would result in disturbances to the sea floor and coastal zone (including dunes, foredunes, sea cliffs, and a small coastal stream), although most construction-related effects would be temporary.

Undersea construction would disturb the sea floor, resulting in direct effects to the benthic community, particularly where trenching would be required. Effects would depend on the type of substrate, either soft-bottomed or rocky. Disturbed sediments from excavation of soft-bottomed substrates would spread over the area, covering benthic organisms along and downcurrent of the installation corridor. Distances the disturbed sediments would travel before settling have not been calculated. Construction of the deeper suspended portion of the outfall would likely result in significantly less sea floor disturbance than the trenched segment. Most fish species, due to their mobility, are not expected to be significantly affected during construction or placement of the pipeline and diffuser and would return to the construction zone once construction was completed. Marine mammals could be injured or disturbed by construction activities and noise, but the degree and probability of effects would depend on the timing of the activity and the activity's distance from areas transiently used by the species. No significant effects to aquatic and wetland resources are anticipated to occur as a result of construction of the outfall.

Operation Effects

Detailed operating plans and development schedules for the Ocean Disposal Alternative's major facilities have not yet been completed. Subsequently, the following evaluation of potential operational effects to aquatic and wetland resources is based on conceptual operating plans.

Reuse Areas. The 19,000 acres of proposed reuse areas would be designed and operated to sustain long-term production and maintenance of selected salt-tolerant crops. Under normal operations no wetland or aquatic habitat would be permitted to develop: therefore, no significant effects to aquatic and wetland resources are anticipated to occur. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Ocean Outfall. An evaluation of the effects of Se discharges on water quality and aquatic resources are presented in Sections 5.2.8 and 8.2.8.2, respectively.

7.2.8.3 Special-Status Species

Based on an extensive literature review, consultations with species experts, reconnaissance surveys of the general vicinities of facility sites and aqueduct alignments, and an evaluation of recent occurrence records (CDFG 2003), it was determined that 16 listed species could occur in areas affected by construction or operation of the Ocean Disposal Alternative. The 69 remaining species (from the list of 85 species provided by the Service, NOAA Fisheries, and CDFG; see Appendix F, Table F-1) were eliminated from further consideration under this alternative because (1) areas of potential occurrence were associated with other action alternatives or fell well outside the probable "footprint" of anticipated construction and operational effects of the Ocean Disposal Alternative, (2) suitable habitat no longer is thought to be present in the areas being evaluated, or (3) the absence of recent occurrence records is highly indicative that the species no longer is present in the areas being evaluated. Table 7-3 identifies the 16 listed special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by the Ocean Disposal Alternative. For Federally listed species with "may adversely affect" determinations, Reclamation would engage in consultation with the Service under Section 7 of the ESA to identify measures to avoid or minimize potential effects if this alternative is selected.

At present, species-focused endangered species biological surveys have not yet been completed on any proposed construction sites or pipeline alignments.

Table 7-3
Special-Status Species That May Be Affected by the Ocean Disposal Alternative

Common Name	Scientific Name	Federal Status	State Status	Effect
San Joaquin kit fox	*Vulpes macrotis mutica*	E	T	May have significant effect; mitigation feasible
Swainson's hawk	*Buteo swainsoni*	--	T	May have significant effect; mitigation feasible
Greater sandhill crane	*Grus canadensis tabida*	--	T/CFP[1]	No significant effect
Giant kangaroo rat	*Dipydomys ingens*	E	E	May have significant effect; mitigation feasible
Western burrowing owl	*Athene cunicularia hypugaea*	--	SC[2]	May have significant effect; mitigation feasible
Giant garter snake	*Thamnophis gigas*	T	T	May have significant effect; mitigation feasible
California red-legged frog[3]	*Rana aurora draytonii*	T	SC	May have significant effect; mitigation feasible
Steelhead (South/Central California)[4]	*Oncorhynchus mykiss*	T	SC	May have significant effect; mitigation feasible
Tidewater goby	*Eucyclogobius newberry*	E	SC	May have significant effect; mitigation feasible
San Joaquin wooly-threads	*Monolopia congdonii*	E	--	May have significant effect; mitigation feasible
Chinook salmon (Central Valley Spring-run)[4]	*Oncorhynchus tshawytscha*	T	T	No significant effect
Chinook salmon (Central Valley Fall/Late Fall-run	*Oncorhynchus tshawytscha*	FC	SC	No significant effect
Chinook salmon (Sacramento Winter-run)[5]	*Oncorhynchus tshawytscha*	E	E	No significant effect
Steelhead (Central Valley)[4]	*Oncorhynchus mykiss*	T	--	No significant effect
Delta smelt[5]	*Hypomesus transpacificus*	T	T	No significant effect
Green sturgeon	*Acipenser medirostris*	FC	SC	No significant effect

Notes:
[1]CFP—California fully protected species
[2]Petitioned for listing as State-threatened or -endangered in April 8, 2003; petition rejected February 5, 2004. Species remains protected under California Fish and Game Code §3503.5—Protection of Raptors.
[3]Designated Critical Habitat within this alternative's "footprint" of potential project effects proposed April 14, 2004.
[4]Designated Critical Habitat within this alternative's "footprint" of potential project effects vacated April 30, 2002.
[5]Listing includes designated Critical Habitat within this alternative's "footprint" of potential project effects.
E – Endangered; T – Threatened; PT - Proposed Threatened; CSC – California Species of Special Concern; FC - Candidate (Federal); "—" - Not Listed; AGS – Annual Grassland; COW – Coastal Oak Woodland; CRP – Croplands; CSC – Coastal Scrub; ASC – Desert Scrub; FEW – Freshwater Emergent Wetland; MAR – Marine; RIV – Riverine; SEW – Saltwater Emergent Wetland; VRI – Valley Foothill Riparian; ESU – Evolutionarily Significant Unit

Construction Effects

The probability of significantly affecting special-status species or adversely modifying Critical Habitats during construction activities associated with the Ocean Disposal Alternative would be quite small. It is anticipated that construction effects would not adversely affect any listed species if preconstruction biological surveys are conducted and accepted protocols and mitigation measures designed to avoid or protect the species are fully implemented.

Construction of the reuse facilities and collection system would occur primarily on active, temporarily fallowed, or retired agricultural lands, greatly limiting the potential for adverse effects to special-status species. Similarly, the proposed Ocean Disposal Alternative aqueduct corridor would follow existing highway, road, railroad, and powerline ROWs to minimize construction in undisturbed habitats.

San Joaquin kit fox territories could extend into proposed reuse area facility sites and collection system alignments where construction activity would take place; however, kit fox use of agricultural lands typically is limited to the edges of the valley floor within 2 miles of natural grassland and shrubland vegetation. Kit fox dens would be unlikely in intensively managed agricultural areas where most major construction would occur, although active dens may be found along the aqueduct corridor in the southern part of the drainage area and along the aqueduct corridor from Kettleman City west to Paso Robles. Significant effects to the kit fox could occur due to construction activities associated with development and installation of the facilities; however, with preconstruction surveys to identify potential kit fox activity and implementation of approved avoidance measures, effects would be reduced to not significant.

Giant kangaroo rats occur open shrublands in the most arid, southwestern edge of the San Joaquin Valley and eastern slopes and plateaus of the Inner Coast Range. A major population unit occurs in the Kettleman Hills, in close general proximity to the Ocean aqueduct alignment. Significant effects to the kangaroo rat could occur due to construction activities associated with development and installation of the facilities; however, with preconstruction surveys and implementation of approved avoidance measures, effects would be reduced to not significant.

Swainson’s hawks are known to nest along the San Joaquin River (and occasionally in isolated individual trees or small stands) and forage for insects, birds, and other small prey in adjacent agricultural lands up to several miles from nest and roost sites. Suitable habitat may also exist along portions of the Ocean aqueduct. Swainson’s hawks could also forage at or near some construction sites, but would likely utilize adjacent areas while construction activities are ongoing. Significant effects to Swainson’s hawks could occur due to construction activities; however, with preconstruction surveys and implementation of established guidelines for construction near nests, effects would be reduced to not significant.

Wintering **greater sandhill cranes** are known to forage over broad areas of the agricultural valley floor for insects, worms, seeds, and grains on recently disked or harvested grain fields, rice or corn stubble, shortgrass grasslands, and open wetlands. Cranes may be attracted to disturbed ground at this alternative’s expansive reuse areas, opportunistically utilizing the sites during hours when construction activity stops each day, and foraging in other fields when construction activity resumes. No significant effects to greater sandhill cranes are expected to occur due to construction activities associated with development and installation of the facilities.

The **western burrowing owl** occurs year-round in the San Joaquin Valley and has been observed nesting in small colonies along earthen canal banks and other sparsely vegetated, disturbed sites. Suitable habitat may also exist along portions of the Ocean aqueduct extending out of the valley west of Kettleman City. Construction of portions of the aqueduct and collection/conveyance systems in and adjacent to the San Luis Drain ROW could significantly affect colonies of western burrowing owls known to nest among the broken or shifted concrete slabs that comprise the abandoned conveyance structure. However, with completion of burrowing owl surveys to determine precise locations of the colonies, and implementation of approved avoidance measures and development of a burrowing owl management plan for the affected Drain ROW segments, it is anticipated that significant effects from construction could effectively be avoided, and therefore, effects would be reduced to not significant.

The **giant garter snake** is found in a variety of permanent aquatic environments including marshes, sloughs, ponds, low gradient streams, and other waterways and agricultural wetlands, such as poorly maintained irrigation and drainage canals. Construction of the collection system may require crossing a small number of permanently watered, poorly maintained irrigation and drainage canals; however, construction in major permanent waterways and wetlands is not anticipated. Significant effects to giant garter snakes could occur due to construction activities; however, with preconstruction surveys and implementation of approved avoidance measures, as necessary, effects would be reduced to not significant.

The **California red-legged frog** may occur in quiet pools of streams, marshes, and ponds within areas potentially disturbed by the Ocean aqueduct or collection system. However, construction-related effects in these types of suitable habitat would be temporary.

Construction of the ocean aqueduct could take place within proposed California red-legged frog Critical Habitat (Unit 20 and/or Unit 21), although it is anticipated most effects would be temporary or would easily be reduced to minor levels with appropriate avoidance, conservation, and site restoration measures. Locations and acreages of occupied and potential California red-legged frog habitat that could be affected by the aqueduct would be precisely determined when field surveys are completed.

Significant effects to the California red-legged frog could occur due to construction activities; however, with preconstruction surveys and implementation of approved avoidance measures, as necessary, effects would be reduced to not significant.

Isolated populations of **San Joaquin woolythreads** could be encountered along the Ocean aqueduct corridor southwest of Kettleman City and in the Kettleman Hills. The species is known to occur in nonnative grassland and saltbush scrub vegetation types and has several recent occurrence records within the California Aqueduct ROW (CDFG 2003). Construction activity could destroy individual plants or isolated populations. Botanical surveys would be conducted prior to construction to determine if the species is present within the proposed construction corridor. If the species is located, the Service and CDFG would be notified and appropriate avoidance measures would be developed. Significant effects to San-Joaquin woolythreads could occur due to construction activities; however, with preconstruction surveys and implementation of approved avoidance measures as necessary, effects would be reduced to not significant.

Two small coastal streams (of the proposed Ocean aqueduct's estimated 102 potential stream crossings identified on 1:24000 USGS topographic maps) are identified in the CNNDB (CDFG 2003) as supporting **tidewater goby** and **South/Central California steelhead**. Pipeline construction in or near these streams could increase turbidity and sedimentation or result in stranding or disruption of breeding activity. However, measures could be taken to minimize potential effects and to schedule construction activity to avoid spawning periods. Significant effects to these species could occur due to construction activities; however, with implementation of approved avoidance measures, as necessary, effects would be reduced to not significant.

None of the three listed **Chinook salmon ESUs**, **Central Valley steelhead ESU**, **Delta smelt**, or **green sturgeon** would be affected by construction activities associated with Ocean Disposal

Alternative features or facilities and no associated Critical Habitats would be adversely modified during construction.

A total of 59 acres of rare or sensitive terrestrial vegetation communities, as identified and mapped in the CNDDB (CDFG 2003), would be affected by construction of the Ocean Disposal Alternative, including 56 acres of Valley Oak Woodlands and 3 acres of mostly second terrace Valley Foothill Riparian (in the vicinity of the Salinas River crossing). Destruction of Valley Oak Woodland habitat would be considered a significant effect because mature trees that are removed from the aqueduct ROW during construction would not be replanted on site or allowed to naturally regenerate. Pipeline construction in the Valley Foothill Riparian community in the vicinity of the Salinas River crossing would be further evaluated. The site is in an urban/industrial environment with very little remaining vegetation.

No waterfowl management areas or refuges, major wetlands, or significant natural areas were identified from the GIS overlay analysis of the Ocean Disposal Alternative.

Operation Effects

None of the listed species would be significantly affected by operation of the collection system, ocean aqueduct, or pumping plants or the anticipated noise, lighting, vehicle traffic, or equipment use that would be associated with facility operations. Once construction is completed, operation of the aqueduct, tunnel portals, and pumping plants would be unlikely to affect the **kit fox** or the **giant kangaroo rat**. Operation and maintenance of the aqueduct and pumping plants would not affect populations of **San Joaquin wooly threads** and would have no effect on coastal streams that may support **tidewater goby** or **South/Central California steelhead**. Potential effects to special-status species as a result of Se bioaccumulation are discussed in Section 8.2.4.3.

No mappable units of native or sensitive terrestrial habitat types, as identified in the CNDDB (CDFG 2003), would be affected by the Ocean Disposal Alternative features.

The **San Joaquin kit fox** would likely forage at the proposed reuse areas, favoring sites located nearest the eastern edges of the project in close proximity to preferred grassland and shrubland habitats. Foraging kit fox would be less likely to utilize other reuse sites that are more isolated within the agricultural landscape. Retirement of large contiguous tracts of cropland in the vicinity of the reuse areas, however, could create travel corridors to the interior sites, expanding potential kit fox foraging areas to eventually include the majority of the reuse areas. Portions of the reuse facilities planted in salt-tolerant grasses, grain crops, or permanent pasture could develop a substantial prey base of common dietary items such as insects, ground-nesting birds, and small mammals. Intensively cropped portions of the reuse facilities would likely support less abundant prey than the areas planted in cover or pasture crops, or nearby nonirrigated parcels and refuge lands. Sparsely vegetated grazed lands and the perimeters of wheat or barley fields also could provide attractive foraging areas. Day-to-day operation of farm equipment and farming infrastructure at the reuse facilities and retired lands would be similar to the common farming activities that already take place throughout the project area and subsequently would not be expected to increase kit fox mortality over current conditions. No significant effects to this species are expected to occur as a result of operation.

While the **Swainson's hawk** and **greater sandhill crane** would also be attracted to grasslands, irrigated pasture, and other suitable croplands (including retired lands converted to dryland farming or grazing land), reuse areas also would provide attractive foraging habitat with an abundance of seeds, grains, worms, insects, and small mammals. No significant effects to these species are expected to occur as a result of operation.

Potential risks to the **San Joaquin kit fox, Swainson's hawk** and **greater sandhill crane** associated with Se exposure at reuse areas are addressed in Section 8.2.9.3.

Following initial construction or development, **western burrowing owls** occupying the San Luis Drain ROW and other sparsely vegetated disturbed sites within the project area would not be affected by subsequent facility operation or maintenance, if appropriate operating rules and conservation measures are included in a proposed burrowing owl management plan that would be developed for this alternative. Retired parcels operated as grazing lands could develop into large areas of potential burrowing owl habitat; however, as currently proposed, operation of the reuse areas as intensively irrigated croplands with large areas of persistent vegetation and uniform groundcover would prevent development of suitable burrowing owl nesting habitat and would provide generally unsuitable foraging habitat. No significant effects to this species are expected to occur as a result of operation.

The **giant garter snake** and **California red-legged frog** would not be adversely affected by operation or maintenance of any of this alternative's facilities. These species, however, could indirectly benefit from a general improvement in water quality in Mud Slough and other Grasslands area delivery channels, wetlands, and waterways that would result from full implementation of this alternative. No significant effects to these species are expected to occur as a result of operation.

7.2.9 Delta-Chipps Island Disposal Alternative

Evaluation of potential effects to biological resources from construction and operation of the Delta-Chipps Island Disposal Alternative is based on appraisal-level designs and specifications. At present, only general site plans for this alternative's major facilities and conveyance alignments have been completed. Detailed specifications for this alternative's permanent structures (buildings, maintenance yards, roads, berms, fences, pump facilities, powerlines, etc.), construction schedules, and facility operating plans are not yet available.

7.2.9.1 Terrestrial Resources

Implementation of the Delta-Chipps Island Disposal Alternative would result in temporary and permanent effects to both natural and disturbed terrestrial habitat types. Effects would result from construction and operation of the 16 reuse facilities (totaling 19,000 acres), the drainwater collection/conveyance systems, centralized biotreatment facility, and the Delta-Chipps Island aqueduct. The 242.6-mile aqueduct would require construction of new canal and buried pipeline segments and two pumping plants, and also would incorporate approximately 83 miles of the existing San Luis Drain. No evaporation basins or RO treatment facilities would be constructed. Construction of the major Delta-Chipps Island facilities would take place over a number of years until buildout is complete.

Construction Effects

Construction of the Delta-Chipps Island Disposal Alternative would include both "in-valley" and "out-of-valley" components. Although final site selections and facility designs have not yet been completed, it is anticipated that the collection and conveyance systems, reuse facilities, biotreatment facility, and San Luis Drain segments would be constructed on active or temporarily fallowed agricultural lands or on permanently retired croplands, settlement lands, or other previously disturbed agricultural parcels (e.g., farm roads, ditches, canal ROWs, fencelines, field borders, etc.). These agricultural parcels are common both locally and regionally and generally are considered to have low habitat value compared to natural vegetation types. The aqueduct construction corridor would initially traverse grassland and shrubland habitat for approximately 7.6 miles in the vicinity of Kesterson National Wildlife Refuge (NWR), but would then closely follow existing transportation and utility ROWs northward through agricultural and urban environments before discharging into the Delta at Chipps Island.

During construction, mobile terrestrial wildlife species would disperse to adjoining areas of similar habitat. Less mobile species (e.g., nesting and burrowing/denning species) could be killed or permanently displaced, resulting in significant effects. However, with completion of preconstruction botanical and biological surveys, and subsequent implementation of approved conservation measures and appropriate construction practices, effects to common terrestrial resources from construction of Delta-Chipps Island Disposal facilities would not be significant. (However, see Sections 7.2.9.2 and 7.2.9.3 for discussion of potential effects to aquatic/wetland resources and special-status species.)

Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of the Delta-Chipps Island Disposal Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations. However, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.

Reuse Areas. Staged development of the 16 reuse areas would require surface disturbance of up to 19,000 acres, most of which would take place on active cropland. The remainder would be retired or settlement lands. Activities required to initially develop typical reuse sites would be similar to farming activities that historically took place at the sites. Development would include surface contouring and leveling; installation of irrigation systems, subsurface drains, sumps, and buried collectors; initial planting, clearing, or turning under of existing crops; and similar site preparation activities. These activities, like the previous farming practices, would result in minor or temporary effects to the common terrestrial species that have adapted to the valley's intensively managed agricultural landscape. For reuse facilities that would be located in whole or in part on already retired, abandoned, or fallowed parcels, construction would remove ruderal vegetation, nonirrigated cover crops, or residual vegetation from earlier farm use. No significant effects to terrestrial resources are expected.

Treatment Facilities. Construction of the Delta-Chipps Island Disposal Alternative's centralized biological treatment facility would also take place entirely on active or former agricultural lands, or other previously disturbed agricultural parcels. Construction of the facility would permanently remove existing vegetation from the site, resulting in the permanent loss of approximately 8 acres of agricultural habitat. Because agricultural habitats are common both locally and regionally, replacement of this small amount of low-value habitat with the treatment structures would not be considered a significant effect.

Collection/Conveyance. Construction of the extensive network of 1,000+ miles of buried collection pipelines and associated sumps, pumps and controls would result in widely distributed, but generally minor and temporary effects to terrestrial species. As currently proposed, the entire system would be constructed as buried pipelines (as opposed to open canals). Construction would take place in narrow linear corridors entirely within the agricultural heart of the valley and generally would be limited to previously disturbed road, canal, and railroad ROWs or the perimeters of agricultural fields. In this previously disturbed, topographically flat, and easily accessed landscape, pipeline construction (trench excavation, pipe placement, and backfilling) would move quickly, with generally minor and temporary disturbance to terrestrial wildlife resources. No significant effects to terrestrial resources are expected.

Delta-Chipps Island Aqueduct. Construction of the 242.6-mile Delta-Chipps Island aqueduct would include 128.6 miles of new and existing canal segments and 113 miles of buried pipeline segments. Most of the alignment would follow existing highway, canal, railroad, and powerline ROWs, greatly reducing the likelihood of significantly affecting undisturbed terrestrial vegetation or natural habitats. Approximately 90 percent of the alignment would traverse agricultural, ruderal, and urban habitats, while less than 10 percent would cross annual grassland habitat types. The small remainder would consist of stream and wetland crossings that are addressed in Section 7.2.9.2. Assuming a 100-foot construction corridor for the new canal segments and a 75-foot corridor for the pipelines, construction of new segments would temporarily disturb approximately 1,005 acres of "nonurban" terrestrial habitat. An undetermined area of previously disturbed, urban, and/or other low-value habitat would be used for temporary access/haul roads and equipment staging areas. No significant effects to terrestrial resources are expected.

Retired Lands. A total of 44,106 acres of active and fallowed agricultural land would be acquired and permanently retired under the Delta-Chipps Island Disposal Alternative, an increase of 23,588 acres over current (2002) conditions, but 65,000 acres less than would be expected over the next 50 years under No Action. None of these lands have been thoroughly inventoried so current ground cover, vegetation conditions, and habitat values are unknown.

A portion of the 44,106 acres of retired land could be developed for project purposes (e.g., reuse areas), and 7,000 acres of the total would be separately acquired and managed under the CVPIA Land Retirement Program to provide wildlife habitat (outside the scope of this project). The remaining retirement lands would be utilized in ways that would require minimal initial development or capital improvements.

As currently proposed, one-third of the remaining land would initially be planted with nonirrigated forage suitable for grazing sheep and two-thirds would be prepared to facilitate dryland farming. Initial management activities would include disking or turning under the existing irrigated crops or cover, planting new vegetation (if appropriate), controlling weeds, and possibly removing or relocating existing infrastructure. These typical farm activities could result in minor or temporary effects to common terrestrial species, many of which are well adapted to the valley's intensively managed agricultural landscape. In general, construction effects to common terrestrial species associated with the Delta-Chipps Island Disposal Alternative's retired lands would not be expected to be significant.

Potential biological effects to terrestrial species from long-term *operation* of the retired lands for grazing or dryland farming is discussed in the following section.

Operation Effects

Facility site plans, detailed design specifications, and development schedules are not yet available. Subsequently, this evaluation of potential operational effects is based on a conceptual operating plan.

Reuse Areas. Effects from operation of the 16 reuse facilities would be identical to other previously described action alternatives. From a local or regional perspective, operation would not significantly alter the overall quantity or availability of terrestrial habitat. The reuse facilities (totaling 19,000 acres at buildout) would continue to provide marginal cover and forage similar to other managed agricultural lands in the San Joaquin Valley. A permanent change in agricultural and ruderal habitats would occur to predominantly salt-tolerant pasture grasses. Any marginal loss of terrestrial habitat value that might result from conversion from prior agricultural uses would be compensated by the addition of substantial acreages of retired land converted to dryland crops (e.g., barley, wheat) and sheep pasture, and by CVPIA Land Retirement Program revegetation parcels. No significant effects to terrestrial resources are expected.

See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Delta-Chipps Island Aqueduct and Collection System. Operation of the Delta-Chipps Island aqueduct and buried collection system would not significantly affect terrestrial resources. See Section 8.2.9.1 for a discussion of potential effects due to Se bioaccumulation.

Biotreatment Facility. Operation and routine maintenance of the biotreatment facility and pumping plants would not be expected to significantly affect terrestrial resources. The facilities would be located on agricultural lands in close proximity to existing roads. Effects from facility noise, traffic, and lighting are expected to be not significant.

Retired Lands. A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 19,000 would be used for project facilities. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. It is assumed that in any given year, approximately one-half of the dryland-farmed acreage would be fallowed. Except for the CVPIA program lands, none of the land would be specifically managed to develop wildlife habitat or to provide long-term wildlife benefits as part of the SLDFR project.

Any retired agricultural lands converted to nonirrigated crops would continue to periodically be disturbed for cultivation and harvesting and, therefore, would not typically develop significant wildlife value. Production of small grains (wheat, barley) would provide a degree of improvement over most existing irrigated crops, but actual wildlife benefits would depend on location, parcel size, adjacent habitats, and management. Similarly, grazed lands managed under a rotation could provide a desirable mix of vegetation cover, offering better forage and cover than previous irrigated crops.

Fallowed, abandoned, or improperly grazed lands could quickly be invaded by noxious weeds and undesirable invasive species; however, it is anticipated that existing coordinated weed control programs would expand to include any newly retired lands. Consequently, the effect would not be significant. Some low-lying retired lands would continue to act as salt sinks, collecting and concentrating salts until they support limited vegetation and offer little wildlife habitat value.

In general, in the absence of any long-term program or funding mechanism to specifically develop and manage the retired lands under the Delta-Chipps Island Disposal Alternative to significantly improve wildlife habitat, the effect to terrestrial wildlife from anticipated long-term changes in vegetation and cropping patterns would be only slightly beneficial, resulting in no significant effect.

7.2.9.2 Aquatic and Wetland Resources

Implementation of the Delta-Chipps Island Disposal Alternative would result in temporary and permanent effects to aquatic and wetland resources. Effects from construction and operation of the 16 reuse facilities (totaling 19,000 acres), centralized biological treatment facility, aqueduct, two pumping plants, underwater outfall and diffuser would vary by type and degree.

Construction Effects

Construction of the 16 reuse facilities, biotreatment plant, and collection system would not be expected to substantially affect aquatic and wetland resources. These facilities would all be located in intensively farmed areas, and would be sited on active or retired agricultural lands. In this landscape, significant effects to aquatic or wetland habitat would be very limited. Construction effects to aquatic and wetland-dependent resources from these facilities would be similar to those described for other action alternatives.

Reuse Areas. Staged development of the reuse facilities is not expected to substantially affect aquatic and wetland resources. Because the facilities would be located on active or retired agricultural lands, significant construction effects to aquatic, riparian, or wetland habitat types would be unlikely. Based on an appraisal-level reconnaissance, few, if any, natural stream channels traverse the sites (hydrologic features are typically shallow swales, irrigation ditches, or agricultural drainageways) and no substantial wetlands were identified. No significant effects to aquatic and wetland resources are anticipated to occur as a result of development of the reuse areas.

Delta-Chipps Island Aqueduct. Almost the entire Delta-Chipps Island aqueduct alignment would follow existing highway, canal, railroad, and powerline ROWs, greatly reducing the number and severity of potential effects to wetlands and other sensitive aquatic habitats. A small probability of encountering vernal pool habitat may exist along the approximately 10 percent of the aqueduct that traverses annual grassland and shrubland vegetation. The aqueduct’s two pumping plants would be located and designed to avoid effects to aquatic and wetland habitats.

Based on a review of 7 ½’ USGS topographic maps, the Delta-Chipps Island aqueduct would cross approximately 21 stream channels. Most of the crossings would be located near existing bridge crossings or road culverts since the majority of the aqueduct alignment would follow existing highway, road, railroad, and powerline ROWs. If a 75-foot construction corridor is assumed at all stream crossings, an average of 0.1 acre of aquatic habitat/riparian habitat would be disturbed at each crossing. All crossings would be restored to original contours and revegetated following construction.

From the current northern terminus of the San Luis Drain, extending northward for a distance of approximately 7.6 miles, the aqueduct would traverse a large wetland/upland complex consisting of State Waterfowl Areas, NWRs, and private duck clubs. Portions of this segment would be considered sensitive habitat and would be constructed as a buried pipeline to reduce the width of the construction corridor and to eliminate permanent effects to the adjacent wetlands.

Construction of the aqueduct could disturb approximately 1.0 acres of Coastal Brackish Marsh (a sensitive community identified and mapped in the CNDDB [CDFG 2003]); however, given the current level of planning detail, the actual degree of effect is uncertain. Assuming a 75-foot construction corridor in all sensitive habitat types, the Delta-Chipps Island Disposal Alternative could disturb a total of 73 acres of sensitive aquatic/wetland communities. In all probability, the actual construction corridor through these areas could be further narrowed to the minimum widths necessary to complete the pipeline installation.

All temporary construction-related facilities (temporary access/haul roads and equipment staging areas) could be designed and sited to avoid effects to streams, wetlands, and other sensitive habitats. When no longer needed, the temporary sites could be recontoured, stabilized, and revegetated to protect downstream aquatic resources (if any). Significant effects to aquatic and wetland resources could occur, but with the measures described above, effects are reduced to not significant.

Collection/Conveyance. Construction of the extensive network of buried collection pipelines and associated sumps, pumps and controls would result in widely distributed, but generally temporary effects. As proposed, the entire collection system would be constructed as buried pipelines (as opposed to open canals). Construction would take place in narrow linear corridors entirely within the agricultural heart of the valley and generally would be limited to previously disturbed road, canal, and railroad ROWs or the perimeters of agricultural fields. Stream crossings in this environment typically would involve existing ditches and canals. In this topographically flat agricultural landscape, pipeline construction (trench excavation, pipe placement, and backfilling) would move quickly, with minor and temporary disturbances at the few anticipated aquatic and wetland sites that might be encountered. No significant effects to aquatic and wetland resources are anticipated to occur as a result of construction of collection and conveyance facilities.

Outfall. Construction of the underwater outfall and diffuser at Chipps Island could affect estuarine aquatic habitat in the Bay-Delta. The effects would be of short duration, but may be considered significant if construction were to occur during certain life stages of listed anadromous fish. See Section 7.2.9.3 for discussion of potential effects to these species.

<u>Operation Effects</u>

Reuse Areas. Operation and routine maintenance of the Delta-Chipps Island Disposal Alternative's 16 reuse facilities would be identical to operations previously described for the other action alternatives (no significant effects expected - see Section 7.2.8.2). See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Outfall. An evaluation of the effects of Se discharges on aquatic resources is presented in Section 8.2.9.2.

7.2.9.3 Special-Status Species

Based on an extensive literature review, consultations with species experts, reconnaissance surveys in the general vicinities of proposed facility sites and aqueduct alignments, and an evaluation of recent occurrence records (CDFG 2003), it was determined that 21 listed special-status species could occur in areas affected by construction or operation of the Delta-Chipps Island Disposal Alternative. Sixty-four species–from the list of 85 species provided by the Service, NOAA-Fisheries, and CDFG (see Appendix F, Table F-1)–were eliminated from further consideration because (1) areas of potential occurrence were either associated with other action alternatives or fell well outside the probable “footprint” of the Delta-Chipps Island Disposal Alternative’s anticipated construction and operational effects, (2) suitable habitat no longer is thought to be present in the areas being evaluated, or (3) the absence of recent occurrence records is highly indicative that the species no longer is present in the areas being evaluated. Table 7-4 identifies the 21 special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by this alternative. For Federally listed species with “may adversely affect” determinations, Reclamation would engage in consultation with the Service under Section 7 of the ESA to identify measures to avoid or minimize potential effects if this alternative is selected.

At present, species-focused endangered species biological surveys have not yet been completed on any proposed construction sites or pipeline alignments.

Table 7-4
Special-Status Species That May Be Affected by the
Delta-Chipps Island Disposal Alternative

Common Name	Scientific Name	Federal Status	State Status	Effect
San Joaquin kit fox	*Vulpes macrotis mutica*	E	T	May have significant effect; mitigation feasible
Swainson’s hawk	*Buteo swainsoni*	--	T	May have significant effect; mitigation feasible
Greater sandhill crane	*Grus canadensis tabida*	--	T/CFP[1]	No significant effect
Saltmarsh harvest mouse	*Reithrodontomys raviventris*	E	E/CFP[1]	May have significant effect; mitigation feasible
Conservancy fairy shrimp	*Branchinecta conservatio*	E	--	May have unavoidable significant effect
Longhorn fairy shrimp	*Branchinecta longiantenna*	E	--	May have unavoidable significant effect
Vernal pool fairy shrimp	*Branchinecta lynchi*	T	--	May have unavoidable significant effect
Vernal pool tadpole shrimp	*Lepidurus packardi*	E	--	May have unavoidable significant effect
Delta button-celery	*Eryngium racemosum*	--	E	May have significant effect; mitigation feasible
California black rail	*Laterallus jamaicensis coturniculus*	--	T/CFP	May have significant effect; mitigation feasible
California clapper rail	*Rallus longirostris obsoletus*	E	E/CFP	May have significant effect; mitigation feasible
California tiger salamander	*Ambystoma californiense*	T[2]	SC	May have unavoidable significant effect

Table 7-4 (concluded)
Special-Status Species That May Be Affected by the
Delta-Chipps Island Disposal Alternative

Common Name	Scientific Name	Federal Status	State Status	Effect
Western burrowing owl	*Athene cunicularia hypugaea*	--	SC[3]	May have significant effect; mitigation feasible
Giant garter snake	*Thamnophis gigas*	T	T	May have significant effect; mitigation feasible
California red-legged frog[4]	*Rana aurora draytonii*	T	SC	May have significant effect; mitigation feasible
Chinook salmon (Central Valley Spring-run)[5]	*Oncorhynchus tshawytscha*	T	T	May have significant effect; mitigation feasible
Chinook salmon (Central Valley Fall/Late Fall-run)	*Oncorhynchus tshawytscha*	FC	SC	May have significant effect; mitigation feasible
Chinook salmon (Sacramento Winter-run)[6]	*Oncorhynchus tshawytscha*	E	E	May have significant effect; mitigation feasible
Steelhead (Central Valley)[5]	*Oncorhynchus mykiss*	T	--	May have significant effect; mitigation feasible
Delta smelt[6]	*Hypomesus transpacificus*	T	T	May have significant effect; mitigation feasible
Green sturgeon	*Acipenser medirostris*	FC	SC	May have significant effect; mitigation feasible

Notes:
[1]CFP California fully protected species
[2]Central California Distinct Population Segment (DPS) listed as Threatened August 4, 2004. Critical Habitat proposed August 10, 2004.
[3]Petitioned for listing as State-threatened or -endangered in April 8, 2003; petition rejected February 5, 2004. Species remains protected under California Fish and Game Code §3503.5—Protection of Raptors
[4]Designated Critical Habitat within this alternative's "footprint" of potential project effects proposed April 14, 2004.
[5]Designated Critical Habitat within this alternative's "footprint" of potential project effects vacated April 30, 2002.
[6]Listing includes designated Critical Habitat within this alternative's "footprint" of potential project effects.
E – Endangered; T – Threatened; PT - Proposed Threatened; CSC – California Species of Special Concern; FC - Candidate (Federal); "—" - Not Listed; AGS – Annual Grassland; COW – Coastal Oak Woodland; CRP – Croplands; CSC – Coastal Scrub; ASC – Desert Scrub; FEW – Freshwater Emergent Wetland; MAR – Marine; RIV – Riverine; SEW – Saltwater Emergent Wetland; VRI – Valley Foothill Riparian; ESU – Evolutionarily Significant Unit

Construction Effects

The probability of significantly affecting listed special-status species or adversely modifying Critical Habitats during construction activity associated with the Delta-Chipps Island Disposal Alternative would be quite small. It is anticipated that construction would not adversely affect any listed species if preconstruction biological surveys are conducted and accepted protocols and mitigation measures designed to avoid or protect the species are fully implemented.

Construction of the reuse facilities, biotreatment plant, and collection system would occur primarily on active, temporarily fallowed, or retired agricultural lands or on ruderal lands surrounded by expanses of active cropland, greatly limiting the potential for adverse effects to special-status species. Similarly, over 90 percent of the proposed Delta-Chipps Island aqueduct would closely follow existing highway, road, aqueduct, and railroad ROWs through developed urban and agricultural landscapes. Special-status species likely to be encountered in these disturbed areas typically are transients or are utilizing a portion of a much larger foraging area.

San Joaquin kit fox territories could extend into proposed reuse area facility sites and collection system alignments where construction activity would take place; however, kit fox use of agricultural lands typically is limited to the edges of the valley floor within 2 miles of natural grassland and shrubland vegetation. The occurrence of kit fox dens would be unlikely in the intensively managed agricultural areas where most major construction would occur. Ideal suitable kit fox habitat is known to occur in and near Kesterson and San Luis NWRs and would be bisected by installation of the southern 7.6 miles of the Delta-Chipps Island aqueduct. All construction sites could be evaluated to identify suitable kit fox habitat and, where appropriate, preconstruction surveys could be conducted to identify potential kit fox activity. Approved avoidance and site restoration measures could be implemented if kit fox are found.

Significant effects to the kit fox could occur due to construction activities associated with development and installation of the facilities; however, with preconstruction surveys to identify potential kit fox activity and implementation of approved avoidance measures, effects would be reduced to not significant.

Swainson's hawks are known to nest along the San Joaquin river (and occasionally in isolated individual trees or small stands) and forage for insects, birds, and other small prey in adjacent agricultural lands up to several miles from nest and roost sites. Suitable foraging habitat or nest trees may also exist in the general vicinity of the Delta-Chipps Island aqueduct corridor. Swainson's hawks could also forage at or near some construction sites, but would likely utilize adjacent areas while construction activities are ongoing. Significant effects to Swainson's hawks could occur due to construction activities; however, with preconstruction surveys and implementation of established guidelines for construction near nests, effects would be reduced to not significant.

Wintering **greater sandhill cranes** are known to forage over broad areas of the agricultural valley floor for insects, worms, seeds, and grains on recently disked or harvested grain fields, rice or corn stubble, shortgrass grasslands, and open wetlands. Cranes may be attracted to disturbed ground at the expansive reuse areas, opportunistically utilizing the sites during hours when construction activity stops each day, and foraging in other nearby or adjacent fields when construction activity resumes. No significant effects to greater sandhill cranes are expected to occur due to construction activities associated with development and installation of the facilities.

The **saltmarsh harvest mouse**, **California black rail**, **and California clapper rail** could occur in tidal marsh habitat in the general vicinity of the Delta-Chipps Island discharge. Potential habitat in the vicinity of the pipeline, however, is generally of low quality and has been substantially fragmented and disturbed. In total, less than 0.25 mile of aqueduct corridor would traverse this potential habitat, with all but a very small segment being located on or adjacent to existing roadways. If determined to be appropriate, surveys could be conducted to locate remaining suitable habitat, and approved conservation measures could be incorporated into construction planning. Significant effects to these species may occur due to construction activities; however, with approved conservation measures, effects would be reduced to not significant.

Isolated **vernal pools** and other ephemeral wetlands could occur within the aqueduct's 75-foot-wide construction corridor in suitable grasslands, particularly in or near the Kesterson and San

Luis NWRs. Any destruction of vernal pool habitat would adversely affect populations of **vernal pool crustaceans** that may inhabit the sites and could adversely affect **California tiger salamanders**, which also inhabit small ephemeral pools and adjacent uplands. Potential effects to isolated pools would most likely be limited to construction of the 7.6 miles of aqueduct immediately north of the current San Luis Drain terminus. Preconstruction surveys could be conducted to locate occurrences of ephemeral pools and their associated species, and avoidance strategies, including minor route modifications, could be implemented if practicable. Any unavoidable permanent destruction of vernal pool habitat could be mitigated with replacement habitat acquired in consultation with the Service and CDFG. Significant effects may be unavoidable, but the severity of effects could be reduced through mitigation.

Isolated populations of **Delta button-celery** could be encountered in the same areas as vernal pools, with several recent occurrence records within 1 mile of the aqueduct corridor (CDFG 2003). Construction activity could destroy individual plants or isolated populations. Botanical surveys could be conducted prior to construction to determine if the species is present within the proposed construction corridor. If the species is located, the CDFG would be notified and appropriate avoidance measures could be developed. Significant effects to this species may occur due to construction activities; however, with approved mitigation measures, effects would be reduced to not significant.

The **western burrowing owl** occurs year-round in the San Joaquin Valley and has been observed nesting in small colonies along earthen canal banks and other sparsely vegetated disturbed sites. Construction in and adjacent to the San Luis Drain ROW could significantly affect colonies of western burrowing owls known to nest among the broken and shifted concrete slabs that comprise the abandoned conveyance structure. Initial development of reuse areas and installation of collection pipelines also could displace individuals or isolated colonies. However, with completion of burrowing owl surveys to determine precise locations of the colonies or individual occurrences, and implementation of a burrowing owl management plan for the affected Drain ROW segments and other project facilities, it is anticipated that significant effects from construction could effectively be avoided, and therefore, effects would be reduced to not significant.

The **giant garter snake** could occur in a variety of permanent aquatic habitats in San Joaquin Valley including marshes, sloughs, ponds, low gradient streams, and agricultural waterways and wetlands, such as poorly maintained irrigation and drainage canals. Construction of the collection system may require crossing a small number of permanently watered, poorly maintained irrigation and drainage canals. In addition, suitable habitat may be encountered along the southern 7.6 miles of the aqueduct in Kesterson and San Luis NWRs. With preconstruction biological surveys and, if necessary, implementation of approved avoidance measures, significant effects from construction of Delta-Chipps Island Disposal Alternative facilities would be reduced to not significant.

The California **red-legged frog** may occur in quiet pools of streams, marshes, and ponds within the Delta-Chipps Island Disposal Alternative project area; however, the species has not been recently documented within areas potentially affected by the proposed reuse areas, collection system, or other “in-valley” facilities. Suitable habitat could be encountered along the Delta-Chipps Island aqueduct, particularly in Contra Costa County where numerous recent occurrences have been recorded within 5 miles of the of the proposed corridor. No areas of proposed Critical Habitat would be affected. Significant effects to this species could occur due to construction activities. With species-directed preconstruction biological surveys and, if necessary, implementation of approved avoidance and conservation measures, effects of construction activities would be reduced to not significant.

The three listed **Chinook salmon ESUs**, **steelhead (Central Valley ESU)**, **Delta smelt**, or **green sturgeon** could be adversely affected by construction activity associated with the Delta-Chipps Island Disposal Alternative and no Critical Habitat (Chinook salmon–Sacramento winter-run ESU; Delta smelt) would be adversely modified during construction. Construction of the outfall and diffuser would disturb bottom sediments, potentially burying benthic organisms and temporarily reducing water quality in the vicinity of the construction site; however, the disturbance would be short term. The short overall length of the outfall/diffuser and its relatively shallow depth would allow installation to proceed rapidly and would not result in a permanent obstruction to fish movement or migration. Construction during critical life stages or migration periods would be a significant effect that could be mitigated to not significant by avoiding construction during these periods.

Operation Effects

The **San Joaquin kit fox** would likely forage at the proposed reuse areas, favoring sites located nearest the eastern edges of the project in close proximity to preferred grassland and shrubland habitats. Foraging kit fox would be less likely to utilize other reuse sites that are more isolated within the agricultural landscape. Retirement of large contiguous tracts of cropland in the vicinity of the reuse areas, however, could create travel corridors to the interior sites, expanding potential kit fox foraging areas to eventually include the majority of the reuse areas. Portions of the reuse facilities planted in salt-tolerant grasses, grain crops, or permanent pasture could develop a substantial prey base of common dietary items such as insects, ground-nesting birds, and small mammals. Intensively cropped portions of the reuse facilities would likely support less abundant prey than the areas planted in cover or pasture crops, or nearby nonirrigated parcels and refuge lands. Sparsely vegetated grazed lands and the perimeters of wheat or barley fields also could provide attractive foraging areas. Day-to-day operation of farm equipment and farming infrastructure at the reuse facilities and retired lands would be similar to the common farming activities that already take place throughout the project area and subsequently would not be expected to increase kit fox mortality over current conditions. No significant effects to this species are expected to occur as a result of operation.

While the **Swainson's hawk** and **greater sandhill crane** would also be attracted to grasslands, irrigated pasture, and other suitable croplands (including retired lands converted to dryland farming or grazing land), reuse areas also would provide attractive foraging habitat with an abundance of seeds, grains, worms, insects, and small mammals. No significant effects to these species are expected to occur as a result of operation.

Potential risks to the **San Joaquin kit fox, Swainson's hawk** and **greater sandhill crane** associated with Se exposure at reuse areas are addressed in Section 8.2.9.3.

The **saltmarsh harvest mouse**, **California black rail**, **and California clapper rail** could occur in tidal marshes in the general vicinity of the Delta-Chipps Island aqueduct, but would not be affected in any way by day-to-day operation or routine maintenance of the buried conveyance. Similarly, following initial construction or development, operation and routine maintenance of the alternative's facilities and conveyance structures would have no effect on the hydrological conditions or vegetation that support suitable habitat for listed **vernal pool crustaceans**, **California tiger salamander**, or **Delta button-celery**.

Following initial construction or development, **western burrowing owls** occupying the San Luis Drain ROW and other sparsely vegetated disturbed sites within the project area would not be affected by subsequent facility operation or maintenance, if appropriate operating rules and conservation measures are included in a proposed burrowing owl management plan that would be developed for this alternative. Retired parcels operated as grazing lands could develop into large areas of potential burrowing owl habitat; however, as currently proposed, operation of the reuse areas as intensively irrigated croplands with large areas of persistent vegetation and uniform groundcover would prevent development of suitable burrowing owl nesting habitat and would provide generally unsuitable foraging habitat. No significant effects to this species are expected to occur as a result of operation.

The **giant garter snake** and **California red-legged frog** would not be adversely affected by operation or maintenance of any of this alternative's facilities. These species, however, could indirectly benefit from a general improvement in water quality in Mud Slough and other Grasslands area delivery channels, wetlands, and waterways that would result from full implementation of this alternative. No significant effects to these species are expected to occur as a result of operation.

None of the three listed **Chinook salmon ESUs**, **steelhead (Central Valley ESU)**, **Delta smelt**, or **green sturgeon** would be significantly affected by operation of the Delta-Chipps Island outfall The outfall location would not interfere with fish passage and the diffuser facilitate mixing and prevent disturbance of sediments in the immediate vicinity of the outfall. Potential risks to these species associated with Se exposure in the vicinity of the outfall are addressed in Section 8.2.9.3.

7.2.10 Delta-Carquinez Strait Disposal Alternative

Evaluation of potential effects to biological resources from construction and operation of the Delta-Carquinez Strait Disposal Alternative is based on *appraisal-level* designs and specifications. At present, only general site plans for this alternative's major facilities and conveyance alignments have been completed. Detailed specifications of this alternative's major facilities, permanent structures (buildings, maintenance yards, roads, berms, fences, pump facilities, powerlines, etc.), construction schedules, and facility operating plans are not yet available.

7.2.10.1 Terrestrial Resources

Implementation of the Delta-Carquinez Strait Disposal Alternative would result in temporary and permanent effects to both natural and disturbed terrestrial habitat types. Effects would result from construction and operation of the 16 reuse facilities (totaling 19,000 acres), the drainwater collection system, a single biotreatment facility, and the Delta-Carquinez Strait aqueduct. The 260-mile aqueduct would require construction of new canal and buried pipeline segments and two pumping plants, but also would incorporate approximately 83 miles of the existing San Luis Drain could be utilized. No evaporation basins or RO treatment facilities would be constructed. Construction of the major Delta-Carquinez Strait facilities would take place over a number of years until buildout is complete.

Construction Effects

Construction of the Delta-Carquinez Strait Disposal Alternative would include both “in-valley” and “out-of-valley” components. Although final site selections and facility designs have not yet been completed, it is anticipated that the collection systems, reuse facilities, biotreatment facility, and San Luis Drain segments would be constructed on active or temporarily fallowed agricultural lands or on permanently retired croplands, settlement lands, or other previously disturbed agricultural parcels (e.g., farm roads, ditches, canal ROWs, fencelines, field borders, etc.). These agricultural parcels are common both locally and regionally and generally are considered to have low habitat value for most species compared to native or natural vegetation types. The aqueduct construction corridor would initially traverse grassland and shrubland habitat for approximately 7.6 miles in the vicinity of Kesterson NWR, but would then closely follow existing transportation and utility ROWs northward through agricultural and urban environments before discharging into the Delta at Carquinez Strait.

During construction, mobile terrestrial wildlife species would disperse to adjoining areas of similar habitat. Less mobile species (e.g., nesting and burrowing/denning species) could be killed or permanently displaced, resulting in significant effects. However, with completion of preconstruction botanical and biological surveys, and subsequent implementation of approved conservation measures and appropriate construction practices, as may be needed, effects to common terrestrial resources from construction of Delta-Carquinez Strait Disposal facilities would be reduced to not significant (However, see Sections 7.2.10.2 and 7.2.10.3 for discussion of potential effects to aquatic/wetland resources and special-status species).

Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of the Delta-Carquinez Strait Disposal Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations. However, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.

Reuse Areas. Staged development of the 16 reuse areas would require surface disturbance up to 19,000 acres, most of which would take place on active croplands. The remainder would be retired or settlement lands. Construction activities at the reuse facilities would be similar to farming practices that historically took place at the sites. Construction would include surface contouring and leveling; installation of subsurface drains, sumps, and buried collectors; planting of crops; and installation of irrigation systems. These actions, like the previous farming practices, would result in minor or temporary effects to common terrestrial species that have adapted to the valley’s intensively managed agricultural landscape. For reuse facilities that would be located in whole or in part on already retired, abandoned, or fallowed parcels, construction would remove ruderal vegetation, nonirrigated cover crops, or residual vegetation from earlier farm use. No significant effects to terrestrial resources are expected.

Collection/Conveyance. Construction of the extensive network of 1,000+ miles of buried collection pipelines and associated sumps, pumps and controls would result in widely distributed, but generally minor and temporary effects to terrestrial species. As currently proposed, the entire collection system would be constructed as buried pipelines (as opposed to open canals). Construction would take place in narrow linear corridors entirely within the agricultural heart of the valley and generally would be limited to previously disturbed road, canal, and railroad ROWs or the perimeters of agricultural fields. In this previously disturbed, topographically flat, and easily accessed landscape, pipeline construction (trench excavation, pipe placement, and backfilling) would move quickly, with generally minor and temporary disturbance to terrestrial wildlife resources.

Treatment Facilities. Construction of the Delta-Chipps Island Disposal Alternative's centralized biological treatment facility would also take place entirely on active or former agricultural lands, or other previously disturbed agricultural parcels. Construction of the facility would permanently remove existing vegetation from the site, resulting in the permanent loss of approximately 8 acres of agricultural habitat. Because agricultural habitats are common both locally and regionally, replacement of this small amount of low-value habitat with the treatment structures would not be considered a significant effect.

Delta-Carquinez Strait Aqueduct. Construction of the 260-mile-long Delta-Carquinez Strait aqueduct would include 128.6 miles of new and existing canal segments and 130.4 miles of buried pipeline segments. Almost all of the alignment would follow existing highway, canal, railroad, and powerline ROWs, greatly reducing the likelihood of significantly affecting undisturbed terrestrial vegetation and wildlife. Approximately 83 percent of the alignment would traverse agricultural and urban habitats, while nearly 13 percent would cross annual grassland and shrubland habitat types. The small remainder would consist of stream and wetland crossings that are addressed in Section 7.2.10.2. Assuming a 100-foot construction corridor for the canal segments and a 75-foot corridor for the pipelines, construction of the aqueduct would temporarily disturb approximately 1,160 acres of terrestrial habitats. An undetermined amount of terrestrial vegetation would also be disturbed for use as temporary access/haul roads and equipment staging areas. No significant effects to terrestrial resources are expected.

Retired Lands. A total of 44,106 acres of active and fallowed agricultural land would be acquired and permanently retired under the Delta-Carquinez Strait Disposal Alternative, an increase of 23,588 acres over current (2002) conditions, but 65,000 acres less than would be expected over the next 50 years under No Action. None of these lands have been thoroughly inventoried so current ground cover, vegetation conditions, and habitat values are unknown.

A portion of the 44,106 acres of retired land could be developed for project purposes (e.g., reuse areas), and 7,000 acres of the total would be separately acquired and managed under the CVPIA Land Retirement Program to provide wildlife habitat (outside the scope of this project). The remaining retirement lands would be utilized in ways that would require minimal initial development or capital improvements.

As currently proposed, one-third of the remaining land would initially be planted with nonirrigated forage suitable for grazing sheep and two-thirds would be prepared to facilitate dryland farming. Initial management activities would include disking or turning under the existing irrigated crops or cover, planting new vegetation (if appropriate), controlling weeds, and possibly removing or relocating existing infrastructure. These typical farm activities could result in minor or temporary effects to common terrestrial species, many of which are well adapted to the valley's intensively managed agricultural landscape. In general, construction effects associated with the Delta-Carquinez Strait Disposal Alternative's retired lands would not be expected to be significant.

Potential biological effects to terrestrial species from long-term *operation* of the retired lands for grazing or dryland farming is discussed in the following section.

Operation Effects

Facility site plans, detailed design specifications, and development schedules are not yet available. Consequently, this evaluation of potential operational effects is based on a conceptual operating plan.

Reuse Areas. Effects from operation of the 16 reuse facilities would be identical to other previously described action alternatives (no significant effects). From a local or regional perspective, operation would not significantly alter the overall quantity or availability of terrestrial habitat. The reuse facilities (totaling 19,000 acres at buildout) would continue to provide marginal cover and forage similar to other managed agricultural lands in the valley. A permanent change in existing agricultural and ruderal habitats would occur to predominantly salt-tolerant pasture grasses. Any marginal loss of terrestrial habitat value that might result from conversion from prior agricultural uses would be compensated by the addition of substantial acreages of retired land converted to dryland crops (e.g., barley, wheat) and sheep pasture, and by CVPIA Land Retirement Program revegetation parcels. No significant effects to terrestrial resources are expected. See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Delta-Carquinez Strait Aqueduct and Collection System. Operation of the Delta-Carquinez Strait aqueduct and buried collection system would not significantly affect terrestrial resources. See Section 8.2.9.1 for a discussion of potential effects due to Se bioaccumulation.

Biotreatment Facility. Operation and routine maintenance of the biotreatment facility and pumping plants would not be expected to significantly affect terrestrial resources. The facilities would be located on agricultural lands in close proximity to existing roads. Effects from facility noise, traffic, and lighting are expected to be not significant.

Retired Lands. A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 19,560 would be used for project facilities. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. It is assumed that in any given year, approximately one-half of the dryland-farmed acreage would be fallowed. Except for the CVPIA program lands, none of the land would be specifically managed to develop wildlife habitat or to provide long-term wildlife benefits as part of the SLDFR project.

Any retired agricultural lands converted to nonirrigated crops would continue to periodically be disturbed for cultivation and harvesting and, therefore, would not typically develop significant wildlife value. Production of small grains (wheat, barley) would provide a degree of improvement over most existing irrigated crops, but actual wildlife benefits would depend on location, parcel size, adjacent habitats, and management. Similarly, grazed lands managed under a rotation could provide a desirable mix of vegetation cover, offering better forage and cover than previous irrigated crops.

Fallowed, abandoned, or improperly grazed lands could quickly be invaded by noxious weeds and undesirable invasive species; however, it is anticipated that existing coordinated weed control programs would expand to include any newly retired lands. Consequently, the effect would not be significant. Some low-lying retired lands would continue to act as salt sinks, collecting and concentrating salts until they support limited vegetation and offer little wildlife habitat value.

In general, in the absence of any long-term program or funding mechanism to specifically develop and manage the retired lands under the Delta-Carquinez Strait Disposal Alternative to significantly improve wildlife habitat, the effect to terrestrial wildlife from anticipated long-term changes in vegetation and cropping patterns would be only slightly beneficial, resulting in no significant effect.

7.2.10.2 Aquatic and Wetland Resources

Implementation of the Delta-Carquinez Strait Disposal Alternative would result in temporary and permanent effects to aquatic and wetland resources. Effects from construction and operation of the 16 reuse facilities (totaling 19,000 acres), biotreatment facility, aqueduct, two pumping plants, and underwater outfall and diffuser would vary by type and degree.

Construction Effects

Construction of the reuse facilities, treatment plant, and collection system would not be expected to substantially affect aquatic and wetland resources. These facilities would all be located in intensively farmed areas, and would be sited on active or retired agricultural lands. In this landscape, significant effects to aquatic or wetland habitat would be very limited. Construction effects to aquatic and wetland-dependent resources from these facilities would be similar to those described for other action alternatives.

Reuse Areas. Staged development of the reuse facilities is not expected to substantially affect aquatic and wetland resources. Because the facilities would be located on active or retired agricultural lands, significant construction effects to aquatic, riparian, or wetland habitat types would be unlikely. Based on an appraisal-level reconnaissance, few, if any, natural stream channels traverse the sites (hydrologic features are typically shallow swales, irrigation ditches, or agricultural drainageways) and no substantial wetlands were identified. No significant effects to aquatic and wetland resources are anticipated to occur as a result of development of the reuse areas.

Collection/Conveyance. Construction of the extensive network of buried collection pipelines and associated sumps, pumps, and controls would result in widely distributed, but generally temporary effects. As proposed, the entire collection system would be constructed as buried pipelines (as opposed to open canals). Construction would take place in narrow linear corridors entirely within the agricultural heart of the valley and generally would be limited to previously disturbed road, canal, and railroad ROWs or the perimeters of agricultural fields. Stream crossings in this environment typically would involve existing ditches and canals. In this topographically flat agricultural landscape, pipeline construction (trench excavation, pipe placement, and backfilling) would move quickly, with minor and temporary disturbances at the few anticipated aquatic and wetland sites that might be encountered. No significant effects to aquatic and wetland resources are anticipated to occur as a result of construction of collection and conveyance facilities.

Delta-Carquinez Strait Aqueduct. Almost the entire Delta-Carquinez Strait aqueduct alignment would follow existing highway, canal, railroad, and powerline ROWs, greatly reducing the number and severity of potential effects to wetlands and other sensitive aquatic habitats. A small probability of encountering vernal pool habitat may exist along the approximately 13 percent of the aqueduct that traverses annual grassland and shrubland vegetation. The aqueduct's two pumping plants would be located and designed to avoid effects to aquatic and wetland habitats.

Based on a review of 7 ½' USGS topographic maps, the Delta-Carquinez Strait aqueduct would cross approximately 30 stream channels. Most of the crossings would be located near existing bridge crossings or road culverts since the majority of the aqueduct alignment would follow existing highway, road, railroad, and powerline ROWs. If a 75-foot construction corridor is assumed at all stream crossings, an average of 0.1 acre of aquatic habitat/riparian habitat would be disturbed at each crossing. All crossings would be restored to original contours and revegetated following construction.

For the first 105.1 miles, the aqueduct alignment for both Delta Disposal Alternatives is identical, including the proposed use of up to 83 miles of the existing San Luis Drain. From the current northern terminus of the San Luis Drain, extending northward for a distance of approximately 7.6 miles, the aqueduct would traverse a large wetland/upland complex consisting of State Waterfowl Areas, NWRs, and private duck clubs. Portions of this segment would be considered sensitive habitat. This segment would be constructed as a buried pipeline to reduce the width of the construction corridor and to eliminate permanent effects to the adjacent wetlands.

Construction of the aqueduct could disturb approximately 39.5 acres of Coastal Brackish Marsh (a sensitive community identified and mapped in the CNDDB [CDFG 2003]). Most of this marshland occurs along a railroad ROW that would be leased for the aqueduct. Given the current level of planning detail, the actual degree of effect is uncertain. Construction could occur along the dry perimeter of the marsh or in upland habitat created by the railroad berm; however, if excavation were required to take place in the wetland (as opposed to adjacent or interspersed uplands), the effect would be considered significant.

Assuming a 75-foot construction corridor in all sensitive habitat types, the Delta-Carquinez Strait Disposal Alternative could disturb a total of 120 acres of sensitive aquatic/wetland communities. In all probability, the actual construction corridor through these areas could be further narrowed to the minimum widths necessary to complete the pipeline installation.

All temporary construction-related facilities (temporary access/haul roads and equipment staging areas) could be designed and sited to avoid effects to streams, wetlands, and other sensitive habitats. When no longer needed, the temporary sites could be recontoured, stabilized, and revegetated to protect downstream aquatic resources (if any). Significant effects to aquatic and wetland resources could occur, but with the measures described above, effects are anticipated to be not significant.

Outfall. Construction of the underwater outfall and diffuser at Carquinez Strait could affect estuarine aquatic habitat in the Bay-Delta. The effects would be of short duration, but may be considered significant if construction were to occur during certain life stages of listed anadromous fish.

Operation Effects

Reuse Areas. Operation and routine maintenance of the Delta-Carquinez Strait Disposal Alternative's reuse facilities would be identical to operations previously described for the other action alternatives (no significant effects expected–see Section 7.2.8.2). See Section 8.2.2.5 for an evaluation of the potential effects to biological resources due to elevated Se concentrations in soil and water at reuse areas.

Outfall. An evaluation of the effects of Se discharges on aquatic resources is presented in Section 8.2.10.2.

7.2.10.3 Special-Status Species

Based on an extensive literature review, consultations with species experts, reconnaissance surveys of approximate facility sites and aqueduct alignments, and an evaluation of recent occurrence records (CDFG 2003), it was determined that 21 listed special-status species could occur in areas affected by construction or operation of the Delta-Carquinez Strait Disposal Alternative. Sixty-four species–from the list of 85 species provided by the Service, NOAA-Fisheries, and CDFG (see Appendix F, Table F-1)–were eliminated from further consideration because (1) areas of potential occurrence fell well outside the probable "footprint" of anticipated construction and operational effects associated with the Delta-Carquinez Strait Disposal Alternative, (2) suitable habitat no longer is thought to be present in the areas being evaluated, or (3) the absence of recent occurrence records is highly indicative that the species no longer is present in the areas being evaluated. Table 7-5 identifies the 21 special-status species that may be present, or that could transiently utilize suitable habitat, in areas potentially affected by the Delta-Carquinez Strait Disposal Alternative. For Federally listed species with "may adversely affect" determinations, Reclamation would engage in consultation with the Service under Section 7 of the ESA to identify measures to avoid or minimize potential effects if this alternative is selected.

At present, focused endangered species biological surveys have not yet been completed on any proposed construction sites or pipeline alignments.

Table 7-5
Special-Status Species That May Be Affected by the Delta-Carquinez Strait Disposal Alternative

Common Name	Scientific Name	Federal Status	State Status	Effect
San Joaquin kit fox	*Vulpes macrotis mutica*	E	T	May have significant effect; mitigation feasible
Swainson's hawk	*Buteo swainsoni*	--	T	May have significant effect; mitigation feasible
Greater sandhill crane	*Grus canadensis tabida*	--	T/CFP[1]	No significant effect
Saltmarsh harvest mouse	*Reithrodontomys raviventris*	E	E/CFP	May have significant effect; mitigation feasible
Conservancy fairy shrimp	*Branchinecta conservatio*	E	--	May have unavoidable significant effect
Longhorn fairy shrimp	*Branchinecta longiantenna*	E	--	May have unavoidable significant effect
Vernal pool fairy shrimp	*Branchinecta lynchi*	T	--	May have unavoidable significant effect
Vernal pool tadpole shrimp	*Lepidurus packardi*	E	--	May have unavoidable significant effect

Table 7-5 (concluded)
Special-Status Species That May Be Affected by the Delta-Carquinez Strait Disposal Alternative

Common Name	Scientific Name	Federal Status	State Status	Effect
Delta button-celery	*Eryngium racemosum*	--	E	May have significant effect; mitigation feasible
California black rail	*Laterallus jamaicensis coturniculus*	--	T/CFP	May have significant effect; mitigation feasible
California clapper rail	*Rallus longirostris obsoletus*	E	E/CFP	May have significant effect; mitigation feasible
California tiger salamander	*Ambystoma californiense*	T[2]	SC	May have unavoidable significant effect
Western burrowing owl	*Athene cunicularia hypugaea*	--	SC[3]	May have unavoidable significant effect
Giant garter snake	*Thamnophis gigas*	T	T	May have unavoidable significant effect
California red-legged frog[4]	*Rana aurora draytonii*	T	SC	May have unavoidable significant effect
Chinook salmon (Central Valley Spring-run)[5]	*Oncorhynchus tshawytscha*	T	T	May have unavoidable significant effect
Chinook salmon (Central Valley Fall/Late Fall-run)	*Oncorhynchus tshawytscha*	FC	SC	May have unavoidable significant effect
Chinook salmon (Sacramento Winter-run)[6]	*Oncorhynchus tshawytscha*	E	E	May have unavoidable significant effect
Steelhead (Central Valley)[5]	*Oncorhynchus mykiss*	T	--	May have unavoidable significant effect
Delta smelt[6]	*Hypomesus transpacificus*	T	T	May have unavoidable significant effect
Green sturgeon	*Acipenser medirostris*	FC	SC	May have unavoidable significant effect

Notes:
[1]CFP--California fully protected species.
[2]Central California Distinct Population Segment (DPS) listed as Threatened August 4, 2004. Critical Habitat proposed August 10, 2004.
[3]Petitioned for listing as State-threatened or -endangered in April 8, 2003; petition rejected February 5, 2004. Species remains protected under California Fish and Game Code §3503.5—Protection of Raptors.
[4]Designated Critical Habitat within this alternative's "footprint" of potential project effects proposed April 14, 2004.
[5]Designated Critical Habitat within this alternative's "footprint" of potential project effects vacated April 30, 2002.
[6]Listing includes designated Critical Habitat within this alternative's "footprint" of potential project effects.
E – Endangered; T – Threatened; PT - Proposed Threatened; CSC – California Species of Special Concern; FC - Candidate (Federal); "—" - Not Listed; AGS – Annual Grassland; COW – Coastal Oak Woodland; CRP – Croplands; CSC – Coastal Scrub; ASC – Desert Scrub; FEW – Freshwater Emergent Wetland; MAR – Marine; RIV – Riverine; SEW – Saltwater Emergent Wetland; VRI – Valley Foothill Riparian; ESU – Evolutionarily Significant Unit

Construction Effects

The probability of significantly affecting listed special-status species or adversely modifying Critical Habitats during construction activity associated with the Delta-Carquinez Strait Disposal Alternative would be quite small. It is anticipated that construction would not adversely affect any listed species if preconstruction biological surveys are conducted and accepted protocols and mitigation measures designed to avoid or protect the species are fully implemented.

Construction of the reuse facilities, biotreatment plant, and collection system would occur primarily on active, temporarily fallowed, or retired agricultural lands or on ruderal lands surrounded by expanses of active cropland, greatly limiting the potential for adverse effects to special-status species. Similarly, over 90 percent of the proposed Delta-Carquinez Strait aqueduct would closely follow existing highway, road, aqueduct, and railroad ROWs through developed urban and agricultural landscapes. Special-status species likely to be encountered in these disturbed areas typically are transients or are utilizing a portion of a much larger foraging area.

San Joaquin kit fox territories could extend into proposed reuse area facility sites and collection system alignments where construction activity would take place; however, kit fox use of agricultural lands typically is limited to the edges of the valley floor within 2 miles of natural grassland and shrubland vegetation. The occurrence of kit fox dens would be unlikely in the intensively managed agricultural areas where most major construction would occur. Ideal suitable kit fox habitat is known to occur in and near Kesterson and San Luis NWRs and would be bisected by installation of the southern 7.6 miles of the Delta-Carquinez Strait aqueduct. Significant effects could occur; however, all construction sites could be evaluated to identify suitable kit fox habitat and, where appropriate, preconstruction surveys could be conducted to identify potential kit fox activity. Approved avoidance and site restoration measures could be implemented if kit fox are found, reducing effects to not significant.

Swainson's hawks are known to nest along the San Joaquin River (and occasionally in isolated individual trees or small stands) and forage for insects, birds, and other small prey in adjacent agricultural lands up to several miles from nest and roost sites. Suitable foraging habitat or nest trees may also exist in the general vicinity of the Delta-Carquinez Strait aqueduct corridor. Swainson's hawks could also forage at or near some construction sites, but would likely utilize adjacent areas while construction activities are ongoing. Significant effects to Swainson's hawks could occur due to construction activities; however, with preconstruction surveys and implementation of established guidelines for construction near nests, effects would be reduced to not significant.

Wintering **greater sandhill cranes** are known to forage over broad areas of the agricultural valley floor for insects, worms, seeds, and grains on recently disked or harvested grain fields, rice or corn stubble, shortgrass grasslands, and open wetlands. Cranes may be attracted to disturbed ground at the expansive reuse areas, opportunistically utilizing the sites during hours when construction activity stops each day, and foraging in other nearby or adjacent fields when construction activity resumes. No significant effects to greater sandhill cranes are expected to occur due to construction activities associated with development and installation of the facilities.

The **saltmarsh harvest mouse**, **California black rail**, **and California clapper rail** could occur in tidal marsh habitat in the general vicinity of the Delta-Carquinez Strait aqueduct segment that extends from Pittsburg to Martinez. Much of the potential habitat in the immediate vicinity of the pipeline, however, has been fragmented and disturbed and most of the pipeline segment is located on or adjacent to existing roadways and railroad berms. If determined to be appropriate, surveys could be conducted to locate remaining suitable habitat, and approved conservation measures could be incorporated into construction planning. Significant effects to these species may occur due to construction activities; however, with approved conservation measures effects would be reduced to not significant.

Isolated **vernal pools** and other ephemeral wetlands could occur within the aqueduct's 75-foot-wide construction corridor in suitable grasslands, particularly in or near the Kesterson and San Luis NWRs. Any destruction of vernal pool habitat would adversely affect populations of **vernal pool crustaceans** that may inhabit the sites and could adversely affect **California tiger salamanders**, which also inhabit small ephemeral pools and adjacent uplands. Potential effects to isolated pools would most likely be limited to construction of the 7.6 miles of aqueduct immediately north of the current San Luis Drain terminus. Preconstruction surveys could be conducted to locate occurrences of ephemeral pools and their associated species, and avoidance strategies, including minor route modifications, could be implemented, if practicable. Any unavoidable permanent destruction of vernal pool habitat could be mitigated with replacement habitat acquired in consultation with the Service and CDFG. Significant effects may be unavoidable, but the severity of effects could be reduced through mitigation.

Isolated populations of **Delta button-celery** could be encountered in the same areas as vernal pools, with several recent occurrence records within 1 mile of the aqueduct corridor (CDFG 2003). Construction activity could destroy individual plants or isolated populations, a significant effect. Botanical surveys could be conducted prior to construction to determine if the species is present within the proposed construction corridor. If the species is located, the CDFG would be notified and appropriate avoidance measures could be developed. Consequently, effects would be reduced to not significant.

The **western burrowing owl** occurs year-round in the San Joaquin Valley and has been observed nesting in small colonies along earthen canal banks and other sparsely vegetated disturbed sites. Construction in and adjacent to the San Luis Drain ROW could significantly affect colonies of western burrowing owls known to nest among the broken and shifted concrete slabs that comprise the abandoned conveyance structure. Initial development of reuse areas and installation of collection pipelines could also displace individuals or isolated colonies. However, with completion of burrowing owl surveys to determine precise locations of the colonies or individual occurrences, and implementation of a burrowing owl management plan for the affected Drain ROW segments and other project facilities, it is anticipated that significant effects from construction could effectively be avoided and the effect reduced to not significant.

The **giant garter snake** could occur in a variety of permanent aquatic habitats in San Joaquin Valley including marshes, sloughs, ponds, low gradient streams, and agricultural waterways and wetlands, such as poorly maintained irrigation and drainage canals. Construction of the collection system may require crossing a small number of permanently watered, poorly maintained irrigation and drainage canals. In addition, suitable habitat may be encountered along the southern 7.6 miles of the aqueduct in Kesterson and San Luis NWRs. Significant effects to giant garter snakes could occur due to construction activities; however, with preconstruction surveys and implementation of approved avoidance measure, as necessary, effects would be reduced to not significant.

The **California red-legged frog** may occur in quiet pools of streams, marshes, and ponds within the Delta-Carquinez Strait Disposal Alternative project area; however, the species has not been recently documented within areas potentially affected by the proposed reuse areas, collection system, or other "in-valley" facilities. Suitable habitat could be encountered along the Delta-Carquinez Strait aqueduct, particularly in Contra Costa County where numerous recent occurrences have been recorded within 5 miles of the of the proposed corridor. No areas of proposed Critical Habitat would be affected. With species-directed preconstruction biological surveys and, if necessary, implementation of approved avoidance and conservation measures, significant effects from construction activities could be mitigated to not significant.

The three listed **Chinook salmon ESUs**, **steelhead (Central Valley ESU)**, **Delta smelt**, or **green sturgeon** could be adversely affected by construction activity associated with Delta-Carquinez Strait Disposal Alternative and no Critical Habitat (Chinook salmon–Sacramento winter-run ESU; Delta smelt) would be adversely modified during construction. Construction of the outfall and diffuser would disturb bottom sediments, potentially burying benthic organisms and temporarily reducing water quality in the vicinity of the construction site; however, the disturbance would be short term. The short overall length of the outfall/diffuser and its relatively shallow depth would allow installation to proceed rapidly and would not result in a permanent obstruction to fish movement or migration. Construction during critical life stages or migration periods would be a significant effect that could be mitigated to not significant by avoiding construction during these periods.

Operation Effects

None of the listed species would be adversely affected by operation or routine maintenance of the collection system, buried aqueduct segments, biotreatment plant, or pumping plants or the anticipated noise, vehicle traffic, or lighting that would be associated with facility operations.

The **San Joaquin kit fox** would likely forage at the proposed reuse areas, favoring sites located nearest the eastern edges of the project in close proximity to preferred grassland and shrubland habitats. Foraging kit fox would be less likely to utilize other reuse sites that are more isolated within the agricultural landscape. Retirement of large contiguous tracts of cropland in the vicinity of the reuse areas, however, could create travel corridors to the interior sites, expanding potential kit fox foraging areas to eventually include the majority of the reuse areas. Portions of the reuse facilities planted in salt-tolerant grasses, grain crops, or permanent pasture could develop a substantial prey base of common dietary items such as insects, ground-nesting birds, and small mammals. Intensively cropped portions of the reuse facilities would likely support less abundant prey than the areas planted in cover or pasture crops, or nearby nonirrigated parcels and refuge lands. Sparsely vegetated grazed lands and the perimeters of wheat or barley fields also could provide attractive foraging areas. Day-to-day operation of farm equipment and farming infrastructure at the reuse facilities and retired lands would be similar to the common farming activities that already take place throughout the project area and, subsequently, would not be expected to increase kit fox mortality over current conditions. No significant effects to this species are expected to occur as a result of operation.

While the **Swainson's hawk** and **greater sandhill crane** would also be attracted to grasslands, irrigated pasture, and other suitable croplands (including retired lands converted to dryland farming or grazing land), reuse areas also would provide attractive foraging habitat with an abundance of seeds, grains, worms, insects, and small mammals. No significant effects to these species are expected to occur as a result of operation.

Potential risks to the **San Joaquin kit fox, Swainson's hawk** and **greater sandhill crane** associated with Se exposure at reuse areas are addressed in Section 8.2.9.3.

The **saltmarsh harvest mouse**, **California black rail**, **and California clapper rail** could occur in tidal marshes in the general vicinity of the Delta-Carquinez Strait Disposal aqueduct, but would not be affected in any way by day-to-day operation or routine maintenance of the buried conveyance. Similarly, following initial construction or development, operation and routine maintenance of the alternative's facilities and conveyance structures would have no effect on the hydrological conditions or vegetation that support suitable habitat for listed **vernal pool crustaceans**, **California tiger salamander**, or **Delta button-celery**.

Following initial construction or development, **western burrowing owls** occupying the San Luis Drain ROW and other sparsely vegetated disturbed sites within the project area would not be affected by subsequent facility operation or maintenance, if appropriate operating rules and conservation measures are included in a proposed burrowing owl management plan that would be developed for this alternative. Retired parcels operated as grazing lands could develop into large areas of potential burrowing owl habitat; however, as currently proposed, operation of the reuse areas as intensively irrigated croplands with large areas of persistent vegetation and uniform groundcover would prevent development of suitable burrowing owl nesting habitat and would provide generally unsuitable foraging habitat. No significant effects to this species are expected to occur as a result of operation.

The **giant garter snake** and **California red-legged frog** would not be adversely affected by operation or maintenance of any of this alternative's facilities. These species, however, could indirectly benefit from a general improvement in water quality in Mud Slough and other Grasslands area delivery channels, wetlands, and waterways that would result from full implementation of this alternative. No significant effects to these species are expected to occur as a result of operation.

None of the three listed **Chinook salmon ESUs**, **steelhead (Central Valley ESU)**, **Delta smelt**, or **green sturgeon** would be significantly affected by operation of the Delta-Carquinez Strait outfall The outfall location would not interfere with fish passage and the diffuser facilitate mixing and prevent disturbance of sediments in the immediate vicinity of the outfall. Potential risks to these species associated with Se exposure in the vicinity of the outfall are addressed in Section 8.2.9.3.

7.2.11 Cumulative Effects

Cumulative biological effects are those effects on the environment that result from the incremental consequences of an action when added to other past, present, and reasonably foreseeable future actions regardless of who undertakes such actions. These actions can be taken by Federal or non-Federal governmental agencies, private organizations, or individuals. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time within a specified region. Because the cumulative effects consider only "reasonable certain" future drainage management actions that have been funded and are outside of implementation of an SLDFR alternative, the cumulative impacts may be overstated if other actions occur that are not currently funded.

Cumulative biological effects relating specifically to Se exposure and bioaccumulation are discussed in Sections 8.2.11 (Selenium Bioaccumulation) and 5.2.12 (Surface Water).

7.2.11.1 In-Valley Disposal Alternatives

- Changes in the historical valley-wide spatial and temporal distribution of migrating, breeding, and wintering waterbirds from incrementally adding up to 3,290 acres of new evaporation basins–and a still-undetermined area of evaporation basin mitigation habitat–represent a cumulative effect. Presumably, the addition of numerous attractive foraging and roosting sites will redistribute patterns of use, possibly reducing historical bird use at existing refuges, duck clubs, and evaporation basins.
- Retirement of agricultural lands as proposed under any of the action alternatives could presumably lead to cumulative adverse effects to listed special-status species when retired parcels are managed in ways that are seemingly incompatible with ongoing species recovery efforts. Efforts to protect or restore native habitats in the San Joaquin Valley for the benefit of listed threatened and endangered species have been ongoing since the early 1980s. With publication of the Service's *Recovery Plan for Upland Species of the San Joaquin Valley, California* in 1998, an ecosystem-wide strategy for recovery was implemented. The plan covers an area of 8.5 million acres, including all of the SLDFR service area, and addresses 11 Federally listed species and 23 additional species of concern, including a number that are affected by the action alternatives. Among the recovery plan's stated objectives are to protect land in large blocks, creating linkages both on the valley floor and adjacent foothills; to promote land uses that can maintain or enhance species habitat values; and to restore continuous corridors or islands of suitable vegetation that can act as "stepping stones" to provide movement corridors. As one means of accomplishing these goals, the plan has targeted "agricultural land that must be retired, due to drainage problems or lack of irrigation water, for restoration to provide linkages or additional habitat for listed species." Specifically identified are lands in the SLDFR's Northerly Areas and Westlands North that have been proposed for reuse and evaporation facilities and land retirement. The project could be planned and designed in a manner compatible with special-status species recovery plans. The In-Valley Disposal Alternative would contribute cumulatively to effects on special-status species from other projects that retire lands from agriculture production. These projects could provide substantial benefits to species such as the San Joaquin kit fox. However, construction of the treatment facilities could cumulatively affect special-status species by removing marginal habitat for species such as the San Joaquin kit fox, burrowing owl, and Swainson's hawk.

7.2.11.2 Ocean Disposal Alternative

- No cumulative biological effects are expected to occur from discharging 21,000 AF/year of untreated drainwater in the Point Estero vicinity, when combined with discharges from the existing power plant and Abalone Farm. The mixing zones of the Ocean Disposal Alternative and the existing discharge locations are not expected to overlap.
- See "Retirement of agricultural lands…" under Section 7.2.11.1, In-Valley Disposal Alternatives, above.

7.2.11.3 Delta Disposal Alternatives

- Construction of new open canal segments, while not significant by themselves, when combined with other existing open canal and highway segments found in the project area could further fragment the landscape and create additional barriers to wildlife movement.
- See "Retirement of agricultural lands…" under Section 7.2.11.1, In-Valley Disposal Alternatives, above.

7.2.12 Environmental Effects Summary

The following sections and tables summarize for each alternative the evaluation of effects, relative to 2002 existing conditions and No Action, for terrestrial resources, aquatic and wetland resources, and Federally and State-listed special-status species. Effects associated with Se bioaccumulation are summarized separately in Section 8.2.12.

7.2.12.1 No Action Alternative

Terrestrial Resources

- When compared to 2002 existing conditions, nearly 88,600 additional acres of irrigated agricultural lands would be retired from irrigated production. Permanent conversion from intensively managed agricultural production to nonirrigated cover crops and ruderal vegetation would generally result in minor net increases in terrestrial habitat value; however, because the retired lands would not be managed under a long-term coordinated, valley-wide program, the benefits would be minimal. At the same time, changes in cropping patterns that would occur in drainage-impaired areas from salt-sensitive irrigated crops (e.g., cereal grains and alfalfa) to more salt-tolerant irrigated crops (e.g., cotton) would reduce the forage and cover value of the affected lands for some terrestrial species. Any permanent loss of large, contiguous blocks of cereal grain and alfalfa could be considered an unavoidable effect for a number of foraging wildlife species. The net effect of project-related and agricultural productivity-related changes in habitat value would depend on the acreages and juxtaposition of the affected lands within the agricultural landscape. In general, because agricultural lands are common both locally and regionally in the project area and cereal grains and alfalfa represent a minor component of the project area's crop mix, conversions to other crop mixes or agricultural uses would not result in significant beneficial or adverse effects to terrestrial wildlife species.
- When compared to 2002 existing conditions, no major facilities would be constructed or operated in areas that would directly or indirectly affect native or natural terrestrial habitat. Under No Action, an additional 4,900 irrigated acres would be acquired under the CVPIA Land Retirement Program and would be revegetated with natural vegetation to provide additional wildlife habitat. While significant improvements in habitat could be recognized for each restored parcel or tract, the overall effect, given the area and dimensions of the project area, would not be significant.
- When compared to 2002 existing conditions, implementation of the No Action Alternative would have no effect on existing sensitive, rare, or ecologically important natural communities.

- When compared to 2002 existing conditions, the risk of introduction or spread of noxious weeds could increase as the aerial extent of retired, settlement, temporarily fallowed, and drainage-impaired lands increases. While the majority of these lands would be dryland farmed or planted to produce desirable cover, unmanaged or abandoned lands could favor growth of undesirable or invasive vegetation. Expansion of invasive species would be considered a significant effect.

Aquatic and Wetland Resources

- When compared to 2002 existing conditions, 28 miles of the San Luis Drain currently used to convey drainwater to Mud Slough as part of the Grassland Bypass Project would be dewatered after December 2009, resulting in the loss of a canal fishery. However, because the canal is an artificial fishery and offers only marginal aquatic habitat, the effect would not be considered significant.
- When compared to 2002 existing conditions, year-round flows in Mud Slough would decrease substantially after December 2009, when drainwater discharges from the San Luis Drain under the Grassland Bypass Project are discontinued. While the reduction in flows could be considered an adverse effect, the associated improvement in water quality for the receiving waters would result in a minor improvement in aquatic habitat conditions in and downstream of Mud Slough. However, unmanaged drainage flows of poor quality would degrade habitat conditions.
- Over the 50-year planning period of the No Action Alternative, it is anticipated that no existing wetlands would be filled or drained and no construction would take place that would alter existing stream channels, interfere with movements of resident and migratory native fish, or impede 100-year floodways.

Federally and State-Listed Special-Status Species

- Compared to 2002 existing conditions, implementation of the various elements that comprise the No Action Alternative would have no effect on special-status terrestrial species. Because no major regional drainwater treatment or management projects would be constructed under the No Action Alternative, no special-status species habitats would be disturbed or fragmented. Because planned land retirements would not be located, developed, or managed specifically to provide suitable habitat for listed terrestrial species, benefits from land retirements would be minimal.
- Compared to 2002 existing conditions, the No Action Alternative would not disturb, degrade, or cause the loss of aquatic or wetland habitat used by special-status aquatic species. Planned land retirements would likely have no direct adverse effects on aquatic or wetland habitat. Elimination of drainwater discharges into Mud Slough from the San Luis Drain after December 2009, could slightly improve 6 miles of habitat for the giant garter snake.

7.2.12.2 In-Valley Disposal Alternative

Terrestrial Resources

- When compared to both the No Action Alternative and 2002 existing conditions, construction of the project's proposed major facilities would result in permanent conversion of approximately 23,000 acres of active, fallowed, and retired agricultural lands to project uses. However, because the affected agricultural lands are common both locally and regionally and typically have low habitat value compared to native and natural terrestrial habitats, loss of habitat value associated with these conversions would be not significant. Furthermore, the proposed locations of the anticipated facilities within the agricultural landscape would not substantially fragment any surrounding natural habitats or interfere with migration corridors.
- When compared to both the No Action Alternative and 2002 existing conditions, no major facilities would be sited, constructed, or operated in areas that would directly or indirectly affect native or natural terrestrial habitat. Conversely, except where might be required for specific mitigation requirements, no land would be acquired, revegetated with native or natural vegetation, or managed specifically to enhance terrestrial habitat (although an additional 4,900 irrigated acres would be acquired under the CVPIA Land Retirement Program to provide additional wildlife habitat). Subsequently, the In-Valley Disposal Alternative would have no significant beneficial or adverse effects on native or natural terrestrial habitats.
- When compared to both the No Action Alternative and 2002 existing conditions, the In-Valley Disposal Alternative would have no significant effect on any sensitive, rare, or ecologically important natural communities.
- A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 22,600 would be used for project facilities and ROWs. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. No significant effect to wildlife habitat from these land use conversions is anticipated.
- During construction, some common species of terrestrial wildlife (e.g., burrowing or ground-nesting species) could be killed or permanently displaced. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.
- Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of In-Valley Disposal Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations. However, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.

- Management of large areas of newly retired lands as fallowed or as grazing lands under multiple lessee/operator arrangements could promote the spread of invasive weeds and other undesirable species, which could result in significant adverse effects; however, all lessees would be required to participate in an active weed management program, thus reducing the potential to introduce or spread noxious weeds to not significant.

Aquatic and Wetland Resources

- When compared to the No Action Alternative and 2002 existing conditions, the In-Valley Disposal Alternative would add 3,290 acres of intensively managed hypersaline evaporation basins to the existing San Joaquin Valley landscape, resulting in a number of potential adverse effects to aquatic or wetland-dependent species that would utilize the basins. Effects not specifically related to Se exposure could include salt encrustations on feathers of wintering waterbirds, increased predation and rapid spread of avian diseases due to crowding, direct mortality from human/equipment activity, and stress-related reductions in the health and vigor of breeding, migrating, and wintering birds from hazing. These significant adverse effects could be reduced by mitigation but not entirely eliminated. Consequently, remaining effects are considered unavoidable.
- When compared to the No Action Alternative and 2002 existing conditions, all permanent and temporary effects to jurisdictional wetlands from filling or draining could be reduced or eliminated with appropriate avoidance measures, construction techniques, and site restoration. All of the In-Valley Disposal Alternative's major facilities could be sited to avoid existing wetland habitat. Pipeline crossings of small isolated wetlands or waterways would be restored to preconstruction conditions. Although significant effects could occur, with mitigation effects would not be significant.
- When compared to both the No Action Alternative and 2002 existing conditions, no historic stream channel characteristics would be altered. No major stream channels or natural waterways would be crossed or affected. Pipeline crossings of agricultural waterways and intermittent streams and swales would be restored to preconstruction conditions.
- Compared to both the No Action Alternative and 2002 existing conditions, the In-Valley Disposal Alternative would have no substantial beneficial or adverse effects on migratory movements of native fish. No proposed facilities would block or impede fish movements. Water quality in Mud Slough and the San Joaquin River immediately below Mud Slough would improve slightly compared to 2002 existing conditions, but the incremental benefit to common resident or migratory fish and other aquatic species would likely not be substantial. No significant effects are anticipated.

Federally and State-Listed Special-Status Species

- San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, western yellow-billed cuckoo, giant garter snake, and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing. For all other listed terrestrial species, avoidance and mitigation measures could reduce or eliminate the potential for adverse effects.

- Compared to both the No Action Alternative and 2002 existing conditions, operation of the In-Valley Disposal Alternative would have either no effect or potentially beneficial effects on Federally and State-listed aquatic and wetland-dependent species. Habitat used by the California black rail would not be affected by the In-Valley Disposal Alternative. No listed aquatic or wetland-dependent species would be directly affected by operation of the evaporation basins, reuse areas, treatment facilities, or retired lands. Effects to special-status species related to Se bioaccumulation are discussed in Section 8.

7.2.12.3 In-Valley/Groundwater Quality Land Retirement Alternative

Terrestrial Resources

- When compared to both the No Action Alternative and 2002 existing conditions, construction of evaporation basins, treatment plants, and reuse facilities and related structures would result in permanent conversion of approximately 20,000 acres of active, fallowed, and retired croplands to project uses. However, because the affected agricultural lands are common both locally and regionally and typically have low habitat value for most species compared to native and natural terrestrial habitats, loss of habitat value associated with these lands would be minimal. The proposed locations of the anticipated facilities would not substantially fragment the existing natural landscape or interfere with migration corridors.
- When compared to both the No Action Alternative and 2002 existing conditions, no major facilities would be sited, constructed, or operated in areas that would directly or indirectly affect native or natural terrestrial habitat. Conversely, except where might be required for specific mitigation requirements, no land would be acquired, revegetated with native or natural vegetation, or managed specifically to enhance terrestrial habitat (although an additional 4,900 irrigated acres would be acquired under the CVPIA Land Retirement Program to provide additional wildlife habitat). Subsequently, the In-Valley/Groundwater Quality Land Retirement Alternative would have no beneficial or adverse effects on native or natural terrestrial habitats.
- When compared to both the No Action Alternative and 2002 existing conditions, the In-Valley/Groundwater Quality Land Retirement Alternative would have no effect on any sensitive, rare, or ecologically important natural communities.
- A total of 92,592 acres would be retired (16,514 fewer acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 19,862 would be used for project facilities and ROWs. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. No significant effect on wildlife habitat is anticipated.
- During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.

- Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of the In-Valley/Groundwater Quality Land Retirement Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations. However, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.
- Management of large areas of newly retired lands as fallowed or as grazing lands under multiple lessee/operator arrangements could promote the spread of invasive weeds and other undesirable species, which could result in significant adverse effects; however, all lessees would be required to participate in an active weed management program, thus reducing the potential to introduce or spread noxious weeds to not significant.

Aquatic and Wetland Resources

- When compared to the No Action Alternative and 2002 existing conditions, the In-Valley/ Groundwater Quality Land Retirement Alternative would add 2,890 acres of intensively managed hypersaline evaporation basins to the existing San Joaquin Valley landscape, resulting in a number of potential adverse effects to aquatic or wetland-dependent species that would utilize the basins. Effects not specifically related to Se exposure could include salt encrustations on feathers of wintering waterbirds, increased predation and rapid spread of avian diseases due to crowding, direct mortality from human/equipment activity, and stress-related reductions in the health and vigor of breeding, migrating, and wintering birds due to hazing. These adverse effects could be reduced by mitigation; remaining effects would be unavoidable.
- When compared to the No Action Alternative and 2002 existing conditions, all permanent and temporary effects to jurisdictional wetlands from filling or draining could be reduced or eliminated with appropriate avoidance measures, construction techniques, and site restoration. All of the In-Valley/Groundwater Quality Land Retirement Alternative's major facilities could be sited to avoid existing wetland habitat. Pipeline crossings of small isolated wetlands or waterways would be restored to preconstruction conditions. Although significant effects could occur, with mitigation effects would not be significant.
- When compared to both the No Action Alternative and 2002 existing conditions, no historic stream channel characteristics would be altered. No major stream channels or natural waterways would be crossed or affected. Pipeline crossings of agricultural waterways and intermittent streams and swales would be restored to preconstruction conditions.
- Compared to both the No Action Alternative and 2002 existing conditions, the In-Valley/ Groundwater Quality Land Retirement Alternative would have no substantial beneficial or adverse effects on migratory movements of native fish. No proposed facilities would block or impede fish movements. Water quality in Mud Slough and the San Joaquin River below Mud Slough would improve slightly compared to 2002 existing conditions, but the incremental benefit to common migratory or resident fish and other aquatic species would likely not be substantial. No significant effects are anticipated.

Federally and State-Listed Special-Status Species

- San Joaquin kit fox, Swainson’s hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, western yellow-billed cuckoo, giant garter snake, and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson’s hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing. For all other listed terrestrial species, avoidance and mitigation measures would reduce or eliminate potential for adverse effects.
- Compared to both the No Action Alternative and 2002 existing conditions, operation of the In-Valley/Groundwater Quality Land Retirement Alternative would have either no effect or potentially beneficial effects on Federally or state-listed aquatic and wetland-dependent species. Habitat used by the California black rail would not be affected by the In-Valley Groundwater Quality Land Retirement Alternative. No listed aquatic or wetland-dependent species would be directly affected by operation of the evaporation basins, reuse areas, treatment facilities, or retired lands. Effects to special-status species related to Se bioaccumulation are discussed in Section 8.

7.2.12.4 In-Valley/Water Needs Land Retirement Alternative

Terrestrial Resources

- When compared to both the No Action Alternative and 2002 existing conditions, construction of evaporation basins, treatment plants, and reuse facilities and related structures would result in permanent conversion of approximately 15,000 acres of active, fallowed, and retired croplands to project uses. However, because the affected agricultural lands are common both locally and regionally and typically have low habitat value for most species compared to native and natural terrestrial habitats, loss of habitat value associated with these lands would be minimal. The proposed locations of the anticipated facilities would not substantially fragment the existing natural landscape or interfere with migration corridors.
- When compared to both the No Action Alternative and 2002 existing conditions, no major facilities would be sited, constructed, or operated in areas that would directly or indirectly affect native or natural terrestrial habitat. Conversely, except where might be required for specific mitigation requirements, no land would be acquired, revegetated with native or natural vegetation, or managed specifically to enhance terrestrial habitat (although an additional 4,900 irrigated acres would be acquired under the CVPIA Land Retirement Program to provide additional wildlife habitat). Subsequently, the In-Valley/Water Needs Land Retirement Alternative would have no significant beneficial or adverse effects on native or natural terrestrial habitats.
- When compared to both the No Action Alternative and 2002 existing conditions, the In-Valley/Water Needs Land Retirement Alternative would have no effect on any sensitive, rare, or ecologically important natural communities.

- A total of 193,956 acres would be retired (84,850 more acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 14,919 would be used for project facilities and ROWs. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. Minor to significant increases/decreases in habitat value would result, depending on location, season, existing vegetation, and affected species. Any significant net reduction in the amount of higher-valued (for wildlife) agricultural crops could result in localized unavoidable adverse effects for some foraging species.
- During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.
- Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of the In-Valley/Water Needs Land Retirement Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations. However, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.
- Management of large areas of newly retired lands as fallowed or as grazing lands under multiple lessee/operator arrangements could promote the spread of invasive weeds and other undesirable species, which could result in significant adverse effects. However, all lessees would be required to participate in an active weed management program, thus reducing the potential to introduce or spread noxious weeds to not significant.

Aquatic and Wetland Resources

- When compared to the No Action Alternative and 2002 existing conditions, the In-Valley/ Water Needs Land Retirement Alternative would add 2,150 acres of intensively managed hypersaline evaporation basins to the existing San Joaquin Valley landscape, resulting in a number of potential adverse effects to aquatic or wetland-dependent species that would utilize the basins. Effects not specifically related to Se exposure could include reduced salt encrustations on feathers of wintering waterbirds, increased predation and rapid spread of avian diseases due to crowding, direct mortality from human/equipment activity, and stress-related reductions in the health and vigor of breeding, migrating, and wintering birds from hazing. These significant adverse effects could be reduced by mitigation; remaining effects would be unavoidable.
- When compared to the No Action Alternative and 2002 existing conditions, all permanent and temporary effects to jurisdictional wetlands from filling or draining could be reduced or eliminated with appropriate avoidance measures, construction techniques, and site restoration. All of this alternative's major facilities could be sited to avoid existing wetland habitat. Pipeline crossings of small isolated wetlands or waterways would be restored to preconstruction conditions. Although significant effects could occur, with mitigation effects would not be significant.

- When compared to both the No Action Alternative and 2002 existing conditions, no historic stream channel characteristics would be altered. No major stream channels or natural waterways would be crossed or affected. Pipeline crossings of agricultural waterways and intermittent streams and swales would be restored to preconstruction conditions.
- Compared to both the No Action Alternative and 2002 existing conditions, the In-Valley/ Water Needs Land Retirement Alternative would have no substantial beneficial or adverse effects on migratory movements of native fish. No proposed facilities would block or impede fish movements. Water quality in Mud Slough and the San Joaquin River immediately below Mud Slough would improve slightly compared to 2002 existing conditions, but the incremental benefit to common resident and migratory fish and other aquatic species would likely not be substantial. No significant effects are anticipated.

Federally and State-Listed Special-Status Species

- San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, western yellow-billed cuckoo, giant garter snake, and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing. Effects to special-status species related to Se bioaccumulation are discussed in Section 8.

7.2.12.5 In-Valley-Drainage-Impaired Area Land Retirement Alternative

Terrestrial Resources

- When compared to both the No Action Alternative and 2002 existing conditions, construction of the evaporation basin, treatment plant, and related permanent structures and the 4,000-acre expansion of the existing Panoche reuse facility would result in permanent conversion of approximately 9,000 acres of active, fallowed, and retired croplands to project uses. However, because the affected agricultural lands are common both locally and regionally and typically have low habitat value for most species compared to native and natural terrestrial habitats, loss of habitat value associated with these lands would be minimal. The proposed locations of the anticipated facilities would not substantially fragment the existing natural landscape or interfere with migration corridors.
- When compared to both the No Action Alternative and 2002 existing conditions, no major facilities would be sited, constructed, or operated in areas that would directly or indirectly affect native or natural terrestrial habitat. Conversely, except where might be required for specific mitigation requirements, no land would be acquired, revegetated with native or natural vegetation, or managed specifically to enhance terrestrial habitat (although an additional 4,900 irrigated acres would be acquired under the CVPIA Land Retirement Program to provide additional wildlife habitat). Subsequently, the In-Valley/Drainage-Impaired Area Land Retirement Alternative would have no significant beneficial or adverse effects on native or natural terrestrial habitats.

- When compared to both the No Action Alternative and 2002 existing conditions, the In-Valley/Drainage-Impaired Area Land Retirement Alternative would have no effect on any sensitive, rare, or ecologically important natural communities.
- A total of 308,000 acres would be retired (198,894 more acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 8,779 would be used for project facilities and ROWs. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. Minor to significant increases/decreases in habitat value would result, depending on location, season, existing vegetation, and affected species. Any significant net reduction in the amount of higher-valued (for wildlife) agricultural crops could result in localized unavoidable adverse effects for some foraging species.
- During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.
- Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of In-Valley/Drainage-Impaired Area Land Retirement Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations. However, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.
- Management of large areas of newly retired lands as fallowed or as grazing lands under multiple lessee/operator arrangements could promote the spread of invasive weeds and other undesirable species, which could result in significant adverse effects; however, all lessees would be required to participate in an active weed management program, thus reducing the potential to introduce or spread noxious weeds to not significant.

Aquatic and Wetland Resources

- When compared to the No Action Alternative and 2002 existing conditions, the In-Valley/ Drainage-Impaired Area Land Retirement Alternative would add 1,270 acres of intensively managed hypersaline evaporation basins to the existing San Joaquin Valley landscape, resulting in a number of potential adverse effects to aquatic or wetland-dependent species that would utilize the basins. Effects not specifically related to Se exposure could include salt encrustations on feathers of wintering waterbirds, increased predation and rapid spread of avian diseases due to crowding, direct mortality from human/equipment activity, and stress-related reductions in the health and vigor of breeding, migrating, and wintering birds from hazing. These significant adverse effects could be reduced by mitigation; remaining effects would be unavoidable.
- When compared to the No Action Alternative and 2002 existing conditions, all permanent and temporary effects to jurisdictional wetlands from filling or draining could be reduced or eliminated with appropriate avoidance measures, construction techniques, and site restoration. All of this alternative’s major facilities could be sited to avoid existing wetland habitat. Pipeline crossings of small isolated wetlands or waterways would be restored to

preconstruction conditions. Although significant effects could occur, with mitigation effects would not be significant.

- When compared to both the No Action Alternative and 2002 existing conditions, no historical stream channel characteristics would be altered. No major stream channels or natural waterways would be crossed or affected. Pipeline crossings of agricultural waterways and intermittent streams and swales would be restored to preconstruction conditions.
- Compared to both the No Action Alternative and 2002 existing conditions, the In-Valley/ Drainage-Impaired Area Land Retirement Alternative would have no substantial beneficial or adverse effects on migratory movements of native fish. No proposed facilities would block or impede fish movements. Water quality in Mud Slough and the San Joaquin River immediately below Mud Slough would improve slightly compared to 2002 existing conditions, but the incremental benefit to common resident and migratory fish and other aquatic species would likely not be substantial. No significant effects are anticipated.

Federally and State-Listed Special-Status Species

- San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, western yellow-billed cuckoo, giant garter snake, and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing. Effects to special-status species related to Se bioaccumulation are discussed in Section 8.
- Compared to both the No Action Alternative and 2002 existing conditions, operation of the In-Valley/Drainage-Impaired Area Land Retirement Alternative would have either no effect or potentially beneficial effects on listed aquatic and wetland-dependent species. Habitat used by the California black rail would not be affected by the In-Valley/Drainage-Impaired Area Land Retirement Alternative. No listed aquatic or wetland-dependent species would be directly affected by operation of the evaporation basins, reuse areas, treatment facilities, or retired lands.

7.2.12.6 Ocean Disposal Alternative

Terrestrial Resources

- When compared to both the No Action Alternative and 2002 existing conditions, construction and operation of the Ocean Disposal Alternative's reuse facilities would result in permanent conversion of approximately 19,000 acres of active, fallowed, and retired croplands to managed salt-tolerant vegetation. Because the affected agricultural lands are common both locally and regionally and typically have low habitat value for most terrestrial species compared to natural habitats, loss of habitat value associated with these lands would be minimal. The proposed locations of the reuse areas, buried collection/conveyance structures, and miscellaneous aboveground structures would not substantially fragment the existing natural landscape or interfere with migration corridors.

- When compared to both the No Action Alternative and 2002 existing conditions, the Ocean Disposal Alternative would have no significant effect on common natural terrestrial habitats. No major permanent structures or facilities would be constructed or operated in areas that would directly or indirectly result in the permanent loss of common native or natural terrestrial habitats. Conversely, except where might be required for specific mitigation requirements, no land would be acquired for the specific purpose of revegetating to develop native or natural vegetation (although an additional 4,900 irrigated acres would be acquired and managed under the CVPIA Land Retirement Program to provide additional wildlife habitat).
- When compared to both the No Action Alternative and 2002 existing conditions, construction of the Ocean aqueduct could temporarily disturb up to 1,700 acres of existing natural terrestrial habitat types including grazed annual grasslands, alkali desert scrub, coastal scrub, and valley oak woodland. With appropriate site restoration and revegetation, these short-term construction effects would have no permanent adverse effect. Up to 56 acres of valley oak woodland would be permanently removed within the permanent aqueduct ROW, representing a significant effect. However, a mitigation plan to replace the cleared trees could be developed, reducing the effect to not significant.
- A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 19,000 would be used for project facilities and ROWs. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. No significant effect on wildlife habitat is anticipated.
- During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.
- Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of Ocean Disposal Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations. However, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.
- Management of large areas of newly retired lands as fallowed or as grazing lands under multiple lessee/operator arrangements could promote the spread of invasive weeds and other undesirable species, which could result in significant adverse effects. However, all lessees would be required to participate in an active weed management program, thus reducing the potential to introduce or spread noxious weeds to not significant.

Aquatic and Wetland Resources

- When compared to the No Action Alternative and 2002 existing conditions, the Ocean Disposal Alternative would have no effect on existing wetland-dependent species. All of the Ocean Disposal Alternative's aboveground structures and major facilities would be sited to avoid existing wetland habitat. When appropriate, avoidance and site restoration measures would be implemented to reduce effects to wetland resources.

- When compared to the No Action Alternative and 2002 existing conditions, all permanent and temporary effects to existing jurisdictional wetlands from filling, draining, or degradation could be reduced or eliminated with appropriate avoidance measures, construction techniques, and site restoration. All of the Ocean Disposal Alternative's aboveground structures and major facilities could be sited to avoid existing wetland habitat. All collection system and aqueduct crossings of waterways or small isolated wetlands, including potential effects to 3 acres of mostly second terrace Valley Foothill Riparian habitat possibly occurring in the vicinity of the Salinas River aqueduct crossing, could be restored to preconstruction conditions. Although significant effects could occur, with mitigation effects would not be significant.
- When compared to both the No Action Alternative and 2002 existing conditions, no historical stream channel characteristics would be permanently altered. All major stream channel crossings would be completed according to Federal and State permit conditions. Crossings of agricultural waterways and intermittent streams and swales would be restored to preconstruction conditions. No significant effects are anticipated.
- Compared to both the No Action Alternative and 2002 existing conditions, the Ocean Disposal Alternative would have no beneficial or adverse effects on migratory movements of native fish. Construction at major stream crossings and at coastal streams would be completed so as to not interfere with fish passage. Flows in Mud Slough and the San Joaquin River below Mud Slough would be reduced compared to 2002 existing conditions, but the effect on resident and migratory fish would be negligible in normal years. No significant effects are anticipated.

Federally and State-Listed Special-Status Species

- Several terrestrial species may occur within the construction corridors of the proposed aqueduct or other buried pipelines and could be significantly affected, but the likelihood of adverse construction effects would be reduced, if not wholly eliminated, with preconstruction surveys and subsequent avoidance or mitigation measures. These terrestrial species include the giant kangaroo rat, San Joaquin kit fox, Swainson's hawk, western burrowing owl, giant garter snake, California red-legged frog, tidewater goby, and San Joaquin wooly threads.
- Compared to both the No Action Alternative and 2002 existing conditions, operation of the Ocean Disposal Alternative would have either no effect or potentially beneficial effects on Federally and state-listed aquatic and wetland-dependent species. No listed aquatic or wetland-dependent species would be directly affected by operation of the reuse areas, retired lands, or the aqueduct pumping plants. Effects to special-status species related to Se bioaccumulation are discussed in Section 8.

7.2.12.7 Delta-Chipps Island Disposal Alternative

Terrestrial Resources

- When compared to both the No Action Alternative and 2002 existing conditions, construction and operation of the Delta-Chipps Island Disposal Alternative's reuse facilities would result in permanent conversion of approximately 19,000 acres of active, fallowed, and retired croplands to managed salt-tolerant crops and other vegetation. Because operation of the reuse areas would not further fragment the existing agricultural landscape or interfere with migration corridors, and because the affected agricultural lands are common both locally and regionally and typically have low habitat value for most species compared to native and natural terrestrial habitats, adverse effects from converting agricultural and ruderal lands to reuse areas would be not significant.
- When compared to both the No Action Alternative and 2002 existing conditions, the Delta-Chipps Island Disposal Alternative would have no significant beneficial or adverse effects on common native or natural terrestrial habitats. No major permanent surface structures or facilities would be constructed or operated in areas that would directly or indirectly result in the loss of common native or natural terrestrial habitat. Conversely, except where might be required for mitigation development, no agricultural or ruderal land would be acquired for the specific purpose of revegetating with native or natural vegetation (although an additional 4,900 irrigated acres would be acquired and managed under the CVPIA Land Retirement Program to provide additional wildlife habitat).
- When compared to both the No Action Alternative and 2002 existing conditions, *temporary* construction disturbances to existing native and natural terrestrial habitats could occur on up to 1,000 acres of annual grasslands, shrublands, coastal scrub, and oak woodland along the Delta-Chipps Island aqueduct corridor. No significant effects are anticipated.
- A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 19,000 would be used for project facilities. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. No significant effect on wildlife habitat is anticipated.
- During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.
- Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of Delta-Chips Island Disposal Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations; however, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.

- Management of large areas of newly retired lands as fallowed or as grazing lands under multiple lessee/operator arrangements could promote the spread of invasive weeds and other undesirable species; however, Reclamation routinely requires all lessees to participate in an active weed management program, thus reducing the potential to introduce or spread noxious weeds to not significant.

Aquatic and Wetland Resources

- When compared to the No Action Alternative and 2002 existing conditions, significant effects to wetland habitat could occur. Construction of the aqueduct could disturb approximately 1 acre of Coastal Brackish Marsh, and a total of 73 acres of sensitive aquatic/wetland communities. however, with appropriate mitigation such as avoidance measures, construction techniques, and site restoration, adverse effects to wetland resources could be reduced or eliminated to not significant.
- When compared to both the No Action Alternative and 2002 existing conditions, no historical stream channel characteristics would be altered. All stream channel crossings would be completed according to Federal and State permit conditions. Crossing sites would be restored to preconstruction conditions.

Federally and State-Listed Special-Status Species

- Several listed species may occur within the construction corridors of the proposed aqueduct or at some reuse area sites. San Joaquin kit fox, Swainson’s hawk, salt-marsh harvest mouse, California black rail, California clapper rail, Delta button-celery, giant garter snake, California red-legged frog, and western burrowing owl could be significantly affected by construction activity, but the likelihood of adverse construction effects would be reduced to not significant with preconstruction surveys and subsequent avoidance or mitigation measures. Effects to special-status species related to Se bioaccumulation are discussed in Section 8.
- If vernal pools are destroyed during construction of the aqueduct, unavoidable significant effects could occur to vernal pool crustaceans (conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp) as well as the California tiger salamander. These effects could be reduced, but possibly not entirely offset, by avoidance and other mitigation measures.
- Construction activity and related impacts (e.g., disturbance and suspension of sediments, underwater noise and vibrations, burying of benthic organisms) associated with installation of the Chipps Island outfall could affect several listed fish known to reside in or migrate through the general area of the discharge site. Three Chinook salmon ESUs, Central Valley steelhead, Delta smelt, and green sturgeon could be significantly affected, particularly during certain life stages or during critical times of year; however, with approved construction techniques and scheduling to avoid critical periods, effects could be reduced to not significant.
- Compared to both the No Action Alternative and 2002 existing conditions, operation of the Delta-Chipps Island Disposal Alternative would have either no effect or potentially beneficial effects on Federally and State-listed aquatic and wetland-dependent species. Effects to special-status species related to Se bioaccumulation are discussed in Section 8.

7.2.12.8 Delta-Carquinez Strait Disposal Alternative

Terrestrial Resources

- When compared to both the No Action Alternative and 2002 existing conditions, construction and operation of the Delta-Carquinez Strait Disposal Alternative's reuse facilities would result in permanent conversion of approximately 19,000 acres of active, fallowed, and retired croplands to managed salt-tolerant crops and other vegetation. Because operation of the reuse areas would not further fragment the existing agricultural landscape or interfere with migration corridors, and because the affected agricultural lands are common both locally and regionally and typically have low habitat value for most species compared to native and natural terrestrial habitats, effects from converting agricultural and ruderal lands to reuse areas would not be significant.
- When compared to both the No Action Alternative and 2002 existing conditions, the Delta-Carquinez Strait Disposal Alternative would have no significant beneficial or adverse effects on common native or natural terrestrial habitats. No major permanent surface structures or facilities would be constructed or operated in areas that would directly or indirectly result in the loss of common native or natural terrestrial habitat. Conversely, except where might be required for mitigation development, no agricultural or ruderal land would be acquired for the specific purpose of revegetating with native or natural vegetation or to manage specifically to enhance terrestrial habitat (although an additional 4,900 irrigated acres would be acquired and managed under the CVPIA Land Retirement Program to provide additional wildlife habitat). No major permanent aboveground structures or facilities would be constructed or operated in areas that would directly or indirectly result in the permanent loss of common native or natural terrestrial habitat.
- When compared to both the No Action Alternative and 2002 existing conditions, temporary construction disturbances to existing native and natural terrestrial habitats could occur on up to 1,000 acres of annual grasslands, shrublands, coastal scrub, and oak woodland along the Delta-Carquinez Strait aqueduct corridor. Approximately 120 acres of sensitive habitats (including coastal brackish marsh and other wetlands, riparian areas at stream crossings, and valley oak woodlands) would be temporarily disturbed, resulting in significant effects. With appropriate site restoration and revegetation, these construction effects could be reduced to not significant.
- A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). Of the total, 7,000 would be retired under the CVPIA Land Retirement Program and managed for wildlife habitat, and about 19,560 would be used for project facilities. The remaining retired lands would convert to dryland farming, summer fallowing, or sheep grazing. No significant effect on wildlife habitat is anticipated.
- During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.

- Compared to both the No Action Alternative and 2002 existing conditions, surface disturbances associated with construction and operation of Delta-Carquinez Strait Disposal Alternative facilities could increase introduction of noxious weeds and/or the spread of existing noxious weed infestations. However, Reclamation routinely requires appropriate construction procedures, site management, and operating controls; therefore, effects would not be significant.
- Management of large areas of newly retired lands as fallowed or as grazing lands under multiple lessee/operator arrangements could promote the spread of invasive weeds and other undesirable species. However, Reclamation routinely requires all lessees to participate in an active weed management program, thus reducing the potential to introduce or spread noxious weeds to not significant.

Aquatic and Wetland Resources

- Construction of the aqueduct could disturb approximately 39.5 acres of Coastal Brackish Marsh, and a total of 120 acres of sensitive aquatic/wetland communities, resulting in significant effects. However, with appropriate mitigation such as avoidance measures, construction techniques, and site restoration, adverse effects to wetland resources could be reduced or eliminated to not significant.
- When compared to both the No Action Alternative and 2002 existing conditions, no historical stream channel characteristics would be altered. All stream channel crossings would be completed according to Federal and State permit conditions. Crossing sites would be restored to preconstruction conditions, resulting in no significant effects.

Federally and State-Listed Special-Status Species

- Several listed species may occur within the construction corridors of the proposed aqueduct or at some reuse area sites. San Joaquin kit fox, Swainson's hawk, salt-marsh harvest mouse, California black rail, California clapper rail, Delta button-celery, giant garter snake, California red-legged frog, and western burrowing owl could be significantly affected by construction activity, but the likelihood of adverse construction effects would be reduced to not significant with preconstruction surveys and subsequent avoidance or mitigation measures. Effects to special-status species related to Se bioaccumulation are discussed in Section 8.
- If vernal pools are destroyed during construction of the aqueduct, unavoidable significant effects could occur to vernal pool crustaceans (conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp) as well as the California tiger salamander. These effects could be reduced, but possibly not entirely offset, by avoidance and mitigation measures.
- Construction activity and related impacts (e.g., disturbance and suspension of sediments, underwater noise and vibrations, burying of benthic organisms) associated with installation of the Carquinez Strait outfall could affect several listed fish known to reside in or migrate through the general area of the discharge site. Three Chinook salmon ESUs, Central Valley steelhead, Delta smelt, and green sturgeon could be significantly affected, particularly during certain life stages or during critical times of year; however, with approved construction

techniques and scheduling to avoid critical periods, effects could be reduced to not significant.

Tables 7-6 through 7-13 summarize the effects of the No Action Alternative and action alternatives on biological resources. Text in these tables was modified for incorporation into Table 2.13-2 to facilitate comparisons among alternatives. Tables 7-7 through 7-13 compare project alternatives to No Action for NEPA analysis and to existing conditions for future CEQA analysis. Significance conclusions criteria for each comparison to No Action have been provided; however, no significance conclusions have been provided for comparison to existing conditions (as required in a CEQA analysis).

Table 7-6
Summary Comparison of Effects of No Action Alternative

Affected Resource and Area of Potential Effect	No Action Alternative Compared to Existing Conditions
Terrestrial Resources	
Permanent change in agricultural and ruderal habitats affecting terrestrial habitat values	88,600 additional acres active and fallow agricultural land would be retired and converted to nonirrigated crops or grazing.
Permanent change in natural habitats	4,900 additional irrigated acres would be acquired and managed for wildlife use under CVPIA Land Retirement Program.
Permanent change in recognized sensitive, rare, or ecologically important natural communities. Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation.	No change or difference would occur.
Introduction or spread of noxious weeds.	Conversion of active cropland to abandoned or unmanaged, fallowed, or heavily grazed retired lands could favor spread of undesirable ruderal vegetation and invasive species.
Aquatic and Wetland Resources	
Adverse effects on aquatic or wetland-dependent species. Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation.	Marginal canal fishery in 28-mile segment of San Luis Drain would be largely dewatered after December 2009. Water quality of refuge water in supply channels would deteriorate after December 2009
Filling, draining, or net loss of existing wetlands	No change or difference would occur.
Alteration of historic stream channel characteristics	No change or difference would occur.
Interference with migratory movements of native fish	No change or difference would occur.
Federally Listed Special-Status Species	
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	No effect.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.
State-Listed Special-Status Species	
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	No effect.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.

Table 7-7
Summary Comparison of Effects of In-Valley Disposal Alternative

Affected Resource and Area of Potential Effect	In-Valley Disposal Compared to No Action	In-Valley Disposal Compared to Existing Conditions
Terrestrial Resources		
Permanent changes in agricultural and ruderal habitats Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation.	A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). No significant effect.	A total of 44,106 acres would be retired (23,600 more than under existing conditions). No adverse effect.
Permanent changes in native and natural upland habitats	No facilities would be sited, constructed, or operated in native or natural upland habitats. 4,900 additional acres would be acquired and revegetated under the CVPIA Land Retirement Program. No significant effect.	No facilities would be sited, constructed, or operated in native or natural upland habitats. 4,900 additional acres would be acquired and revegetated under the CVPIA Land Retirement Program. Minor beneficial effect.
Permanent loss or degradation of recognized sensitive, rare, or ecologically important natural upland communities	No effect.	No effect.
Losses of terrestrial biological resources.	During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation and construction practices effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.	During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated.
Introduction or spread of noxious weeds	Retired lands that are fallowed or grazed may facilitate the spread of noxious weeds. No significant effect with implementation of a weed management program.	Retired lands that are fallowed or grazed may become highly susceptible to noxious weeds. Weeds would be reduced or controlled with an active weed management program.
Aquatic and Wetland Resources		
Adverse effects to aquatic or wetland-dependent species Also see Section 8 for effects relating specifically to Se exposure and bioaccumulation at evaporation basins and reuse areas.	Losses of waterbirds that occur due to salt toxicosis and salt encrustation despite available hazing and dispersal measures would be a significant unavoidable effect.	Losses of waterbirds that occur due to salt toxicosis and salt encrustation despite available hazing and dispersal measures would be an adverse unavoidable effect.

Table 7-7 (continued)
Summary Comparison of Effects of In-Valley Disposal Alternative

Affected Resource and Area of Potential Effect	In-Valley Disposal Compared to No Action	In-Valley Disposal Compared to Existing Conditions
Filling, draining, or net loss of existing wetlands	Construction activity in or near identified wetlands could result in the loss of wetland functions and values, resulting in significant effects. No significant effect with appropriate facility siting, construction procedures, site management, and operating controls.	Construction activity in or near identified wetlands could result in the loss of wetland functions and values, resulting in adverse effects. No net loss of functions and values with appropriate facility siting, construction procedures, site management, and operating controls.
Alteration of historic stream channel characteristics	Pipeline crossings could damage or disturb stream channels, resulting in significant effects. No significant effect with appropriate construction procedures.	Pipeline crossings could damage or disturb stream channels, resulting in adverse effects. No permanent adverse effect with appropriate construction procedures.
Interference with migratory movements of native fish	No significant effect.	No effect.
Federally Listed Special-Status Species (NOTE: Formal consultation has been completed for listed species that may be adversely affected if this alternative is selected.)		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s). See Section 8 for an evaluation of effects to Se bioaccumulation.	San Joaquin kit fox and bald eagle could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	San Joaquin kit fox and bald eagle could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Giant garter snake and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	Giant garter snake and California red-legged frog could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.	Not applicable.

Table 7-7 (concluded)
Summary Comparison of Effects of In-Valley Disposal Alternative

Affected Resource and Area of Potential Effect	In-Valley Disposal Compared to No Action	In-Valley Disposal Compared to Existing Conditions
State-Listed Special-Status Species		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s). See Section 8 for an evaluation of effects due to Se bioaccumulation.	San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, and western yellow-billed cuckoo could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing.	San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, and western yellow-billed cuckoo could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing.
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Giant garter snake and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	Giant garter snake and California red-legged frog could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.	Not applicable.

Table 7-8
Summary Comparison of Effects of
In-Valley/Groundwater Quality Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Groundwater Quality Land Retirement Compared to No Action	In-Valley/Groundwater Quality Land Retirement Compared to Existing Conditions
Terrestrial Resources		
Permanent changes in agricultural and ruderal habitats Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	A total of 92,592 acres would be retired (16,514 fewer acres than under No Action). No significant adverse effect.	A total of 92,592 acres would be retired (72,074 more than under existing conditions). No adverse effect.
Permanent changes in native and natural upland habitats	No facilities will be sited, constructed, or operated in native or natural upland habitats. 4,900 additional acres would be acquired and revegetated under the CVPIA Land Retirement Program. No significant effect.	No facilities will be sited, constructed, or operated in native or natural upland habitats. 4,900 additional acres would be acquired and revegetated under the CVPIA Land Retirement Program. Minor beneficial effect.
Permanent loss or degradation of recognized sensitive, rare, or ecologically important natural communities	No effect.	No effect.
Losses of terrestrial biological resources.	During construction, less mobile species, including some burrowing nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.	During construction, less mobile species, including some burrowing/nesting species could be killed or permanently displaced during construction, resulting in adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated.
Introduction or spread of noxious weeds	Retired lands that are fallowed or grazed may facilitate the spread of noxious weeds. No significant effect with implementation of a weed management program.	Retired lands that are fallowed or grazed may become highly susceptible to noxious weeds. Weeds could be reduced or controlled with an active weed management program.
Aquatic and Wetland Resources		
Adverse effects to aquatic or wetland-dependent species Also see Section 8 for effects relating specifically to Se exposure and bioaccumulation at evaporation basins and reuse areas.	Losses of waterbirds that occur due to salt toxicosis and salt encrustation despite available hazing and dispersal measures would be a significant unavoidable effect.	Losses of waterbirds that occur due to salt toxicosis and salt encrustation despite available hazing and dispersal measures would be an adverse unavoidable effect.

Table 7-8 (continued)
Summary Comparison of Effects of
In-Valley/Groundwater Quality Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Groundwater Quality Land Retirement Compared to No Action	In-Valley/Groundwater Quality Land Retirement Compared to Existing Conditions
Filling, draining, or net loss of existing wetlands	Construction activity in or near identified wetlands could result in the loss of functions and values, resulting in significant effects. No significant effect with appropriate construction procedures, site management, and operating controls.	Construction activity in or near identified wetlands could result in the loss of functions and values, resulting in adverse effects. No net loss of functions and values with appropriate construction procedures, site management, and operating controls.
Alteration of historic stream channel characteristics	Pipeline crossings could damage or disturb stream channels, resulting in significant effects. No significant effect with appropriate construction procedures.	Pipeline crossings could damage or disturb stream channels, resulting in adverse effects. No permanent adverse effect with appropriate construction procedures.
Interference with migratory movements of native fish	No significant effect.	No effect.
Federally Listed Special-Status Species (NOTE: Formal consultation has been completed for listed species that may be adversely affected if this alternative is selected.)		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s). Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	San Joaquin kit fox and bald eagle could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	San Joaquin kit fox and bald eagle could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Giant garter snake and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	Giant garter snake and California red-legged frog could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *marine/coastal aquatic* species or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.	Not applicable.

Table 7-8 (concluded)
Summary Comparison of Effects of
In-Valley/Groundwater Quality Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Groundwater Quality Land Retirement Compared to No Action	In-Valley/Groundwater Quality Land Retirement Compared to Existing Conditions
State-Listed Special-Status Species		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s). Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, and western yellow-billed cuckoo could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing.	San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, and western yellow-billed cuckoo could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing.
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Giant garter snake and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	Giant garter snake and California red-legged frog could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.	Not applicable.

Table 7-9
Summary Comparison of Effects of
In-Valley/Water Needs Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Water Needs Land Retirement Compared to No Action	In-Valley/Water Needs Land Retirement Compared to Existing Conditions
Terrestrial Resources		
Permanent changes in agricultural and ruderal habitats Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	A total of 193,956 acres would be retired (84,850 more acres than under No Action). Any significant net reduction in the amount of higher-valued (for wildlife) agricultural crops could result in localized unavoidable adverse effects for some foraging species. Significant adverse effect.	A total of 193,956 acres would be retired (173,438 more than under existing conditions). Any net reduction in the amount of higher-valued (for wildlife) agricultural crops could result in localized unavoidable adverse effects for some foraging species.
Permanent changes in native and natural upland habitats	No facilities will be sited, constructed, or operated in native or natural upland habitats. 4,900 additional acres would be acquired and revegetated under the CVPIA Land Retirement Program. No significant beneficial effect.	No facilities will be sited, constructed, or operated in native or natural upland habitats. 4,900 acres would be acquired and revegetated under the CVPIA Land Retirement Program. Minor beneficial effect.
Permanent loss or degradation of recognized sensitive, rare, or ecologically important natural communities	No effect.	No effect.
Losses of terrestrial biological resources.	During construction, less mobile species, including some burrowing nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.	During construction, less mobile species, including some burrowing/nesting species could be killed or permanently displaced during construction, resulting in adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated.
Introduction or spread of noxious weeds	Retired lands that are fallowed or grazed may facilitate the spread of noxious weeds. No significant effect with implementation of a weed management program.	Retired lands that are fallowed or grazed may become highly susceptible to noxious weeds. Weeds could be reduced or controlled with an active weed management program.

Table 7-9 (continued)
Summary Comparison of Effects of
In-Valley/Water Needs Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Water Needs Land Retirement Compared to No Action	In-Valley/Water Needs Land Retirement Compared to Existing Conditions
Aquatic and Wetland Resources		
Adverse effects to aquatic or wetland-dependent species Also see Section 8 for effects relating specifically to Se exposure and bioaccumulation at evaporation basins and reuse areas.	Losses of waterbirds that occur due to salt toxicosis and salt encrustation despite available hazing and dispersal measures would be a significant unavoidable effect.	Losses of waterbirds that occur due to salt toxicosis and salt encrustation despite available hazing and dispersal measures would be an adverse unavoidable effect.
Filling, draining, or net loss of existing wetlands	Construction activity in or near identified wetlands could result in the loss of functions and values, resulting in significant effects. No significant effect with appropriate construction procedures, site management, and operating controls.	Construction activity in or near identified wetlands could result in the loss of functions and values, resulting in adverse effects. No net loss of functions and values with appropriate construction procedures, site management, and operating controls.
Alteration of historic stream channel characteristics	Pipeline crossings could damage or disturb stream channels, resulting in significant effects. No significant effect with appropriate construction procedures.	Pipeline crossings could damage or disturb stream channels, resulting in adverse effects. No permanent adverse effect with appropriate construction procedures.
Interference with migratory movements of native fish	No significant effect.	No effect.
Federally Listed Special-Status Species (NOTE: Formal consultation has been completed for listed species that may be adversely affected if this alternative is selected.)		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s) Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	San Joaquin kit fox and bald eagle could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	San Joaquin kit fox and bald eagle could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.

Table 7-9 (concluded)
Summary Comparison of Effects of
In-Valley/Water Needs Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Water Needs Land Retirement Compared to No Action	In-Valley/Water Needs Land Retirement Compared to Existing Conditions
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Giant garter snake and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	Giant garter snake and California red-legged frog could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.	Not applicable.
State-Listed Special-Status Species		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s) Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, and western yellow-billed cuckoo could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing.	San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, and western yellow-billed cuckoo could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing.
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Giant garter snake and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	Giant garter snake and California red-legged frog could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.	Not applicable.

Table 7-10
Summary Comparison of Effects of
In-Valley/Drainage-Impaired Area Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Drainage-Impaired Area Land Retirement Compared to No Action	In-Valley/Drainage-Impaired Area Land Retirement Compared to Existing Conditions
Terrestrial Resources		
Permanent changes in agricultural and ruderal habitats Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	A total of 308,000 acres would be retired (198,894 more acres than under No Action). Any significant net reduction in the amount of higher-valued (for wildlife) agricultural crops could result in localized unavoidable adverse effects for some foraging species. Significant adverse effect.	A total of 308,000 acres would be retired (287,482 more than under existing conditions). Any net reduction in the amount of higher-valued (for wildlife) agricultural crops could result in localized unavoidable adverse effects for some foraging species.
Permanent changes in native and natural upland habitats	No facilities will be sited, constructed, or operated in native or natural upland habitats. 4,900 additional acres would be acquired and revegetated under the CVPIA Land Retirement Program. No significant beneficial effect.	No facilities will be sited, constructed, or operated in native or natural upland habitats. 4,900 additional acres would be acquired and revegetated under the CVPIA Land Retirement Program. Minor localized beneficial effects.
Permanent loss or degradation of recognized sensitive, rare, or ecologically important natural communities	No effect.	No effect.
Losses of terrestrial biological resources.	During construction, less mobile species, including some burrowing nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.	During construction, less mobile species, including some burrowing/nesting species could be killed or permanently displaced during construction, resulting in adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated.
Introduction or spread of noxious weeds	Retired lands that are fallowed or grazed may facilitate the spread of noxious weeds. No significant effect with implementation of a weed management program.	Retired lands that are fallowed or grazed may become highly susceptible to noxious weeds. Weeds would be reduced or controlled with an active weed management program.

Table 7-10 (continued)
Summary Comparison of Effects of
In-Valley/Drainage-Impaired Area Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Drainage-Impaired Area Land Retirement Compared to No Action	In-Valley/Drainage-Impaired Area Land Retirement Compared to Existing Conditions
Aquatic and Wetland Resources		
Adverse effects to aquatic or wetland-dependent species Also see Section 8 for effects relating specifically to Se exposure and bioaccumulation at evaporation basin.	Losses of waterbirds that occur due to salt toxicosis and salt encrustation despite available hazing and dispersal measures would be a significant unavoidable effect.	Losses of waterbirds that occur due to salt toxicosis and salt encrustation despite available hazing and dispersal measures would be an adverse unavoidable effect.
Filling, draining, or net loss of existing wetlands	Construction activity in or near identified wetlands could result in the loss of functions and values, resulting in significant effects. No significant effect with appropriate construction procedures, site management, and operating controls.	Construction activity in or near identified wetlands could result in the loss of functions and values, resulting in adverse effects. No net loss of functions and values with appropriate construction procedures, site management, and operating controls.
Alteration of historic stream channel characteristics	Pipeline crossings could damage or disturb stream channels, resulting in significant effects. No significant effect with appropriate construction procedures.	Pipeline crossings could damage or disturb stream channels, resulting in adverse effects. No permanent adverse effect with appropriate construction procedures.
Interference with migratory movements of native fish	No significant effect.	No effect.
Federally Listed Special-Status Species **(NOTE: Formal consultation has been completed for listed species that may be adversely affected if this alternative is selected.)**		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s) Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	San Joaquin kit fox and bald eagle could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	San Joaquin kit fox and bald eagle could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Giant garter snake and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	Giant garter snake and California red-legged frog could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.

Table 7-10 (concluded)
Summary Comparison of Effects of
In-Valley/Drainage-Impaired Area Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Drainage-Impaired Area Land Retirement Compared to No Action	In-Valley/Drainage-Impaired Area Land Retirement Compared to Existing Conditions
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.	Not applicable.
State-Listed Special-Status Species		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s) Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, and western yellow-billed cuckoo could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing.	San Joaquin kit fox, Swainson's hawk, American peregrine falcon, bald eagle, California black rail, western burrowing owl, and western yellow-billed cuckoo could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures. Swainson's hawks and sandhill cranes could benefit from improved and expanded foraging habitat associated with conversion of retired lands to dryland farming and grazing.
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Giant garter snake and California red-legged frog could experience significant adverse effects due to construction activities. These effects could be mitigated to not significant by conducting preconstruction surveys and implementing avoidance and conservation measures.	Giant garter snake and California red-legged frog could experience adverse effects due to construction activities. These effects could be mitigated by conducting preconstruction surveys and implementing avoidance and conservation measures.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Not applicable.	Not applicable.

Table 7-11
Summary Comparison of Effects of Ocean Disposal Alternative

Affected Resource and Area of Potential Effect	Ocean Disposal Compared to No Action	Ocean Disposal Compared to Existing Conditions
Terrestrial Resources		
Permanent changes in agricultural and ruderal habitats Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). No significant effect.	A total of 44,106 acres would be retired (23,600 more than under existing conditions). No adverse effect.
Permanent changes in natural upland habitats	1,980 acres temporarily disturbed during aqueduct construction could result in significant effects; however, mitigation would reduce effects to not significant. No agricultural lands would be acquired under project authority for conversion to native or natural upland habitats; however, 4,900 additional acres (for a total of 7,000) would be acquired and revegetated under the CVPIA Land Retirement Program. No significant effect.	1,980 acres temporarily disturbed during aqueduct construction; however, mitigation would reduce effects. No agricultural lands would be acquired under project authority for conversion to native or natural upland habitats; however, 4,900 additional acres (for a total of 7,000) would be acquired and revegetated under the CVPIA Land Retirement Program. Minor beneficial effect.
Permanent loss or degradation of recognized sensitive, rare, or ecologically important natural communities	3 acres valley foothills riparian and 56 acres valley oak woodland habitats would be permanently removed for aqueduct construction, resulting in a significant effect. Mitigation feasible, but detailed assessment of mitigation needs has not been completed.	3 acres valley foothills riparian and 56 acres valley oak woodland habitats would be permanently removed for aqueduct construction. Mitigation feasible, but detailed assessment of mitigation needs has not been completed.
Losses of terrestrial biological resources.	During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.	During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced, resulting in adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated.

Table 7-11 (continued)
Summary Comparison of Effects of Ocean Disposal Alternative

Affected Resource and Area of Potential Effect	Ocean Disposal Compared to No Action	Ocean Disposal Compared to Existing Conditions
Introduction or spread of noxious weeds	Noxious weeds could be introduced and spread at disturbed construction sites and project facilities. No significant effect with appropriate site management, construction procedures, and operating controls. Retired lands that are fallowed or grazed may facilitate the spread of noxious weeds. No significant effect with implementation of a weed management program.	Noxious weeds could be introduced and spread at disturbed construction sites and project facilities. Undesirable species could be reduced or controlled with appropriate site management, construction procedures, and operating controls. Retired lands that are fallowed or grazed may become highly susceptible to noxious weeds. Weeds could be reduced or controlled with an active weed management program.
Aquatic and Wetland Resources		
Adverse effects to aquatic or wetland-dependent species Also see Section 8 for effects relating specifically to Se exposure and bioaccumulation at reuse areas.	Potential construction disturbances or permanent loss of habitat at major river crossings along aqueduct and at undersea outfall, resulting in significant effects. With appropriate construction procedures, site management, and operating controls, no significant effect.	Potential construction disturbances or permanent loss of habitat at major river crossings along aqueduct and at undersea outfall. With appropriate construction procedures, site management, and operating controls, no adverse effect.
Filling, draining, or net loss of existing wetlands	Construction activity in or near identified wetlands could result in the loss of functions and values, resulting in significant effects. No net loss or significant effect with appropriate construction procedures, site management, and operating controls.	Construction activity in or near identified wetlands could result in the loss of functions and values. No effect or net loss of functions and values with appropriate construction procedures, site management, and operating controls.
Alteration of historic stream channel characteristics	Pipeline/aqueduct crossings could damage or disturb stream channels. Affected channels would be restored or maintained with appropriate construction procedures, site management, and operating controls. No significant effect.	Pipeline/aqueduct crossings could damage or disturb stream channels. Affected channels would be restored or maintained with appropriate construction procedures, site management, and operating controls. No effect.
Interference with migratory movements of native fish	Pipeline/aqueduct crossings could interfere with fish movement. No interference with fish passage with appropriate construction procedures, site management, and operating controls.	Pipeline/aqueduct crossings could interfere with fish movement. No interference with fish passage with appropriate construction procedures, site management, and operating controls.

Table 7-11 (continued)
Summary Comparison of Effects of Ocean Disposal Alternative

Affected Resource and Area of Potential Effect	Ocean Disposal Compared to No Action	Ocean Disposal Compared to Existing Conditions
Federally Listed Special-Status Species **(NOTE: Formal consultation would be initiated for listed species that may be adversely affected if this alternative is selected.)**		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s) Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	Significant adverse effects to **San Joaquin kit fox**, **giant kangaroo rat,** and **San Joaquin woolythreads** from construction of aqueduct and to **San Joaquin kit fox** from construction of in-valley project facilities and the loss of marginal foraging habitat and established travel corridors following conversion of existing agricultural and ruderal habitats to reuse areas and nonirrigated retired land. No significant effect with completion of preconstruction surveys and implementation of approved avoidance and/or mitigation.	Potential adverse effects to **San Joaquin kit fox**, **giant kangaroo rat,** and **San Joaquin woolythreads** from construction of aqueduct and to **San Joaquin kit fox** from construction of in-valley project facilities and the loss of marginal foraging habitat and established travel corridors following conversion of existing agricultural and ruderal habitats to reuse areas and nonirrigated retired land. No effect with completion of preconstruction surveys and implementation of approved avoidance and/or mitigation.
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Significant adverse effects to **giant garter snake** and **California red-legged frog** from construction of collection facilities. No significant effect with completion of preconstruction surveys and implementation of approved avoidance and/or mitigation.	Potential adverse effects to **giant garter snake** and **California red-legged frog** from construction of collection facilities. No adverse effect with completion of preconstruction surveys and implementation of approved avoidance and/or mitigation.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Construction disturbances to coastal stream habitat of **tidewater goby** during aqueduct construction, resulting in significant adverse effects. With use of approved avoidance and site restoration measures, no significant effect.	Construction disturbances to coastal stream habitat of **tidewater goby** during aqueduct construction. With use of approved avoidance and site restoration measures, potential adverse effects would be eliminated.

Table 7-11 (concluded)
Summary Comparison of Effects of Ocean Disposal Alternative

Affected Resource and Area of Potential Effect	Ocean Disposal Compared to No Action	Ocean Disposal Compared to Existing Conditions
State-Listed Special-Status Species		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s) Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation at reuse areas.	Significant adverse effects to **San Joaquin kit fox**, **Swainson's hawk**, **giant kangaroo rat,** and **western burrowing owl** from construction of aqueduct and to **kit fox** from construction of in-valley project facilities and the loss of marginal foraging habitat and established travel corridors following conversion of existing agricultural and ruderal habitats to reuse areas and nonirrigated retired land. No significant effect with completion of preconstruction surveys and implementation of approved avoidance and/or mitigation.	Potential adverse effects to **San Joaquin kit fox**, **Swainson's hawk**, **giant kangaroo rat,** and **western burrowing owl** from construction of aqueduct and to **kit fox** from construction of in-valley project facilities and the loss of marginal foraging habitat and established travel corridors following conversion of existing agricultural and ruderal habitats to reuse areas and nonirrigated retired land. No effect with completion of preconstruction surveys and implementation of approved avoidance and/or mitigation.
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Significant adverse effects to **giant garter snake** and **California red-legged frog** from construction of collection facilities. No significant effect with completion of preconstruction surveys and implementation of approved avoidance and/or mitigation.	Potential adverse effects to **giant garter snake** and **California red-legged frog** from construction of collection facilities. No adverse effect with completion of preconstruction surveys and implementation of approved avoidance and/or mitigation.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	Construction disturbances to coastal stream habitat of **tidewater goby** during aqueduct construction, resulting in significant adverse effects. With use of approved avoidance and site restoration measures, no significant effect.	Construction disturbances to coastal stream habitat of **tidewater goby** during aqueduct construction. With use of approved avoidance and site restoration measures, potential adverse effects would be eliminated.

Table 7-12
Summary Comparison of Effects of Delta-Chipps Island Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Chipps Island Disposal Compared to No Action	Delta-Chipps Island Disposal Compared to Existing Conditions
Terrestrial Resources		
Permanent changes in agricultural and ruderal habitats Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). No significant effect.	A total of 44,106 acres would be retired (23,600 more than under existing conditions). No adverse effect.
Permanent changes in native and natural upland habitats	Approximately 1,000 acres temporarily disturbed during aqueduct construction would be restored to previous conditions. No significant effect. No other permanent facilities would be sited in native or natural upland habitat. No agricultural land would be acquired under project authority and converted to natural terrestrial habitats; however, 4,900 additional acres (for a total of 7,000) would be acquired and revegetated under CVPIA Land Retirement Program. No significant beneficial effect.	Approximately 1,000 acres temporarily disturbed during aqueduct construction would be restored to previous conditions. No adverse effect. No other permanent facilities would be sited in native or natural habitat. No agricultural lands would be acquired under the project and converted to native or natural habitat; however, 4,900 additional acres (for a total of 7,000) would be acquired and revegetated under CVPIA Land Retirement Program. No beneficial effect.
Permanent loss or degradation of recognized sensitive, rare, or ecologically important natural communities	73 acres would be temporarily disturbed during aqueduct construction, resulting in significant effects. Restoration of the disturbed sites would result in no significant effect.	73 acres would be temporarily disturbed during aqueduct construction. Restoration of the disturbed sites would result in no adverse effect.
Losses of terrestrial biological resources.	During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.	During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated.

Table 7-12 (continued)
Summary Comparison of Effects of Delta-Chipps Island Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Chipps Island Disposal Compared to No Action	Delta-Chipps Island Disposal Compared to Existing Conditions
Introduction or spread of noxious weeds	Noxious weeds could be introduced and spread at disturbed construction sites and project facilities. No significant effect with appropriate site management, construction procedures, and operating controls. Retired lands that are fallowed or grazed may facilitate the spread of noxious weeds. No significant effect with implementation of a weed management program.	Noxious weeds could be introduced and spread at disturbed construction sites and project facilities. Undesirable species could be reduced or controlled with appropriate site management, construction procedures, and operating controls. Retired lands that are fallowed or grazed may become highly susceptible to noxious weeds. Weeds could be reduced or controlled with an active weed management program.
Aquatic and Wetland Resources		
Adverse effects on aquatic or wetland-dependent species Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	Construction of the aqueduct could disturb approximately 73 acres of sensitive aquatic/wetland communities, resulting in significant effects. No significant effect with approved mitigation measures.	Construction of the aqueduct could disturb approximately 73 acres of sensitive aquatic/wetland communities, resulting in adverse effects. No adverse effect with approved mitigation measures.
Filling, draining, or net loss of existing wetlands	Construction activity associated with the aqueduct, outfall, and several smaller pipeline segments would take place in or near identified wetlands and could damage habitat or result in the loss of other wetland functions and values, resulting in significant effects. All construction in identified wetlands could utilize appropriate construction procedures, site management, and operating controls so that no significant effects will occur.	Construction activity associated with the aqueduct, outfall, and several smaller pipeline segments would take place in or near identified wetlands and could damage habitat or result in the loss of other wetland functions and values. All construction in identified wetlands could utilize appropriate construction procedures, site management, and operating controls to avoid adverse effects.
Alteration of historic stream channel characteristics	Pipeline/aqueduct crossings would not permanently damage or disturb stream channels. Affected channels would be restored or maintained with appropriate construction procedures, site management, and operating controls. No significant effect.	Pipeline/aqueduct crossings would not permanently damage or disturb stream channels. Affected channels would be restored or maintained with appropriate construction procedures, site management, and operating controls. No effect.

Table 7-12 (continued)
Summary Comparison of Effects of Delta-Chipps Island Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Chipps Island Disposal Compared to No Action	Delta-Chipps Island Disposal Compared to Existing Conditions
Interference with migratory movements of native fish	Construction of stream crossings and placement of the outfall structure at Chipps Island could interfere with fish passage at some sites. With appropriate structure designs, construction procedures, site management, and operating controls, interference with fish movements would not be significant.	Construction of stream crossings and placement of the outfall structure at Chipps Island could interfere with fish passage at some sites. With appropriate structure designs, construction procedures, site management, and operating controls, installed structures would have no effect.
Federally Listed Special-Status Species **(NOTE: Formal consultation would be initiated for listed species that may be adversely affected if this alternative is selected.)**		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s). Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation.	Significant adverse effects to **San Joaquin kit fox** from construction of aqueduct and reuse areas. No significant effect with adequate preconstruction surveys and approved avoidance and/or mitigation.	Potential adverse effects to **San Joaquin kit fox** from construction of aqueduct and reuse areas. No effect with adequate preconstruction surveys and approved avoidance and/or mitigation.
Adverse effects resulting in take of a listed *freshwater aquatic or wetland species* or loss, degradation, fragmentation, or disturbance of habitat(s)	Significant adverse effects to **California clapper rail**, **saltmarsh harvest mouse**, four **vernal pool crustaceans**, **California tiger salamander**, **California red-legged frog**, and **giant garter snake** from construction of aqueduct. No significant effect with preconstruction surveys and approved avoidance and/or mitigation. Significant adverse effects to three **Chinook salmon ESUs**, **Central Valley steelhead**, **Delta smelt**, and **green sturgeon** during construction of underwater outfall. No significant effect with approved construction techniques and scheduling.	Potential adverse effects to **California clapper rail**, **saltmarsh harvest mouse**, four **vernal pool crustaceans**, **California tiger salamander**, **California red-legged frog**, and **giant garter snake** from construction of aqueduct. No effect with preconstruction surveys and approved avoidance and/or mitigation. Potential adverse effect to three **Chinook salmon ESUs**, **Central Valley steelhead**, **Delta smelt**, and **green sturgeon** during construction of underwater outfall. No effect with approved construction techniques and scheduling.

Table 7-12 (concluded)
Summary Comparison of Effects of Delta-Chipps Island Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Chipps Island Disposal Compared to No Action	Delta-Chipps Island Disposal Compared to Existing Conditions
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	No effects to marine/coastal species.	No effects to marine/coastal species.
State-Listed Special-Status Species		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s). Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	Significant adverse effects to **San Joaquin kit fox**, **Swainson's hawk**, and **western burrowing owl** from construction of aqueduct and reuse areas. No significant effect with adequate preconstruction surveys and approved avoidance and/or mitigation, including a burrowing owl management plan.	Potential adverse effects to **San Joaquin kit fox**, **Swainson's hawk**, and **western burrowing owl** from construction of aqueduct and reuse areas. No effect with adequate preconstruction surveys and approved avoidance and/or mitigation, including a burrowing owl management plan.
Adverse effects resulting in take of a listed *freshwater aquatic or wetland species* or loss, degradation, fragmentation, or disturbance of habitat(s) Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	Significant adverse effects to **California clapper rail**, **California black rail**, **saltmarsh harvest mouse**, **California tiger salamander**, **California red-legged frog**, **Delta button-celery**, and **giant garter snake** from construction of aqueduct. No significant effect with preconstruction surveys and approved avoidance and/or mitigation. Significant adverse effects to three **Chinook salmon ESUs**, **Delta smelt**, and **green sturgeon** during construction of underwater outfall. No significant effect with approved construction techniques and scheduling.	Potential adverse effects to **California clapper rail**, **California black rail**, **saltmarsh harvest mouse**, **California tiger salamander**, **California red-legged frog**, **Delta button-celery**, and **giant garter snake** from construction of aqueduct. No effect with preconstruction surveys and approved avoidance and/or mitigation. Potential adverse effect to three **Chinook salmon ESUs**, **Delta smelt**, and **green sturgeon** during construction of underwater outfall. No effect with approved construction techniques and scheduling.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	No effects to marine/coastal species.	No effects to marine/coastal species.

Table 7-13
Summary Comparison of Effects of Delta-Carquinez Strait Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Carquinez Strait Disposal Compared to No Action	Delta-Carquinez Strait Disposal Compared to Existing Conditions
Terrestrial Resources		
Permanent changes in agricultural and ruderal habitats affecting wildlife habitat values Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation	A total of 44,106 acres would be retired (65,000 fewer acres than under No Action). No significant effect.	A total of 44,106 acres would be retired (23,600 more than under existing conditions. No adverse effect
Permanent changes in native and natural habitats	Approximately 1,000 acres temporarily disturbed during aqueduct construction would be restored to previous conditions. No significant effect. No other permanent facilities would be sited in native or natural upland habitats. No agricultural land acquired under project authority would be converted to natural terrestrial habitat; however, 4,900 additional acres (for a total of 7,000) would be acquired and revegetated under CVPIA Land Retirement Program. No significant beneficial effect.	Approximately 1,000 acres temporarily disturbed during aqueduct construction would be restored to previous conditions. No long-term effect to native or natural terrestrial habitat. No other permanent facilities would be sited in native or natural upland habitats. No agricultural land acquired under project authority would be converted to natural terrestrial habitat; however, 4,900 additional acres (for a total of 7,000) would be acquired and revegetated under CVPIA Land Retirement Program. Minor beneficial effect.
Permanent loss or degradation of recognized sensitive, rare, or ecologically important natural communities	120 acres would be temporarily disturbed during aqueduct construction resulting in significant effects. Restoration of the disturbed sites would result in no significant effects.	120 acres temporarily disturbed during aqueduct construction could be restored with mitigation. No adverse effect.
Losses of terrestrial biological resources.	During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in significant adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated to not significant.	During construction, less mobile species, including some burrowing/nesting species, could be killed or permanently displaced during construction, resulting in adverse effects. However, with preconstruction biological surveys and appropriate conservation measures and construction practices, effects to common terrestrial biological resources could be avoided or minimized and mitigated.

Table 7-13 (continued)
Summary Comparison of Effects of Delta-Carquinez Strait Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Carquinez Strait Disposal Compared to No Action	Delta-Carquinez Strait Disposal Compared to Existing Conditions
Introduction or spread of noxious weeds	Noxious weeds could be introduced and spread at disturbed construction sites and project facilities. No significant effect with appropriate site management, construction procedures, and operating controls. Retired lands that are fallowed or grazed may facilitate the spread of noxious weeds. No significant effect with implementation of a weed management program.	Noxious weeds could be introduced and spread at disturbed construction sites and project facilities. Undesirable species could be reduced or controlled with appropriate site management, construction procedures, and operating controls. Retired lands that are fallowed or grazed may become highly susceptible to noxious weeds. Weeds could be reduced or controlled with an active weed management program.
Aquatic and Wetland Resources		
Adverse effects on aquatic or wetland-dependent species Also see Section 8 for effects relating specifically to Se exposure and bioaccumulation.	Construction of the aqueduct could disturb approximately 120 acres of sensitive aquatic/wetland communities, resulting in significant effects. No significant effect with approved mitigation measures.	Construction of the aqueduct could disturb approximately 120 acres of sensitive aquatic/wetland communities, resulting in adverse effects. No adverse effect with approved mitigation measures.
Filling, draining, or net loss of existing wetlands	Construction activity associated with the aqueduct, outfall, and several smaller pipeline segments will take place in or near identified wetlands and could damage habitat or result in the loss of other wetland functions and values, resulting in significant effects. All construction in identified wetlands could utilize appropriate construction procedures, site management, and operating controls so that no significant effects will occur.	Construction activity associated with the aqueduct, outfall, and several smaller pipeline segments will take place in or near identified wetlands and could damage habitat or result in the loss of other wetland functions and values. All construction in identified wetlands could utilize appropriate construction procedures, site management, and operating controls to avoid adverse effects.
Alteration of historical stream channel characteristics	Pipeline/aqueduct crossings would not permanently damage or disturb stream channels. Affected channels would be restored or maintained with appropriate construction procedures, site management, and operating controls. No significant effect.	Pipeline/aqueduct crossings would not permanently damage or disturb stream channels. Affected channels would be restored or maintained with appropriate construction procedures, site management, and operating controls. No effect.
Interference with migratory movements of native fish	No interference with fish passage at pipeline and aqueduct stream crossings or Carquinez Strait outfall with appropriate construction procedures, site management, and operating controls.	No interference with fish passage at pipeline and aqueduct stream crossings or Carquinez Strait outfall with appropriate construction procedures, site management, and operating controls.

Table 7-13 (continued)
Summary Comparison of Effects of Delta-Carquinez Strait Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Carquinez Strait Disposal Compared to No Action	Delta-Carquinez Strait Disposal Compared to Existing Conditions
Federally Listed Special-Status Species **(NOTE: Formal consultation would be initiated for listed species that may be adversely affected if this alternative is selected.)**		
Adverse effects resulting in take of a listed terrestrial species or loss, degradation, fragmentation, or disturbance of its habitat(s). Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation.	Significant adverse effects to **San Joaquin kit fox** from construction of aqueduct and reuse areas. No significant effect with adequate preconstruction surveys and approved avoidance and/or mitigation.	Potential adverse effects to **San Joaquin kit fox** from construction of aqueduct and reuse areas. No effect with adequate preconstruction surveys and approved avoidance and/or mitigation.
Adverse effects resulting in take of a listed *freshwater aquatic or wetland species* or loss, degradation, fragmentation, or disturbance of habitat(s)	Significant adverse effects to **California clapper rail**, **saltmarsh harvest mouse**, four **vernal pool crustaceans**, **California tiger salamander**, **California red-legged frog**, and **giant garter snake** from construction of aqueduct. No significant effect with preconstruction surveys and approved avoidance and/or mitigation. Significant adverse effects to three **Chinook salmon ESUs**, **Central Valley steelhead**, **Delta smelt**, and **green sturgeon** during construction of underwater outfall. No significant effect with approved construction techniques and scheduling.	Potential adverse effects to **California clapper rail**, **saltmarsh harvest mouse**, four **vernal pool crustaceans**, **California tiger salamander**, **California red-legged frog**, and **giant garter snake** from construction of aqueduct. No effect with preconstruction surveys and approved avoidance and/or mitigation. Potential adverse effect to three **Chinook salmon ESUs**, **Central Valley steelhead**, **Delta smelt**, and **green sturgeon** during construction of underwater outfall. No effect with approved construction techniques and scheduling.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	No effects to marine/coastal species.	No effects to marine/coastal species.
State-Listed Special-Status Species		
Adverse effects resulting in take of a listed *terrestrial species* or loss, degradation, fragmentation, or disturbance of its habitat(s). Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation.	Significant adverse effects to **San Joaquin kit fox**, **Swainson's hawk**, and **western burrowing ow**l from construction of aqueduct and reuse areas. No significant effect with adequate preconstruction surveys and approved avoidance and/or mitigation, including a burrowing owl management plan.	Potential adverse effects to **San Joaquin kit fox**, **Swainson's hawk**, and **western burrowing owl** from construction of aqueduct and reuse areas. No effect with adequate preconstruction surveys and approved avoidance and/or mitigation, including a burrowing owl management plan.

Table 7-13 (concluded)
Summary Comparison of Effects of Delta-Carquinez Strait Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Carquinez Strait Disposal Compared to No Action	Delta-Carquinez Strait Disposal Compared to Existing Conditions
Adverse effects resulting in take of a listed *freshwater aquatic/wetland species* or loss, degradation, fragmentation, or disturbance of its habitat(s) Also see Section 8 for effects specifically relating to Se exposure and bioaccumulation.	Significant adverse effects to **California clapper rail**, **California black rail**, **saltmarsh harvest mouse**, **California tiger salamander**, **California red-legged frog**, **Delta button-celery**, and **giant garter snake** from construction of aqueduct. No significant effect with preconstruction surveys and approved avoidance and/or mitigation. Significant adverse effects to three **Chinook salmon ESUs**, **Delta smelt**, and **green sturgeon** during construction of underwater outfall. No significant effect with approved construction techniques and scheduling.	Potential adverse effects to **California clapper rail**, **California black rail**, **saltmarsh harvest mouse**, **California tiger salamander**, **California red-legged frog**, **Delta button-celery**, and **giant garter snake** from construction of aqueduct. No effect with preconstruction surveys and approved avoidance and/or mitigation. Potential adverse effect to three **Chinook salmon ESUs**, **Delta smelt** and **green sturgeon** during construction of underwater outfall. No effect with approved construction techniques and scheduling.
Adverse effects resulting in take of a listed *marine/coastal aquatic species* or loss, degradation, fragmentation, or disturbance of its habitat(s)	No effect to marine/coastal species.	No effect to marine/coastal species.

7.2.13 Mitigation Recommendations

All action alternatives could include design features, operating procedures, and other pre and postconstruction measures to minimize effects to significant biological resources and to compensate, if necessary, for unavoidable losses or damage to protected species, important habitats, and sensitive natural communities. All action alternatives would include a range of measures and strategies from the following mitigation categories.

- **<u>Design and Siting Measures</u> –** Design features incorporated into the planning, sizing, or routing/siting of project facilities to minimize their adverse environmental effects (e.g., installing tailwater collection systems at reuse areas; incorporating diffusers at Bay-Delta and Ocean Disposal outfalls; and locating pipeline corridors within previously disturbed road and utility ROWs).
- **<u>Preconstruction Biological Surveys (including wetland delineations, baseline inventories, species-focused surveys, etc.)</u> –** At appropriate times prior to construction, biologists/botanists using established or approved protocols would conduct biological and botanical surveys to identify occurrences of protected plant and animal species, rare communities, mature oak trees, stream crossings, wetlands, and other significant biological resources or special-status species that may be affected by project construction. A detailed *Biological Survey Plan*, which would identify the timing, locations, and intensity of

individual site surveys would be developed for the preferred alternative in consultation with the Service, Endangered Species Recovery Program, and CDFG.

- **Construction-related Measures –** Actions incorporated into construction activities and construction contract specifications to eliminate or reduce potential effects that could occur during construction. Actions may include effects avoidance strategies (e.g., construction scheduling to avoid critical life stages of selected species, exclusion fencing, limiting the size of disturbance zones); utilizing approved construction techniques and practices (e.g., stockpiling of topsoil, using construction BMPs at stream crossings); construction monitoring activities (including utilization of on-site biologists at selected construction sites); and construction site restoration/revegetation (including post-restoration monitoring).
- **Operation and Maintenance (O&M) Measures –** Measures incorporated into the standard operating procedures of each facility to minimize long- and short-term biological effects that could result from facility operation (e.g., using portable pumps to facilitate more rapid draining/filling of evaporation basin cells, limiting furrow lengths at reuse facilities, developing “wildlife friendly” management plans for selected retired lands).
- **Implementation of Facility Monitoring and Adaptive O&M Plans –** Long-term monitoring activities, contingency plans, and adaptive management plans incorporated into the operating plans of individual facilities (e.g., biological and water quality monitoring at evaporation basins, reuse facilities, or outfall sites). A detailed *Monitoring and Adaptive Management Plan* would be developed for the Preferred Alternative.
- **Compensation Measures –** Measures developed in consultation with the Service, Endangered Species Recovery Program, CDFG, and others to replace or compensate for lost or irreparably damaged biological resources in cases where significant effects cannot be avoided (e.g., replacing mature oak trees removed during ocean aqueduct construction). Compensation measures, when required, would be monitored to assure that compensation objectives are met.
- **Weed Management –** Owners, operators, or lessees of newly retired lands would be required to participate in an active weed management program.

For the majority of these mitigation measures, comprehensive descriptions and detailed cost estimates have not yet been fully developed and, therefore, are not included in this EIS. However, conceptual designs and preliminary cost estimates for these measures have been completed at an appraisal level, commensurate with the current level of planning detail. Additional information relating to a number of specific mitigation measures and biological monitoring activities associated with the In-Valley Alternatives is provided in Section 20 – Environmental Mitigation, Appendix J – Implementation of In-Valley Alternatives, Appendix M2 – U.S. Fish and Wildlife Service Biological Opinion, and Appendix M3 – NOAA Fisheries Informal Consultation on Endangered Species Act Section 7. Preliminary cost estimates for the action alternatives are provided in Appendix O – Mitigation Cost Estimates.

SECTIONEIGHT

SELENIUM BIOACCUMULATION

This section presents the results of evaluations conducted to determine the potential effects on regional selenium (Se) bioaccumulation due to operation of each of the action alternatives. A detailed ecological risk assessment for Se was conducted for the In-Valley Disposal Alternative, and methods and results for the risk assessment are presented in Appendix G, which examines the potential for adverse ecological effects to avian receptors from evaporation basins.

8.1 AFFECTED ENVIRONMENT

Se can exist in several oxidation states (IV, VI, 0, -II) as well as in organic and inorganic form, and can exist as a dissolved species, or can be attached to suspended particulate matter (SPM) in the water column, or to bedded sediment and detritus. The following oxidation states can occur in the dissolved phase:

- Selenide or organo-selenium (-II), substituting for S (-II) in proteins seleno-methionine, or seleno-cysteine
- Selenite, SeO_3^{-2} (IV), an analog to sulfite
- Selenate (VI), an analog to sulfate
- Elemental Se, which has low solubility although it may exist as a suspended colloidal species

The reduced organic, elemental, or selenite forms of inorganic Se are converted to the selenite or selenate forms through the oxidation process. Methylation is the process by which inorganic or organic Se is converted to an organic form that contains one or more methyl groups (usually resulting in a volatile form). Assimilative reduction is the process in which oxidized forms are taken into cells and reduced to organic species such as seleno-methionine and seleno-cysteine. These organo-Se forms can then be released to the water column following death or depuration. These processes are responsible for converting relatively less bioavailable inorganic forms of Se to highly bioavailable organic forms.

Four oxidation and methylation processes also contribute to Se bioavailability in aquatic systems:

- Oxidation and methylation of inorganic and organic Se by plant roots and microorganisms
- Biological mixing and associated oxidation of sediments that results from burrowing of benthic invertebrates and foraging activities of wildlife
- Physical agitation and chemical oxidation associated with water circulation and mixing (e.g., wind, current, stratification)
- Oxidation of sediments through plant photosynthesis (Lemly 1999)

Once Se enters the aquatic environment, it has the potential to bioaccumulate in primary and secondary consumers (e.g., zooplankton and benthic invertebrates), and biomagnify as it reaches top-level predators (e.g., predatory fish, birds, and mammals). Biomagnification is a form of bioaccumulation in which the concentration of a chemical in a higher-trophic-level organism is greater than the concentration in the food that this organism consumes.

Se is an essential element necessary for proper enzyme formation and function (Eisler 1985). However, chronic exposure to significantly elevated Se levels in the diet or water can also cause severe toxicological effects, including death. The concentration range separating effects of Se deficiency from those of toxicity (i.e., selenosis) is very narrow (Luoma and Presser 2000). With the exception of mortality, the two major toxicological effects to aquatic organisms from chronic exposure are reproductive effects and teratogenesis (i.e., malformations in developing fetus). Excessive Se contamination is often associated with localized extinction of certain species and reduction in biodiversity. Based on field and laboratory studies with fish and wildlife, it is apparent that elevated Se concentrations in environmental media, including dietary components, can cause reproductive abnormalities. These abnormalities include congenital malformations, selective bioaccumulation by the organism, and growth retardation (Eisler 1985). Table 8-0 summarizes avian toxicity threshold concentrations that have been identified for various media (see Appendix G, Section G7.2 for additional detail and sources of data).

Table 8-0
Selenium Concentrations Associated with Adverse Effects in Birds

Bird Species	Life Stage	Endpoint	Media	Threshold Concentrations (dry weight for tissue)	Reference
Multiple	Embryo	Reproductive	Water	NOEC = 0.5–2.3 µg Se/L	Skorupa and Ohlendorf (1991)
Multiple	Embryo	Reproductive	Water	NOEC = 2 µg Se/L	Skorupa 1998
Mallard	Embryo	Hatching success	Diet	NOAEL = 3.5 mg selenomethionine/kg feed LOAEL = 7 mg selenomethionine/kg feed	Stanley et al. 1996
Mallard	Embryo	Hatching success	Diet	EC_{10} = 4.87 mg Se/kg feed (form of Se not specified)	Ohlendorf 2003
Mallard	Embryo	Hatching success	Diet	EL = 3 to 5 mg selenomethionine/kg feed	Heinz and Fitzgerald 1993a,b
Mallard	Embryo/ duckling	Hatching success/ survival	Diet	EL = 10 mg selenomethionine/kg feed	Heinz and Hoffman 1996
Mallard	Duckling	Survival/ number produced per hen	Diet	EL = 10 mg selenomethionine/kg feed NOAEL = 10 mg sodium selenite/kg feed LOAEL = 25 mg sodium selenite/kg feed	Heinz et al. 1987
Mallard	Duckling	Survival	Diet	NOAEL = 20 mg selenomethionine/kg feed LOAEL = 40 mg selenomethionine/kg feed	Heinz, Hoffman, and Gold 1988
Mallard	Duckling	Survival	Diet	NOAEL = 4 mg selenomethionine/kg feed LOAEL = 8 mg selenomethionine/kg feed	Heinz, Hoffman, and Gold 1989
Chicken	Embryo	Hatching success	Diet	LOAEL = 5 mg sodium selenite/kg feed	Ort and Latshaw 1978
Black-Crowned Night Heron	Embryo	Hatching success	Diet	NOAEL = 3.3 mg selenomethionine/kg feed	Smith et al. 1988
Japanese Quail	Embryo	Hatching success	Diet	EL = 6 mg sodium selenite/kg feed	El-Begearmi, Sunde, and Ganther 1977
Japanese Quail	Embryo	Hatching success	Diet	EL = 5 mg selenomethionine/kg feed	Martin 1988, as cited in Heinz 1996
Mallard	Embryo	Teratogenesis	Egg	EC_{10} = 23 mg Se/kg	Ohlendorf, in press, as cited in Hanson Environmental 2003

Table 8-0 (concluded)
Selenium Concentrations Associated with Adverse Effects in Birds

Black-necked stilt	Embryo	Teratogenesis	Egg	EC_{10} = 37 mg Se/kg	Ohlendorf, in press, as cited in Hanson Environmental 2003
American avocet	Embryo	Teratogenesis	Egg	EC_{10} = 74 mg Se/kg	Ohlendorf, in press, as cited in Hanson Environmental 2003
Mallard	Embryo	Hatchability	Egg	EC_{10} = 16 mg Se/kg	Fairbrother et al. 1996, as cited in Hanson Environmental 2003
Mallard	Embryo	Hatchability	Egg	EC_{10} = 12.5 mg Se/kg	Ohlendorf 2003

EL = effect level
LOAEL = lowest-observable-adverse-effect level
NOAEL = no-observable-adverse-effect level
NOEC = no-observable-effect concentration

The following sections summarize existing data on Se speciation, bioavailability, and bioaccumulation in the areas that would be affected by each action alternative.

8.1.1 In-Valley Disposal Alternative Area

The proposed evaporation basins to be created under this alternative would be located on land where waterbodies do not currently exist. However, waterbodies do exist in adjacent areas within the Grasslands area, including the San Luis NWR complex and the Mendota NWR. Se concentrations in these areas have been measured in eggs of aquatic birds (Ohlendorf and Hothem 1995; Paveglio et al. 1992). Mean Se concentrations in duck and shorebird eggs randomly collected in 1987 were consistently low, ranging from 1.34 mg/kg in mallard eggs to 1.86 mg/kg in pintail eggs, and from 1.77 mg/kg in killdeer eggs to 1.86 mg/kg in avocet eggs (Ohlendorf and Hothem 1995). These concentrations are well below egg tissue concentrations associated with adverse reproductive effects. In addition, no deformities were observed in shorebird embryos (Ohlendorf and Hothem 1995).

In the Grasslands area, 14 of 189 duck eggs collected in 1986 and 1987 contained more than 20 mg/kg of Se. In shorebirds, the geometric mean Se concentration ranged from 3.72 mg/kg in stilt eggs to 15.3 mg/kg in killdeer eggs. The highest Se concentration in stilt eggs was 8.3 mg/kg and the highest in avocet eggs was 12.8 mg/kg. These concentrations are high enough to potentially cause adverse reproductive effects (Ohlendorf and Hothem 1995).

Se concentrations in aquatic bird eggs in the Grasslands area were found to decrease after 1986, when the water in the wetlands was switched from direct use of agricultural drainwater to predominantly freshwater (Paveglio et al. 1992). However, concentrations in 1994 were still elevated, and it is likely that Se deposited in sediments during the period of agricultural drainwater use continue to present a source of bioavailable Se in the wetland system (Paveglio et al. 1992).

8.1.2 In-Valley/Land Retirement Alternatives Area

The information described in Section 8.1.1 also applies to the In-Valley/Land Retirement Alternatives area.

8.1.3 Ocean Disposal Alternative Area

As Se is not considered to be a water quality problem in Morro Bay, limited data are available on existing Se concentrations in biota in the area. The California State Mussel Water Program was initiated in 1977 as a program to help identify water quality impairment of California’s estuaries, bays, and other coastal waters. Rather than direct analysis of water samples, the program measures water quality through the analysis of clam and mussel tissues. Since many water contaminants are attached to suspended particles, and because contamination can be transitory or too low to be measured, sessile organisms such as clams and mussels that accumulate high levels of contaminants in their tissues allow for a better picture of water quality over an extended time period.

At each sampling location, three analytical replicates of 15 mussels (*Mytilus californianus*) each are analyzed for trace elements. Mussels collected from Bodega Head are transplanted to the sampling location if a suitable resident population does not exist. The mussel transplant system consists of a bottom-anchored float buoy in water up to a 40-meter depth. A 4- to 6-month transplant interval is used to allow adequate contaminant uptake.

The State Mussel Water Program sampled Se concentrations in mussel tissue collected or deployed at several stations in the Morro Bay area between 1987 and 1991. The Cayucos Pier station is located at the northern end of Morro Bay, and transplanted California mussels were sampled in 1991. The Morro Bay Boat Works station, located in inner Morro Bay, had transplanted California mussels sampled in 1987. Finally, Montana de Oro State Park at the southern end of Morro Bay contained resident California mussels, which were sampled five times from 1990 to 1992. At two other locations in Montana de Oro State Park (Montana de Oro 1 and 2), transplanted California mussels were sampled once each in 1990. Another sample from transplanted mussels was analyzed from Montana de Oro 1 in 1991. Mean Se concentrations measured in mussels at these locations are presented in Table 8-1, and ranged from 0.18 to 2.5 mg/kg dry weight. These concentrations are below thresholds associated with adverse effects to birds feeding on invertebrates.

Table 8-1
Morro Bay Area Selenium Concentrations in Mussel (*Mytilus californianus*) Tissue

Station Name	Date	Mussel Type	Wet Weight Se (mg/kg)	Dry Weight Se (mg/kg)
Cayucos Pier	2/25/1991	Transplanted	0.35	1.8
Morro Bay Boat Works	1/26/1987	Transplanted	0.49	3.1
Montana De Oro	11/14/1990	Resident	0.18	0.90
Montana De Oro	2/25/1991	Resident	0.20	1.3
Montana De Oro	9/9/1991	Resident	0.34	1.6
Montana De Oro	12/3/1991	Resident	0.45	2.3
Montana De Oro	2/25/1992	Resident	0.51	2.1
Montana De Oro 1	11/14/1990	Transplanted	0.19	1.1
Montana De Oro 1	12/4/1991	Transplanted	0.43	2.5
Montana De Oro 2	11/14/1990	Transplanted	0.20	1.1

8.1.4 Delta Disposal Alternatives Area

Se speciation and fate in the Bay-Delta Estuary are not well established; however, several studies have investigated the matter. Cutter (1989) measured and analyzed several species of Se in the Bay, Delta, and San Joaquin and Sacramento rivers between 1984 and 1987. The study measured total dissolved Se, selenate, and selenite. Concentrations of elemental Se plus selenide (-II + 0) were calculated from the measured data. Total dissolved Se concentrations were higher in the San Joaquin River than in the Sacramento River. However, because of diversions in the San Joaquin River, its flow only reached the Delta during April and May 1986. Selenate was the dominant dissolved Se species in the San Joaquin River (74±13%), while dissolved Se in Sacramento River was evenly split between selenate (48±15%) and elemental Se plus selenide (-II + 0) (40±15%). Further analysis revealed that higher concentrations of total dissolved Se and selenate were correlated with higher flows from the rivers to the Delta, implying that higher selenate and total dissolved Se concentrations are expected during winter months. Contrary to total dissolved Se and selenate concentrations, higher Se (-II and 0) concentration was found to correlate with decreased flows. No correlation was found between flow and selenite (Cutter 1989). In the North Bay, industrial effluent discharges near Carquinez Strait were found to be significant sources of anthropogenic Se, particularly during the dry season when river discharges are low (Cutter 1989).

Another study of Se speciation in San Francisco Bay (Cutter and San Diego-McGlone 1990) analyzed Se measurements from October (low flow) and December 1987 (high flow) and arrived at similar conclusions. The study found that the primary Se loadings to the Bay were Delta flows, industrial effluent near Carquinez Strait, and municipal discharges in the South Bay. The highest riverine loading of Se to the Bay occurred at times of high river discharge. Anthropogenic sources were relatively constant and, therefore, become more significant during the dry season when river discharge was small. Industrial discharges near Carquinez Strait contained up to three orders of magnitude more total dissolved Se than river discharges and, unlike river discharges, were dominated by selenite (62 percent of total dissolved Se) (Cutter and San Diego-McGlone 1990). While the municipal discharges in the South Bay were higher in total Se than river discharges, the speciation of Se was similar (60 percent selenate, 25 percent selenite, 15 percent selenide + elemental Se) (Cutter and San Diego-McGlone 1990).

More recent data presented by Cutter et al. (2000) indicated that while total Se concentrations have not increased since the mid 1980s, the percentage of selenite has diminished substantially, perhaps due to changes in industrial effluents. Particulate Se concentrations ranged from 0.2 to 1.1 micrograms per gram, with the highest concentrations seen in the Delta and more than 75 percent of particulate Se was the most bioavailable form, organic selenide. Sedimentary Se was dominated by the elemental species, making it less bioavailable than the Se suspended in the water column (Cutter et al. 2000). Cutter and Cutter (2004) examined data on Se riverine fluxes, estuarine processes, and anthropogenic inputs from the mid 1980s to 2000, and found that dissolved Se concentrations from the San Joaquin River have decreased by almost half during that period, while Se speciation from this river has remained similar. Se concentrations and speciation from the Sacramento River remained relatively unchanged, and the concentration of Se from refineries decreased by 66 percent and speciation changed from being dominated by selenite (66 percent) to only 14 percent selenite. In San Francisco Bay, one of the primary mechanisms of entry into the food chain is through assimilation by phytoplankton. Different algal species accumulate Se to varying degrees and in such a way that selenite and organic selenides are taken up in higher concentrations than selenate (Baines, Fisher, and Stewart 2002). Bivalves represent a significant source of dietary Se for wildlife in comparison to other benthic invertebrates and have also been shown to preferentially bioaccumulate selenite over selenate (Eisler 1985). Stewart et al. (2004) found that Se concentrations in the filter-feeding bivalve *Potamocorbula amurensis* collected from San Pablo Bay and Suisun Bay in 1999 were roughly 5 times higher than other invertebrate species (*Ampelisca abdita*, mysids, isopods, *Corophium* spp., and *Crongon fransiscorum*) collected in the same areas during the same time frame. Therefore, species composition of phytoplankton and benthic invertebrate communities are expected to have a substantial influence on Se accumulation and transfer through the food chain. Dietary preference, foraging strategy, and feeding rate significantly influence the rate of bioaccumulation in the food chain, which may ultimately lead to adverse effects in wildlife species (Luoma et al. 1992).

Bioaccumulation of Se may differ substantially between different species of bivalves. For example, Linville et al. (2002) found that Se concentrations in resident Asian clams (*Potamocorbula amurensis*) collected at three Regional Monitoring Program (RMP) sampling locations were often 2 to 3 times higher than Se concentrations in the deployed bivalve species. Since the Asian clam was introduced to the Bay-Delta Estuary in 1986, it has rapidly invaded and displaced native species. As a result, it is likely that this clam now composes a large percentage of the prey of some upper trophic level receptors.

Species that experience the highest level of chemical exposure are those most likely to suffer adverse effects, potentially at the population level. Due to the biomagnification potential of Se, species at the highest risk of toxicology effects are those found at the top of the food chain. In the *Selenium Verification Study* (Urquhart and Regalado 1991) the highest concentrations of Se in aquatic organisms were found in white sturgeon, a long-lived benthic predator of the Bay-Delta. Linares et al. (2004) measured effects of Se on health and reproduction of white sturgeon in the Sacramento-San Joaquin estuary, including collection and analysis of sturgeon tissue in 2003. While they found considerable variability in Se concentrations in sturgeon tissue, concentrations in several individual fish did exceed levels that have been associated with toxicity and reproductive failure in other fish species. Sturgeon collected by Linares et al. (2004) contained Se concentrations somewhat lower than those reported by Stewart et al. (2004) for white sturgeon collected from northern San Francisco Bay in 2000. Age and possible feeding patterns may partially explain the difference (all sturgeon collected by Stewart et al. [2004] were older than 9 years, while sturgeon collected by Linares et al. [2004] varied in age). Linares et al. (2004) found that Se concentrations were positively correlated with age, and speculated that the relationship may be due to changes in feeding habits as sturgeon mature.

The highest Se concentrations in aquatic birds in the Bay-Delta were found in surf scoter from Suisun and San Pablo bays (Urquhart and Regalado 1991). A surf scoter's diet is almost entirely comprised of benthic invertebrates, as opposed to other birds evaluated in the *Selenium Verification Study*, which include mallards, double-crested cormorants, American bitterns, northern shoveler, and scaups. The diets of these birds are comprised of higher proportions of plant material, aquatic insects, or fish.

Hunt et al. (2003) reported that in 2002, Se concentrations in surf scoter and greater scaup breast muscle tissue collected in Suisun Bay were significantly higher than Se concentrations in tissue from the same species collected in San Pablo Bay and South Bay. The authors hypothesized that the difference in concentrations may be due to a diet higher in Asian clams in Suisun Bay. Gut content analysis showed that 100 percent of the diet of surf scoters wintering in Suisun Bay was composed of the Asian clam, while only 25 percent of the diet of surf scoters wintering in San Pablo Bay and 0 percent of the diet of surf scoters wintering in South Bay was composed of the Asian clam (Hunt 2004). Studies conducted by the USGS have also found that lesser scaup consume Asian clams almost exclusively in some parts of San Francisco Bay, and greater scaup and canvasback also consume Asian clams as part of their diet (USGS 2004). Greater scaup and lesser scaup comprise about 43 to 46 percent of the total number of waterfowl on San Francisco Bay during winter, and data indicate that up to 92 percent of scaup in the Pacific Flyway may be found in San Francisco Bay at any one time (Poulton et al. 2002). Hunt (2004) reported that Se concentrations measured in surf scoter in 2002 were significantly lower than peak concentrations measured during the *Selenium Verification Study* in 1989 and 1990.

Data indicate that the Asian clam is a dominant food item found in the digestive tracts of the white sturgeon and Sacramento splittail (Stewart et al. 2004). Se concentrations in the tissue of white sturgeon collected from Suisun Bay and San Pablo Bay in January 2000 ranged from approximately 5 to 42 mg/kg dry weight, and Se concentrations in the tissue of Sacramento splittail collected from Suisun Bay and San Pablo Bay in Fall 1999/Winter 2000 ranged from approximately 7 to 20 mg/kg dry weight (Stewart et al. 2004). These concentrations exceeded the fish tissue toxicity threshold of 15 mg/kg Se dry weight, which was identified by the authors based on a literature review. The concentrations in these species were also substantially higher than concentrations in other fish species studied (yellowfin goby, starry flounder, leopard shark, and striped bass).

Studies conducted in the Bay-Delta have shown that predators with the highest tissue residues of Se are those that consume benthic invertebrates, with a high proportion consisting of bivalves (Luoma and Presser 2000). Predatory fish that primarily feed on water-column species are likely to be less exposed and accumulate less Se in their tissues than dimersal fish that consume benthic invertebrates, especially bivalves. In addition, studies on rates of accumulation revealed higher Se concentrations in smaller mussels and freshwater fish than larger individuals (i.e., older). The reverse was reported for marine mammals and fish (Eisler 1985).

8.1.5 Reuse Facilities (All Action Alternatives)

As described in Section 2.3.2.3, all of the action alternatives will include regional reuse facilities. The biological resources expected to be present within the reuse areas are described in Section 7.1.1. Little quantitative information on terrestrial Se concentrations in these areas is available. Most of the Se bioaccumulation data available for Panoche Drainage District and Red Rock Ranch reuse areas (H.T. Harvey and Associates 2004, 2005; Buchnoff 2006) are related to Se concentrations in waterbird eggs during ponding events and do not include Se bioaccumulation data for terrestrial receptors. Se concentrations have also been measured in wheat grass, alfalfa, and pasture crops grown in the Panoche Drainage District/San Joaquin River Improvement Project reuse area. Concentrations ranged from 0.63 to 3.2 ppm (dry weight). Some values fell above the recommended ranges for cattle feed; however, wildlife may feed on specific portions of the plants (such as seeds), making it difficult to draw any general conclusions regarding effects to biological resources based on the limited data available.

8.2 ENVIRONMENTAL CONSEQUENCES

The discussion of evaluation criteria and modeling methods and assumptions is followed by the analysis of the environmental consequences associated with each alternative.

8.2.1 Evaluation Criteria

The criteria for determination of significant effects to wildlife or humans resulting from increases in Se bioaccumulation due to the action alternatives include the following:

- Adverse effects such as reduced reproduction or development, or increased mortality to populations or communities of birds, mammals, or fish
- Adverse effects such as reduced reproduction or development, or increased mortality to individuals of special-status birds, mammals, or fish
- Adverse effects such as reduced reproduction or development, or increased mortality to individual humans

To determine whether the predicted increases in Se concentrations in prey tissues are likely to result in significant effects to upper-trophic-level ecological receptors such as invertebrate-feeding birds and fish, a literature search was conducted to identify prey tissue concentrations of Se that are associated with adverse effects to predators.

Luoma et al. (1992) state that Se concentrations of 9 to 10 mg/kg (dry weight) occur in the most contaminated individuals of the clam *Corbicula fluminea* in Suisun Bay, and that at this concentration dietary toxicity is observed in fish in laboratory studies. Lemly (1996) reviewed data on Se toxicity and assigned a hazard ranking for dietary toxicity and reproductive failure in fish and aquatic birds from ingestion of Se-contaminated macroinvertebrates. A Se concentration of 2 to 3 mg/kg (dry weight) was assigned a hazard ranking of minimal toxicity, 3 to 4 mg/kg was assigned a hazard ranking of low toxicity, 4 to 5 mg/kg was assigned a hazard ranking of moderate toxicity, and greater than 5 mg/kg was assigned a hazard ranking of high toxicity. Peterson and Nebeker (1992) described the results of several comprehensive reviews on the effects of Se on animals. They concluded that it is widely agreed that chronic exposure to Se dietary concentrations greater than 5 mg/kg can result in adverse effects to birds and mammals.

Based on the studies discussed above, the significance threshold used to determine potential for adverse effects in this evaluation is a predicted average invertebrate tissue concentration exceeding 4 mg/kg Se (dry weight). To evaluate potential effects to populations, the average tissue concentration over the habitat is considered.

For this evaluation, the term "baseline conditions" for the Delta Disposal Alternatives refers to Se loading conditions for the year 2001 (existing conditions for this EIS), which incorporates changes in Se discharges from refineries as compared to previous years. Because it is not possible to quantitatively predict changes in Se bioaccumulation for the No Action Alternative, results for the action alternatives are compared to the baseline conditions to determine whether significant effects are likely. The baseline conditions are used to represent both existing conditions and No Action. In some cases, the methods used in this evaluation to assess the potential for adverse effects may predict that adverse effects would occur even under baseline conditions. In this case, a decrease of at least 10 percent in reproductive success, or any increase in adult mortality, would be considered a significant effect to a population. For special-status species, any decrease in reproductive success or increase in mortality would be considered a significant effect to individuals.

Recently, the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment issued the following advisories for waterfowl consumption. The office determined whether a public health hazard may exist from consumption of waterfowl taken from certain locations based on laboratory testing data. The guidelines are based on risk estimates that assume long-term consumption; therefore, the occasional intake of duck meat above the recommended amounts is not expected to produce a health hazard. All of the following warnings are due to elevated Se levels (CDFG 2004):

- Grasslands area (western Merced County) – no one should eat more than 4 ounces of duck meat in any 2-week period. No one should eat livers of duck from the area.
- Suisun Bay (Contra Costa and Solano counties) – no one should eat more than 4 ounces per week of (greater or lesser) scaup meat or more than 4 ounces of scoter meat in any 2-week period. No one should eat livers of duck from the area.
- San Pablo Bay (Contra Costa, Marin, Solano, and Sonoma counties) – no one should eat more than 4 ounces per week of greater scaup meat or more than 4 ounces of scoter meat in any 2-week period from the Bay. No one should eat livers of duck from the area.
- San Francisco Bay (Alameda, Contra Costa, Marin, San Francisco, San Mateo, and Santa Clara counties) – no one should eat more than 4 ounces per week of greater scaup meat from the Central Bay or more than 4 ounces of greater scaup meat from the South Bay in any 2-week period. No one should eat livers of duck from the area.

Because public health advisories for waterfowl consumption are already in effect for the Bay-Delta, it is conservatively assumed that any significant increase in Se concentrations in tissue of ducks within recreational populations could result in significant effects to human health.

Because considerable uncertainty exists in how Se bioaccumulation in the Bay-Delta will change under No Action conditions due to changes in the food web, hydrology, etc., baseline conditions are used to represent the No Action Alternative.

8.2.2 Modeling Methods and Assumptions

Se bioaccumulation rates are highly dependent on local environmental factors. Therefore, site-specific data were used to model aquatic Se bioaccumulation in benthic and/or aquatic invertebrates for each of the alternatives considered. This section describes the modeling methods used and the data used to develop modeling parameters. Most of the criteria and parameters used in this assessment are intended to provide a conservative (high-end) evaluation of potential effects. Uncertainties are discussed in Section 8.2.2.6. Appendix G provides a detailed risk assessment for the In-Valley Disposal Alternative.

8.2.2.1 In-Valley Disposal Alternative

As currently proposed, operation of the evaporation basin facilities, totaling 3,290 acres, would not create attractive habitat for common terrestrial seed-eating, predatory, or scavenging species. Under normal basin operation, terrestrial and shoreline vegetation that could provide forage, prey habitat, cover, and nesting substrates for terrestrial species would be systematically sprayed or mechanically removed. The high water temperatures, high salinity, and generally poor aquatic conditions would restrict development of fish, amphibian, and crustacean prey populations. Dead waterbirds (potential prey for scavengers) would be collected and removed. Seasonal hazing would reduce avian use numbers and nesting attempts, further reducing potential prey (eggs, hatchlings). The limited prey base and relative absence of terrestrial and emergent vegetation would limit attraction to the basin sites and significantly reduce the risk of dietary Se exposure for most terrestrial wildlife species. Therefore, this evaluation focuses on potential effects to waterbirds likely to forage on Se-contaminated plants and invertebrates in evaporation basins.

It is possible to predict concentrations in invertebrate prey in the evaporation basins based on Se concentrations predicted in the water and sediments of the evaporation basins. However, a large amount of uncertainty may be related to these predictions, due to various factors including:

- Limited information on Se speciation expected to be present in influent water
- Limited information on Se speciation expected to be present in water and sediments throughout the evaporation basin
- Spatial and temporal variation in factors that affect bioavailability, such as salinity, dissolved oxygen, sulfides, etc.
- Fluctuations in Se concentrations and bioavailability over time
- Chemical interactions with other constituents
- Highly variable Se bioaccumulation in different prey species
- Differences in primary production and algal biomass in various systems
- Length of exposure duration for prey species

Monitoring reports available for existing evaporation basins are based on untreated effluent, which may have very different speciation compositions than the treated influent to the proposed evaporation basins. Even if the Se speciation in the treated influent to the basins could be predicted with a reasonable amount of certainty, it is difficult to predict what will happen to the Se speciation when the water flows through the basin. Because speciation is dependent on various chemical and physical parameters that are characteristic of conditions in the evaporation basins, the speciation would eventually change if the residence time were long enough. Alaimo et al. (1994) measured Se speciation in four evaporation basins, and found that speciation varied considerably. In the Westlake Farms basins (where the total Se concentration in water was 4.3 µg/L), Se was measured as 100 percent selenate (the least bioavailable form). In contrast, Se in the Bowman Farms evaporation basins was found to be 78 percent organic selenide (the most bioavailable form), even though the total Se concentration (10.8 µg/L) was in the same range of that in the Westlake Farms basins. Total Se concentrations in the Lost Hills Water District and Sumner Peck Ranch basins were substantially higher (320 and 679 µg/L, respectively). The Lost Hills basin contained all three forms of Se (selenate, selenite, and organic selenide), while only selenate and selenite were measured in the Sumner Peck Ranch basin water. These data demonstrate that no typical Se speciation distribution can be assumed for conditions in evaporation basins. See Appendix B, Section B4, for a discussion of the Se bioaccumulation pilot study to address the lack of information currently available on Se speciation.

Historical and recent data on Se bioaccumulation in Central Valley evaporation basins are described in Appendix G. Moore et al. (1990) compiled historical data on Se concentrations in water, plants, and invertebrates of evaporation basins in the San Joaquin Valley. These data, as well as the more recent data collected by Fan et al. (2002), were used in this evaluation to develop regression equations to predict bioaccumulation for each of the dietary components (plant matter, nektonic invertebrates, and benthic invertebrates). Data for widgeongrass were used to represent Se uptake in plants, data for waterboatmen were used to represent Se uptake in nektonic invertebrates, and data for fly larvae (all available species) were used to represent Se uptake in benthic invertebrates. The regression equations are presented below and are discussed in more detail in Appendix G.

$$\text{Veg [Se]} = 10^{1.8985 + 0.7350 \text{ Log}_{10} \text{ Water [Se]}}$$

$$\text{Nektos [Se]} = 10^{2.0804 + 0.5711 \text{ Log}_{10} \text{ Water [Se]}}$$

$$\text{Benthos [Se]} = 10^{2.8625 + 0.8345 \text{ Log}_{10} \text{ Water [Se]}}$$

Where:

Veg [Se]	=	Vegetation tissue Se concentration in mg/kg dry weight
Nektos [Se]	=	Nektos tissue Se concentration in mg/kg dry weight
Benthos [Se]	=	Benthos tissue Se concentration in mg/kg dry weight
Water [Se]	=	Total recoverable waterborne Se concentration in mg/L

Dietary composition percentages used for this evaluation are presented in Table 8-2, and discussed in detail in Appendix G. The following equation is used to calculate the average dietary Se concentration for each bird category:

$$BX_{group} = (P_v * Veg\ [Se]) + (P_n * Nektos\ [Se]) + (P_b * Benthos\ [Se])$$

Where:

BX_{group} = Average dietary concentration for birds within the category being considered (mg Se/kg tissue [dry weight])

P_v = Proportion of diet from vegetation

P_n = Proportion of diet from nektonic inverts

P_b = Proportion of diet from benthic invertebrates

Table 8-2
Estimated Dietary Composition for Bird Categories

Bird Category	Dietary Composition (Percent)							
	Breeding Season				Nonbreeding Seasons			
	Benthic Invertebrates	Nektonic Invertebrates	Plants	Source	Benthic Invertebrates	Nektonic Invertebrates	Plants	Source
Dabblers (except for Northern Shoveler)	77	8	15	Estimated from data presented in Appendix G, Table G-4 (no Central Valley data)	42	9	49	Euliss et al. (1991) (Central Valley data on northern pintail)
Northern Shoveler	0	100	0	Estimated from data presented in Appendix G, Table G-4 and Euliss et al. (1991)	5	88	7	Euliss et al. (1991) (Central Valley data)
Divers	85	0	15	Brua (2002) (Ruddy duck at Tulare Basin)	53	37	10	Euliss et al. (1991) (Central Valley data on ruddy duck)
Shorebirds (“Breeding” and “Nonbreeding”)	96	4	0	Cooper et al. (unpublished) (Central Valley stilts and avocets)	96	4	0	Cooper et al. (unpublished) (Central Valley stilts and avocets)

8.2.2.2 In-Valley/Land Retirement Alternatives

The methods described in Section 8.2.2.1 are also applied to the In-Valley/Land Retirement Alternatives. No additional quantitative analysis was performed for these alternatives, as results are expected to be comparable to the In-Valley Disposal Alternative (but potential effects would be lower in magnitude due to less evaporation basin acreage required).

8.2.2.3 Ocean Disposal Alternative

As discussed in Section 5.2.8, no significant increases in Se concentrations in surface water or sediments are predicted under this alternative. Therefore, no significant increases in Se bioaccumulation would be expected, and no quantitative bioaccumulation modeling was conducted.

8.2.2.4 Delta Disposal Alternatives

Approximately 90 percent of the Se present in drainwater is found as the selenate form. Prior to discharge to the Bay-Delta, a biological treatment process would be used to remove most of the Se from solution. It is not known what forms of Se would be discharged after treatment. Recent data from pilot Se treatment plants indicate a mix of Se species can be found in the effluent with approximately equal percentages of the total Se found as selenate and selenite, and organic species (Amweg et al. 2003).

To model bioaccumulation throughout trophic levels in the affected area, a review of published data was conducted on Se concentrations in bivalve tissue, sediment, and water at various sampling locations in San Francisco Bay and the Delta. The RMP has been monitoring various stations throughout the greater Bay ecosystem several times a year since 1993 (SFEI 2002b). Although the Mussel Watch program implemented by the National Oceanographic and Atmospheric Administration measured Se concentrations in mussels in the Bay before the RMP began, this program did not include measurements in sediment or water. To develop site-specific bioconcentration factors (BCFs), it is necessary to obtain co-located samples in both tissue and water (or sediment) collected during the same time period. Because the RMP provides co-located water, sediment, and bivalve tissue data, these data sets have been used to evaluate correlations between environmental concentrations and tissue concentrations of Se in the Bay.

For this evaluation, various groupings of the RMP data were experimented with to identify the strongest correlations between Se concentrations in tissue versus Se concentrations in water and sediment. Correlation plots were run on data for individual sampling locations, grouped sampling locations, and the entire data sets. Correlation plots of Se concentration in tissue versus Se concentration in sediment, dissolved Se concentration in water, and total Se concentration in water did not display any significant trends. However, bivalve exposure to Se primarily occurs through filtering of particulate matter in their environment. Therefore, the dissolved Se concentration was subtracted from the total Se concentration in water (to estimate the Se concentration associated with the particulate phase), and this result was divided by the total suspended solids concentration to obtain the Se concentration on SPM. For each RMP North Bay and Delta station, this SPM Se concentration was plotted against measured bivalve tissue concentrations. In some cases, the SPM Se concentration was negative due to analytical error; these data points were excluded from the analysis. In addition, a data point from the Sacramento River station was excluded from analysis due to the fact that the tissue concentration recorded was anomalously high (4 times higher than the next largest value in the data set). Linear regressions were then applied.

Most sites (six of eight total) displayed the expected increasing bivalve tissue Se concentrations with increasing SPM Se concentrations. However, correlations were generally weak ($r^2 < 0.15$). The Point Pinole and Napa River mouth stations showed relatively strong correlations between SPM and tissue Se concentrations ($r^2 = 0.50$ and 0.52, respectively). The Petaluma River station data contained too few points to establish a correlation, but when grouped with the Napa River station (both stations are in the North Bay at the mouths of freshwater creeks), a better correlation between SPM and tissue Se concentrations than either station alone was observed ($r^2 = 0.53$). In the South Bay, the Coyote Creek station displayed a correlation as well ($r^2 = 0.62$).

The RMP deploys three different bivalve species due to varying salinities in different areas of the Bay. With the exception of the Point Pinole station, at which the mussel *Mytilus californicus* was deployed, all stations with acceptable correlations contained the oyster *Crassostrea gigas*. All data from the North Bay and Delta were also grouped and analyzed by species (*C. gigas, M. californicus*) or by location (rivers, open-water Bay-Delta); no significant correlations were observed. The third bivalve deployed in the RMP study was the clam *Corbicula fluminea*. Available Se tissue concentrations in *C. fluminea* deployed at the Sacramento River and Grizzly Bay stations displayed no significant correlations with SPM Se concentrations.

Many reasons may contribute to explaining why the RMP data may not always exhibit good correlations among Se concentrations in corresponding water, sediment, and tissue samples. Some of the main factors are suspected to be the following:

- The RMP sediment and water data consist of instantaneous point concentrations collected one to three times per year. Bivalves from uncontaminated waters are deployed at stations in the Bay for 90 days, after which they are sampled for Se and other trace elements. Sampling dates and station locations for water and bivalve tissue do not always match; therefore, the data set used for the correlations was not very large. In addition, the water quality at one point in time during a 3-month bivalve deployment period may not be representative of the average concentration over that 3-month period. If more frequent water analyses were conducted, temporally averaged concentrations could be calculated, and these average concentrations would most likely be a better predictor of concentrations in tissue.
- As discussed earlier, bioaccumulation potential varies dramatically between different species of Se. No data are available on Se species present in the samples collected.
- The deployment period may not correspond to a period of abundant phytoplankton food. Therefore, the bivalves may have very low ingestion rates during the deployment period, resulting in low assimilation of Se.

Biota-Sediment Accumulation Factor

The RMP data were used to develop a Baywide biota-sediment accumulation factor (BSAF) based on the ratio of Se concentration in bivalve tissue to Se concentration on SPM. For development of the BSAF, the SPM concentration was selected over water or bedded sediment concentration because this media was the only one for which a reasonable correlation with tissue concentrations was exhibited, as discussed above. In addition, the available data indicate that food-web uptake of Se is much more important than uptake of Se dissolved in the water column. Bivalves feed on both SPM in the water column and detrital matter in bedded sediment, depending on species and availability of food. Because the RMP data exhibited no good correlations between Se concentrations in bedded sediment and tissue, the BSAF developed with SPM data was used to predict tissue concentrations from both the SPM Se concentration and the bedded sediment Se concentration.

The initial goal was to identify separate BSAFs for several different regions of the Bay, based on habitat types and differences in Se speciation. However, because strong correlations were only exhibited at a few sampling locations throughout the Bay, not enough data were available to assign BSAFs to specific regions. Therefore, the BSAFs calculated for each of these locations were averaged to calculate a BSAF for the entire Bay-Delta Estuary.

The BSAF for each location was calculated as the unitless ratio of the average Se concentration in SPM (mg/kg dry weight) to the average Se concentration in bivalve tissue (mg/kg dry weight).

Therefore, the Se concentration in SPM can be multiplied by the BSAF to predict the Se concentration in bivalve tissue. BSAFs were calculated based on concentrations in *C. gigas*, because the best correlations were observed for this species, as discussed above. BSAFs calculated for each location are summarized as follows:

- Napa River mouth BSAF = 4.5
- San Pablo Bay BSAF = 4.7
- Coyote Creek mouth BSAF = 3.4

The average of the above BSAFs is 4.2, and this number was used as the Baywide BSAF for this evaluation. This BSAF is similar to the predictions made by Luoma and Presser (2000), using a kinetic bioaccumulation model. They predicted that Se concentrations in bivalve tissue (mg/kg dry weight) would be 8 times greater than Se concentrations in particulate matter for organo-Se, the most bioavailable form, and 2 times greater for elemental Se, the least bioavailable form. The BSAF of 4.2 used for this evaluation falls in between these values, as would be expected.

M. californicus exhibited a fairly strong correlation at Point Pinole, and the BSAF calculated for this species at this location was very low (1.0). To determine whether the difference was likely to be due to differences in Se speciation and bioavailability at this location, the average ratio of *M. californicus* tissue concentration to SPM concentration for the entire RMP data set was compared to the average ratio for *C. gigas.* The average ratio for *M. californicus* was 0.63, while the average ratio for *C. gigas* was 4.0. Therefore, it is likely that the large difference is due to the difference in bivalve species. *M. californicus* is a detrital feeder on bottom sediments, while *C. gigas* is expected to obtain much of its food from particulate matter in the water column.

Evidence indicates that *Potamocorbula amurensis*, an introduced species of clam that has aggressively invaded the San Francisco Bay-Delta, may accumulate Se at higher concentrations than the species deployed by the RMP (Linville et al. 2002). Three locations where resident *P. amurensis* tissue samples were collected in 1995 were near RMP sampling locations. At these three sites, Se concentrations in resident *P. amurensis* ranged from 11.6 to 15.4 mg/kg dry weight, while Se concentrations in the bivalves deployed by the RMP ranged from 2.5 to 4.8 mg/kg dry weight (Linville et al. 2002). While the differences may be due to some degree to variation in accumulation between species, differences in tissue concentrations may also be affected by other factors such as period of deployment (less uptake than occurs in resident organisms), and differences in Se concentrations in sediments and/or water at specific locations. If Se tissue concentrations in *P. amurensis* are consistently higher than those in other benthic organisms, and if this species comprises a substantial fraction of the food of upper-trophic-level receptors, it is possible that the toxicity threshold of 4 mg/kg may be exceeded even under baseline conditions.

Because data discussed in Section 8.1.4 indicate that *P. amurensis* does compose a large part of the diet of certain species of birds such as the surf scoter, particularly in Suisun Bay, this evaluation also includes a BSAF based on bioaccumulation in this species. Although it was not feasible to develop an empirical *P. amurensis* BSAF due to limited published data on water or sediment Se concentrations colocated with tissue samples of this species, a BSAF was estimated for *P. amurensis* by multiplying the BSAF developed based on *C. gigas* by a factor of 3. The factor of 3 was identified based on evidence presented by Linville et al. (2002) for the three sites discussed above where Se concentrations in resident *P. amurensis* ranged from 11.6 to 15.4

mg/kg dry weight, approximately 3 times the Se concentrations in the bivalves deployed by the RMP, which ranged from 2.5 to 4.8 mg/kg dry weight. Se concentrations in *P. amurensis* averaged 2.6 times greater than concentrations in the deployed bivalves. However, it should be noted that the deployed bivalves included three species (M. *californicus, C. gigas,* and *C. fluminea*), while the BSAF of 4.2 was developed based only on concentrations in *C. gigas.* Se concentrations in *P. amurensis* averaged 2.1 times greater than concentrations in *C. gigas*, but only 4 data points were available for comparison. In one case, the Se concentration in *P. amurensis* was 5.3 times greater than the concentrations in *C. gigas* deployed at the same location. Therefore, a factor of 3 was chosen to conservatively represent the limited data available, and the BSAF used in this evaluation to predict Se concentrations in *P. amurensis* is 12.6.

Bioconcentration Factor

Literature was reviewed to attempt to identify BCFs that could be used to predict how much Se is expected to be bioaccumulated directly from the water column. The BCF is the ratio of the average Se concentration in bivalve tissue (mg/kg dry weight) to the average dissolved Se concentration in water (mg/L). Therefore, the units of the BCF ratio are liter per kilogram, and the concentration of dissolved Se in water can be multiplied by the BCF to obtain the Se concentration in tissue at a given location.

A literature search was conducted to obtain information on studies that investigated BCFs in various organisms. Although a substantial number of studies were identified, the vast majority of these studies were conducted on freshwater species. To compare uptake routes (Se absorbed to particulate matter versus dissolved in water), it was desirable to identify BCF studies conducted on estuarine bivalves similar to those used in the RMP monitoring. Two such studies were identified.

Zhang, Hu, and Huang (1990) conducted a laboratory experiment to investigate Se uptake in the clam *Puditapes philippnarum*. However, they measured Se concentrations in the shell and in the whole body (including the shell), but not in the soft tissue alone. Because the RMP measured Se concentrations in the soft tissue alone, it is not appropriate to compare the results of these studies.

A study by Fowler and Benayoun (1976) investigated uptake of selenite (IV) and selenate (VI) by the mussel *Mytilus galloprovincialis*. Groups of mussels were placed in water containing 1, 10, and 100 ppb of either form of Se, and during a period of 21 days, Se was allowed to accumulate. Selenite tended to accumulate almost an order of magnitude more than selenate. Absorbed Se appeared to vary approximately linearly with water concentration. Se concentrations in soft tissue were given on a wet-weight basis, and no information on moisture content was provided. To calculate a BCF that could be used to predict tissue concentrations on a dry-weight basis, it was necessary to assume a moisture content. The average moisture content of *M. californicus* (a similar species of mussel) measured by the RMP was 88 percent, and this value was used for conversion to dry weight. The average ratio of soft tissue Se concentration (mg/kg dry weight) to water selenite concentration (mg/L) was 1,750. Because this value significantly underpredicts Se bioaccumulation as compared to the BSAF discussed above, the BCF approach was not used quantitatively in this evaluation.

Temporal and Spatial Averaging

Based on the water quality modeling results (see Sections 5.2.9 and 5.2.10), the summer and fall months are expected to exhibit the highest Se concentrations. Therefore, the 6-month period of June–November was used to calculate temporal averages of Se concentrations in bivalves for each scenario (No Action Alternative, Delta Disposal Alternatives). Model conditions are based on a wet year, as calibrated with Se data from the 1997 dry season. Se loads for baseline conditions were updated to reflect 2001 conditions, which incorporate reductions in Se discharges from refineries.

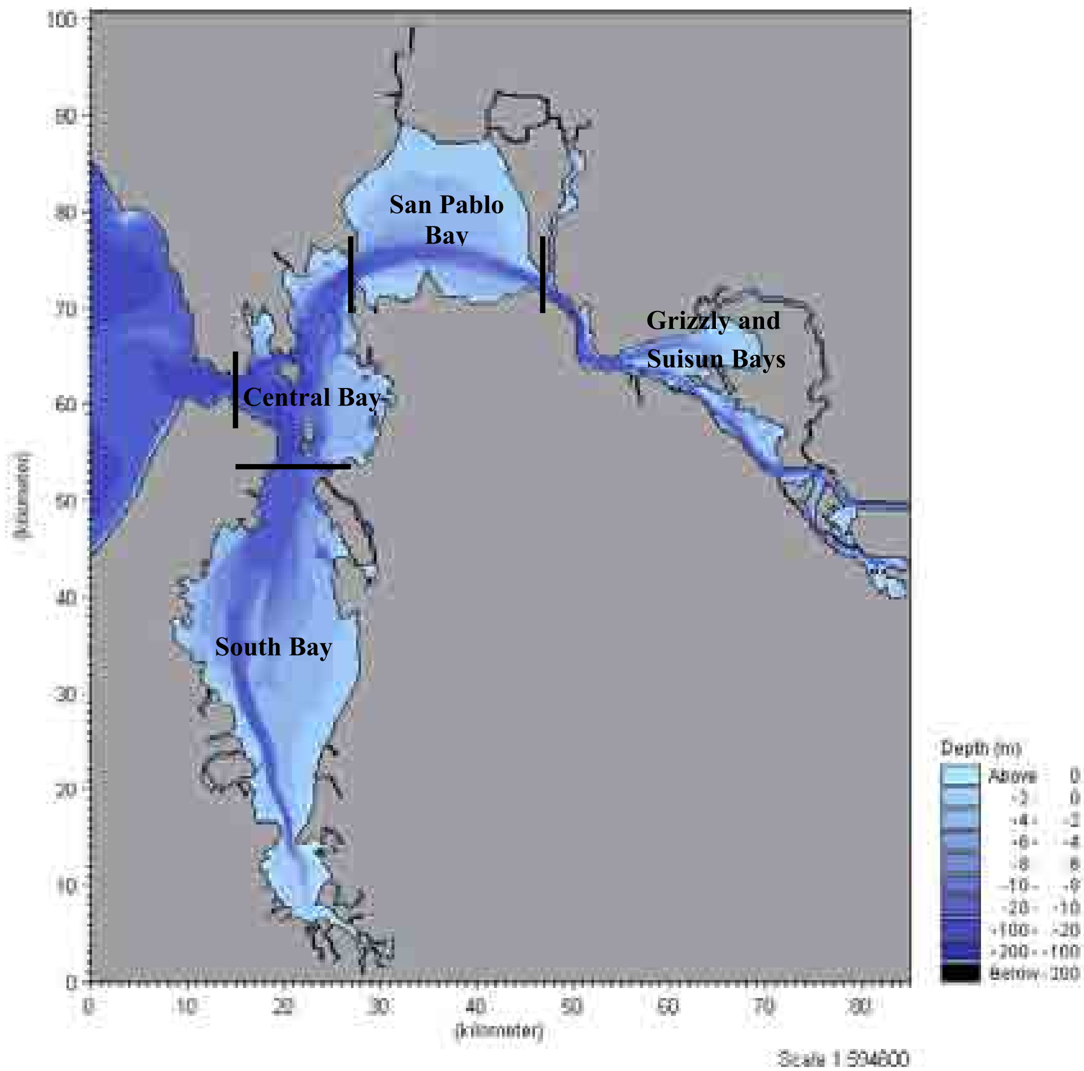
Spatial averages of 6-month average Se concentrations in bivalve tissue were calculated for four regions of the Bay-Delta Estuary as shown on Figure 8-1: the Delta (including Suisun and Grizzly bays), San Pablo Bay, Central Bay, and South Bay. In addition, to evaluate a "reasonable worst case" in terms of Se bioaccumulation close to discharge points and during the time periods of highest concentrations, a shorter time averaging period (30 days) and spatial averages for locations close to the discharge points were also calculated (see Figures 8-2 and 8-3). Although Se concentrations in the water column do fluctuate during the tidal cycles, bioaccumulation typically does not fluctuate on this short of a time scale (see Appendix G, Section G3.1.3.3).

8.2.2.5 Reuse Facilities (All Action Alternatives)

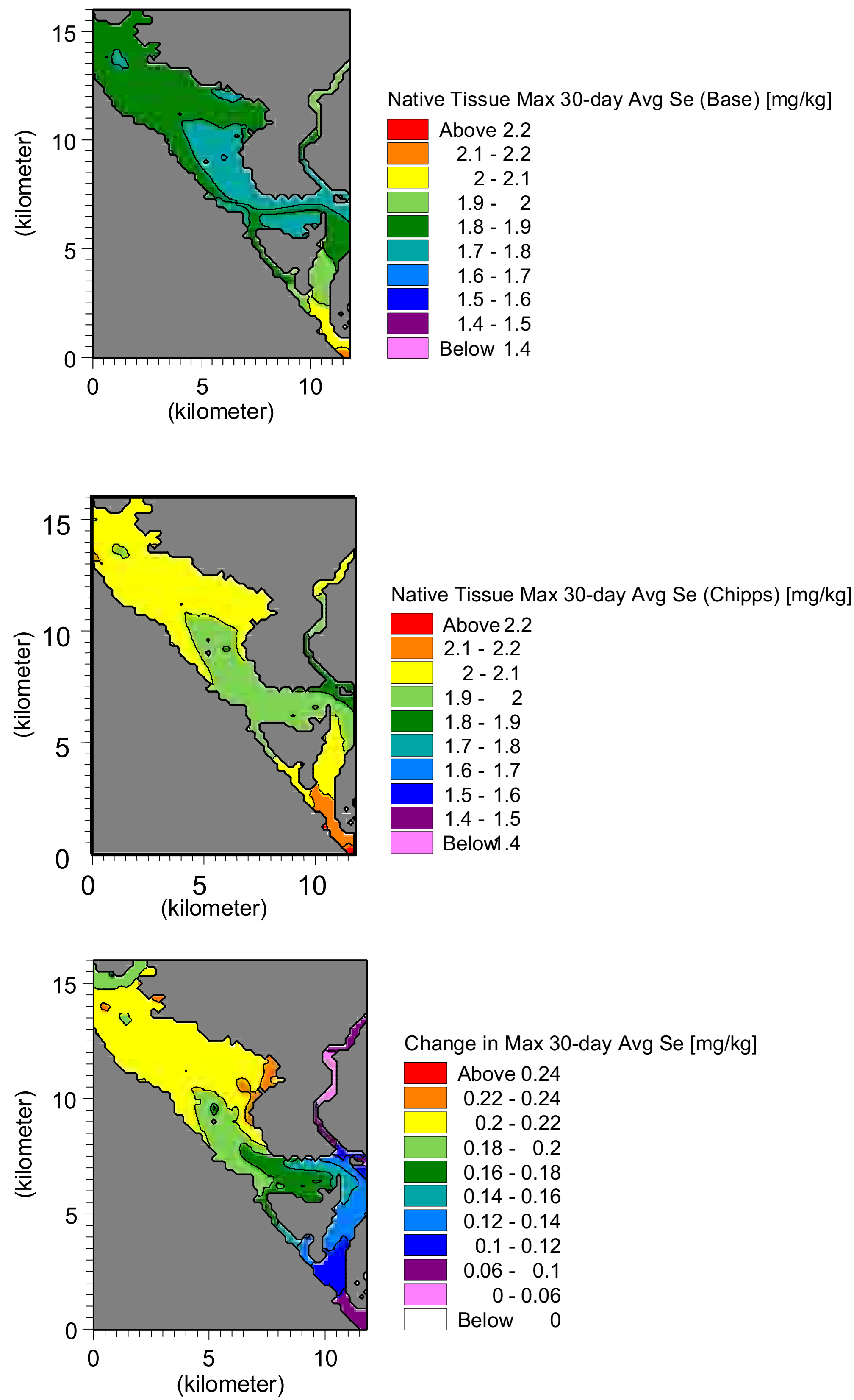
The up to 19,000 acres of proposed reuse areas would be designed and operated to sustain long-term production and maintenance of selected salt-tolerant crops. Irrigation would be strictly controlled to maintain the productivity of the sites and to prevent standing water. No new permanent, seasonal, or intermittent wetland or aquatic habitat would intentionally be permitted to develop at the sites. All fields would be leveled and low spots identified and managed. Application of drainwater would not be permitted until subsurface drains are operational and planned tailwater management capabilities have been installed. Every reuse site would have clean ditchwater or groundwater available on a limited basis for mixing with applied drainwater to better establish newly seeded crops or for field-specific salt management. Under normal conditions, these standard operating procedures would be expected to control shallow groundwater elevations at the sites and limit occurrences of leaching, temporary ponding, and surface evaporation. Strict prevention of ponded irrigation water would reduce potential use of the sites by shorebirds and waterfowl.

During abnormal storm events and prolonged wet periods, leaching of Se from the shallow stored drainwater and temporary ponding of rainwater and surface runoff could occur for short periods of time. Surface evaporation could concentrate Se in the exposed water. These intermittent occurrences could result in short-term Se exposure risks to opportunistic shorebirds and waterfowl foraging at the temporarily inundated sites. The Se risks would be minimized with field leveling, surface drainage management, a program of surface and groundwater monitoring, and with appropriate operating modifications to limit the occurrences or durations of the hazardous conditions. Under unusual prolonged wet conditions, bypass pipelines at the reuse facilities could temporarily redirect influent drainwater, if needed, directly to the treatment plants or evaporation facilities.

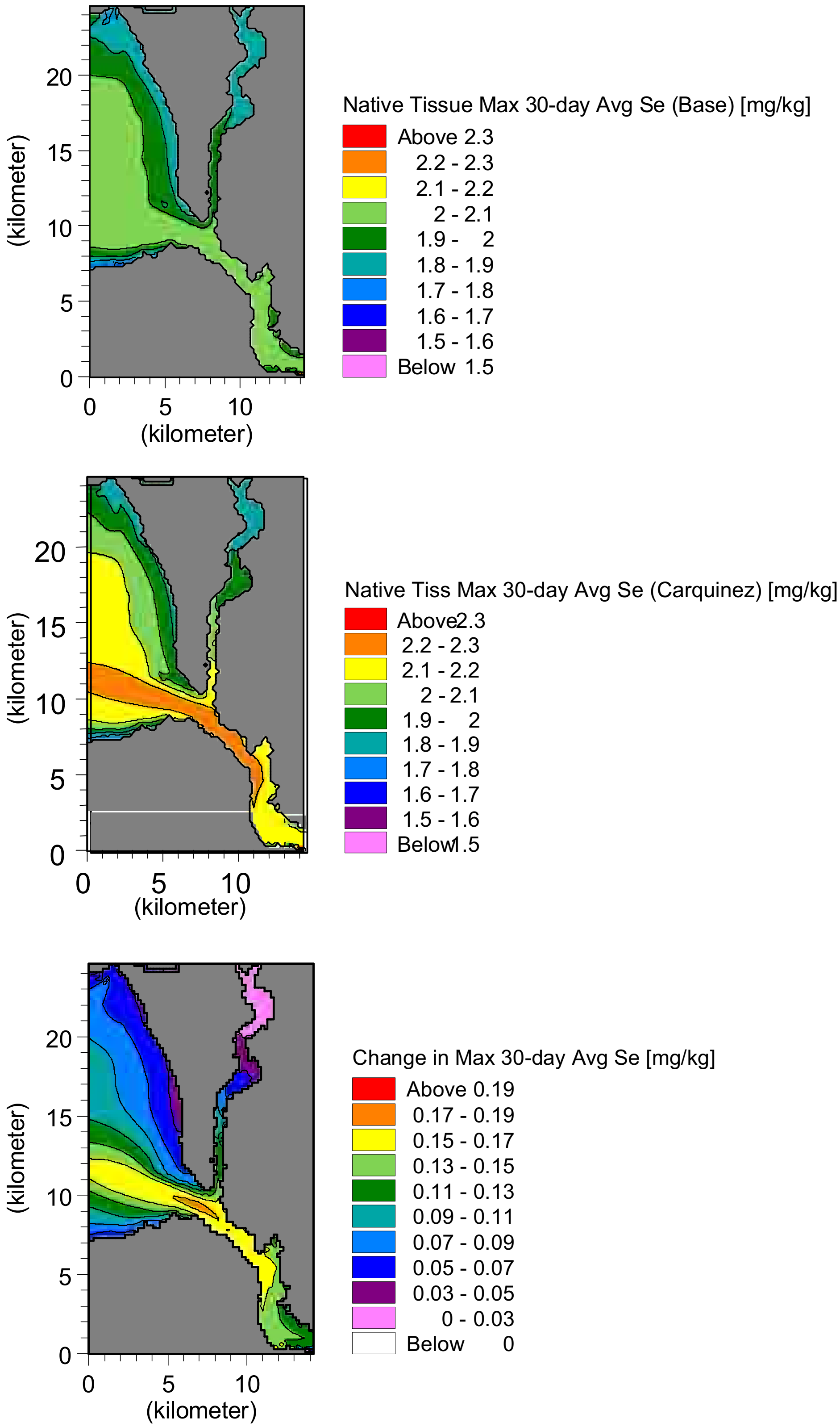
It is anticipated that significant effects to aquatic and wetland-dependent species from operation of the reuse areas could be effectively minimized with (1) responsive operating rules including seasonal or incident-based actions directed at at-risk species, (2) implementation of a reuse area



San Luis Drainage Feature Re-evaluation	Bathymetry and Areas Selected for Average Tissue Concentration Calculations	Figure 8-1
17324004		



San Luis Drainage Feature Re-evaluation	MIKE 21 Chipps Discharge (June-November 1997) Maximum 30-Day Average Native Bivalve Tissue Selenium Concentration Near Discharge and Difference from Baseline Conditions	Figure 8-2
17324004		



San Luis Drainage Feature Re-evaluation	MIKE 21 Carquinez Discharge (June-November 1997) Maximum 30-Day Average Native Bivalve Tissue Selenium Concentration Near Discharge and Difference from Baseline Conditions	Figure 8-3
17324004		

monitoring program (including surface and groundwater, soil, vegetation, bird use, dietary items, and bird eggs/tissues), and (3) adequate contingency strategies cooperatively developed by the Service, CDFG, and Regional Board. No quantitative modeling is necessary.

Due to elevated Se concentrations in soil, operation of these reuse areas could increase the risk of Se exposure for some terrestrial species (e.g., seed- and insect-eating species and the larger species that prey on them), potentially resulting in significant effects. No quantitative modeling has been performed at this time. Further evaluation and/or prevention measures or other mitigation would be necessary to ensure that no significant effects occur.

8.2.2.6 Uncertainties

Any evaluation of ecological effects has a number of limitations, including the degree of success in meeting objectives, range of conditions over which conclusions can be applied, and certainty with which conclusions can be drawn (USEPA 1989). The conclusions of an effects assessment are useful once they have been placed into perspective relative to the uncertainties associated with the evaluation. The major sources of uncertainty pertinent to this evaluation are discussed below.

General Sources of Uncertainty

Due to the multiplicity of potential receptor species and general lack of knowledge regarding their life cycles, feeding habits, and relative toxicological sensitivity, the uncertainty surrounding estimates of ecological effects may be substantial. Most of the criteria and parameters used in this assessment are intended to provide a conservative (high end) evaluation of potential effects. The measurement endpoints utilized are chemical-specific and, as such, cannot address the additive, antagonistic, or synergistic effects of the mixtures of chemicals typically found in the environment. Furthermore, they do not account for many site-specific conditions regulating chemical contact and bioavailability, the potential toxicity of other constituents that were not quantified, or the pervasive influence of physical stressors associated with short-term and long-term disruption by human activities.

Specific Sources of Uncertainty

In addition to the broadly influential general sources discussed above, several discrete sources of uncertainty are described below.

Temporal and Spatial Distribution of Selenium Concentrations in Water. Because this ecological evaluation is based on predicted concentrations of Se in water, all results are based on the accuracy of the water quality modeling results. Assumptions and uncertainties in the water quality modeling of influent Se concentrations are described in detail in Appendix C. In addition, it was assumed that the influent Se concentrations would be representative of Se concentrations in water throughout the evaporation basins. Se concentrations in water are likely to change as the water flows through the system, due to factors such as partitioning and bioaccumulation. However, it is difficult to quantitatively predict changes in concentrations.

Selenium Speciation and Bioavailability. Limited information is available to predict what forms of Se will exist in the proposed evaporation basins and the San Francisco Bay -Delta. Even if the speciation of Se in the treated effluent could be predicted with a reasonable amount of certainty, it is difficult to predict what will happen to the Se speciation when the water is transported. Because speciation is dependent on various chemical and physical parameters that are characteristic of environmental conditions, the speciation is likely to eventually change.

Species Sensitivity. No data could be found that relate dietary Se concentrations to effects to the birds species most likely to nest and breed at evaporation basins (recurvirostrids such as stilts and avocets). However, available egg tissue effects data do include results of studies conducted on recurvorostrids, which indicates that birds in this family may be less sensitive to Se than some other species such as mallards (Ohlendorf 2003). Sensitivity to Se exposure can vary substantially even in closely related species, like stilts and avocets. The EC50 for overt teratogenesis was estimated to be 31 mg Se/kg egg tissue of dabbling ducks, whereas, the respective EC50s for stilts and avocets are 58 and 105 mg Se/kg egg tissue. These results indicate that ducks may be twice as sensitive to Se exposure as recurvirostrids, and avocets are relatively insensitive to selenosis (Skorupa 1998). The species examined in this study can be summarized as “sensitive” (duck), “average” (stilt), and “tolerant” (avocet) (Ohlendorf 2003).

Exposure Assessment. This evaluation assumed that birds would be ingesting food obtained from the area of concern only. If adjacent foraging habitat is available, it is likely that birds would obtain a portion of their food from areas with lower Se concentration, and exposure would be lower than predicted in this assessment.

In addition, a significant amount of uncertainty exists regarding the duration of time that migrating and wintering birds would spend at one location.

This evaluation also assumed that the dietary compositions of all bird species and all individuals within each bird category would be identical. However, dietary composition is likely to vary considerably, depending on numerous factors such as species, food availability, and time of year. In general, this evaluation assumed dietary composition that would predict Se exposure at the high end of the range (i.e., more consumption of benthic invertebrates, which accumulate higher Se levels).

Se exposure in birds is a function of two main factors: Se concentration in dietary items and food ingestion rates. Ingestion rates may vary substantially among species and at different times of the year. However, ingestion rates were not considered in this evaluation.

8.2.3 No Action Alternative

The No Action Alternative evaluates the effect of not conveying drainwater out of the drainage study area for disposal. This alternative is defined as what could be expected to occur in the 50-year planning period if drainage service is not provided to the Unit and related areas. It represents existing conditions for drainage management plus changes in management reasonably expected to be implemented by individual farmers and districts in the absence of Federal drainage services. The No Action Alternative includes only regional conveyance, treatment, or disposal facilities that existed in 2001 or that are authorized, funded projects. No use of the San Luis Drain would be planned after 2009, as it would require a new action and NEPA documentation.

As discussed in Section 5.2.3, it is anticipated that adverse effects to surface water quality in the San Joaquin Valley wetlands would occur under the No Action Alternative, because some subsurface drainage is expected to migrate uncontrollably and laterally into wetland channels. Refuge waterways would be adversely affected because they have benefited in recent years from declining contaminant levels. Therefore, because Se bioaccumulation is primarily dependent on water quality, adverse effects to aquatic receptors related to changes in Se bioaccumulation are anticipated under the No Action Alternative. Special-status species affected may include the giant garter snake and California red-legged frog.

8.2.4 In-Valley Disposal Alternative

8.2.4.1 Terrestrial Resources

As currently proposed, operation of the evaporation basin facilities, totaling 3,290 acres, would not create attractive habitat for common terrestrial seed-eating, predatory, or scavenging species. Under normal basin operation, terrestrial and shoreline vegetation that could provide forage, prey habitat, cover, and nesting substrates for terrestrial species would be systematically sprayed or mechanically removed. The high water temperatures, high salinity, and generally poor aquatic conditions would restrict development of fish, amphibian, and crustacean prey populations. Dead waterbirds (potential prey for scavengers) would be collected and removed. Seasonal hazing would reduce avian use numbers and nesting attempts, further reducing potential prey (eggs, hatchlings). The limited prey base and relative absence of terrestrial and emergent vegetation would limit attraction to the basin sites and significantly reduce the risk of dietary Se exposure for most terrestrial wildlife species.

Due to elevated Se concentrations in soil, operation of the reuse areas could increase the risk of Se exposure for some terrestrial species (e.g., seed- and insect-eating species and the larger species that prey on them), potentially resulting in significant effects. It is difficult to predict the likelihood or severity of effects to terrestrial Se bioaccumulation as limited historical bioaccumulation monitoring data are available for reuse areas in the region. As described in Section 8.1.5, egg Se tissue concentrations have been monitored at Panoche Drainage District (H.T. Harvey and Associates 2004, 2005) and Red Rock Ranch (Buchnoff 2006); however, these egg tissue monitoring events were focused on waterbird use of the area during ponding events and did not include terrestrial birds. As discussed in Section 2.3.2.3, this project will incorporate design and management measures to minimize ponding at reuse areas.

The ecological risk assessment for Kesterson Reservoir (CH2M Hill and Lawrence Berkeley National Laboratory 2000) included a review of historical data on Se bioaccumulation in the terrestrial food chain. The conclusions from this risk assessment indicated that although the terrestrial bird species (American kestrel, barn owl, loggerhead shrike, and killdeer) would likely continue to have elevated Se egg tissue concentrations, the concentrations would be below those expected to cause reproductive effects. Predicted Se concentrations were below levels known to cause health or reproductive effects in small mammals. Se levels in terrestrial food chain items other than mushrooms and shrews were generally low. In contrast to Se bioaccumulation that occurs in waterbirds when ponding occurs, Se tissue concentrations in upper-trophic-level terrestrial receptors tend to be fairly stable.

Because conditions at Kesterson are not necessarily representative of conditions at the project reuse areas, considerable uncertainty exists regarding risk to terrestrial receptors at reuse areas. Therefore, it is conservatively assumed that significant effects may occur.

8.2.4.2 Aquatic Resources

During abnormal storm events and prolonged wet periods at reuse areas, Se leaching from the shallow stored drainwater and temporary ponding of rainwater and surface runoff could occur for short periods of time. Surface evaporation could concentrate Se in the exposed water. These intermittent occurrences could result in short-term Se exposure risks to opportunistic shorebirds and waterfowl foraging at the temporarily inundated sites. The Se risks would be minimized with field leveling, surface drainage management, a program of surface and groundwater monitoring, and with appropriate operating modifications to limit the occurrences or durations of the hazardous conditions. Under unusual prolonged wet conditions, bypass pipelines at the reuse facilities could temporarily redirect influent drainwater, if needed, directly to the treatment plants or evaporation facilities.

It is anticipated that significant effects to aquatic and wetland-dependent species from operation of the reuse areas could be effectively minimized with (1) responsive operating rules including seasonal or incident-based actions directed at at-risk species, (2) implementation of a reuse area monitoring program (including surface and groundwater, soil, vegetation, bird use, dietary items, and bird eggs/tissues), and (3) adequate contingency strategies cooperatively developed by the Service, CDFG, and Regional Board.

Table 8-3 presents the predicted Se concentrations in influent water and plant, nektonic invertebrate, and benthic invertebrate tissue for the proposed evaporation basins.

Table 8-3
Predicted Selenium Concentrations in Influent Water and Dietary Tissue

[Se] in Influent Water (μg/L)	[Se] in Plant Tissue (mg/kg dry weight)	[Se] in Nektonic Invertebrate Tissue (mg/kg dry weight)	[Se] in Benthic Invertebrate Tissue (mg/kg dry weight)
10	2.7	8.7	15.6

Table 8-4 presents the average predicted Se concentrations in the dietary items of each bird category. These estimates were calculated based on the estimated dietary composition of each bird category, as described in Appendix G, Section G5.3.

Table 8-4
Predicted Average Selenium Concentration in Diet of Each Bird Category

Bird Category	Average Dietary [Se] (mg/kg dry weight)	
	Breeding Season	Nonbreeding Seasons
Dabblers (except for Northern Shoveler)	13.1	8.7
Northern Shoveler	8.7	8.6
Divers	13.7	11.8
Shorebirds (“Breeding” and “Nonbreeding”)	15.3	15.3

Predicted mean Se concentrations in dietary tissue exceed the effects threshold of 4 mg/kg for all four evaporation basins during the breeding season. Therefore, significant effects would be expected to occur under the unmitigated alternative. These results are based on water quality modeled based on long-term irrigation with drainwater after project completion. The time needed to reach final water quality projections would be approximately 20 to 25 years after project completion. Results of the detailed ecological risk assessment conducted for this alternative are presented in Appendix G.

If not prevented or fully compensated by mitigation, effects such as reproductive impairment, embryonic deformities, sublethal reductions in health and vigor, and other Se-related effects that result in mortality or reduced reproductive success to protected migratory birds would be considered “takings” in violation of the Migratory Bird Treaty Act and, subsequently, would be considered a significant effect, and consultations with the Service are required.

To reduce the adverse effects to waterbirds, a number of design and management strategies would be implemented to modify habitat characteristics known to attract waterbirds to evaporation basins. Mitigation would be developed in consultation with the Service, CDFG, Regional Board, and others and would include a yet-to-be-determined number of development, enhancement, and restoration options as described in Section 20. With successful mitigation, the effects to waterbirds would be reduced to not significant.

8.2.4.3 Special-Status Species

Table 7-2 in Section 7.2.4.3 identifies the 16 listed special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by this alternative. This section identifies those special-status species that may be exposed to elevated Se concentrations due to implementation of the In-Valley Disposal Alternative.

Predatory birds may feed on aquatic birds that forage on invertebrates in the evaporation basins. Aquatic birds that obtain a large amount of their diet from evaporation basins are likely to contain elevated Se levels in their tissue. Therefore, predatory birds are likely to receive Se exposure by feeding on these birds. **American peregrine falcons** (a state-listed endangered species) have been observed feeding on shorebirds at the Tulare Lake Drainage District evaporation basins. Two sick American peregrine falcons were recovered during mid-summer 1992, and blood and feather samples collected from these birds contained elevated Se levels. One birds was too weak to fly. Both birds experienced full recovery after being fed a diet containing a normal Se concentration (Hanson Environmental 2003). Evidence presented in Appendix G indicates that this species may experience significant adverse effects due to Se bioaccumulation in waterbird prey.

While the **California least tern** (a federally and state-listed endangered species) generally breeds in large nesting colonies along the coast, single nesting pairs have been reported at evaporation basins in the Tulare Lake Basin (see Appendix M2). Also one least tern nest was reported at an evaporation basin in Kettleman City, and foraging was observed at sewage ponds in Lemoore. California least terns dive for small fish and macroinvertebrates. While it is unlikely that prey will be sufficient to support this species at the proposed evaporation basins, it is possible they may forage there and may be adversely affected by Se concentrations in prey.

Operation of In-Valley facilities would be unlikely to affect the **bald eagle**, which has not been observed at evaporation basins and would favor riparian and reservoir foraging areas with suitable hunting and roosting perches.

The **San Joaquin kit fox** could forage at several of the proposed reuse areas located nearest the eastern edges of the drainage areas, but would be less likely to utilize project sites that are more isolated within the surrounding agricultural landscape. Retirement of large contiguous tracts of cropland in the vicinity of the reuse areas, however, could create travel corridors to the interior sites, expanding potential kit fox foraging areas to include all reuse areas. Portions of the reuse facilities that would be planted in salt-tolerant grasses, grain crops, or permanent pasture could develop a substantial prey base and expose foraging kit fox to elevated Se in common dietary items such as insects, ground-nesting birds, and small mammals. The more intensively cropped portions of the reuse facilities would likely support less abundant prey than the areas planted in cover or pasture crops, or nearby nonirrigated parcels and refuge lands.

Kit fox use of evaporation facilities would likely be limited. The removal of ground cover and emergent vegetation at the evaporation basins and intensive hazing of nesting shorebirds would limit development of an attractive prey base. Without an abundance of prey to attract kit fox to the evaporation facilities, the potential for significant adverse effects would be limited.

Operation of In-Valley reuse facilities also could adversely affect the **Swainson's hawk** and **greater sandhill crane**. While both species would also be attracted to grasslands, irrigated pasture, and other suitable croplands (including retired lands converted to dryland farming or grazing land), this alternative's reuse areas also would provide attractive foraging habitat, exposing foraging individuals to elevated Se in seeds, grains, worms, insects, and small mammals.

The **California black rail** and the **western yellow-billed cuckoo** would not be exposed to Se bioaccumulation associated with operation of any In-Valley disposal facility. Habitat types used by these species (extensive emergent marshlands and multi-layered riparian forest, respectively) do not currently exist within the identified project area and would not be expected to develop at any of the proposed reuse sites, evaporation basins, or lands identified for retirement.

Burrowing owl colonies occupying the existing San Luis Drain would not be affected by operation of portions of the collection system located within the Drain's ROW if appropriate operating rules and conservation measures are included in a proposed burrowing owl management plan that would be developed for the Drain. This species typically does not nest in areas of heavy vegetation, so it is unlikely to nest in the reuse areas.

The **giant garter snake** and **California red-legged frog** would not be adversely affected by operation of any In-Valley facilities. These species, however, could indirectly benefit from a general improvement in water quality in Mud Slough and other Grasslands area waterways.

The listed **Chinook salmon** or **steelhead ESUs**, **Delta smelt**, or **green sturgeon** may benefit from implementation of the In-Valley Disposal Alternative. A reduction in the Se load entering the San Joaquin River as a direct result of the project would improve water quality in the Bay-Delta habitats used by these species. Although no evidence indicates that **Chinook salmon** or **steelhead ESUs**, **Delta smelt** would be affected by Se concentrations, sturgeon are known to accumulate Se at higher concentrations than other fish.

8.2.5 In-Valley/Groundwater Quality Land Retirement Alternative

Environmental consequences of this alternative are expected to be comparable to those discussed in Section 8.2.4, but may be lower in magnitude because evaporation basins are not required to be as large. The maximum acreage of the evaporation basin is estimated to be 2,890. Operation of reuse areas could increase the risk of Se exposure for some terrestrial species, potentially resulting in significant effects (see Section 8.2.4.1).

8.2.6 In-Valley/Water Needs Land Retirement Alternative

Environmental consequences of this alternative are expected to be comparable to those discussed in Section 8.2.4, but would be lower in magnitude because evaporation basins are not required to be as large (2,150 acres). Operation of reuse areas could increase the risk of Se exposure for some terrestrial species, potentially resulting in significant effects (see Section 8.2.4.1).

8.2.7 In-Valley/Drainage-Impaired Area Land Retirement Alternative

Environmental consequences of this alternative are expected to be comparable to those discussed in Section 8.2.4, but would be lower in magnitude with only 1,270 acres of evaporation basins. Operation of reuse areas could increase the risk of Se exposure for some terrestrial species, potentially resulting in significant effects (see Section 8.2.4.1).

8.2.8 Ocean Disposal Alternative

8.2.8.1 Terrestrial Resources

Due to elevated Se concentrations in soil, operation of these reuse areas could increase the risk of Se exposure for some terrestrial species (e.g., seed- and insect-eating species and the larger species that prey on them), potentially resulting in significant effects (see Section 8.2.4.1).

8.2.8.2 Aquatic Resources

As discussed in Section 5 of the EIS, the 6-month median marine aquatic life criterion of 15 ppb of Se reported in the California Ocean Plan was used as the standard for evaluating impacts to water quality. However, this criterion is based on aquatic toxicity, not bioaccumulation to upper-trophic-level receptors, and it is recognized that bioaccumulation-related effects can occur at Se concentrations below the 15 µg/L criterion. Therefore, to respond to this concern, an additional analysis was conducted to evaluate the size of the mixing zone that would be required before a concentration of 2 µg/L Se is achieved. The value of 2 µg/L Se was selected because this is the lowest promulgated water quality criterion for Se in California and was put in place to protect the waterfowl (based on food-chain effects) in Grassland Water District, San Luis National Wildlife Refuge, and Los Banos State Wildlife Area.

Although a fair amount of Se research has been conducted in estuarine environments such as the San Francisco Bay-Delta, limited data exist on the concentrations, speciation, and bioavailability of Se in open ocean waters offshore of California (or in other parts of the world). Cutter and Bruland (1984) measured vertical profiles of Se species in the North and South Pacific Oceans to depths of 3,250 meters. At the VERTEX II site (18N, 108W, off the coast of Mexico) total dissolved Se concentrations ranged from 0.075 µg/L (15-meter depth) to 0.19 µg/L (3,000-meter depth). The water was about 3,500 meters deep with a surface mixed layer of about 30 meters. Dissolved organic selenide averaged 0.6 µg/L within the 30-meter mixed layer and increased to a maximum of about 0.79 µg/L between 45 and 60 meters deep. This depth also coincided with maximums for primary productivity, total pigments, and bioluminescence. Below 100 meters, dissolved organic selenide ranged from less than 0.0079 to 0.037 µg/L. Surface selenate values averaged 0.011 µg/L, and selenate increased rapidly from 30 to 125 meters to 0.092 µg/L.

Cutter and Bruland (1984) also measured surface-water Se speciation on a horizontal transect beginning off the coast south of Monterey and north of Morro Bay. The station closest to the shore was about 250 km southwest of Monterey, and at this location the dissolved organic selenide concentration in the surface mixed layer was 0.030 µg/L, while the dissolved selenate concentration was almost the same (0.029 µg/L).

Several other studies measured Se concentrations and speciation in ocean environments. However, like the Cutter and Bruland (1984) study, these studies have been conducted in deep ocean waters or fjord systems very different than the near-shore shallow coastal shelf environment at the Ocean Disposal Alternative outfall location off the coast of Point Estero. For example, Nakaguchi et al. (2004) measured vertical profiles of dissolved Se species in the Celebes, Sulu, and South China seas, and found considerable variation among locations and sometimes among sampling events, but in general organic selenide made up less than half of the total Se concentration. Nakaguchi et al. (2004) compared their results to an earlier study in the Indian Ocean by Hattori et al. (2001, cited in Nakaguchi et al. 2004), which found that organic selenide was the dominant species at that location. Wrench and Measures (1982) measured Se speciation at a fjord ecosystem (Bedford Basin, Nova Scotia, Canada) at a depth of 5 meters on a weekly basis in the winter/spring, and found that biological activity can modify the redox balance and Se speciation. In general, most studies found data to indicate that the Se speciation regime is correlated with nutrient profiles and biological activity.

As indicated by the above studies, variation appears to be considerable in Se speciation regimes in the ocean environment, and it is not possible to predict the Se forms that would occur when Se is released to the ocean under the Ocean Disposal Alternative. Data on Se bioaccumulation and toxicity in the open ocean environment are also insufficient to predict bioaccumulation or toxic effects in this environment. Therefore, the analysis presented here uses available data from inland and estuarine environments, using conservative values due to the inherent uncertainty. Skorupa and Ohlendorf (1991) identified a threshold of 3 ppm Se in avian eggs as elevated compared to background conditions, and used existing water and tissue data to develop a regression equation that identified 2.3 ppb total recoverable Se as the corresponding threshold in water. The regression equation was developed using primarily evaporation basin data, not marine data. Skorupa and Ohlendorf (1991) also identified an embryotoxicity threshold of 2 to 13 ppb total recoverable Se, based on a dietary threshold of 5 ppm Se in dietary items and empirically derived bioaccumulation curves for dietary items from Tulare Basin evaporation basins. While few data are available on Se bioaccumulation rates and adverse effects in the open ocean environment, available data on Se toxicity to birds indicate that marine (salt-tolerant) species tend to be less sensitive to Se than freshwater species (Hamilton 2004).

Under stagnant (worst-case) ocean current conditions, the resulting Se plume modeled based on the diffuser design discussed in Section 5.2.2, and shown in Table 5.2-6, did not reach the 2 ppb target before reaching either a trapping depth (i.e., a level at which upward plume motion is halted due to density gradients) or the water surface. Because EPA’s VP program is not able to model the lateral spread of the plume that would occur after the trapping depth or water surface is reached, an additional diffuser design was produced as an example of the kind of diffuser that would be able to meet the 2ppb target before the water surface is reached, and could be modeled using EPA's VP program. Table 8-4a shows the design parameters for this additional diffuser design (the "2 ppb design"). Under stagnant (worst-case) ocean current conditions (summer and winter), the Se plume resulting from this design would reach a concentration of 2 ppb at a height of approximately 13 meters above the diffuser. At this elevation the plume would be less than 6 meters wide and would be approximately 284 meters long (again, for both summer and winter). Note that this is not the only diffuser configuration that would achieve the 2 ppb target within a reasonable ZID and is only a preliminary example. The 2 ppb diffuser design would need to be refined if the Ocean Disposal Alternative and the 2 ppb Se target were selected for the preferred alternative in the future.

Table 8-4a
2-ppb Diffuser Design Parameters, Point Estero Diffuser

Diffuser Design Parameter	Parameter Value
Diffuser port valve type	Tideflex®
Port diameter	6.1 cm
Diffuser design depth	61 meters
Port elevation above ocean floor	0.61 meter
Port angle	Vertical (0^o)
Number of ports	77
Port spacing	3.7meters on center
Diffuser length	278 meters
Diffuser discharge velocity	3.67 meters/second (12 feet/second)

Under stagnant (worst-case) ocean current conditions (summer and winter), the Se plume resulting from this design would reach a concentration of 2 ppb at a height of approximately 13 meters above the diffuser. At this elevation the plume would be less than 6 meters wide, and would be approximately 284 meters long (again, for both summer and winter). Note that this diffuser configuration is not the only one that would achieve the 2 ppb target within a reasonable ZID and is only a preliminary example. The exact configuration and location of the diffuser has not been determined – it could either be T-shaped, with a pipe extending out to the diffuser, where the length of the diffuser is oriented roughly parallel to the shoreline (and along the depth contour), or the diffuser could be continued in the direction of the pipe, with the length extended out perpendicular to the shoreline and into deeper water. For this evaluation it is assumed that the area of the plume could include habitat within a distance of about 300 meters in any direction from the approximate outfall location. This area would include habitat at a depth of approximately 50 to 65 meters.

As described in Section 2.8.1, the ocean diffuser would be approximately 1.4 miles offshore at a depth of about 200 feet. The substrate surrounding the area where the diffuser would be located is likely to consist of silty mud with fine-grained sand that is typically found at this depth. The epifauna in this region typically includes cerianthaid anemones, the seastars *Luidia foliolata* and *Rathbunaster californicus*, and the seapens *Stylatula elongate*, *Ptilosarcus gurneyi*, and *Pennatula* sp. (California State Lands Commission 2005). The diffuser would create a hard substrate that would likely be colonized by epifauna typically found at the same depth and substrate type along much of the California coast. These communities commonly include cup corals, e.g., *Paracyathus* and *Balanophyllia*, hydroids, encrusting sponges, ascidians, gorgonians, anemones, e.g., *Metridium* and *Urticina*, and ophiuroids (MEC 2002).

Submerged aquatic vegetation found in the general area includes red and brown macroalgae such as giant kelp (*Macrocystis pyrifera*), *Sargassum* spp., *Taonia* spp., *Gigartina* spp., and *Corallina* spp. (USACE 2002). Giant kelp is found at depths up to 40 meters, temperatures less than 20ºC, hard substrate, and bottom light intensities about 1 percent that of the surface (North 1971; Foster and Schiel 1985). Kelp beds extend low-relief, hard-bottom habitat from the seafloor to the surface, creating a vertically structured habitat for fish, invertebrates, and marine mammals. The 40-meter depth contour is approximately 0.4 mile inshore from where the diffuser would be located; therefore, the closest kelp forests would be expected to be at least 0.4 mile from the diffuser.

A study by the Southern California Coastal Water Research Project found that demersal and pelagic fish communities in shallow-water areas (236- to 279-foot [72- to 85-meter] water depth) along the Southern California coast are typified by sanddabs (*Citharichthys* spp.), California lizardfish (*Synodus lucioceps*), plainfin midshipman (*Porichthys notatus*), bigmouth sole (*Hippoglossina stomata*), California tonguefish (*Symphurus atricaudus*), hornyhead turbot (*Pleuronichthys verticalis)*, rex sole (*Errex zachirus)*, English sole (*Pleuronectes vetulus)*, and pink surfperch (*Zalembius rosaceus)* in all studies at these depths (SCCWRP 1993).

Because the diffuser ports would be elevated above the ocean floor and the effluent would be expected to rise due to lower salinity, the plume is not expected to directly impact the benthic environment on the ocean floor, although organisms that colonize the diffuser itself might be expected to accumulate Se at elevated levels. The plume would cover an area of approximately 1,700 square meters (less than half an acre). Pelagic organisms are very unlikely to be constricted to an area this small for any significant period of time (longer than a portion of a day).

An exception might occur if conditions that attract organisms existed in the diffuser vicinity. Such conditions might include increases in temperature and/or elevated nutrient concentrations that result in increased productivity. Fish species have been shown to be attracted to thermal discharges in some cases. The attraction may be advantageous for several reasons, including temperatures that closely approximate seasonally preferred temperatures, that fish may maintain energetically optimal temperatures near the warm water discharge, and discharges may attract and concentrate prey species.

Little information could be found regarding the potential for fish to be attracted to thermal plumes in the open ocean environment. Literature discussed in environmental documentation for Portlands Energy Centre, a power plant located on Lake Ontario, suggests numerous cases where fish have been found to be attracted to warm-water discharges where temperatures do not approach the upper tolerance ranges (generally around 30°C) (Portlands Energy Centre 2003). For example, Spigarelli and Thommes (1976, 1979) found that rainbow trout appeared to be attracted to warm-water discharges in Lake Michigan and that sport fishing success for various trout species as well as coho and chinook salmon had increased in the thermal discharge plume of a nuclear power plant. Shuter et al. (1985) also found that the numbers of smallmouth bass increased near thermal plumes. Others studies, however, have found a lack of correlation between temperature plumes and fish. For example, studies by Minns et al. (1978) showed no correlation between fish distribution and thermal plumes from different power plant thermal discharges. The fish in these cases appeared to be more influenced by currents and turbulence than by the thermal plume. Studies of thermal discharges from the west coast such as from power plants including Diablo Canyon, San Onofre Nuclear Generating Station, or Morro Bay Power Plant have generally focused on impacts of the thermal plume itself and measurement of any resulting decline in plant and animal populations in the plume rather than on the attractive properties of the warm water.

In cases were temperatures approach the upper tolerable levels, fish tend to avoid the thermal plume. Gray (1990) reported that juvenile chinook salmon avoided thermal plumes in laboratory tests when the difference in temperature exceeded 9 to 11°C above ambient temperatures, but thermal discharge in the Hanford reach of the Columbia River did not block the upstream migration of tagged adult chinook salmon and rainbow trout even at temperature differences of 17°C.

Many of the studies cited in the Portlands Energy Centre document on the attractive properties of thermal plumes appear to have been conducted on discharges to canals or semienclosed bays rather than open ocean conditions. In these cases, the discharge canal represents a fixed location where temperatures remain elevated.

Given the lack of data on thermal attraction in the open ocean environment, it may be conservatively assumed that some fish species may be attracted to the warmer waters. However, given that the thermal plume from the Ocean Disposal Alternative discharge would be relatively small (less than half an acre) in relation to the surrounding open-water areas, it would be unlikely that large numbers of fish would be able to congregate in any large number and forage within the plume for a sustained length of time. Any food sources for fish would also need to stay within the plume for a length of time to experience increased Se accumulation.

No significant effects to marine organisms or human health are expected to occur as a result of increased Se bioaccumulation due to the Ocean Disposal Alternative.

8.2.8.3 Special-Status Species

Table 7-3 identifies the listed special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by this alternative. This section identifies those special-status species that may be exposed to elevated Se concentrations due to implementation of the Ocean Disposal Alternative.

Operation of this alternative would be unlikely to affect the **bald eagle**, which would favor riparian and reservoir foraging areas with suitable hunting and roosting perches.

The **San Joaquin kit fox** could forage at several of the proposed reuse areas located nearest the eastern edges of the drainage areas, but would be less likely to utilize project sites that are more isolated within the surrounding agricultural landscape. Retirement of large contiguous tracts of cropland in the vicinity of the reuse areas, however, could create travel corridors to the interior sites, expanding potential kit fox foraging areas to include all reuse areas. Portions of the reuse facilities that would be planted in salt-tolerant grasses, grain crops, or permanent pasture could develop a substantial prey base and expose foraging kit fox to elevated Se in common dietary items such as insects, ground-nesting birds, and small mammals. The more intensively cropped portions of the reuse facilities would likely support less abundant prey than the areas planted in cover or pasture crops, or nearby nonirrigated parcels and refuge lands.

Operation of reuse facilities also could adversely affect the **Swainson's hawk** and **greater sandhill crane**. While both species would also be attracted to grasslands, irrigated pasture, and other suitable croplands (including retired lands converted to dryland farming or grazing land), this alternative's reuse areas also would provide attractive foraging habitat, exposing foraging individuals to elevated Se in seeds, grains, worms, insects, and small mammals.

The **California black rail** and the **western yellow-billed cuckoo** would not be affected. Habitat types (emergent marshlands and riparian forest, respectively) utilized by these species would not be affected by operation of any Ocean Disposal Alternative facility.

Burrowing owl colonies occupying the existing San Luis Drain would not be affected by operation of portions of the collection system located within the Drain's ROW if appropriate operating rules and conservation measures are included in a proposed burrowing owl management plan that would be developed for the Drain. This species typically does not nest in areas of heavy vegetation, so it is unlikely to nest in the reuse areas.

The **giant garter snake** and **California red-legged frog** would not be adversely affected by operation of any Ocean Disposal Alternative facilities. These species, however, could indirectly benefit from a general improvement in water quality in Mud Slough and other Grasslands area waterways.

The listed **Chinook salmon** or **steelhead ESUs**, **Delta smelt**, or **green sturgeon** may benefit from implementation of the Ocean Disposal Alternative. A reduction in the Se load entering the San Joaquin River would improve water quality in the Bay-Delta habitats used by these species. Although no evidence indicates that **Chinook salmon** or **steelhead ESUs**, **Delta smelt** would be affected by Se concentrations, sturgeon are known to accumulate Se at higher concentrations than other fish.

8.2.9 Delta-Chipps Island Disposal Alternative

8.2.9.1 Terrestrial Resources

The aqueduct's approximately 73 miles of open canal segments between the biotreatment plant and the discharge at Chipps Island could create a small risk of Se exposure for some species; however, the relatively small concrete-lined structure (normal capacity of 29.1 cfs) would not be particularly attractive to wildlife and would carry only treated drainwater (Se concentration of 10 ppb or less). Furthermore, at least 45.6 miles of the 73 miles of open canal segments that would convey treated drainwater would be located in developed urban and agricultural areas where wildlife exposure would be limited and natural habitat would not be bisected. Therefore, no significant effects to terrestrial resources are expected to occur due to Se exposure at the aqueduct.

The remaining open canal segments, comprised of the southern 56 miles of the existing San Luis Drain and the valley collection canal, would convey untreated drainwater collected from the reuse areas. Se concentrations in the conveyed drainwater would vary. A portion of this open canal segment passes near or through Federal and State refuges and wildlife areas, presenting additional exposure risk.

Due to elevated Se concentrations in soil, operation of the reuse areas could increase the risk of Se exposure for some terrestrial species (e.g., seed- and insect-eating species and the larger species that prey on them), potentially resulting in significant effects (see Section 8.2.4.1).

8.2.9.2 Aquatic Resources

Predicted 6-month average bivalve tissue concentrations throughout the Bay-Delta Estuary for the Delta-Chipps Island Disposal Alternative are presented on Figures 8-4 (native species) and 8-5 (exotic species–Asian clam). In addition to predicted concentrations, the incremental change from baseline conditions is also shown on these figures. Predictions for all scenarios are shown based on bioaccumulation from Se adsorbed to SPM using a BSAF of 4.2 for native species and a BSAF of 12.6 for the Asian clam.

SPM Se concentrations are believed to be the best predictor of bivalve tissue Se concentrations. As would be expected, the most highly affected area under the Delta-Chipps Island Disposal Alternative discharge scenario is the North Bay, where average Se concentrations in tissue are predicted to be approximately 9 percent higher than the concentrations under baseline conditions (Tables 8-5 and 8-6).

Table 8-5
Mean Predicted Native Bivalve Tissue Selenium Concentration (June-November)

Area Name	Bioaccumulation (mg/kg)		
	Baseline Conditions	Chipps Island Discharge Predictions	Carquinez Strait Discharge Predictions
North Bay	1.57	1.71	1.61
San Pablo Bay	1.83	1.88	1.92
Central Bay	1.93	2.01	2.04
South Bay	2.20	2.22	2.23

Table 8-6
Mean Predicted Exotic Bivalve Tissue Selenium Concentration (June-November)

Area Name	Bioaccumulation (mg/kg)		
	Baseline Conditions	Chipps Island Discharge Predictions	Carquinez Strait Discharge Predictions
North Bay	4.71	5.12	4.82
San Pablo Bay	5.50	5.64	5.76
Central Bay	5.78	6.02	6.11
South Bay	6.60	6.65	6.69

Under the Delta-Chipps Island Disposal Alternative, the highest predicted average native bivalve concentrations are well under 4 mg/kg. These concentrations are not expected to result in significant toxicity to upper trophic level receptors. However, it should be noted that these comparisons are general and that localized effects have the potential to occur at areas with the highest Se concentrations, especially if the more bioavailable forms of Se are present. As shown on Figure 8-4, the largest increment in Se tissue concentrations occurs closest to the discharge point, where average Se concentrations in native species over the 6-month period are predicted to increase by approximately 0.18 to 0.26 mg/kg. To determine the worst-case increase in Se tissue concentrations in native species at this location, the maximum 30-day average was calculated, as shown on Figure 8-6. The maximum predicted 30-day average Se concentration is less than 2.2 mg/kg, with a maximum increase of 0.24 mg/kg as compared to baseline conditions. The 30-day spatial average over the discharge area (as shown on Figure 8-2) is 2.01 mg/kg (see Table 8-7).

Table 8-7
Mean Predicted Native Bivalve Tissue Selenium Concentration (Maximum 30-day Average)

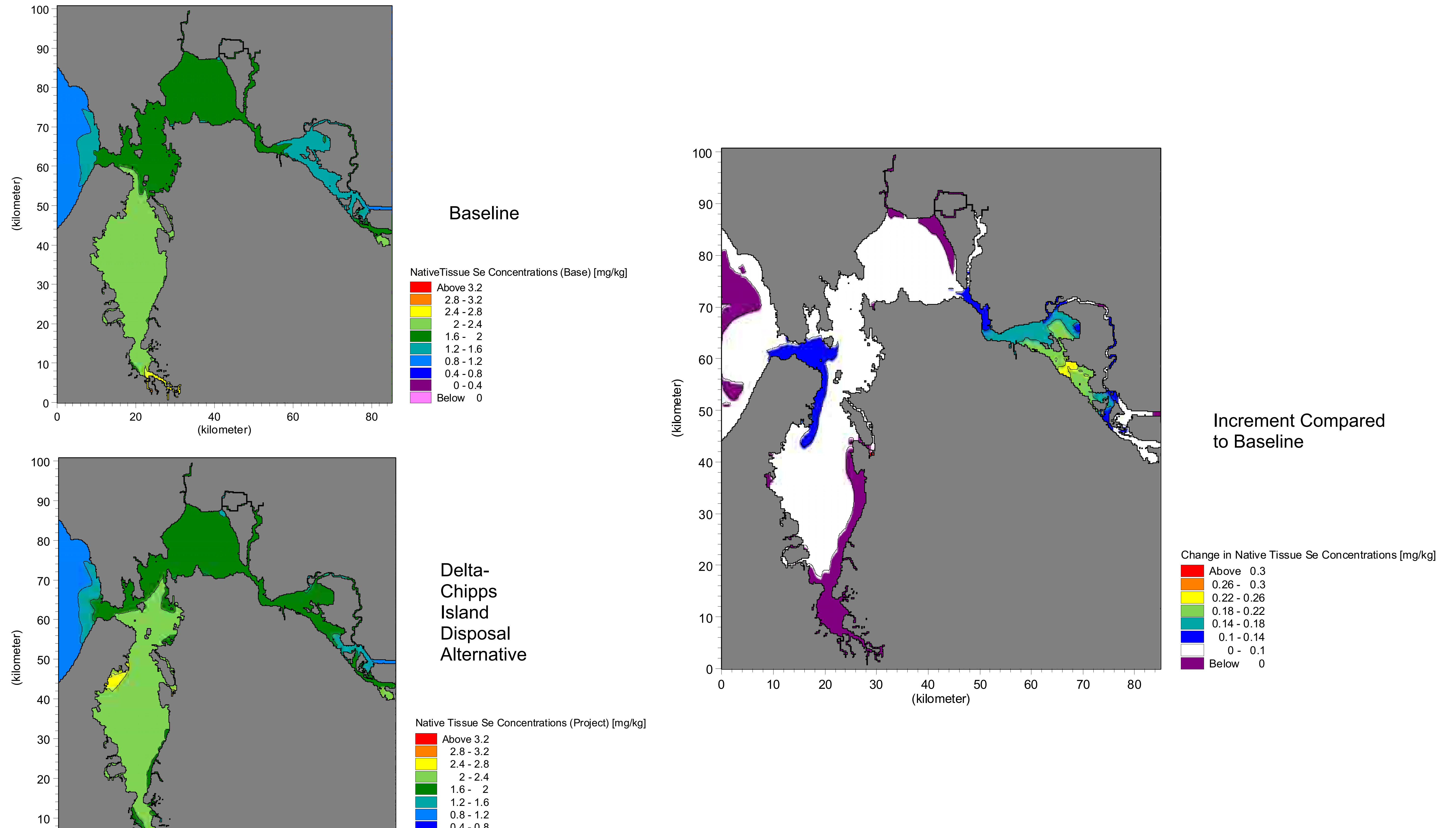
Area Name	Bioaccumulation (mg/kg)		
	Baseline Conditions	Chipps Island Discharge Predictions	Carquinez Strait Discharge Predictions
Chipps Discharge Area (See Figure 8-2)	1.83	2.01	---
Carquinez Discharge Area (See Figure 8-3)	1.97	---	2.07

A BSAF of 12.6 was used to predict Se tissue concentrations in the Asian clam over the same areas and same time frame. Results for the 6-month period indicate that Se concentrations in Asian clams in the South Bay could reach as high as 8 mg/kg in the South Bay and 7 mg/kg in the North Bay. As shown on Figure 8-5, the largest increase in Se tissue concentrations occurs closest to the discharge point, where average Se concentrations in exotic species over the 6-month period are predicted to increase by approximately 0.5 to 0.7 mg/kg. To determine the worst-case increase in Se tissue concentrations in exotic species at this location, the maximum 30-day average was calculated, as shown on Figure 8-2. The maximum predicted 30-day average Se concentration is 6.4 to 6.7 mg/kg, with a maximum increase of 0.7 mg/kg as compared to baseline conditions. The 30-day spatial average over the discharge area (as shown on Figure 8-2) is 6.04 mg/kg (see Table 8-8).

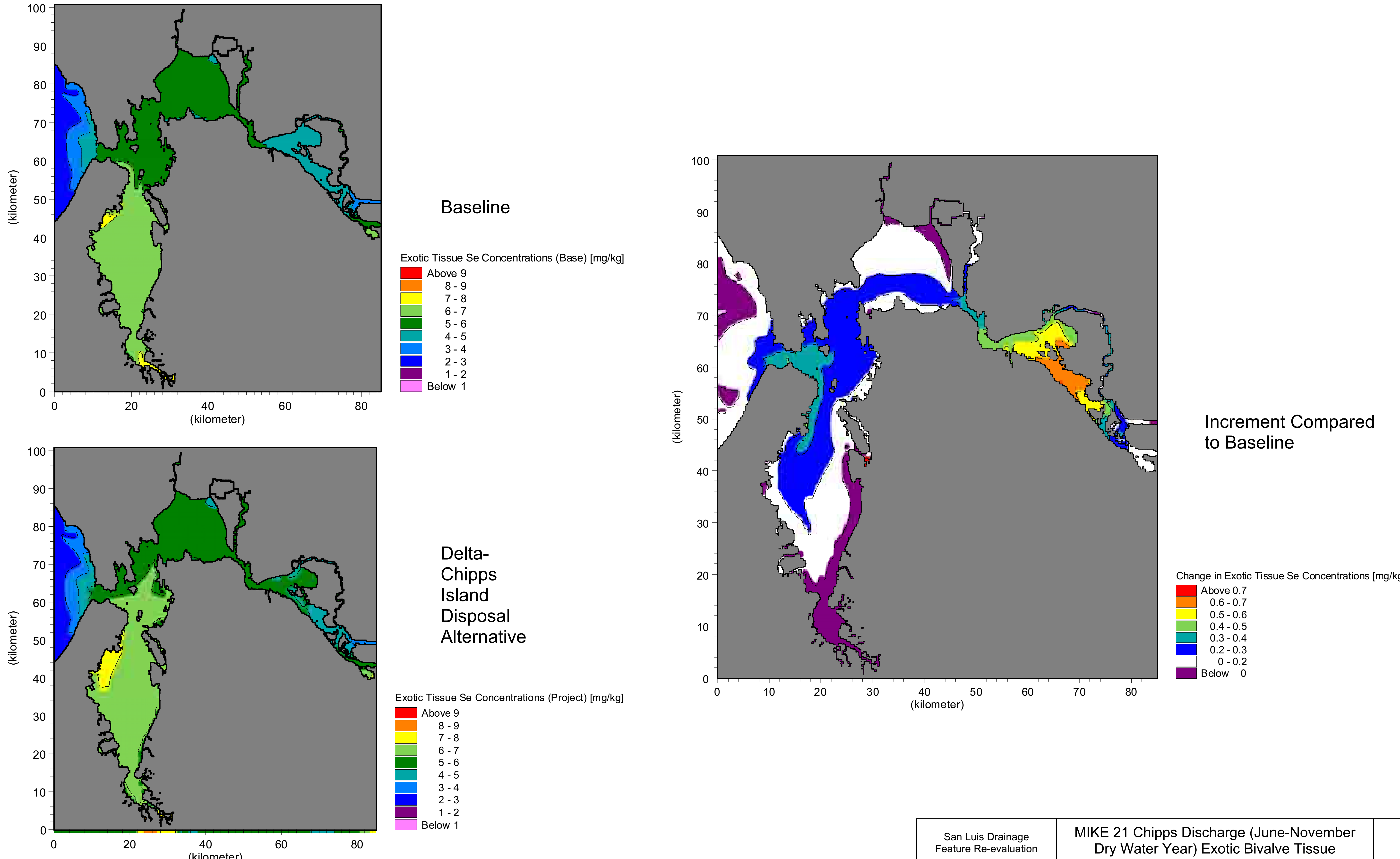
Table 8-8
Mean Predicted Exotic Bivalve Tissue Selenium Concentration (Maximum 30-day Average)

Area Name	Bioaccumulation (mg/kg)		
	Baseline Conditions	Chipps Island Discharge Predictions	Carquinez Strait Discharge Predictions
Chipps Discharge Area (See Figure 8-2)	5.50	6.04	---
Carquinez Discharge Area (See Figure 8-3)	5.92	---	6.22

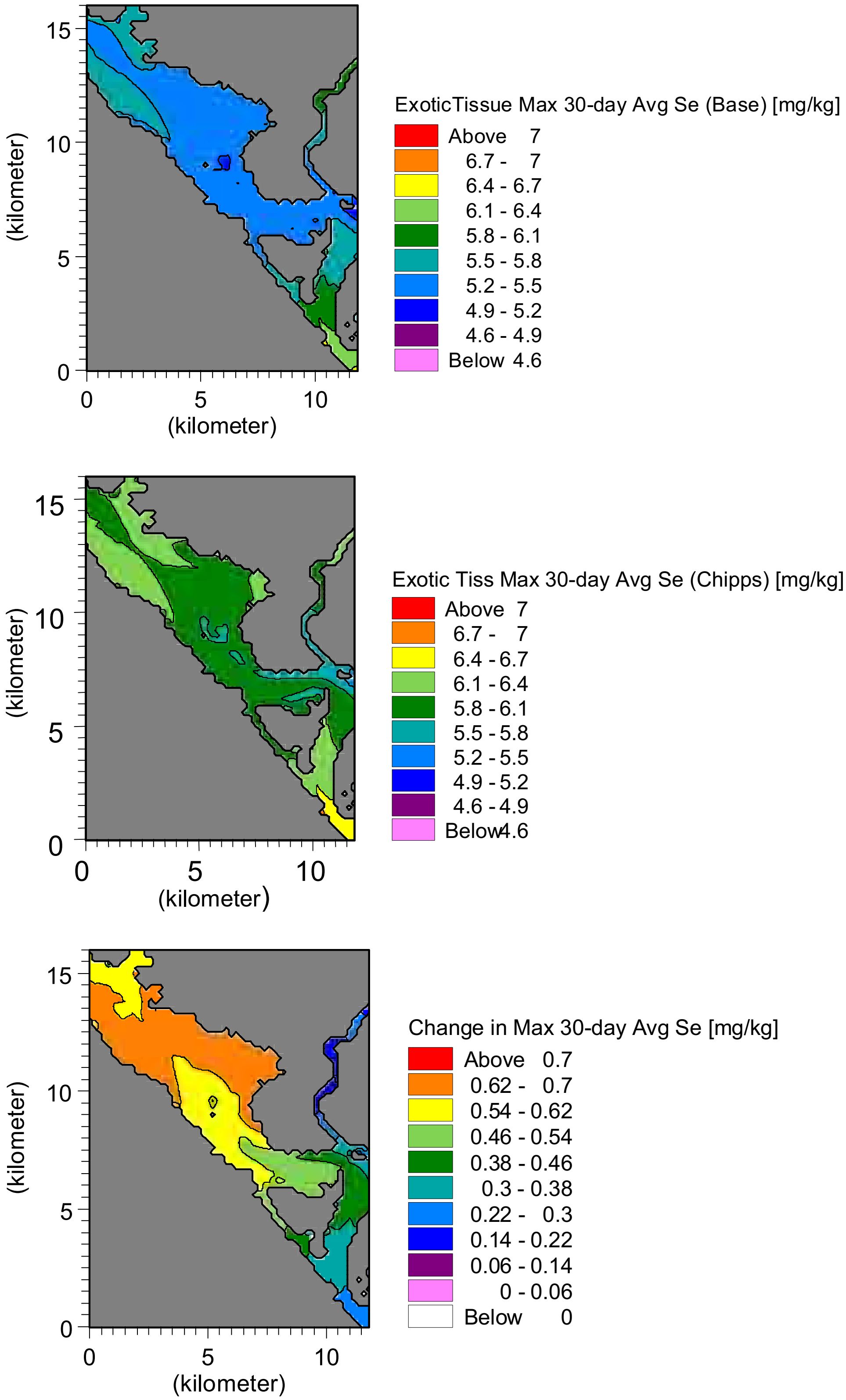
If Se tissue concentrations in *P. amurensis* are consistently higher than those in other benthic organisms, and if this species comprises a substantial fraction of the food of upper-trophic-level receptors, it is possible that the toxicity threshold of 4 mg/kg may be exceeded even under baseline conditions. As discussed in Section 8.1.4, data indicate that Asian clams do compose a large part of the diet of certain species of birds such as the surf scoter, lesser scaup, and greater scaup, in the North Bay, as well as some species of fish such as white sturgeon and Sacramento splittail. The predicted invertebrate concentrations exceed the threshold for adverse reproductive effects (4 mg/kg) for baseline conditions as well as for the Delta-Chipps Island Disposal Alternative. The threshold for increased adult mortality (10 mg/kg Se; see Appendix G) is not



San Luis Drainage Feature Re-evaluation	MIKE 21 Chipps Discharge (June-November Dry Water Year) Native Bivalve Tissue Selenium Concentration (mg/kg) Predicted Based on BSAF and Adsorbed Selenium	Figure 8-4
17324004		



San Luis Drainage Feature Re-evaluation 17324004	MIKE 21 Chipps Discharge (June-November Dry Water Year) Exotic Bivalve Tissue Selenium Concentration (mg/kg) Predicted Based on BSAF and Adsorbed Selenium	Figure 8-5



San Luis Drainage Feature Re-evaluation	MIKE 21 Chipps Discharge (June-November 1997) Maximum 30-Day Average Exotic Bivalve Tissue Selenium Concentration Near Discharge and Difference from Baseline Conditions	Figure 8-6
17324004		

predicted to be exceeded under the modeled conditions, although considerable variation in concentrations occurs under existing conditions, and some exceedances of this threshold are likely to occur under baseline conditions as well as project conditions.

To evaluate the significance of potential effects to shorebirds and fish that may feed primarily on the Asian clam in the most highly affected area near the discharge location, the decrease in projected reproductive success was estimated using toxicity data presented in Appendix G, Section G7.2.1.1. Assuming that the worst-case increase in dietary Se concentration would be from 6.0 to 6.7 mg/kg, the projected decrease in percent eggs hatched was calculated based on the following equation:

$$\text{Percent Eggs Hatched} = 150.2 - 84.06 * \exp(0.03547*[Se])$$

The percentage of eggs hatched is projected to decrease from approximately 46.2 to 43.6 percent, representing a decrease of approximately 5.7 percent, less than the 10 percent change that would be deemed a significant effect.

Similarly, the projected decrease in percentage survival of ducklings to 6 days of age was calculated based on the following equation:

$$\text{Percent Survival} = 105.8 - 5.058 * \exp(0.1901*[Se])$$

The survival of ducklings to 6 days of age is projected to decrease from approximately 90.0 to 87.7 percent, representing a decrease of approximately 2.6 percent from baseline conditions, less than the 10 percent change that would be deemed a significant effect.

The projected decrease in number of surviving 6-day-old ducklings produced per hen was calculated based on the following equation:

$$\text{Number of Ducklings} = 17.32 - 8.634 * \exp(0.04374*[Se])$$

The number of surviving 6-day-old ducklings produced per hen is projected to decrease from approximately 6.1 to 5.7 percent, representing a decrease of approximately 6.6 percent, less than the 10 percent change that would be deemed a significant effect.

Based on the above analysis, no significant effects are expected to occur to populations of shorebirds or fish feeding on the Asian clam or native invertebrates in the Bay-Delta Estuary. It should be noted that the toxicity data used to estimate reproductive effects to the potentially affected species of birds and fish are based on Se toxicity to mallard ducks. As discussed in Appendix G, available toxicity data indicate that mallards are more sensitive to Se than shorebirds are. In addition, uncertainty exists regarding the threshold of 10 percent reduction in reproduction as it relates to actual effects on the population of a given species. The true threshold for effects to the population of a given species would require considerable research to determine, and is dependent on multiple factors such as population size, reproduction rates, predation rates, and lifespan.

8.2.9.3 Special-Status Species

Table 7-4 identifies the listed special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by this alternative. This section identifies those special-status species that may be exposed to elevated Se concentrations due to implementation of the Delta-Chipps Island Disposal Alternative.

Operation of this alternative would be unlikely to affect the **bald eagle**, which would favor riparian and reservoir foraging areas with suitable hunting and roosting perches.

The **San Joaquin kit fox** could forage at several of the proposed reuse areas located nearest the eastern edges of the drainage areas, but would be less likely to utilize project sites that are more isolated within the surrounding agricultural landscape. Retirement of large contiguous tracts of cropland in the vicinity of the reuse areas, however, could create travel corridors to the interior sites, expanding potential kit fox foraging areas to include all reuse areas. Portions of the reuse facilities that would be planted in salt-tolerant grasses, grain crops, or permanent pasture could develop a substantial prey base and expose foraging kit fox to elevated Se in common dietary items such as insects, ground-nesting birds, and small mammals. The more intensively cropped portions of the reuse facilities would likely support less abundant prey than the areas planted in cover or pasture crops, or nearby nonirrigated parcels and refuge lands.

Operation of reuse facilities also could adversely affect the **Swainson's hawk** and **greater sandhill crane**. While both species would also be attracted to grasslands, irrigated pasture, and other suitable croplands (including retired lands converted to dryland farming or grazing land), this alternative's reuse areas also would provide attractive foraging habitat, exposing foraging individuals to elevated Se in seeds, grains, worms, insects, and small mammals.

The **California black rail** and the **western yellow-billed cuckoo** would not be affected. Habitat types (emergent marshlands and riparian forest, respectively) utilized by these species would not be affected by operation of any Delta-Chipps Island Disposal Alternative facility.

Burrowing owl colonies occupying the existing San Luis Drain would not be affected by operation of portions of the collection system located within the Drain's ROW if appropriate operating rules and conservation measures are included in a proposed burrowing owl management plan that would be developed for the Drain. This species typically does not nest in areas of heavy vegetation, so it is unlikely to nest in the reuse areas.

The **giant garter snake** and **California red-legged frog** would not be adversely affected by Se bioaccumulation under this alternative. These species, however, could indirectly benefit from a general improvement in water quality in Mud Slough and other Grasslands area waterways.

The **Delta smelt** is known to breed in or migrate through the Delta in the vicinity of the Chipps Island outfall. Presumably, the species could forage near the outfall where elevated Se in the discharge could contaminate or bioaccumulate in prey species or other dietary items. For the Delta smelt, portions of the Bay-Delta in the vicinity of the proposed outfall location have been formally designated by the Service and National Marine Fisheries Service as Critical Habitat, thus requiring special consideration in avoiding any adverse modifications to the species' habitat. However, this species feeds primarily on zooplankton and is unlikely to forage significantly on Asian clams. Juvenile Chinook salmon and steelhead feed primarily on plankton and aquatic invertebrates, while adults feed primarily on fish. Individuals of these species are unlikely to spend long periods of time near the discharge location, but would migrate through the area. No significant effects to this species are expected to occur due to Se bioaccumulation.

Although no evidence indicates that **Chinook salmon** or **steelhead ESUs**, **Delta smelt** would be affected by Se concentrations, white sturgeon are known to accumulate Se at higher concentrations than other fish. There is little information to indicate whether **green sturgeon** would be likely to feed on Asian clams in the vicinity of the discharge location for extended periods of time. In the absence of better information, it is assumed that this species may experience significant adverse effects due to Se bioaccumulation.

8.2.9.4 Human Health

As described in Section 8.2.9.2, data indicate that Asian clams (which tend to accumulate Se at higher concentrations than other organisms) compose a large part of the diet of certain species of birds such as the surf scoter, lesser scaup, and greater scaup, in the North Bay, as well as some species of fish such as white sturgeon. Because public health advisories for waterfowl consumption are already in effect for the Bay-Delta, it is conservatively assumed that any significant increase in Se concentrations in tissue of ducks within recreational populations could result in significant effects to human health. Because Se concentrations in the Asian clam are expected to increase significantly as a result of the Delta-Chipps Island Disposal Alternative, it is expected that Se concentrations in the ducks such as scoters and scaup, and fish such as the white sturgeon would also increase significantly, and significant effects to human health could result if individuals are consuming affected species in large enough quantities during sensitive life.

8.2.10 Delta-Carquinez Strait Disposal Alternative

8.2.10.1 Terrestrial Resources

Operation of the Delta-Carquinez Strait aqueduct and buried collection system would not significantly affect terrestrial resources. Buried collection pipelines and aqueduct segments would not expose wildlife to Se-contaminated drainwater. The aqueduct's approximately 73 miles of open canal segments between the biotreatment plant and the discharge at the Carquinez Strait could create a small risk of Se exposure for some species; however, the relatively small concrete-lined structure (normal capacity of 29.1 cfs) would not be particularly attractive to wildlife and would carry only treated drainwater (Se concentration of 10 ppb or less). Furthermore, at least 45.6 miles of the 73 miles of open canal segments that would convey treated drainwater would be located in developed urban and agricultural areas where wildlife exposure would be limited and natural habitat would not be bisected.

The remaining open canal segments, comprised of the southern 56 miles of the existing San Luis Drain and the valley collection canal, would convey untreated drainwater collected from the reuse areas to the treatment facility. Se concentrations in the conveyed drainwater would vary. A portion of this open canal segment passes near or through Federal and State refuges and wildlife areas, presenting additional exposure risk. The potential risk of Se exposure associated with use of the existing Drain segments in these areas would be evaluated and strategies devised to reduce or eliminate identified hazards.

Due to elevated Se concentrations in soil, operation of these reuse areas could increase the risk of Se exposure for some terrestrial species (e.g., seed- and insect-eating species and the larger species that prey on them), potentially resulting in significant effects.

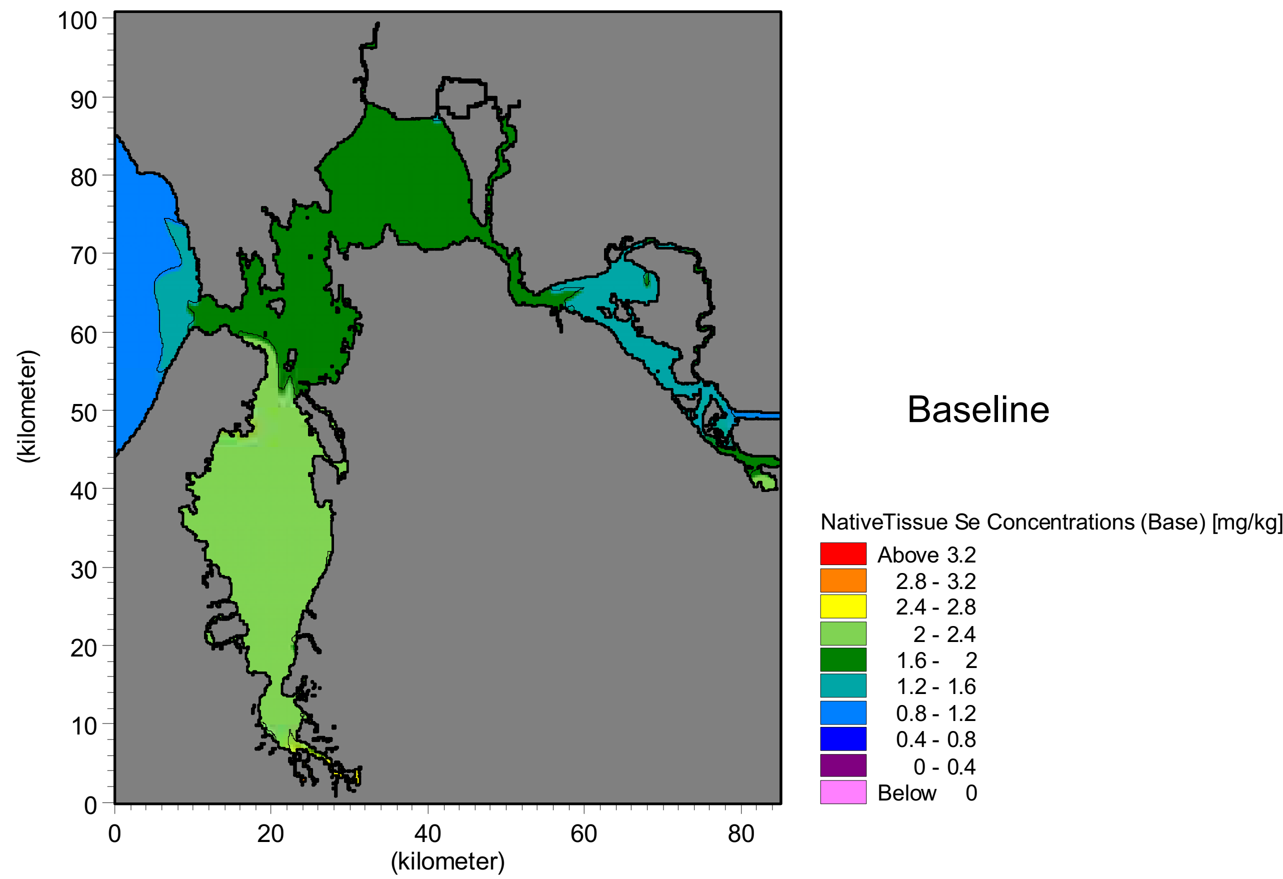
8.2.10.2 Aquatic Resources

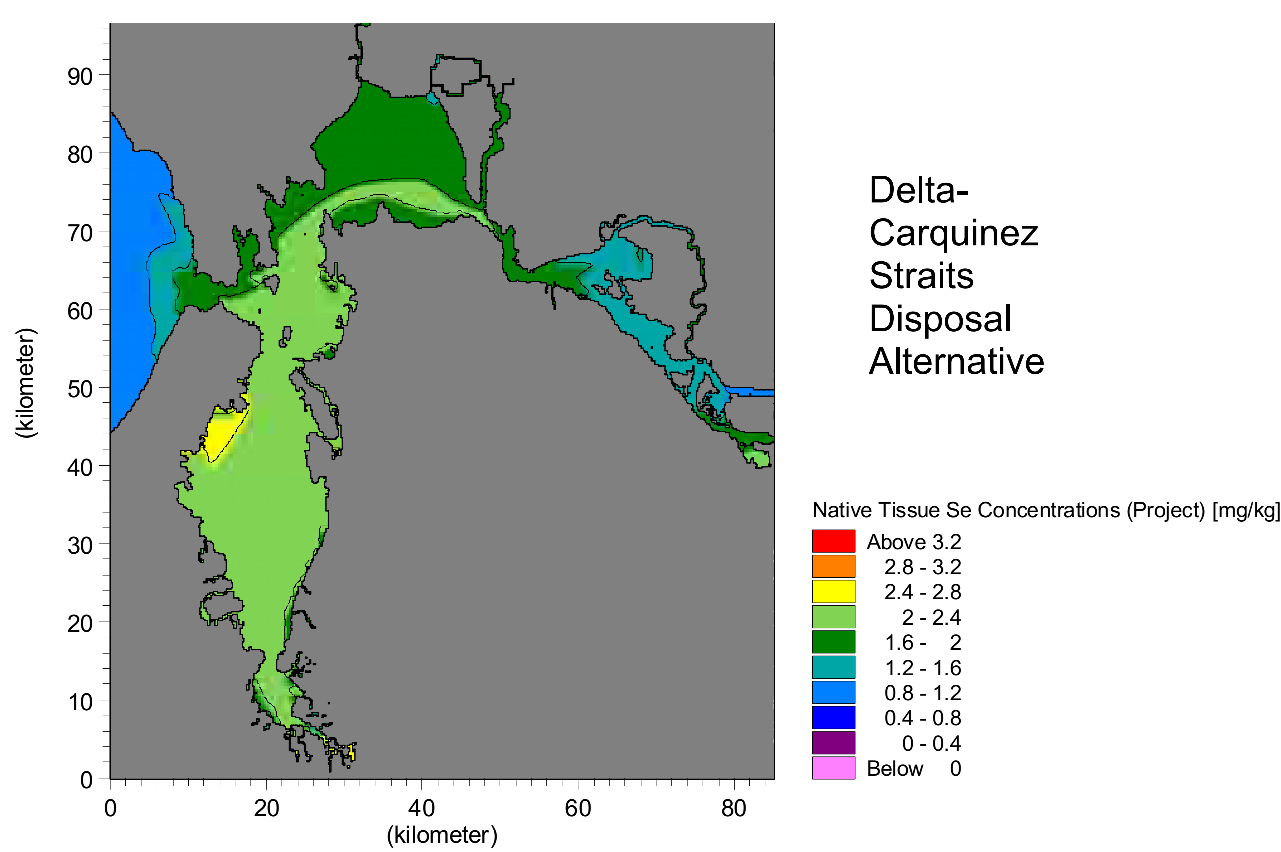
Predicted 6-month average bivalve tissue concentrations throughout the Bay-Delta Estuary for the Delta-Carquinez Strait Disposal Alternative are presented on Figures 8-7 (native species) and 8-8 (exotic species–Asian clam). In addition to predicted concentrations, the incremental change from No Action Alternative conditions is also shown on these figures. Predicted spatial averages of 6-month average Se concentrations in bivalve tissue are presented in Tables 8-5 (native species) and 8-6 (exotic species–Asian clam). Predictions for all scenarios are shown based on bioaccumulation from Se adsorbed to SPM using a BSAF of 4.2 for native species and a BSAF of 12.6 for the Asian clam.

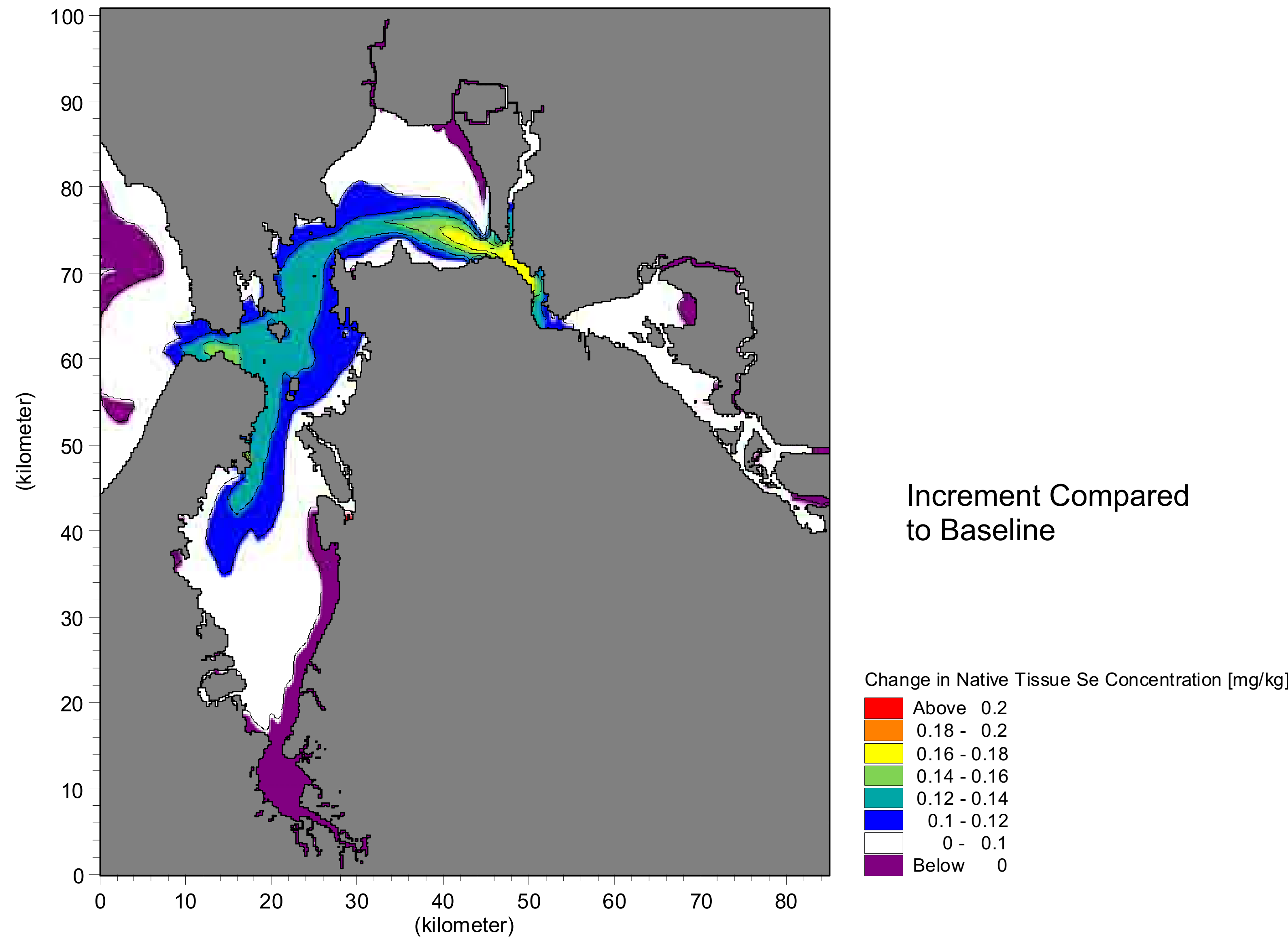
The most highly affected area under the Delta-Carquinez Strait Disposal Alternative discharge scenario is the North Bay, where average Se concentrations in tissue are predicted to be approximately 6 percent higher than the concentrations under baseline conditions (Tables 8-5 and 8-6).

Under the Delta-Carquinez Strait Disposal Alternative, the highest predicted average native bivalve concentrations are well under 4 mg/kg. These concentrations are not expected to result in significant toxicity to upper trophic level receptors. However, it should be noted that these comparisons are general and that localized effects have the potential to occur at areas with the highest Se concentrations, especially if the more bioavailable forms of Se are present. As shown on Figure 8-7, the largest increment in Se tissue concentrations occurs closest to the discharge point, where average Se concentrations in native species over the 6-month period are predicted to increase by up to 0.18 mg/kg. To determine the worst-case increase in Se tissue concentrations in native species at this location, the maximum 30-day average was calculated, as shown on Figure 8-3. The maximum predicted 30-day average Se concentration is less than 2.3 mg/kg, with a maximum increase of 0.19 mg/kg as compared to baseline conditions. The 30-day spatial average over the discharge area (as shown on Figure 8-3) is 2.07 mg/kg (see Table 8-7).

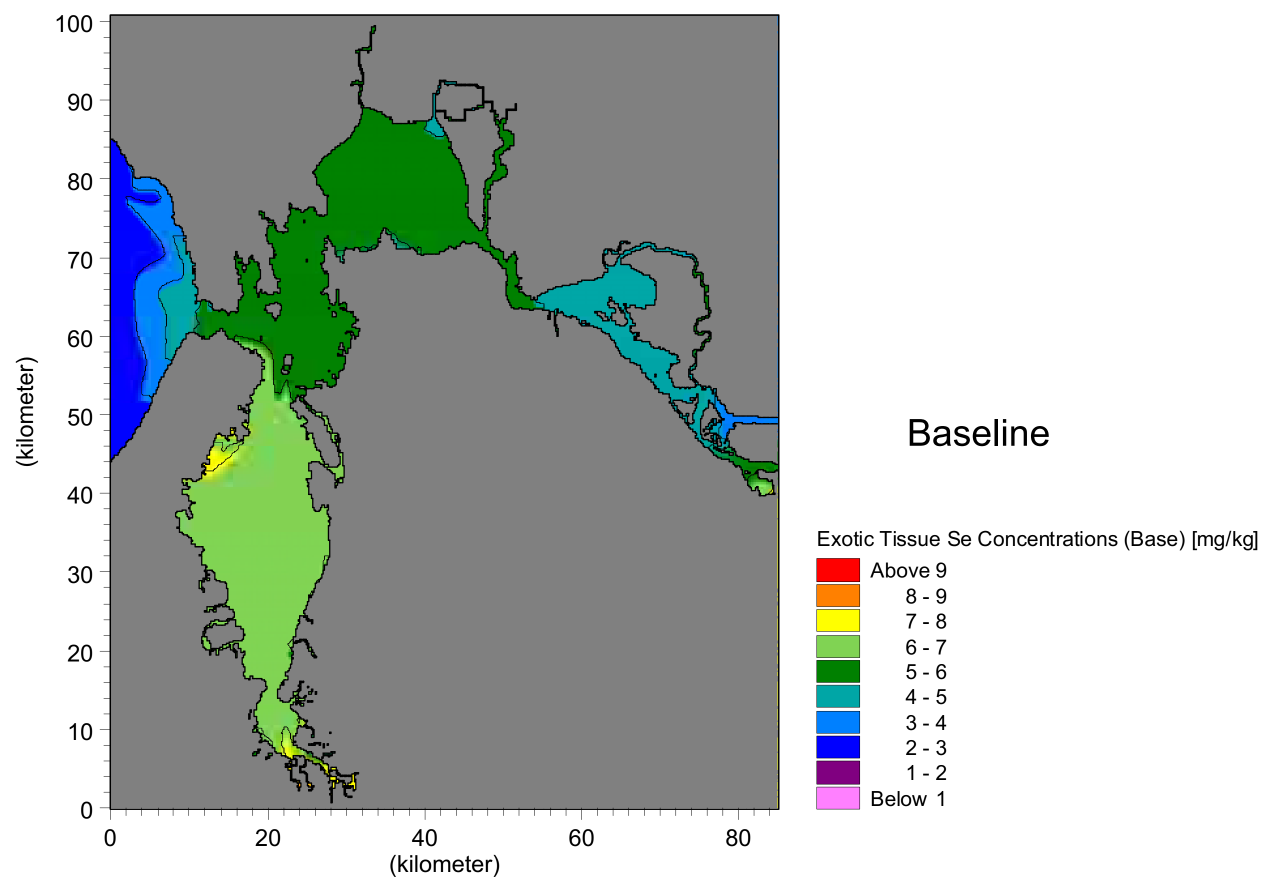
A BSAF of 12.6 was used to predict Se tissue concentrations in the Asian clam over the same areas and same time frame. Results for the 6-month period indicate that Se concentrations in Asian clams in the South Bay could reach as high as 8 mg/kg in the South Bay and 7 mg/kg in the North Bay. As shown on Figure 8-8, the largest increase in Se tissue concentrations occurs closest to the discharge point, where average Se concentrations in native species over the 6-month period are predicted to increase by up to 0.6 mg/kg. To determine the worst-case increase in Se tissue concentrations in exotic species at this location, the maximum 30-day average was calculated, as shown on Figure 8-9. The maximum predicted 30-day average Se concentration is 6.7 to 7 mg/kg, with a maximum increase of 0.55 mg/kg as compared to baseline conditions. The 30-day spatial average over the discharge area (as shown on Figure 8-9) is 6.22 mg/kg (see Table 8-8).

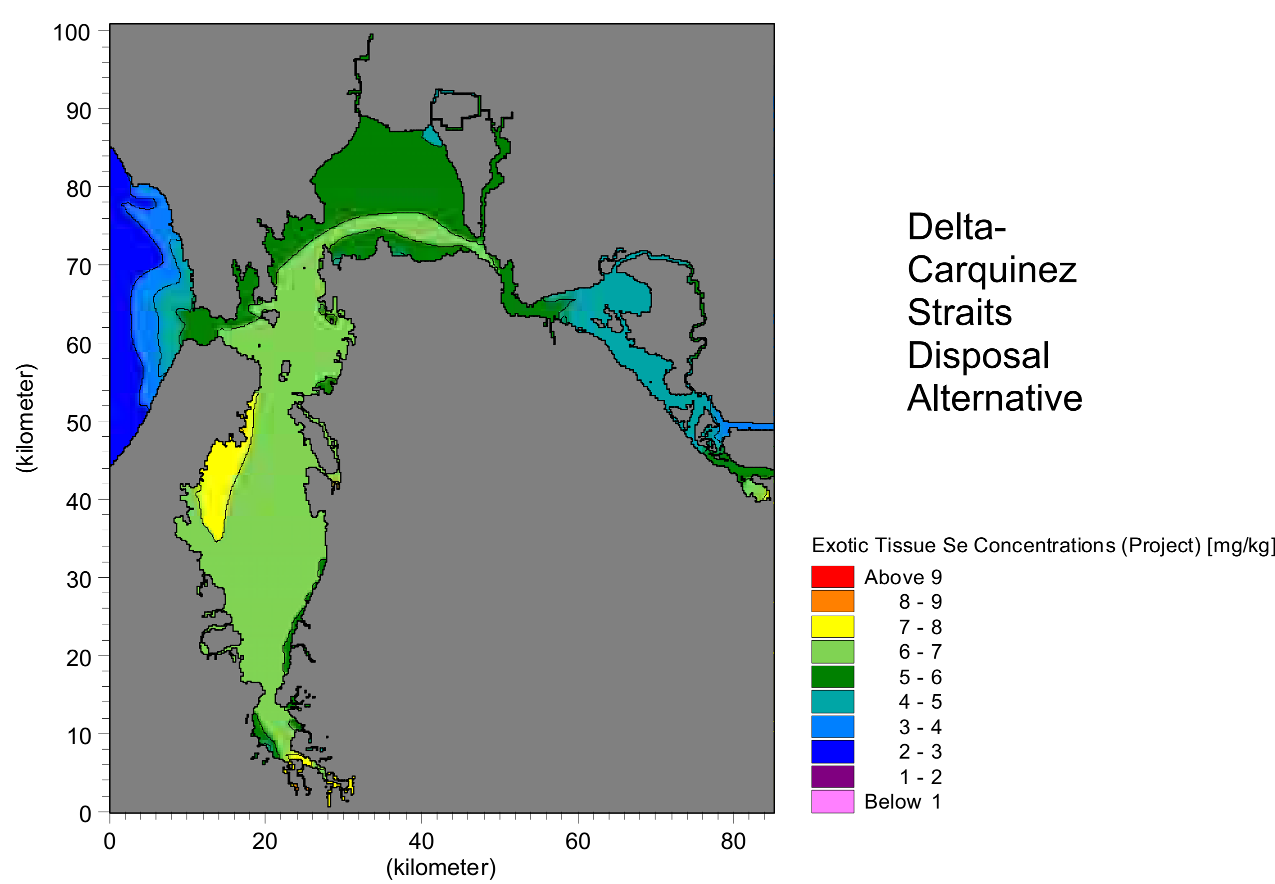


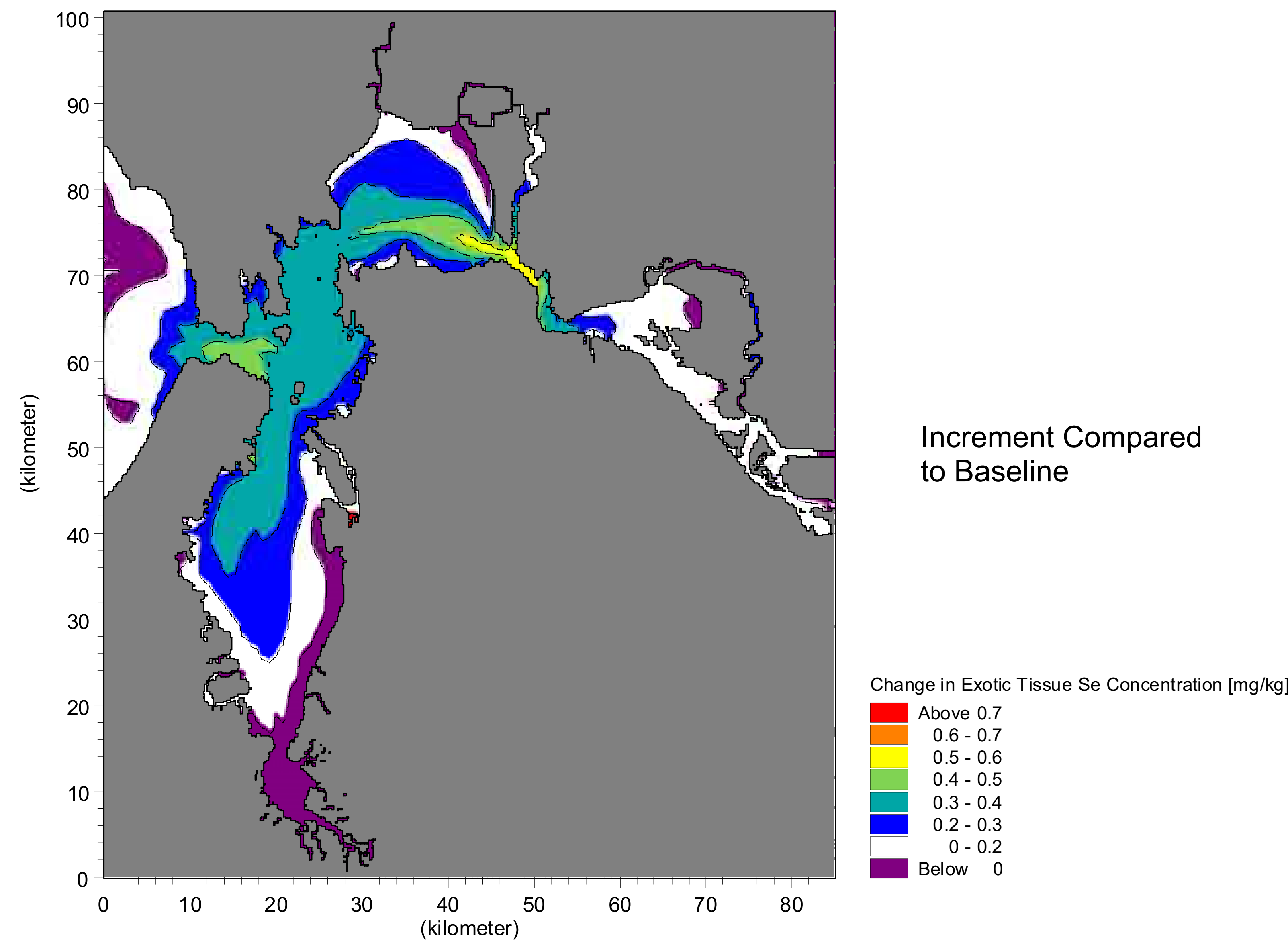




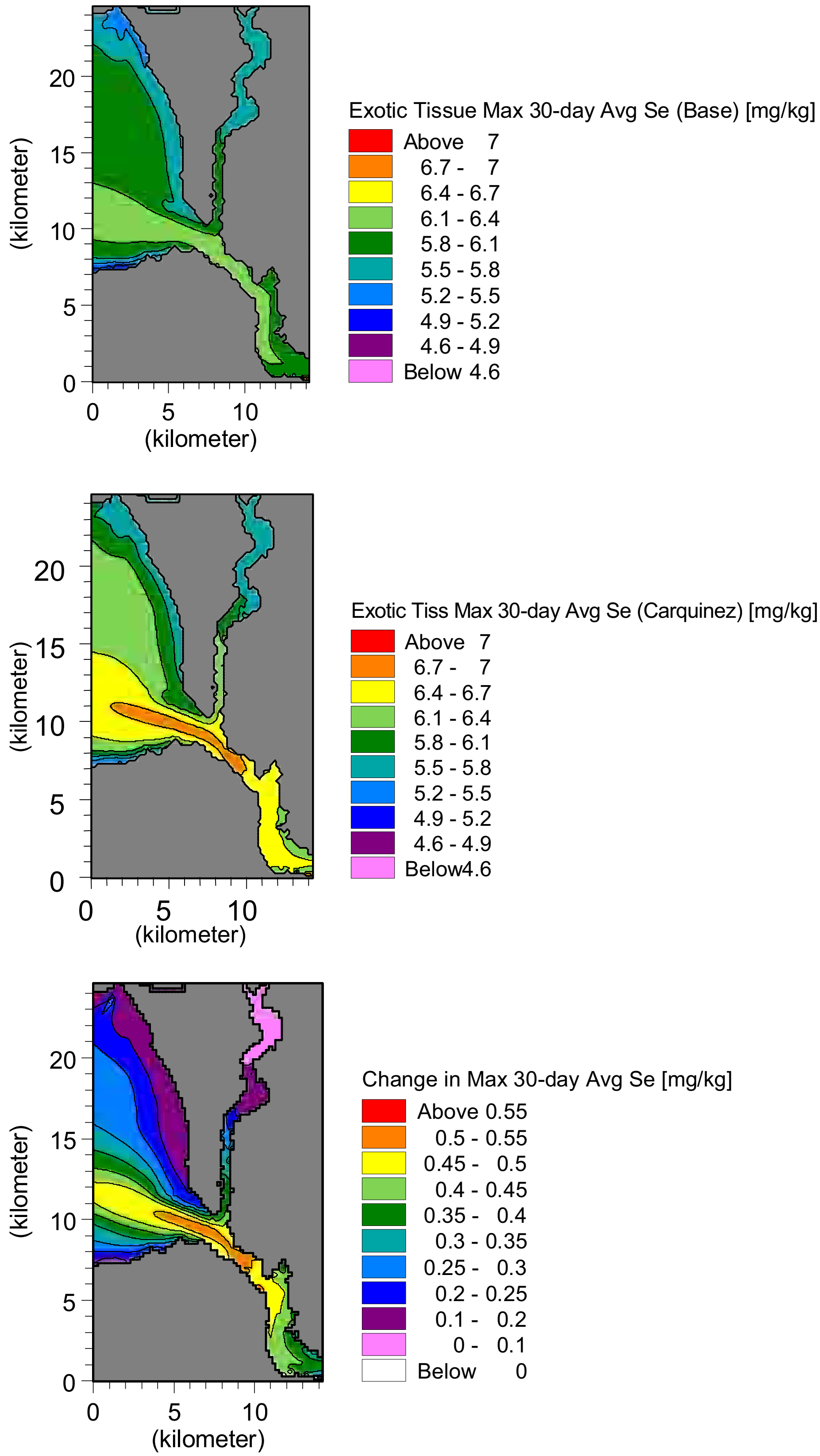
San Luis Drainage Feature Re-evaluation	MIKE 21 Carquinez Discharge (June-November Dry Water Year) Native Bivalve Tissue Selenium Concentration (mg/kg) Predicted Based on BSAF and Adsorbed Selenium	Figure 8-7
17324004		







San Luis Drainage Feature Re-evaluation	MIKE 21 Carquinez Discharge (June-November Dry Water Year) Exotic Bivalve Tissue Selenium Concentration (mg/kg) Predicted Based on BSAF and Adsorbed Selenium	Figure 8-8
17324004		



San Luis Drainage Feature Re-evaluation	MIKE 21 Carquinez Discharge (June-November 1997) Maximum 30-Day Average Exotic Bivalve Tissue Selenium Concentration Near Discharge and Difference from Baseline Conditions	Figure 8-9
17324004		

If Se tissue concentrations in *P. amurensis* are consistently higher than those in other benthic organisms, and if this species comprises a substantial fraction of the food of upper-trophic-level receptors, it is possible that the toxicity threshold of 4 mg/kg may be exceeded even under baseline conditions. As discussed in Section 8.1.4, data indicate that Asian clams do compose a large part of the diet of certain species of birds such as the surf scoter, lesser scaup, and greater scaup in the North Bay, as well as some species of fish such as white sturgeon and Sacramento splittail. The predicted invertebrate concentrations exceed the threshold for adverse reproductive effects (4 mg/kg) for baseline conditions as well as for the Delta-Carquinez Strait Disposal Alternative. The threshold for increased adult mortality (10 mg/kg Se; see Appendix G) is not predicted to be exceeded under the modeled conditions, although considerable variation in concentrations occurs under existing conditions, and some exceedances of this threshold are likely to occur under baseline conditions as well as project alternative conditions.

To evaluate the significance of potential effects to the shorebirds and fish that may feed primarily on the Asian clam in the most highly affected area near the discharge location, the decrease in projected reproductive success was estimated using toxicity data presented in Appendix G, Section G7.2.1.1. Assuming that the worst-case increase in dietary Se concentration would be from 6.45 to 7.0 mg/kg, the projected decrease in percent eggs hatched was calculated based on the following equation:

$$\text{Percent Eggs Hatched} = 150.2 - 84.06 * \exp(0.03547*[\text{Se}])$$

The percentage of eggs hatched is projected to decrease from approximately 44.5 to 42.4 percent, representing a decrease of approximately 4.8 percent, less than the 10 percent change that would be deemed a significant effect.

Similarly, the projected decrease in percentage survival of ducklings to 6 days of age was calculated based on the following equation:

$$\text{Percent Survival} = 105.8 - 5.058 * \exp(0.1901*[\text{Se}])$$

The survival of ducklings to 6 days of age is projected to decrease from approximately 88.6 to 86.7 percent, representing a decrease of approximately 2.2 percent from baseline conditions, less than the 10 percent change that would be deemed a significant effect.

The projected decrease in number of surviving 6-day-old ducklings produced per hen was calculated based on the following equation:

$$\text{Number of Ducklings} = 17.32 - 8.634 * \exp(0.04374*[\text{Se}])$$

The number of surviving 6-day-old ducklings produced per hen is projected to decrease from approximately 5.9 to 5.6 percent, representing a decrease of approximately 5.1 percent, less than the 10 percent change that would be deemed a significant effect.

Based on the above analysis, no significant effects are expected to occur to populations of shorebirds or fish feeding on the Asian clam or native invertebrates in the Bay-Delta Estuary.

It should be noted that the toxicity data used to estimate reproductive effects to the potentially affected species of birds and fish are based on Se toxicity to mallard ducks. As discussed in

Appendix G, available toxicity data indicate that mallards are more sensitive to Se than shorebirds are. In addition, uncertainty exists regarding the threshold of 10 percent reduction in reproduction as it relates to actual effects on the population of a given species. The true threshold for effects to the population of a given species would require considerable research to determine, and is dependent on multiple factors such as population size, reproduction rates, predation rates, and lifespan.

8.2.10.3 Special-Status Species

Table 7-5 identifies the listed special-status species that may be present, or that could occasionally utilize suitable habitat, in areas potentially affected by this alternative. This section identifies those special-status species that may be exposed to elevated Se concentrations due to implementation of the Delta-Carquinez Strait Disposal Alternative.

Operation of this alternative would be unlikely to affect the **bald eagle**, which would favor riparian and reservoir foraging areas with suitable hunting and roosting perches.

The **San Joaquin kit fox** could forage at several of the proposed reuse areas located nearest the eastern edges of the drainage areas, but would be less likely to utilize project sites that are more isolated within the surrounding agricultural landscape. Retirement of large contiguous tracts of cropland in the vicinity of the reuse areas, however, could create travel corridors to the interior sites, expanding potential kit fox foraging areas to include all reuse areas. Portions of the reuse facilities that would be planted in salt-tolerant grasses, grain crops, or permanent pasture could develop a substantial prey base and expose foraging kit fox to elevated Se in common dietary items such as insects, ground-nesting birds, and small mammals. The more intensively cropped portions of the reuse facilities would likely support less abundant prey than the areas planted in cover or pasture crops, or nearby nonirrigated parcels and refuge lands.

Operation of reuse facilities also could adversely affect the **Swainson's hawk** and **greater sandhill crane**. While both species would also be attracted to grasslands, irrigated pasture, and other suitable croplands (including retired lands converted to dryland farming or grazing land), this alternative's reuse areas also would provide attractive foraging habitat, exposing foraging individuals to elevated Se in seeds, grains, worms, insects, and small mammals.

The **California black rail** and the **western yellow-billed cuckoo** would not be affected. Habitat types (emergent marshlands and riparian forest, respectively) utilized by these species would not be affected by operation of any Delta-Carquinez Strait Disposal Alternative facility.

Burrowing owl colonies occupying the existing San Luis Drain would not be affected by operation of portions of the collection system located within the Drain's ROW if appropriate operating rules and conservation measures are included in a proposed burrowing owl management plan that would be developed for the Drain. This species typically does not nest in areas of heavy vegetation, so it is unlikely to nest in the reuse areas.

The **giant garter snake** and **California red-legged frog** would not be adversely affected by Se bioaccumulation under this alternative. These species, however, could indirectly benefit from a general improvement in water quality in Mud Slough and other Grasslands area waterways.

The **Delta smelt** is known to breed in or migrate through the Delta in the vicinity of the Carquinez Strait outfall. Presumably, the species could forage near the outfall where elevated Se in the discharge could contaminate or bioaccumulate in prey species or other dietary items. For the Delta smelt, portions of the Bay-Delta in the vicinity of the proposed outfall location have been formally designated by the Service and National Marine Fisheries Service as Critical Habitat, thus requiring special consideration in avoiding any adverse modifications to the species' habitat. However, this species feeds primarily on zooplankton and is unlikely to forage significantly on Asian clams. Juvenile Chinook salmon and steelhead feed primarily on plankton and aquatic invertebrates, while adults feed primarily on fish. Individuals of these species are unlikely to spend long periods of time near the discharge location, but would migrate through the area. No significant effects to this species are expected to occur due to Se bioaccumulation.

Although no evidence indicates that **Chinook salmon** or **steelhead ESUs**, **Delta smelt** would be affected by Se concentrations, white sturgeon are known to accumulate Se at higher concentrations than other fish. There is little information to indicate whether **green sturgeon** would be likely to feed on Asian clams in the vicinity of the discharge location for extended periods of time. In the absence of better information, it is assumed that this species may experience significant adverse effects due to Se bioaccumulation.

8.2.10.4 Human Health

As described in Section 8.2.10.2, data indicate that Asian clams (which tend to accumulate Se at higher concentrations than other organisms) compose a large part of the diet of certain species of birds such as the surf scoter, lesser scaup, and greater scaup, in the North Bay, as well as some species of fish such as white sturgeon. Because public health advisories for waterfowl consumption are already in effect for the Bay-Delta, it is conservatively assumed that any significant increase in Se concentrations in tissue of ducks within recreational populations could result in significant effects to human health. Because Se concentrations in the Asian clam are expected to increase significantly as a result of the Delta-Chipps Island Disposal Alternative, it is expected that Se concentrations in the ducks such as scoters and scaup, and fish such as the white sturgeon would also increase significantly, and significant effects to human health could result if individuals are consuming affected species in large enough quantities during sensitive life stages.

8.2.11 Cumulative Effects

The In-Valley Alternatives that include evaporation basins would likely contribute to Se bioaccumulation by birds within the San Joaquin Valley. When this contribution of up to 3,300 acres (not significant by itself with mitigation) is combined with the effects of other existing evaporation basins (4,000 acres) within the San Joaquin Valley, these incremental effects could contribute to a significant cumulative adverse effect to birds within the valley from approximately 7,300 total acres of evaporation basins.

For both of the Delta Disposal Alternatives, changes in Se bioaccumulation are primarily dependent on changes in surface water quality. As discussed in Section 5.2.12, cumulative effects on water quality from other ongoing projects were included in the evaluation of the action alternatives. For future projects, such as implementation of TMDLs for Se in the San Joaquin River Basin, it was assumed that required actions needed to comply with discharge requirements would be taken. Therefore, the cumulative effects of future projects to comply with TMDLs were included in the analysis. In addition, flows planned under the VAMP were included in the analysis. Other programs relevant to water quality in the Bay-Delta include the CALFED Bay-Delta Program, Interim South Delta Program, SJVDIP, and CVPIA. Implementation of these programs is expected to reduce Se concentrations in surface waters of the Bay-Delta. Therefore, no additional Se bioaccumulation is expected to occur in combination with the increased Se bioaccumulation due to the Delta-Chipps Island Disposal Alternative or the Delta-Carquinez Straits Disposal Alternative. No significant cumulative Se bioaccumulation effects are expected to occur if either of these alternatives is implemented.

For the Ocean Disposal Alternative, existing discharges in the Point Estero vicinity are described in Section 5.1.4. No new sources of Se discharges are currently proposed in this vicinity. Cumulative effects are not expected to occur, because mixing zones for the Ocean Disposal Alternative discharge location and existing discharge locations are not expected to overlap and Se is not known to be a compliance or environmental issue with these discharges.

Due to elevated Se concentrations in soil, operation of the reuse areas could increase the risk of Se exposure for some terrestrial species (e.g., seed- and insect-eating species and the larger species that prey on them), potentially resulting in significant effects under operation of any of the action alternatives. Therefore, significant cumulative effects to terrestrial resources would be expected to occur under any of the alternatives.

8.2.12 Environmental Effects Summary

The following sections and tables summarize the evaluation of effects relative to baseline conditions which are used to represent both existing conditions and the No Action Alternative.

8.2.12.1 No Action Alternative

- It is anticipated that adverse effects to surface water quality in the San Joaquin Valley wetlands would occur under the No Action Alternative relative to existing conditions due to seepage into wetland channels. Therefore, because Se bioaccumulation is primarily dependent on water quality, potentially adverse effects to aquatic receptors related to changes in Se bioaccumulation are anticipated to occur in the San Joaquin Valley and the Bay-Delta under the No Action Alternative. Special-status species affected may include the giant garter snake and California red-legged frog.

8.2.12.2 In-Valley Disposal Alternative

- Predicted mean Se concentrations in dietary tissue exceed the effects threshold of 4 mg/kg for all four evaporation basins during the breeding season. Therefore, significant effects to birds using the evaporation basins would be expected to occur under the unmitigated alternative. Potential adverse effects include decreased reproduction and development, as well as direct mortality. With successful mitigation, the effect would be reduced to not significant.
- Operation of the In-Valley Disposal facilities may adversely affect San Joaquin kit fox, Swainson’s hawks, and wintering greater sandhill cranes (at proposed reuse areas); and California least tern and American peregrine falcons (at evaporation basins) by increasing potential exposure to elevated Se in preferred dietary items. Any taking under ESA/CESA would be considered a significant effect. Avoidance and mitigation measures for these upland species would reduce, but may not entirely eliminate, the potential for Se

bioaccumulation. Additional studies and monitoring would be needed, and Section 7 consultation with the Service is required.

- The In-Valley Disposal Alternative would continue to reduce uncontrolled seepage of Se-contaminated drainwater into the San Joaquin River, as well as into drainage ditches, canals (including the Delta-Mendota Canal), and other waterways (e.g., Mud Slough), thus improving the water quality in habitats potentially used by the giant garter snake and California red-legged frog. The incremental reduction in Se load in the lower San Joaquin River and the Bay-Delta resulting from implementation of the In-Valley Disposal Alternative may benefit Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon.

8.2.12.3 In-Valley/Groundwater Quality Land Retirement Alternative

- Although predicted mean Se concentrations in migratory bird dietary tissue in evaporation basins were not quantitatively evaluated, they are expected to be similar to those predicted under the In-Valley Disposal Alternative, and would exceed the effects threshold of 4 mg/kg for all four evaporation basins during the breeding season. Therefore, significant effects to birds using the evaporation basins would be expected to occur under the unmitigated alternative.
- Operation of the In-Valley/Groundwater Quality Land Retirement Disposal facilities may adversely affect San Joaquin kit fox, Swainson's hawks, and wintering greater sandhill cranes (at proposed reuse areas); and California least tern and American peregrine falcons (at evaporation basins) by increasing potential exposure to elevated Se in preferred dietary items. Any taking under ESA/CESA would be considered a significant effect. Avoidance and mitigation measures for these upland species would reduce, but may not entirely eliminate, the potential for Se bioaccumulation. Additional studies and monitoring would be needed, and Section 7 consultation with the Service is required.
- This alternative would continue to reduce uncontrolled seepage of Se-contaminated drainwater into the San Joaquin River, as well as into drainage ditches, canals (including the Delta-Mendota Canal), and other waterways (e.g., Mud Slough), thus improving the water quality in habitats potentially used by the giant garter snake and California red-legged frog. The incremental reduction in Se load in the lower San Joaquin River and the Bay-Delta resulting from implementation of the In-Valley/Groundwater Quality Land Retirement Alternative may benefit Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon.

8.2.12.4 In-Valley/Water Needs Land Retirement Alternative

- Although predicted mean Se concentrations in migratory bird dietary tissue in evaporation basins were not quantitatively evaluated, they are expected to be similar to those predicted under the In-Valley Disposal Alternative, and would exceed the effects threshold of 4 mg/kg for all four evaporation basins during the breeding season. Therefore, significant effects to birds using the evaporation basins would be expected to occur under the unmitigated alternative.
- Operation of the In-Valley/Water Needs Land Retirement Disposal facilities may adversely affect San Joaquin kit fox, Swainson's hawks, and wintering greater sandhill cranes (at

proposed reuse areas); and California least tern and American peregrine falcons (at evaporation basins) by increasing potential exposure to elevated Se in preferred dietary items. Any taking under ESA/CESA would be considered a significant effect. Avoidance and mitigation measures for these upland species would reduce, but may not entirely eliminate, the potential for Se bioaccumulation. Additional studies and monitoring would be needed, and Section 7 consultation with the Service is required.

- This alternative would continue to reduce uncontrolled seepage of Se-contaminated drainwater into the San Joaquin River, as well as into drainage ditches, canals (including the Delta-Mendota Canal), and other waterways (e.g., Mud Slough), thus improving the water quality in habitats potentially used by the giant garter snake and California red-legged frog. The incremental reduction in Se load in the lower San Joaquin River and the Bay-Delta resulting from implementation of the In-Valley/Water Needs Land Retirement Alternative may benefit Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon.

8.2.12.5 In-Valley/Drainage-Impaired Area Land Retirement Alternative

- Although predicted mean Se concentrations in migratory bird dietary tissue in evaporation basins were not quantitatively evaluated, they are expected to be similar to those predicted under the In-Valley Disposal Alternative, and would exceed the effects threshold of 4 mg/kg for all four evaporation basins during the breeding season. Therefore, significant effects to birds using the evaporation basins would be expected to occur under the unmitigated alternative.
- Operation of the In-Valley/Drainage-Impaired Land Retirement Disposal facilities may adversely affect San Joaquin kit fox, Swainson's hawks, and wintering greater sandhill cranes (at proposed reuse areas); and California least tern and American peregrine falcons (at evaporation basins) by increasing potential exposure to elevated Se in preferred dietary items. Any taking under ESA/CESA would be considered a significant effect. Avoidance and mitigation measures for these upland species would reduce, but may not entirely eliminate, the potential for Se bioaccumulation. Additional studies and monitoring would be needed, and Section 7 consultation with the Service is required.
- This alternative would continue to reduce uncontrolled seepage of Se-contaminated drainwater into the San Joaquin River, as well as into drainage ditches, canals (including the Delta-Mendota Canal), and other waterways (e.g., Mud Slough), thus improving the water quality in habitats potentially used by the giant garter snake and California red-legged frog. The incremental reduction in Se load in the lower San Joaquin River and the Bay-Delta resulting from implementation of the In-Valley/Drainage-Impaired Land Retirement Alternative may benefit Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon.

8.2.12.6 Ocean Disposal Alternative

- No significant increases in Se concentrations in surface water, sediments, or invertebrate tissue are predicted under this alternative. Therefore, no significant effects to aquatic resources due to Se bioaccumulation would be expected. Compared to both the No Action Alternative and baseline conditions, operation of the Ocean Disposal Alternative's Point

Estero discharge would result in a minor increase the risk of Se bioaccumulation in the general vicinity of the ocean outfall. However, the depth and offshore location of the diffuser would limit the exposure risk to not significant levels.

- Operation of the Ocean Disposal facilities may adversely affect San Joaquin kit fox, Swainson's hawks, and wintering greater sandhill cranes at proposed reuse areas by increasing potential exposure to elevated Se in preferred dietary items. Any taking under ESA/CESA would be considered a significant effect. Avoidance and mitigation measures for these upland species would reduce, but may not entirely eliminate, the potential for Se bioaccumulation. Additional studies and monitoring would be needed, and Section 7 consultation with the Service is required.
- This alternative would continue to reduce uncontrolled seepage of Se-contaminated drainwater into the San Joaquin River, as well as into drainage ditches, canals (including the Delta-Mendota Canal), and other waterways (e.g., Mud Slough), thus improving the water quality in habitats potentially used by the giant garter snake and California red-legged frog. The incremental reduction in Se load in the lower San Joaquin River and the Bay-Delta resulting from implementation of the Ocean Disposal Alternative may benefit Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon.

8.2.12.7 Delta-Chipps Island Disposal Alternative

- Under this alternative, the highest predicted average bivalve concentrations are well below 4 mg/kg. These concentrations are not expected to result in significant toxicity to upper trophic level aquatic receptors, including waterbirds. However, it should be noted that these comparisons are general, that localized effects have the potential to occur at areas with the highest Se concentrations, and that accumulation in certain species such as P. amurensis may be higher than indicated in this evaluation. If the green sturgeon is present in the affected area, this special-status species may experience significant adverse effects.
- Operation of the Delta-Chipps Island Disposal facilities may adversely affect San Joaquin kit fox, Swainson's hawks, and wintering greater sandhill cranes at proposed reuse areas by increasing potential exposure to elevated Se in preferred dietary items. Any taking under ESA/CESA would be considered a significant effect. Avoidance and mitigation measures for these upland species would reduce, but may not entirely eliminate, the potential for Se bioaccumulation. Additional studies and monitoring would be needed, and Section 7 consultation with the Service is required.
- This alternative would continue to reduce uncontrolled seepage of Se-contaminated drainwater into the San Joaquin River, as well as into drainage ditches, canals (including the Delta-Mendota Canal), and other waterways (e.g., Mud Slough), thus improving the water quality in habitats potentially used by the giant garter snake and California red-legged frog. The incremental reduction in Se load in the lower San Joaquin River and the Bay-Delta resulting from implementation of the Delta-Chipps Island Disposal Alternative may benefit Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon.

8.2.12.8 Delta-Carquinez Strait Disposal Alternative

- Under this alternative, the highest predicted average bivalve concentrations are well below 4 mg/kg. These concentrations are not expected to result in significant toxicity to upper trophic level receptors. However, it should be noted that these comparisons are general, that localized effects have the potential to occur at areas with the highest Se concentrations, and that accumulation in certain species such as *P. amurensis* may be higher than indicated in this evaluation. If the green sturgeon is present in the affected area, this special-status species may experience significant adverse effects.
- Operation of the Delta-Carquinez Strait Disposal facilities may adversely affect San Joaquin kit fox, Swainson's hawks, and wintering greater sandhill cranes at proposed reuse areas by increasing potential exposure to elevated Se in preferred dietary items. Any taking under ESA/CESA would be considered a significant effect. Avoidance and mitigation measures for these upland species would reduce, but may not entirely eliminate, the potential for Se bioaccumulation. Additional studies and monitoring would be needed, and Section 7 consultation with the Service is required.
- This alternative would continue to reduce uncontrolled seepage of Se-contaminated drainwater into the San Joaquin River, as well as into drainage ditches, canals (including the Delta-Mendota Canal), and other waterways (e.g., Mud Slough), thus improving the water quality in habitats potentially used by the giant garter snake and California red-legged frog. The incremental reduction in Se load in the lower San Joaquin River and the Bay-Delta resulting from implementation of the Delta-Carquinez Strait Disposal Alternative may benefit Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon.

Tables 8-9 through 8-16 summarize the results of the bioaccumulation analysis.

Table 8-9
Summary Comparison of Effects of No Action Alternative

Affected Resource and Area of Potential Effect	No Action Alternative Compared to Existing Conditions
Terrestrial Resources	
Population-level effects to terrestrial resources in the San Joaquin Valley	No effect.
Aquatic and Wetland Resources	
Population-level effects to aquatic resources (including waterbirds) in the Bay-Delta	Adverse effect.
Population-level effects to aquatic resources (including waterbirds) in the San Joaquin Valley	Potential adverse effect.
Population-level effects to aquatic resources (including waterbirds) in Morro Bay	No effect.
Federally Listed Special-Status Species	
Individual-level effects to Federally listed special-status species in the Bay Delta	No effect.
Individual-level effects to Federally listed special-status species in the San Joaquin Valley	Potential effects to the giant garter snake and California red-legged frog.
Individual-level effects to Federally listed special-status species in Morro Bay	No effect.
State-Listed Special-Status Species	
Individual-level effects to State-listed special-status species in the Bay Delta	No effect.
Individual-level effects to State-listed special-status species in the San Joaquin Valley	Potential effects to the giant garter snake and California red-legged frog.
Individual-level effects to State-listed special-status species in Morro Bay	No effect.

Table 8-10
Summary Comparison of Effects of In-Valley Disposal Alternative

Affected Resource and Area of Potential Effect	In-Valley Disposal Compared to No Action	In-Valley Disposal Compared to Existing Conditions
Terrestrial Resources		
Population-level effects to terrestrial resources in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Aquatic and Wetland Resources		
Population-level effects to aquatic resources (including waterbirds) in the Bay-Delta	No significant effect.	No effect.
Population-level effects to aquatic resources (including waterbirds) in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Population-level effects to aquatic resources (including waterbirds) in Morro Bay	No significant effect.	No effect.
Federally Listed Special-Status Species		
Individual-level effects to Federally listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to Federally listed special-status species in the San Joaquin Valley	Significant adverse effects to the San Joaquin kit fox and California least tern. Section 7 consultation has been completed.	Potential effects to the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in Morro Bay	No significant effect.	No effect.
State-Listed Special-Status Species		
Individual-level effects to State-listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to State-listed special-status species in the San Joaquin Valley	Significant adverse effects to the American peregrine falcon, Swainson's hawk, greater sandhill crane, San Joaquin kit fox, and California least tern. Potentially unavoidable.	Potential effects to the American peregrine falcon, Swainson's hawk, greater sandhill crane, and San Joaquin kit fox.
Individual-level effects to State-listed special-status species in Morro Bay	No significant effect.	No effect.

Table 8-11
Summary Comparison of Effects of
In-Valley/Groundwater Quality Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley Groundwater Quality Land Retirement Compared to No Action	In-Valley Groundwater Quality Land Retirement Compared to Existing Conditions
Terrestrial Resources		
Population-level effects to terrestrial resources in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Aquatic and Wetland Resources		
Population-level effects to aquatic resources (including waterbirds) in the Bay-Delta	No significant effect.	No effect.
Population-level effects to aquatic resources (including waterbirds) in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Population-level effects to aquatic resources (including waterbirds) in Morro Bay	No significant effect.	No effect.
Federally Listed Special-Status Species		
Individual-level effects to Federally listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to Federally listed special-status species in the San Joaquin Valley	Significant adverse effects to the San Joaquin kit fox and California least tern. Section 7 consultation has been completed.	Potential effects to the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in Morro Bay	No significant effect.	No effect.
State-Listed Special-Status Species		
Individual-level effects to State-listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to State-listed special-status species in the San Joaquin Valley	Significant adverse effects to the American peregrine falcon, Swainson’s hawk, greater sandhill crane, San Joaquin kit fox, and California least tern. Potentially unavoidable.	Potential effects to the American peregrine falcon, Swainson’s hawk, greater sandhill crane, and San Joaquin kit fox.
Individual-level effects to State-listed special-status species in Morro Bay	No significant effect.	No effect.

Table 8-12
Summary Comparison of Effects of
In-Valley/Water Needs Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Water Needs Land Retirement Compared to No Action	In-Valley/Water Needs Land Retirement Compared to Existing Conditions
Terrestrial Resources		
Population-level effects to terrestrial resources in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Aquatic and Wetland Resources		
Population-level effects to aquatic resources (including waterbirds) in the Bay-Delta	No significant effect.	No effect.
Population-level effects to aquatic resources (including waterbirds) in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Population-level effects to aquatic resources (including waterbirds) in Morro Bay	No significant effect.	No effect.
Federally Listed Special-Status Species		
Individual-level effects to Federally listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to Federally listed special-status species in the San Joaquin Valley	Significant adverse effects to San Joaquin kit fox and California least tern. Section 7 consultation has been completed.	Potential effects to the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in Morro Bay	No significant effect.	No effect.
State-Listed Special-Status Species		
Individual-level effects to State-listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to State-listed special-status species in the San Joaquin Valley	Significant adverse effects to the American peregrine falcon, Swainson’s hawk, greater sandhill crane, San Joaquin kit fox, and California least tern. Potentially unavoidable.	Potential effects to the American peregrine falcon, Swainson’s hawk, greater sandhill crane, and San Joaquin kit fox.
Individual-level effects to State-listed special-status species in Morro Bay	No significant effect.	No effect.

Table 8-13
Summary Comparison of Effects of
In-Valley/Drainage-Impaired Area Land Retirement Alternative

Affected Resource and Area of Potential Effect	In-Valley/Drainage-Impaired Area Land Retirement Compared to No Action	In-Valley/Drainage-Impaired Area Land Retirement Compared to Existing Conditions
Terrestrial Resources		
Population-level effects to terrestrial resources in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Aquatic and Wetland Resources		
Population-level effects to aquatic resources (including waterbirds) in the Bay-Delta	No significant effect.	No effect.
Population-level effects to aquatic resources (including waterbirds) in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Population-level effects to aquatic resources (including waterbirds) in Morro Bay	No significant effect.	No effect.
Federally Listed Special-Status Species		
Individual-level effects to Federally listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to Federally listed special-status species in the San Joaquin Valley	Significant adverse effects to the San Joaquin kit fox and California least tern. Section 7 consultation has been completed.	Potential effects to the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in Morro Bay	No significant effect.	No effect.
State-Listed Special-Status Species		
Individual-level effects to State-listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to State-listed special-status species in the San Joaquin Valley	Significant adverse effects to the American peregrine falcon, Swainson's hawk, greater sandhill crane, San Joaquin kit fox, and California least tern. Potentially unavoidable.	Potential effects to the American peregrine falcon, Swainson's hawk, greater sandhill crane, and San Joaquin kit fox.
Individual-level effects to State-listed special-status species in Morro Bay	No significant effect.	No effect.

Table 8-14
Summary Comparison of Effects of Ocean Disposal Alternative

Affected Resource and Area of Potential Effect	Ocean Disposal Compared to No Action	Ocean Disposal Compared to Existing Conditions
Terrestrial Resources		
Population-level effects to terrestrial resources in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Aquatic and Wetland Resources		
Population-level effects to aquatic resources (including waterbirds) in the Bay-Delta	No significant effect.	No effect.
Population-level effects to aquatic resources (including waterbirds) in the San Joaquin Valley	No significant effect.	No effect.
Population-level effects to aquatic resources (including waterbirds) in Morro Bay	No significant effect.	No effect.
Federally Listed Special-Status Species		
Individual-level effects to Federally listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to Federally listed special-status species in the San Joaquin Valley	Significant adverse effects to the San Joaquin kit fox. Section 7 consultation would be initiated.	Potential effects to the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in Morro Bay	No significant effect.	No effect.
State-Listed Special-Status Species		
Individual-level effects to State-listed special-status species in the Bay Delta	No significant effect.	No effect.
Individual-level effects to State-listed special-status species in the San Joaquin Valley	Significant adverse effects to the Swainson's hawk, greater sandhill crane, and San Joaquin kit fox. Potentially unavoidable.	Potential effects to the Swainson's hawk, greater sandhill crane, and San Joaquin kit fox.
Individual-level effects to State-listed special-status species in Morro Bay	No significant effect.	No effect.

Table 8-15
Summary Comparison of Effects of Delta-Chipps Island Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Chipps Island Disposal Compared to No Action	Delta-Chipps Island Disposal Compared to Existing Conditions
Population-level effects to terrestrial resources in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Aquatic and Wetland Resources		
Population-level effects to aquatic resources (including waterbirds) in the Bay-Delta	No significant effect.	No adverse effect.
Population-level effects to aquatic resources (including waterbirds) in the San Joaquin Valley	No significant effect.	No effect.
Population-level effects to aquatic resources (including waterbirds) in Morro Bay	No significant effect.	No effect.
Federally Listed Special-Status Species		
Individual-level effects to Federally listed special-status species in the Bay Delta	Significant adverse effects to the green sturgeon (currently a Federal candidate species). Section 7 consultation would be initiated.	Potential effects to the green sturgeon (currently a Federal candidate species) and the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in the San Joaquin Valley	Significant adverse effects to the San Joaquin kit fox. Section 7 consultation would be initiated.	Potential effects to the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in Morro Bay	No significant effect.	No effect.
State-Listed Special-Status Species		
Individual-level effects to State-listed special-status species in the Bay Delta	Significant adverse effects to the green sturgeon. Potentially unavoidable.	No effect.
Individual-level effects to State-listed special-status species in the San Joaquin Valley	Significant effects Swainson’s hawk, greater sandhill crane, and San Joaquin kit fox. Potentially unavoidable.	Potential effects to the Swainson’s hawk, greater sandhill crane, green sturgeon, and San Joaquin kit fox.
Individual-level effects to State-listed special-status species in Morro Bay	No significant effect.	No effect.

Table 8-16
Summary Comparison of Effects of Delta-Carquinez Strait Disposal Alternative

Affected Resource and Area of Potential Effect	Delta-Carquinez Strait Disposal Compared to No Action	Delta-Carquinez Strait Disposal Compared to Existing Conditions
Population-level effects to terrestrial resources in the San Joaquin Valley	Significant adverse effect; with mitigation = not significant.	Adverse effect; mitigation feasible.
Aquatic and Wetland Resources		
Population-level effects to aquatic resources (including waterbirds) in the Bay-Delta	No significant effect.	No adverse effect.
Population-level effects to aquatic resources (including waterbirds) in the San Joaquin Valley	No significant effect.	No effect.
Population-level effects to aquatic resources (including waterbirds) in Morro Bay	No significant effect.	No effect.
Federally Listed Special-Status Species		
Individual-level effects to Federally listed special-status species in the Bay Delta	Significant adverse effects to the green sturgeon (currently a Federal candidate species). Section 7 consultation would be initiated.	Potential effects to the green sturgeon (currently a Federal candidate species) and the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in the San Joaquin Valley	Significant effects to the San Joaquin kit fox. Section 7 consultation would be initiated.	Potential effects to the San Joaquin kit fox.
Individual-level effects to Federally listed special-status species in Morro Bay	No significant effect.	No effect.
State-Listed Special-Status Species		
Individual-level effects to State-listed special-status species in the Bay Delta	Significant adverse effects to the green sturgeon. Section 7 consultation would be initiated.	No effect.
Individual-level effects to State-listed special-status species in the San Joaquin Valley	Significant adverse effects to the Swainson’s hawk, greater sandhill crane, and San Joaquin kit fox. Potentially unavoidable.	Potential effects to the Swainson’s hawk, greater sandhill crane, green sturgeon, and San Joaquin kit fox.
Individual-level effects to State-listed special-status species in Morro Bay	No significant effect.	No effect.

8.2.13 Mitigation Recommendations

Design and management of the evaporation basins proposed under the In-Valley Disposal Alternative should incorporate measures that minimize wildlife exposure to Se. These measures would include, but not be limited to:

- Maintaining basin depths greater than 4 feet
- Vegetation control to minimize nesting and roosting habitat
- No islands or windbreaks
- Side slopes at least 3:1
- Hazing

In addition, mitigation habitat would be created to attract birds away from the evaporation basins, dilute the average Se concentration in the diet of birds foraging at the evaporation basins, and compensate for affected bird populations. Recommendations for mitigation are presented in Section 20, Conceptual Mitigation and Monitoring Program, and Appendix M2, U.S. Fish and Wildlife Service Biological Opinion.