CHAPTER 3.0

Affected Environment and Environmental Consequences

3.1 Introduction

Chapter 3 describes the ***affected environment*** and the ***environmental consequences*** of implementing the various alternatives described in Chapter 2. Issues discussed include the geomorphic environment; water resources; water quality; fishery resources; tribal trust; vegetation, wildlife, and ***wetlands***; recreation resources; land use; power resources; socioeconomics; cultural resources; air quality; and environmental justice.

Each section includes a discussion of the affected environment (CEQA existing conditions), environmental consequences (CEQA environmental impacts), methodology, significance criteria (if applicable), and mitigation measures. Section 4.5, Environmental Commitments and Mitigation and Significant Unavoidable Impacts, as well as Table 4-4 provides a summary of significant adverse environmental impacts and proposed mitigation, the anticipated level of significance after mitigation is implemented, and those impacts that cannot be avoided and remain significant in accordance with Public Resources Code (PRC) §21100, subd. (b)(2) and State CEQA Guidelines §§15126. Section 4.3 Irreversible and Irretrievable Commitments of Resources and Significant Impacts that Would Remain Unavoidable Even after Mitigation also addresses significant unavoidable impacts. Some sections address issues only required to satisfy federal law (e.g., NEPA), and are not required to comply with CEQA. For example, because CEQA generally does not require lead agencies to consider the purely economic or social effects of proposed projects, Sections 3.11 (Socioeconomics) and 3.14 (Environmental Justice) were not prepared with CEQA compliance in mind. Furthermore, to the extent that Section 3.10 (Power Resources) focuses on the economic consequences of lost hydropower production, such analysis is also unnecessary under CEQA. Sections are organized in the following manner:

- Affected Environment (CEQA Existing Conditions): These subsections describe the existing regional and local conditions. Information presented is the most current available and is used as the CEQA baseline for analysis for all sections that are qualitatively analyzed. Existing conditions with regard to sections that utilize hydrologic models (see Section 3.3, Water Resources, and

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the Water Resources / Water Quality Technical Appendix A for information regarding the use of water-related models) assume a modeled 1995 condition with regard to CVP / SWP operations.

- Environmental Consequences (CEQA Environmental Impacts): These subsections identify the anticipated impacts within the context of each section. Those impacts that are deemed to be potentially significant prior to mitigation are identified as such in the text. For some sections, impacts are analyzed and identified based on modeling simulations. The following subsections are also presented under Environmental Consequences:

  – Methodology: These subsections identify the method used to analyze impacts, as well as the key assumptions used in the analysis process. All sections that incorporate quantitative assessments reference complimentary technical appendices within each of the relevant Methodology subsections. Key assumptions used in qualitative analyses are also described for those sections that did not include the use of quantitative tools.

  – Significance Criteria: These subsections present the criteria and thresholds used to identify potentially significant effects on the environment in accordance with PRC §21082.2, and State CEQA Guidelines §§15064 and 15065. Thresholds include guidance provided by Appendix G of the CEQA Guidelines, as well as agency standards or legislative or regulatory requirements as applicable, in addition to professional judgement. All impacts that do not exceed the stated significance criteria described for each section are assumed to be less than significant and are therefore not discussed in detail in the document (PRC §21100 and State CEQA Guidelines §§15128).

  - Mitigation: These subsections identify what lead agency staff and consultants believe to be potentially feasible mitigation measures that would reduce significant impacts associated with each of the alternatives. Where no feasible mitigation can be identified, such impacts are identified as significant and unavoidable.

A number of models were used to assist in the identification of potential impacts associated with the implementation of any of the alternatives. Figure 3-1 provides a general summary of the relationship of the primary modeling tools used to analyze impacts. A description of each model, key assumptions, and use is provided in each section where a given model is used, as well as the associated technical appendices. Many of these models have been used in other

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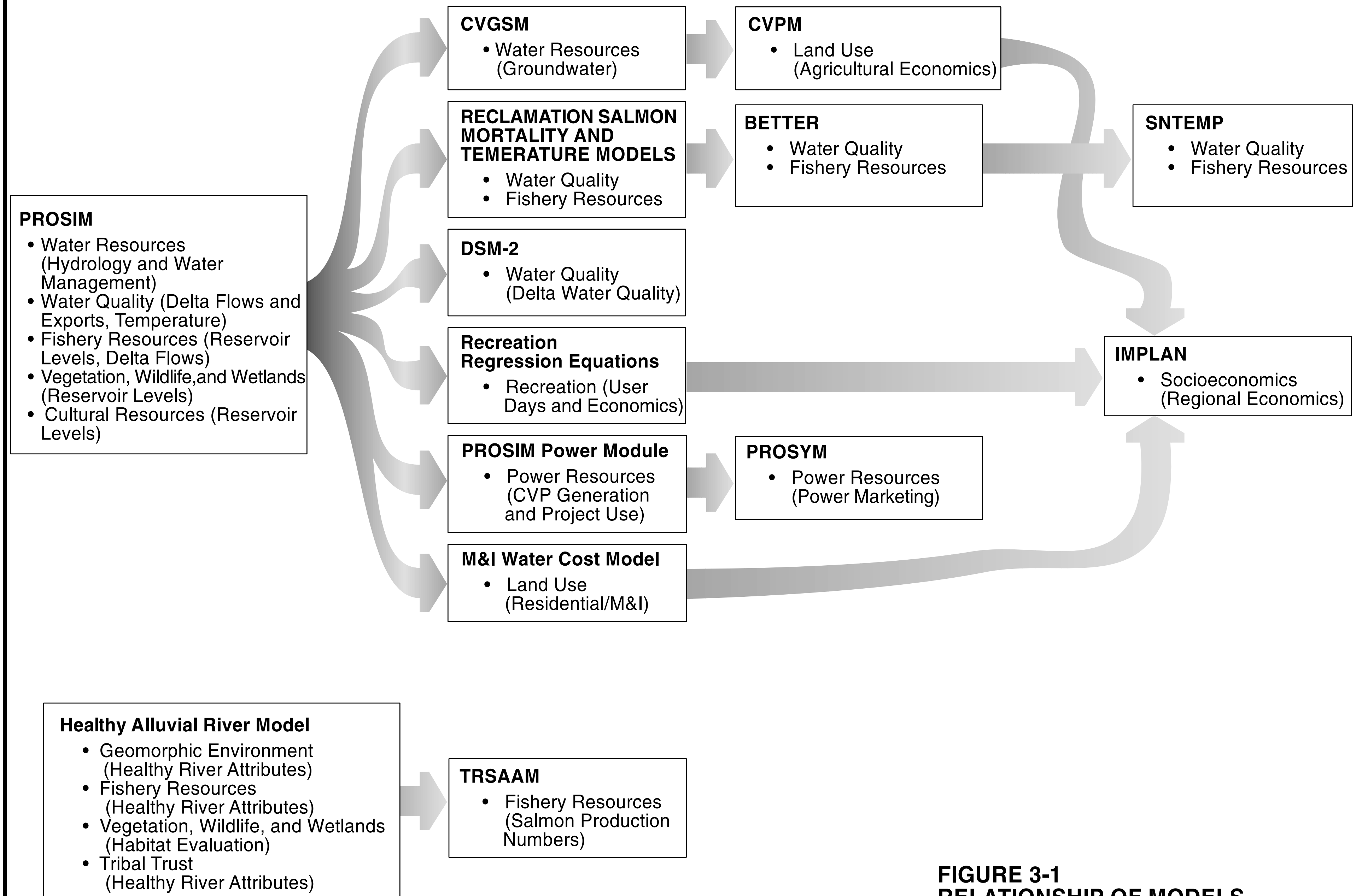

FIGURE 3-1
RELATIONSHIP OF MODELS USED FOR RESOURCE ANALYSES
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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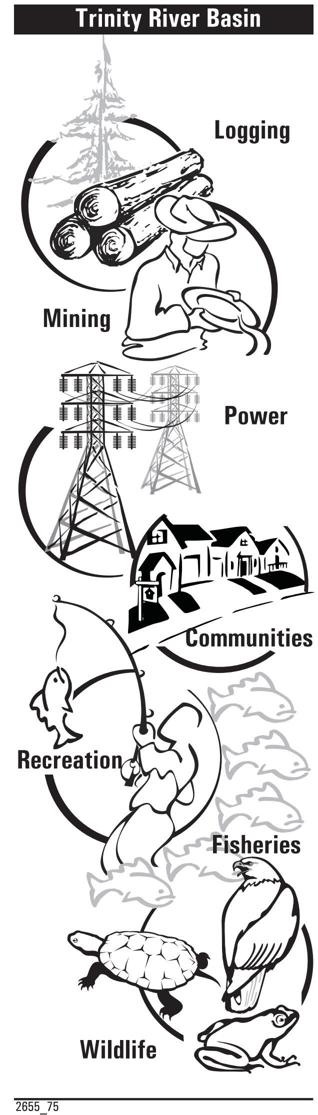
large-scale water management studies, including the CVPIA PEIS (and technical appendices), which includes a very detailed description of the same models used to identify potential water management effects.

For most issues the discussion is divided into the Trinity River Basin, the Lower Klamath River Basin / Coastal Area, and the Central Valley. However, some sections are outlined differently. For example, the geomorphic section discusses only the Trinity River Basin because impacts would be limited to the basin, and the power section is not subdivided because the power system operation spans all basin areas. Figure 3-2 shows the three geographic impact areas.

The following describes the general setting of the Trinity River Basin, the Lower Klamath River Basin / Coastal Area, and the Central Valley. More specific discussions of the affected environment can be found in each issue section.



3.1.1 Trinity River Basin

The Trinity River drains a watershed of approximately 3,000 square miles; approximately one-quarter of which is above Lewiston Dam. The terrain is predominantly mountainous and forested, with little available farming area. Elevations in the basin range from 8,888 feet above sea level in the headwater areas to less than 300 feet at the confluence with the Klamath River.

The Trinity River is the largest tributary to the Klamath River. It consists primarily of the mainstem and the North and South Forks, and New River. The mainstem Trinity River originates approximately 20 miles southwest of Mount Shasta in the canyons bordered by the Scott Mountains, the Eddy Mountains, and the Salmon-Trinity Alps.

Trinity and Lewiston Dams regulate Trinity River flows beyond approximately RM 112. The mainstem flows a total of 170 miles west from its origins to the Klamath River confluence at Weitchpec, which is located 43.5 miles upstream from the Pacific Ocean. The majority of lands directly adjacent to the river are managed by either the USFS or the BLM; however, about half of the land bordering the river between Lewiston Dam and the North Fork is private.

Trinity Reservoir, impounded by Trinity Dam, stores Trinity River water. Lewiston Dam regulates releases from Trinity Dam and provides a forebay for the diversion of flows from the Trinity River Basin through the Clear Creek Tunnel.

Urban development within the Trinity River Basin is primarily limited to the communities of Lewiston, Weaverville, Junction City, Hayfork, Willow Creek, Trinity Center, and Hoopa. In addition,

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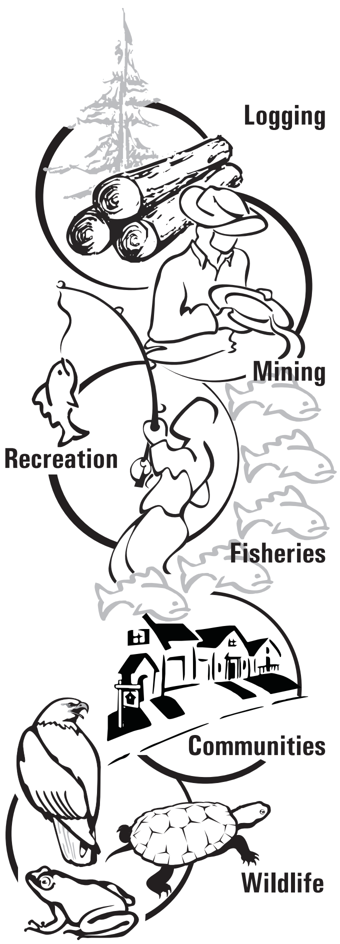
several smaller communities have sprung up along State Highway 299 on level terrain adjacent to the river. Access to the river is provided by State Highway 299, which follows the river from Junction City to Willow Creek. At this point, the river veers north, and State Highway 96 parallels it to its confluence with the Klamath River. Numerous recreation sites exist along the river (see Section 3.8).

Klamath River Basin



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The Hoopa Valley Indian Reservation is located north of Willow Creek along the Trinity River and State Highway 96. The reservation is approximately 14 square miles, with the northern border lying near Weitchpec at the confluence with the Klamath River.

3.1.2 Lower Klamath River Basin/Coastal Area

The Klamath River Basin is located adjacent to and north of the Trinity River Basin. The entire basin drains approximately 15,600 square miles. Most of the land is under public ownership in the form of eight national forests; two national parks; BLM lands, Reclamation lands, Department of Defense lands, and Hoopa Valley and Yurok Indian Reservations, held in trust by the Bureau of Indian Affairs (BIA); as well as state and county properties. The lower Klamath River Basin portion of the Klamath Basin extends from the confluence of the Trinity and Klamath Rivers to the Pacific Ocean. Private timber companies and the federal government own much of the land in the lower basin. The Yurok Indian Reservation extends along the entire length of the lower Klamath River. Land uses in the lower Klamath River Basin have generally been tied to natural resources—predominantly logging, mining, fisheries, and recreation. Klamath, Klamath Glen, and Requa are the primary communities.

The coastal component of the Lower Klamath River Basin / Coastal Area impact area extends from southern California to the Oregon / Washington border. The area includes all ocean waters and resources that could be impacted by the proposed action and alternatives.

3.1.3 Central Valley

The Central Valley consists of the Sacramento River Basin (Sacramento Valley), the San Joaquin River Basin (San Joaquin Valley), and the Tulare Basin. The Sacramento River and its tributaries flow southward, draining the Sacramento River Basin. The San Joaquin River and its tributaries flow northward, draining the San Joaquin Basin. The Tulare Basin lies south of the San Joaquin River and includes the Kings, Tule, Kaweah, and Kern Rivers. The Sacramento and San Joaquin river systems join at the Sacramento-San Joaquin River Delta and flow through Suisun Bay and Carquinez Straits into San Francisco Bay and the Pacific Ocean.

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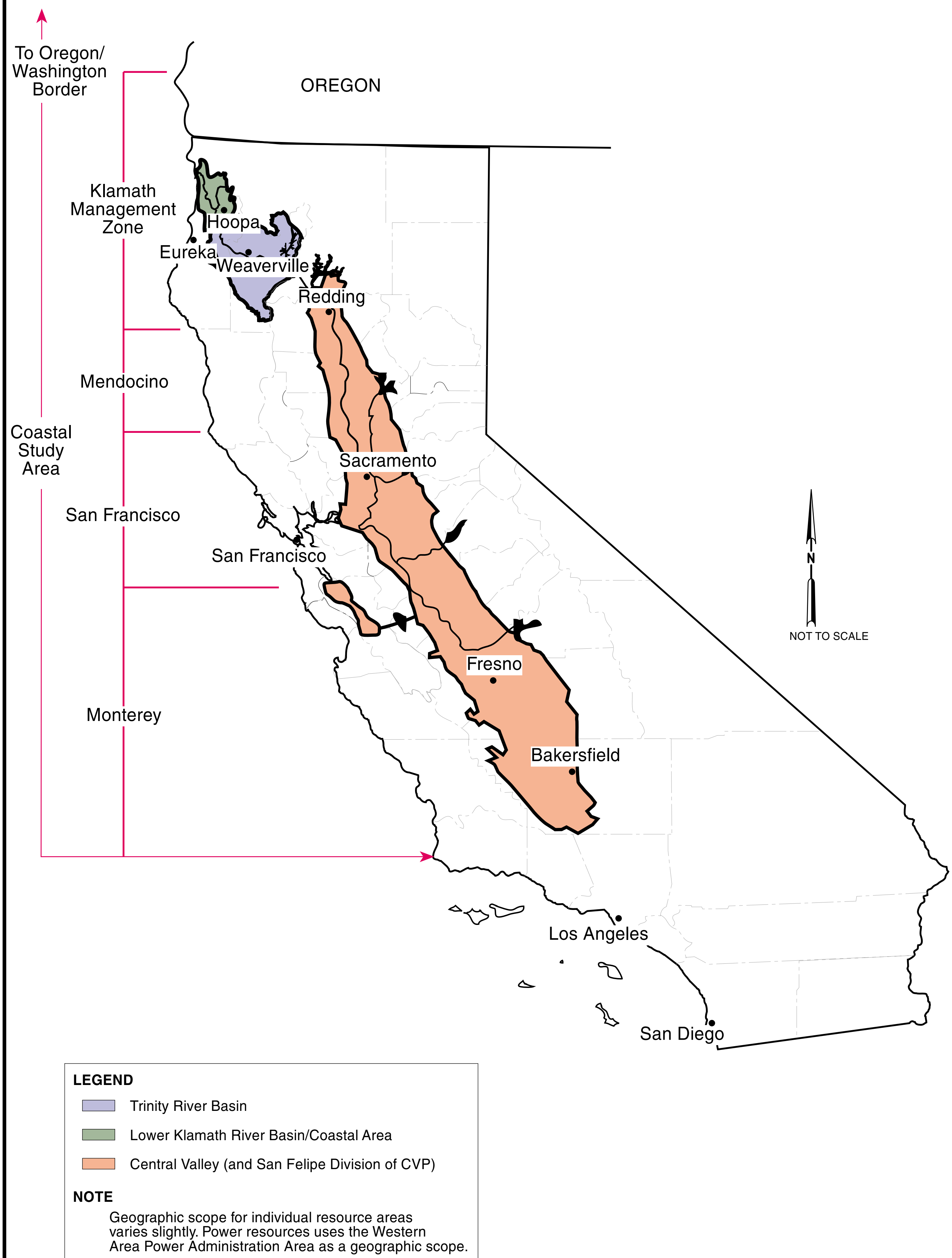

FIGURE 3-2
GEOGRAPHIC SCOPE OF EIS/EIR
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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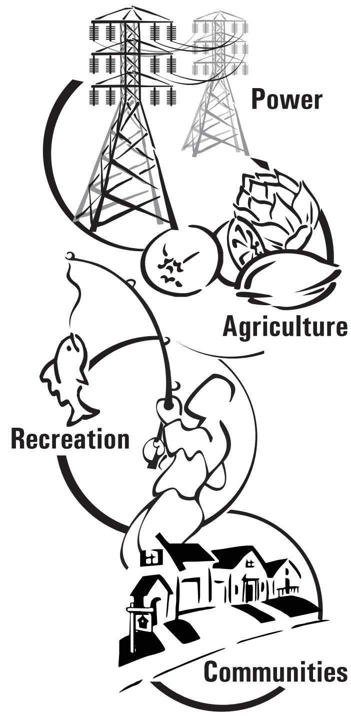
Major water management features of the Central Valley include 20 reservoirs, with a combined storage capacity of approximately 11 maf; 9 powerplants and 2 pumping-generating plants, with a maximum capacity of about 2.0 million kW; and approximately 500 miles of major canals and aqueducts. The federally operated CVP and state-operated SWP are the primary water conveyance systems in the state, which together deliver an annual total of approximately 9 maf of water. The Central Valley is one of the world's premier agricultural regions, accounting for 40 percent of the U.S. vegetable, fruit, and nut production. Approximately 6 percent of the region is urbanized. The largest urban area in the valley is the city of Sacramento, and the primary access route through the valley is Interstate 5.

Central Valley



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3.2 Geomorphic Environment

The term ***geomorphic environment*** refers to the Trinity River mainstem and the physical processes that create and maintain the river and its floodplain. These processes shape the physical structures that define habitat along the river, which directly affects many other resources identified in this DEIS/EIR such as fish and wildlife (Figure 3-3). Hence, the condition of the riverine environment is considered background information for impact analyses of other resources because the condition of the riverine environment does not have benefits or impacts except with regards to other issue areas, such as fishery resources or wildlife habitat. Further discussions of how the geomorphic environment affects other resources listed on Figure 3-3 are presented in those individual sections.

The Trinity River geomorphic environment is directly affected by the operation of the TRD.

The Trinity River geomorphic environment is directly affected by the operation of the TRD as these operations control hydrology and block all upstream sediment supply, both of which affect the geomorphic processes and in turn the physical shape of the river (McBain and Trush, 1997). The effects of the TRD are particularly noticeable upstream of the confluence with the North Fork because tributary inflows to the mainstem above that point are relatively limited. This section discusses pre- and post-dam geomorphic processes within the Trinity River.

3.2.1 Channel Geomorphology and Fluvial Processes

Individual rivers are composed of a unique set of these building blocks… soils, climate, and geology. The resulting geomorphic environment typically supports a unique ecosystem that depends on geomorphic processes to maintain its fundamental structure.

Rivers channels are formed by three primary building blocks: various sizes of sediment, varying amounts and stages of vegetation, and varying amounts of water. The results of these complex interactions comprise the geomorphic environment and can provide a diversity of physical structures, such as ***point bars*** and riffle-pool sequences that perform a variety of environmental functions. Individual rivers are composed of a unique set of these building blocks that are determined by soils, climate, and geology. The resulting geomorphic environment typically supports a unique ecosystem that depends on geomorphic processes to maintain its fundamental structure. A change in one or more of the building blocks will change the geomorphic environment.

Generally, a highly variable hydrology in an alluvial river system will result in a physically complex river that provides substantial ecological benefits. A physically complex river provides a variety of habitats that can be used by different species under a range of flows. Hydrology changes seasonally, daily, and hourly, causing energy inputs to a river to be in constant flux. Varying flows impart varying amounts of energy throughout a river channel and elicit varying responses in the river channel. Flows can mobilize and deposit a

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wide range of sediment particle sizes (ranging from fine material to large boulders during peak events). This movement and deposition of sediment particles in turn scours and shapes the river channel, creating river bars, pools and ***riffles***, and can force the main channel to shift its position in the floodplain. Vegetation is also often scoured during high flows, leaving open gravel bars and preventing vegetation from maturing in the scour zone.

The elimination of major peak flow events has resulted in the development of berms… caused accumulation of fine sediments and limited the ability of the river to maintain its point bars and associated habitats.

The current Trinity River mainstem is an example of a degraded system where the amount of water within the system has been significantly reduced. This reduction in water, and its associated energy, has had direct effects on the geomorphic environment. For example, the elimination of major peak flow events (which historically flushed sediment from the system and scoured and reshaped the channel) has resulted in the development of berms along streambanks, caused accumulation of fine sediments in the channel, and limited the ability of the river to maintain its point bars and associated habitats. The following discussion summarizes historical-to-contemporary changes to the channel as affected by geomorphic processes.

The Pre-dam Trinity River. In the reach between Lewiston and the North Fork, the pre-dam Trinity River was a meandering alluvial river, and large exposed point bars were a predominant feature. Point bars alternated from one side of the channel to the other, creating riffle-pool sequences, often referred to as alternate bar sequences (Figure 3-4). Prior to the dam, average annual discharge at Lewiston was approximately 1.2 maf. Peak flows in excess of 100,000 cfs were recorded at Lewiston, and daily average flows greater than 70,000 cfs occurred three times between 1912 and 1963. These peak flows were extremely important as they shaped and maintained the river channel and floodplain, even during extensive human activities. For example, pre-dam gold mining operations left large dredger tailings throughout the floodplain, and upland logging operations increased fine sediment inputs to the river, but winter peak flows would reshape the channel through the tailings and flush much of the fine sediment out of the river.

Aerial photographs suggest that coarse sediment on the point bars were frequently mobilized by these large flows, which promoted dynamic and diverse channel geomorphology and ***early-successional riparian vegetation communities*** (Figure 3-5). Remnant point bars contain particle sizes ranging from gravels to small boulders, which illustrates the ability of floods to transport sediment and shape bars. This sediment tended to sort within a meander, such that a wide variety of particle sizes were available to provide habitats for a variety of species and life stages. Deposits of smaller cobbles and gravels were frequently mobilized by high flows, cleansing the

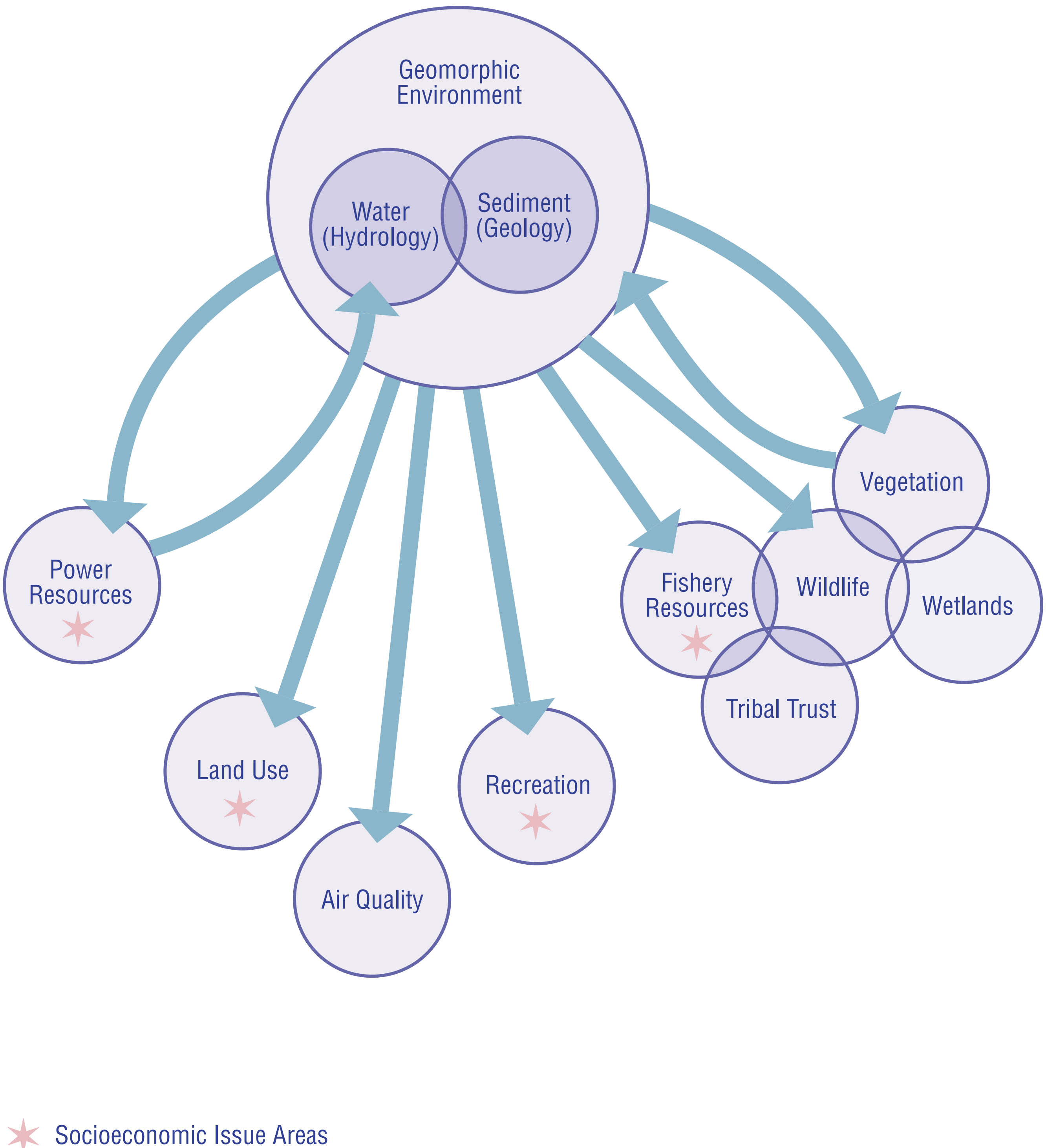

FIGURE 3-3
RESOURCE LINKAGE OVERVIEW
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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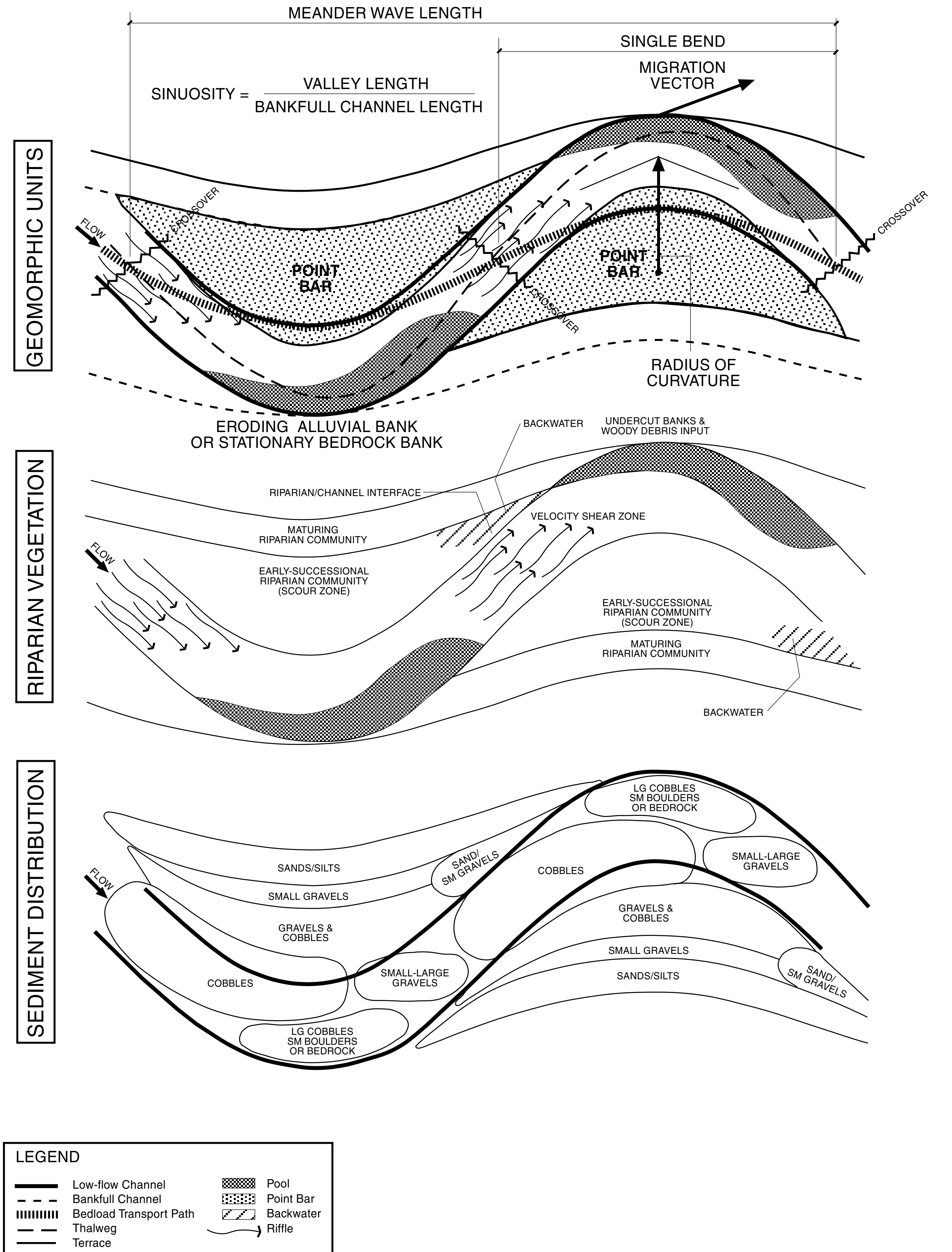

Source: McBain & Trush

FIGURE 3-4
IDEALIZED GEOMORPHIC ENVIRONMENT, INCLUDING RIPARIAN AND SEDIMENT EFFECTS
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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FIGURE 3-5
1960 AERIAL PHOTO OF JUNCTION CITY
PRE-DAM GEOMORPHOLOGY
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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gravel of fine sediment and discouraging riparian colonization within the channel.

Channel geometry through the point bars was typified by a scour pool on the outside of the meander and an exposed, gently sloping cobble/gravel surface on the inside of the meander bend (Figure 3-6). Further up the point bar, particle size decreased to sands and silts toward and upon floodplain surfaces (Figure 3-4). Meanders were large (with wavelengths greater than 2,000 feet), although their location and size were confined by bedrock formations in some reaches. The channel migrated over time, but it was likely a sporadic process because of the boulder-dominated point bars (i.e., there was rapid migration during large floods, little or no movement during interim periods). Although the channel infrequently migrated, the sediments in the channel were often mobilized and redeposited. Even given considerable human manipulation of the entire width of the floodplain during the gold mining era, the unregulated Trinity River flows were large enough and of sufficient frequency and duration to reshape and maintain a dynamic channel geomorphology.

The Post-dam Trinity River. Construction of the TRD fundamentally changed the geomorphic processes of the Trinity River in the following ways:

- Flow volume, variability, magnitude, peak frequency, and duration of flows greatly decreased. For example, scheduled peak releases are now usually around 2,000 cfs at Lewiston, and releases above 6,000 cfs are extremely rare.
- Sediment (including spawning-size gravel) supply upstream of Trinity and Lewiston Dams has been blocked.
- Downstream tributary sediment supply has continued or increased (because of land use practices), and the reduced sediment transport capacity of the TRD releases has allowed fine and coarse sediment to accumulate in the mainstem.

For almost 20 years following dam completion, instream release volumes were set at 120,500 af/yr (10 percent of the average unimpaired inflow, which would be an extreme drought relative to pre-dam hydrology). Post-dam release volumes have only recently been increased to 340,000 af/yr; however, that still represents drought levels. For example, 340,000 af/yr represents the third lowest recorded and potential flow (based on Trinity Reservoir inflows) at Lewiston since 1912.

For almost 20 years following dam completion, instream release volumes were set at 120,500 af/yr…which would be an extreme drought relative to pre-dam hydrology.

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The channel quickly responded to the low flow releases from Lewiston Reservoir in the following ways:

- Sediment Budget Disrupted: The decreased flows and loss of coarse sediment supply from the upper watershed greatly disrupted the quasi-equilibrium of the Trinity River's sediment budget immediately downstream of Lewiston Dam, with some reaches experiencing a reduction in spawning gravels. Gravel introduction efforts by Reclamation have mitigated some of the negative impacts.

Coarse sediment from (the) tributaries accumulated at the deltas, aggrading the mainstem channel and increasing the frequency and magnitude of local flooding.

- Tributary Sediments Aggraded: The loss of periodic, high volume, scouring flows also greatly disrupted the quasi-equilibrium of the Trinity River at downstream tributary junctions. Coarse sediment from these tributaries accumulated at the deltas, aggrading the mainstem channel and increasing the frequency and magnitude of local flooding. Fine sediment, particularly from Grass Valley Creek, also accumulated in the channel. Pools filled with sand, spawning gravels were infiltrated with sand, and sand berms developed along the riparian-encroached channel margins.

- Berms Formed: Riparian trees germinated, grew, and matured on point bars along the low-water channel margin (Figures 3-6 and 3-7) because year-round flow releases of 150-300 cfs created favorable soil moisture conditions at the water's edge. The near absence of high flows (that historically scoured and killed seedlings) allowed seedlings to mature to the point where high flows could not easily remove them. This dense riparian vegetation decreased water velocities during floods, which allowed coarse sands to deposit and accumulate around the vegetation, forming berms.

The near absence of high flow…allowed seedlings to mature to the point where high flows could not easily remove them.

- The Channel Fossilized: The once mobile, alluvial channelbed and banks of the pre-TRD mainstem became functionally immobile (fossilized) as berms continued to build and riparian vegetation continued to grow in the pre-dam channel (riparian encroachment) under low flow releases. The harmful riparian berms are evident 40 miles downstream of Lewiston Dam because the contribution of flow from tributaries above the confluence of the North Fork was insufficient to discourage riparian encroachment and berm formation. Channel geomorphology downstream of the North Fork begins to approximate pre-dam conditions, illustrating the substantial influence that current Lewiston Dam releases have had on the geomorphic environment above the North Fork.

- Riverine Habitats Changed: Berm formation narrowed the wetted channel and the roots of the vegetation held sediments in

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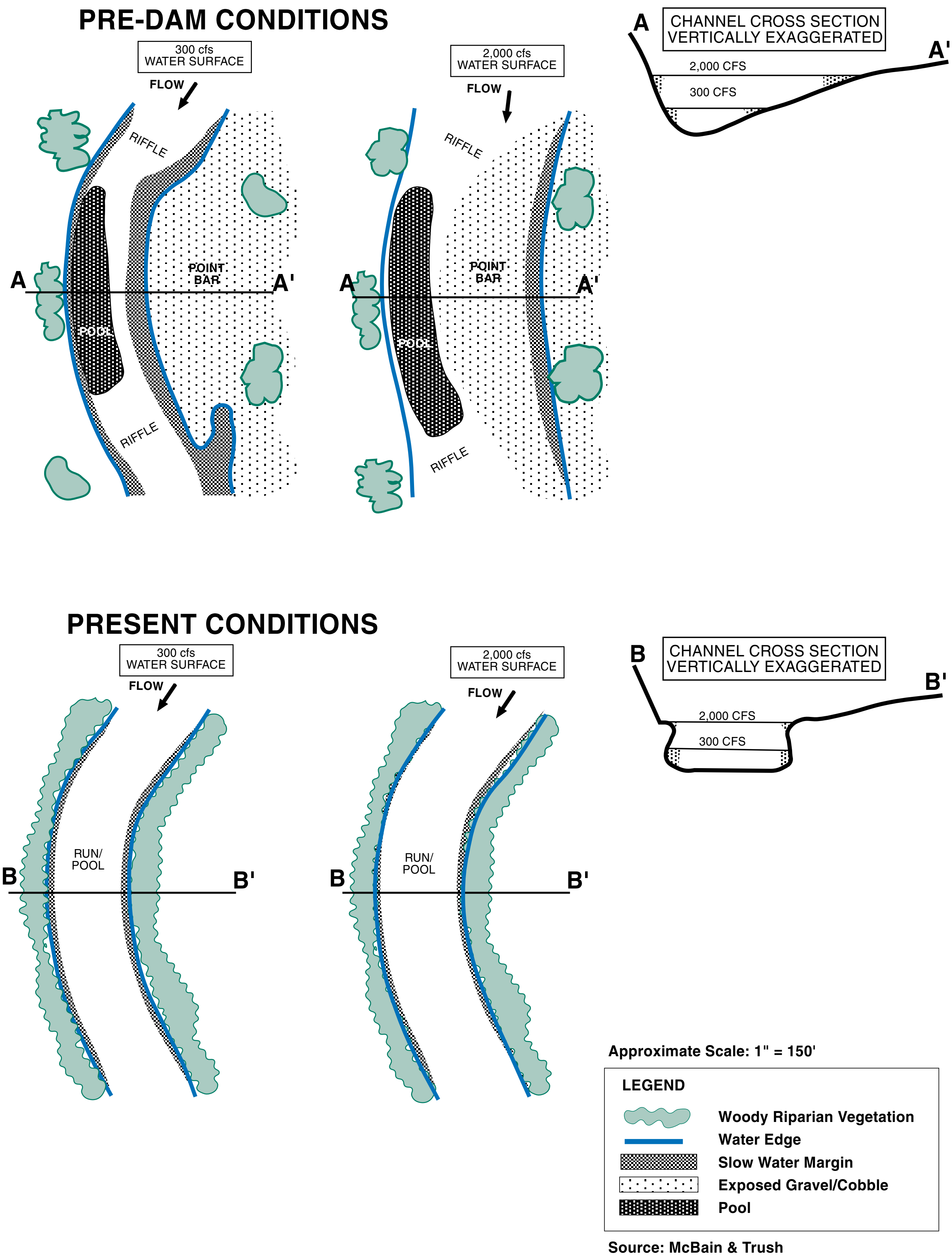

FIGURE 3-6
SIMPLIFIED GEOMORPHOLOGY, PRE-DAM VERSUS CURRENT CONDITIONS
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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FIGURE 3-7
1989 AERIAL PHOTO OF JUNCTION CITY
POST-DAM GEOMORPHOLOGY
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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place, causing the channel to simplify. The river channel changed from a wide, point bar-dominated system with a gently sloping, asymmetrical channel geomorphology to a narrow channel confined within relatively steep banks created by the berms (Figure 3-6). The riffle-pool sequences associated with point bars were largely replaced with monotypic runs, which reduced the quantity, quality, and diversity of ***aquatic*** habitats (Figure 3-6).

These channel responses become less pronounced as distance downstream of Lewiston Dam increases. Unregulated tributaries provide sediments and increase flows that partially counteract the harmful effects of the dams. However, the Trinity River does not approach a pre-dam channel geomorphology until the confluence with the North Fork.

Summary. The Trinity River's pre-dam hydrology has been replaced with a greatly reduced, near-constant flow schedule. This reduction in water and associated energy has directly affected the character of the channel. The low flows allowed woody riparian vegetation along the channel to become established and mature. Sediment berms then developed along the channel margins. These berms further anchored the sides of the channel and kept it from moving, which resulted in the loss of many of the broad, gently sloping point bars, which changed the pool-riffle-run sequences created by alternate bar sequences to a large monotypic-run habitat. The loss of these bars has substantially reduced the complexity and diversity of riparian and riverine habitats (McBain and Trush, 1997). These changes in geomorphic processes and channel geomorphology have decreased the quantity and quality of riverine habitats.

Ten (healthy river)… attributes were developed specifically for the Trinity River.

3.2.2 Attributes of a Healthy Alluvial River

A definition of what constitutes a healthy alluvial river was used to assist in restoring the geomorphic environment that existed prior to the TRD. Ten attributes were identified to describe the geomorphic environment and processes of a healthy alluvial river (Table 3-1). These attributes were developed specifically for the Trinity River based on an in-depth historical and literature evaluation of the river (McBain and Trush, 1997) and a comparison of pre- and post-dam conditions in the watershed. Much of this comparison was accomplished with aerial photographs taken before and after dam construction. This evaluation also included studies examining sediment budgets, riparian community, and channel characteristics in the basin.

The methodology assumed that if all 10 of these attributes were present, the Trinity River would have the physical characteristics to support a healthy alluvial river ecosystem.

The 10 attributes serve as a foundation for building toward restoration goals. The methodology assumed that if all 10 of these attributes were present, the Trinity River would have the physical characteristics to support a healthy alluvial river ecosystem.

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TABLE 3-1
Attributes of a Healthy Alluvial River System

Attributes	Physical Characteristics	Ecological Significance
Attribute 1. Spatially complex channel geomorphology: No single segment of channelbed provides habitat for all species or all life stages of a single species, but the sum of channel segments provides high-quality habitat for native species. A wide range of structurally complex physical environments supports diverse and productive biological communities.	Restore alluvial channel (self-forming bed particle and bank dimensions). Threshold: Integration of attributes 3, 4, 5, 7, and 9.	Development of all stages of riparian community.
	Create and/or maintain structural complexity of alternate bar sequences. Threshold: Integration of attributes 2, 3, 4, 5, and 8.	Maintenance of riparian habitat following channel migration.
	Create and maintain functional floodplains. Threshold: Integration of attributes 2, 5, 6, 7, 8, and 9.	Diverse salmonid habitat available for all life stages over a wide range of flows.
	Increase diversity of channelbed particle size. Threshold: Integration of attributes 3, 4, 5, and 6.	
	Greater topographic complexity in side channels. Threshold: Integration of attributes 2, 4, 6, 7, 8, 9, and 10.	
Attribute 2. Flows and water quality are predictably unpredictable: Interannual and seasonal flow regimes are broadly predictable, but specific flow magnitudes, timing, duration, and frequencies are unpredictable due to runoff patterns produced by storms and droughts. Seasonal water quality characteristics, especially water temperature, turbidity, and suspended sediment concentration, are similar to regional unregulated rivers and fluctuate seasonally. This temporal "predictable unpredictability" is a foundation of river ecosystem integrity.	Provide inter- and intra-annual flow variation for summer baseflows. Threshold: Variable flow between July 1 and October 1.	Discourage riparian plant germination on alternate bars.
	Provide inter- and intra-annual flow variation for winter baseflows. Threshold: Variable flow between January 1 and April 1.	Spatially distributes spawning salmon and protects different life stages from high flows.
	Provide inter- and intra-annual flow variation for winter floods. Threshold: Variable flow between October 1 and April 30.	Creation of slack water areas for early life stages of salmonids and amphibians.
	Provide inter- and intra-annual flow variation for snowmelt peak periods. Threshold: Variable flow between October 1 and April 30.	Stimulus for out-migrant salmon and variable macroinvertebrate habitat.
	Provide inter- and intra-annual flow variation for snowmelt recession. Threshold: Variable flow between snowmelt periods.	Rapid snowmelt recession dessicates developing riparian vegetation.

TABLE 3-1
Attributes of a Healthy Alluvial River System

Attributes	Physical Characteristics	Ecological Significance
Attribute 3. Frequently mobilized channelbed surface: Channelbed framework particles of coarse alluvial surfaces are mobilized by the bankfull discharge, which on average occurs every 1-2 years.	Achieve incipient motion for most of channelbed surface (riffles, face of point bars). Threshold: Flows greater than 6,000 cfs every 2 or 3 years. Exceed incipient motion for mobile active channel alluvial features (median bars, pool tails, spawning gravel deposits). Threshold: Flows greater than 3,000 cfs every 2 or 3 years. Exceed threshold for transporting sand through most pools. Threshold: Flows greater than 3,000 cfs every 2 or 3 years, or mechanical rehabilitation.	Higher egg and alevin survival due to reduced fine sediment in redds. Lower rates of riparian encroachment through removal of 1- to 2-year old seedlings. Greater substrate complexity, increasing macroinvertebrate production, and creating deeper pool depths for adult fish cover and holding.
Attribute 4. Periodic channelbed scour and fill: Alternate bars are scoured deeper than the coarse surface layer by floods exceeding 3-5 year annual maximum flood recurrences. This scour is typically accompanied by redeposition, such that net change in channelbed topography following these scouring floods is usually minimal.	Scour/redeposit faces of alternate bars (at least to D_{84}). Threshold: Flows greater than 8,500 cfs every 3-5 years. Maintain scour channels on alternate bar surfaces. Threshold: Flows greater than 8,500 cfs every 3-5 years. Scour/redeposit spawning gravel deposits (at least to D_{84}). Threshold: Flows greater than 6,000 cfs every 2 or 3 years. Deposit fine sediment onto upper alternate bar and floodplain surfaces. Threshold: Flows greater than 6,000 cfs.	Lower rates of riparian encroachment through removal of 2- to 4-year old seedlings on alternate bars, re-establishment of various stages of diverse riparian plant stands. Anadromous spawning and rearing habitat. Channelwide habitat complexity.
Attribute 5. Balanced fine and coarse sediment budgets: River reaches export fine and coarse sediment at rates approximately equal to sediment inputs. The amount and mode of sediment storage within a given reach fluctuates but sustains channel geomorphology in dynamic equilibrium when averaged over many years. A balanced coarse sediment budget implies bedload continuity: most particle sizes of the channelbed must be transported through the river reach.	Reduce fine sediment storage in mainstem. Threshold: Qualitative based on fine sediment budget. Maintain coarse sediment budget in the mainstem. Threshold: Qualitative based on coarse sediment budget. Route mobilized D_{84} through alternate bar sequence. Threshold: 6,000 cfs every 2-3 years. Prevent excessive aggradation of tributary-derived material in mainstem. Threshold: 6,000-14,000 cfs every 2-3 years, or mechanical rehabilitation.	Improved spawning, rearing, and overwintering habitat. Reduced riparian fossilization. Maintenance of habitat complexity.

TABLE 3-1
Attributes of a Healthy Alluvial River System

Attributes	Physical Characteristics	Ecological Significance
Attribute 6. Periodic channel migration: The channel migrates at variable rates and establishes wavelengths consistent with regional rivers with similar flow regimes, valley slopes, confinement, sediment supply, and sediment caliber.	Create channel avulsions every 10 years. Threshold: 30,000 cfs every 10 years. Channel migrates in alluvial reaches. Threshold: 6,000 cfs. Maintain channel geometry as channel migrates. Threshold: 6,000 cfs.	Multi-age structure of cottonwoods and other species dependent on channel migration. Improved habitat for developing salmon. Refugia from high-flow and high-temperature conditions.
Attribute 7. A functional floodplain: On average, floodplains are inundated once annually by high flows equaling or exceeding bankfull stage. Lower terraces are inundated by less frequent floods, with their expected inundation frequencies dependent on norms exhibited by similar, but unregulated river channels. These floods also deposit finer sediment onto the floodplain and low terraces.	Encourage local floodplain surface scour and deposition by infrequent but larger floods. Threshold: 8,500 cfs every 3-5 years. Inundate the floodplain. Threshold: 6,000 cfs every 2-3 years. Floodplain construction keeps pace with floodplain loss on opposite bank. Threshold: 6,000 cfs.	Increased woody riparian overstory and understory species diversity. Physical processes conducive for early-successional riparian-dependent species, especially for birds and amphibians.
Attribute 8. Infrequent channel resetting floods: Single large floods (e.g., exceed-ing 10- to 20-year recurrences) cause channel avulsions, widespread rejuvenation of mature riparian stands to early-successional stages, side-channel formation and maintenance, and off-channel wetlands (e.g., oxbows). Resetting floods are as critical for creating and maintaining channel complexity as lesser magnitude floods.	Major reorganization of alternate bar sequence. Threshold: 30,000 cfs every 10-20 years. Infrequent deep scour on floodplain surfaces. Threshold: 24,000 cfs every 5-10 years. Remove upstream bedload impedance by distributing tributary delta materials. Threshold: 14,000 cfs. Deposit fine sediment on lower terrace surfaces. Threshold: 11,000-14,000 cfs. Construct and maintain/rejuvenate side channels. Threshold: 11,000 cfs, or mechanical rehabilitation.	Conversion of mature, less productive riparian habitats to highly productive, early-successional stages. Control populations of 3- to 4-year old saplings and scour stands of mature riparian vegetation. Creation of greater pool depths for adult fish cover and holding.

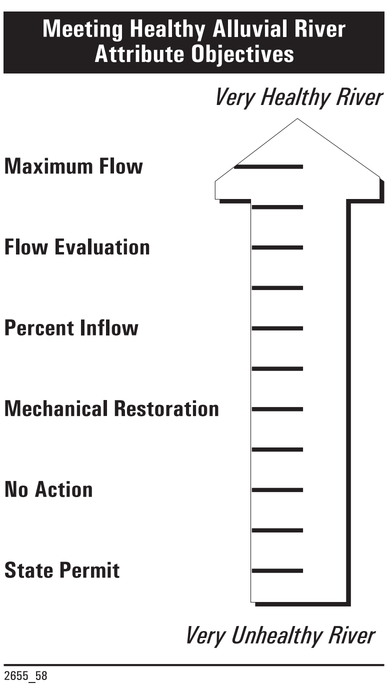
TABLE 3-1
Attributes of a Healthy Alluvial River System

Attributes	Physical Characteristics	Ecological Significance
Attribute 9. Self-sustaining diverse riparian plant: Natural woody riparian plant establishment and mortality, based on species' life history strategies, culminate in early- and late-successional stand structures and species' diversities (canopy and understory) characteristic of self-sustaining riparian communities common to regional, unregulated river corridors.	Periodic removal of individual mature riparian trees. Threshold: 14,000-30,000 cfs at least every 10 years. Scour of most established seedlings (2- to 3-year old plants). Threshold: 8,500-14,000 cfs. Scour of most initiating seedlings (0- to 1-year old plants). Threshold: 6,000 cfs, or mechanical rehabilitation. Seed deposition on floodplains. Threshold: 5,000-6,000 cfs every 2-3 years. Prevent seedling germination on lower bar surfaces. Threshold: 1,500-2,000 cfs.	Increased wood riparian overstory and understory diversity. Increased patchwork of riparian stands. Increased diversity in age of riparian stands.
Attribute 10. Naturally fluctuating groundwater table: Interannual and seasonal groundwater fluctuations in floodplains, terraces, sloughs, and adjacent wetlands occur, similar to regional, unregulated river corridors.	Groundwater recharge of terraces and associated wetland habitats. Threshold: 10,000-14,000 cfs. Groundwater recharge of floodplains and off-channel wetland habitats. Threshold: 6,000 cfs. Groundwater recharge of gravel bars. Threshold: 1,500-2,000 cfs.	High diversity of habitat types within the entire river corridor.

Total attribute scores represent a spectrum of river health from 0-10 where a river with all 10 attributes is considered a very healthy river, and a river with 0 attributes is considered a very unhealthy river. The physical characteristics and ecological significance of each attribute is described in Table 3-1.

Most of the alluvial river attributes and associated characteristics are achieved by a specific Trinity River flow magnitude and frequency. Flow thresholds for restoring and maintaining the physical characteristics are listed in Table 3-1 and Figure 3-8. The thresholds are based on the best available scientific information.

Each alternative was evaluated to determine which thresholds (both quantified and qualified) of the 10 attributes were met, and the frequency they were met (Table 3-2). Most of the characteristics were given a rating of “no,” “some,” or “yes.” A “no” rating reflects a complete inability to achieve the characteristic. A “some” rating reflects a partial achievement of the characteristic. A “yes” rating represents an ability to fully achieve the characteristic for the required duration and frequency. The frequency for a threshold flow was assumed to be 12 percent of all years (i.e., it would have to occur in all extremely wet years) to meet that attribute, unless another frequency was identified (Table 3-2). Attributes 1, 2, and 5 used different rating systems. Attribute 1 is an integration of other attributes. Attribute 2 evaluated the seasonal and annual variations present in each alternative. Attribute 5 partially used the above ranking system, but also used a qualitative analysis of each alternative’s ability to balance sediment budgets in the Trinity Basin.



Changes to the geomorphic environment of the Lower Klamath River Basin / Coastal Area and Central Valley were not evaluated because the relatively large influence of tributary flows in these basins negate the effects of changes in TRD operations.

<u>Significance Criteria</u>. Significance criteria were not developed for this section because it was determined that changes in the geomorphic environment lead to impacts to other resources, such as fish or wildlife habitats, which are discussed and assessed in other sections and include significance criteria as appropriate.

Predicted Riverine Conditions by Alternative.

Table 3-2 compares the relative abilities of the alternatives to create geomorphic effects as measured by healthy river attributes.

<u>No Action</u>. This alternative would maintain the current release schedule from Lewiston Dam and existing fishery restoration programs. Some of these restoration programs have geomorphic implications including:

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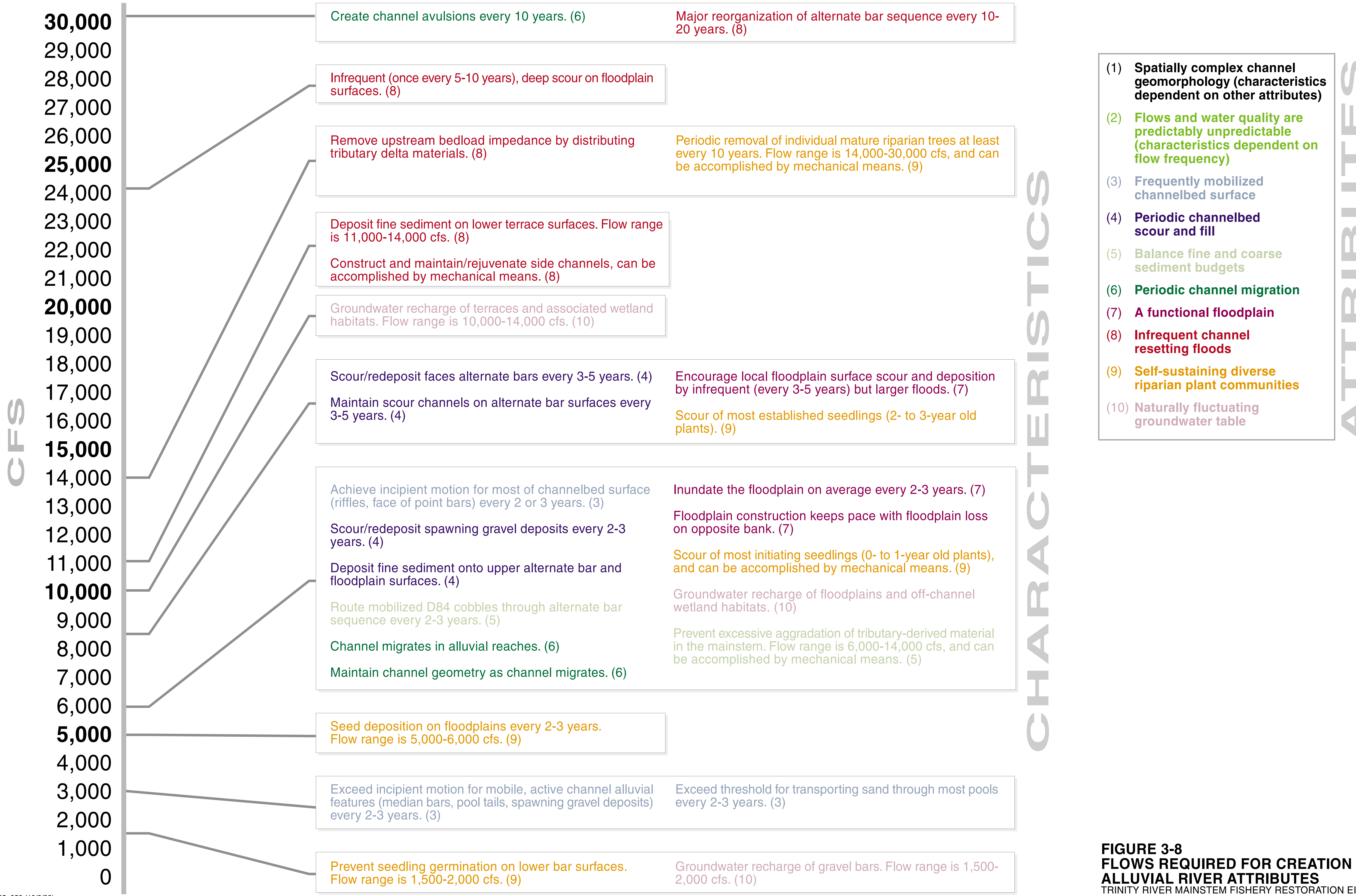

FIGURE 3-8
FLOWS REQUIRED FOR CREATION OF ALLUVIAL RIVER ATTRIBUTES
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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TABLE 3-2
Predicted Riverine Conditions by Alluvial River Attribute for Each Alternative Relative to No Action

Attributes	Thresholds	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
1. Spatially complex channel geomorphology		Geomorphology will remain channelized by berms, resulting in simplified channel.	Complexity of the channel will increase substantially riverwide, approaching pre-dam geomorphology.	Complexity will increase substantially throughout the river and especially at rehabilitation sites.	Complexity will increase, especially at rehabilitation sites.	Complexity will likely only increase at rehabilitation sites.	Channelization will continue, and simplification of geo-morphology will increase.	Geomorphology is channelized by berms, resulting in simplified channel.
	Sum of scores for all attributes	1 Yes, 3 Some, 29 No	24 Yes, 6 Some, 3 No	18 Yes, 7 Some, 8 No	6 Yes, 5 Some, 22 No	2 Yes, 7 Some, 24 No	0 Yes, 0 Some, 33 No	1 Yes, 3 Some, 29 No
Restore alluvial channel (self-forming bed particle and bank dimensions).								
Create and/or maintain structural complexity of alternate bar sequences.								
Create and maintain functional floodplains.								
Increase diversity of channelbed particle size.								
Greater topographic com-plexity in side channels.								
2. Flows and water quality are predictably unpredictable		Flows will follow the same release schedule every water-year class (no inter-annual variation). Some intra-annual variability occurs during snowmelt peak and recession periods.	Five different water-year classes provide interannual variation. Intra-annual variability occurs during snowmelt peak and recession periods.	Five different water-year classes provide interannual variation. Intra-annual variability occurs during snowmelt peak and recession periods.	Each water year is unique because it is backed on actual hydrology. Intra-annual variability occurs throughout the years.	Same as No Action.	Flows will follow the same release schedule every water-year class (no inter-annual variation). Almost no intra-annual variation occurs.	Flows have generally followed a similar release pattern, although some adjustments have been made for safety of dam releases and resource management (i.e., pulse flows, etc.), depending on year class.
Provide inter- and intra-annual flow variation for summer baseflows.	Variable flows between July 1 and October 1	No	No	No	Yes	No	No	No
Provide inter- and intra-annual flow variation for winter baseflows.	Variable flows between January 1 and April 1	No	No	No	Yes	No	No	No
Provide inter- and intra-annual flow variation for winter floods.	Variable flows between October 1 and April 30	No	No	No	Some	No	No	No
Provide inter- and intra-annual flow variation for snowmelt peak periods.	Variable flows between April 1 and June 30	Some	Yes	Yes	Yes	Some	No	Some
Provide inter- and intra-annual flow variation for snowmelt recession.	Variable flows between May 1 and July 31	Some	Yes	Yes	Yes	Some	No	Some
3. Frequently mobilized channelbed surface		Channelbed will not be mobilized by peak flows.	Channelbed will be frequently mobilized.	Channelbed will be frequently mobilized.	Channelbed will be mobilized to some extent.	Channelbed will not be mobilized, but mechanical dredging of pools will remove sand from pools.	Same as No Action.	Channelbed will not be mobilized by peak flows.
Achieve incipient motion for most of channelbed surface (riffles, face of point bars).	6,000 cfs every 2 of 3 years	No	Yes	Yes	No	No	No	No
Exceed incipient motion for mobile, active channel alluvial features (median bars, pool tails, spawning gravel deposits).	3,000 cfs every 2 of 3 years	No	Yes	Yes	Some	No	No	No

TABLE 3-2
Predicted Riverine Conditions by Alluvial River Attribute for Each Alternative Relative to No Action

Attributes	Thresholds	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
Exceed threshold for transporting sand through most pools.	3,000 cfs or mechanical every 2 of 3 years	No	Yes	Yes	Yes	Some	No	No
4. Periodic channelbed scour and fill		Peak flows are insufficient to cause the channelbed to scour and fill.	Peak flow of 30,000 cfs will cause channelbed scour and fill, but threshold flows are not met as frequently.	Periodic channelbed scour and fill will occur with necessary frequencies.	Peak flows will cause minimal channelbed scour and fill, but threshold flows do not occur with necessary frequencies.	Same as No Action.	Same as No Action.	Peak flows are insufficient to cause the channelbed to scour and fill.
Scour/redeposit faces of alternate bars (at least to D_{84}).	8,500 cfs every 3-5 years	No	Some	Yes	No	No	No	No
Maintain scour channels on alternate bar surfaces.	8,500 cfs every 3-5 years	No	Some	Yes	No	No	No	No
Scour/redeposit spawning gravel deposits (at least to D_{84}).	6,000 cfs every 2-3 years	No	Yes	Yes	No	No	No	No
Deposit fine sediment onto upper alternate bar and floodplain surfaces.	6,000 cfs	No	Yes	Yes	No	No	No	No
5. Balanced fine and coarse sediment budgets		Coarse and fine sediments will continue to be in oversupply. Flows are unable to route all sediment.	Coarse and fine sediments budgets will be at a notably improved balance. Flows are able to route all sediment.	Coarse and fine sediments budgets will be at a notably improved balance. Flows are able to route most sediment.	Coarse and fine sediments budgets will be somewhat improved. Flows are able to route some sediment.	Fine sediment budget will be somewhat improved, but coarse sediment will continue to be in oversupply. Flows are unable to route all sediment.	Fine and coarse sediment accumulation will increase, and both will continue to be in oversupply. Flows are unable to route almost all sediments.	Coarse and fine sediments will continue to be in oversupply. Flows are unable to route all sediment.
Reduce fine sediment storage in mainstem.	Qualitative based on fine sediment budget	No Change	Notably improved balance	Notably improved balance	Somewhat improved balance	Somewhat improved balance	Worsened balance	No Change
Maintain coarse sediment budget in the mainstem.	Qualitative based on coarse sediment budget	No Change	Notably improved balance	Notably improved balance	Somewhat improved balance	No Change	Worsened balance	No Change
Route mobilized D_{84} through alternate bar sequence every 2 of 3 years.	6,000 cfs	No	Yes	Yes	No	No	No	No
Prevent excessive aggradation of tributary-derived material in mainstem.	6,000-14,000 cfs and/or mechanical delta manipulation	No	Yes	Some	No	No	No	No
6. Periodic channel migration		Peak flows will not cause channel avulsions or migration, and will not maintain channel geometry.	Channel avulsions will occur during 30,000-cfs peak flow in extremely wet years. Some channel migration will occur. Channel geometry will be maintained by flows.	Peak flows will not cause channel avulsions. Some migration will occur. Channel geometry will be maintained by flows.	Peak flows will not cause channel avulsions. Minimal migration will occur. Channel geometry will be maintained by flows, although the frequency of maintenance flows are less than needed.	Same as No Action.	Same as No Action.	Peak flows will not cause channel avulsions or migration, and will not maintain channel geometry.
Create channel avulsions every 10 years.	30,000 cfs	No	Yes	No	No	No	No	No
Channel migrates in alluvial reaches.	6,000 cfs	No	Some	Some	No	No	No	No
Maintain channel geometry as channel migrates.	6,000 cfs	No	Yes	Yes	No	No	No	No

TABLE 3-2
Predicted Riverine Conditions by Alluvial River Attribute for Each Alternative Relative to No Action

Attributes	Thresholds	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
7. A functional floodplain		Floodplain characteristics will not be present because of lack of high flows and presence of berms.	Floodplain characteristics will be present, although larger floods will be less frequent than needed.	Floodplain characteristics will be present.	Floodplain characteristics will be present to some degree, although larger floods will be much less frequent than needed.	Same as No Action.	Same as No Action.	Floodplain characteristics will not be present because of lack of high flows and presence of berms.
Encourage local floodplain surface scour and deposition by infrequent (every 3-5 years) but larger floods.	8,500 cfs	No	Some	Yes	No	No	No	No
Inundate the floodplain on average every 2 of 3 years.	6,000 cfs	No	Yes	Yes	No	No	No	No
Floodplain construction keeps pace with floodplain loss on opposite bank.	6,000 cfs	No	Yes	Yes	No	No	No	No
8. Infrequent channel resetting floods		Peak flows will not be large enough to reset channel nor create most objectives for this attribute. Mechanical maintenance of 18 constructed side channels will occur.	Peak flow of 30,000 cfs in extremely wet year types will create all objectives for this attribute.	Peak flows will not be large enough to create most objectives for this attribute. Peak flows will deposit fine sediment. Mechanical maintenance of constructed side channel will occur.	Peak flows will not be large enough to create all objectives for this attribute. Mechanical maintenance of constructed side channel will occur.	Same as No Action.	Same as No Action.	Peak flows will not be large enough to reset channel nor create most objectives for this attribute. Mechanical maintenance of 18 constructed side channels will occur.
Major reorganization of alternate bar sequence every 10-20 years.	30,000 cfs	No	Yes	No	No	No	No	No
Infrequent (once every 5-10 years), deep scour on floodplain surfaces.	24,000 cfs	No	Yes	No	No	No	No	No
Remove upstream bedload impedance by distributing tributary delta materials.	14,000 cfs	No	Yes	No	No	No	No	No
Deposit fine sediment on lower terrace surfaces.	11,000-14,000 cfs	No	Yes	Some	No	No	No	No
Construct and maintain/ rejuvenate side channels.	11,000 cfs or mechanical	No	Yes	Some	Some	Some	No	No
9. Self-sustaining diverse riparian plant communities		Simplified riparian communities will continue to grow uninhibited on berms. No flows will scour vegetation.	All of the characteristics of diverse riparian communities will be present. Early-successional communities will often be present on bars; mature trees in mid- to low-floodplain will be scoured; cottonwoods will establish high on outer margins of the floodplain.	Most of the characteristics of diverse riparian communities will be present, except periodic removal of mature riparian trees will not occur. Early- succesional communities will often be present on bars; cottonwoods will establish high on outer margins of the floodplain.	Some of the characteristics of diverse riparian communities will be present to a minimal degree. Removal of mature trees will not occur. Early-succesional communities will be present on some bars after large releases, but are not scoured as frequently as necessary.	Same as No Action, except some characteristics will be met by mechanical means at bank restoration sites where mature trees will be periodically removed, and seedlings on rehabilitated gravel bars will be removed by mechanical means.	Similar to No Action, except vegetation on riparian berms is likely to increase.	Simplified riparian communities will continue to grow uninhibited on berms. No flows will scour vegetation.
Periodic removal of individual mature riparian trees at least every 10 years.	14,000-30,000 cfs or mechanical	No	Yes	No	No	Yes	No	No
Scour of most established seedlings (2- to 3-year old plants).	8,500-14,000 cfs	No	Yes	Some	No	Some	No	No
Scour of most initiating seedlings (0- to 1-year old plants).	6,000 cfs or mechanical	No	Yes	Yes	No	Some	No	No

TABLE 3-2
Predicted Riverine Conditions by Alluvial River Attribute for Each Alternative Relative to No Action

Attributes	Thresholds	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
Seed deposition on flood-plains every 2-3 years.	5,000-6,000 cfs	No	Yes	Yes	Some	No	No	No
Prevent seedling germination on lower bar surfaces.	1,500-2,000 cfs	No	Some	Some	Some	No	No	No
10. Naturally fluctuating groundwater table		Peak flows will recharge inchannel groundwater, but not those in the floodplain and outside of the main channel.	Peak flows will recharge inchannel groundwater, groundwaters outside of the main channel, and some in the floodplain.	Peak flows will recharge inchannel groundwater, but recharge will seldome occur in the floodplain, or outside of the main channel.	Peak flows will recharge inchannel groundwater, but recharge will seldom occur in the floodplain, or outside of the main channel.	Same as No Action.	Minimal groundwater recharge is expected.	Peak flows will recharge inchannel groundwater, but not those in the floodplain and outside of the main channel.
Groundwater recharge of terraces and associated wetland habitats.	10,000-14,000 cfs	No	Some	Some	No	No	No	No
Groundwater recharge of floodplains and off-channel wetland habitats.	6,000 cfs	No	Yes	Yes	No	No	No	No
Groundwater recharge of gravel bars.	1,500-2,000 cfs	Yes	Yes	Yes	Yes	Yes	No	Yes

- Dredging of the sediment control ponds on Grass Valley Creek
- Placing spawning gravels inriver to compensate for the loss of supply upstream of the dams
- Continuing operation of Buckhorn Reservoir

(No Action is unable to create most of the characteristics of a healthy alluvial river.)

Peak flows would be fixed at 2,000 cfs in all water-year classes (excluding uncontrolled spill events).

Flows in the No Action Alternative are too low to support most of the characteristics of a healthy alluvial river. However, these flows would support several characteristics of three attributes (Table 3-1).

Maximum Flow (would) use all available Trinity River water (and)…result in very substantial improvements in the geomorphic environment.

Maximum Flow. The Maximum Flow Alternative was designed to use all available Trinity River water to restore the river to a pre-dam geomorphology (i.e., there would be no water exported from the river). These large flow releases are designed to restore and maintain river habitats along the entire length of the channel, rather than at discrete restoration sites. Based on healthy alluvial river attributes, this alternative would result in very substantial improvements in the geomorphic environment compared to the No Action Alternative.

(Flow Evaluation would) use a combination of increased flow and mechanical manipulations (and)…result in substantial improvements in the geomorphic environment.

Flow Evaluation. This alternative was designed to use a combination of increased flow and mechanical manipulations to restore the Trinity River to a pre-dam geomorphology, but on a smaller scale than the pre-dam river, such that meander wavelength and the length of a single bend (Figure 3-4) would be less than those of the pre-dam river. Based on healthy alluvial river attributes, this alternative would result in substantial improvements in the geomorphic environment compared to the No Action Alternative.

(Percent Inflow would release) 40 percent of the previous week's inflow…(and) result in an improvement in the geomorphic environment.

Percent Inflow. Flows for this alternative would vary each year, both in quantity and timing, by releasing 40 percent of the previous week's inflow to Trinity Reservoir. This schedule would create a schedule that mimics each year's unimpaired flow, but on a reduced, dampened schedule. One notable aspect of this schedule is that releases would tend to follow the same pattern as Trinity River tributary flows, which might increase the geomorphic efficiency of releases by piggy-backing on tributary flows. However, because using a weekly average reduces instantaneous peak flows, this alternative does not meet many of the mid-range flows necessary for creating and maintaining some attributes. Based on healthy alluvial river attributes, this alternative would result in an improvement in the geomorphic environment compared to the No Action Alternative.

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(Mechanical Restoration) addresses some attributes, but the benefits are largely limited to specific rehabilitation sites … (it) would result in a slight improvement.

Mechanical Restoration. The proposed mechanical work does address some attributes, but the benefits are largely limited to specific rehabilitation sites. The additional bank rehabilitation projects proposed in this alternative are specifically designed to improve geomorphic aspects of the river by re-shaping the channel at specific sites. Mechanical manipulations of the channel are unable to address some attributes that are flow dependent, such as deposition and sorting of sediments within a meander, as depicted on Figure 3-7. Although the flow release schedule is the same as the No Action Alternative, the additional mechanical restoration in this alternative would result in a slight improvement over the No Action Alternative.

Scheduled flows under (State Permit) are too low to effectively create any of the healthy alluvial river attributes … accordingly, the geomorphic environment would experience additional degradation.

State Permit. This alternative reduces total annual flows back to 120,500 af. Scheduled flows under this alternative are too low to effectively create any of the healthy alluvial river attributes. Berm formation, fine sediment accumulation, riparian encroachment, and degradation of riverine habitats is expected to continue. Accordingly, the geomorphic environment would experience additional degradation compared to the No Action Alternative.

Existing Conditions versus Preferred Alternative. Implementation of the Preferred Alternative would substantially restore river health compared to existing (1995) conditions. The greater volumes of water associated with the Preferred Alternative (369-815 taf/yr) can be better managed to restore and maintain a healthy alluvial river than the volume available with existing conditions (340 taf/yr). Because the Preferred Alternative also includes the watershed protection component of the Mechanical Restoration Alternative, it would likely further improve the geomorphic environment over existing conditions due to the expected decline in fine sediment input to the Trinity River (although the healthy alluvial river model was not sensitive to such improvements).

Mitigation. Significance criteria were not developed for impacts to the geomorphic environment; therefore, no mitigation is required.

3.3 Water Resources

3.3.1 Surface-water Hydrology and Management

Affected Environment. This section describes the hydrology and management of water associated with CVP operations. Because operations span the Trinity River Basin and Central Valley areas, the discussion of operations and facilities is included in both geographic areas as appropriate.

Trinity River Basin. The Trinity River drains a watershed of approximately 2,965 square miles, about one-quarter of which is above Lewiston Dam. Elevations range from 8,888 feet mean sea level (msl) at Sawtooth Mountain in the Trinity Alps to 300 feet msl at the confluence of the Trinity and Klamath Rivers. Average precipitation for this watershed is approximately 62 inches per year; throughout the basin it varies from 30-70 inches and typically occurs as rain in the lower elevations and snow at the higher elevations.

The Trinity River is the largest tributary to the Klamath River. The mainstem Trinity River flows a total of 170 miles from its headwaters to its confluence with Klamath River at Weitchpec, 43.5 miles upstream from the Pacific Ocean. Trinity and Lewiston Dams currently regulate Trinity River flows below RM 112 (see Figure 3-3). Prior to the completion of the TRD, flows in the Trinity River were highly variable, ranging from summer flows of 25 cfs to extreme winter events with instantaneous peak flows greater than 100,000 cfs. Annual hydrographs typically followed a seasonal pattern of high winter and spring flows followed by low summer and fall flows. Total annual flow volumes at Lewiston ranged from 0.27-2.7 maf, with an average of 1.2 maf.

The TRD was authorized in 1955 and began operating in 1964. The TRD consists of a series of dams, tunnels, and powerplants that export water from the Trinity River Basin into the Sacramento River Basin. With a capacity of 2.4 maf, Trinity Reservoir is the centerpiece of the TRD. Releases from Trinity Reservoir are re-regulated in Lewiston Reservoir prior to release downstream into the Trinity River. Lewiston Reservoir also acts as a forebay for the trans-basin export of water into Whiskeytown Reservoir via the Clear Creek Tunnel.

The TRD consists of a series of dams, tunnels, and powerplants that export water from the Trinity River Basin into the Sacramento River Basin.

Since operation of the dam in 1964, an average of 74 percent of the river's flows has been exported annually, or about 988,000 af. In recent years (1985-1997) annual exports have decreased to an average of 732,400 af. Conversely, post-dam Trinity River flows at Lewiston have been as low as 121,000 af annually (10 percent of pre-dam levels). Currently, releases to the Trinity River are not less than

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340,000 af annually, as mandated by the 1992 CVPIA. Although these releases are larger than most from 1965-92, they still represent drought conditions (Figure 3-9). Based on records of pre-dam flows at Lewiston and post-dam inflow to Trinity Reservoir, 340,000 af approximates the third lowest flow since 1912.

All but the largest runoff events are retained in the reservoirs for later export or downstream release, eliminating most of the variability in flow below Lewiston Dam. The decrease in flows is most pronounced in the late winter and early spring months (January-June). From 1965-1992, post-dam flows (excluding unplanned releases) were a fairly constant 150-300 cfs year-round, as opposed to the pre-dam flows of 25-71,000 cfs or more. Since 1992, spring releases have occasionally ranged up to 6,000 cfs. Lewiston Dam releases are the major component of Trinity River flows until the confluence with the North Fork Trinity River. Downstream of the confluence the accretion of tributary inflows reduces the harmful effects of the TRD. Accordingly, the frequency and magnitude of flood events has decreased dramatically at Lewiston, but much less so at Burnt Ranch and Hoopa (approximately 60 and 100 miles downstream of Lewiston Dam, respectively). (See Geomorphic Environment [Section 3.2] for more information on pre- and post-dam conditions.)

Although flood control is not an expressly authorized function of the TRD, Reclamation's Safety of Dams criteria provide a measure of downstream flood control.

Although flood control is not an expressly authorized function of the TRD, Reclamation's Safety of Dams criteria provide a measure of downstream flood control. During the flood season, exports to the Central Valley are made to provide additional space within Trinity Reservoir as necessary (however, exports are not made if the Sacramento River is near flood stage).

TRD operations are integrated with operations of the Shasta Division of the CVP (Figures 3-10 and 3-11). For example, TRD exports have been made in consideration of minimum flow requirements in the Trinity and Sacramento Rivers, storage levels in Trinity and Shasta Reservoirs, and other CVP operating requirements (e.g., CVP deliveries, water quality requirements, the Winter-run Biological Opinion). Trinity Reservoir is also operated to maximize power production during the summer and fall, in coordination with the Shasta Division.

TRD exports are used in conjunction with releases from Shasta Reservoir to meet (Sacramento River) temperature requirements and manage the coldwater pool in Shasta Reservoir.

The Winter-run Biological Opinion mandates temperature requirements in the Sacramento River below Keswick Dam. Compliance with the Biological Opinion is a major influence on Shasta Division operations. TRD exports are used in conjunction with releases from Shasta Reservoir to meet temperature requirements and manage the coldwater pool in Shasta Reservoir. The majority of TRD exports

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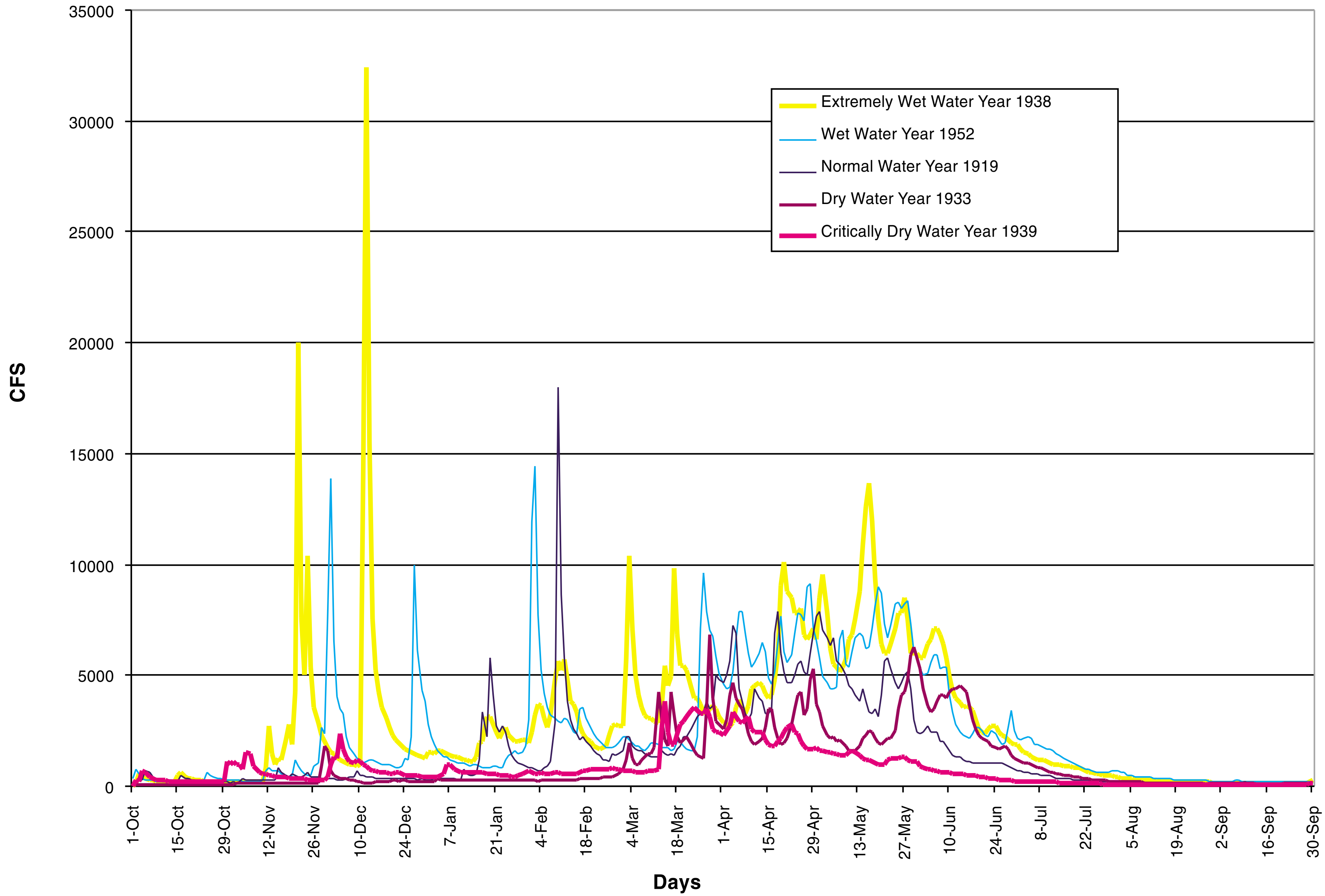

FIGURE 3-9
PRE-DAM DAILY FLOW COMPARISONS
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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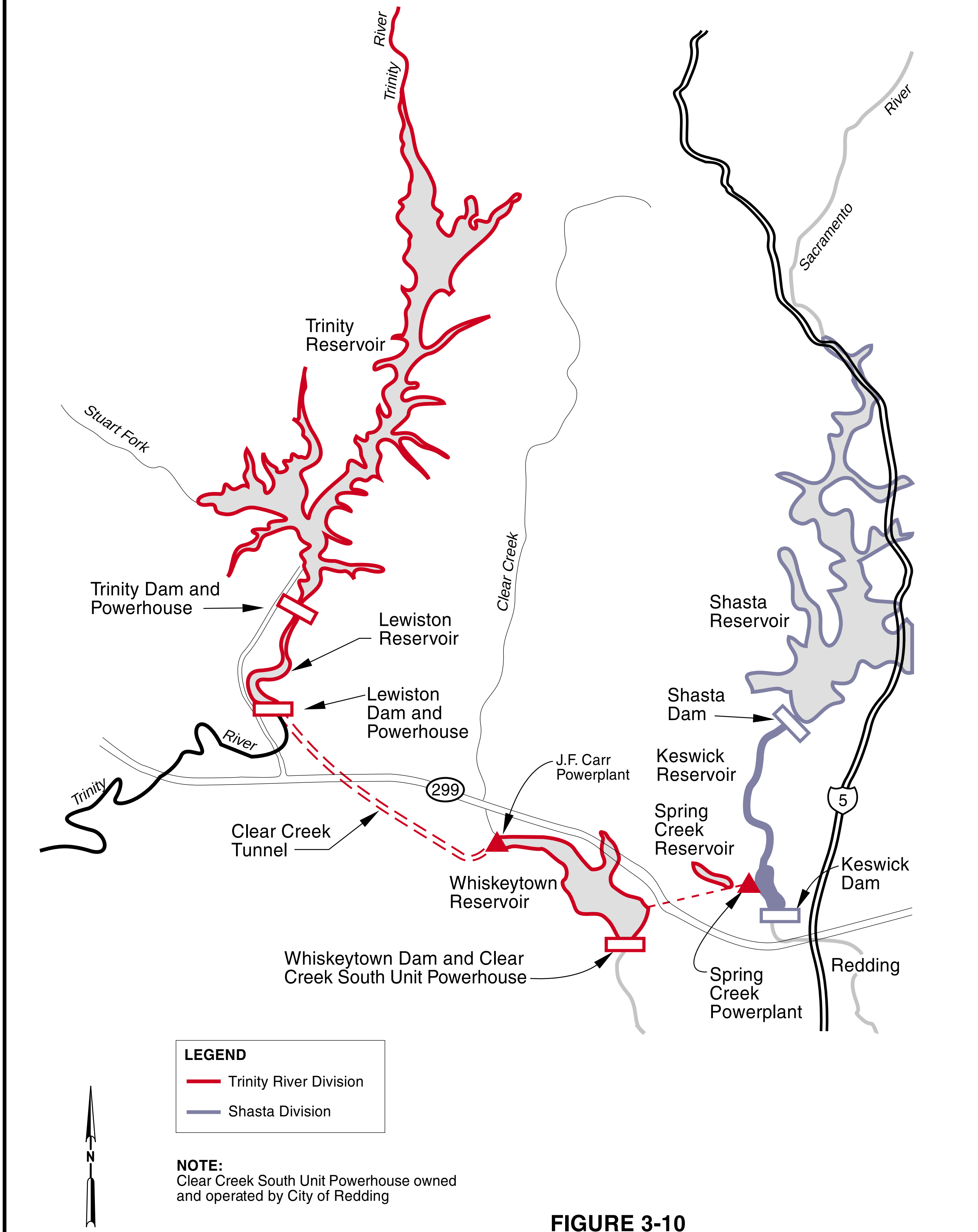

NOTE:
Clear Creek South Unit Powerhouse owned and operated by City of Redding

FIGURE 3-10
TRINITY RIVER DIVISION AND NEIGHBORING SHASTA DIVISION
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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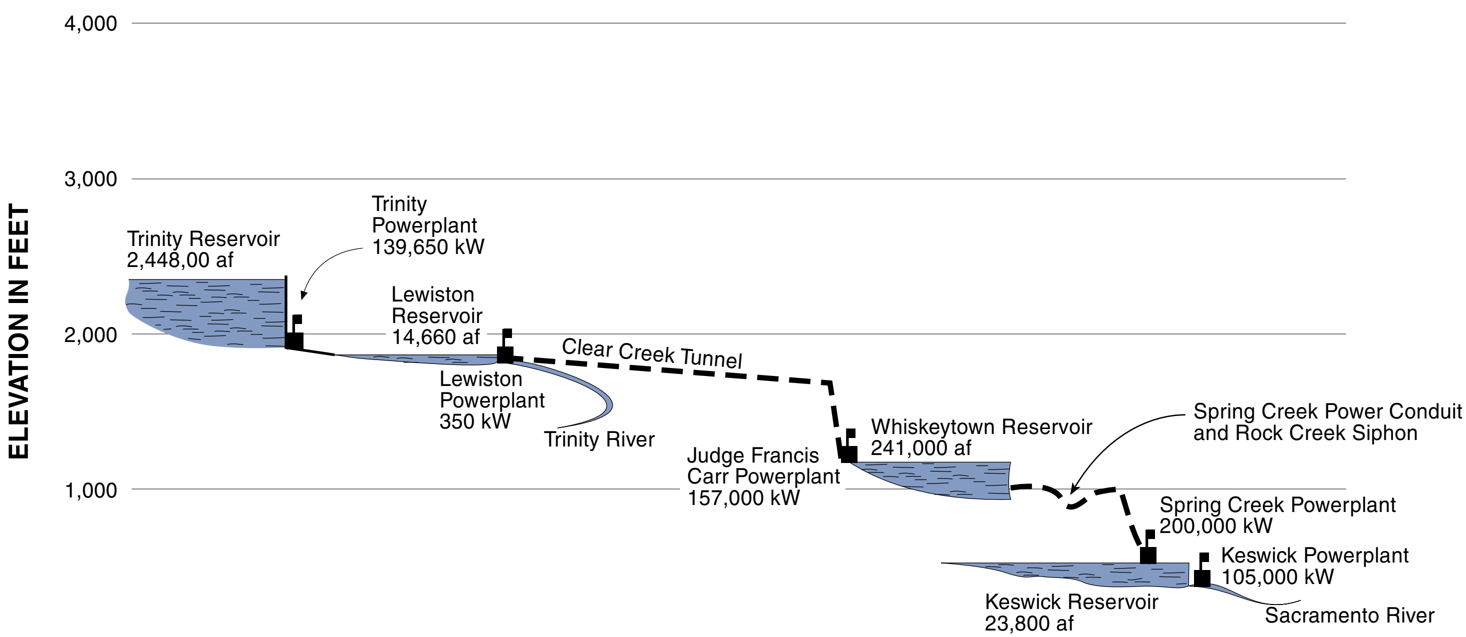

FIGURE 3-11
DEVELOPED PROFILE,
TRINITY RIVER DIVERSION
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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occur in the spring and summer. At the same time, temperature objectives to protect Trinity River salmon must also be met. Addressing the temperature needs of the two systems is but one of the factors driving operations.

TRD water is also used to dilute and transport acid mine drainage from the Spring Creek Debris Dam adjacent to Keswick Reservoir. The Spring Creek Debris Dam receives polluted runoff from Iron Mountain Mine, a superfund site (see Water Quality [Section 3.4]). Flows from the Spring Creek Powerplant are typically maintained at a minimum of 200 cfs to aid in diluting the polluted runoff and to avoid pollution events. This number should be considered very conservative given the current construction of metal emission control systems, as well the dilution capability of Clear Creek. Additional information on the operation of the TRD and CVP is provided in the Water Resources / Water Quality Technical Appendix A.

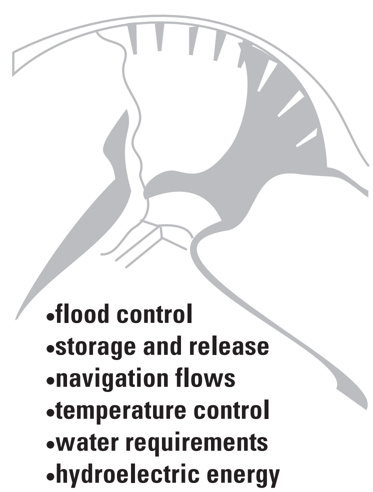
The CVP…is the largest surface-water storage and delivery system in California, covering 35 of the state's 58 counties.

Lower Klamath River Basin / Coastal Area. The Klamath River Basin is located adjacent to and north of the Trinity River Basin. It drains approximately 15,600 square miles. Basin elevations range from more than 9,500 feet msl at the headwaters near Mount McLoughlin to sea level at the mouth of the river. Discharge near the mouth of the Klamath River averages approximately 13 maf per year. Prior to dam completion, the Trinity River contributed approximately 33 percent of the flow at the mouth of the Klamath River. After dam completion, Trinity River contributions averaged 28 percent.

Central Valley. The CVP, of which the TRD and Shasta Division are key components, is the largest surface-water storage and delivery system in California, covering 35 of the state's 58 counties. The project includes 20 reservoirs, with a combined storage capacity of approximately 11 maf; and 9 powerplants and 2 pump-generating plants, with a combined generation capacity of approximately 2 million kW (Figures 3-12 and 3-13). Operations of the CVP are quite complex given the multiple demands that must be met. Key Shasta Division operational issues include:

- Flood control
- Storage and release of water for agricultural, M&I, fish and wildlife, refuges, and other needs
- Navigation flows
- Temperature control as specified by the 1993 Biological Opinion for Sacramento winter chinook salmon
- Bay-Delta water requirements
- Generation of hydroelectric energy

Shasta Division Operational Issues



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Historically, the vast majority of ***CVP water*** has been delivered to agricultural users. However, continued urban growth is resulting in greater demand from CVP M&I customers (see the Land Use section [3.9]). In contrast to the CVP, where most of the customers are agricultural, over 50 percent of the SWP deliveries go to urban areas, primarily in Southern California.

CVP operations are guided by a series of documents including the 1992 CVP-OCAP, various Biological Opinions for endangered species, the COA between the CVP and SWP, and regional Water Resources Control Board water quality plans. Additional information on the operation of the CVP and assumptions made for this analysis is provided in the Water Resources / Water Quality Technical Appendix A, as well as the CVPIA DPEIS and associated appendices (U.S. Bureau of Reclamation, 1997a).

With a capacity of 4.6 maf, Shasta Dam has the largest capacity of any reservoir in the state. Annual releases range from 9 maf in wet years to 3 maf in dry years.

Flows in the upper Sacramento River are primarily regulated by Shasta Dam and are re-regulated 15 miles downstream at Keswick Dam. The watershed above Shasta Dam drains approximately 6,650 square miles with an average annual runoff of 5.7 maf. With a capacity of 4.6 maf, Shasta Dam has the largest capacity of any reservoir in the state. Annual releases range from 9 maf in wet years to 3 maf in dry years. From 1964-1996, Keswick releases averaged 7.3 maf annually, of which TRD exports accounted for 14 percent. In recent years (1986-1996) Keswick annual releases averaged 5.9 maf, of which 12 percent was TRD export.

The Winter-run Biological Opinion is one of the most influential factors governing Shasta releases, both in terms of quantity and timing. The Biological Opinion sets temperature requirements below Keswick Dam for April through October, and established an end-of-September minimum carryover storage for Shasta Reservoir of 1.9 maf. In years when CVP facilities cannot be operated to meet required temperature and storage objectives, Reclamation re-initiates consultation with NMFS.

In order to meet daily temperature requirements at Bend Bridge (or Jellys Ferry in dry years) in the summer and early fall, Reclamation attempts to maintain a minimum coldwater pool in Shasta Reservoir, as well as Trinity and Whiskeytown Reservoirs, throughout the summer. Spring exports from the TRD allow cold water to be held in Shasta for summer release during the critical salmon incubation period. In addition, Reclamation operates the system to attempt to minimize warming within Whiskeytown Reservoir, which is prone to warming in a similar manner to Lewiston Reservoir. Excessive warming of Whiskeytown Reservoir can in turn require that additional Shasta releases be made to dilute warm Whiskeytown releases through Keswick. In general, CVP operations include bringing exports into Whiskeytown Reservoir in late May and June.

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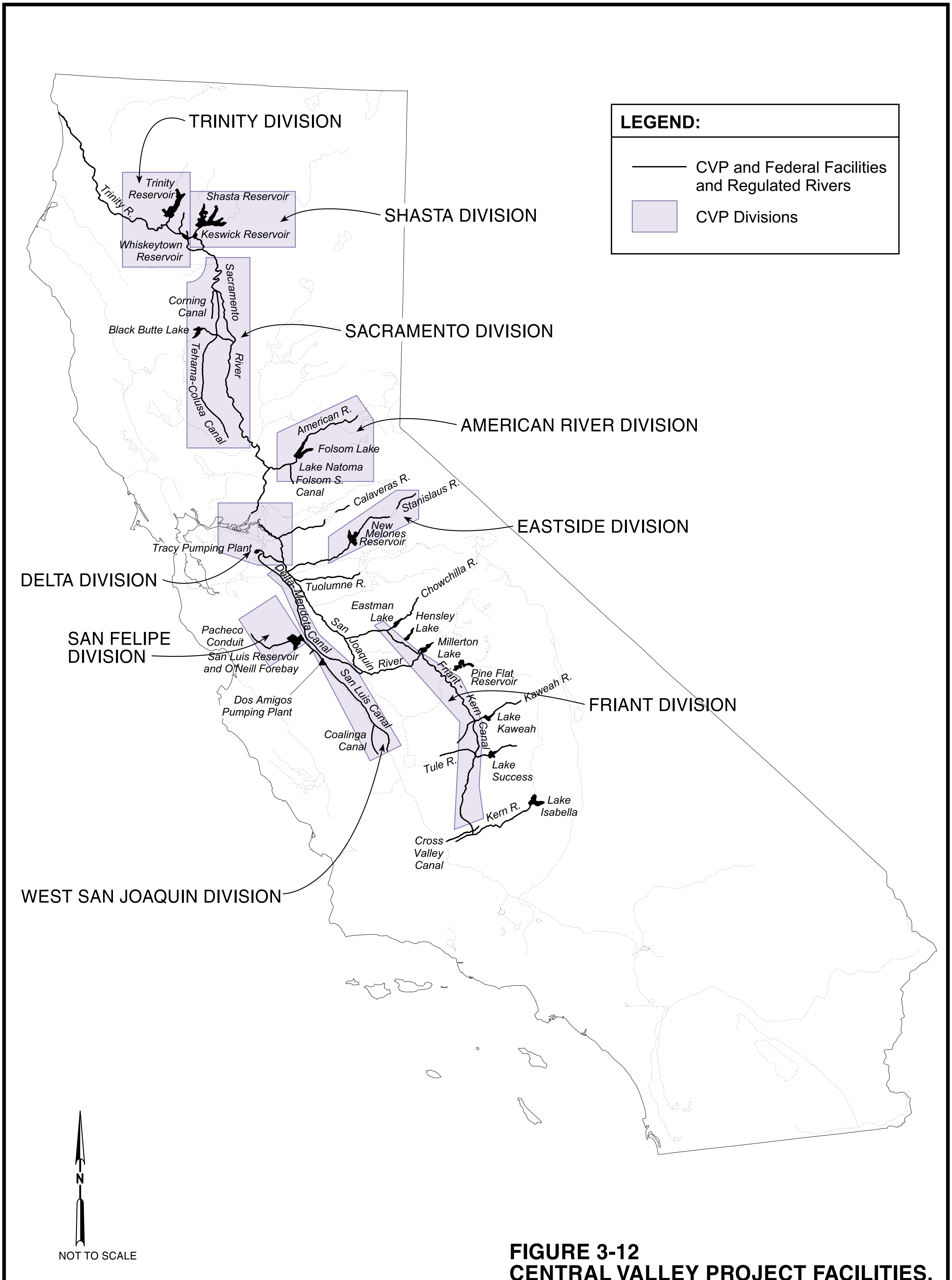

FIGURE 3-12
CENTRAL VALLEY PROJECT FACILITIES, REGULATED RIVERS, AND DIVISIONS
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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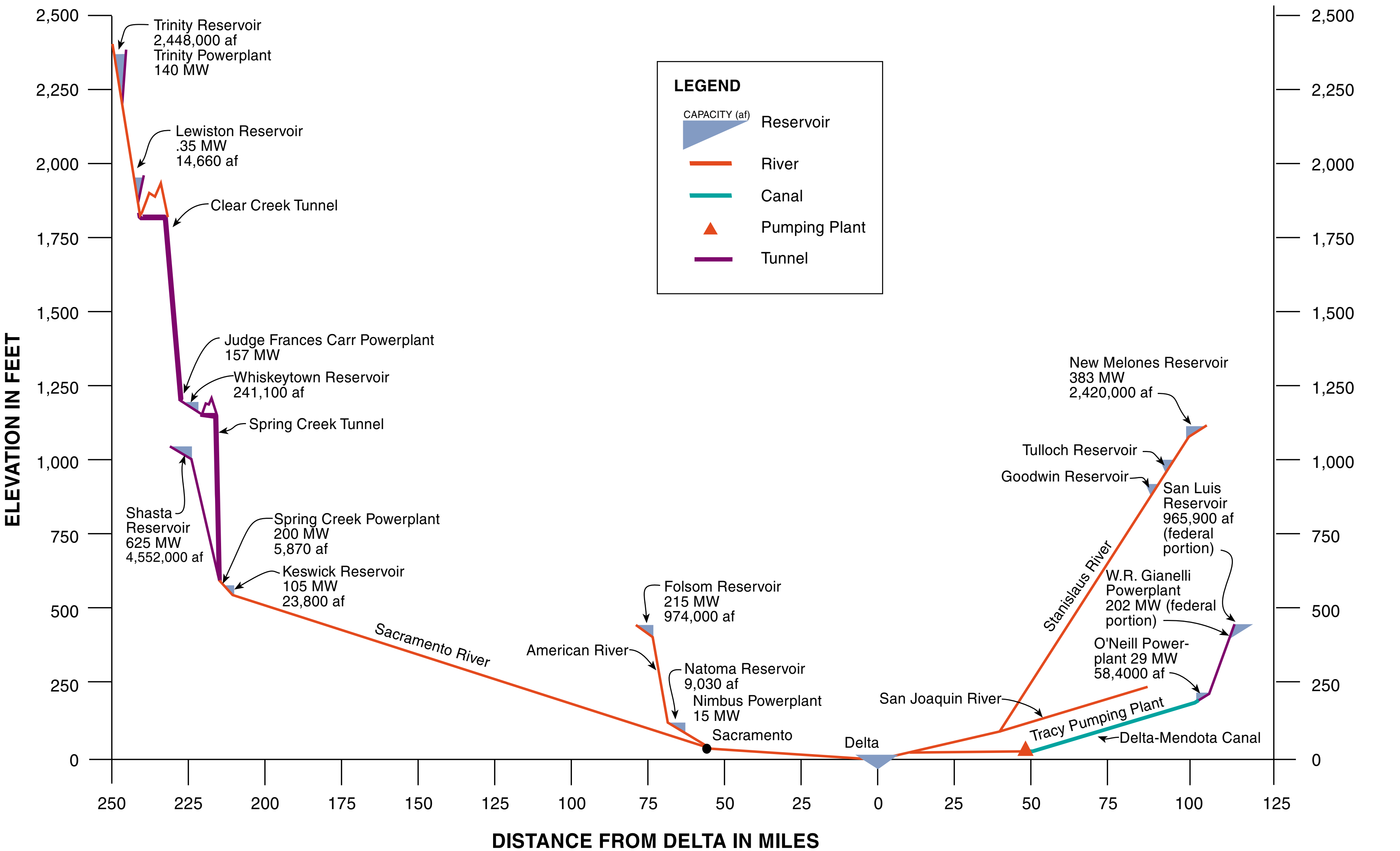

FIGURE 3-13
CENTRAL VALLEY PROJECT RIVER PROFILE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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Aside from making water available for downstream uses, exports for the remainder of the water year are managed to maximize the following:

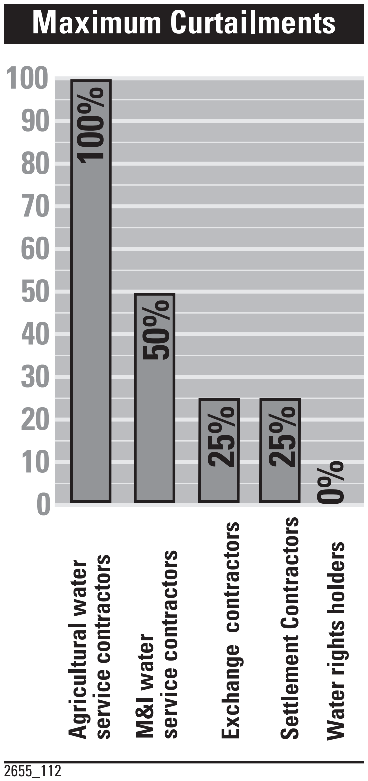
- Movement of water through Whiskeytown Reservoir to minimize warming
- Conservation of Shasta coldwater reserves
- Production of high-value summer and early fall power generation

The TRD water not only assists in Sacramento temperature needs, but is also used for agricultural, M&I, and Delta water quality purposes. (For additional discussion of temperature see the Water Quality [3.4] and Fishery Resources [3.5] sections). The agricultural contractors account for the vast majority of consumptive uses of water along the Sacramento River. Of the total amount that is diverted for agricultural use, the portion of the water that is applied to fields but is not actually used by crops is assumed to return to the Sacramento River either through surface water or ***groundwater***. This water is then available for other downstream uses, including CVP contractors within the Bay Area (e.g., Contra Costa Water District [CCWD]) or those served through Delta exports (e.g., the San Joaquin Exchange contractors, or agricultural and M&I ***water service contractors*** located south of the Delta).

The CVP supplies up to approximately 6.2 maf annually to water contractors in the Central and Santa Clara Valleys as well as Contra Costa County. (The Friant Division, which holds contracts for 1.9 maf, is not included in this discussion because those contractors are independent of CVP operations that may be affected by changes in the TRD.) The CVP is required by contracts to make deliveries up to the contract amount, if requested, except in periods of water shortage. During periods of reduced supply, water deliveries are decreased according to terms in the contracts. Contractors are grouped into three general categories:

1. Sacramento River Water Rights Settlement Contractors. These contractors claimed water rights in the Sacramento Basin prior to construction of Shasta Dam. Contract provisions allow for reductions of up to 25 percent of contracted amounts during dry conditions (as determined by the Shasta Inflow Index).

2. San Joaquin River Exchange Contractors. These contractors claimed water rights in the San Joaquin River and agreed to forgo these rights in exchange for CVP water diverted from the Bay-Delta and delivered to the Mendota Pool. Contract provisions allow for reductions of up to 25 percent of contracted amounts under dry conditions (as determined by the Shasta Inflow Index).



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3. CVP Water Service Contractors. These agricultural and M&I water service contractors entered into agreements with Reclamation for delivery of CVP water as a supplemental supply. Water deliveries to agricultural water service contractors can be reduced up to 100 percent in particularly dry years. Maximum curtailment levels are not specified for most M&I water service contractors. Historically, Reclamation has limited maximum curtailments to M&I contractors to 25 percent; future system demands are assumed to potentially require curtailments of up to 50 percent. Water availability for delivery to CVP water service contractors during periods of insufficient supply is determined based on a combination of operational objectives, hydrologic conditions, and reservoir storage conditions.

The Bay-Delta is located at the confluence of the Sacramento and San Joaquin Rivers and consists of a maze of channels, sloughs, and dredger cuts that drain to the ocean through an area of 1,200 square miles (Figure 3-14). Average annual flow into the Bay-Delta is about 27.8 maf, accounting for approximately 40 percent of all the surface water in California. The Sacramento Basin contributes approximately 75 percent of the freshwater flows into the Bay-Delta. Trinity River exports on average 4 percent of the annual Sacramento River inflow to the Bay-Delta. Annual Bay-Delta inflow varies widely, as evident during a recent 10-year period when annual flows ranged from 5.9 maf (1977) to 70 maf (1986).

Bay-Delta outflow is greatly influenced by tidal and seasonal variations. For example, average tidal flow (ebb or flood tide) at Chipps Island near Pittsburg is approximately 170,000 cfs, compared to an average net winter freshwater outflow of 32,000 cfs and a summer net outflow of 6,000 cfs. The effect of flows on salinity levels and other water quality parameters in the Delta are discussed in the Water Quality section (3.4).

Environmental Consequences.

Methodology. The following analysis and conclusions are based on the results obtained from the PROSIM model. The lead agencies have used this model because it represents the “state of the art” methodology for assessing impacts to the hydrological system potentially affected by the project alternatives. PROSIM is a monthly planning model designed to simulate the hydrologic system comprised of the CVP and SWP. This model uses a modified hydrologic sequence that is meant to be representative of future hydrology. Operations of the CVP and SWP for the purposes of water supply, flood control, recreation, maintenance of instream flows, water quality, fish and wildlife, hydroelectric power generation, etc., are defined by the user via input data files. The model is intended to be a tool to aid the user in determining impacts

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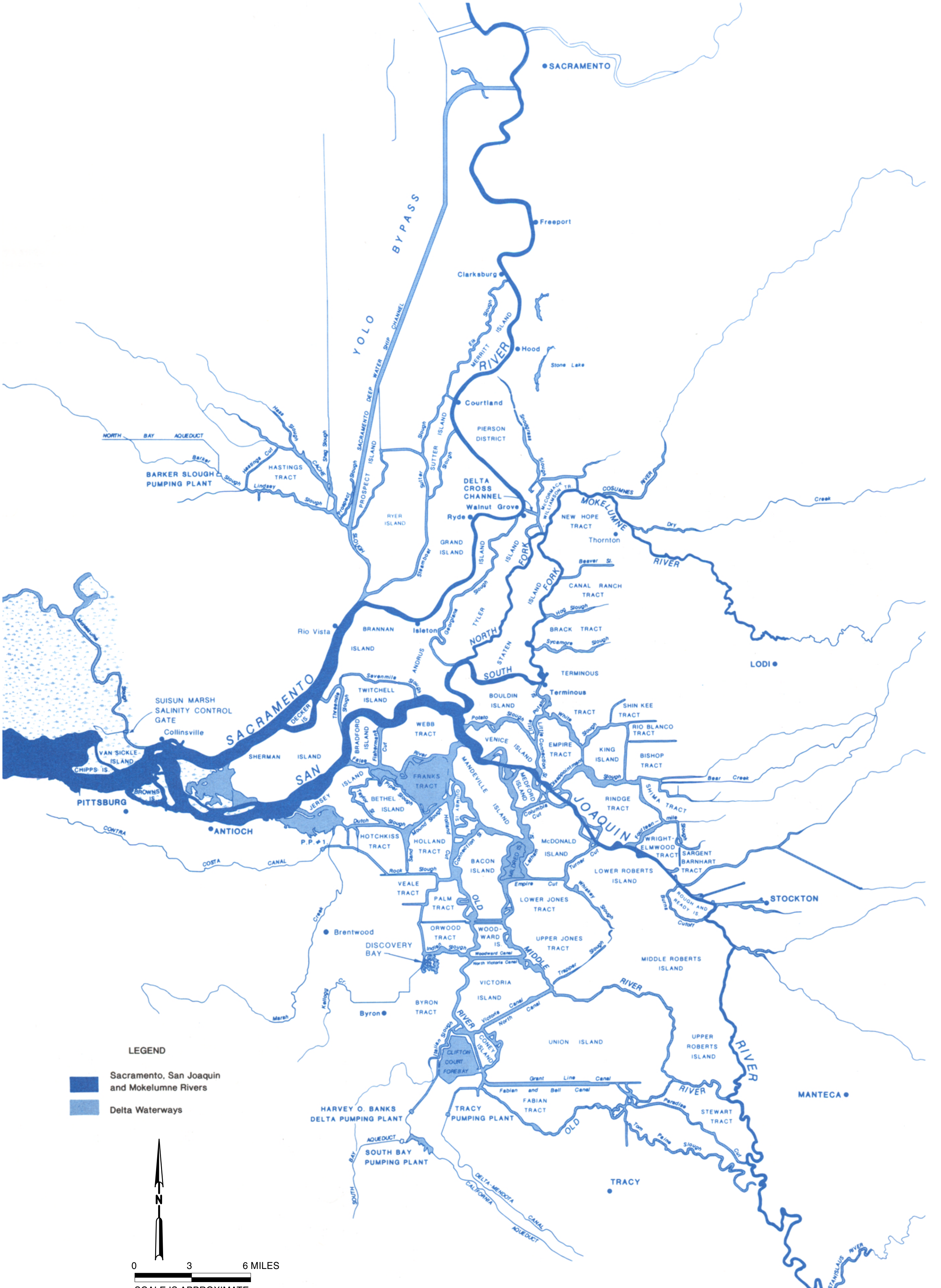

SOURCE: Department of Water Resources, *Sacramento-San Joaquin Delta Atlas*

FIGURE 3-14
DELTA WATERWAYS
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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of proposed changes to the system. As a monthly model, PROSIM does not account for the complex changes associated with daily operations. A more detailed description of the PROSIM model and primary assumptions is provided in the Water Resources/Water Quality Technical Appendix A, as well as the CVPIA PEIS and associated appendices.

The modeling assumptions used by the PROSIM model represent the best efforts of expert hydrologists to mimic the CVP and SWP, and to predict future changes to the systems. PROSIM separates the CVP and SWP into a number of nodes that can each be assigned operational rules for inputs (i.e., streamflow from upstream areas) or outputs (i.e., water diversions). Accordingly, assumptions as to inputs and outputs are key when determining what effects are to be studied. The nodes are interconnected such that they approximate the flow of water in the joint CVP-SWP systems. Future projections are based on the assumption that the hydrology that occurred and was recorded over an approximately 70-year period (1922-1992) is representative of the range of hydrology that will again occur in the future. Particularly dry (1928-1934) and wet (1967-1971) periods over the historical record can be isolated to simulate such conditions again occurring. This allows for the identification of simulated water supply impacts that would occur if such scenarios were to occur in the future under any of the project alternatives. Key facilities for which operations are modeled include:

- Trinity/Lewiston, Whiskeytown, Shasta/Keswick Reservoirs
- Folsom/Natoma Reservoirs
- San Luis Reservoir
- Oroville Reservoir (SWP)
- Tracy (CVP) and Banks (SWP) pumping plants

Thus, key operational parameters to the Trinity River Basin include Trinity River flows and associated exports to the Central Valley, as well as carryover storage in Trinity Reservoir. Key operational parameters in the Central Valley include Trinity exports via the Clear Creek Tunnel through the Spring Creek Powerhouse, carryover storage at Shasta Reservoir, CVP deliveries (both north and south of the Delta), and inflow and outflow within the Bay-Delta.

The PROSIM model has been used on numerous occasions by Reclamation internally to assess the impact of proposed changes (e.g., Bay-Delta standards, re-circulation of Delta-Mendota Canal [DMC] flows) with regard to project water supply reliability given it is Reclamation’s primary water management modeling tool. Other recent processes and/or environmental documentation efforts of state-wide significance using the model include:

- Central Valley Project Improvement Act PEIS
- CALFED
- Consolidated and Expanded Place of Use
- Interim Folsom Re-operation
- American River Water Resources Investigation
- American River Watershed Project
- Water Augmentation
- Water Forum Proposal EIR

In short, PROSIM represents the best tool currently available for attempting to predict future impacts on a hydrological system that, by any assessment, is extremely complex. Although the model's conclusions may not be perfect, and may sometimes be expressed in general terms, they nevertheless embody the best information that can be obtained in light of current levels of knowledge and technology.

The greatest increases in CVP demands (between now and 2020) are assumed to occur north of the Delta in association with M&I water rights and water service contracts with the CVP's American River Division.

The No Action Alternative is used as the baseline for comparison of alternatives. No Action and the other alternatives reflect future conditions at the year 2020 level of development. These future conditions are based on projections concerning future growth, land use changes, and changes in CVP operational policies that are being considered and are undergoing separate environmental documentation. The hydrology and demands included in these simulations reflect DWR Bulletin 160-93. At the year 2020 level of development, annual CVP contracts are assumed to total 6.5 maf (with annual demands ranging from 6.2-6.5 maf), and annual SWP entitlements assumed to total 4.2 maf (with annual demands ranging from 3.4-4.2 maf). The greatest increases in CVP demands are assumed to occur north of the Delta in association with M&I water rights and water service contracts with the CVP's American River Division (approximately a 320,000 af increase in annual demand).

The impacts of the alternatives were analyzed for three representative periods: the long-term period (1922-1990), the wet hydrologic period (1967-1971), and the dry hydrologic period (1928-1934). The periods were based on Sacramento River Basin hydrology. It should be noted that hydrologic conditions in the Sacramento River Basin do not always match those in the Trinity River Basin.

As described previously with regard to potential curtailments, the agricultural water service contractors are the CVP contract holders who are assumed to be most affected by reductions in CVP water supplies. The Sacramento River Water Rights Settlement and San Joaquin River Exchange Contractors are assumed to be generally unaffected by a reduction in Trinity exports, as their respective contracts tie curtailments in dry years (of up to 25 percent) to the Shasta Inflow Index. This index accounts only for inflow in Shasta

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Reservoir. Because Trinity exports enter the Sacramento River downstream of Shasta Reservoir (through Keswick Reservoir), it was assumed that no additional curtailments would be experienced by the Sacramento River Water Rights Settlement and San Joaquin River Exchange Contractors as a result of decreased Trinity exports.

There are no major water management issues downstream of the confluence of the Klamath and Trinity Rivers. As noted previously, the influence of tributaries downstream of the North Fork reduces the effects of changes in Lewiston releases. Accordingly, impacts to the Lower Klamath River Basin / Coastal Area are not discussed. Impacts related to flooding are addressed in Residential / Municipal and Industrial (Section 3.9.1).

Significance Criteria. Significance criteria were not developed for Surface-water Hydrology and Management because changes to releases, reservoir levels, and water deliveries per se were not considered impacts. Rather, such changes were considered to be the causative agents that result in impacts to water quality, fishery resources, land use, power resources, and other issue areas.

No Action. The No Action Alternative would essentially maintain the current operations of the TRD and the CVP, as described under Affected Environment and Section 2.1.2, at a projected 2020 level of development.

This alternative assumes an annual Trinity River minimum instream flow requirement not less than 340,000 af for all water-year classes. TRD exports are assumed to continue to be used to conserve the coldwater pool in Shasta Reservoir through spring and early summer diversions in response to the Winter-run Biological Opinion. Table 3-3 and Figures 3-15 through 3-20 present the results of the No Action Alternative as compared to the other alternatives.

Maximum Flow. This alternative would increase Trinity River instream flows by a greater degree than any other alternative. In comparison to the No Action Alternative, scheduled spring peak releases during extremely wet years would increase from 2,000 to 30,000 cfs (a 15-fold increase). The long-term average annual instream release schedule would increase by approximately 900,000 af more water than No Action, or 263 percent of No Action levels.

(The Maximum Flow Alternative) would increase Trinity River instream flows by a greater degree than any other alternative…TRD exports would be eliminated…operations of…CVP facilities would need to be modified.

Under this alternative, TRD exports would be eliminated. In essence, the reservoir would be managed to ensure the availability of water for the spring peak releases, with no increase by minimum storage level. As such, average end-of-water-year storage (September 30) in Trinity Reservoir would increase during the dry period by about 440,000 af (60 percent) in comparison to the No Action Alternative.

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TABLE 3-3
Comparison of Impacts on Water Resources

Parameter	Hydrologic Conditions[a]	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions	Preferred Alternative to Existing Conditions
			Alternatives Compared to No Action						
Trinity Reservoir elevation (ft)	Dry	2,255	34	11	19	0	22	2,267	-1
May 30	Wet	2,352	-43	-3	-8	0	6	2,357	-8
	Average	2,319	-33	4	2	0	16	2,325	-2
September 30	Dry	2,207	64	18	25	0	11	2,217	8
	Wet	2,318	-18	-2	-2	0	4	2,320	-4
	Average	2,282	-9	2	4	0	11	2,287	-3
Shasta Reservoir elevation (ft)	Dry	995	-22	-7	-3	0	0	998	-10
May 30	Wet	1,062	-3	-3	-1	0	1	1,062	-3
	Average	1,045	-5	-3	-1	0	1	1,046	-4
September 30	Dry	933	-65	-11	-1	0	3	939	-17
	Wet	1,020	-15	-6	-2	0	2	1,020	-6
	Average	992	-15	-3	0	0	4	995	-6
San Luis Res. elevation (ft)	Dry	467	4	1	1	0	-3	463	5
May 30	Wet	511	-2	1	0	0	1	520	-8
	Average	487	4	1	0	0	0	491	-3
September 30	Dry	381	-3	-2	0	0	-5	373	6
	Wet	430	-10	1	-1	0	1	445	-14
	Average	396	-2	-2	0	0	0	401	-7
Trinity River Exports (af/yr)	Dry	540,000	-100%	-30%	-2%	0%	39%	530,000	-28%
	Wet	1,110,000	-100%	-33%	-26%	0%	17%	1,100,000	-33%
	Average	870,000	-100%	-28%	-16%	0%	23%	870,000	-28%
Trinity Reservoir storage (af)	Dry	730,000	60%	5%	14%	0%	5%	750,000	3%
September 30	Wet	1,720,000	-15%	-2%	-2%	0%	2%	1,730,000	-2%
	Average	1,390,000	-12%	-4%	-1%	0%	6%	1,400,000	-4%

TABLE 3-3
Comparison of Impacts on Water Resources

Parameter	Hydrologic Conditions[a]	Alternatives Compared to No Action: No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions	Preferred Alternative to Existing Conditions
Shasta Reservoir storage (af)	Dry	1,690,000	-30%	-8%	-1%	0%	2%	1,780,000	-12%
September 30	Wet	3,290,000	-10%	-4%	-1%	0%	1%	3,280,000	-4%
	Average	2,770,000	-8%	-2%	0%	0%	2%	2,810,000	-4%
San Luis Reservoir storage (af)	Dry[b]	390,000	-5%	-3%	0%	0%	-10%	340,000	12%
September 30	Wet	850,000	-13%	0%	-1%	0%	1%	990,000	-14%
	Average	540,000	-6%	-4%	-2%	0%	-2%	590,000	-12%
CVP deliveries north of Delta[b] (af/yr)	Dry[b]	2,680,000	-6%	-4%	0%	0%	2%	2,390,000	8%
	Wet	3,240,000	-1%	0%	0%	0%	0%	2,880,000	13%
	Average	3,120,000	-4%	-1%	0%	0%	1%	2,780,000	11%
CVP deliveries south of Delta[b] (af/yr)	Dry[b]	1,580,000	-13%	-3%	1%	0%	13%	1,630,000	-6%
	Wet	2,960,000	-3%	-1%	0%	0%	0%	2,980,000	-1%
	Average	2,570,000	-13%	-2%	0%	0%	2%	2,600,000	-3%
Exports, Tracy Pumping Plant (af/yr)	Dry	1,810,000	-13%	-5%	0%	0%	10%	1,830,000	-6%
	Wet	2,850,000	-1%	0%	0%	0%	0%	2,870,000	-1%
	Average	2,640,000	-12%	-2%	0%	0%	2%	2,670,000	-3%
Exports, Banks Pumping Plant (af/yr)	Dry	1,860,000	-2%	1%	0%	0%	3%	1,880,000	1%
	Wet	4,060,000	-1%	-1%	0%	0%	-1%	3,160,000	27%
	Average	3,310,000	-1%	0%	0%	0%	0%	2,890,000	14%
Exports, Tracy and Banks Pumping Plants (af/yr)	Dry	3,670,000	-5%	-2%	0%	0%	6%	3,710,000	-3%
	Wet	6,910,000	-1%	-1%	0%	0%	0%	6,030,000	14%
	Average	5,950,000	-6%	-1%	0%	0%	1%	5,560,000	6%

TABLE 3-3
Comparison of Impacts on Water Resources

Parameter	Hydrologic Conditions[a]	Alternatives Compared to No Action: No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions	Preferred Alternative to Existing Conditions
Delta Inflow (af/yr)	Dry	11,830,000	-2%	-1%	0%	0%	2%	11,850,000	0%
	Wet	29,730,000	-4%	-1%	-1%	0%	1%	29,690,000	-1%
	Average	22,570,000	-4%	-1%	-1%	0%	1%	22,550,000	-1%
Delta Outflow (af/yr)	Dry	6,320,000	-1%	0%	0%	0%	-1%	6,320,000	0%
	Wet	20,890,000	-5%	-1%	-1%	0%	1%	21,770,000	-5%
	Average	14,710,000	-3%	-1%	-1%	0%	1%	15,120,000	-4%
Trinity River releases (af/yr)	Critically dry	340,000[b]	36%	8.5%	-51%	0%	-65%	340,000	8.5%
	Dry	340,000[b]	160%	33%	-4.7%	0%	-65%	340,000	33%
	Normal	340,000[b]	250%	87%	30%	0%	-65%	340,000	87%
	Wet	340,000[b]	340%	110%	93%	0%	-65%	340,000	110%
	Extremely wet	340,000[b]	530%	140%	190%	0%	-65%	340,000	140%

[a]"Dry" is based on hydrology in the dry period (1928-34); "wet" is based on a wet period (1967-71); and "average" is based on the long-term average (1922-90).

[b]Plus additional releases as required by U.S. Bureau of Reclamation Safety of Dams criteria, if needed.

HOW TO READ A FREQUENCY DISTRIBUTION CURVE

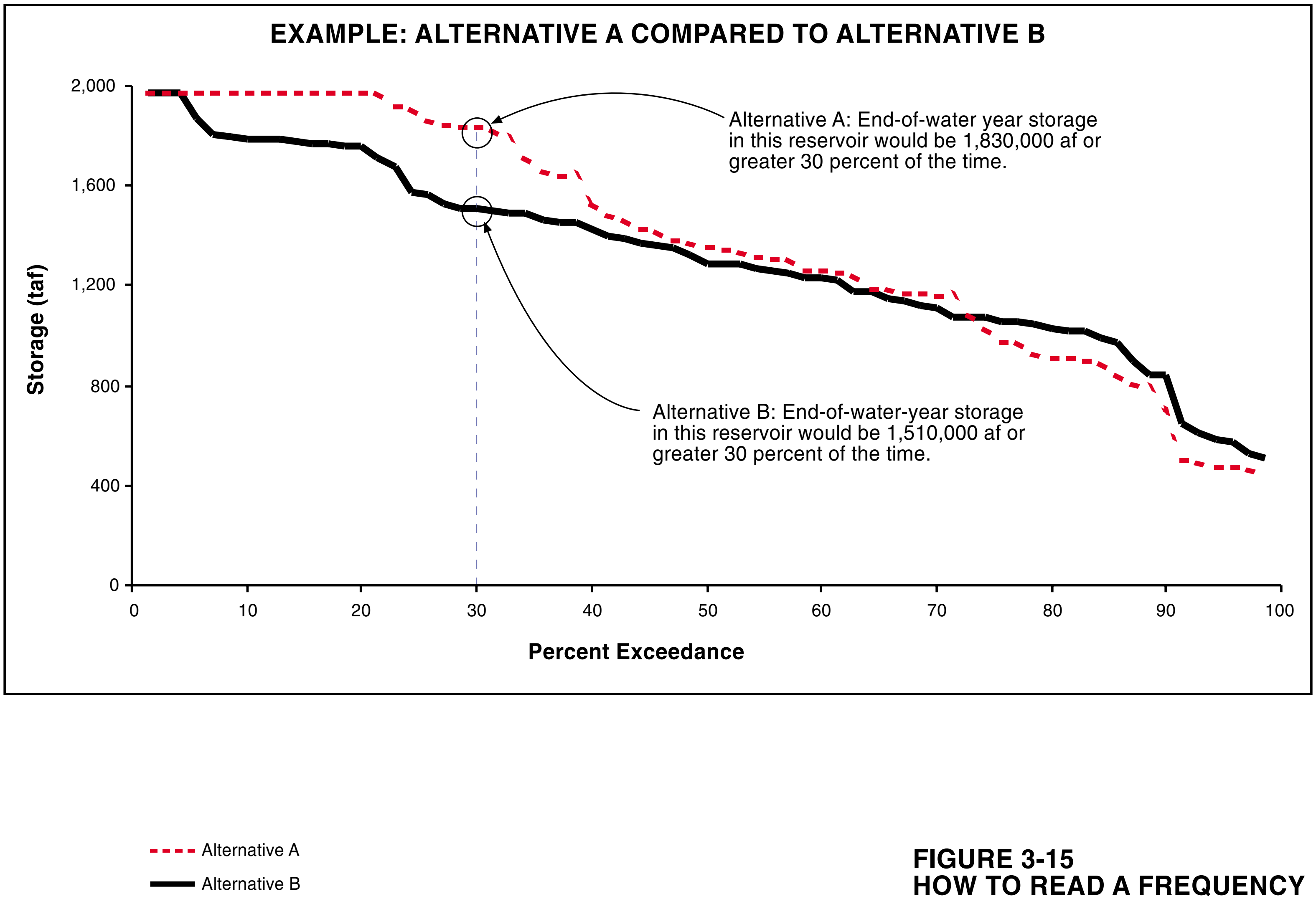

FIGURE 3-15
HOW TO READ A FREQUENCY DISTRIBUTION CURVE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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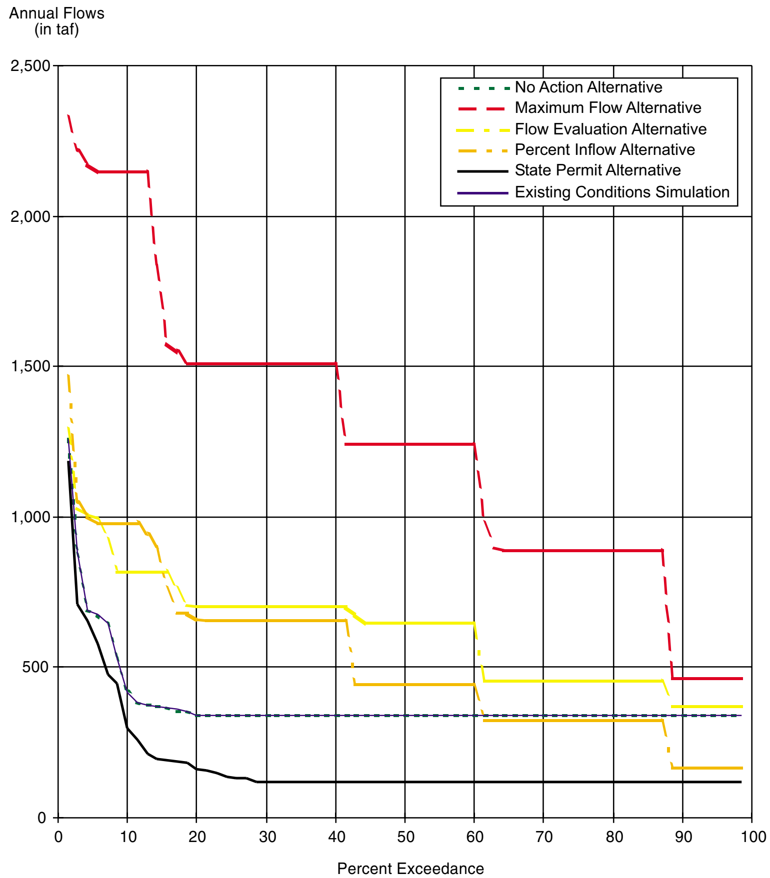
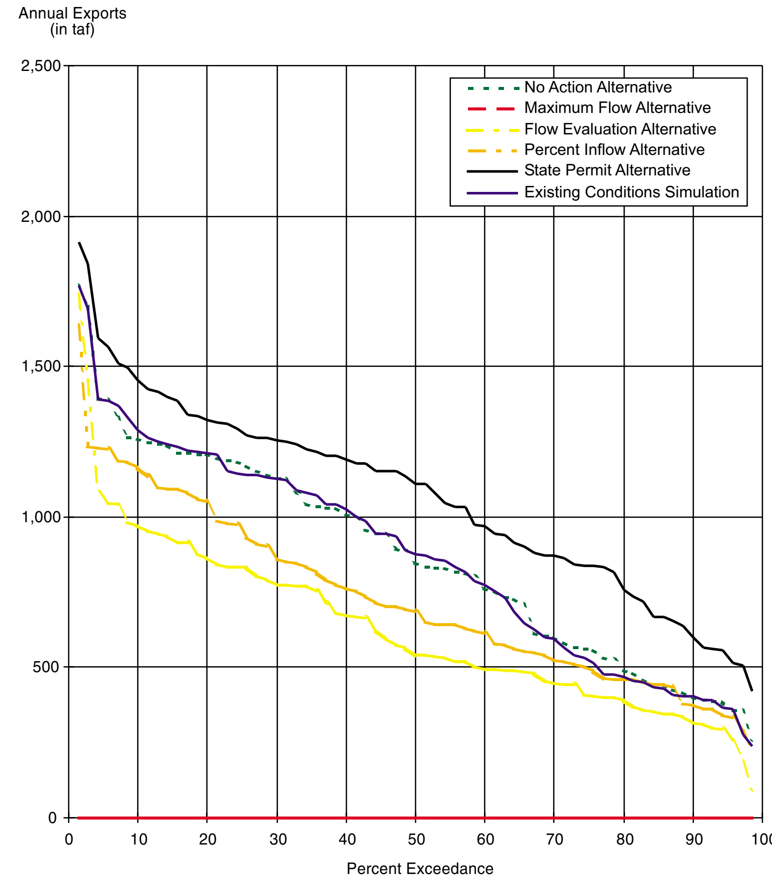


ANNUAL FLOWS IN THE TRINITY RIVER BELOW LEWISTON



TRINITY RIVER BASIN EXPORTS

FIGURE 3-16
SIMULATED FREQUENCY OF ANNUAL FLOWS IN THE TRINITY RIVER BELOW LEWISTON AND ANNUAL TRINITY RIVER BASIN EXPORTS

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

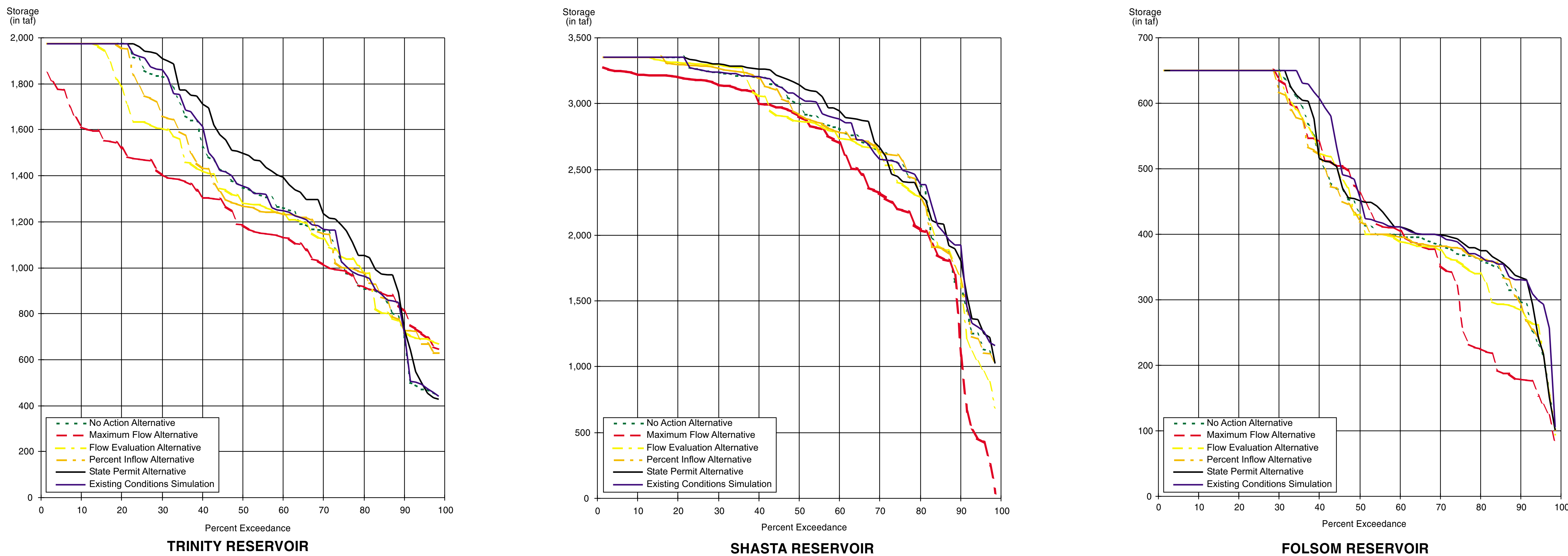


FIGURE 3-17
SIMULATED FREQUENCY OF END-OF-WATER-YEAR STORAGE – SHASTA, TRINITY, AND FOLSOM RESERVOIRS

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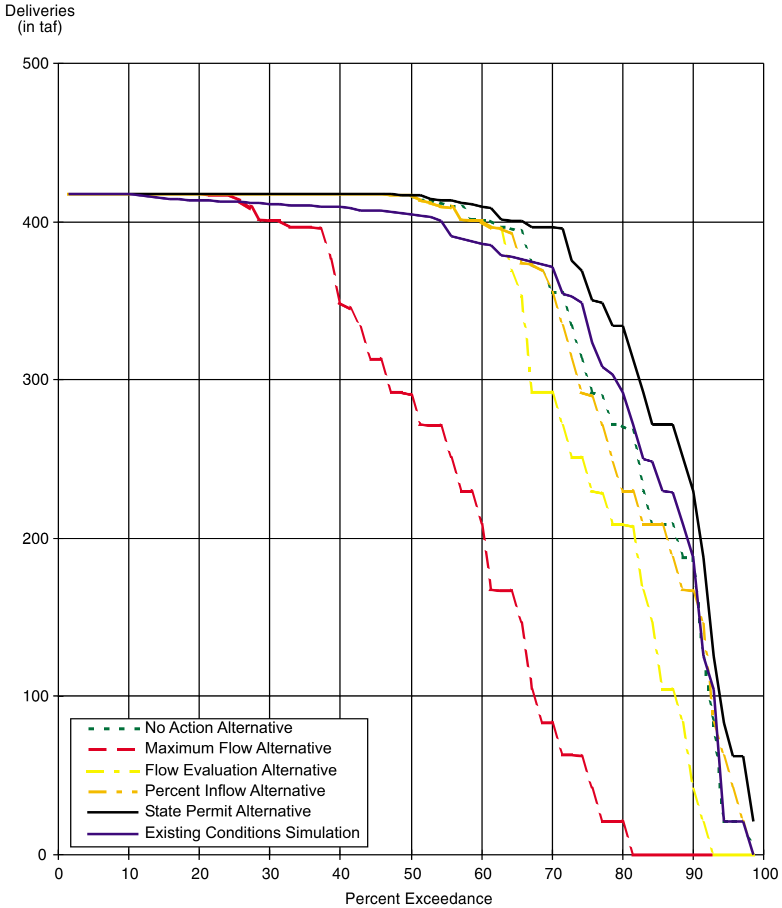
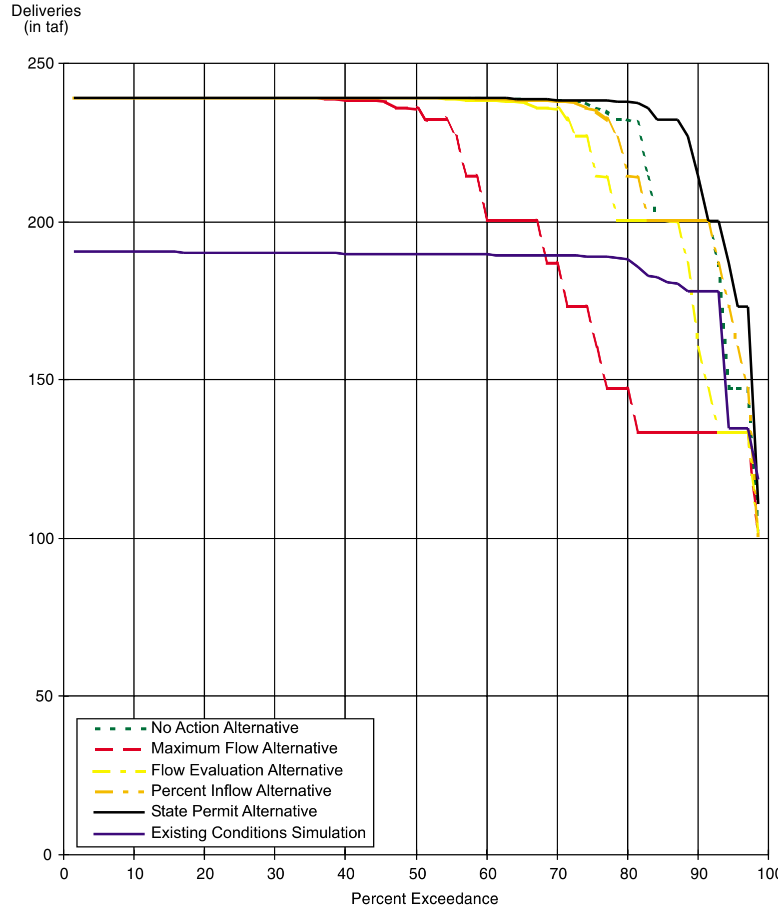


Note: Includes Sacramento River and American River divisions.

CVP AGRICULTURAL WATER SERVICE CONTRACTORS



Note: Includes Sacramento River and American River Divisions plus Contra Costa exports.

CVP M&I WATER SERVICE CONTRACTORS

FIGURE 3-18
SIMULATED FREQUENCY OF ANNUAL DELIVERIES – CVP WATER SERVICE CONTRACTORS NORTH OF THE DELTA
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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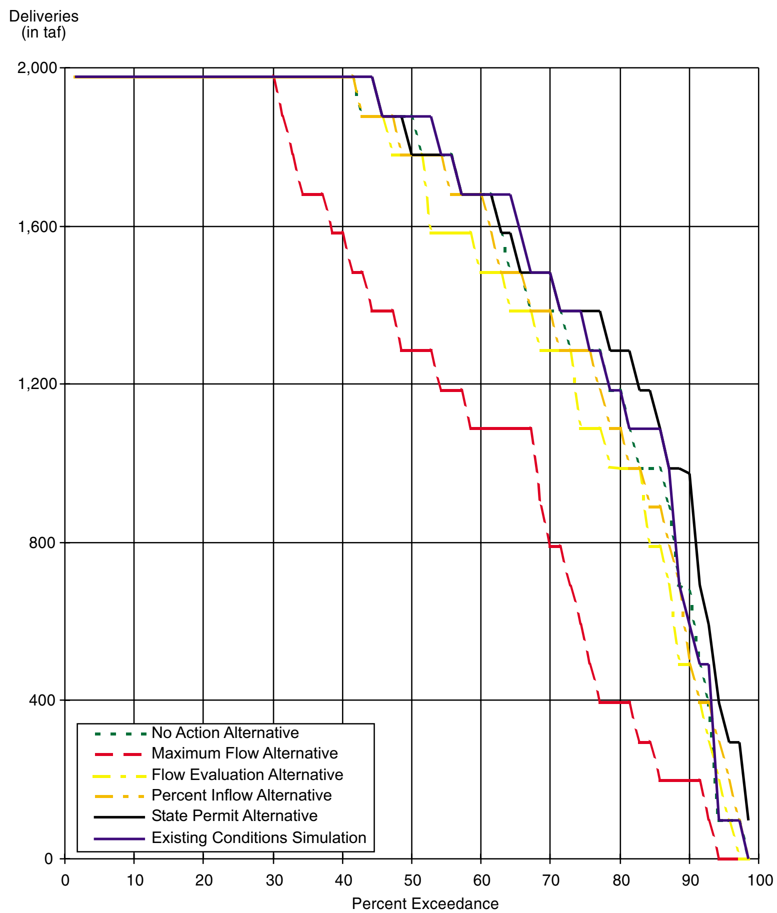
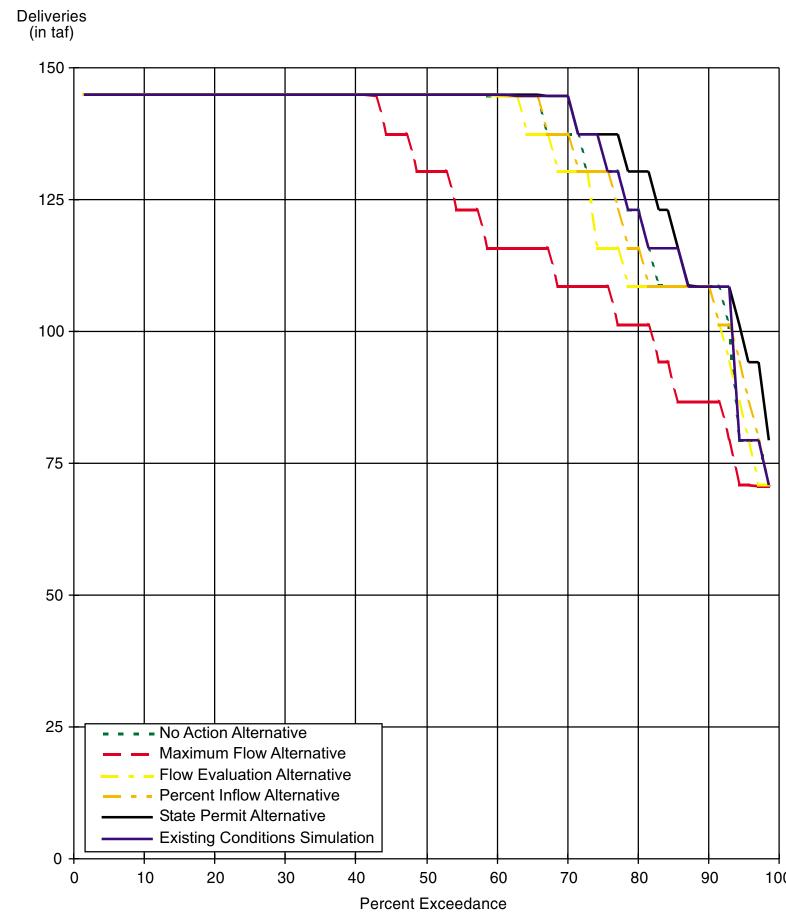


Note: Includes Delta (DMC only), West San Joaquin, and San Felipe divisions.

CVP AGRICULTURAL WATER SERVICE CONTRACTORS



Note: Includes San Felipe unit.

CVP M&I WATER SERVICE CONTRACTORS

FIGURE 3-19
SIMULATED FREQUENCY OF ANNUAL DELIVERIES – CVP WATER SERVICE CONTRACTORS SOUTH OF THE DELTA

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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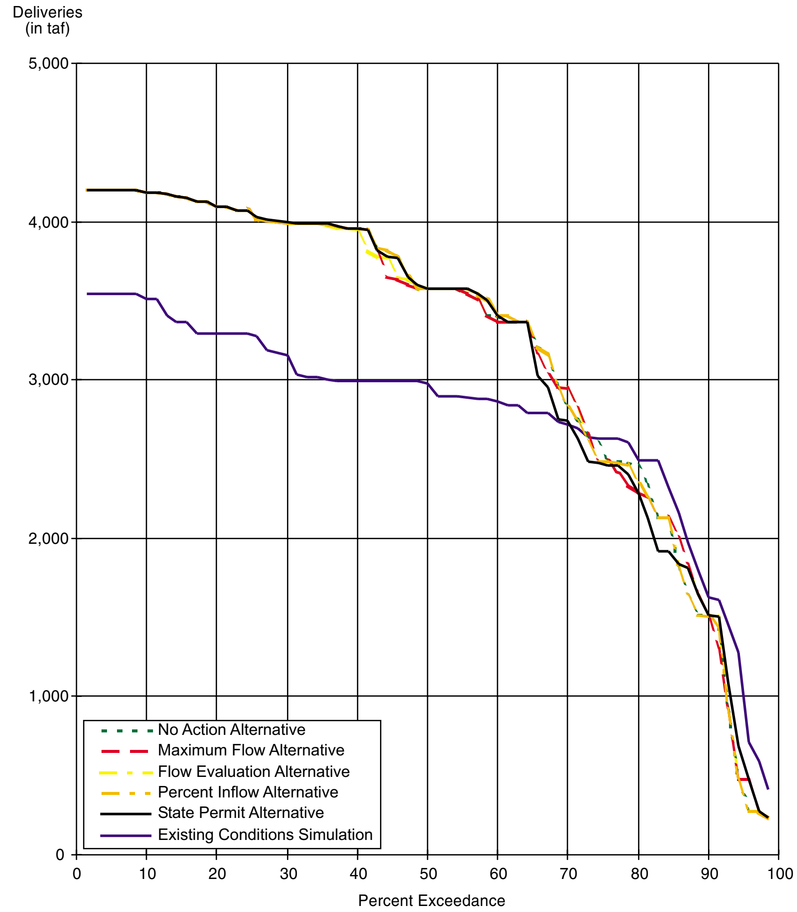

SWP AGRICULTURAL AND M&I ENTITLEMENT HOLDERS

FIGURE 3-20
SIMULATED FREQUENCY OF ANNUAL DELIVERIES TO SWP AGRICULTURAL AND M&I ENTITLEMENT HOLDERS SOUTH OF THE DELTA

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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Storage would decrease over the long term by about 170,000 af (12 percent) due to the spring geomorphic flow requirements and the low refill potential of the reservoir.

Operations of the remaining CVP facilities would need to be modified due to the reduction in available water (870,000 af on an average annual basis). In the absence of exports from the TRD, Whiskeytown Reservoir storage would fall below No Action levels during the dry period (reduction of 8 percent). During this period, local inflow would be insufficient to meet Clear Creek minimum flow requirements, and Whiskeytown Reservoir would have to be drawn down to provide additional releases.

Long-term average end-of-water-year Shasta Reservoir storage would be less than the No Action Alternative by approximately 210,000 af (8 percent). A major impact would occur in the dry period when average annual storage would be reduced by 510,000 af (30 percent). At storages below 550,000 af, air can be drawn into the dam conveyance structures causing vortex conditions, potentially resulting in severe structural damage to the facilities.

The reduction in Shasta Reservoir storage would reduce the ability of the CVP to maintain the coldwater pool for releases to meet the 1993 Winter-run Biological Opinion temperature requirements and associated 1.9 maf minimum carryover storage level, as well as all other Central Valley demands. End-of-water-year storage in Shasta Reservoir would be below the 1.9 maf storage criterion more frequently than under the No Action Alternative (14 percent of the years as compared to 12 percent). This increase is associated with lower Shasta storage levels during dry periods. In comparison to the No Action Alternative, the elimination of Trinity exports would result in average annual CVP deliveries during the dry period decreasing by about 360,000 af (8 percent). Long-term average annual CVP deliveries would decrease by 470,000 af (8 percent).

(Under the Flow Evaluation Alternative) TRD would be operated to release more Trinity Reservoir water to the Trinity River, and the pattern of exports to the Central Valley would be shifted to later in the summer.

Average annual Delta exports through the Tracy Pumping Plant during the dry period would be reduced by 230,000 af (13 percent). Compared to the No Action Alternative, long-term average annual Delta inflow would be reduced 790,000 af (4 percent), and long-term average annual Delta outflow would be reduced 420,000 af (3 percent).

Flow Evaluation. Compared to the No Action Alternative, the TRD would be operated to release more Trinity Reservoir water to the Trinity River, and the pattern of exports to the Central Valley would be shifted to later in the summer to help meet Trinity River instream temperature requirements. (The movement of exports through Lewiston Reservoir helps minimize warming in the reservoir and the resultant release temperatures into the Trinity River.) Compared to

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the No Action Alternative, this alternative generally has a larger spring peak release. Peak Trinity River flows during extremely wet years would increase from 2,000 to 11,000 cfs (a 5-fold increase); during critically dry years, releases would be reduced from 2,000 to 1,500 cfs (a reduction of 25 percent). The long-term average annual instream release would increase by 240,000 af (75 percent) compared to the No Action Alternative.

Compared to the No Action Alternative, this alternative would reduce long-term average annual exports from the TRD by about 240,000 af (28 percent). Dry-period annual exports would be reduced by 160,000 af (30 percent). Under this alternative, the prescribed minimum storage in Trinity Reservoir would be 600,000 af. Dry-period storage would average 5 percent more than No Action, reflecting the greater carryover storage level. In spite of this increase in required minimum carryover storage, average end-of-water-year carryover storage would decrease by 50,000 af (4 percent). Whiskeytown water levels would be generally unaffected, including during the dry period.

Shasta Reservoir storage would be only slightly impacted due to reduced TRD exports in the long-term average, while dry period effects would be more substantial. In this alternative, long-term average end-of-water-year storage is only slightly less than the No Action Alternative (60,000 af decrease, or 2 percent), while dry-period levels drop 130,000 af (8 percent). The Biological Opinion end-of-water year minimum storage criterion of 1.9 maf is met with the same frequency as under No Action (12 percent for both alternatives). However, during the dry period, minimum storage levels drop approximately 350,000 af below the No Action level.

Trinity River flows (under the Percent Inflow Alternative) would vary each week depending on (Trinity Reservoir) inflow and would, therefore, be more unpredictable in the short term than the other alternatives.

Long-term average annual CVP deliveries decrease by 90,000 af (2 percent). Reductions during the dry period average 160,000 af (4 percent). Annual Delta exports through the Tracy Pumping Plant are reduced by 60,000 af (2 percent) over the entire long-term period and 90,000 af (4 percent) during the dry period. Annual Delta inflow would decrease by 220,000 af (1 percent) over the long-term period and 90,000 af (1 percent) during the dry period. Average annual Delta outflow would decrease by 150,000 af (1 percent) over the long-term period, but would be similar to No Action for the dry period.

Percent Inflow. This alternative was designed to mimic natural flow patterns and variability by releasing from Lewiston Dam 40 percent of the previous week's inflow to Trinity Reservoir. Accordingly, Trinity River flows would vary each week depending on inflow and would, therefore, be more unpredictable than the other alternatives.

Compared to the No Action Alternative, this alternative would reduce long-term average annual TRD exports by 140,000 af

(16 percent), and the export pattern would be modified to help meet Trinity River instream temperature requirements. The prescribed minimum storage in Trinity Reservoir would be 600,000 af. As such, average end-of-water-year storage in Trinity Reservoir would increase during the dry period by 100,000 af (14 percent) due to holding more water to meet the storage requirement and to decreased Trinity River releases during the dry period as compared to No Action. Shasta Reservoir storage levels would be slightly affected, particularly during the dry period. End-of-water-year storage in Shasta Reservoir would be below the Biological Opinion minimum threshold (1.9 maf), the same frequency as the No Action Alternative (12 percent).

Annual exports through the Tracy Pumping Plant would be approximately the same as No Action. Compared to the No Action Alternative, long-term average annual Delta inflow would be reduced by 140,000 af (1 percent), and Delta outflow would be reduced by 120,000 af (1 percent). Long-term average annual CVP deliveries would be approximately the same as No Action.

Mechanical Restoration. All surface-water hydrology and management impacts would be the same as the No Action Alternative.

State Permit. Compared to the No Action Alternative, the State Permit Alternative would decrease minimum flows in the Trinity River to the levels specified in Reclamation's seven California water permits issued by the SWRCB during construction of the TRD. Releases would be the same for all water-year classes. The release schedule calls for 219,500 af (65 percent) less than the No Action Alternative.

The State Permit Alternative would decrease minimum flows in the Trinity River…this alternative would increase long-term average annual exports to the Central Valley.

Compared to the No Action Alternative, this alternative would increase long-term average annual exports to the Central Valley by 200,000 af (23 percent) and dry-period exports by 220,000 af (41 percent). Under this alternative, the prescribed minimum storage in Trinity Reservoir would be the same as the No Action Alternative (400,000 af). Average end-of-water-year storage in Trinity Reservoir would increase during the dry period by 40,000 af (4 percent) and over the long-term by 80,000 af (6 percent).

Shasta Reservoir storage would also increase in this alternative, with storage greater than the No Action Alternative by 60,000 af (2 percent) for the long-term average and 40,000 af (2 percent) for the dry period. The Biological Opinion threshold (1.9 maf) would be met more frequently than in the No Action Alternative, i.e., the alternative would not meet the threshold 10 percent of the years compared to 12 percent for the No Action Alternative.

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Long-term average annual CVP deliveries would increase by 80,000 af. Average annual Delta exports through the Tracy Pumping Plant would increase by 60,000 af (2 percent) over the long-term period, but would increase by 180,000 af (10 percent) in the dry period. The larger increase in exports during the dry period is due to the greater availability of unused pumping capacity at Tracy Pumping Plant, relative to No Action. Long-term average annual Delta inflow would increase by 170,000 af (1 percent), and outflow would increase by 120,000 af (1 percent). Average annual Delta inflows would increase by 200,000 af (2 percent) in the dry period due to the additional 210,000 af in annual exports from the Trinity River less increased diversions in the Sacramento Valley.

Existing Conditions versus Preferred Alternative. Compared to existing conditions (i.e., 1995), the Preferred Alternative would release more water to the Trinity River, and the pattern of exports to the Central Valley would be shifted to later in the summer to help meet Trinity River temperature requirements (water management in the Preferred Alternative is identical to the Flow Evaluation Alternative). It is important to note that the 1995 existing conditions analysis assumed a release hydrograph identical to the No Action Alternative (not less than 340,000 af/yr); however, actual Trinity River flows in recent years have varied due to a variety of factors (e.g., altered flow schedules that were being evaluated as part of the TRFES, Safety of Dam releases).

A large portion of the change in water impacts between 1995 existing conditions and the year 2020 under the Preferred Alternative is attributed to growth and development.

A large portion of the change in water impacts between 1995 existing conditions and the year 2020 under the Preferred Alternative is attributed to growth and development. In other words, existing conditions assumes a 1995 level of social and economic development, whereas the Preferred Alternative assumes a 2020 level of development (as do the other alternatives). For example, between 1995 and 2020, annual M&I water service contracts and water rights demands are assumed to increase 320,000 af north of the Delta, due primarily to increased M&I demand in the CVP American River Division (major contractors within this division include the City of Sacramento and Placer County). Similarly, agricultural water service contracts and water rights demands north of the Delta are expected to increase 40,000 af over the long-term average. (CVP demands south of the Delta in the year 2020 are anticipated to remain comparable to 1995 levels.)

Compared to 1995 conditions, long-term average annual exports through the SWP Banks Pumping Plant in the Delta would increase in the year 2020 by approximately 410,000 af (14 percent) even without project implementation in order to meet increased (primarily M&I) demands. Partly as a result of those exports, long-term average annual Delta outflow would be reduced by about 560,000 af

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(4 percent). (Although M&I demands upstream of the Delta would increase substantially, long-term average annual Delta inflow in 2020 would be similar to 1995 levels because the majority of the water used for M&I purposes is assumed to return to the system.)

The following discussion identifies changes between 1995 existing conditions and conditions in 2020 under the Preferred Alternative, as well as what portion of this change is attributable to the project (by comparing Preferred Alternative impact levels to both existing condition and No Action levels). Implementation of the Preferred Alternative would reduce long-term average annual exports from the TRD by 240,000 af (28 percent) and increase Trinity Reservoir minimum storage from 400,000 to 600,000 af. End-of-water year Trinity Reservoir storage over the average period would decrease by 60,000 af (4 percent) compared to 1995 conditions, but would be similar during the dry period. The majority of this decrease in storage is attributable to the increased instream releases associated with the Preferred Alternative.

Shasta Reservoir end-of-water-year storage would be less than existing conditions by 100,000 af (4 percent). This reduction is attributable to decreased TRD exports as well as increased demand levels in 2020. The Biological Opinion storage threshold of 1.9 maf would be met less frequently than in existing conditions (12 percent of years compared to 10 percent). The reduced frequency of meeting the threshold is attributable to non-project changes between 1995 and 2020. During the dry period, minimum storage levels under the Preferred Alternative drop more than 500,000 af below existing condition levels.

Compared to existing conditions, annual Delta exports through the Tracy Pumping Plant would be reduced by 90,000 af (3 percent) under the Preferred Alternative. This reduction is primarily a result of project-related changes. Long-term average annual Delta inflow would be reduced by 200,000 af (1 percent). This reduction is primarily due to decreased TRD exports as a result of the Preferred Alternative. Average annual Delta outflow would be reduced by 560,000 af (4 percent). Approximately 400,000 af (3 percent) of the observed decrease in Delta outflow is attributable to meeting increased demands (primarily SWP) in the year 2020. The remainder is due to decreased TRD exports associated with the Preferred Alternative.

Mitigation. As described under Significance Criteria, changes to releases, reservoir levels, and water deliveries per se were not considered impacts. Rather, such changes are considered to be the causative agents that result in impacts to the human environment. Those impacts are discussed in the Water Quality (3.4), Fishery

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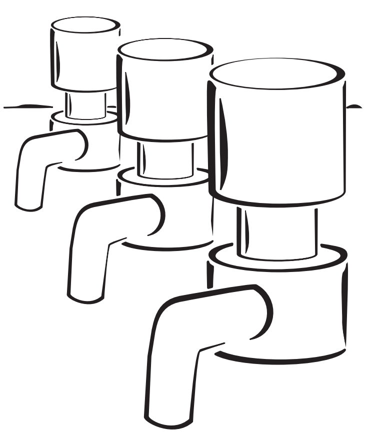
Resources (3.5), Land Use (3.9), Power Resources (3.10), and other sections.

Although water supply changes per se were not considered an impact, the development of additional water supplies to meet demands would lessen the associated impacts. A number of demand- and supply-related programs are currently being studied across California, many of which are being addressed through the on-going CALFED and CVPIA programs and planning processes. Although none of these actions would be directly implemented as part of the alternatives discussed in this DEIR/EIS, each could assist in offsetting impacts resulting from decreased Trinity River exports. Examples of actions being assessed in the CALFED and CVPIA planning processes include:

- Develop and implement additional groundwater and/or surface-water storage. Such programs could include the construction of new surface reservoirs and groundwater storage facilities, as well as expansion of existing facilities. Potential locations include sites throughout the Sacramento and San Joaquin Valley watersheds, the Trinity River Basin, and the Delta.
- Purchase long- and/or short-term water supplies from ***willing sellers*** (both in-basin and out-of-basin) through actions including, but not limited to, temporary or permanent ***land fallowing***.
- Facilitate willing buyer/willing seller inter- and intra-basin water transfers that derive water supplies from activities such as conservation, crop modification, land fallowing, land retirement, groundwater substitution, and reservoir re-operation.
- Promote and/or provide incentive for additional water conservation to reduce demand.
- Decrease demand through purchasing and/or promoting the temporary fallowing of agricultural lands.
- Conserve water supplies by promoting additional water recycling.

Groundwater Pumping



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3.3.2 Groundwater

This section focuses on groundwater impacts associated with implementation of the various alternatives. Potential groundwater impacts, such as changes to groundwater elevations, land ***subsidence***, and groundwater quality could occur as a result of users pumping additional groundwater to substitute for decreased surface supplies. For purposes of this analysis, the Central Valley is divided into three groundwater regions: the Sacramento Valley, the San Joaquin Valley, and the Tulare Basin. (A summary of impacts to groundwater resources as compared to No Action is provided at the end of 3.3.2 in Table 3-4.)

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Affected Environment.

Trinity River Basin. Most usable groundwater in the mountainous Trinity River Basin occurs in widely scattered alluvium-filled valleys, such as those immediately adjacent to the Trinity River. These valleys contain only small quantities of recoverable groundwater, and therefore, are not considered a major source. Groundwater withdrawals in the Trinity River Basin totaled approximately 5,000 af in 1990. The Hoopa Valley is a notable groundwater resource located in the Trinity River Basin. This shallow ***aquifer*** supplies mostly domestic water and is recharged from precipitation and infiltration from local streams.

Lower Klamath River Basin / Coastal Area. Groundwater conditions in the Lower Klamath River Basin / Coastal Area are similar to the Trinity River Basin. In general, the mountainous region is not a major source of groundwater, although some alluvial valleys do have usable resources.

Central Valley. Extensive groundwater development has occurred in the Central Valley to meet agricultural demands. The Central Valley regional aquifer is a 400-mile-long asymmetric trough averaging 50 miles in width. Historically, groundwater resources have been extensively developed in the Sacramento, San Joaquin, and Tulare Basin regions. The Friant Division, one of the initial features of the CVP, was developed specifically to supplement groundwater resources in the eastern portion of the San Joaquin Valley with surface water from the San Joaquin River.

Prior to development of the CVP, ***groundwater overdraft*** conditions occurred in portions of the San Joaquin Valley and Tulare Basin as a result of extensive groundwater development and the reliance on groundwater during drought years. In some areas, regional groundwater elevations declined by more than 300 feet during the 1940s and 1950s. The development of surface-water supplies in the 1950s and 1960s reduced reliance on groundwater and helped control the rapid rate of groundwater-level decline. However, the long-term effects of continued groundwater use have resulted in regional land subsidence. The largest example of human-induced land subsidence in the world occurs in the San Joaquin Valley. Approximately 5,200 square miles have experienced land subsidence of more than 1 foot. The maximum subsidence of 29.6 feet, recorded between 1925 and 1977, is within western Fresno County (U.S. Geological Survey, 1991). The geographic extent of land subsidence generally coincides with areas where groundwater elevations have declined significantly as a result of historical overdraft conditions (Figure 3-21).

Prior to development of the CVP, groundwater overdraft conditions occurred in portions of the San Joaquin Valley and Tulare Basin... development of surface-water supplies in the 1950s and 1960s reduced reliance on groundwater.

Sacramento Valley. The northern third of the Central Valley regional aquifer system is located in the Sacramento Valley. DWR identifies

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this portion of the Central Valley aquifer as the Sacramento Valley and Redding Basins, which cover over 5,500 square miles. In DWR California Water Plan Update (Bulletin 160-93), the usable storage capacity in the Sacramento Valley was estimated to be 40 maf.

Surface-water and groundwater resources in this region are interdependent. A majority of streambeds in the Sacramento Valley are hydraulically connected with the underlying aquifer. Many streams in this region have historically been gaining streams, a condition where groundwater is discharged into the stream. Only when the aquifer water level falls below the elevation of the streambed would the system be considered hydraulically disconnected.

Groundwater elevations associated with the Sacramento Valley have historically declined moderately during extended droughts, generally recovering to pre-drought levels as a result of subsequent wetter periods. Depth to groundwater varies throughout the region, from as little as a few feet below ground surface to greater than 100 feet. Local efforts, such as the American River Regional Master Plan, are intended to promote long-term sustainable groundwater resource management.

Surface-water availability and natural recharge in the Sacramento Valley have compensated for ***groundwater pumping***, resulting in minimal declines in groundwater elevations. Consequently, land subsidence in the Sacramento Valley has been limited to the southwestern part of the region, near Davis and Zamora where more than 2 feet of land subsidence has been recorded.

Groundwater quality is generally excellent throughout the Sacramento Valley and is suitable for most uses. Concentration of total dissolved solids (TDS) is normally less than 300 milligrams per liter (mg/L), although water in some areas may contain TDS as high as 1,500 mg/L. The California Department of Health Services (DHS) has set secondary drinking water standards for TDS at 500 mg/L (maximum contaminant level, or MCL); however, short-term levels up to 1,500 mg/L are considered acceptable. Agricultural water quality goals are set at 450 mg/L (this is considered only a desired target by DHS). TDS concentrations are higher in the south-central part of the Sacramento Valley. Although not a widespread problem, pesticides have been detected in groundwater in some locations. (See Water Resources/Water Quality Technical Appendix A for more information on groundwater quality.)

San Joaquin Valley. The southern two-thirds of the Central Valley regional aquifer system, which covers over 13,500 square miles extending from just south of the Delta to just south of Bakersfield, is referred to as the San Joaquin Valley Basin. For purposes of this

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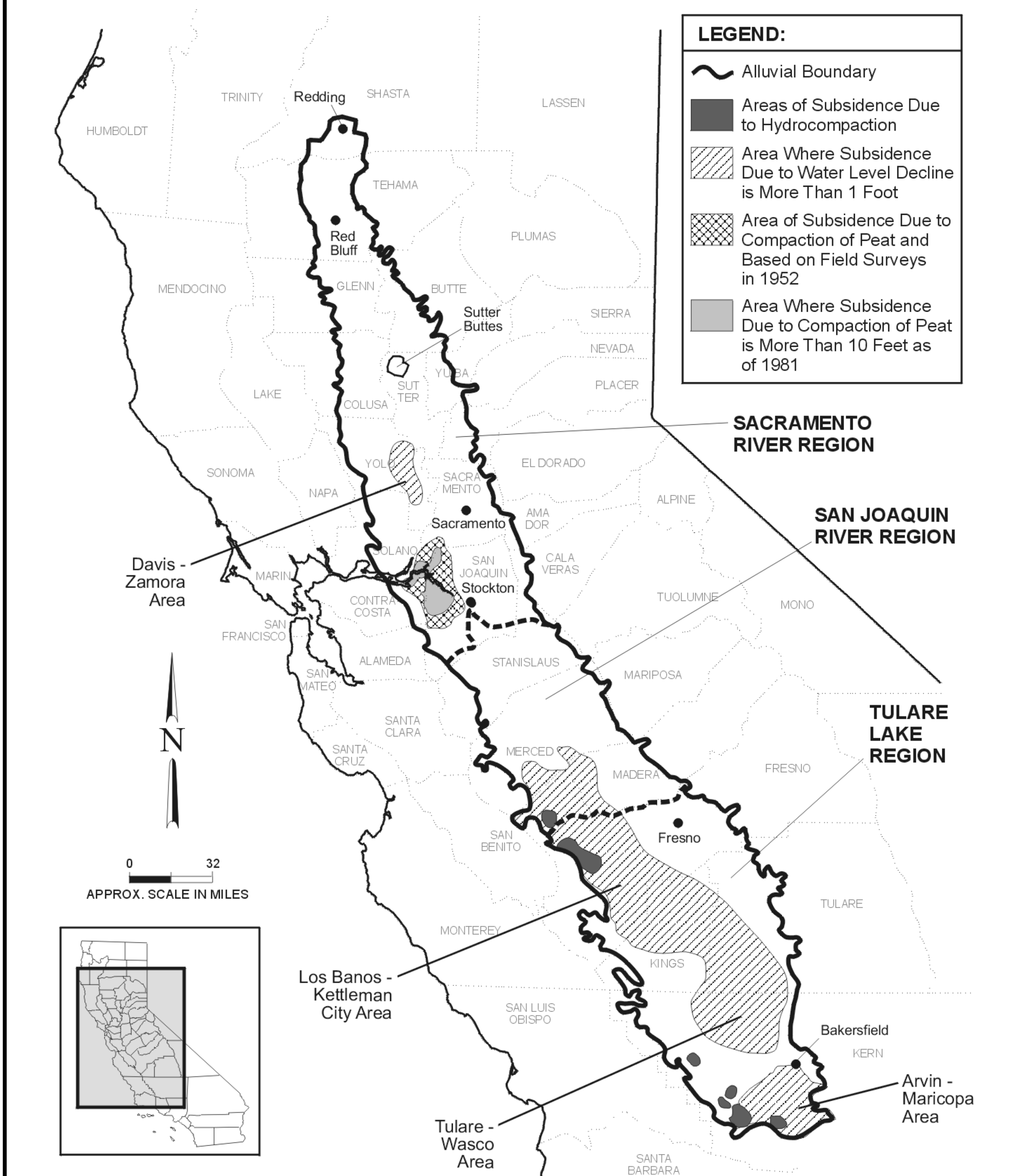

Source: Adapted from Bertoldi et al., 1991.

FIGURE 3-21
AERIAL EXTENT OF LAND SUBSIDENCE IN THE CENTRAL VALLEY DUE TO DECLINES IN GROUNDWATER ELEVATIONS
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analysis this basin is divided into the San Joaquin Valley (North of Fresno) and the Tulare Basin (South of Fresno).

The Corcoran Clay Member that divides the groundwater system into two major aquifers underlies much of the western portion of this region. Aquifer recharge to the semi-confined upper aquifer historically occurs from stream seepage, deep ***percolation*** of rainfall, and subsurface inflow along the basin boundary. The lower confined aquifer is recharged from subsurface inflow coming from the east boundary of the Corcoran Clay Member. Annual groundwater pumping in the San Joaquin Valley exceeds recent estimates of perennial yield by 200,000 af. Prior to the mid 1950s, the interaction of groundwater and surface water in the San Joaquin Valley resulted in net gains to the streams. Under more recent conditions however, a net loss from streams to the groundwater system has become the predominant condition, a result of groundwater declines from increased pumping. Depth to groundwater is approximately 50-100 feet.

Historically, land subsidence has been a significant problem in the southern half of the San Joaquin Valley. From 1920-1970, approximately 5,200 square miles of irrigated land registered at least 1 foot of land subsidence (most of the vast acreage affected by land subsidence lies in the Tulare Basin). By the mid 1970s, the use of imported surface water in the western and southern portions of the San Joaquin Valley Basin essentially halted the progression of land subsidence. However, during the 1976-1977 and 1987-1992 droughts, land subsidence was again observed in areas previously affected because of renewed high groundwater pumping rates.

Groundwater in the San Joaquin Valley and Tulare Basin varies widely in type and concentration of chemical constituents. Several groundwater quality issues are present in the San Joaquin Valley. Municipal use of groundwater as a drinking water supply is impaired due to elevated nitrate concentrations in the northern San Joaquin County, Tracy, Modesto-Turlock, Merced, and Madera areas. High boron concentrations also occur in the San Joaquin Valley. Agricultural use of groundwater is impaired due to elevated boron concentrations in eastern Stanislaus and Merced Counties. High selenium concentrations in soils on the west side of the San Joaquin Valley have raised considerable concern because of their potential to leach from the soil by subsurface irrigation return flow into the groundwater and receiving surface waters.

Reclamation and other state and local agencies continue to study programs to reduce poor quality drainage on the west side, including on-farm conservation measures and retirement of some lands.

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Tulare Basin. The southern part of the San Joaquin Valley Basin, referred to here as the Tulare Basin, is a basin of interior drainage. The Corcoran Clay Member that divides the groundwater system into two major aquifers underlies much of the western portion of this area. Groundwater conditions in the Tulare Basin are similar to those of the San Joaquin Valley. Importation of CVP and SWP water has largely alleviated chronic subsidence problems, although episodic subsidence still occurs during drought periods when groundwater extraction increases due to reductions in SWP and CVP supplies. The DWR has measured up to 2 feet of subsidence occurring between 1970 and 1994 along the California Aqueduct near Mendota. DWR also observed similar amounts along the California Aqueduct near Lost Hills, and up to 1 foot near the Kern Lake Bed. Average depth to groundwater in the Northern Tulare Basin is 200 feet, and is more than 300 feet in the southern Tulare area.

A significant limitation on groundwater use in the Tulare Basin has been caused by the presence of toxins such as dibromochloropropane (DBCP) and ethylene dibromide (EDB) which exceed drinking water standards. DBCP levels resulting from historical agricultural use exceed the maximum standard in large areas of eastern Fresno County and Tulare County and limit groundwater use in Fresno and other urban areas. EDB contamination, also resulting from historical agricultural use, limits groundwater use in many areas of Kern County. In addition to DBCP and EDB, several other toxic compounds limit the use of water for municipal purposes in parts of the Tulare Basin.

High salts and other contaminants have been observed in subsurface irrigation drainage in some areas within the Tulare Basin. Reclamation and other state and local agencies continue to study programs to reduce poor quality drainage, including onfarm conservation measures and retirement of some lands.

Environmental Consequences.

The groundwater analysis assumed groundwater pumping would increase to replace reductions in CVP or SWP deliveries.

Methodology. The groundwater analysis assumed groundwater pumping would increase to replace reductions in CVP or SWP deliveries. Groundwater conditions were simulated using the Central Valley Groundwater-Surface Water Simulation Model (CVGSM), a monthly planning model developed by Reclamation, DWR, and the SWRCB for the Central Valley regional aquifer system. The CVGSM delineates the Central Valley into 21 subregions and hydrologic and water service boundaries (see Figure 3-22). The CVGSM model is a monthly groundwater planning tool that can be used to evaluate the groundwater conditions of the Central Valley regional aquifer under different management scenarios. For the Trinity hydrologic modeling efforts (includes surface-water and groundwater modeling) a static land use approach was taken. For

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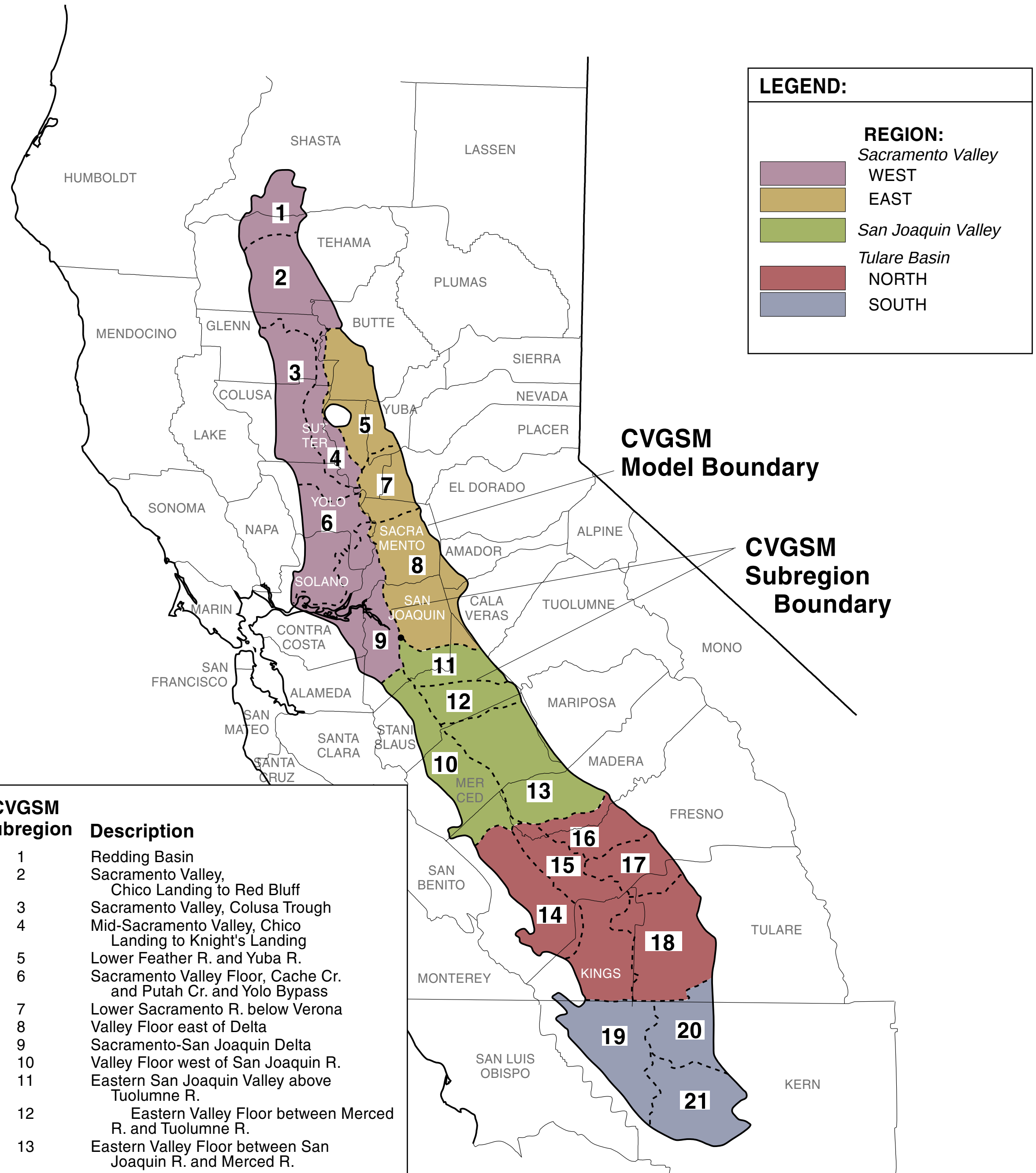

CVGSM Subregion	Description
1	Redding Basin
2	Sacramento Valley, Chico Landing to Red Bluff
3	Sacramento Valley, Colusa Trough
4	Mid-Sacramento Valley, Chico Landing to Knight's Landing
5	Lower Feather R. and Yuba R.
6	Sacramento Valley Floor, Cache Cr. and Putah Cr. and Yolo Bypass
7	Lower Sacramento R. below Verona
8	Valley Floor east of Delta
9	Sacramento-San Joaquin Delta
10	Valley Floor west of San Joaquin R.
11	Eastern San Joaquin Valley above Tuolumne R.
12	Eastern Valley Floor between Merced R. and Tuolumne R.
13	Eastern Valley Floor between San Joaquin R. and Merced R.
14	Westland
15	Mid-Valley Area
16	Fresno Area
17	Kings R. Area
18	Kaweah R. and Tule R. Area
19	Western Kern County
20	Eastern Kern County
21	Kern River Area

FIGURE 3-22
GROUNDWATER STUDY AREA
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static model runs the projected land use conditions are fixed over time. Two projected land use conditions were used as the basis for these static conditions: (1) a 1995 projected level and (2) a 2020 projected level. These projected-level conditions are the driving force behind the development of much of the projected-level data and assumptions required for the use of CVGSM for Trinity hydrologic modeling.

Hydrologic conditions (i.e., rainfall and stream inflows) are an important consideration in the CVGSM modeling analysis of projected-level conditions. The amount of rainfall and stream inflow has a direct impact on groundwater recharge, which in turn may impact groundwater levels and other related groundwater conditions. For the purposes of the static land use approach, a long-term period of historical hydrologic conditions is imposed on the groundwater system, providing a wide range of possible circumstances that could be expected under projected land use conditions. The study period chosen for this groundwater analysis consists of water years 1922 through 1990. This 69-year simulation period, represented by historical rainfall records and historical streamflows upstream of major reservoirs (modified to account for upstream usage at the projected level), was used as the long-term period to represent varied hydrologic conditions in the Central Valley. This historical period covers a range of hydrologic conditions including prolonged droughts, such as 1928-1934 and most of 1987-1992; short duration droughts of extreme conditions, such as 1976-1977; and periods of above normal precipitation such as 1967-1971, 1982-1983 and 1985-1986. Hence, the 1922-1990 historical hydrologic period is considered to be representative of future hydrologic conditions. Furthermore, this historical period is commonly used in water resources planning studies conducted by federal, state, and local agencies in California, including Reclamation and DWR. Streamflow conditions for this simulation period are represented by a combination of historical records for streams with little or no development, and simulated flows downstream of major reservoirs, based on reservoir operations that take into account projected land use conditions.

CVGSM is a planning scale simulation model that can be used to analyze the relative impacts between alternatives for the groundwater resources of the Central Valley regional aquifer. Relative impacts between alternatives are inferred from CVGSM results. For the purposes of this study the user can approximate impacts of an alternative by comparing simulation output resulting from base input assumptions to simulation output resulting from alternative input assumptions. Because CVGSM is not intended to be used as a detailed predictive model, simulation output of a single alternative should not be used as absolute results.

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These simulations represent the long-term impact of holding projected-level conditions and assumptions constant for 69 years. In contrast, the same 69 years of historical hydrology has moved past a constantly changing landscape of land use and facilities, leading to a unique set of conditions at any given point in history. Therefore, any direct comparison of simulation results for fixed conditions to historical conditions is not meaningful. The model results are meaningful only as a measure of the potential long-term impacts of projected conditions and assumptions.

Impacts for each alternative were compared to No Action levels summarized as changes to groundwater elevations, groundwater storage, land subsidence, and groundwater quality. Because groundwater storage and groundwater elevations are closely linked, changes in storage are presented in the Water Resources / Water Quality Technical Appendix A only. Modeled groundwater elevations at the end of the 69-year simulation period were used to represent long-term differences in groundwater conditions.

Declining groundwater elevations can cause land subsidence in areas where clay and silt lenses susceptible to compaction are prevalent. Land subsidence impacts for each alternative were derived from conditions at the end of the 69-year simulation period. Groundwater-quality degradation can occur due to migration of poor-quality groundwater. Groundwater-quality impacts were inferred from changes in groundwater elevations.

Declining groundwater elevations can cause land subsidence in areas where clay and silt lenses susceptible to compaction are prevalent.

No significant impacts to groundwater resources or groundwater levels are anticipated within the Trinity River Basin and the Lower Klamath Basin / Coastal Area and, therefore, are not analyzed under Environmental Consequences.

Significance Criteria. The following impacts would be significant if they occurred as a result of any of the alternatives:

- A long-term decline in groundwater elevations (or a net reduction in groundwater storage)
- Detectable land subsidence
- Detectable degradation of groundwater quality

Groundwater impacts were assessed at the scale of a groundwater basin or sub-basin. The significance of declining (or increasing) water levels depends in part on the duration and permanence of the impact. Because groundwater elevations fluctuate naturally due to changes in rainfall, short-term changes in groundwater elevations were not considered significant.

No Action. Given the assumptions for the No Action Alternative described in Chapter 2, groundwater impacts may be overstated under the No Action Alternative in comparison to existing conditions in some areas. Local efforts to reduce groundwater impacts (i.e., American River Regional Master Plan) are still in the planning stages and, as such, were not included in the assumptions for the No Action Alternative. Consequently, as these efforts are implemented, groundwater impacts may be reduced.

Sacramento Valley. Projected groundwater elevations under the No Action Alternative are shown on Figure 3-23. The groundwater gradient along the west side of the Sacramento Valley is assumed to follow surface hydrographic features, except for a groundwater depression in the Yolo County area. This type of groundwater gradient suggests that groundwater conditions would continue to be near a state of equilibrium. The hydraulic connection between streams and the underlying ***groundwater tables*** would be maintained similar to recent conditions. Increased land subsidence would occur at a rate similar to recent historical conditions, primarily in the Yolo County area near Davis and Zamora, due to continued extraction of groundwater in this area.

Increased land subsidence would occur at a rate similar to recent historical conditions, primarily in the Yolo County area near Davis and Zamora, due to continued extraction of groundwater in this area.

Groundwater elevations on the east side of the Sacramento Valley are assumed to be dominated by groundwater elevation depressions north and south of the City of Sacramento and in eastern San Joaquin County. These conditions are a reflection of groundwater use in excess of groundwater recharge. ***Hydraulic disconnection*** between stream reaches and underlying groundwater tables has occurred historically in these areas; under the No Action Alternative this occurrence would likely expand to affect larger reaches of these streams in the year 2000.

Groundwater quality is assumed to continue to degrade due to the induced migration of groundwater with high TDS levels from areas south of the Sutter Buttes and southern Yolo County towards areas to the south and east with depressed groundwater elevations. Potential boron problems in central Yolo County could also result in groundwater quality degradation from this induced migration.

Groundwater quality is assumed to continue to degrade due to the induced migration of groundwater with high TDS levels from areas south of the Sutter Buttes and southern Yolo County towards areas to the south and east with depressed groundwater elevations.

San Joaquin Valley and Tulare Basin. Under the No Action Alternative, the hydraulic connection between the San Joaquin River tributaries and underlying groundwater tables would be similar to recent conditions. Portions of east-side streams would remain hydraulically disconnected from underlying groundwater tables. From Madera County south to the Tulare-Kern County boundary, groundwater elevations would be lower compared to recent conditions, increasing the extent of hydraulic disconnection in this area. Along the west side of the San Joaquin Valley, groundwater elevations would vary gradually. Levels in the extreme northern end decline towards

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groundwater depression areas in eastern San Joaquin County, and in the southern end they decline in the direction of depressed groundwater elevations in Fresno County.

Historically, groundwater supplies have been augmented with surface water imported through the San Luis Canal and Friant-Kern Canal. Although this would continue under the No Action Alternative, pumping would still occur at a rate in excess of groundwater replenishment. It is assumed that additional land subsidence, ranging from 1-5 feet over a 69-year simulation period, would occur in areas along the west side of the San Joaquin Valley as a result of continued increases in groundwater extractions required to compensate for possible reductions in SWP and CVP supplies.

It is assumed that additional land subsidence would occur in these areas as a result of continued increases in groundwater extractions required to compensate for possible reductions in SWP and CVP supplies.

Groundwater quality would be similar to recent conditions for the San Joaquin Valley. Groundwater quality would remain degraded due to the induced migration of groundwater with high TDS levels along the west side into the mid-valley areas with depressed groundwater level. Consistent with assumptions in DWR Bulletin 160-93, 45,000 acres on the west side of the San Joaquin Valley and Tulare Basin are assumed to be retired for drainage control purposes. Possible upwelling of saline groundwater into productive groundwater zones could also occur. Groundwater contaminated with DBCP in eastern Fresno County could be mobilized towards these depressed groundwater level areas.

Maximum Flow. Long-term regional groundwater conditions in several areas in the Central Valley would be considerably impacted compared to the No Action Alternative. With less surface-water supply to the Central Valley, groundwater pumping would increase in portions of the Sacramento Valley, the San Joaquin Valley, and the Tulare Basin. The greatest impacts would occur in the Tulare Basin.

Sacramento Valley. Long-term groundwater elevations on the western side of the Sacramento Valley would be lowered by as much as 25 feet, primarily in areas receiving CVP agricultural service contractor water, such as the Tehama-Colusa Canal service area. These declines are the result of an additional average 85 thousand acre-feet (taf)/yr of groundwater pumped primarily for agricultural needs to compensate for the reduction in CVP deliveries. Long-term declines in groundwater elevations in this region would be a significant impact. No additional impacts in regard to subsidence or decreased groundwater quality would be expected compared to the No Action Alternative.

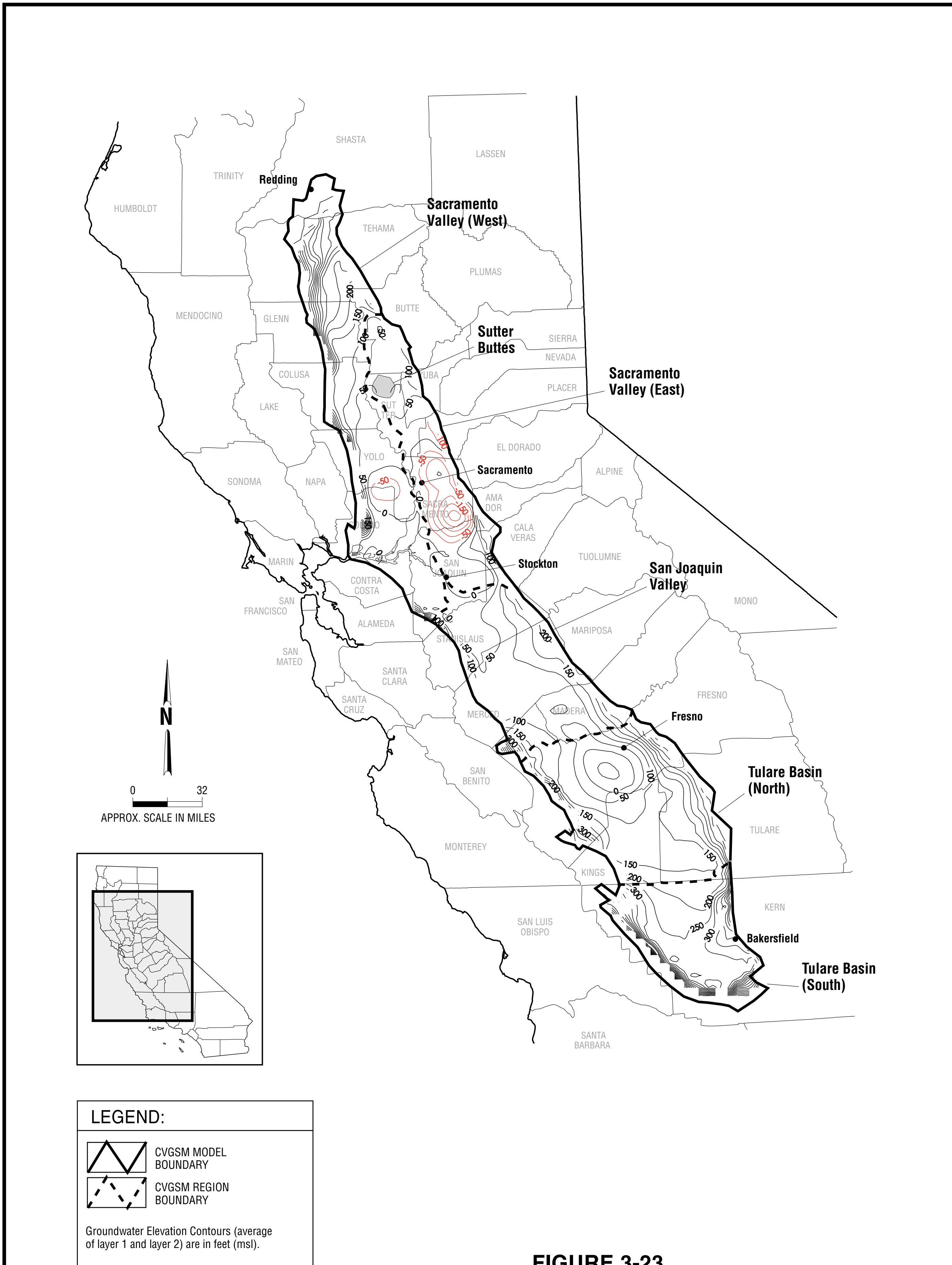

FIGURE 3-23
GROUNDWATER ELEVATIONS,
NO ACTION ALTERNATIVE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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(Under Maximum Flow) groundwater elevations would be significantly lower…along the west side of the San Joaquin Valley…(and) the west side of the Tulare Basin.

San Joaquin Valley. Groundwater elevations would be significantly lower compared to the No Action Alternative along the west side of the San Joaquin Valley. The maximum decline would be approximately 10 feet (Figure 3-24). These declines are a direct result of an additional average 59 taf/yr of groundwater pumping to compensate for the reduction in surface water delivered to CVP agricultural service contractors in the Delta-Mendota Canal service area. Long-term declines in groundwater elevations in this region would be a significant impact.

Significant additional subsidence of 1-5 feet would occur in the southwestern portion of the San Joaquin Valley (Figure 3-24). This is a result of groundwater elevation declines occurring primarily in areas receiving CVP agricultural service contract water, such as the San Luis Canal service area. The area of land subsidence surrounds major conveyance facilities including the DMC and the California Aqueduct. The increased land subsidence would be a significant impact.

Additional groundwater pumping, causing the upwards migration of lesser quality groundwater along the west side of the region, could result in upwelling of groundwater high in TDS into productive groundwater zones, resulting in significant impacts to groundwater quality.

Tulare Basin. Groundwater elevations under the Maximum Flow Alternative would be significantly lower compared to the No Action Alternative along the west side of the Tulare Basin. The area of greatest decline is located on the west side of the region in the vicinity of the Westlands Water District (WWD: Subregion 14) where the maximum decline is approximately 75 feet (see Figure 3-25). This is a result of reduced surface-water deliveries from the San Luis Canal to agricultural users in the region, resulting in an increase in average groundwater pumping of 205 taf/yr, with most of this occurring in the vicinity of WWD (157 taf/yr). This, in turn, results in significant groundwater elevation declines in adjacent areas. For example, groundwater levels in the mid-valley area (Subregion 15) decline by as much as 30 feet as a result of the increased pumping to the west. Long-term declines in groundwater elevations in this region would be a significant impact.

Accordingly, additional land subsidence would occur along the west side of the Tulare Basin (Figure 3-24). The range of increased subsidence along the west side is 1-20 feet, primarily in areas receiving CVP agricultural service contract water via the San Luis Canal. Additional subsidence of 1-5 feet would be found near the axis of the Central Valley. This area of land subsidence surrounds major conveyance facilities, including the California Aqueduct. The increased land subsidence would be a significant impact.

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Additional groundwater pumping, causing the upwards migration of lesser quality groundwater along the west side of the region, could possibly result in upwelling of groundwater high in TDS into productive groundwater zones, resulting in significant impacts to groundwater quality.

(Under Flow Evaluation) significant differences in groundwater elevations, quality, or subsidence would not be seen in the San Joaquin Valley...the greatest groundwater impacts...would occur in the Tulare Basin.

Flow Evaluation.

Sacramento Valley. Long-term groundwater elevations on the west side of the Sacramento Valley would be lowered by as much as 5 feet, primarily in areas receiving CVP agricultural service contract water, such as the Tehama-Colusa Canal service area (Figure 3-26). These declines are a direct result of an additional average 25 taf/yr of groundwater pumping primarily for agricultural needs to compensate for the reduction in CVP surface-water deliveries in this area.

Long-term declines in groundwater elevations in this region would be a significant impact.

San Joaquin Valley. Significant differences in groundwater elevations, quality, or subsidence would not be seen in the San Joaquin Valley.

Tulare Basin. The greatest groundwater impacts associated with the Flow Evaluation Alternative would occur in the Tulare Basin (Figure 3-26). Reduced surface-water deliveries from the San Luis Canal to agricultural users in the region would result in an increase in average groundwater pumping of 61 taf/yr, with most of that occurring in the WWD area and adjacent mid-valley area (Subregion 15: 31 and 15 taf/yr, respectively). The area of greatest groundwater-level decline would be in the WWD area (Subregion 14), where the maximum decline would be approximately 20 feet (Figure 3-26). In response to the declining groundwater elevations, boundary inflow to the WWD increases relative to the No Action Alternative. Areas to the east of the subregion would be modestly affected (Figure 3-26). For example, groundwater elevations in Subregion 15 would decline by approximately 5 feet as a result of the increased pumping to the west. Long-term declines in groundwater elevations in this region would be a significant impact.

Additional groundwater-level declines would lead to additional land subsidence along the west side of the Tulare Basin (Figure 3-27). The range of change is 1-10 feet, occurring primarily in areas receiving CVP agricultural service contract water via the San Luis Canal. The range of change decreases to 1-5 feet towards the axis of the Central Valley. The area of land subsidence surrounds major conveyance facilities, including the California Aqueduct. The increased land subsidence would be a significant impact. Additional groundwater pumping , causing the upwards migration of lesser quality groundwater along the west side of the region, could possibly result in

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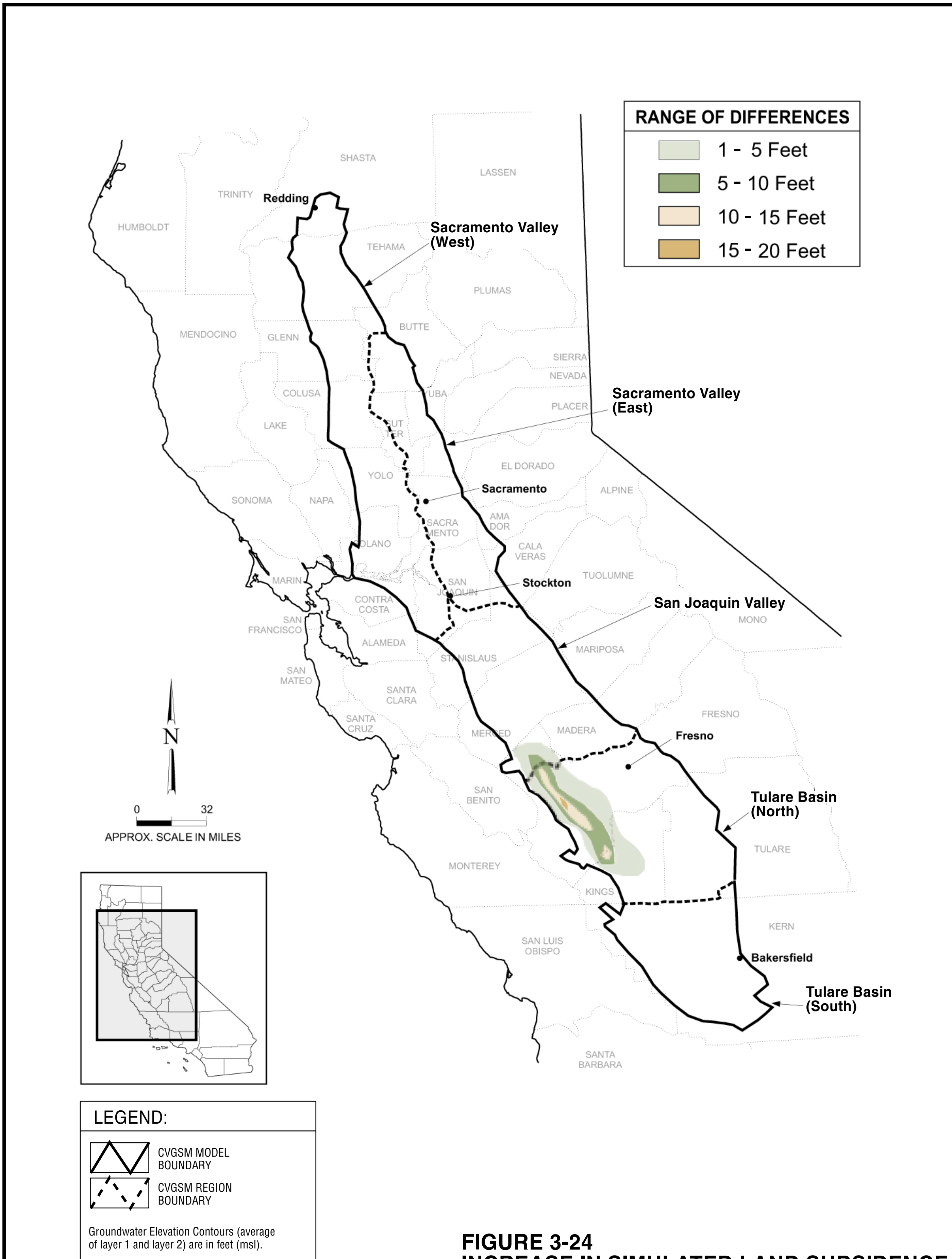

FIGURE 3-24
INCREASE IN SIMULATED LAND SUBSIDENCE IN MAXIMUM FLOW ALTERNATIVE FROM NO ACTION ALTERNATIVE

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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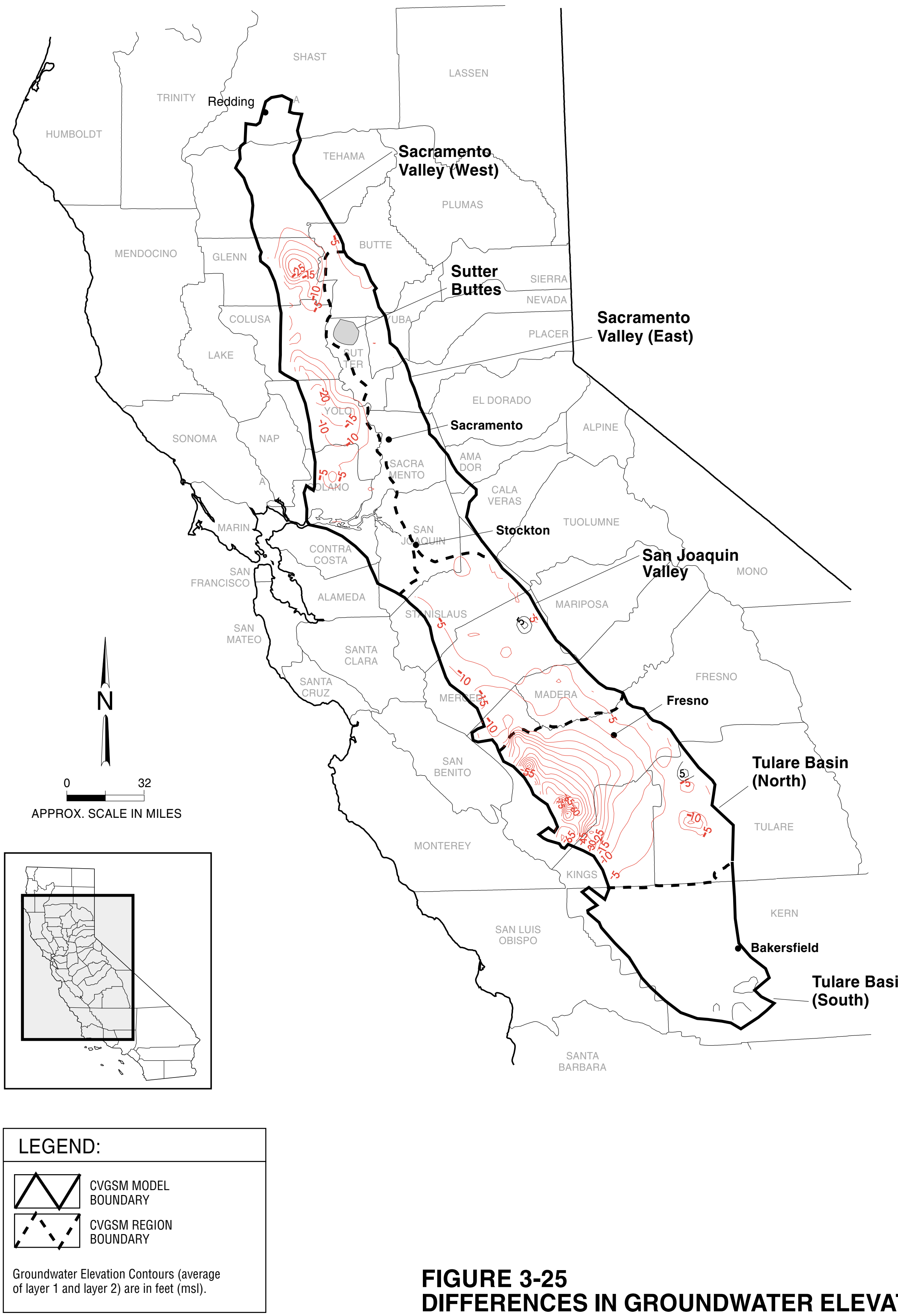

FIGURE 3-25
DIFFERENCES IN GROUNDWATER ELEVATIONS FOR MAXIMUM FLOW ALTERNATIVE AS COMPARED TO NO ACTION ALTERNATIVE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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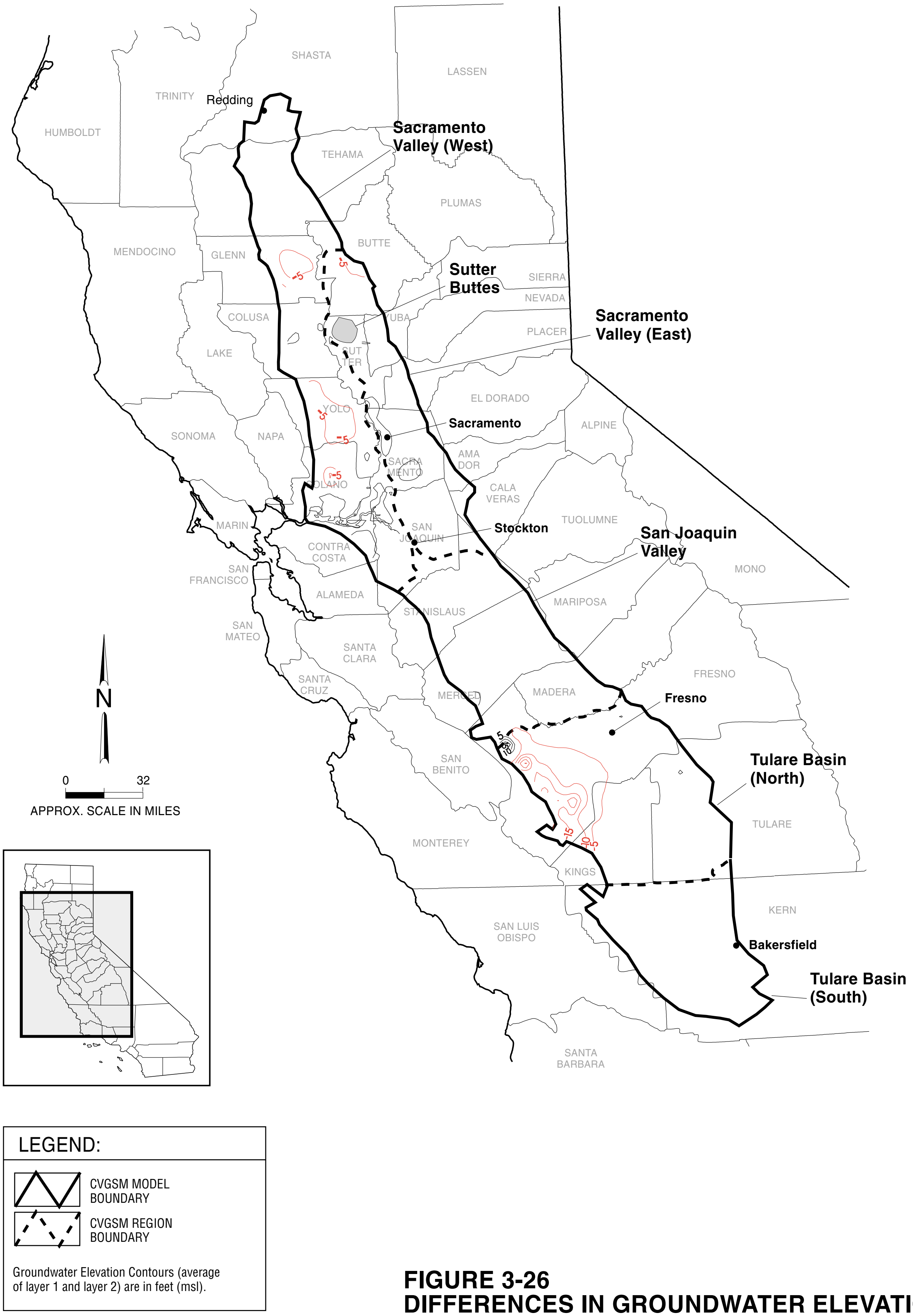

FIGURE 3-26
DIFFERENCES IN GROUNDWATER ELEVATIONS FOR FLOW EVALUATION ALTERNATIVE AS COMPARED TO NO ACTION ALTERNATIVE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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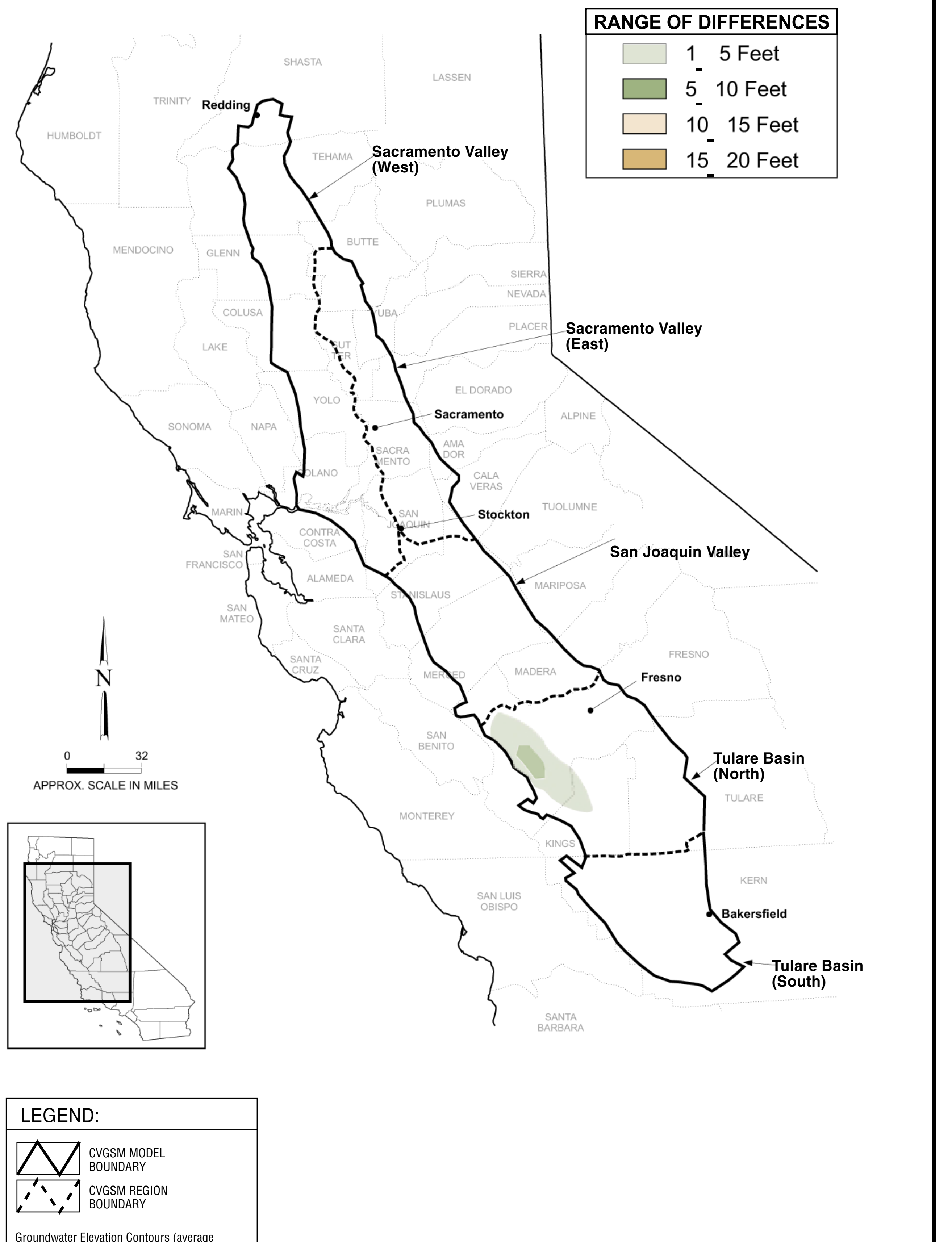

FIGURE 3-27
INCREASE IN SIMULATED LAND SUBSIDENCE IN FLOW EVALUATION ALTERNATIVE FROM NO ACTION ALTERNATIVE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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upwelling of groundwater high in TDS into productive groundwater zones, resulting in significant impacts to groundwater quality.

Under the Percent Inflow Alternative, long-term regional groundwater conditions would be similar to No Action levels in the Sacramento and San Joaquin Valleys.

Percent Inflow. Under the Percent Inflow Alternative, long-term regional groundwater conditions would be similar to No Action levels in the Sacramento and San Joaquin Valleys (Figure 3-28). On the west side of the Tulare Basin, groundwater elevations would be as much as 10 feet lower compared to No Action levels (Subregion 14: Figure 3-28). Reduced surface-water deliveries from the San Luis Canal to agricultural users in the region would result in an increase in average groundwater pumping of 35 taf/yr, with most of that occurring in Subregions 14 and 15 (9 and 15 taf/yr, respectively). The long-term declines in groundwater elevations would be significant.

Additional land subsidence would occur in localized areas along the west side of the Tulare Basin (Figure 3-29). The range of change is 1-5 feet, with a possibility of up to 10 feet in a small region along the west side (see Figure 3-29). The increased land subsidence would be a significant impact. Additional groundwater pumping, causing the upwards migration of lesser quality groundwater along the west side of the region, could possibly result in upwelling of groundwater high in TDS into productive groundwater zones, resulting in significant impacts to groundwater quality.

Mechanical Restoration. Impacts would be the same as No Action.

Under the State Permit Alternative, long-term regional groundwater conditions in the Sacramento and San Joaquin Valleys would be similar to No Action levels.

State Permit. Under the State Permit Alternative, long-term regional groundwater conditions in the Sacramento and San Joaquin Valleys would be similar to No Action levels; elevations in the Tulare Basin would increase as much as 15 feet (Figure 3-30). Most increases in the Tulare Basin would occur in Subregion 14 where an increase in surface-water deliveries from the San Luis Canal would result in a decrease in groundwater pumping by as much as 25 taf/yr. Compared to No Action levels, no additional subsidence or groundwater-quality impacts would occur.

Existing Conditions versus Preferred Alternative. The comparison of the Preferred Alternative (i.e., Flow Evaluation) to 1995 existing conditions to without-project conditions in 2020 (i.e., No Action) indicates that most impacts to groundwater elevations between 1995 and 2020 would be attributed to changes unrelated to the project. For example, the largest declines in groundwater elevations are seen in the urban areas of Sacramento and Fresno, the result of population growth (Figure 3-31). Impacts as a result of the Preferred Alternative are not as great (Figure 3-26).

Sacramento Valley. Groundwater elevations under the Preferred Alternative would be lower compared to existing conditions primarily on the east side of the region where long-term elevations

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would decline by as much as 65 feet in the Sacramento area (see Figure 3-31). However, these impacts are caused by the increase in development (e.g., population growth) from 1995-2020**.** Groundwater-elevation declines of 5 feet on the west side of the region can be attributed to the Preferred Alternative, and would result in a significant impact. These declines occur in areas receiving agricultural service contract water from the CVP, such as the Tehama-Colusa Canal service area. No additional impacts with regard to subsidence or decreased water quality would be expected in comparison to existing conditions.

San Joaquin Valley. Groundwater elevations under the Preferred Alternative would be higher compared to existing conditions on the northeast side of the region where long-term groundwater elevations would increase by as much as 20 feet (see Figure 3-31). These impacts are caused by the assumed level of development from 1995-2020. No significant impacts to groundwater elevations, subsidence, or water quality can be attributed to the Preferred Alternative.

Tulare Basin. Groundwater elevations in the south and east side of the region would be 15 and 25 feet lower, respectively, under the Preferred Alternative compared to existing conditions (see Figure 3-31). Groundwater elevations would increase 5-15 feet along the west side and mid-valley areas. All of these changes are caused by the assumed level of development from 1995-2020, i.e., they are not related to the project. Impacts attributable to the Preferred Alternative would occur along the extreme west side area, where the maximum decline in groundwater elevations would be approximately 20 feet (Figure 3-31). Additional land subsidence would occur along the west side of the Tulare Basin. The range of changes is from 1 and 10 feet, primarily in areas receiving CVP agricultural service contract water via the San Luis Canal. The range impacts decreases to 1-5 feet towards the axis of the Central Valley. The area of land subsidence surrounds major conveyance facilities, including the California Aqueduct. Additional groundwater pumping, causing the upwards migration of lesser quality groundwater along the west side of the region, could possibly result in upwelling of groundwater high in TDS into productive groundwater zones; resulting in significant impacts to groundwater quality.

Potentially significant groundwater-related impacts could occur with the implementation of the Maximum Flow, Flow Evaluation, and Percent Inflow Alternatives as a result of decreased surface-water supplies.

Mitigation. Potentially significant groundwater-related impacts could occur with the implementation of the Maximum Flow, Flow Evaluation, and Percent Inflow Alternatives as a result of decreased surface-water supplies. Although changes to water supply per se were not considered an impact, the development of additional water supplies to meet demands would lessen the associated impacts (e.g., groundwater impacts). A number of demand- and supply-related

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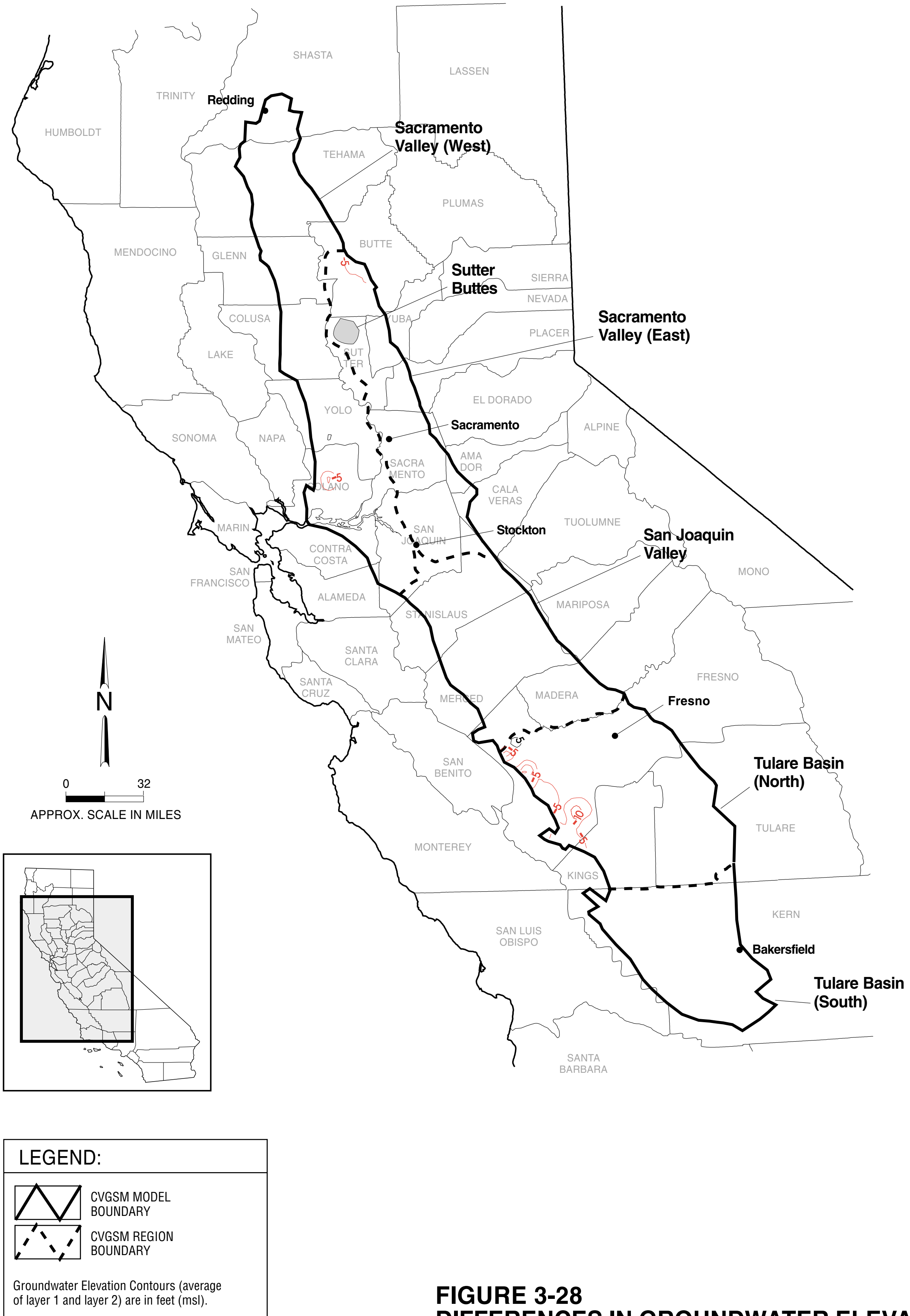

FIGURE 3-28
DIFFERENCES IN GROUNDWATER ELEVATIONS FOR PERCENT INFLOW ALTERNATIVE AS COMPARED TO NO ACTION ALTERNATIVE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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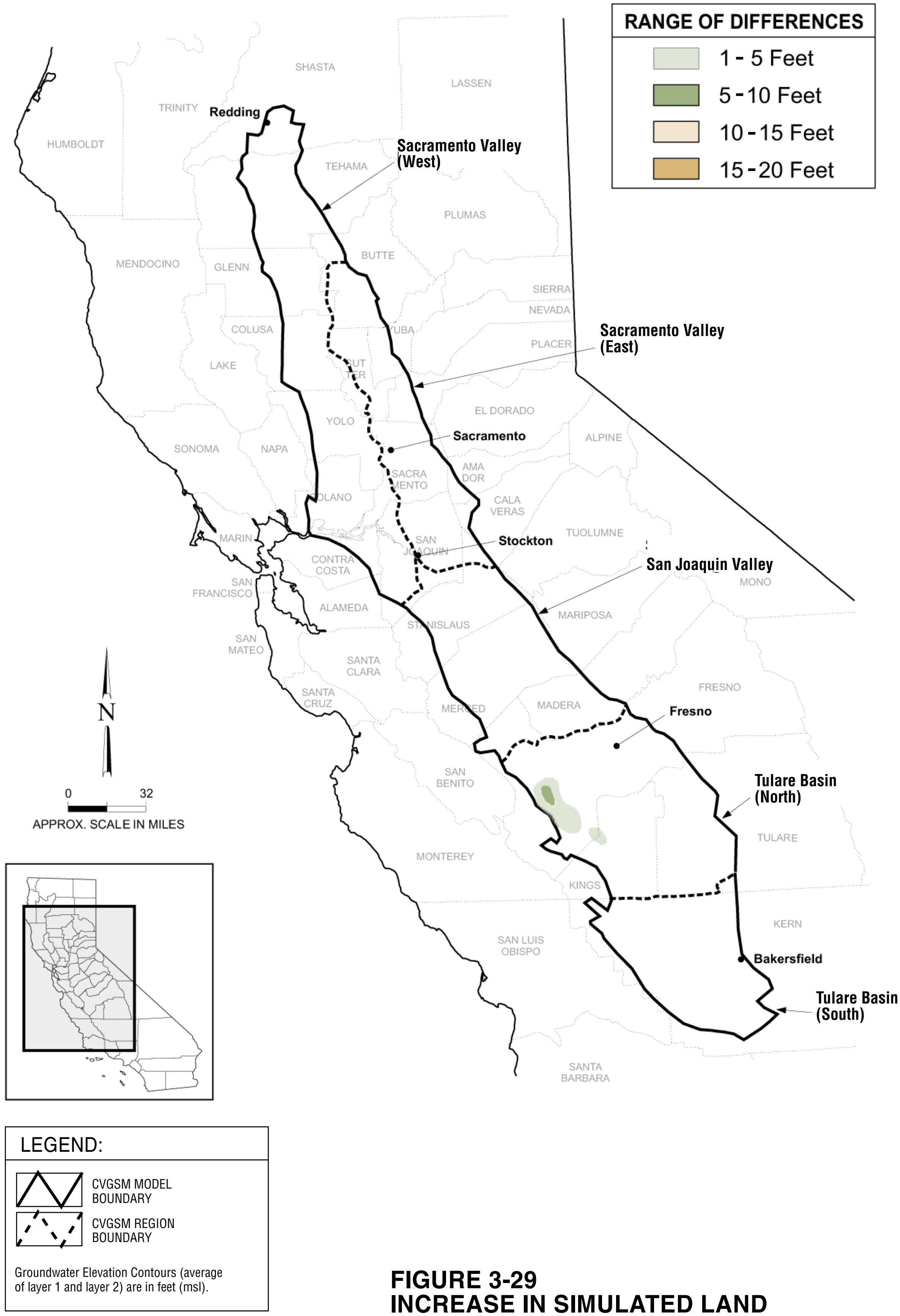

FIGURE 3-29
INCREASE IN SIMULATED LAND SUBSIDENCE IN PERCENT INFLOW ALTERNATIVE FROM NO ACTION ALTERNATIVE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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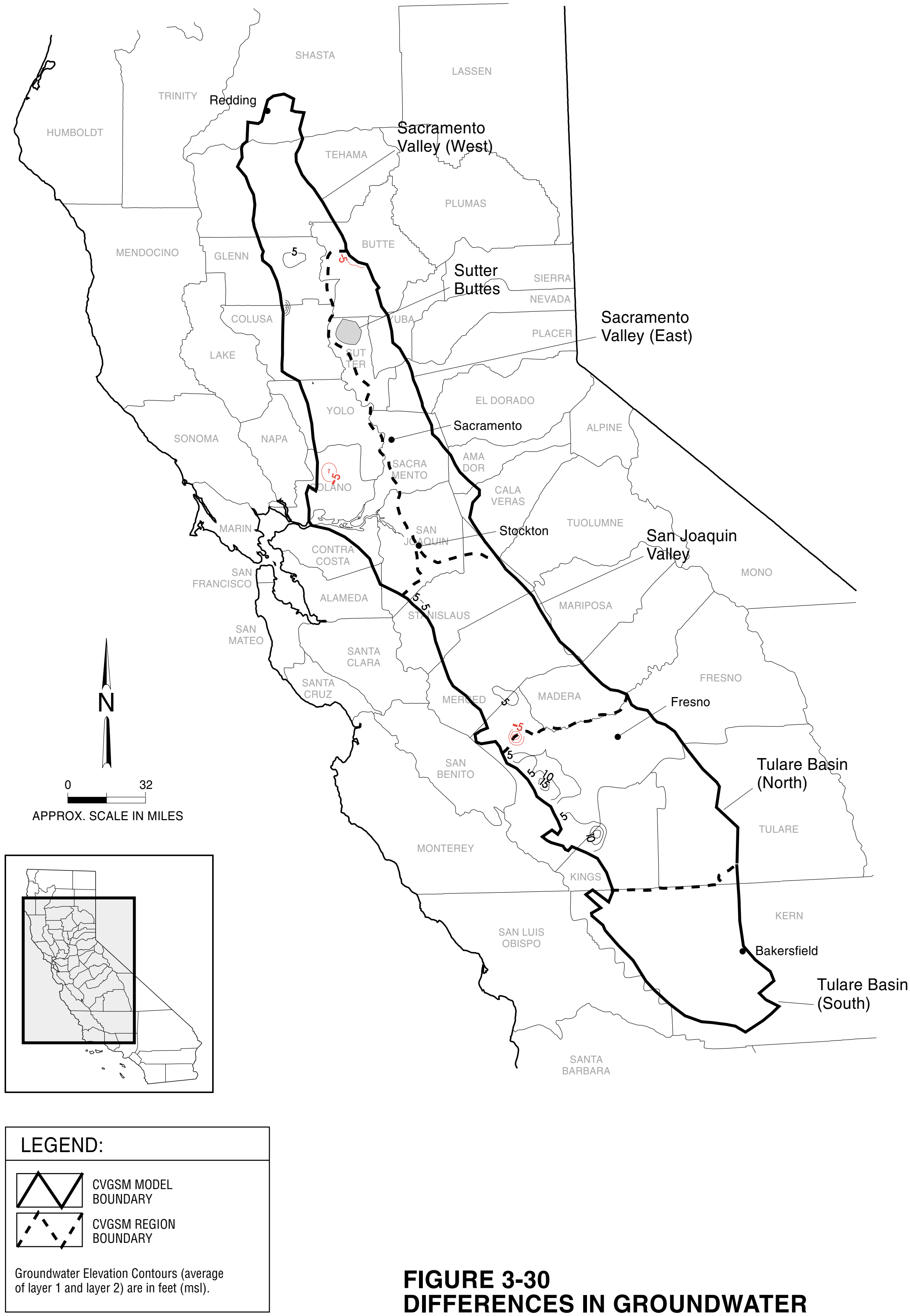

FIGURE 3-30
DIFFERENCES IN GROUNDWATER ELEVATIONS FOR STATE PERMIT ALTERNATIVE AS COMPARED TO NO ACTION ALTERNATIVE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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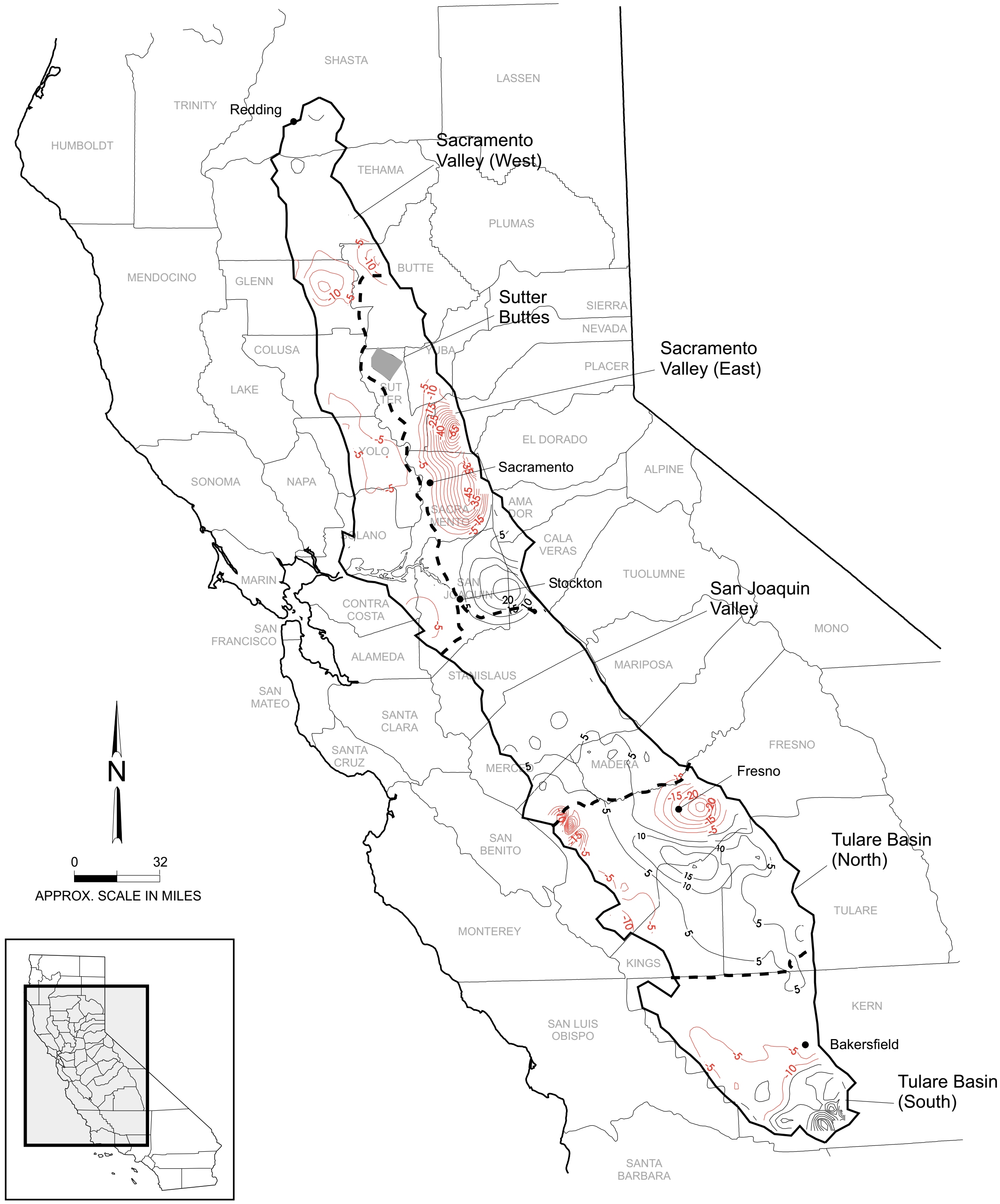

LEGEND:

CVGSM MODEL BOUNDARY

CVGSM REGION BOUNDARY

Groundwater Elevation Contours (average of layer 1 and layer 2) are in feet (msl).

FIGURE 3-31
DIFFERENCES IN GROUNDWATER ELEVATIONS FOR PREFERRED ALTERNATIVE AS COMPARED TO EXISTING CONDITIONS
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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programs are currently being studied across California, many of which are being addressed through the on-going CALFED and CVPIA programs and planning processes. Although none of these actions would be directly implemented as part of the alternatives discussed in this DEIR/EIS, each could assist in offsetting impacts resulting from decreased Trinity River exports. Examples of actions being assessed in the CALFED and CVPIA planning processes include:

- Develop and implement additional groundwater and/or surface-water storage. Such programs could include the construction of new surface reservoirs and groundwater storage facilities, as well as expansion of existing facilities. Potential locations include sites throughout the Sacramento and San Joaquin Valley watersheds, the Trinity River Basin, and the Delta.
- Purchase long- and/or short-term water supplies from willing sellers (both in-basin and out-of-basin) through actions including, but not limited to, temporary or permanent land fallowing.
- Facilitate willing buyer/willing seller inter- and intra-basin water transfers that derive water supplies from activities such as conservation, crop modification, land fallowing, land retirement, groundwater substitution, and reservoir re-operation.
- Promote and/or provide incentive for additional water conservation to reduce demand.
- Decrease demand through purchasing and/or promoting the temporary fallowing of agricultural lands.
- Increase water supplies by promoting additional water recycling.

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TABLE 3-4
Summary of Impacts to Groundwater Resources

	No Action[a]	Alternatives Compared to No Action: Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions	Preferred Alternative to Existing Conditions
Sacramento Valley								
Groundwater Levels	Declines in groundwater levels near Sacramento.	Significant declines on the west side of the region, primarily in areas receiving CVP agricultural service contract water, such as the Tehama-Colusa Canal service area.	Significant declines on the west side of the region, primarily in areas receiving CVP agricultural service contract water, such as the Tehama-Colusa Canal service area.	No additional impacts compared to No Action.	Same as No Action	No additional impacts compared to No Action.	Minimal declines in groundwater levels throughout the region.	Significant declines on the west side of the region attributed to the Preferred Alternative.
Land Subsidence	Land subsidence would occur, primarily in Yolo County at rates similar to recent historical conditions.	No additional impacts compared to No Action.	No additional impacts compared to No Action.	No additional impacts compared to No Action.	Same as No Action	No additional impacts compared to No Action.	Limited to the southwestern part of the region, primarily in Yolo County.	No additional impacts attributed to the Preferred Alternative.
Groundwater Quality	Degradation would continue in some portions of the region, including areas south of the Sutter Buttes and in southern Yolo County.	No additional impacts compared to No Action.	No additional impacts compared to No Action.	No additional impacts compared to No Action.	Same as No Action	No additional impacts compared to No Action.	Generally suitable for most uses; however, TDS concentrations are higher in the south-central part of the region. In addition, a limited presence of pesticides has been detected in some locations.	No additional impacts attributed to the Preferred Alternative.
San Joaquin Valley								
Groundwater Levels	Levels would be similar to recent conditions, and hydraulic disconnection would continue on the east side of the region.	Significant declines in groundwater levels along the west side of the San Joaquin Valley.	No additional impacts compared to No Action.	No additional impacts compared to No Action.	Same as No Action	No additional impacts compared to No Action.	Groundwater levels are declining due to increased pumping in recent years. (Annual groundwater pumping in the San Joaquin Valley Region exceeds recent estimates of perennial yield by approximately 200,000 af.)	No additional impacts attributed to the Preferred Alternative.
Land Subsidence	Additional land subsidence ranging from 1-5 feet over a 69-year simulation period would continue to occur.	Significant land subsidence of 1-5 feet would occur in the southwestern portion of the San Joaquin Valley.	No additional impacts compared to No Action.	No additional impacts compared to No Action.	Same as No Action	No additional impacts compared to No Action.	Land subsidence is a significant problem in the southern half of the San Joaquin Valley.	No additional impacts attributed to the Preferred Alternative.
Groundwater Quality	Groundwater quality would be similar to recent conditions, and would most likely continue to be degraded.	Potential significant impacts to groundwater quality.	No additional impacts compared to No Action.	No additional impacts compared to No Action.	Same as No Action	No additional impacts compared to No Action.	Municipal and agricultural use of groundwater is impaired in many areas of the region due to elevated nitrate and boron concentrations. In addition, high selenium concentrations in soils may potentially leach into the groundwater.	No additional impacts attributed to the Preferred Alternative.
Tulare Basin								
Groundwater Levels	Levels would be similar to recent conditions.	Significant declines in groundwater levels along the west side of the region in the vicinity of the WWD, and in adjacent areas.	Significant declines in groundwater levels along the west side of the region in the vicinity of the WWD, and in adjacent areas.	Significant declines in groundwater levels on the west side of the region.	Same as No Action	Substantial increases in groundwater levels.	Levels declining due to increased pumping in recent years.	Significant declines in groundwater levels attributable to the Preferred Alternative would occur along the extreme west side of the region.

TABLE 3-4
Summary of Impacts to Groundwater Resources

		Alternatives Compared to No Action						
	No Action[a]	**Maximum Flow**	**Flow Evaluation**	**Percent Inflow**	**Mechanical Restoration**	**State Permit**	**Existing Conditions**	**Preferred Alternative to Existing Conditions**
Land Subsidence	Additional land subsidence, ranging from 1-5 feet over a 69-year stimulation period would occur.	Additional land subsidence along the west side of the region would occur.	Additional land subsidence along the west side of the region would occur.	Additional land subsidence in localized areas along the west side of the region.	Same as No Action	No additional impacts compared to No Action.	Importation of SWP/ CVP surface water has largely alleviated chronic subsidence problems, although episodic subsidence still occurs during drought periods.	Additional land subsidence along the west side of the region would occur, and would be attributable to the Preferred Alternative.
Groundwater Quality	Groundwater quality would be similar to recent conditions, and would most likely continue to be degraded.	Potentially significant impacts to groundwater quality.	Potentially significant impacts to groundwater quality.	Potentially significant impacts to groundwater quality.	Same as No Action	No additional impacts compared to No Action.	Significant limitations on groundwater use in portions of the region due to presence of DBCP and EDB.	Potentially significant impacts to groundwater quality attributed to the Preferred Alternative.

[a]Projected groundwater impacts may be overstated in some areas. Local efforts to reduce groundwater impacts (i.e., American River Regional Master Plan) are still in the planning stages and, as such, were not included in the assumptions for the No Action Alternative. Consequently, as these efforts are implemented, groundwater impacts may be reduced.

3.4 Water Quality

Affected Environment.

Trinity River Basin. Trinity River water temperatures are influenced by Trinity and Lewiston Reservoir release temperatures, flow rates, channel geometry, regional meteorology, and tributary flows and temperatures (the affect of Trinity and Lewiston Reservoirs diminishes with distance downstream). Generally speaking, the greater the release volumes from the dams, the less susceptible the river's temperature is to other factors. Trinity Reservoir releases tend to be generally cold (42-47°F), whereas Lewiston Reservoir, which is much shallower, tends to provide releases that are more affected by ambient temperatures.

Generally speaking, the greater the release volumes from the dams, the less susceptible the (Trinity) river's temperature is to other factors.

During storm periods, turbidity in the Trinity River from Lewiston Dam to the South Fork is caused primarily by heavy inflows of suspended sediment from tributaries and the reservoirs. Highly erosive soils compose approximately 17 percent of the Trinity River Basin, resulting in significant sediment loads entering the river. The reduced flows since the construction of the dams have caused these sediments to accumulate in the river. High flows, which historically flushed these sediments through the system, have become less frequent and of lower magnitude (see the Geomorphic Environment section [3.2]).

Water quality objectives regarding Trinity River temperature, turbidity, and sediment were determined by the NCRWQCB in conjunction with federal, state, and local agencies. Temperature standards are effective from July 1-December 31 for the upper reach between Lewiston Dam and the North Fork Trinity River. Standards for the Trinity River are presented in Table 3-5. The objectives also stipulate that water released into the Trinity River may be no more than 5°F warmer than receiving water temperatures. Turbidity standards state that turbidity shall not increase more than 20 percent above naturally occurring background levels. The NCRWQCB does issue permits and waivers that identify allowable dilution zones within which higher percentages can be tolerated. The NCRWQCB criteria for sediment, suspended material, and settable material in the basin is narrative, meaning that standards are not based on numerical goals. Rather, criteria are set to avoid nuisance and maintain beneficial uses in the river. These standards are used to condition activities that affect, or potentially affect, water quality. When appropriate, the NCRWQCB may establish appropriate numeric water quality standards in waste discharge orders for narrative standards. Waste discharge orders are considered on a case-by-case basis, and are typically tied to naturally occurring water quality

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background conditions. In addition to the state criteria, the Hoopa Valley Tribe is in the process of establishing water quality standards pursuant to the Clean Water Act; and the U.S. Environmental Protection Agency (EPA) is scheduled to complete TMDL criteria for the middle and lower Trinity River by the end of 2001 (see Chapter 4, Cumulative Effects).

TABLE 3-5
NCRWQCB Temperature Objectives for the Trinity River

Temperature Not to Exceed	Time Period	River Reach
60°F (15.6°C)	July 1-September 14	Lewiston Dam to Douglas City Bridge
56°F (13.3°C)	September 15-October 1	Lewiston Dam to Douglas City Bridge
56°F (13.3°C)	October 1-December 31	Lewiston Dam to confluence with North Fork

Trinity River water quality is also explicitly protected by Water Right Orders 90-05 and 91-01. These orders state that exports from the TRD to the Central Valley for Sacramento River temperature control shall not harm Trinity River fisheries, as measured by compliance with specific temperature requirements in the Trinity River. The temperature requirements contained in Water Right Orders 90-05 and 91-01 for the Trinity River are 56°F (13.3°C) and 60°F (15.6°C) at Douglas City and the North Fork confluence, respectively, as shown in Table 3-5. The summer objective at Douglas City is not a requirement of Water Right Orders 90-05 and 91-01.

Lower Klamath River Basin / Coastal Area. Water quality in the lower Klamath River is regulated by the NCRWQCB. Standards for the Trinity River generally apply to the Klamath River because beneficial uses are similar, except that there are no time- and location-specific temperature objectives. Current water quality concerns in the Klamath River Basin are the result of agricultural practices, water management, timber harvesting activities, natural geologic instability, and mining operations.

Water quality in the lower Klamath River can be influenced by dam releases from Iron Gate Dam on the Klamath River or dam releases from Lewiston Dam of the Trinity River. Water quality in the upper Klamath River Basin is at times characterized as being turbid and high in nutrients. As a consequence of the excess nutrients from agricultural run-off, at times the water quality of the Klamath River is degraded. Excessive nutrients have resulted in an abundance of phytoplankton blooms that have correspondingly lowered dissolved oxygen concentrations to levels considered to be unsafe for aquatic life. Lower in the Klamath River, the effects of the high nutrient loads from the upper basin are typically diluted by tributary flow, including the Trinity River, the largest of tributaries.

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Lower Klamath River water temperatures may be influenced by releases from Iron Gate Dam. However, to date there is a better understanding of the thermodynamics of the Trinity River system than the Klamath River system. Indeed, the two systems are different in that the coldwater storage of Trinity Reservoir is much greater than that of the upper Klamath River Basin reservoirs. Empirical data and a temperature model of the Trinity River has provided insight into the effects that variable Lewiston Dam releases may have on water temperatures at the confluence of the Klamath River at Weitchpec (U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999). Empirical data have shown the influence of a high Lewiston Dam release on Klamath River water temperatures. In June of 1992, a 10-day Lewiston Dam release of 6,000 cfs occurred and greatly influenced the temperature of the lower Klamath River. This release decreased the mainstem Klamath River (immediately below the confluence) by nearly 4.5°F. Because this year was a critically dry year, tributary accretion in both the Klamath and Trinity Rivers was very small. As a consequence, the high release from Lewiston Dam resulted in the Trinity River becoming the dominant water source at the confluence.

Modeled dam releases from Lewiston Dam also provided assessments of the likely effects of releases on water temperatures at the confluence of the Klamath River during the spring and early summer (U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999). While these evaluations focused on recommended flows identified in the Flow Evaluation, the following generalities were identified from this evaluation. First, the model predicts that high-level releases can result in Trinity River water temperatures being colder than the Klamath River. Conversely, low magnitude releases can result in lower Trinity River water temperatures becoming warmer than the Klamath River. The main factor that can offset temperature differentials is likely the quantity of tributary accretion. When either the Lewiston Dam release is large under drought conditions (low tributary accretion) or small during wet conditions, the temperature differentials become greatest. Marked temperature differentials may have a harmful effect on sensitive fishery resources. When dam release magnitudes are matched to emulate pre-TRD hydrologic conditions the differences are lessened. For more detailed information on this subject see Appendix L of the *Trinity River Flow Evaluation Report* (U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999).

Central Valley. Shasta Dam is a major influence on Sacramento River water quality and, consequently, on the Bay-Delta. Operation of the TRD also affects water quality in the Sacramento River through the timing, magnitude, and temperature of exports, and the coordination with Shasta releases. Sacramento River water quality from Keswick

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Dam to the Red Bluff Diversion Dam (RBDD) is primarily influenced by Shasta Division releases and Trinity River exports. Downstream of RBDD, tributary inflow lessens the influence of the Shasta Division and TRD exports. During warm weather, Sacramento River water temperatures tend to increase downstream from Keswick Dam. This effect is magnified during dry water years with lower instream flows.

Shasta Dam controls flows and temperatures in the Upper Sacramento River and, to a lesser degree, in the lower river and the Bay-Delta.

Following adoption of Water Right Orders 90-05 and 91-01 by the SWRCB and implementation of the 1993 Biological Opinion for Sacramento River winter chinook salmon, temperature requirements became a much more important constraint in the operation of the Shasta Division. Water Right Orders 90-05 and 91-01 implement the year-round 56°F Sacramento River temperature objective contained in the Sacramento River Basin Plan (Basin Plan) for the protection of all Sacramento River chinook runs (winter, spring, fall, and late fall). The Biological Opinion requires a minimum Shasta Reservoir carryover storage of 1.9 million af on September 30. The Biological Opinion also set temperature compliance standards at downstream measuring points (Figure 3-32 and Table 3-6). Before the Biological Opinion and Water Right Orders 90-05 and 91-01, Shasta Dam was operated to maximize water deliveries, power generation, and flood control.

The Shasta Division currently imports Trinity water in the spring and summer to conserve the coldwater pool in Shasta Reservoir for release later in the year. An important aspect of this coordination is to move Trinity water through Whiskeytown Reservoir at a rate sufficient to prevent warming. Water moving too slowly can result in warming, requiring additional coldwater releases from Shasta Dam to meet downstream temperature standards, which can reduce the amount of cold water available to meet standards later in the year and also affect water quality and deliveries in the Bay-Delta. Lower storage levels in Shasta Reservoir can also increase Shasta release temperatures, again requiring higher flows to comply with downstream temperature objectives. Reclamation recently added a Temperature Control Device (TCD) to the upstream (reservoir side) face of Shasta Dam. The TCD allows dam operators to pull cold water from lower depths throughout the year, increasing the ability to generate power while assisting in meeting temperature objectives in the Sacramento River.

Dilution of Iron Mountain Mine runoff is also an important Sacramento River water quality consideration. Runoff from the mine, a EPA Superfund site near Redding, can be highly acidic and contain toxic metals. Runoff is held at Spring Creek Debris Dam, located upstream from the tailrace of Spring Creek Powerplant.

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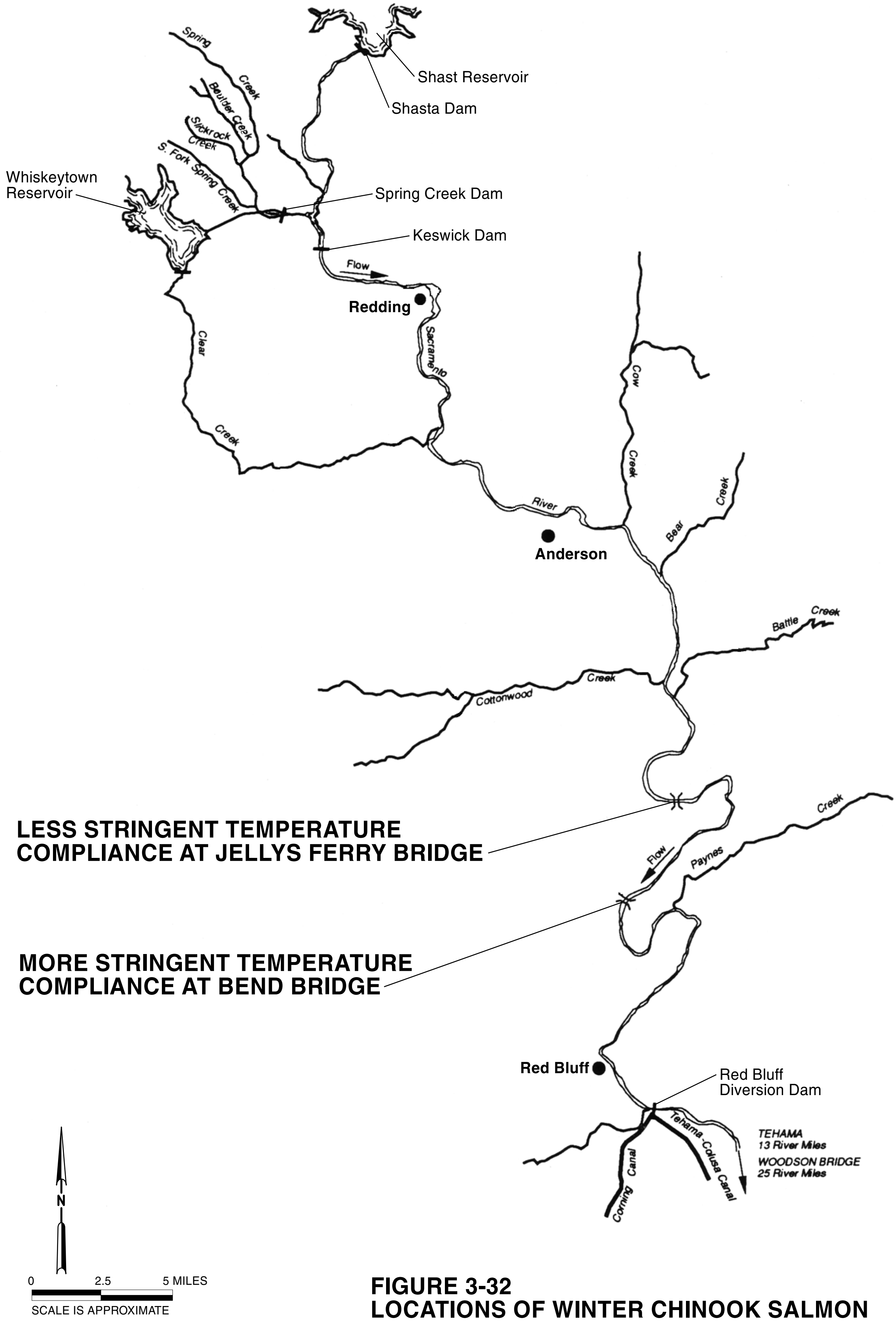

FIGURE 3-32
LOCATIONS OF WINTER CHINOOK SALMON BIOLOGICAL OPINION TEMPERATURE COMPLIANCE
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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TABLE 3-6
Temperature Standards Required by 1993 Biological Opinion for Winter Chinook Salmon

Water-year Class[a, b]	September 30 Storage in Shasta[c]	Temperature Compliance Standards (Daily Average Water Temperature Not to Exceed)
Wet	All levels	56°F at Bend Bridge April 15 through September 30 60°F at Bend Bridge October 1 through October 30
Above Normal	All levels	56°F at Bend Bridge April 15 through September 30 60°F at Bend Bridge October 1 through October 30
Dry	3.2 maf	56°F at Bend Bridge April 15 through September 30 60°F at Bend Bridge October 1 through October 30
Dry	2.5 maf	56°F at Bend Bridge April 15 through August 31 56°F at Jellys Ferry September 1 through September 30 60°F at Jellys Ferry October 1 through October 30
Dry	1.7 maf	56°F at Jellys Ferry April 15 through September 30 60°F at Jellys Ferry October 1 through October 30
Critical	All levels	56°F at Jellys Ferry April 15 through September 30 60°F at Jellys Ferry October 1 through October 30
Extremely Critical	3.2 maf	56°F at Jellys Ferry April 15 through September 30 60°F at Jellys Ferry October 1 through October 30
Extremely Critical	2.5 maf	Reclamation must re-initiate consultation with NMFS 14 days prior to the first announcement of water delivery allocations
Extremely Critical	2.0 maf	Reclamation must re-initiate consultation with NMFS 14 days prior to the first announcement of water delivery allocations
Extremely Critical	1.7 maf	Reclamation must re-initiate consultation with NMFS 14 days prior to the first announcement of water delivery allocations

[a]Based on the Sacramento River Index, which differs from water-year index used elsewhere in document.
[b]Water-year class projections must be Reclamation's 90 percent probability of exceedance forecast of runoff released in February, or an exceedance forecast at least as conservative. Actual runoff will be less than a 90 percent forecast in only 10 percent of years. Forecasts made later in the water year are more accurate than forecasts made earlier in the year.
[c]When carryover storage is less than 1.9 maf, Reclamation must re-initiate consultation with NMFS prior to first water allocation announcement.

The debris dam allows mine runoff to be released into Keswick Reservoir on a controlled schedule so that it can be diluted to safe levels. During wet periods when the debris dam fills and spills, runoff flows directly into Keswick Reservoir, and metal concentrations occasionally exceed desirable levels in the Sacramento River. Releases of water from Whiskeytown Reservoir (of which Trinity River exports are a major part) to the Spring Creek Powerplant are typically maintained at a minimum level of 200 cfs to help dilute the polluted water prior to entry into Keswick Reservoir. This number should be considered very conservative given the ongoing construction of metal emission control systems associated with Iron Mountain Mine, as well as the dilution capability of Clear Creek.

Freshwater inflows (to the Bay-Delta) are continuously influenced by the tidal cycle, which moves into and out of the Bay-Delta approximately twice a day.

Water quality in the Bay-Delta is primarily affected by the way water moves through the region. Freshwater inflows are continuously influenced by the tidal cycle, which moves into and out of the Bay-Delta approximately twice a day. This tidal interaction is important because it moves the saltwater/freshwater interface back and forth, which influences water quality at specific locations throughout the Bay-Delta, both daily and seasonally. Water exports from the Bay-Delta are impacted by these changing water quality characteristics.

Currently, a combination of agreements and directives are used to maintain water quality in the Bay-Delta including the:

- Bay-Delta Accord (Accord)
- SWRCB D-1485, as amended by WR 95-1, and 95-6 and 98-9
- Coordinated Operations Agreement

These agreements and directives outline standards and operating procedures that, when used in conjunction with upstream water quality plans and biological opinions for endangered species, determine water quality in the Bay-Delta.

SWRCB Bay-Delta water quality standards are conditioned by water-year class and, in general, become less stringent in critically dry years.

The Accord, formulated by CALFED and representatives of several urban, agricultural, and environmental groups, is effective until the adoption of final Delta water quality standards. Originally intended to be valid for 3 years, the Accord has been extended twice. The Accord established new outflow standards, modified Biological Opinions for winter chinook salmon and Delta smelt to increase water project flexibility, and established a funding mechanism for non-flow related measures.

SWRCB Bay-Delta water quality standards are conditioned by water-year class and, in general, become less stringent in critically dry years. D-1485 outlined standards for salinity, chloride, and habitat protection (X2 criteria for example). X2 criteria refers to the management of upstream movement of water with 2 parts-per-thousand (ppt) concentration of salt. X2 is measured as kilometers (km) from the Golden Gate Bridge. Higher X2 values indicate salt water intrusion into the Delta.

Water quality standards are much more difficult to meet in critically dry years because there is less water supply to meet them and multi-objective CVP purposes must be made on a tradeoff basis with limited resources. Water quality standards become more protective (or enhanced) as conditions become wetter, and there are generally more water resources and project flexibility to meet these competing multi-objective needs. The CVP no longer operates to meet D-1485

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standards, but is now guided by the SWRCB May 1995 Water Quality Control Plan as amended by WR95-1 ,95-6, and 98-9.

Because of their ability to significantly alter flows, and therefore water quality in the Bay-Delta, the major export pumps are also regulated. Exports from the pumps are restricted based on Delta inflow and San Joaquin River flow. These limits are intended to be monitored in real time in order to detect fish in the areas adjacent to the pumps. Currently, exports are limited to 35 percent of Delta in-flow from February through June and 65 percent of inflow for the remainder of the year. In 1995, the export/inflow ratio averaged 18.4 percent, with a low of 6.2 and a daily maximum of 64.3. Exports are also limited between April 15 and May 15 to 1,500 cfs or 100 percent of San Joaquin River flow at Vernalis, whichever is greater. The San Joaquin export limit is only used if it is more restrictive than the 35 percent limit.

The Delta provides drinking water for about 20 million people, making water quality, and the ability to adequately treat Delta water, a major concern. Fresh water not used in the Delta or not exported from the Delta flows to the Pacific Ocean through San Francisco Bay, which helps prevent saline water from encroaching into the Delta and degrading water quality. Managing the balance between water taken from the Delta for drinking water and water left in the Delta to protect water quality is a key concern.

The Safe Drinking Water Act (SDWA) was enacted and signed into law in 1974. Through the SDWA, the EPA was given the authority to set standards for contaminants in drinking water supplies. The EPA was required to establish primary regulations for the control of contaminants that affect public health and secondary regulations for compounds that affect the taste or aesthetics of drinking water. Under the SDWA, DHS has the primary enforcement responsibility (referred to as “primacy”). The Health and Safety Code and Title 22 of the California Administrative Code establishes DHS authority and stipulates drinking water quality and monitoring standards. To maintain primacy, a state’s drinking water regulations can be no less stringent than the federal standards (i.e., California regulations can be more stringent).

Water in the Delta generally meets public water supply water quality standards identified by the EPA and the DHS. However, stricter federal standards have been promulgated and are significantly more difficult and costly to meet. The standards of concern relate to disinfection byproducts and the potential requirements for more rigorous disinfection. Since 1914, chlorine has been the preferred disinfectant in most U.S. public surface-water systems. It is relatively easy to use, inexpensive, and it persists in water, continuing to kill bacteria throughout the distribution system. In the 1960s, concern

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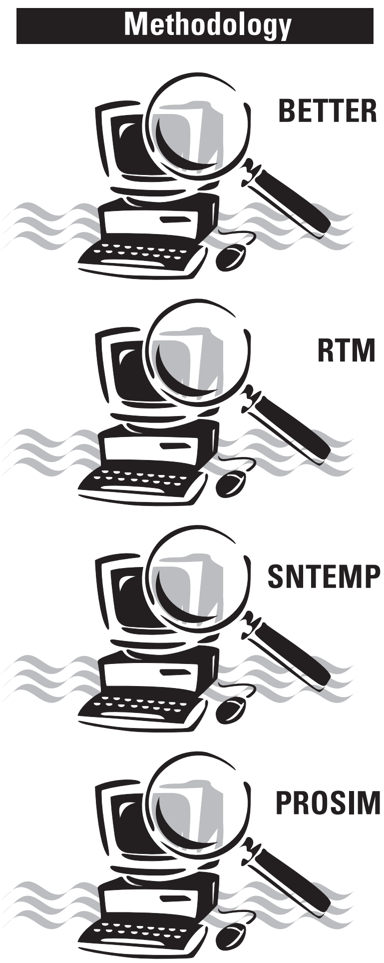
arose over newly discovered compounds that form when chlorine combines with naturally occurring organic, carbon-based materials, such as decaying vegetation or some salts. Known as disinfection by-products (DBPs), these synthetic organic compounds are suspected carcinogens.

For drinking water, DBPs have only been consistently measured since the early 1980s, as the EPA first adopted an MCL for trihalomethanes (THMs) in 1981. Constituents that can cause DBPs include bromide (naturally occurring in seawater) and organic carbon. Tidal currents created by the rise and fall of sea levels modify stream flow, particularly when outflows are low or when tides are high (California Department of Water Resources, 1989). Intruded seawater is a major source of bromide, particularly in the western Delta. Intrusion profoundly affects Delta water withdrawn at the CCWD, SWP, and CVP intakes. The presence of bromide in a drinking water source complicates the disinfection process because it is heavier than chlorine, and the THM standard is based on weight. Hence, it takes fewer molecules of brominated THMs to exceed the drinking water standard. Another method of disinfection, ozone treatment, is also complicated by the presence of bromide because it forms bromate, which is also a DBP.

Of the agricultural land acreage in the Delta, 80 percent contain peat soils. The organic carbon content of peat soil is 50-80 percent, while intermediate organic type soils have 30-50 percent organic matter. High organic content makes peat soil highly productive for agriculture, but prone to wind erosion and subsidence. Subsidence is the result of exposure of peat to oxygen, which converts the organic carbon solids to carbon dioxide gas and aqueous carbon. Organic carbon can also form THMs, including the most common THM, chloroform.



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Environmental Consequences.

Methodology. Several water temperature models were used to evaluate the effects of each alternative on Trinity River water temperatures. These models included: (1) Reclamation's Temperature Model (RTM) (U.S. Bureau of Reclamation, 1990), which predicts Trinity Dam release temperatures as a function of storage and outlet works used; (2) a 2-dimentional temperature model of Lewiston Reservoir (based on the Box Exchange Transport Temperature and Ecology of Reservoirs Model –BETTER), which predicts temperatures at outflow locations; and (3) the Service's Stream Network Temperature Model (SNTEMP), which predicts Trinity River water temperatures below Lewiston Reservoir. These models were used in sequence, with output of upstream used as input for downstream models.

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The monthly RTM model (sometimes called the Sacramento River Basin Temperature model) is used as an analytical tool for evaluating the effects of reservoir operations on riverine habitat water quality conditions. The RTM model simulates temperature profiles in five major reservoirs (Trinity, Whiskeytown, Shasta, Folsom, and Oroville Reservoirs), four downstream regulating reservoirs (Lewiston Reservoir, Keswick Reservoir, Thermalito Afterbay, and Natoma Reservoir), and three major river systems (Sacramento, Feather, and American Rivers). The model was developed as a tool for evaluating the effects of monthly simulated CVP-SWP reservoir operations on basin water temperatures. For this analysis the BETTER model was used to predict temperatures in Lewiston Reservoir because it was developed specifically for Lewiston, rather than as a piece of the entire CVP. The RTM model was also used for the CVPIA EIS.

For each alternative, simulations of the RTM and BETTER models were performed for five specific years (1983, 1986, 1989, 1990, and 1977) representing five different water-year classes (extremely wet, wet, normal, dry, and critically dry). Lewiston Dam release temperatures predicted from the BETTER model were subsequently modeled in the SNTEMP model under projected cold-wet, median, and hot-dry hydrometeorological conditions. Model results identified the percentage of time that NCRWQCB temperature objectives would be met. Table 3-7 presents the combinations of flows and temperatures necessary to meet temperature objectives under median weather conditions. Table 3-8 presents the modeling results for each alternative under median conditions. Cold-wet and hot-dry conditions are presented in the Water Resources / Water Quality Technical Appendix A. Each alternative’s effect on turbidity, sediment, and water quality of the lower Klamath River were analyzed qualitatively. An evaluation of the flow schedules of the Preferred Alternative (U.S. Fish and Wildlife Service and Hoopa Valley Tribe, 1999) provided information to provide qualitative assessments of the likely effects of alternative flows on water quality in the lower Klamath River. Flow alternatives were assessed for their ability to provide temperatures beneficial to salmonids in the Klamath River and their ability to provide dilution for potentially polluted Klamath River water.

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TABLE 3-7
Combinations of Discharge and Water Temperatures Necessary to Meet SWRCB Temperature Objectives for the Trinity River Under Median Climatic Conditions

Water Temperature (F) of Releases	Lewiston Dam Discharge (cfs)					
	150	300	450	600	900	1,200
	July 1 to September 14: Target 60°F at Douglas City[a]					
46	59.9	55.9	53.7	52.3	50.7	49.8
47	60.2	56.4	54.3	53.0	51.4	50.6
48	60.6	56.9	55.0	53.7	52.3	51.5
49	60.9	57.4	55.6	54.4	53.0	52.2
50	61.2	58.0	56.3	55.1	53.9	53.1
51	61.5	58.6	57.0	55.9	54.7	54.0
52	61.8	59.1	57.5	56.6	55.4	54.8
53	62.2	59.6	58.2	57.3	56.3	55.7
54	62.5	60.1	58.8	58.0	57.0	56.4
55	62.8	60.7	59.5	58.7	57.8	57.3
56	63.1	61.1	60.0	59.3	58.5	58.1
57	63.4	61.7	60.7	60.1	59.4	58.9
58	63.7	62.1	61.3	60.7	60.1	59.7
59	64.0	62.7	62.0	61.5	60.9	60.6
60	64.3	63.2	62.6	62.2	61.8	61.5
	September 15 to September 30: Target 56°F at Douglas City[a]					
46	56.2	52.6	50.9	50.0	48.9	48.3
47	56.6	53.2	51.6	50.7	49.7	49.2
48	57.1	53.9	52.4	51.5	50.6	50.1
49	57.5	54.4	53.1	52.3	51.4	50.9
50	57.9	55.2	53.9	53.1	52.3	51.9
51	58.4	55.8	54.7	54.0	53.2	52.8
52	58.8	56.4	55.3	54.7	54.0	53.6
53	59.2	57.1	56.1	55.5	54.9	54.6
54	59.6	57.7	56.8	56.2	55.7	55.4
55	60.0	58.4	57.6	57.1	56.6	56.3
56	60.4	58.9	58.2	57.8	57.3	57.1
57	60.9	59.6	59.0	58.6	58.3	58.0
58	61.2	60.1	59.6	59.3	59.0	58.8
59	61.6	60.8	60.4	60.2	59.9	59.8
60	62.1	61.5	61.2	61.0	60.8	60.7

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TABLE 3-7
Combinations of Discharge and Water Temperatures Necessary to Meet SWRCB Temperature Objectives for the Trinity River Under Median Climatic Conditions

Water Temperature (F) of Releases	Lewiston Dam Discharge (cfs)					
	150	300	450	600	900	1,200
	October 1 to December 31: Target 56°F at N. Fork Confluence[a]					
46	56.8	54.4	52.9	51.8	50.6	49.8
47	56.9	54.8	53.3	52.4	51.2	50.5
48	57.1	55.1	53.9	53.0	51.9	51.3
49	57.3	55.5	54.3	53.5	52.5	51.9
50	57.4	55.9	54.8	54.1	53.3	52.7
51	57.6	56.2	55.3	54.7	54.0	53.5
52	57.7	56.5	55.8	55.3	54.6	54.2
53	57.9	56.9	56.3	55.9	55.3	55.0
54	58.0	57.2	56.7	56.4	55.9	55.7
55	58.2	57.6	57.2	57.0	56.6	56.5
56	58.3	57.9	57.7	57.5	57.3	57.1
57	58.4	58.3	58.2	58.1	58.0	57.9
58	58.6	58.6	58.6	58.6	58.6	58.6
59	58.7	58.9	59.1	59.1	59.3	59.3
60	58.9	59.3	59.5	59.7	60.0	60.1

[a] Shaded cells indicate combinations that can meet temperature objectives.

TABLE 3-8
Water Quality Summary Table Trinity River Impacts

	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit[a]	Existing Conditions
Percentage of Days from July 1 to October 15 with Modeled Temperature Violations in the Trinity River [a]							
Extremely wet (1983)	0.0%	72.9%	0.0%	53.3%	0.0%	58.9%	0.0%
Wet (1986)	0.0%	28.0%	0.0%	73.8%	0.0%	86.0%	0.0%
Normal (1989)	1.9%	28.0%	0.9%	86.0%	1.9%	60.7%	2.8%
Dry (1990)	24.3%	29.0%	0.9%	86.9%	24.3%	43.0%	0.0%
Critically dry (1977)	77.6%	29.0%	5.6%	100.0%	77.6%	100.0%	84.1%

[a]Temperature standards actually continue to December 31; however, meteorological conditions after October 15 typically ensure temperature compliance.

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Although these models are the best available tools for analyzing temperature impacts, they do use monthly time steps, whereas actual operations would be dependent on daily, and sometimes hourly, variations in flow, climate, and exports.

Temperature effects in the Sacramento River were analyzed using PROSIM and RTM; the Shasta TCD was assumed to be fully operational. Although these models are the best available tools for analyzing temperature impacts, they do use monthly time steps, whereas actual operations would be dependent on daily, and sometimes hourly, variations in flow, climate, and exports (therefore, daily impacts could be masked). The ability to dilute uncontrolled acid mine runoff from Spring Creek Debris Dam is assumed to be relatively unaffected by any of the alternatives because:

- Uncontrolled spills from Spring Creek Debris Dam (which would typically be in the winter/early spring months) would correlate with increased inflow to Shasta and Whiskeytown Reservoirs, which in turn would be available for release to dilute water in Keswick Reservoir.

A minimum 200-cfs release through Spring Creek Powerhouse to mobilize acid mine drainage into Keswick Reservoir is assumed in all alternatives (except Maximum Flow given no exports are assumed). As described above under Affected Environment, this should be viewed as a conservative number.

PROSIM operating rules ensure that minimum water quality standards are maintained in the Bay-Delta.

PROSIM operating rules ensure that minimum water quality standards are maintained in the Bay-Delta for all alternatives on a monthly basis. However, inflows to the Bay-Delta and Delta exports were further evaluated for their effects on water quality using DWR's DSM2 Delta model in order to analyze potential impacts associated with each alternative to drinking water quality versus the No Action. The hydrodynamic model, DSM2, simulates the channel flows, tidal effects, and water quality of the Bay-Delta estuary. For the purposes of this analysis, model simulations were conducted for a 15-year historical hydrologic sequence (water years 1976-1990). This period was selected to cover a broad range of Delta inflows and exports and is generally representative of the 69-year historical hydrologic sequence used in PROSIM. DSM results, given the model provides a more detailed representation of the Delta, may identify modeled exceedances for some standards in some locations for individual months. DSM2 results were evaluated for changes in electrical conductivity (EC), bromide, and dissolved organic carbon (DOC) concentrations at six Delta locations critical to drinking water quality. These locations include Greens Landing on the Sacramento River, North Bay Aqueduct, Contra Costa Canal Intake, Old River at Highway 4, Delta-Mendota Canal Intake, and Clifton Court Forebay, as shown on Figure 3-33.

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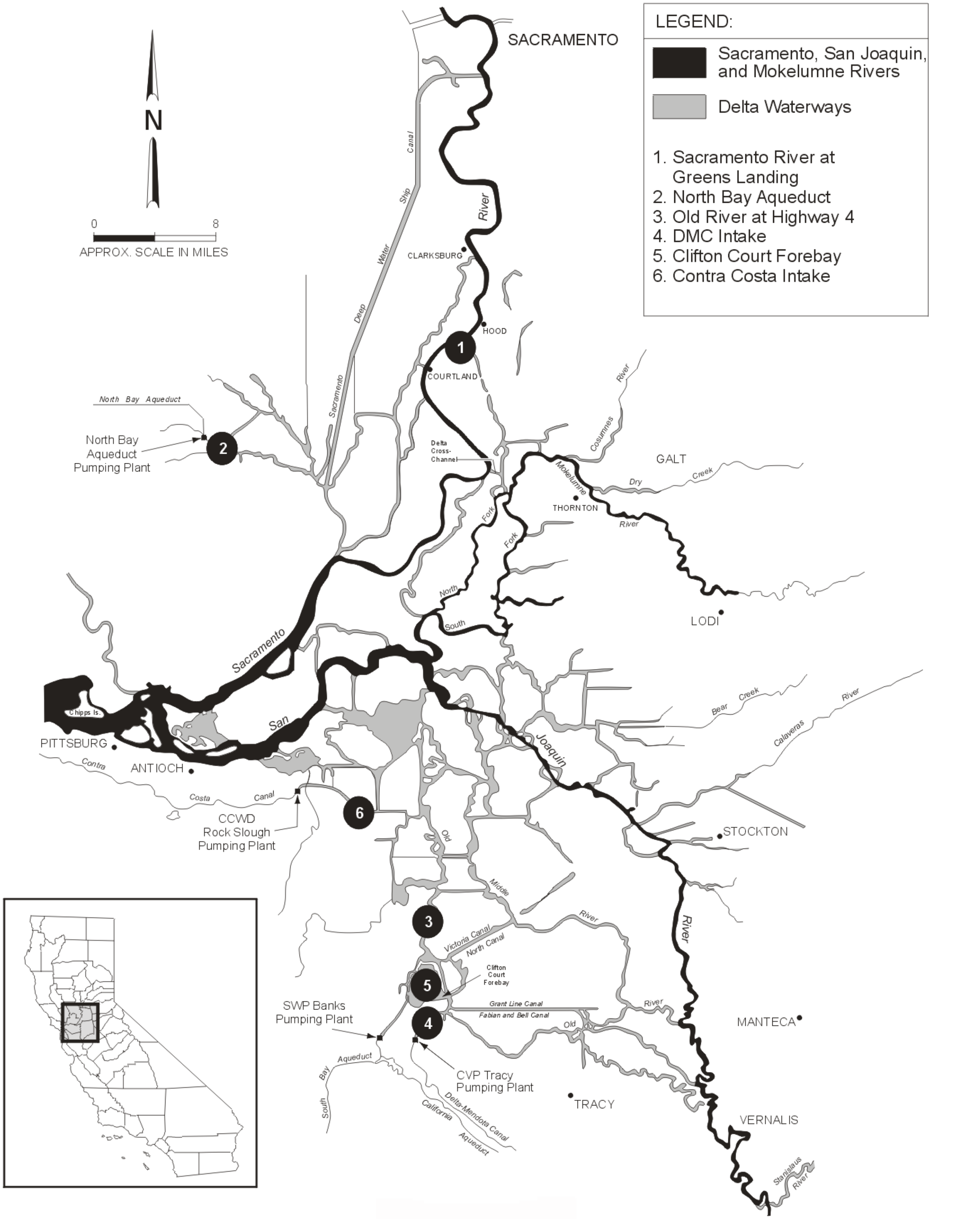

FIGURE 3-33
OUTPUT LOCATIONS FOR SIMULATED AVERAGE MONTHLY WATER QUALITY

TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

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Significance Criteria. The following impacts were considered significant for both the Trinity Basin and the Central Valley:

- Substantial degradation of water quality, such that existing beneficial uses are precluded specifically due to adverse water quality.
- Violate any water quality standards or waste discharge requirements.
- Substantial alterations of the course of a stream or river in a manner that would result in substantial erosion or siltation on- or off-site.
- Short- or long-term increases in turbidity of 20 percent or more over naturally occurring background levels.
- Contamination of a public water supply.
- Variation in instream temperatures so as to adversely impact state or federally listed aquatic species (see the Fishery Resources section [3.5]). This is defined as an increase in the number of months with modeled temperatures exceeding the 1993 Winter-run Biological Opinion by more than 0.5°F, or a change in carryover storage at Shasta Reservoir compared to No Action. Notably, the use of a 0.5°F change in temperature as a significant impact represents a very conservative approach, in that the
- Central Valley Regional Water Quality Control Board normally considers a temperature change to be significant if a 1.0 degree change occurs.
- Degradation of water quality for a water quality constituent in a waterbody listed as impaired (e.g., under California's Clean Water Act 303(d) list).
- Increases in Delta water quality concentrations for EC, bromide, and DOC of greater than 5 percent, based on the accuracy of analytical methods.

No Action. Exports to the Central Valley would be similar to current operations and would generally maintain current temperatures in the Trinity River (Table 3-8). Under the No Action Alternative, Sacramento River temperature objectives established in the Biological Opinion would not be met in some months (Table 3-8). These months are distributed across wet to dry hydrology due to the variable nature of the standards depending on water-year class. Carryover violations at Shasta Reservoir would occur in 12 percent of the years (Table 3-9). Existing Trinity River channel rehabilitation projects would be maintained, resulting in occasional, short-term increases in turbidity. Because this alternative does not provide dam

Under the No Action Alternative, Sacramento River temperature objectives established in the Biological Opinion would not be met in some months.

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releases sufficient in magnitude or duration to emulate pre-TRD flow patterns during the spring and early summer, except possibly in critically dry years, there would be times when water temperatures would be warmer than the Klamath River. Minimum Bay-Delta water quality standards are assumed to be met on a monthly basis.

TABLE 3-9
Water Quality Summary Table Sacramento River Impacts

	No Action	Maximum Flow	Flow Evaluation	Percent Inflow	Mechanical Restoration	State Permit	Existing Conditions
Sacramento River Violations[a]							
Percentage of months with violations	19.7%	22.8%	20.5%	20.1%	19.7%	16.4%	14.3%
Shasta Carryover Storage Violations							
Percentage of years less than 1.9 maf	11.6%	14.5%	11.6%	11.6%	11.6%	10.1%	8.7%
Average Modeled Position of X2 in Delta, Distance from Golden Gate Bridge (km)							
Average Period (1922-1990)	75.2	75.6	75.3	75.3	75.2	75.1	74.9
Wet Period (1967-1971)	70.1	71.0	70.5	70.3	70.1	70.0	69.6
Dry Period (1928-1934)	80.7	80.8	80.6	80.7	80.7	80.7	80.7

[a]As established in the Sacramento Winter-run Biological Opinion. Temperature standards are enforced April through October.

Maximum Flow.

Trinity River Basin. The elimination of TRD exports resulted in additional modeled Trinity River temperature violations of NCRWQCB temperature standards in all five water-year classes, compared to No Action levels. The increased frequency of violations reflects the slower rate at which water moves through Lewiston Reservoir (i.e., lack of diversions to the Central Valley), and the associated warming effect (due to the reservoir's relatively shallow depth). The resultant Trinity River temperature impact would be significant. Since this alternative does not include mechanical channel rehabilitation there would be no associated impacts to turbidity.

Lower Klamath River Basin/Coastal Area. Because this alternative does provide dam releases greater than the No Action Alternative, and flows are sufficient in magnitude and duration to partially emulate pre-TRD flow patterns during the spring and early summer relative to the No Action Alternative, the increased flow during the spring and early summer would improve water temperatures of the lower Klamath River. As compared to the No Action Alternative, the additional flows of this alternative would dilute Klamath River flow that could be of poor quality. During the late summer and early fall (beginning in September) when dam releases are reduced to less than those of the No Action Alternative, there would be slight reduction in Klamath River water quality.

Central Valley. The elimination of TRD exports would significantly reduce the ability to meet temperature criteria in the Sacramento River. This is evidenced by an increase of 3 percentage points in the frequency that Sacramento River temperatures would exceed the Biological Opinion temperature objectives, compared to the No Action Alternative. Shasta Reservoir carryover storage violations would increase 2 percentage points compared to No Action due to increased reliance on the reservoir to meet river temperature requirements in spring and early summer. Relative to No Action, modeled X2 position would increase 0.4 km in the average condition, 0.9 km in the wet condition, and 0.1 km in the dry condition. However, as previously noted, PROSIM operates the system to meet water quality standards in the Delta. PROSIM results also project reductions in Delta outflow in a number of months when No Action flows were already low – conditions when Delta water quality is especially susceptible to degradation. DSM2 Delta water quality results show varying increases in average monthly EC, bromide, and DOC concentrations during the months of March through September at Contra Costa Canal Intake, Old River at Highway 4, Delta-Mendota Canal Intake, and Clifton Court Forebay. The greatest increase is at the Delta-Mendota Canal Intake, where EC and bromide levels rise up to 23 percent in critical dry years and 30 percent under average conditions in the high export months of June and July. DOC concentrations are similar to No Action, except in October and November of critical dry years when levels increase up to 9 percent at the Delta-Mendota Canal Intake. Greens Landing and North Bay Aqueduct concentrations are similar to the No Action Alternative for the three constituents. The decreased ability to meet the Biological Opinion criteria and the potential for Delta water quality impacts would be significant impacts.

Flow Evaluation.

Trinity River Basin. The frequency of Trinity River modeled temperature violations decreased in all water-year classes compared to No Action levels. This improvement in water temperature is the result of changing TRD export patterns from spring/summer to a summer only. Construction of the 47 new channel rehabilitation projects associated with this alternative would result in potentially significant short-term turbidity impacts in relation to NCRWQCB objectives (actual implementation of the projects would undergo a site-specific environmental review).

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Lower Klamath River Basin/Coastal Area. Because this alternative provides releases greater than the No Action alternative, and flows are sufficient in magnitude and duration to partially emulate pre-TRD flow patterns during the spring and early summer, water quality of the lower Klamath River would improve. Water temperatures of the lower Trinity River would be reduced compared to the No Action, and as a consequence, the water temperature of the lower Klamath River would be improved. As compared to the No Action Alternative, the additional flows of this alternative would dilute Klamath River flow that could be of poor quality. During the late summer and early fall when flows are equal to the No Action alternative there would be no significant differences in water quality.

Central Valley. Sacramento River modeled temperature violations occurred at a slightly higher frequency than under the No Action Alternative (20.5 percent versus 19.7). Violations occurred in both wet and dry conditions due to the variable nature of the standards. This impact would be significant. Modeled frequency of Shasta Reservoir carryover violations was the same as under No Action. The relatively small increase in frequency of temperature violations and the lack of change in carryover storage violations is at least partially attributable to the increase in demand for water under the 2020 condition. Because demand is forecast to occur downstream of compliance points in the Sacramento River, water deliveries assist in meeting temperature standards. Increased demand in the 2020 period results in lower carryover storage in the Central Valley reservoirs as system wide resources are used to meet demand.

PROSIM results indicate that the effect of the increased demand in 2020 is greater than the effect of the Flow Evaluation, with regard to carryover storage. The modeled position of X2 increased by 0.1 km over the period of record compared to No Action. During the wet period, X2 position increased 0.4 km, while during the dry period, X2 decreased slightly. Delta standards continue to be met under this alternative. PROSIM results also project reductions in Delta outflow in a number of months when No Action flows were already low – conditions when Delta water quality is especially susceptible to degradation. DSM2 Delta water quality results show increases in average monthly EC and bromide levels of up to 15 percent at the Delta-Mendota Canal Intake in the months of April through July under average and critical dry conditions. Average monthly DOC concentrations increase up to 6 percent during the months of April and May at the Contra Costa Canal Intake and Old River at Highway 4 in critical dry years. The decreased ability to meet the Biological Opinion criteria and the potential for Delta water quality impacts would be significant impacts.

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Percent Inflow.

Trinity River Basin. Modeled Trinity River water temperature violations increased substantially in comparison to No Action. These violations are due in large part to the fact that summer releases would be as low as 27 cfs. Such low summer flows would be unable to meet temperature objectives, in spite of a shift in TRD exports from spring/summer to summer only. The resultant Trinity River temperature increases would be significant. Construction of 47 new channel rehabilitation projects would result in potentially significant short-term turbidity impacts in relation to NCRWQCB objectives (actual implementation of the projects would undergo a site-specific environmental review).

Lower Klamath River Basin/Coastal Area. Because this alternative does provide releases greater than the No Action Alternative, and flow patterns are sufficient in magnitude and timing to partially emulate pre-TRD flow patterns (although only at 40 percent) during the spring and early summer, water quality of the Klamath River would improve relative to the No Action Alternative. Water temperatures would improve and the additional flows of this alternative would dilute Klamath River flow that can be of poor quality during the early summer. During the late summer and early fall; compared to No Action, the projected low releases under this alternative would significantly reduce the benefits of Trinity River dilution, and would significantly increase water temperatures of the Klamath River.

Central Valley. Sacramento River modeled temperature violations would occur slightly more frequently than No Action levels (20.1 percent versus 19.7), resulting in a significant impact. The months with violations occur across wet and dry conditions due to the variable nature of the standards. The modeled frequency of Shasta carryover violations was the same as under No Action. In comparison with No Action, modeled position of X2 would increase 0.1 km over the period of record. In the wet condition, X2 would increase approximately 0.2 km. X2 would remain unchanged in the dry period. Delta standards continue to be met under this alternative. PROSIM results also project reductions in Delta outflow in a number of months when No Action flows were already low – conditions when Delta water quality is especially susceptible to degradation. DSM2 Delta water quality results are very similar to the No Action Alternative. The only exception is the increase in average monthly Bromide concentrations of up to 8 percent during the months of April through July, at the Delta-Mendota Canal under average and critical dry conditions. The decreased ability to meet the Biological Opinion criteria and the potential for Delta water quality impacts would be significant impacts.

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Mechanical Restoration.

Trinity River Basin. Trinity River instream temperatures would be identical to No Action levels given that the Lewiston Dam release schedule would be the same. Construction of the 47 new channel rehabilitation projects included as part of this alternative would result in potentially significant short-term turbidity impacts in relation to NCRWQCB objectives. In addition, turbidity objectives could also be exceeded when the sites are mechanically maintained (actual implementation of the projects would undergo site-specific environmental review). By the year 2020, the watershed protection projects would reduce sediment inputs into tributaries, and subsequently, into the Trinity River by 240,000-480,000 yd^3/yr, which is approximately 9-17 percent of the average annual sediment produced in the basin.

Lower Klamath River Basin/Coastal Area. No water quality impacts would occur in the Lower Klamath River Basin/Coastal Area because flows would not change relative to No Action.

Central Valley. No water quality impacts would occur in the Sacramento River or Bay-Delta, compared to No Action levels, because quantity and timing of exports would not change.

State Permit.

Trinity River Basin. The State Permit Alternative had significantly more modeled water temperature violations due to the fact that summer release rates are too low. These modeled violations occurred in all five water-year classes. This alternative would not result in direct increases in turbidity, as no mechanical restoration projects are proposed.

Lower Klamath River Basin/Coastal Area. Because this alternative does not provide for variable releases by water-year class and smaller releases than the No Action Alternative, the water quality of the lower Klamath River would worsen in all year types. Water temperatures would increase during the spring and summer, and dilution of potential poor water quality of the Klamath River would lessen.

Central Valley. Conditions would improve with regard to meeting both Sacramento River temperature and Shasta Reservoir carryover storage objectives as a result of the increased TRD exports compared to No Action levels. These months with temperature violations occurred across both wet and dry conditions due to the variable nature of the standards. Modeled X2 position decreased by 0.1 km in the average and wet conditions, and remained essentially unchanged in the dry period. In general Delta outflow would increase, resulting in improvements in Delta water quality. However, there are some

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critical dry years when modeled Delta outflows in November and December are reduced due to increased Delta exports to fill San Luis Reservoir (increased Delta pumping is associated with more water being available with this alternative). In these months, average monthly EC and bromide levels increase up to 11 percent at Contra Costa Canal Intake, Old River at Highway 4, Delta-Mendota Canal Intake, and Clifton Court Forebay. Such a potential impact would not be a result of the alternative, in that the effect is attributable to a modeled assumed increase in pumping rather than the alternative itself.

Existing Conditions versus Preferred Alternative.

Trinity River Basin. The modeled Preferred Alternative in the year 2020 has fewer temperature violations in the Trinity River than the modeled 1995 existing conditions. This is largely due to the diversion pattern under the Preferred Alternative that reduces Lewiston Reservoir warming in mid- to late-summer and the difference in minimum carryover storage. The most drastic improvement is modeled to occur in the critically dry water-year class. Construction of the channel rehabilitation projects would result in an increase in short-term turbidity impacts compared to existing conditions, resulting in potentially significant short-term turbidity impacts in relation to NCRWQCB objectives (actual implementation of the projects would undergo a site-specific environmental review). However, the watershed protection component of the Preferred Alternative would reduce sediment inputs into tributaries, and subsequently, into the Trinity River by 240,000-480,000 yd^3/yr, which is approximately 9-17 percent of the average annual sediment produced in the basin. Implementation of this alternative is assumed to result in beneficial effects.

The modeled Preferred Alternative in the year 2020 has fewer temperature violations in the Trinity River than the modeled 1995 existing conditions.

Lower Klamath River Basin/Coastal Area. The Preferred Alternative in the year 2020 provides variable releases by year type and large magnitude flows during the spring and into mid summer, thereby improving water quality of the lower Klamath River compared to 1995 conditions. Water temperatures of the lower Trinity River would be reduced compared to the 1995 conditions, and as a consequence, the water temperature of the lower Klamath River would be maintained or slightly improved. The Preferred Alternative would provide additional flows that would contribute to dilution of Klamath River water that can be of poor quality. During the late summer and early fall when flows are equal to 1995 conditions, there would be no significant differences in water quality.

Central Valley. Modeled Sacramento River temperature violations would occur more frequently under the Preferred Alternative than under 1995 existing conditions (20 percent of the months compared

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to 14 percent). However, most (87 percent) of the non-compliance is attributed to the increase in water demand assumed for the 2020 level of development. Preferred Alternative carryover storage violations also increased compared to 1995 existing conditions, but all of the increase was attributed to non-project changes (e.g., population growth and higher contract demand). (In other words, the Preferred Alternative and No Action impacts are identical.) While PROSIM operates system resources to meet Delta water quality standards, there is a slight increase in modeled X2 position between existing conditions and the Preferred Alternative. Over the period of record average X2 position would increase approximately 0.4 km. In the wet period, X2 would increase approximately 0.9 km, while in the dry period, X2 is essentially unchanged. PROSIM results also project general reductions in Delta inflow and outflow, as well as a substantial increase in SWP exports at Banks Pumping Plant to meet increased 2020 level demands in the Preferred Alternative relative to existing conditions. Due to these changes in Delta conditions, DSM2 Delta water quality results show increases in average monthly EC, bromide, and DOC concentrations. EC and bromide levels generally increase during the months of October through March at Contra Costa Canal Intake, Old River at Highway 4, Delta-Mendota Canal Intake, and Clifton Court Forebay. The greatest increase is at the Delta-Mendota Canal Intake, where EC and bromide levels rise up to 20 percent in April of critical dry years. DOC concentrations increase up to 8 percent in April and May of critical dry years at the same locations. Greens Landing and North Bay Aqueduct concentrations are similar to the No Action Alternative for the three constituents. The decreased ability to meet the Biological Opinion criteria and the potential for Delta water quality impacts would be significant impacts.

Mitigation. The following mitigation would be implemented to reduce significant Trinity River turbidity-related impacts associated with the Flow Evaluation, Percent Inflow, and Mechanical Restoration Alternatives to less than significant levels:

- A 401 water quality certification would be obtained from the NCRWQCB, and a construction procedure would be developed to meet the Basin Plan turbidity requirements. Monitoring would be conducted as specified by the NCRWQCB, and efforts would be taken to reduce levels if they are 20 percent or more over background (e.g., isolating the work area and/or slowing or halting construction until the 20-percent level is achieved).
- Notify individual diverters with state diversion permits and riparian water rights within 2 miles downstream of any mechanical channel rehabilitation activity at least 2 days in advance of activities likely to produce turbidity.

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Significant Trinity River temperature impacts identified for the Maximum Flow, Percent Inflow, and State Permit Alternatives would need to be evaluated by the NCRWQCB, as well as NMFS. The following mitigation could reduce impacts of temperature violations in the Trinity River:

- Bypassing the Trinity Powerplant could offset impacts to temperature related to Trinity Reservoir releases. Preliminary analysis of powerplant bypasses indicates that pulling colder water from lower in the reservoir could help alleviate temperature impacts in the Trinity and Sacramento Rivers. The magnitude, timing, costs, and benefits of powerplant bypasses would need to be evaluated on a case-by-case basis during specific dry/critically dry years with low carryover storage (see Water Resources/Water Quality Technical Appendix A).
- Changing operations of the TRSSH to use colder water from lower in Lewiston Reservoir to rear hatchery-produced fish. Currently, warmer water from the upper levels of Lewiston Reservoir is used to promote growth in rearing salmon and steelhead.
- "Slugging" Lewiston Reservoir with large quantities of cold water from Trinity Reservoir could reduce the warming effect of Lewiston Reservoir. This technique has been used in the past when climatic or hydrologic conditions have induced temperature violations.
- Increasing minimum storage requirements in Trinity Reservoir could increase the coldwater pool available for summer and fall releases.

Significant impacts identified for the increased frequency of Sacramento Basin temperature and carryover storage violations for the Maximum Flow, Flow Evaluation, and Percent Inflow Alternatives would need to be evaluated by the NMFS pursuant to the ESA. Such consultation could result in modification of the existing Biological Opinion. Given the result of this consultation is unknown, this significant impact is considered to be unmitigable at this time.

The following mitigation could reduce impacts of temperature violations in the Sacramento River:

- Bypassing the Trinity Powerplant in order to provide colder water for diversion to the Sacramento River (see above).
- Reducing wet-season instream flow requirements for the Sacramento River to increase dry season carryover storage in Shasta Reservoir.

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- If approved by EPA, rescheduling the wet season portion of the 200-cfs Iron Mountain Mine dilution flows to spring/summer in a way that would improve Sacramento River temperatures.

In addition to consultation under ESA, the potentially significant water quality-related impacts (impacts to listed salmonids in the Sacramento River) could be lessened by the development of additional water supplies to meet demands. A number of demand- and supply-related programs are currently being studied across California, many of which are being addressed through the on-going CALFED and CVPIA programs and planning processes. Although none of these actions would be directly implemented as part of the alternatives discussed in this DEIR/EIS, each could assist in offsetting impacts resulting from decreased Trinity River exports. Examples of actions being assessed in the CALFED and CVPIA planning processes include:

- Develop and implement additional groundwater and/or surface-water storage. Such programs could include the construction of new surface reservoirs and groundwater storage facilities, as well as expansion of existing facilities. Potential locations include sites throughout the Sacramento and San Joaquin Valley watersheds, the Trinity River Basin, and the Delta.
- Purchase long- and/or short-term water supplies from willing sellers (both in-basin and out-of-basin) through actions including, but not limited to, temporary or permanent land fallowing.
- Facilitate willing buyer/willing seller inter- and intra-basin water transfers that derive water supplies from activities such as conservation, crop modification, land fallowing, land retirement, groundwater substitution, and reservoir re-operation.
- Promote and/or provide incentive for additional water conservation to reduce demand.
- Decrease demand through purchasing and/or promoting the temporary fallowing of agricultural lands.
- Increase water supplies by promoting additional water recycling.

Because the outcome of the planning processes described above remains unknown, water quality impacts to salmonid species in the Sacramento River are considered at present to be significant and unavoidable. Additional discussion of these impacts are addressed in Section 3.5, Fishery Resources.