North-of-the-Delta Offstream Storage Investigation

Plan Formulation Report

Prepared for Reclamation by URS Corporation under Contract No. 06CS204097A

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Sacramento, California

September 2008

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

A – B	Accord	Bay-Delta Accord
	ACHP	Advisory Council on Historic Preservation
	ACID	Anderson Cottonwood Irrigation District
	AF	acre-foot
	AFPA	acre-feet per acre
	AFRP	Anadromous Fish Restoration Program
	AFS	anadromous fish survival
	Agreement	Sacramento Valley Water Management Agreement
	AIR Com	Area Impact and Restoration Communication
	APCD	Air Pollution Control District
	ARB	California Air Resources Board
	ASIP	Action Specific Implementation Plan
	ASR	aquifer storage and recovery
	ASTM	American Society for Testing and Material
	BA	Biological Assessment
	Bank Pumping Plant	Harvey O. Banks Delta Pumping Plant
	Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
	BCWC	Battle Creek Water Conservancy
	BLM	United States Department of the Interior, Bureau of Land Management
	BMP	best management practice
	BO	Biological Opinion
	BP	before present
C	CA	California Aqueduct
	CALFED	CALFED Bay-Delta Program
	CalSim	Statewide California Water Resource System Planning Model
	Caltrans	California Department of Transportation
	CalTrout	California Trout
	CAR	USFWS Coordination Action Report
	CARB	California Air Resources Board
	CASIL	California Spatial Information Library
	CAT	Climate Action Team
	CBD	Colusa Basin Drain
	CBDA	California Bay-Delta Authority
	CCR	California Code of Regulations

	CCWD	Contra Costa Water District
	CDF	California Department of Forestry and Fire Protection
	CDFG	California Department of Fish and Game
	CEC	California Energy Commission
	CEQA	California Environmental Quality Act
	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
	CESA	California Endangered Species Act
	CFR	Code of Federal Regulations
	cfs	cubic feet per second
	CHP	California Highway Patrol
	CNDDB	California National Diversity Database
	CNE/Ldn	community noise equivalent level/day-night average level
	CNPS	California Native Plant Society
	CO	combined objectives
	COA	Coordinated Operations Agreement
	Corps	United States Army Corps of Engineers
	CP	comprehensive Plan
	CRMP	Coordinated Resource Management Plan
	CVP	Central Valley Project
	CVPIA	Central Valley Project Improvement Act
	CVPM	Central Valley Production Model
	CVP-OCAP	Central Valley Project Operations Criteria and Plan
	CVRWQCB	Central Valley Regional Water Quality Control Board
	CWA	Clean Water Act
	CWP	California Water Plan
	CWPU-SRHRR	California Water Plan Update, Sacramento River Hydrologic Regional Report
D – E	dbA	A-weighted decibels
	DBH	diameter at breast height
	DEWS	Delta Environmental Water Supply
	DDT	dichlorodiphenyltrichloroethane
	Delta	Sacramento-San Joaquin Delta
	DMC	Delta-Mendota Canal
	DMC/CA	Delta-Mendota Canal/California Aqueduct
	DPS	distinct population segment
	DTSC	Department of Toxic Substances

DWR	California Department of Water Resources
EC	electrical conductivity
ECw	electrical conductivity measurement
EDD	Employment Development Department
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
elevation	elevation in feet above mean sea level
EPA	United States Environmental Protection Agency
EQ	environmental quality
ERA	Ecosystem Restoration Account
ERP	Ecosystem Restoration Program
ESA	Endangered Species Act
ESU	evolutionary significant unit
EWA	Environmental Water Account

F – G

FAQ	frequently ask questions
FERC	Federal Energy Regulatory Commission
FESA	federal Endangered Species Act
FNA	Future No Action
FPIP	Fish Passage Improvement Program
fps	foot per second
FR	feasibility report
FRAGMD	Feather River Air Quality Management District
ft	foot
ft^2	square feet
FS	feasibility study
FTA	Federal Transit Administration
FWUA	Friant Water Users Authority
FY	Fiscal Year
GCM	General Circulation Model
GCID	Glenn-Colusa Irrigation District
GIS	geographic information system
GPCPD	gallons per capita per day
GWh	gigawatt-hour

H – M	HAP	hazardous air pollutant
	HCP	Habitat Conservation Plan
	HORB	head of Old River Barrier
	I-5	Interstate 5
	IAIR	Initial Alternatives Information Report
	IDC	interest during construction
	IEP	Interagency Ecological Program
	IMPLAN	Impact Analysis for Planning
	in/sec	inches per second
	Interior	U.S. Department of the Interior
	IPCC	Intergovernmental Panel on Climate Change
	ISI	Integrated Storage Investigations
	ISO	Independent Systems Operator
	ITA	Indian Trust Assets
	JPOD	joint point of diversion
	km	kilometer
	kW	kilowatt
	kV	kilovolt
	LCPSIM	Least Cost Planning Simulation Model
	Leq	equivalent sound pressure level
	lf	linear feet
	M&I	municipal and industrial
	MAF	million acre-feet
	mg/L	milligrams per liter
	MID	Maxwell Irrigation District
	mil	million
	Mmax	maximum moment magnitude
	MOU	Memorandum of Understanding
	msl	mean sea level
	MSMPS	Mill Site Main Pump Station
	MSMR	Mission Statement Milestone Report
	MW	megawatt

N	NAVD	North American Vertical Datum
	NBA	North Bay Aqueduct
	NCCP	Natural Community Conservation Planning
	NCWA	Northern California Water Association
	NED	National Economic Development
	NEPA	National Environmental Policy Act
	NER	National Environmental Restoration
	NGGI	National Greenhouse Gas Inventories
	NHPA	National Historic Preservation Act
	NMHC	non-methane hydrocarbon
	NO	nitrogen oxide
	NOAA	National Oceanic and Atmospheric Administration
	NOD	Notice of Determination
	NODOS	North-of-the-Delta Offstream Storage
	NOI	Notice of Intent
	NOP	Notice of Preparation
	NPDES	National Pollutant Discharge Elimination System
	NRA	National Recreation Area
	NRDC	Natural Resources Defense Council
	NWR	National Wildlife Refuge
O – Q	O&M	operations and maintenance
	O_3	ozone
	OCAP	Operations Criteria and Plan
	OEHHA	California Office of Environmental Health Hazard Assessment
	OHV	off-highway vehicle
	ORV	outstandingly remarkable values
	OSE	other social effects
	OUWUA	Orland Unit Water Users' Association
	P&G	U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
	PCB	polychlorinated biphenyl
	PCT	Project Coordination Team
	PEIS	Programmatic Environmental Impact Statement
	PFR	Plan Formulation Report
	PG&E	Pacific Gas and Electric

	PL	Public Law
	Plan	Strategic Agency and Public Involvement Plan for the SLWRI
	PM_{10}	particulate matter greater than 10 microns
	$PM_{2.5}$	particulate matter greater than 2.5 microns
	PPA	Preferred Program Alternative
	ppm	parts per million
	PPV	peak particular velocity
R	R	river
	RBDD	Red Bluff Diversion Dam
	RCC	roller-compacted concrete
	RCD	Resource Conservation District
	Reclamation	United States Department of the Interior, Bureau of Reclamation
	Reclamation Board	Reclamation Board of the State of California
	RED	regional economic development
	RHJV	Riparian Habitat Joint Venture
	RMS	root mean square
	ROD	Record of Decision
	ROG	reactive organic gases
	ROW	right-of-way
	RPP	Research Pumping Plant
	RWQCB	Regional Water Quality Control Board
S	SB	Senate Bill
	SCAQMD	Shasta County Air Quality Management District
	SCE	Southern California Edison
	SCRB	Separable Cost-Remaining Benefits
	SDIP	South Delta Improvements Program
	Secretary	(the) Secretary of the Interior
	Service	(the) United States Fish and Wildlife Service
	SGP	Strategic Growth Plan
	SHPO	State Historic Preservation Office
	SLWRI	Shasta Lake Water Resources Investigation
	SMT	Study Management Team
	SMUD	Sacramento Municipal Utility District
	sq-mi	square mile

	SR	State Route
	SRAH	shaded riverine aquatic habitat
	SRCA	Sacramento River Conservation Area
	SRWP	Sacramento River Watershed Program
	State	State of California
	STNF	Shasta-Trinity National Forest
	STNFLRMP	Shasta-Trinity National Forest Land Resource Management Plan
	SVAB	Sacramento Valley Air Basin
	SVWMA	Sacramento Valley Water Management Agreement
	SVWMP	Sacramento Valley Water Management Program
	SWAG	Sacramento Watersheds Action Group
	SWP	State Water Project
	SWRCB	State Water Resources Control Board
T – Y	TAC	toxic air contaminant
	TAF	thousand acre-feet
	TAG	technical advisory group
	TC Canal	Tehama Colusa Canal
	TCCA	Tehama-Colusa Canal Authority
	TCD	temperature control device
	TDS	total dissolved solids
	TNC	The Nature Conservancy
	TOC	total organic carbon
	tpd	tons per day
	Tribal Com	Tribal Communication
	TRR	Terminal Regulating Reservoir
	TU	temperature unit
	U.C.	University of California
	UPRR	Union Pacific Railroad
	U.S.	United States
	U.S.C.	United States Code
	USFS	United States Forest Service
	USFWS	United States Fish and Wildlife Service
	USGS	United States Geological Survey
	V	Volt

VdB	vibration decibels
VELB	valley elderberry longhorn beetle
VMT	vehicle miles traveled
WAPA	Western Area Power Administration
WCB	Wildlife Conservation Board of CDFG
WHR	Wildlife Habitat Relationships Program
WLA	William Lettis & Associates, Inc.
WQCP	Water Quality Control Plan
WRC	United States Water Resources Council
WSCC	Western Systems Coordinating Council
WSR	water supply reliability
WSR Com	Water Supply and Reliability Communication
WUE	water use efficiency
YCWA	Yuba County Water Agency
yd^3	cubic yard
°F	degree Fahrenheit
ºC	degree Celsius
µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter

Executive Summary

This Plan Formulation Report (PFR) is an interim product of the North-of-the-Delta Offstream Storage (NODOS) Investigation being performed by the United States (U.S.) Department of the Interior (Interior), Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR). This investigation evaluates the feasibility of offstream storage in the northern Sacramento Valley for improved water supply and water supply reliability, improved water quality, and enhanced survival of anadromous fish and other aquatic species in the Primary Study Area and Extended Study Area. This PFR serves as a progress report describing the formulation and the evaluation and comparison of initial alternative plans that address NODOS Investigation planning objectives. The next steps in the NODOS Investigation are to better develop and define alternative plans for inclusion into the draft and final feasibility report and environmental impact statement/environmental impact report (EIS/EIR). As the feasibility study continues, the alternative plans will become more defined and will be optimized.

Primary Planning Objectives – Alternatives will be formulated to address the following objectives:

- Increase water supplies to meet existing contract requirements, including improved water supply reliability, and provide greater flexibility in water management for agricultural, municipal and industrial, and environmental users;
- Increase the survival of anadromous fish populations in the Sacramento River, as well as the survivability of other aquatic species; and
- Improve drinking and environmental water quality in the Delta.

Secondary Planning Objectives – To the extent possible, while meeting the primary planning objectives, the NODOS Investigation will recognize opportunities to accomplish the following:

- Provide ancillary hydropower benefits to the statewide power grid;
- Develop additional recreational opportunities in the Primary Study Area; and
- Create incremental flood-damage reduction opportunities in support of major northern California flood-control reservoirs.

Background

Traditionally, reservoirs are created by constructing dams on major streams (onstream storage). Offstream storage involves diverting water from a stream and transporting the water through a conveyance system to a reservoir that may be miles away from the point of diversion.

Implementation of the CALFED Bay-Delta Program (CALFED) began after the circulation of the *CALFED Bay-Delta Program Final Environmental Impact Statement/Environmental Impact Report* (CALFED EIS/EIR) (CALFED, 2000a) and the signing of the *CALFED Bay-Delta Programmatic Record of Decision* (ROD) (CALFED, 2000b). The Preferred Program Alternative (PPA) in the CALFED ROD identified five potential surface-water storage projects to be considered during the first stage of the CALFED program. Reclamation and DWR were provided feasibility study authority for the NODOS Investigation in 2003 and 1996, respectively.[1] Reclamation and DWR, in partnership with local interests, are investigating NODOS opportunities. The overall planning process is illustrated in figure ES-1.

The Primary Study Area for the NODOS Investigation encompasses the upper Sacramento River and the northern Sacramento Valley and includes watersheds flowing into the upper Sacramento River from Colusa, Tehama, and Glenn Counties, as well as smaller portions of Shasta, Sutter, and Butte Counties (figure ES-2). The Extended Study Area includes the Sacramento River watershed, the Delta, and the service areas for the State Water Project (SWP) and Central Valley Project (CVP).

This PFR defines the existing and likely future resources and conditions in the Primary Study Area. These conditions include information available at this level of study on physical, biological, socioeconomic, and cultural parameters. Additional information will be included in the draft feasibility report and EIS/EIR and the supporting documentation.

Problems, Needs, and Opportunities

Attitudes and approaches to managing water resources in California have changed significantly over the past several decades. Challenges persist and seem to have multiplied. They include strained aquatic ecosystems and species, diminished water supply reliability for agricultural and urban users and the environment, impaired source water quality, growing recognition of the need for greater flood and environmental protection, increasing population, climate change, an increasingly inflexible water resources system, and aging infrastructure to name a few.

All of these inform surface storage planning. Consequently, local, State of California, and Federal planners are developing a new era of surface storage projects to meet a new era of water resources needs, in addition to contributing to meeting more traditional purposes. Ecosystem and water quality needs have been joined to more traditional water supply needs in establishing investigation objectives. This investigation has identified problems, needs, and opportunities based upon national and study-specific objectives and has developed primary and secondary objectives.

[1] Table 1-1 provides specifics on Federal and State authority for the NODOS Investigation.

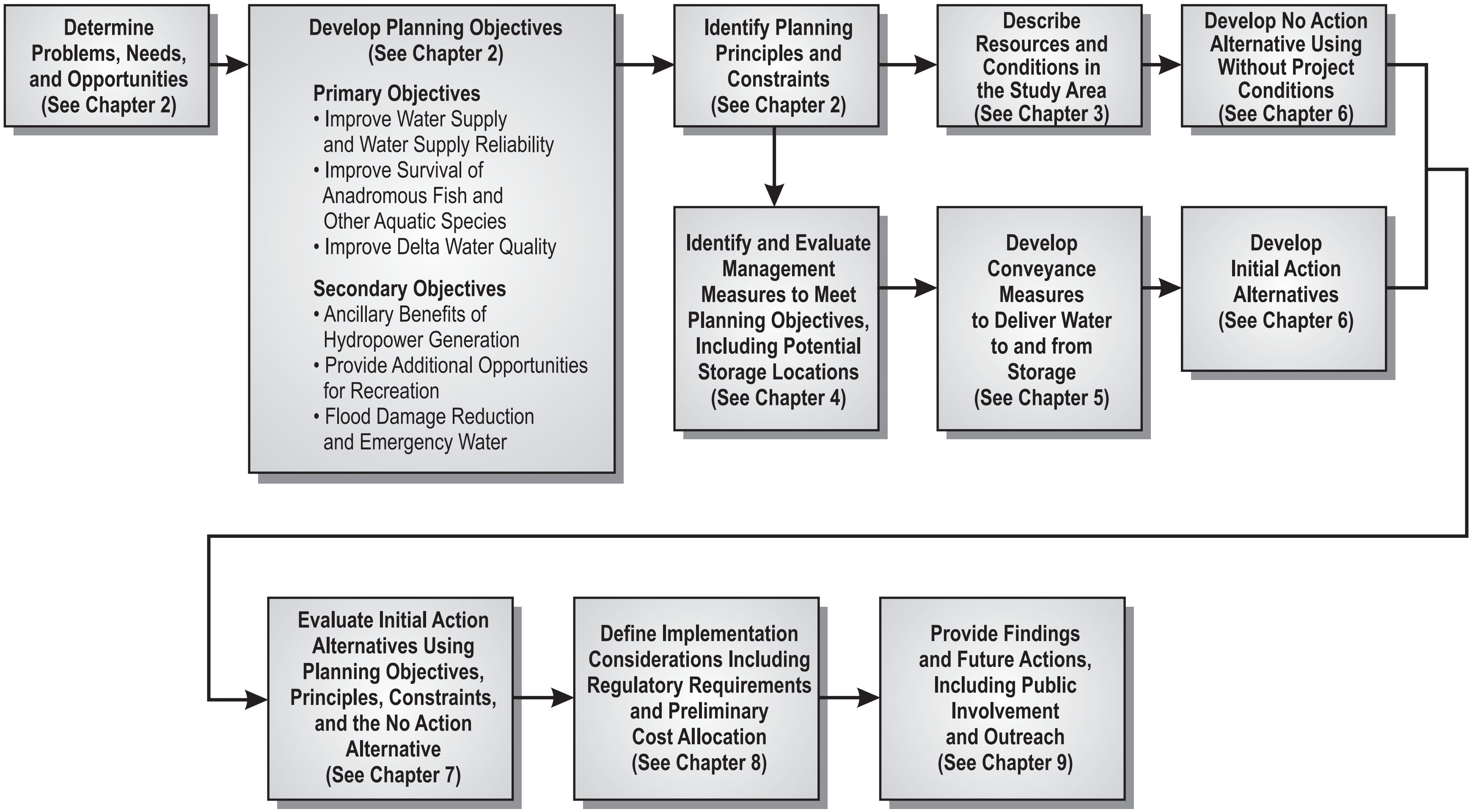


Figure ES-1. Plan Formulation Process

This page left blank intentionally.

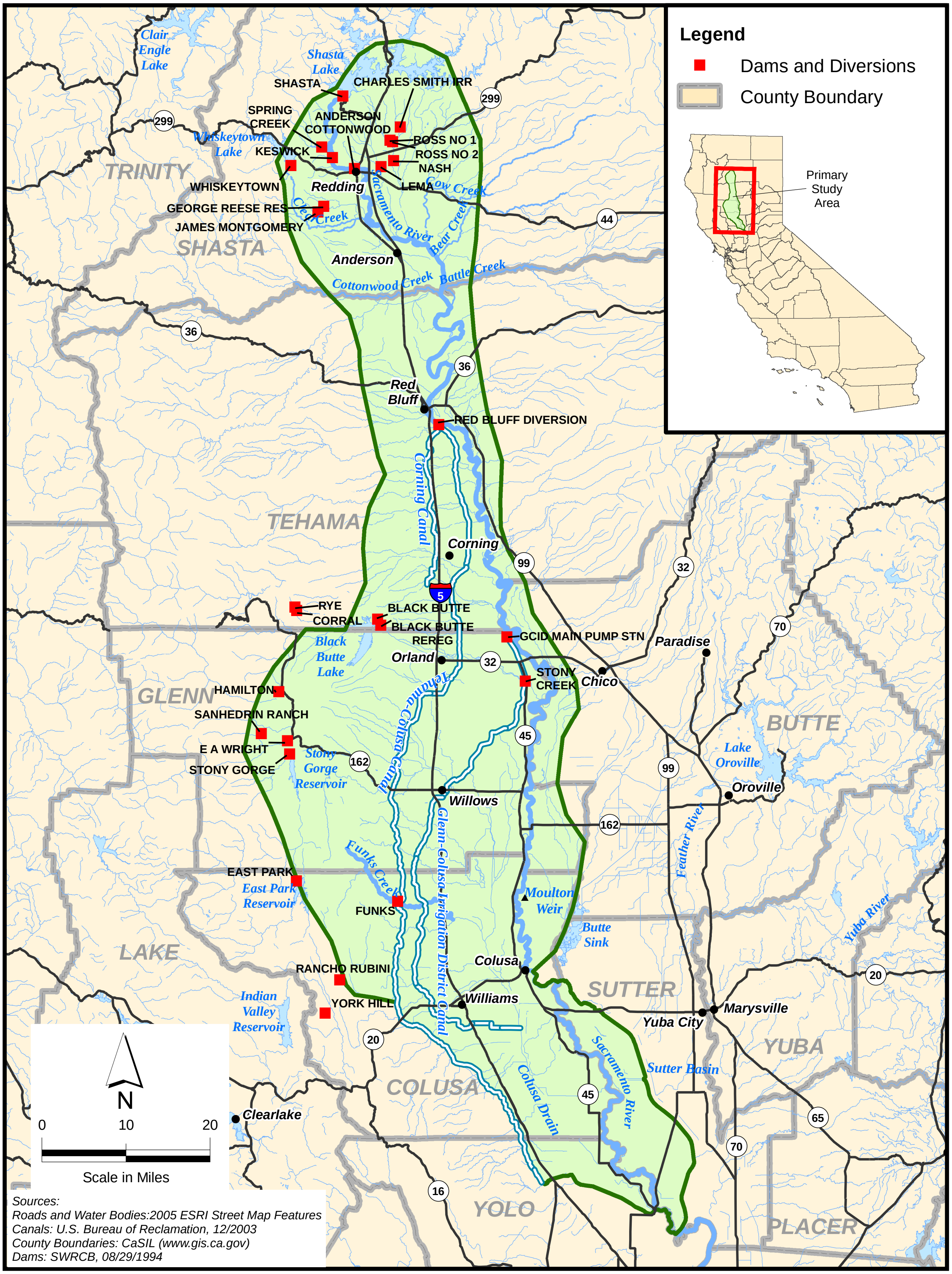


Figure ES-2. Primary Study Area

This page left blank intentionally.

The problems, needs, and opportunities include:

- Water supply and water supply reliability;
- Survival of anadromous fish and other aquatic species;
- Delta water quality; and
- Other opportunities.

CALFED and investigation planners recognized early on the diverse set of benefits that could derive from locating offstream storage downstream from Shasta Lake and upstream from the Delta. Additional detail is provided under each of the following sections.

Water Supply and Water Supply Reliability

According to the *California Water Plan Update 2005: A Framework for Action* (DWR, 2005a):

> *The biggest challenge facing California water resources management remains making sure that water is in the right places at the right time. This challenge is greatest during dry years: When water for the environment is curtailed sharply, less water is available from rainfall for agriculture and greater reliance on groundwater results in higher costs for many users. In the mean time, those who have already increased water use efficiency may find it more challenging to achieve additional water use reductions.*

The challenge is especially acute, and consequences are exacerbated, during multiple dry years, as evidenced by the 1976-77 and 1987-92 droughts.

The PPA in the CALFED ROD identified a need for up to 6 million acre-feet (MAF) of new storage in California, including up to 3 MAF of storage north of the Bay-Delta. Satisfying this demand will require adequate water supplies and the ability to reliably deliver the water to the users at the time it is needed. The CALFED ROD (CALFED, 2000b) specifically addressed the linkage of surface water storage to the successful implementation of all other elements of CALFED.

> *Expanding water storage capacity is critical to the successful implementation of all aspects of the CALFED Program. Not only is additional storage needed to meet the needs of a growing population, but, if strategically located, it will provide much needed flexibility in the system to improve water quality and support fish restoration efforts. Water supply reliability depends upon capturing water during peak flows and during wet years, as well as more efficient water use through conservation and recycling.*

The Sacramento region's CVP contractors, including settlement contractors, are subject to dry-year deficiencies and are especially vulnerable to droughts. During extended droughts, decreased deliveries could eventually force water users to either use groundwater to replace surface-water supply or remove agricultural acreage from production (DWR, 2005a). Added use of groundwater supplies during droughts may result in adverse impacts on the groundwater resource, as well as on regular users of groundwater (DWR, 2005a).

The NODOS Investigation is evaluating the use of offstream storage to provide additional water supply and improve water supply reliability. Water stored in the winter during higher flow conditions in the Sacramento River would be available for use throughout the year and allow additional water to be carried over in storage from year to year. Additional water in storage is especially helpful for mitigating the effects of drought, or multiple dry years.

Over the past decade, protective actions, including the Central Valley Project Improvement Act (CVPIA) and the *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (SWRCB, 1995), have reduced the ability of the SWP and CVP to contribute to statewide water supply reliability. CALFED has estimated that these two protective actions have reduced water contract deliveries by over 1 million AF annually during dry periods.

Following is a list of general water supply and water supply reliability needs that can be met directly by NODOS:

- Agricultural Water Supply Reliability
  - Local agricultural water districts
  - SWP contractors
  - CVP contractors
- Environmental Water Supply Reliability
  - Replace Environmental Water Account (EWA) or similar program north-of-Delta purchases
  - Sacramento and San Joaquin Valleys Level 4 Refuge water supply
- Municipal and Industrial Water Supply Reliability
  - CVP contractors
  - SWP contractors

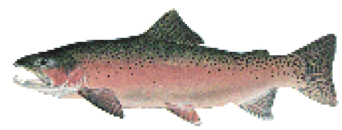
Survival of Anadromous Fish and Other Aquatic Species

Title 34 (Public Law 102-575) defines anadromous fish as: ". . . those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean." Loss of riparian habitat, the operations of dams and pumping facilities, polluted runoff, and changes in geomorphology have negatively impacted the populations of anadromous fish and other aquatic species in the Sacramento River hydrologic region. Table ES-1 identifies the fish species of primary concern that are affected by water operations in the Sacramento River and Bay-Delta (figure ES-3).

Table ES-1. Fish Affected by Water Operations

Species	Status
Chinook Salmon (Winter-Run)	Federal and California Endangered Species
Delta Smelt	Federal and California Threatened Species
River Lamprey	California Species of Special Concern
Central Valley Steelhead	Federal Threatened Species
Central Valley Chinook (Spring-Run)	Federal and California Threatened Species
Fall and Late Fall Run Chinook	Federal and California Species of Special Concern
Green Sturgeon	Federal Threatened and California Species of Special Concern
Sacramento Splittail	California Species of Special Concern

Delta Smelt

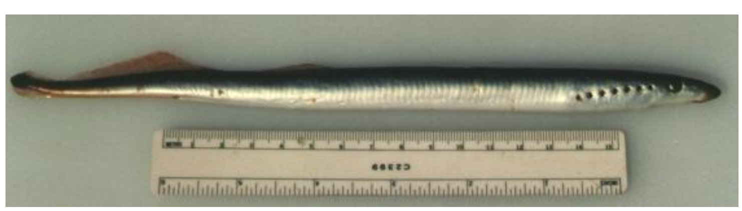


Central Valley Steelhead

Green Sturgeon

Chinook Salmon

Sacramento Splittail



River Lamprey

Figure ES-3. Fish Affected by Water Operations

Biological opinions for these species affect current water supply operations. Non-listed fish species that also may be affected by water operations include striped bass, Pacific lamprey, white sturgeon, and American shad. The NODOS Investigation must address the ability to change systemwide operations to improve the adequacy of anadromous fish migration flows and provide cooler water for fish spawning habitat.

Considerable benefits to fish and other aquatic species can be achieved by accomplishing the ecosystem restoration objectives identified through the CALFED Ecosystem Restoration Program (ERP) (CALFED, 2000c and 2000d). The ERP adaptive management implementation approach, which supports the flexible use of environmental water, has been accommodated in NODOS planning by dedicating a NODOS storage allocation to ERP objectives (an ERP pool or account, hereafter Environmental Restoration Account [ERA]). A potential NODOS project may benefit anadromous fish and other aquatic species by providing additional flows in the Sacramento River for environmental purposes and increasing the cold water storage pool at Shasta Lake. Ecosystem restoration needs identified by the CALFED ERP and the NODOS investigation include the following.

- Improve the reliability of cold-water carry-over storage at Shasta Dam.
- Increase supplemental flows for cold water releases for salmon and steelhead between Keswick and Red Bluff Diversion Dam (RBDD).
- Reduce diversions at Red Bluff to provide water into the Tehama-Colusa Canal (TC Canal) and at Hamilton City to provide water into the Glenn-Colusa Irrigation District (GCID) Canal during critical fish migration periods.
- Improve the reliability of cold water carry-over storage at Folsom Reservoir and stabilize flows in the American River.
- Modify spring flows into a “snowmelt pattern” in years with peak storm events in late-winter and early-spring, from Red Bluff to Colusa, to increase the success of cottonwood cohorts.
- Stabilize fall flows to avoid abrupt reductions from Keswick to Red Bluff. This concept is designed to avoid adverse conditions for spawning fall-run Chinook salmon (i.e., egg desiccation).
- Provide a flow event by supplementing normal operating flows from Shasta and Keswick Dams in March during years when no flow event has occurred during winter or is expected to occur.
- Provide a 10-day March Delta outflow from the natural late-winter and early-spring peak inflow from the Sacramento River.
- Provide a minimum flow of 13,000 cubic feet per second (cfs) on the Sacramento River below Sacramento in May of all but critical years.

Delta Water Quality

The Bay-Delta system is the diversion point for drinking water for millions of Californians, and it is critical to California's agricultural sector. Typically, the months of April through July are most favorable with respect to the Delta as a source of drinking water. Outflow from natural runoff is usually high enough during this period to push seawater out of the Delta. This period is also outside of the peak loading time related to agricultural drainage. Addressing fishery concerns has resulted in a shift in exports from the higher water quality spring months to the typically lower water quality fall months, with a corresponding degradation in delivered water quality. Improved water quality in the Bay-Delta is needed for drinking water, agriculture, and environmental restoration. The composition requirements of each end use vary, but the guiding elements of a Bay-Delta water quality "needs assessment" are salinity, toxins, and drainage. Habitat quality in the Delta is dependent upon many of these same factors and, more specifically, the survivability of fish and other aquatic species is dependent upon the water quality of the estuary. The NODOS Investigation is evaluating methods to improve water quality by providing increased flows of high quality water during periods when water quality is impaired. This would be achieved by increased releases from other reservoirs and/or releases directly from a potential NODOS project back to the Sacramento River.

Other Opportunities

The NODOS Investigation recognizes opportunities to accomplish hydropower generation, recreation, and flood-damage reduction/emergency water objectives.

In addition to offsetting the power needs of offstream storage pumping, a potential NODOS project could produce energy benefits through hydropower generation during peak demand periods.

Recreational activities within the watersheds of the streams flowing through the Primary Study Area include hiking, fishing, camping, boating, mountain biking, and off-road vehicle use. As a large and growing metropolitan area, Sacramento has a high demand for water-oriented recreational opportunities that could benefit from a potential NODOS project.

Improvements to the water management system might provide opportunities to increase flood protection through better coordination of these reservoirs in the Sacramento region; additional flood storage space could be provided at selected onstream reservoirs, including Folsom, Oroville, and Shasta. Furthermore, a potential NODOS project may be able to provide emergency water in the event of a catastrophic levee failure in the Delta.

Planning Objectives

Primary planning objectives are the first priority that initial alternative plans must address; secondary objectives are to be fulfilled by opportunities that should be considered in the plan formulation process, to the extent possible, while meeting the primary objectives.

On the basis of the identified problems, needs, and opportunities in the Primary Study Area, three primary and three secondary planning objectives were developed.

Primary Planning Objectives – Alternatives will be formulated to address the following objectives:

- Increase water supplies to meet existing contract requirements, including improved water supply reliability, and provide greater flexibility in water management for agricultural, municipal and industrial, and environmental users;
- Increase the survival of anadromous fish populations in the Sacramento River, as well as the survivability of other aquatic species; and
- Improve drinking and environmental water quality in the Delta.

Secondary Planning Objectives – To the extent possible, while meeting the primary planning objectives, the NODOS Investigation will recognize opportunities to accomplish the following:

- Provide ancillary hydropower benefits to the statewide power grid;
- Develop additional recreational opportunities in the Primary Study Area; and
- Create incremental flood-damage reduction opportunities in support of major northern California flood-control reservoirs.

Formulation of Alternative Plans

The formulation of initial alternative plans for the NODOS Investigation is a long-term process identified in the CALFED ROD (CALFED, 2000b). Storage north of the Delta was one of five surface water storage projects to be investigated as part of the PPA in the ROD. The NODOS Initial Alternatives Information Report (IAIR) (Reclamation and DWR, 2006a), which documented the first stage in the planning process, identified several features and activities (structural and non-structural) called management measures that meet the planning objectives. The IAIR summarized the preliminary screening of the management measures that focused on the evaluation of potential reservoir locations. Numerous alternative reservoir locations, conveyance systems, and other features required consideration as potential candidates for providing storage within the northern Sacramento Valley. The measures that were retained following the screening are summarized in table ES-2.

Table ES-2. Retained Measures that Address the Primary Objectives

Primary Objective	Management Measure
Water Supply and Water Supply Reliability	Construct Sites Reservoir, a new conservation offstream surface storage facility, near the Sacramento River, downstream from Shasta Dam
	Increase opportunities for conjunctive use of surface and groundwater storage near Sacramento River, downstream from Shasta Dam
	Implement water-use efficiency methods
	Transfer water between water users, and use source shifting (use groundwater in lieu of surface water)
Survival of Anadromous Fish and Other Aquatic Species	Restore abandoned gravel mines along Sacramento River
	Construct instream aquatic habitat downstream from Keswick Dam
	Replenish spawning gravel in Sacramento River
	Improve flow from a new conservation offstream surface storage facility at Sites Reservoir
Delta Water Quality	Improve water quality by increasing flows to the Delta from a new conservation offstream surface storage at Sites Reservoir

Recognizing the limited scope of the IAIR and the iterative nature of the planning process, the PFR revisits the problems and needs, planning objectives, and constraints. It provides a more complete evaluation of management measures, including the identification of additional measures, such as conveyance options, groundwater and conjunctive use, and others. The PFR identifies a No-Action Alternative Plan and eight Action Alternative Plans. The following initial action alternative plans, in addition to the No Action Alternative, were developed from the retained measures:

- Three initial action alternatives with a water supply focus (WS1A, WS1B, and WS1C);
- Two initial action alternatives with an environmental enhancement focus, to improve the survival of anadromous fish and other aquatic species (AF1A and AF1B);
- Two initial action alternatives with a water quality focus (WQ1A and WQ1B); and
- One initial action alternative with fish enhancements and operations designed to maximize water supply, fishery, and water quality benefits (WSFQ).

Each of the initial alternatives meets all three primary objectives, but to varying degrees. The “focus” described above indicates the relative priority of the use of the facilities associated with NODOS. Major features of the action alternative plans are presented schematically in figure ES-4. Several features are common to all of the initial action alternative plans, including the following:

- Sites Reservoir, including 2 major dams and 9 saddle dams;

This page left blank intentionally.

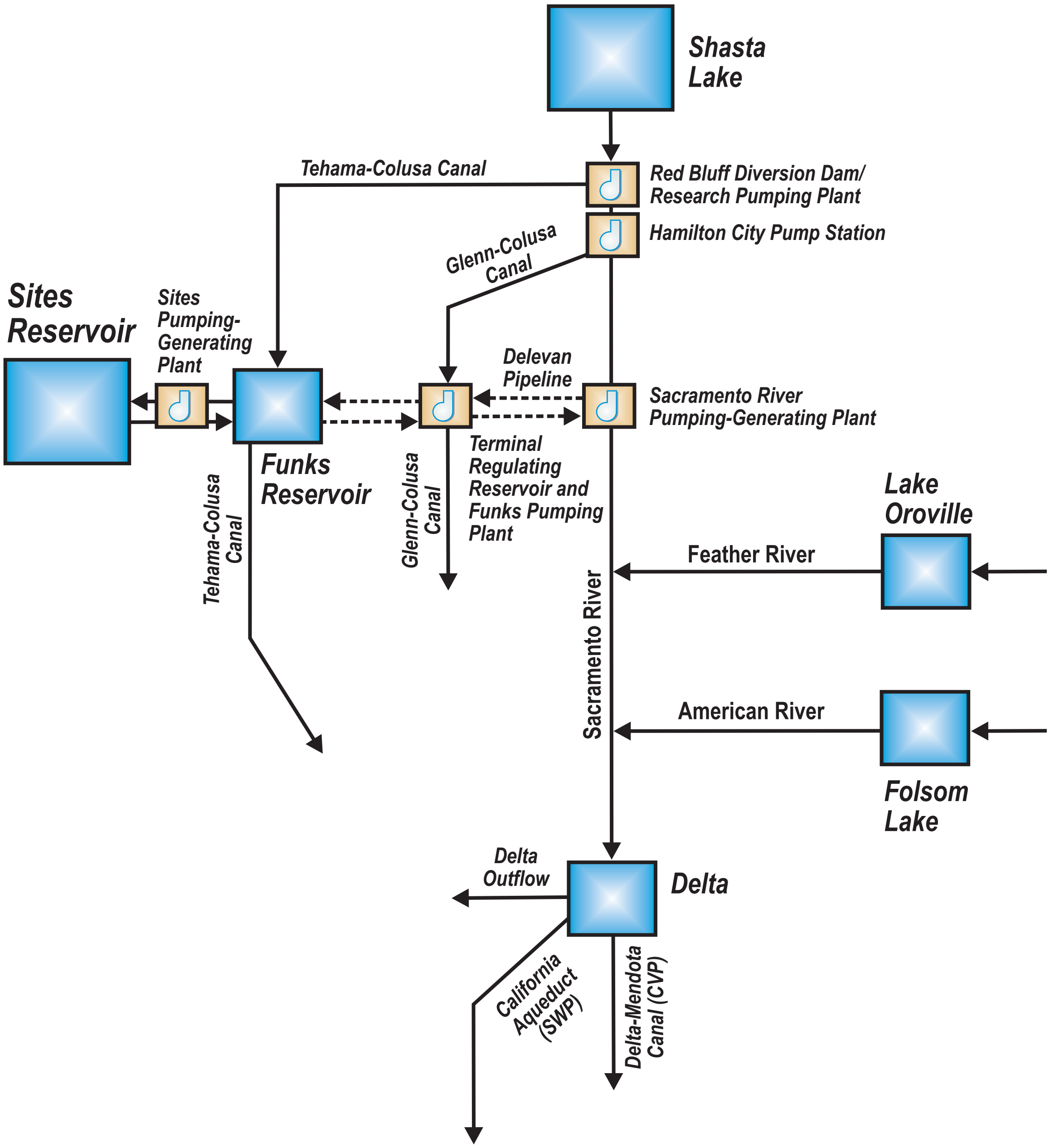


Figure ES-4. NODOS System Flow Diagram

This page left blank intentionally.

- Sites Pumping Plant;
- Funks Reservoir Enlargement;
- Minor Modifications to the GCID Canal Fish Screens at Hamilton City;
- Modifications to the GCID Canal;
- Terminal Regulating Reservoir (TRR);
- Road and Utility Relocations;
- Transmission Lines and Substation Requirements;
- Hydroelectric Facilities;
- Recreation Facilities;
- Ecosystem Restoration Features; and
- Sites Reservoir Operations Strategy.
- In addition to these common features, the action alternative plans include dedicated storage allocations to ERP objectives (the NODOS ERA). The NODOS planning team identified ERP objectives that could be supported by implementing a NODOS project. Ultimately, the selected ERP objectives were incorporated into the operations strategy for the initial action alternatives (see table ES-3).

For the initial alternative analysis, a 1.8-MAF reservoir was used in CalSim II[2] model simulations to assess potential benefits to the water resources categories that make up the project objectives. Table ES-4 summarizes major plan costs and accomplishments. Each of the initial alternative plans considered, including the No Action Alternative, is summarized hereafter.

No Action Alternative

Under the No Action Alternative, the Federal government and State of California would undertake no actions to provide storage north of the Delta to improve water supply, the survivability of anadromous fish, or drinking water quality in the Delta. Under the No Action Alternative, it is still assumed that conjunctive use of groundwater, water use efficiency (WUE), and transfers would be implemented to improve water supply. In addition, the No Action Alternative includes assumed implementation of the Red Bluff Diversion Dam Fish Passage Improvement Program, which includes potential solutions to improve anadromous fish passage upstream and downstream from the RBDD while meeting the needs of water districts served by the Tehama-Colusa Canal Authority (TCCA). For this study, the Federal/National Environmental Policy Act (NEPA) No Action Alternative is considered to be synonymous with the State of California/California Environmental Quality Act (CEQA) No Project Alternative.

[2] CalSim II is a general water resources planning software developed jointly by Reclamation and DWR that provides a comprehensive simulation of the SWP and CVP.

Table ES-3. NODOS Ecosystem Restoration Account (ERA) Objectives

Description	Initial Alternative Plans			
	WS1A	AF1A, AF1B	WSFQ	WS1B, WS1C, WQ1A, WQ1B
ERP Objectives (ERA Short List)				
Improve the reliability of cold-water carry-over storage at Shasta Dam (from the 2000 CALFED ERP Plan, Sacramento River Zone, Central Valley Stream Temperatures, Target 1 / Action 1) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Increase supplemental flows for cold water releases for salmon and steelhead between Keswick and Red Bluff Diversion Dam (from the 2000 CALFED ERP Plan, Sacramento River Zone, Central Valley Stream Temperatures, Target 1—use Nov. 1997 AFRP targets) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Reduce diversions at Red Bluff to provide water into the TC Canal and at Hamilton City to provide water into the GCID Canal during July, August, and September. Priority is to reduce diversions at GCID. This concept is designed to minimize diversion effects to fish during identified critical periods (from the 2000 CALFED ERP Plan, Sacramento River Zone, Water Diversion, Target 1 / Action 1C) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Improve the reliability of cold water carry-over storage at Folsom Reservoir and stabilize flows in the American River (from the 2000 CALFED ERP Plan, American River Basin Zone, Central Valley Stream-flow, Targets 1, 2, and 3) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Modify spring flows into a "snowmelt pattern" in years with peak storm events in late winter and early spring, from Red Bluff to Colusa. The snowmelt pattern would be designed to increase the success of cottonwood cohorts, specifically (from the 2000 CALFED ERP Plan, Sacramento River Zone, Riparian and Riverine Aquatic Habitats, Target 1 / Action 1C) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Stabilize fall flows to avoid abrupt reductions from Keswick to Red Bluff (assumes November 1997 AFRP flow targets). This is intended to reduce adverse conditions for spawning fall-run Chinook salmon (U.S. Fish and Wildlife Service, 2007).			✓	
Stabilize fall flows to avoid abrupt reductions from Keswick to Red Bluff (assumes 6,000-cfs target from October through January and 4,500-cfs target for September). This concept is designed to avoid adverse conditions for spawning fall-run Chinook salmon (i.e., egg desiccation) (from the 2000 CALFED ERP Plan, Sacramento River Zone, Central Valley Stream-flow, Target 2 / Action 2) (CALFED, 2000c and 2000d).		✓		✓

Table ES-3. Continued

Description	Initial Alternative Plans			
	WS1A	AF1A, AF1B	WSFQ	WS1B, WS1C, WQ1A, WQ1B
ERP Objectives (ERA Long List – ERA Short List plus Actions Below)				
Provide a flow event by supplementing normal operating flows from Shasta and Keswick Dams in March during years when no flow event has occurred during winter or is expected to occur. Flow events would be provided only when sufficient inflow to Lake Shasta was available to sustain the prescribed releases. This action could be refined by evaluating its indirect costs and the overall effectiveness of achieving objectives, which are 8,000 to 10,000 cfs in dry years and 15,000 to 20,000 cfs in below-normal years (from the 2000 CALFED ERP Plan, Sacramento River Zone, Central Valley Stream-flow, Action 1 / Target 1) (CALFED, 2000c and 2000d).		✓		
Provide a March Delta outflow from the natural late-winter and early-spring peak inflow from the Sacramento River. This outflow should be at least 20,000 cfs for 10 days in dry years, at least 30,000 cfs for 10 days in below-normal water years, and 40,000 cfs for 10 days in above-normal water years. Wet-year outflow is generally adequate under the present level of development (from the 2000 CALFED ERP Plan, Sac-SJ Delta Zone, Central Valley Stream-Flow, Target 1) (CALFED, 2000c and 2000d).		✓		
Provide a minimum flow of 13,000 cfs on the Sacramento River below Sacramento in May of all but critical years (from the 2000 CALFED ERP Plan, Sac-SJ Delta Zone, Central Valley Stream-flow, Target 4) (CALFED, 2000c and 2000d).		✓		

Key:

AFRP = Anadromous Fish Restoration Program
CALFED = CALFED Bay-Delta Program
cfs = cubic feet per second
ERA = Ecosystem Restoration Account
ERP = Ecosystem Restoration Program
GCID = Glenn-Colusa Irrigation District
NODOS = North-of-the-Delta Offstream Storage
SJ = San Joaquin
TC Canal = Tehama-Colusa Canal

This page left blank intentionally.

Table ES-4. Initial Action Alternative Plan Costs and Accomplishments

Discriminator	Initial Action Alternative Plan							
	WS1A	**WS1B**	**WS1C**	**AF1A**	**AF1B**	**WSFQ**	**WQ1A**	**WQ1B**
ALTERNATIVE FEATURES								
Delevan Pipeline Diversion (cfs)	N/A	1,500	2,000	1,500	2,000	2,000	N/A	2,000
Delevan Pipeline Release (cfs)	N/A	1,125	1,500	1,125	1,500	1,500	1,500	1,500
Environmental Enhancements (Habitat Improvements)	N/A	N/A	N/A	Included	Included	Included	N/A	N/A
WATER SUPPLY INCREASES (DRIEST PERIODS AVERAGE INCREASE/AVERAGE ANNUAL INCREASE) IN TAF/YEAR[1]								
Total Ag and M&I								
CVP, SWP, and Local Supply	190 / 192	232 / 221	275 / 232	131 / 112	108 / 116	208 / 184	204 / 154	258 / 197
Environmental								
Level 4 Water Supply for Refuges	32 / 56	24 / 55	26 / 55	11 / 23	11 / 24	15 / 35	15 / 31	17 / 35
EWA	51 / 88	60 / 92	62 / 95	24 / 49	25 / 49	39 / 57	22 /40	26 / 44
Total – All Users	273 / 336	316 / 368	**363 / 382**	166 / 184	144 / 189	262 / 276	241 / 225	301 / 276
DELTA WATER QUALITY								
Driest Periods/Average Annual Delta Water Quality Augmentation (TAF/year)	48 / 74	55 / 84	60 / 91	59 / 73	57 / 76	**192 / 170**	138 / 169	187 / 169
Percent Reduction of the 'No Action' Weighted Monthly Average Chloride Concentration (mg/L)	4%	3%	4%	3%	3%	**9%**	8%	9%
ANADROMOUS FISH AND OTHER AQUATIC SPECIES SURVIVAL								
Ecosystem Restoration Program Yield Estimate (TAF/year)	117	147	144	222	**225**	176	163	154
SECONDARY OBJECTIVES								
Hydropower Generation – Total Energy (GWh) Generated	105	138	150	152	**158**	150	128	151
Recreation	**Med**	Low	Low	Low	Low	Low	Low	Low
Flood Damage Reduction – Emergency Water	Low	**Med**	**Med**	**Med**	**Med**	**Med**	**Med**	**Med**
COST/BENEFIT SUMMARY[2]								
Construction Cost[3] (million dollars)	**$2,138**	$2,937	$3,022	$2,951	$3,036	$3,036	$2,665	$3,022
Annual Benefits (million dollars)	$113	$152	$155	$108	$111	$**215**	$144	$183
Annual Costs (million dollars)	$**134**	$183	$188	$184	$189	$189	$166	$188
Net Annual Benefits (million dollars)	-$21	-$31	-$33	-$76	-$78	+$**26**	-$22	-$5

Notes:
[1] Driest periods average is the average quantity for the combination of periods from May 1928 through October 1934, October 1975 through October 1977, and June 1986 through September 1992. Average annual is the annual for the period of October 1922 through September 2003.
[2] All costs and benefits presented in this PFR are preliminary and subject to revision in the feasibility report.
[3] Construction Costs include: Field Costs (which include Unlisted Items [10%] and Construction Contingency [20%]), Non-Contract Costs (25%), and Mitigation/Permitting (10%).
Bold indicates values that most fulfill the objective for the particular analysis.

Key:
Ag = agriculture
cfs = cubic feet per second
CVP = Central Valley Project
EWA = Environmental Water Account
GWh = gigawatt hour
M&I = municipal and industrial
Med = medium
mg/L = milligrams per liter
N/A = not applicable
PFR = Plan Formulation Report
SWP = State Water Project
TAF = thousand acre-feet

This page left blank intentionally.

Initial Action Alternative Plan WS1A, Reliance on Existing Canals

Initial action alternative plan WS1A (see figure ES-5) would focus on meeting the primary objective of water supply by constructing Sites Reservoir and relying on the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir.

Figure ES-5. Alternative WS1A

The primary purpose of this alternative would be to meet the existing contract demands of CVP and SWP contractors and to provide additional local water supply for the TC Canal. Sites Reservoir could supply contract deliveries to TC Canal and GCID contractors, enabling Shasta to provide additional water for other CVP and SWP contractors. This alternative would meet five ERP objectives.

Initial Action Alternative Plan WS1B, Existing Canals and New 1,500-cfs Diversion/1,125-cfs Release Pipeline

Initial action alternative plan WS1B (see figure ES-6) would focus on meeting the primary objective of water supply by constructing Sites Reservoir. It would include a new pipeline (the Delevan Pipeline) to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir. The Delevan Pipeline could be designed to provide a 1,500-cfs diversion with a 1,125-cfs release. Releases from the Delevan Pipeline would provide increased water supply reliability and Delta water quality benefits. Reservoir operations would be integrated with the operation of Shasta Dam to provide benefits to anadromous fish between Keswick Dam and the RBDD. This alternative would meet six ERP objectives.

Figure ES-6. Alternative WS1B

Initial Action Alternative Plan WS1C, Existing Canals and New 2,000-cfs Diversion/1,500-cfs Release Pipeline Diversion

Figure ES-7. Alternative WS1C

Initial action alternative plan WS1C (see figure ES-7) would focus on meeting the primary objective of water supply by constructing Sites Reservoir. It would include a new pipeline (the Delevan Pipeline) to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir. The Delevan Pipeline would be designed to provide a 2,000-cfs diversion with a 1,500-cfs release. Releases from the Delevan Pipeline could provide increased water supply reliability and Delta water quality benefits. During the months of July, August, and September, diversions at RBDD to the TC Canal and at Hamilton City to the GCID Canal would be reduced to minimize diversion effects on fish. Reservoir operations would be integrated with the operation of Shasta Dam and Lake Oroville to provide benefits to anadromous fish between Keswick Dam and RBDD. This alternative would meet six ERP objectives.

Initial Action Alternative Plan AF1A, Existing Canals and New 1,500-cfs Diversion/1,125-cfs Release Pipeline with Enhanced Ecological Benefits

Initial action alternative plan AF1A (see figure ES-8) would focus on meeting the primary objective of anadromous fish survivability by using Sites Reservoir to provide additional flexibility in water management that could benefit anadromous fish. It would include a new pipeline (the Delevan Pipeline) to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir. The Delevan Pipeline would be designed to provide a 1,500-cfs diversion with a 1,125-cfs release. The operation of Sites Reservoir would be integrated with the operation of Shasta Dam to provide flows to improve fish passage and lower water temperatures between Keswick Dam and the RBDD. Other measures to support anadromous fish would include restoring gravel mines, developing instream habitat, and adding new spawning gravel. This alternative would meet nine ERP objectives.

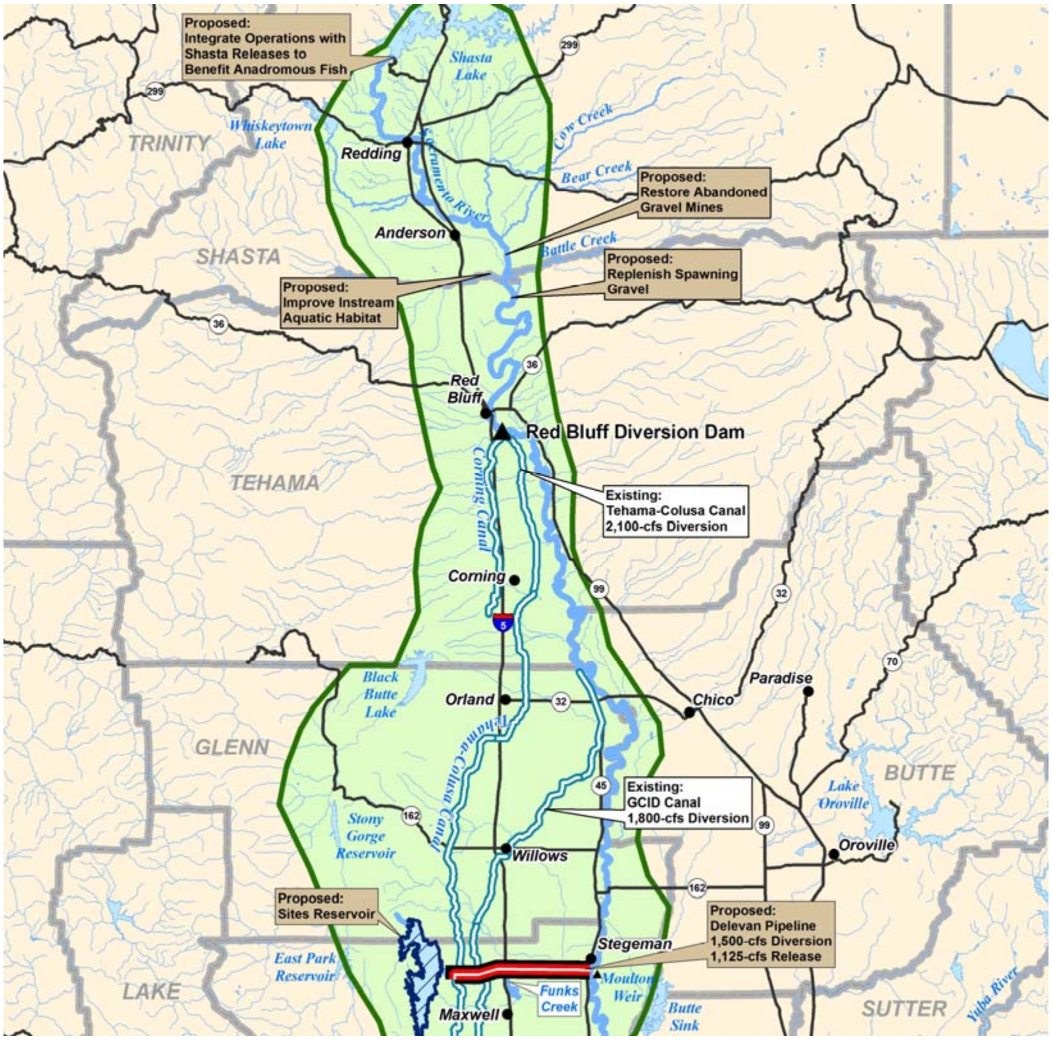


Figure ES-8. Alternative AF1A

Initial Action Alternative Plan AF1B, Existing Canals and New 2,000-cfs Diversion/1,500-cfs Release Pipeline with Enhanced Ecological Benefits

Initial action alternative plan AF1B (see figure ES-9) would focus on meeting the primary objective of anadromous fish survivability by using Sites Reservoir to provide additional flexibility in water management that could benefit anadromous fish. It would include a new pipeline (the Delevan Pipeline) to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir. The Delevan Pipeline would be designed to provide a 2,000-cfs diversion with a 1,500-cfs release. The operation of Sites Reservoir would be integrated with the operation of Shasta Lake to provide flows to improve fish passage and lower water temperatures between Keswick Dam and RBDD. Other measures to support anadromous fish would include restoring gravel mines, developing instream habitat, and adding new spawning gravel. This alternative would meet nine ERP objectives.

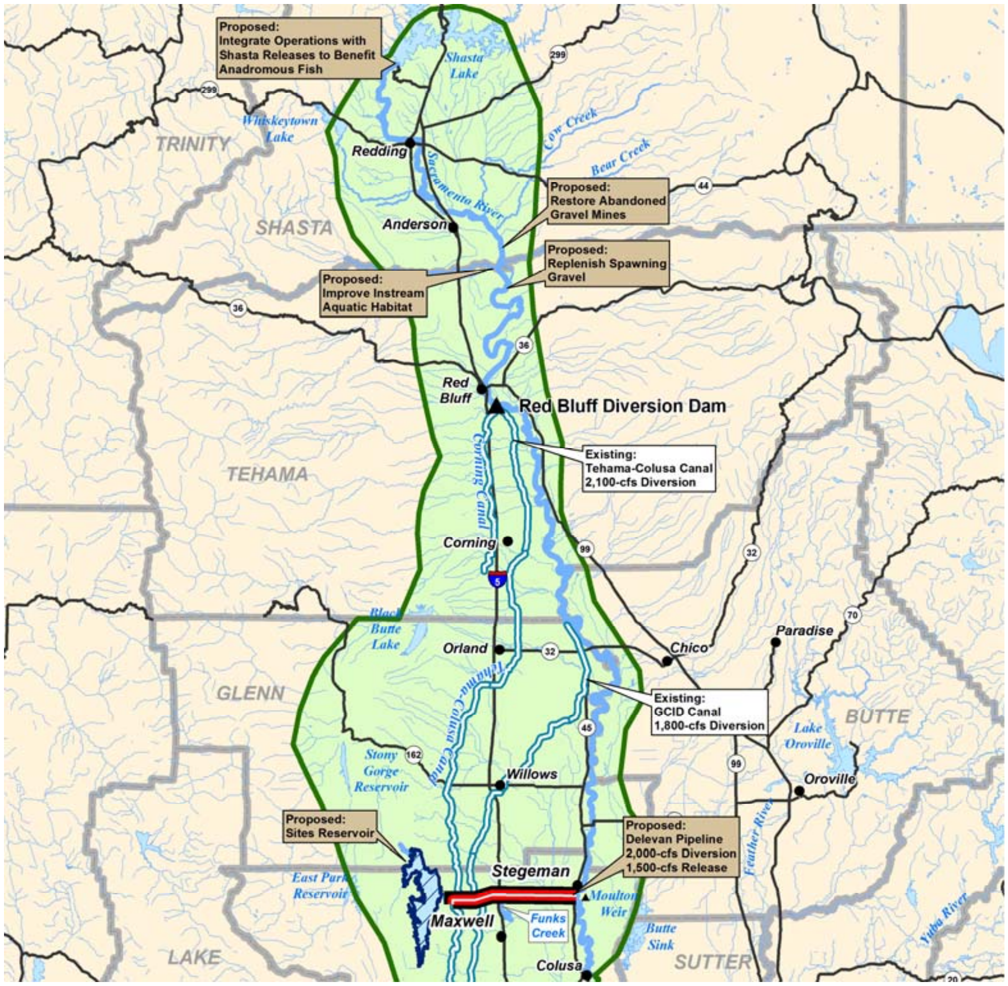


Figure ES-9. Alternative AF1B

Initial Action Alternative Plan WSFQ, Existing Canals and New 2,000-cfs Diversion/1,500-cfs Release Pipeline with Enhanced Ecological Benefits

Initial action alternative plan WSFQ (see figure ES-10) allocates water in a way that balances the three primary objectives, with the intent of maximizing the benefits. Alternative WSFQ is very similar to AF1B, but differs in the operational priorities and the way water is allocated. Alternative AF1B prioritizes water for anadromous fish over water supply and water quality, whereas Alternative WSFQ is more balanced when allocating to the primary objectives. Alternative WSFQ would include the common features previously described as well as the Delevan Pipeline (2,000-cfs diversion with 1,500-cfs release) to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir. Operations of the reservoir would be integrated with the operation of Shasta Dam to provide benefits to anadromous fish between Keswick Dam and RBDD. Other measures to support anadromous fish would include restoring gravel mines, developing instream habitat, and adding new spawning gravel. This alternative would meet six ERP objectives.

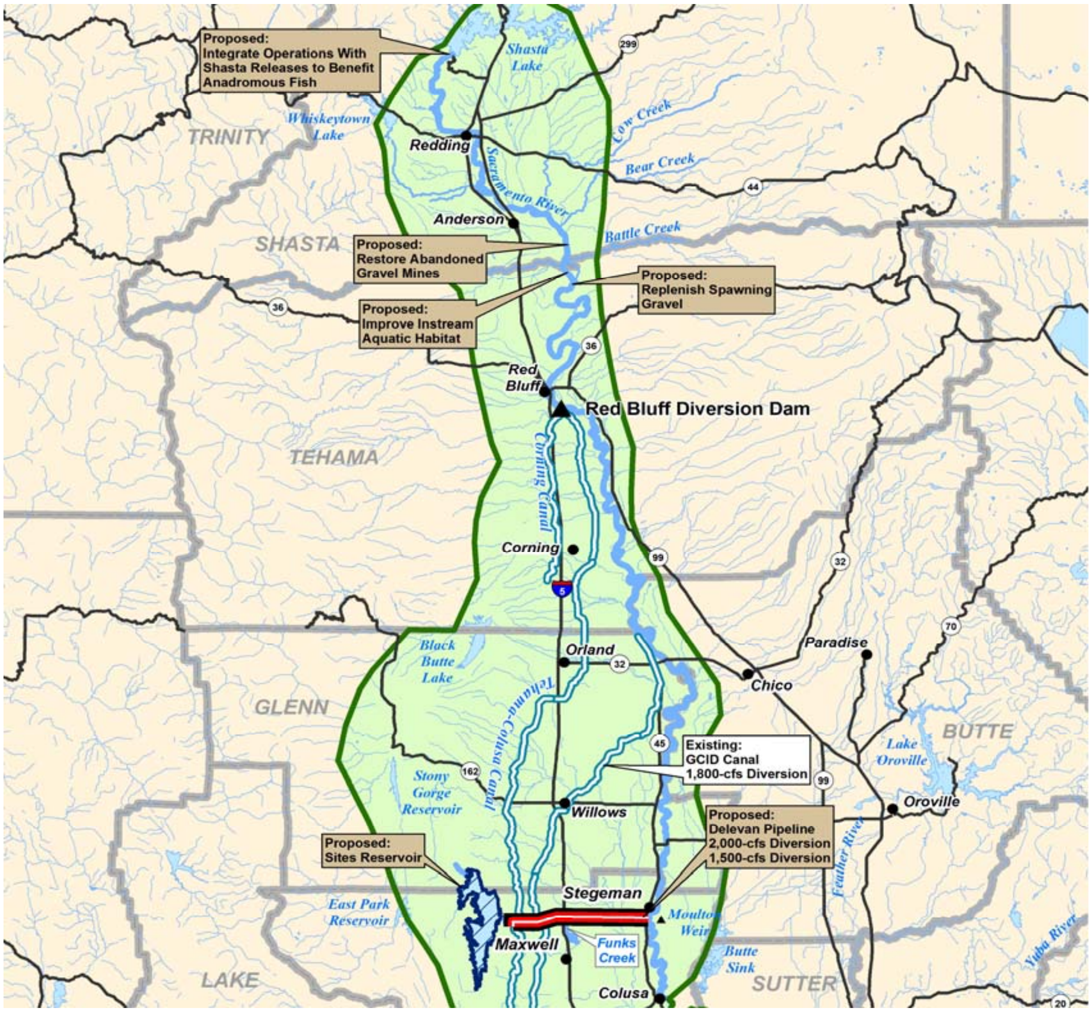


Figure ES-10. Alternative WSFQ

Initial Action Alternative Plan WQ1A, Existing Canals and New 1,500-cfs Release Pipeline

Initial action alternative plan WQ1A (see figure ES-11) would focus on meeting the primary objective of water quality by releasing water to the Sacramento River to increase flows to the Delta during the summer and fall. This alternative would include a new release-only pipeline to augment flow from the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water from the reservoir. The pipeline would be designed to release 1,500-cfs to the Sacramento

Figure ES-11. Alternative WQ1A

River. The release-only pipeline was selected to better evaluate the water quality benefits versus the cost of the new pipeline and to evaluate what impact the diversion would have on aquatic species, compared to the alternative plans with new diversions. The reservoir would be filled using the existing diversions at RBDD and Hamilton City for the TC Canal and GCID Canal, respectively. Reservoir operations would be integrated with the operation of Shasta Lake to provide benefits to anadromous fish between Keswick Dam and RBDD. This alternative would meet six ERP objectives.

Initial Action Alternative Plan WQ1B, Existing Canals and New 2,000-cfs Diversion/1,500-cfs Release Pipeline

Figure ES-12. Alternative WQ1B

Initial action alternative plan WQ1B (see figure ES-12) would focus on meeting the primary objective of water quality by releasing water to the Sacramento River to increase flows to the Delta during the summer and fall. This alternative would include a larger pipeline capable of a 2,000-cfs diversion with a 1,500-cfs release that would supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) in conveying water to and from the reservoir. Reservoir operations would be integrated with the operation of Shasta Lake to provide benefits to anadromous fish between Keswick Dam and RBDD. This alternative would meet six ERP objectives.

Plan Evaluation and Comparison

Each of the initial action alternative plans was evaluated giving consideration to the planning objectives and constraints and the four criteria of completeness, effectiveness, efficiency, and acceptability, as defined in the Principles and Guidelines (P&Gs) presented in the U.S. Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (U.S. Water Resources Council [WRC], 1983). The evaluation used the information available at this stage in the feasibility study process. Table ES-4 shows the differences between the estimated costs and accomplishments of the initial action alternative plans. All of the action plans would meet the completeness criterion equally. All of the action plans would be effective in accomplishing the planning objectives for which they were formulated. All action plans are estimated to meet the acceptability criteria similarly, though continued coordination of the plans would be necessary among other agencies and public interests.

Alternative plan WSFQ has benefits greater than costs and also offers the greatest total benefits of any of the alternatives considered. It clearly warrants additional evaluation and analysis in the next stage of the feasibility study.

Alternative plan WQ1B has costs that are only slightly greater than benefits and merits additional investigation to better define the design, costs, and benefits. This would include additional characterization of ecosystem benefits to the Delta and water quality benefits to agriculture south of the Delta.

Alternative plan WS1A is ranked third among the alternative plans when comparing benefits to costs. It has the third highest benefit to cost ratio. This plan's benefit to cost ratio could change substantially if the reservoir size were optimized. This alternative is also the least expensive of the alternatives considered. Because it lacks the Delevan Pipeline, it is very distinct from the other alternatives and can provide a broader basis of alternative comparison in subsequent phases of the feasibility study.

Based on this analysis, the preliminary evaluation ranks WSFQ, WQ1B, and WS1A the highest. These alternative plans and the No Action Alternative provide a reasonable array of alternative plans for further refinement and detailed analysis in the feasibility report and EIS/EIR, to meet the requirements of the P&G, NEPA, CEQA, and other pertinent Federal, State of California, and local laws, regulations, and policies.

Future evaluations may include the optimization of any of the alternatives carried forward from the PFR. Additional alternatives also may be considered that are introduced in the NEPA/CEQA process or formulated as a result of additional information gained during development of the feasibility report. When all relevant analysis has been completed, a Recommended Plan will be identified in the final feasibility report and EIS/EIR.

It should be noted that engineering design and cost estimates presented in table ES-4 are preliminary and subject to change. This PFR is an interim product of the feasibility study; it is not a decision document. Reclamation and DWR are continuing to refine and evaluate alternative plans and related cost estimates as part of an iterative planning process that will culminate in a recommended plan in the final feasibility report and EIS/EIR. These documents may be used as a basis for discussions among potential project sponsors and concerned stakeholders. It is recognized that details and costs may change in subsequent documents and when they are considered at higher agency review levels and/or approved by executive and legislative decision makers who are responsible for authorization of a NODOS project.

Planning and Implementation Considerations

Development of this PFR revealed several considerations that should be evaluated as part of the continuance of the NODOS Investigation and the implementation of a NODOS project:

- Data, analysis, and operations uncertainties;
- Native American tribes and cultural resources;
- Acquisition of property owners' land and water rights;
- Regulatory requirements for environmental compliance; and
- Cost allocations of NODOS project alternatives.

Many of these issues represent planning and implementation considerations this NODOS Investigation will seek to resolve through an active program of stakeholder and public participation.

Data, Analysis, and Operations Uncertainties

The NODOS study team participants identified the following uncertainties that required making reasonable assumptions based on engineering and scientific judgment:

- Data uncertainties, such as Delta sustainability and climate change;
- Analysis uncertainties, such as anadromous fish populations; and
- Operations uncertainties, such as future systems operations.

These uncertainties are discussed in this report and will be considered further during the feasibility and environmental impact analysis compliance (NEPA/CEQA) phases of the NODOS Investigation and addressed in the feasibility report and EIS/EIR.

Native American Tribes and Cultural Resources

The NODOS study team has been coordinating with Native American Tribes (including the Colusa Indian Rancheria, Cortina Indian Rancheria, Grindstone Indian Rancheria, and the Paskenta Band of Nomlaki Indians) in the vicinity of the proposed Sites Reservoir. The study team met regularly with Tribal representatives through March 2004, on an informal basis, to provide updates on the NODOS Investigation progress and to encourage input on issues of concern from the Tribes. Through the completion of the IAIR (Reclamation and DWR, 2006a), eight coordination meetings were held with Tribal representatives, in addition to the Tribal scoping meeting and one field tour of the Sites Reservoir, facilities, and cultural resource sites. The feasibility report and EIS/EIR will comply with the National Historic Preservation Act, Section 106, and will include a description of supporting analyses, coordination, studies, mitigations, and impacts, as required.

Acquisition of Land and Water Rights

Should a NODOS project at Sites be approved, acquisitions of lands, easements, and/or rights-of-way (ROW) would proceed in cooperation with affected property owners and in accordance with the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 and the Uniform Relocation Act Amendments of 1987. The purpose of this legislation is to implement fair and equitable treatment of persons displaced by the project so that they do not suffer disproportionate injuries as a result of a program designed to benefit the larger public.

If the NODOS project is authorized for implementation, it will be subject to the laws, policies, and regulations of the California State Water Resources Control Board (SWRCB). Reclamation and DWR would be required to obtain new water rights or amend its existing water right permits from the SWRCB for diverting water from the surface water sources and for storing water in the proposed reservoir before project construction could be initiated. In addition, the NODOS project would be required to identify, analyze and develop mitigation measures for any negative impacts that may result from the implementation of the project on the existing water right holders in their ability for diverting water from the surface water sources. Such analysis would be conducted in compliance with SWRCB laws, policies, and regulations. Also, the NODOS project would result in higher flow in the Sacramento River at different times of the year due water releases from the proposed reservoir. Reclamation and DWR would seek appropriate provisions from the SWRCB to ensure that such additional flows in the river due to the water releases from the proposed reservoir are protected from diversions by the water right holders downstream of the project to ensure such water reaches the Delta and achieves its intended purposes.

Regulatory Requirements for Environmental Compliance

A NODOS project, if authorized for implementation, would be subject to the laws, policies, and regulations of Federal, State of California, and local jurisdictions. Reclamation is the Lead Agency for NEPA compliance. All products of the NODOS Investigation will be compliant with CEQA under the guidance of DWR, California's Lead Agency. Reclamation would be required to obtain various permits and regulatory approvals and to comply with several regulatory requirements before project construction could be initiated.

The following are among the regulatory requirements that would be likely to affect the implementation of a NODOS project.

- U.S. Army Corps of Engineers (the Corps) – Clean Water Act (CWA) Section 404 Individual Permit Rivers and Harbors Act, Section 10 Permit;
- U.S. Fish and Wildlife Service (the Service)/National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries

Service) – Federal Endangered Species Act (ESA), Section 7 consultation;

- The Service/NOAA Fisheries Service/California Department of Fish and Game (CDFG) – U.S. Fish and Wildlife Service Coordination Act Report;
- State Historic Preservation Office/Advisory Council on Historic Preservation (SHPO/ACHP) – National Historic Preservation Act (NHPA), Section 106;
- Regional Water Quality Control Board (RWQCB) – CWA Section 401 Water Quality Certification;
- CDFG – California Endangered Species Act (CESA) Section 2081(b): Incidental Take Permit or 2080.1 Consistency Determination; and
- CDFG – Fish and Game Code Section 1602 Streambed Alteration Agreement.

Cost Allocations for NODOS Project Alternatives

Cost allocation is the process of apportioning the total project financial costs and repayment responsibilities among the purposes served by the plan. Costs to be allocated include construction costs, interest during construction, engineering and planning costs, construction supervision costs, land costs, mitigation costs, O&M costs, and net power costs. Once all project costs have been identified, they are allocated to project purposes. The federally preferred method of cost allocation, Separable Cost – Remaining Benefits (SCRB) will be used for the NODOS Investigation (WRC, 1983).

The initial alternative assumptions, responsibilities, and cost estimates presented in this report are preliminary and subject to change during the completion of the feasibility report; therefore, preliminary costs will be allocated for illustrative purposes only in this report. As the initial alternatives are refined in subsequent phases of the feasibility study, cost allocations will be further defined and presented in the feasibility report.

Findings, Future Actions, and Public Outreach

This PFR finds that there is both Federal and State of California interest in continuing the feasibility study for a NODOS project to meet the primary planning objectives of improving water supply and water supply reliability, increasing the survival of anadromous fish and other aquatic species, and improving water quality. The Federal and State of California interest in these objectives will be refined and investigated in greater detail in the feasibility report.

The next steps in the NODOS Investigation will be to better develop and define alternative plans for inclusion into the draft and final feasibility report and

EIS/EIR. As the feasibility study process continues, the alternatives will become more defined and optimized. Other important future actions include the following:

- Completing engineering, economic, and environmental studies to support the NEPA/CEQA process and agency coordination and consultation;
- Identifying the potential impacts and mitigation features of the alternative plans;
- Refining designs, costs, and benefits for the alternative plans and performing cost allocation analysis;
- Completing a financial feasibility analysis;
- Completing the environmental compliance for Federal and non-Federal sponsors;
- Defining the selection and rationale for a recommended plan; and
- Preparing and publishing a draft and final feasibility report and EIS/EIR for public review and decision making by the California legislature and the U.S. Congress.

DWR will continue as California's Lead Agency in the planning and feasibility study development. As a potential partner in a NODOS project, California must determine its interest by actively participating in the development of project objectives, alternatives, and associated technical, environmental, and economic analyses. California must determine the degree to which the planning objectives of ecosystem restoration (consistent with the CALFED ecosystem restoration objectives), water quality improvement, climate change, flood control, and recreation are considered broad public benefits.

The draft feasibility report and EIS/EIR are currently scheduled for Washington-level review in early 2009. The final feasibility report and EIS/EIR are scheduled to be provided for Washington-level review in January 2010.

This page left blank intentionally.

Chapter 1
Introduction

Implementation of the CALFED Bay-Delta Program (CALFED) began after the circulation of the *CALFED Bay-Delta Program Final Environmental Impact Statement/Environmental Impact Report* (CALFED EIS/EIR) (CALFED, 2000a) and the signing of the *CALFED Bay-Delta Programmatic Record of Decision* (CALFED ROD) (CALFED, 2000b). The Preferred Program Alternative (PPA) in the CALFED ROD identified five potential surface-water storage projects to be considered during the first stage of the CALFED program. The United States (U.S.) Department of Interior (Interior), Bureau of Reclamation (Reclamation), received feasibility study authority for the North-of-the-Delta Offstream Storage (NODOS) Investigation in 2003. California's Department of Water Resources (DWR) received authorization to study NODOS beginning in 1996. The Federal and State of California authority for the NODOS Investigation is summarized in table 1-1.

Table 1-1. Federal and California Authority for the NODOS Investigation

Type of Authorization	Law	Date	Authorization
Federal	Division D, Title II, Section 215 of Public Law 108-7, Consolidated Appropriations Resolution	February 20, 2003	"The Secretary of the Interior, in carrying out CALFED Bay Delta Authority (CALFED)-related activities, may undertake feasibility studies for Sites Reservoir, Los Vaqueros Reservoir Enlargement, and Upper San Joaquin Storage projects. These storage studies should be pursued along with ongoing environmental and other projects in a balanced manner."
Federal	Title II, Section 211 of Public Law 108-137, Energy and Water Development Appropriations Act, 2004	December 1, 2003 (fiscal year 2004 appropriation)	"The Secretary of the Interior, in carrying out CALFED-related activities, may undertake feasibility studies for Sites Reservoir, Los Vaqueros Reservoir Enlargement, and Upper San Joaquin Storage projects, hereafter. These storage studies should be pursued along with ongoing environmental and other projects in a balanced manner."
Federal	Title I, Section 103 of Public Law 108-361, CALFED Bay-Delta Authorization Act	October 25, 2004	**(1) Record of Decision as general framework**. The Record of Decision is approved as a general framework for addressing the CALFED Bay-Delta Program, including its components related to water storage, ecosystem restoration, water supply reliability (including new firm yield), conveyance, water-use efficiency, water quality, water transfers, watersheds, the Environmental Water Account, levee stability, governance, and science . . .

Table 1-1. Continued

Type of Authorization	Law	Date	Authorization
Federal (cont'd)			**Authorizations for Federal Agencies Under Applicable Law.** **(2) Secretary of the Interior.** The Secretary of the Interior is authorized to carry out the activities . . . to the extent authorized under the reclamation laws, the Central Valley Project Improvement Act (title XXXIV of Public Law 102-575; 106 Stat. 4706), the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), and other applicable law . . . Description of Activities Under Applicable Law (1) Water storage . . . (i) planning and feasibility studies for . . . (I) the Sites Reservoir in Colusa County . . . ."
California	Proposition 204, The Safe, Clean, Reliable Water Supply Act, Chapter 6, Article 2, Section 78656	1996	"Notwithstanding Section 13340 of the Government Code, the money in the subaccount is hereby continuously appropriated, without regard to fiscal year, to the department, for the administration of this article and for feasibility and environmental investigations for any of the following projects: (a) Off-stream storage upstream of the delta that will provide storage and flood control benefits in an environmentally sensitive and cost-effective manner."
California	Budget Act	1997-1998	This act authorized DWR to continue feasibility and environmental studies pertaining to the Sites Reservoir and alternatives. As a result, DWR expanded the 1997 reconnaissance study to a broader investigation.
California	Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002	November 2002	"The sum of eight hundred twenty five million ($825,000,000) shall be available for appropriation by the Legislature from the fund for the balanced implementation of the CALFED Bay-Delta Program Expenditures and grants pursuant to this chapter shall be limited to . . . Fifty million dollars ($50,000,000) for surface water storage planning and feasibility studies."
California	Proposition 84, Chapter 4	November 2006	"The sum of $65 million shall be available to the department (DWR) for planning and feasibility studies related to the existing and potential future needs for California's water supply, conveyance and flood control systems. The studies shall be designed to promote integrated, multi-benefit approaches that maximize the public benefits of the overall system including protection of the public from floods, water supply reliability, water quality, and fish, wildlife and habitat protection and restoration."

Key:
CALFED = CALFED Bay Delta Program
DWR = California Department of Water Resources
NODOS = North-of-the-Delta Offstream Storage

Purpose and Scope of Plan Formulation Report

This Plan Formulation Report (PFR) is an interim step in the NODOS feasibility study. DWR and Reclamation, in partnership with local interests, are investigating NODOS opportunities. This PFR is a progress report, not a decision document. Additional analyses and documentation will be completed during the feasibility study, which will culminate in the draft and final feasibility report and EIS/EIR, with opportunities for public review and participation.

The scope of this PFR includes the following topics.

- Chapter 1 describes the purpose and scope of the PFR; the study authorization; Primary and Extended Study Areas; highlights of relevant studies, projects, and programs; and report organization.
- Chapter 2 describes water resources and related problems and needs in the Primary Study Area warranting Federal and State of California consideration; presents planning objectives to address these problems, needs, and opportunities; and identifies the planning constraints, principles, and criteria used to guide the NODOS Investigation.
- Chapter 3 describes existing and potential future water resources and related conditions within the potentially affected environment of the Primary and Extended Study Areas.
- Chapter 4 describes the development and initial evaluation of the management measures that constitute the initial alternative plans.
- Chapter 5 describes the evaluation of conveyance measures.
- Chapter 6 presents the initial alternative plans formulated using the management measures.
- Chapter 7 provides a comparative analysis of the initial alternative plans and identifies potential environmental, social, and economic effects.
- Chapter 8 identifies and describes planning and implementation considerations associated with the potential project.
- Chapter 9 summarizes the findings of the PFR and the public involvement strategy for future phases of the NODOS Investigation and discusses requirements to comply with applicable laws, policies, and plans.
- References and a Glossary are provided following Chapter 9.

Problems, Needs, and Planning Objectives

The following problems, needs, and opportunities have been identified for the NODOS Investigation:

- There is an increased demand for current and future water supplies and water supply reliability;
- Dams, levees and diversions have affected the survivability of anadromous fish and other aquatic species;
- Water quality in the Delta has become increasingly degraded;
- There is an increased need for hydropower generation facilities;
- There is an opportunity to provide additional recreation in the Sacramento Valley while addressing identified problems and needs; and
- There are opportunities to increase flood protection in the Sacramento Valley through improvements in the water system and its management.

Based on the problems, needs, and opportunities identified for the NODOS Investigation, three primary and three secondary planning objectives were developed to guide the formulation of solutions.

The primary planning objectives include the following:

- Increase water supplies to meet existing contract requirements, including improved water supply reliability, and provide greater flexibility in water management for agricultural, environmental, and municipal and industrial (M&I) users;
- Increase the survival of anadromous fish populations in the Sacramento River, as well as the survivability of other aquatic species; and
- Improve drinking water quality in the Delta.

Alternatives will be formulated to address these primary objectives.

To the extent possible, while meeting the primary planning objectives, the NODOS Investigation will recognize opportunities to accomplish the following secondary objectives:

- Provide ancillary hydropower benefits to the statewide power grid;
- Develop additional recreational opportunities in the Primary Study Area; and
- Create incremental flood-damage reduction opportunities to support the northern California flood management system.

Primary and Extended Study Areas

The Primary Study Area for the NODOS Investigation encompasses the upper Sacramento River and the northern Sacramento Valley and includes watersheds flowing into the upper Sacramento River from Colusa, Tehama, and Glenn Counties, as well as smaller portions of Shasta, Sutter, and Butte Counties (figure 1-1).

Given the potential influence of any proposed additional surface-water storage on other programs and projects in the Central Valley, an Extended Study Area also has been identified for the NODOS Investigation (figure 1-1). The Extended Study Area includes the Sacramento River watershed, the Delta, and the service areas for the State Water Project (SWP) and Central Valley Project (CVP).

Feasibility Study Process

For the NODOS Investigation, an iterative planning process consistent with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (U.S. Water Resources Council [WRC], 1983) (P&Gs) was used. This process includes seven fundamental steps for Federal water resource studies (figure 1-2).

1. Identify problems, needs, and opportunities.
2. Develop planning objectives and identify planning principles and constraints.
3. Identify and evaluate management measures to meet planning objectives.
4. Formulate an array of alternative plans.
5. Evaluate initial action alternatives and compare to No Action Alternative.
6. Define implementation considerations.
7. Select a recommended plan, including rationale.

The results of the initial phase of the feasibility study are documented in the *North-of-the-Delta Offstream Storage Investigation Final Initial Alternatives Information Report* (IAIR) (Reclamation and DWR, 2006a).

As shown in figure 1-2, the emphasis in the planning phases changes as the feasibility study progresses. Initially, emphasis is placed on defining problems, needs, and opportunities and compiling and forecasting conditions in the Primary Study Area to support the development of planning objectives. The emphasis then shifts to defining management measures and combining them to

This page left blank intentionally.

Figure 1-1. Primary and Extended Study Areas

This page left blank intentionally.

2004-2006: Initial Phase

Problems, Needs, and Objectives

- Describe Problems and Needs
- Define Existing and Likely Future Conditions
- Identify Needed Technical Tools and Studies
- Establish Planning Objectives
- Define Planning Constraints and Criteria
- Define and Screen Resource Management Measures
- Formulate Initial Alternative Plans
- Public Scoping and Documentation
- Confirm State and Federal Interest in Continuing Feasibility Study

Initial Alternatives Information Report

(Interim Progress Report)

2006-2008: Intermediate Phase

Develop Preliminary Alternative Plans

- Continue Environmental Analysis
- Formulate, Evaluate, and Compare Concept Plans
- Identify Preliminary Impacts, Costs, and Accomplishments
- Identify Initial Alternatives for Further Development
- Refine Measures and Initial Alternatives
- Formulate Alternatives
- Identify Preliminary Impacts, Mitigations, Costs, and Benefits
- Identify Federal and Non-Federal Roles and Responsibilities
- Evaluate and Compare Alternatives
- Prepare Draft Coordination Action Report, Planning Aid Letter, and Other Support Documents
- Continue Agency Coordination and Public Involvement

Plan Formulation Report

(Interim Progress Report)

2008-2010: Refinement and Recommendation Phase

Refine and Compare Plans

- Refine Alternatives
- Identify and Develop Tentatively Selected Plan
- Prepare Action-Specific Implementation Plan
- Prepare and Circulate Draft Feasibility Report (FR/EIS-EIR)
- Identify Recommended Plan
- Confirm Federal and Non-Federal Responsibilities and Sponsorship
- Prepare and Process Final Feasibility Report (FR/EIS-EIR)
- Ensure Agency Coordination in Action and Public Involvement

(Environmental Documentation)

EIS-EIR

Feasibility Report

(Decision Document)

Figure 1-2. Plan Formulation Process

This page left blank intentionally.

formulate and evaluate alternative plans, which will be used to prepare the feasibility study report.

Public Scoping

During 2001 and 2002, Reclamation and DWR developed the scope of the NODOS Investigation and took public comments, including comments regarding potential alternatives in the Primary Study Area, at one Tribal and three other public scoping meetings. A summary of these comments is in the *North-of-the-Delta Offstream Storage Investigation Scoping Report* (Reclamation and DWR, 2002) (Scoping Report). Comments from the public scoping session have been considered in the definition of problems, needs, and opportunities, the development of the NODOS Investigation objectives, and the identification of measures to meet those objectives. This effort is documented in the IAIR (Reclamation and DWR, 2006a).

Related Studies, Projects, and Programs

Related activities of various governmental agencies, local working groups, and private organizations in the Primary and Extended Study Areas are summarized in this section.

Federal

Department of the Interior, Bureau of Reclamation – Projects and Programs

As the owner and operator of Shasta Dam and Reservoir, Keswick Dam and Reservoir, and various components of the CVP, Reclamation has a major effect on existing and future environmental resources in the region. Ongoing projects or continuing programs relevant to the NODOS Investigation include the CVP and the Central Valley Project Improvement Act (CVPIA).

- **Central Valley Project –** The CVP is the largest reservoir and delivery system in California. It spans 35 California counties and supplies water to more than 250 long-term water contractors in the Central Valley, the Santa Clara Valley, and the San Francisco Bay Area. About 90 percent of the water delivered through the CVP is for agriculture. The operation of the CVP is regulated by several requirements and agreements.
- **Central Valley Project Improvement Act –** The CVPIA redefined the purposes of the CVP to include the protection, restoration, and enhancement of fish and wildlife and associated habitats. The CVPIA identified many specific measures and programs to meet the new project purposes and directed the Secretary of the Interior (the Secretary) to operate the CVP consistent with these purposes.

Shasta Lake Water Resources Investigation

Reclamation is conducting a feasibility study to evaluate raising Shasta Dam and enlarging the reservoir. It will evaluate raising Shasta Dam by as much as 18.5-feet and creating up to 634 thousand acre feet (TAF) in new storage capacity. The primary objectives are to increase water supply, water supply reliability, and the survival of anadromous fish in the Sacramento River.

Fish Passage Improvement Project at the Red Bluff Diversion Dam (RBDD)

Reclamation and the Tehama-Colusa Canal Authority (TCCA) are working together to improve anadromous fish passage upstream and downstream from the RBDD and to improve the long-term ability to divert enough water into the Tehama-Colusa (TC) Canal and the Corning Canal systems to meet the needs of water districts served by the TCCA. Given the lapse in time and the selection of a project, Reclamation and TCCA reissued the draft EIS/EIR to the public in 2008 (U.S. Department of the Interior, 2008). (It was originally made available to the public in 2002 [U.S. Department of the Interior, 2002].)

Department of the Interior, Bureau of Land Management (BLM) – Management Plans

The BLM is responsible for the administration of natural resources, lands, and mineral programs on 250,000 acres of public land in northern California. BLM land in the Primary Study Area includes the 17,000-acre Sacramento River Bend area, south of Jelly’s Ferry, and off-highway vehicle areas near Shasta Lake. BLM has been involved in many restoration and conservation projects in area watersheds, including the Clear Creek Floodplain Restoration Project. BLM also has a role in implementing the Northwest Forest Plan.

National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries Service) (formerly the National Marine Fisheries Service) – Salmon and Steelhead Proposed Recovery Plan

NOAA Fisheries Service has designated the Sacramento River from Keswick Dam downstream to the Golden Gate Bridge as critical habitat for federally listed winter-run Chinook salmon. The Central Valley recovery-planning domain also includes Central Valley spring-run Chinook salmon, Central Valley steelhead, and Federal candidate species fall-run/late fall-run Chinook salmon. Clear, Cow, Bear, Battle, and Cottonwood Creeks have been identified as essential fish habitat. The *Proposed Recovery Plan for Sacramento River Winter-Run Salmon* (NOAA Fisheries Service, 1997) presents restoration goals and actions, some of which would be applied in the NODOS Investigation Primary Study Area.

U.S. Environmental Protection Agency (EPA) – Iron Mountain Mine Restoration

The EPA is involved in remediation and cleanup related to the Iron Mountain Mine Superfund site in the Spring Creek drainage west of the Sacramento River. Acid mine drainage from the former copper mine has considerably affected the Spring Creek watershed and killed fish in the Sacramento River. This site is being addressed through interim emergency actions and long-term remedial phases focusing on water management and cleanup of major sources in Boulder Creek, the Old Mine/No. 8 Mine, area source acid mine drainage discharges, and sediments. Additional planned activities include the construction of an acid mine drainage treatment plant in the Boulder Creek watershed.

U.S. Army Corps of Engineers (the Corps) – Sacramento Valley Programs

Many projects, programs, and studies by the Corps affect the Sacramento River and its tributaries. Flood management projects include dams and reservoirs, hundreds of miles of levee and channel improvements, and a flood bypass system. *The Sacramento and San Joaquin River Basins Comprehensive Study Interim Report* (DWR, 2002) (Comprehensive Study) included strategies and recommendations that could influence flood damage reductions and ecosystem restoration along the Sacramento and San Joaquin Rivers.

California

California Department of Water Resources – Projects and Plans

DWR programs and projects that could affect the NODOS Investigation include the SWP and California Water Plan (CWP).

- **State Water Project –** The SWP, authorized by the California Legislature in 1951, is the largest state-built, multipurpose water project in the country. The SWP was designed and built to deliver water, control floods, generate power, provide recreational opportunities, and enhance habitats for fish and wildlife. The SWP is operated and maintained by DWR and includes 29 dams and reservoirs, 26 pumping and generating plants, and about 675 miles of aqueducts. The SWP delivers water to 29 public water agencies under long-term contracts signed in the early 1960s for an eventual annual delivery of 4.2 million acre-feet (MAF) throughout the San Joaquin Valley, the Central Coast, San Francisco, and the South Coast. The SWP delivers an average of 2.4 MAF of water annually to its contractors.

- **California Water Plan –** DWR prepares and publishes updates to the CWP through its Bulletin 160 series. The most recent update, the *California Water Plan Update 2005: A Framework for Action* (DWR, 2005a), identifies water resources issues and includes a strategic plan, goals, policy recommendations, and recommended actions to ensure sustainable water uses and reliable water supply.

California Department of Fish and Game (DFG) – Restoration and Recovery Programs

The DFG is responsible for managing California's fish and wildlife resources and overseeing the restoration and recovery of threatened and endangered species under the California Endangered Species Act (CESA). DFG participates in conservation planning, environmental compliance and permitting, coordinated resource management planning, and restoration and recovery programs. DFG is involved in many investigations, projects, and monitoring in the Primary Study Area, including fish passage, riparian restoration, and aquatic habitat restoration. The Wildlife Conservation Board (WCB), established under DFG, administers a capital outlay program for wildlife conservation and related recreation projects.

Federal-California

Following are several Federal or State of California programs and projects that affect the NODOS Investigation.

CALFED Bay-Delta Program

CALFED is a cooperative effort of California agencies, Federal agencies, and California's environmental, urban, and agricultural communities. In August 2000, the CALFED Bay-Delta Program agencies issued a Programmatic ROD (CALFED, 2000b) that provided a 30-year plan to address ecosystem health and water supply reliability problems in the Bay-Delta. This ROD plan addresses four interrelated, interdependent resource management objectives: water quality, ecosystem quality, water supply reliability, and levee integrity. The Water Storage Program is one of the key program elements. Several programs identified in the ROD are summarized hereafter.

- **Storage –** The Water Storage Program seeks to develop more storage capacity, thereby increasing system flexibility to improve water quality and restore ecosystems while also improving water supply reliability to help meet the needs of California's growing population. Five potential surface storage projects are under consideration: Enlargement of Shasta Dam, Los Vaqueros Enlargement, In-Delta Storage, Upper San Joaquin River Basin Storage Investigation, and NODOS.

- **Conveyance –** As part of the Conveyance Program, DWR and Reclamation have proposed to implement the South Delta Improvements Program (SDIP) to improve water management and coordination between California and Federal projects. The SDIP includes an operational component that involves considering raising the permitted diversion limit into the SWP Clifton Court Forebay from 6,680 cubic feet per second (cfs) to 8,500 cfs. The Final *South Delta Improvements Program EIS/EIR* (Reclamation, and DWR, 2006) was released in

December 2006; however, further actions are postponed, pending the outcome of related agency consultations.

- **Water Management –** The CALFED Bay-Delta Program has an array of projects and approaches (including storage) to expand water supplies and ensure efficient water use.

- **Water Transfer –** Potential water transfers are being evaluated to minimize the effects of a drought(s).

- **Environmental Water Account –** The Environmental Water Account (EWA) Program has two primary elements: (1) assisting fish population recovery for at-risk native Delta-dependent fish species; and (2) improving water supply reliability by reducing the uncertainty associated with fish recovery actions. The EWA is aimed at increasing the flexibility of California's water delivery system to provide water at critical times to meet environmental needs without creating water supply effects on cities, farms, and businesses. The EWA gives water managers the tools to acquire, store, transfer, and release water to respond to real-time ecosystem needs. The 2004 EWA ROD and Notice of Determination implement the EWA Flexible Purchase Alternative described in the *Final Environmental Impact Statement/Environmental Impact Report CALFED Environmental Water Account* (Reclamation et al., 2004) through December 31, 2007. The CALFED ROD defined the EWA as a 4-year program unless EWA agencies agree to an extension. Because of uncertainties associated with EWA operations, Delta pelagic organism decline, and ongoing planning efforts for a proposed Bay-Delta Conservation Plan, completion of an environmental document for the long-term EWA has been postponed. Until these uncertainties are resolved, the EWA agencies have decided to extend the existing program for up to 4 years. A supplemental EWA EIS/EIR was prepared for this purpose and was completed in March 2008 (Reclamation, 2008).

- **Water-Use Efficiency (WUE) –** The goal of the WUE Program is to make the best use of water supplies by defining appropriate water measurement, certifying urban best management practices (BMPs), and refining quantifiable objectives for agricultural WUE. The program supports local water conservation and recycling projects.

- **Water Quality –** The focus of the Water Quality Program is to improve water quality, from source to tap, for Californians whose drinking water supplies come from the Bay-Delta watershed. The program includes developing source improvements and drainage management programs.

- **Levee System Integrity –** The purpose of the Levee System Integrity Program is to reduce the threat of levee failure and seawater intrusion to protect water supplies, water quality, major roadways, cities, towns, agriculture, and environmental and aquatic habitat, primarily in the Delta.

- **Ecosystem Restoration Program (ERP) and Watershed Management –** The ERP consists of improving the ecological health of the Bay-Delta watershed by restoring and protecting habitats, ecosystem functions, and native species.

- **Science Program –** The long-term goal of CALFED's Science Program is to establish a body of knowledge relevant to CALFED actions and their implications.

Interagency Ecological Program on Pelagic Organism Decline

Studies on the decline of pelagic organisms represent an interdisciplinary, multi-agency effort involving staff from the California Department of Fish and Game (DFG), DWR, Reclamation, EPA, the U.S. Geological Survey (USGS), and the University of California (U.C.) at Davis. The Interagency Ecological Program (IEP) develops annual work plans to augment monitoring, to perform new data analyses, and to conduct special studies to investigate threats to pelagic fish and their prey. Over the past few years, abundance indices calculated by the IEP show unexpected declines in numerous pelagic fishes and zooplankton in the Upper San Francisco Estuary (the Delta and Suisun Bay).

Riparian Habitat Joint Venture

The Riparian Habitat Joint Venture (RHJV), initiated in 1994, includes signatories from 18 Federal, California, and private agencies. The RHJV promotes conservation and the restoration of riparian habitat to support the native bird population. The RHJV's conservation plan identifies Lower Clear Creek as a prime breeding area for yellow warblers and song sparrows, advocating a continuous riparian corridor along lower Clear Creek. Other recommendations of the conservation plan apply to the NODOS Investigation Primary Study Area in general.

Sacramento Valley Water Management Program (SVWMP)

The Bay-Delta Accord, signed in 1994, established water quality standards and required the State Water Resources Control Board (SWRCB) to determine which water users would be responsible for meeting those standards. In response, the SWRCB adopted a Water Quality Control Plan (WQCP) and proceeded to hold hearings to allocate responsibility for meeting the WQCP goals in eight phases.

Phase 8 was to allocate responsibility for WQCP flow-related requirements affecting Sacramento Valley water users. Reclamation and DWR, as operators of Federal and State of California export projects, respectively, have collaborated with certain water-rights holders in the Sacramento Valley to either cease diversions or release water from storage to help meet water quality standards and flow requirements in the Delta. As an alternative to Phase 8, under the *Sacramento Valley Water Management Short Term Settlement Agreement* (SVWMP, 2002) (Short-Term Settlement Agreement), DWR, Reclamation, and export water users agreed to meet water supply, quality, and environmental needs through four successive agreements:

- Stay Agreements;
- Short-Term Settlement Agreements;
- Short-Term Project Implementation Agreements; and
- Long-Term Agreements.

The Short Term Settlement Agreement (SVWMP, 2002) specifically identified Sites Reservoir and the Shasta Enlargement as potential long-term projects. The *Sacramento Valley Water Management Settlement Agreement Short-Term Work Plan* (SVWMP, 2001a) identified and evaluated approximately 45 projects that could be implemented within 1 to 2 years, including conjunctive management and surface storage reoperation projects. The projects were selected through a proposal process that solicited projects across northern California. Objectives of the Short-Term Settlement Agreement are to develop projects that provide up to 185,000 acre-feet (AF) of new water supply to augment CVP and SWP water supplies and to provide 100,000 AF in benefits resulting from system improvements during below-normal, dry, and critically dry years (SVWMP, 2002). These projects were categorized as 12 Surface/ Groundwater Planning Projects; 13 System Improvement Projects; 14 Conjunctive Water Management Projects; and 6 Institutional Projects.

Long-Term Operations Criteria and Plan (OCAP) Biological Assessments

Reclamation and DWR completed an update to the 2004 OCAP biological assessments (BAs), to reflect recent operational and environmental changes occurring throughout the CVP/SWP system, and submitted them to NOAA Fisheries Service and U. S. Fish and Wildlife Service (the Service) describing and evaluating the updated criteria in August 2008. In addition to current operations, the BA considered several proposed future actions, including increased flows in the Trinity River system, permanent barriers in the South Delta, the SWP/CVP Intertie, the Freeport Regional Water Project, and various operational changes. Reclamation received biological opinions from NOAA Fisheries Service in October 2004 and from the Service in February 2005, and thereby completed its 2004/2005 Section 7 ESA consultations. The terms and conditions specified in the biological opinions established the instream habitat conditions and operational requirements that Reclamation and DWR must maintain as part of the integrated CVP/SWP operations.

Given the numerous changed circumstances since the 2004/2005 OCAP BA consultations (e.g., Delta smelt population decline; newly designated critical habitat for Central Valley steelhead, Central California Coast steelhead, and spring-run Chinook salmon; and new listing of the Southern District Population Segment of North American green sturgeon), in 2006, Reclamation requested initiation of Section 7 ESA consultation with both NOAA Fisheries Service and the Service. It is expected that consultations will be complete by spring 2009.

On August 31, 2007, U.S. District Court Judge Wanger ruled from the bench, in the Natural Resources Defense Council v. Kempthorne, to remand (but not vacate) the 2005 Fish and Wildlife Service biological opinion for Delta smelt back to the Service to prepare a new opinion (expected in late 2008). Judge Wanger also issued a prohibitory injunction against Reclamation and DWR from operating the SWP and CVP inconsistent with actions the judge ordered based upon proposals submitted by the parties. On December 14, 2007, an interim remedial order was issued to provide additional protection of the federally listed Delta smelt pending completion of a new biological opinion for the continued operation of the CVP and SWP.

Lower Yuba River Accord

The Lower Yuba River Accord (Yuba Accord) is a settlement between the Yuba County Water Agency (YCWA) and State of California and Federal fisheries agencies in response to DFG's *Lower Yuba River Fisheries Management Plan* (DFG, 1991), which addresses issues associated with the operation of the Yuba River Development Project (Yuba Project). The Yuba Accord is intended to resolve instream flow issues associated with operation of the Yuba Project in a way that protects and enhances lower Yuba River fisheries. The Yuba Project also is intended to improve local water supply reliability while providing CALFED with water to protect and restore Delta fisheries and improve statewide water supply management, including supplemental water for the CVP and the SWP.

The Yuba Accord includes the Yuba Accord Conjunctive Use Agreement, between the YCWA and water districts within Yuba County, for the implementation of a comprehensive program for conjunctive use of surface water and groundwater supplies and actions to improve water-use efficiencies. As part of the Yuba Accord, a groundwater monitoring and reporting program will be implemented to ensure that pumping is within a safe yield for the aquifer, that groundwater will not be exported out of Yuba County, and that groundwater will be used to irrigate farmland.

Reclamation and the YCWA completed a draft EIS/EIR (Reclamation and YCWA, 2007) on the Yuba Accord. The YCWA is the Lead Agency under the

California Environmental Quality Act (CEQA), and Reclamation is the Lead Agency under the National Environmental Policy Act (NEPA).

Delta-Mendota Canal Recirculation Feasibility Study

Reclamation and DWR are conducting a feasibility study to evaluate the feasibility, benefits, and impacts of recirculating water from the Delta, through the use of excess capacity in CVP pumping and conveyance facilities, to the San Joaquin River. The purpose of the Delta-Mendota Canal Recirculation Project is to determine whether recirculation of export water is an effective and feasible method to reduce salinity and improve dissolved oxygen in the San Joaquin River [Public Law 108.361, Sec 103 (f)(G)]; and to develop a program “to provide flow, reduce the concentration of salinity in the San Joaquin River, and reduce reliance on New Melones Reservoir for meeting water quality and fishery flow objectives through the use of excess capacity in export pumping and conveyance facilities [Public Law 108-361, Sec. 103(d)(D)(2)(D)(iii). In addition, the Delta-Mendota Canal Recirculation Feasibility Study will fulfill the requirements of D-1641 and the CALFED ROD, both of which require completion of the study.

Franks Tract Project

DWR and Reclamation are conducting studies to evaluate the feasibility of modifying the hydrodynamic conditions near Franks Tract to improve Delta water quality and enhance the aquatic ecosystem. The Franks Tract Project would consist of constructing and operating one or more flow control facilities in the Franks Tract area to better manage hydrodynamic conditions to improve salinity levels and protect at-risk fish species in the central and south Delta. Objectives of the project include reducing ocean salinity intrusion into the central and south Delta; enhancing conditions for Delta fisheries, particularly delta and longfin smelt; improving operational flexibility; and developing water quality and fishery protection measures consistent with long-term planning efforts. The Draft EIS/EIR is expected to be released May 2009.

Federal-Private

Following are several Federal-private programs and projects that may affect the NODOS Investigation.

San Luis Reservoir Low Point Improvement Project

Reclamation, the San Luis and Delta-Mendota Water Authority, and the Santa Clara Valley Water District are preparing a feasibility study for the San Luis Reservoir Low Point Improvement Project. Project objectives include avoiding supply interruptions to south-of-Delta contractors; increasing the reliability and quantity of yearly allocations to south-of-Delta contractors; and announcing higher allocations earlier in the season. The San Luis Reservoir Low Point

Improvement Project is proposed to maintain a high quality, reliable, and cost-effective water supply for the Santa Clara Valley Water District and other south-of-Delta contractors to ensure that these contractors receive their annual CVP contract allocations at the time needed to meet water supply demands.

Other Programs and Private Organizations

Many programs and private organizations related to the NODOS Investigation, and groups active in the Primary Study Area in the past decade, have helped in fishery recovery and watershed restoration. Several of the groups that are tied closely to the NODOS Investigation are described hereafter.

- **Sacramento River Conservation Area Program –** California Senate Bill (SB) 1086 called for a management plan for the Sacramento River and its tributaries to protect, restore, and enhance fisheries and riparian habitat. The Sacramento River Conservation Area Program has an overall goal of preserving remaining riparian habitat, re-establishing a continuous riparian ecosystem along the Sacramento River between Redding and Chico, and re-establishing riparian vegetation along the river from Chico to Verona.

- **Resource Conservation Districts –** Numerous resource conservation districts (RCDs) are within the Primary Study Area. Once known as Soil Conservation Districts, RCDs were established under California law with a primary purpose of implementing local conservation measures. RCDs are empowered to conserve resources within their districts by implementing projects on public and private lands and to educate landowners and the public about resource conservation. They are often involved in the formation and coordination of watershed working groups and other conservation alliances. In the Shasta Lake and upper Sacramento River vicinity, districts include the Western Shasta County and the Tehama County RCDs. To the east are the Fall River and Pit River RCDs, and to the west and north are the Trinity County and Shasta Valley RCDs.

- **Delta Vision –** The Delta Vision process was initiated in 2006 by Executive Order S-17-06, issued by California Governor Arnold Schwarzenegger to develop a durable vision for sustainable management of the Sacramento–San Joaquin Delta. The Delta Vision Blue Ribbon Task Force released a final report, *Our Vision for the California Delta* (2008), and a strategic plan to implement the vision is scheduled for release by October 2008. The vision seeks to integrate the values of ecosystem function and water supply, ensure that conservation and construction both occur, and develop effective systems of storage and conveyance of water.

- **Bay Delta Conservation Plan** – A comprehensive conservation plan is being developed for the Sacramento–San Joaquin Delta. Conservation strategy options incorporate the structural approach to convey water for environmental and water supply purposes along with habitat restoration opportunities in the Delta and Suisun Marsh. Four conservation strategy options have been developed and are undergoing further evaluation. A larger, more comprehensive conservation plan will be developed once a preferred option is selected; it will be evaluated through a formal public environmental review process under NEPA/CEQA.

- **Other Private Organizations –** Other private organizations active in the Primary Study Area and involved with fisheries and watershed restoration include the following.
  - Battle Creek Watershed Conservancy
  - Butte Creek Watershed Conservancy
  - California Friends of the River Organization
  - California Trout
  - Cantara Trustee Council
  - Sacramento River Preservation Trust
  - Sacramento River Watershed Program
  - Sacramento Watersheds Action Group
  - Shasta Land Trust
  - The Nature Conservancy
  - The Trust for Public Land

Existing Agreements

The following existing agreements affect the NODOS Investigation.

- **Clean Water Act Section 404 Memorandum of Understanding**–The CALFED ROD includes a Memorandum of Understanding (MOU) between Reclamation, the EPA, the U.S. Army Corps of Engineers (Corps), and DWR regarding compliance with Section 404 of the Clean Water Act (CWA). Although the Corps cannot issue a 404 Permit based on the programmatic investigations, the signatories agreed that the programmatic evaluations contribute to the overall Section 404 evaluations.
- **Sites Reservoir Memorandum of Understanding**–Directed by the CALFED ROD to develop a joint planning program through an MOU, DWR, Reclamation, 12 local water interests, and three other Federal and State of California agencies signed an MOU in 2000 to investigate offstream storage north of the Delta.

This page left blank intentionally.

Chapter 2
Need for Additional Water Storage North of the Delta

This chapter describes the problems, needs, and opportunities that serve as the basis for the NODOS Investigation, the planning objectives that were developed, and the planning principles and constraints that will further guide the plan formulation process.

Identification of Problems, Needs, and Opportunities

Problems and opportunities associated with additional storage north of the Delta have been considered in several prior studies. In 2001, the CALFED ROD (CALFED, 2000b) identified specific programmatic problems, needs, and opportunities, affirming the need for action. The CALFED ROD identified the following primary concerns:

- Water supply and water supply reliability;
- Survival of anadromous fish and other aquatic species; and
- Delta water quality.

Public Scoping Process

The P&Gs (WRC, 1983) and NEPA both require that interested and affected agencies, groups, and persons be provided opportunities to participate throughout the planning process, as stated in the P&Gs, Section IV.1.4.3. Specifically, "planning should include an early and open process termed 'scoping' to identify the likely significant issues to be addressed and the range of those issues," as stated in the P&Gs, Section IV.1.4.8, which is complementary with CEQA/NEPA regulations (40 CFR Parts 11500-1508). For the present study, the initial step in identifying the problems, needs, and opportunities specific to the NODOS project was a public scoping effort to solicit public and stakeholder input. On November 5, 2001, the Notice of Preparation (NOP) was filed with the State Clearinghouse, and on November 9, 2001, the federal Notice of Intent (NOI) was published in the *Federal Register*. The formal scoping process for the NODOS Investigation began with the publication of the NOP and NOI and concluded on February 8, 2002. During the 2001-2002 scoping period, one Tribal and three public scoping meetings were held.

The study team received 57 comments that addressed program alternatives. Some comments were specific suggestions related to the types or range of alternatives, such as water-use efficiency, conjunctive use, land fallowing, wastewater reclamation and recycling, and Shasta reservoir enlargement, which should be considered in the environmental documents. Others discussed more generally what alternatives should or should not be developed or what some of the possible benefits or impacts might be for certain alternatives. A complete summary of the comments received during the scoping period can be found in the Scoping Report (Reclamation and DWR, 2002).

Water Supply and Water Supply Reliability: Problems, Needs, and Opportunities

According to the *California Water Plan Update 2005: A Framework for Action* (DWR, 2005a):

> The biggest challenge facing California water resources management remains making sure that water is in the right places at the right time. This challenge is greatest during dry years: When water for the environment is curtailed sharply, less water is available from rainfall for agriculture and greater reliance on groundwater results in higher costs for many users. In the mean time, those who have already increased water use efficiency may find it more challenging to achieve additional water use reductions.

The challenge is especially acute and consequences are exacerbated during multiple dry years, as evidenced by the 1976-77 and 1987-92 droughts.

Water Demand

The *California Water Plan Update 2005: A Framework for Action* (DWR, 2005a) evaluated three scenarios for water demand changes between 2000 and 2030. All three scenarios indicate an additional 1 to 2 MAF per year of water will be needed by 2030 to stop groundwater overdraft statewide. According to on of those scenarios, the Current Trends Scenario, population in California is expected to grow by 41 percent between 2000 and 2030. The greater urban water demand predicted under all three scenarios presents considerable challenges to water planners. If future factors influencing water demand resemble the Current Trends Scenario, California will have to offset an additional 3.5 MAF of urban and environmental water demand each year with a combination of management strategies to reduce demand, improve system efficiency, and redistribute and augment supplies. The ability to transfer water from the Central Valley to southern California could be constrained by existing conveyance facilities, area-of-origin issues, environmental impacts, and other third-party effects.

According to the Sacramento River Hydrologic Regional Report in the *California Water Plan Update 2005: A Framework for Action* (DWR, 2005a), the population of the Sacramento River and San Joaquin River Basins in the Central Valley is expected to increase from approximately 4.3 million people in 2000 to about 8 million by 2030. The PPA in the CALFED ROD identified a need for up to 6 MAF of new storage in California, including up to 3 MAF of storage north of the Bay-Delta.

The Sacramento River region water balance summary was reviewed for water years 1998, 2000, and 2001 in the *California Water Plan Update 2005: A Framework for Action* (DWR, 2005a). These years represent 168 percent of normal precipitation (1998), 105 percent of normal precipitation (2000), and a dry 67 percent of normal precipitation (2001) for the region. The review indicates that water in storage increased in 1998, but both surface and groundwater storage were depleted in 2000 and 2001. The regional and statewide water summaries indicate that both the Sacramento region and the State of California rely on carry-over storage even in normal precipitation years (DWR, 2005a). Details on the statewide change in total storage (surface and groundwater) are provided in table 2-1; this table shows a total storage change of -5.7 MAF for normal years (2000 data) and -14.3 MAF for dry years (2001 data).

Table 2-1. California Water Balance Summary (MAF)

	Water Year (Percent of Normal Precipitation)		
	1998 (168%)	**2000 (105%)**	**2001 (67%)**
Water Entering California			
Precipitation	329.6	187.7	139.2
Inflow from Oregon/Mexico	2.3	1.7	1.1
Inflow from Colorado River	5.0	5.3	5.2
Imports from Other Regions	N/A	N/A	N/A
Total	336.9	194.7	145.5
Water Leaving California			
Consumptive Use of Applied Water[1] (Agricultural, M&I, Wetlands)	22.5	27.9	27.8
Outflow to Oregon/Nevada/Mexico	1.6	0.9	0.7
Exports to Other Regions	N/A	N/A	N/A
Statutory Required Outflow to Salt Sink	43.8	28.0	13.9
Additional Outflow to Salt Sink	73.0	37.1	17.7
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Agricultural Effective Precipitation & Other Outflows	190.5	106.5	99.7
Total	331.4	200.4	159.8
Storage Changes in California			
[+] Water Added to Storage			
[−] Water Removed from Storage			
Change in Surface Reservoir Storage	7.2	-1.3	-4.6
Change in Groundwater Storage[1]	-1.7	-4.4	-9.7
Total	5.5	-5.7	-14.3

Table 2-1. Continued

	Water Year (Percent of Normal Precipitation)		
	1998 (168%)	**2000 (105%)**	**2001 (67%)**
Applied Water[2] (compare with Consumptive Use)	33.9	41.8	41.2

Source: DWR, 2005a, table 1-2.

Notes:

[1] Change in groundwater storage is based on the best available information. Basins in the northern part of California (North Coast, San Francisco, Sacramento River, and North Lahontan regions and parts of the Central Coast and San Joaquin River regions) have been modeled for spring 1997 to spring 1998, for the 1998 water year, and for spring 1999 to spring 2000, for the 2000 water year. All other regions and the year 2001 were calculated using the following equation, which does not include unknown factors, such as natural recharge and subsurface inflow and outflow:

[2] Consumptive use is the amount of applied water used that is no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

GW change in storage = intentional recharge + deep percolation of applied water + conveyance deep percolation - withdrawals

Key:

DWR = California Department of Water Resources

GW	=	groundwater
M&I	=	municipal and industrial
MAF	=	million acre-feet
N/A	=	not available

Water Supply

The Sacramento region's CVP contractors and settlement contractors are subject to dry-year deficiencies and are especially vulnerable to droughts. During extended droughts, decreased surface water deliveries will eventually force water users to use groundwater, if they have this capability, to replace surface-water supply or to remove agricultural acreage from production (DWR, 2005a). Additional use of groundwater supplies during droughts may result in adverse impacts on the groundwater resource, as well as adverse impacts on regular users of groundwater (DWR, 2005a).

During extended periods of drought in the Sacramento River hydrologic region, local water districts that rely exclusively on surface-water supplies will encounter insufficient supplies. The reasons for this insufficiency include allocation cutbacks imposed by their CVP and SWP water contracts, direct diversions that often conflict with the needs of sensitive species, and the reduction in the length of the diversion period.

There is growing concern among scientists and water managers regarding the potential impacts of global warming on California's water resources. One of the more considerable impacts identified is related to California's reliance on Sierra and Trinity snowpack storage. Estimates indicate that a rise of 3 degrees Celsius (ºC) in California would result in the loss of snow at lower elevations by as much as 1,500 feet, with a corresponding loss of up to 5 MAF of April 1 snowpack storage (DWR, 2005a).

In the Sacramento River hydrologic region, high precipitation levels result in major water supplies being provided by surface-water storage reservoirs and groundwater (DWR, 2005a). The CALFED ROD (CALFED, 2000b) specifically addressed the linkage of surface water storage to the successful implementation of all other elements of CALFED:

> Expanding water storage capacity is critical to the successful implementation of all aspects of the CALFED Program. Not only is additional storage needed to meet the needs of a growing population, but, if strategically located, it will provide much needed flexibility in the system to improve water quality and support fish restoration efforts. Water supply reliability depends upon capturing water during peak flows and during wet years, as well as more efficient water use through conservation and recycling.

Over the past decade, protective actions, including the CVPIA and the *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (SWRCB, 1995), have reduced the ability of the SWP and CVP to contribute to statewide water supply reliability. CALFED has estimated that these two protective actions have reduced water contract deliveries by over 1 MAF annually during dry periods.

Following is a general listing of water supply and water supply reliability benefits that can be supported directly by NODOS.

Agricultural water supply reliability:

- Local agricultural water districts;
- SWP contractors; and
- CVP contractors.

Environmental water supply reliability:

- Replace EWA or similar program north-of-Delta purchases; and
- Sacramento and San Joaquin Valleys Level 4 Refuge water supply.

Municipal and industrial water supply reliability:

- CVP contractors; and
- SWP contractors.

A more extensive listing of water supply and water supply reliability beneficiaries is possible by adding a NODOS facility. However, the listing provided represents only those potential benefits evaluated in this report.

Water Supply Reliability

Water supply reliability is defined as delivering a specific quantity of water with a determined frequency to a particular location at a particular time. It indicates an acceptable level of dependability (e.g., timing) of water delivery to the people receiving it. Water supply reliability is one of CALFED's four primary interrelated objectives. Water supply reliability integrates the water supply elements of storage, conveyance, and quality. Local, regional, California, and federal governments and water suppliers all have a role in assuring water resource sustainability and improving water supply reliability for the existing and future population and the environment.

Water supply reliability in the upper Sacramento River and northern Sacramento Valley is complicated by the consistent and expedited delivery of water to downstream environmental, agricultural, and urban users. Present conditions along the upper Sacramento River periodically delay the delivery of water (DWR, 2005a).

As competition grows among water users, management of the highly constrained and regulated water system becomes more challenging and complex. The following situations can occur during long or extreme droughts.

- Water supplies are less reliable, heightening competition and sometimes leading to conflict among water users.
- Water quality is degraded, making it difficult and costly to bring raw water up to drinking water quality standards.
- Business and irrigated agriculture are adversely affected, jeopardizing California's economy.
- Ecosystems are strained, risking sensitive and endangered plants, animals, and habitats.
- Groundwater levels decline, and many rural residents who are dependent on small water systems or wells cannot access water from their wells.

The NODOS Investigation focuses on the use of offstream storage to provide additional water supply and improve reliability. Water stored in the winter during higher flow conditions in the Sacramento River would be available for use throughout the year. In addition, increased storage allows more water to be carried over in storage from year to year. Additional water in storage is especially helpful in mitigating the effects of drought or multiple dry years.

Survival of Anadromous Fish and Other Aquatic Species: Problems, Needs, and Opportunities

Anadromous Fish

An anadromous fish spawns in freshwater and spends part of its lifecycle in brackish or salt water. Sacramento River system anadromous fish include native species, such as steelhead, North American green sturgeon, and four runs of Chinook salmon, as well as introduced species, such as striped bass and American shad. Loss of riparian habitat, the operation of dams and pumping facilities, polluted runoff, and changes in geomorphology have negatively affected anadromous fish and other aquatic species in the Sacramento River hydrologic region. The following fish species are among those affected by water operations in the Sacramento River and Bay-Delta:

- Chinook salmon – Sacramento River Winter-Run distinct population segment (DPS) (Federal and California Endangered Species);
- Delta smelt (Federal and California Threatened Species);
- Steelhead – California Central Valley evolutionary significant unit (ESU) (Federal Threatened Species);
- Chinook salmon – Central Valley Spring-Run ESU (Federal and California Threatened Species);
- North American green sturgeon – southern DPS – (Federal Threatened Species and California Species of Special Concern);
- Sacramento splittail (California Species of Special Concern); and
- River lamprey (California Species of Special Concern).

Biological Opinions for these species affect water supply operations. Non-listed fish species that also may be affected by water operations include:

- Striped bass;
- Pacific lamprey;
- White sturgeon; and
- American shad.

Several non-fish species, such as the western pond turtle and the valley elderberry longhorn beetle (VELB), may be affected by systemwide water operations. Both are Federal and California Endangered Species that depend on riparian habitat in the Delta and Sacramento River.

The CVPIA (U.S. Department of the Interior, 1999) redefined the purposes of the CVP and required the dedication of 800,000 AF annually to the Anadromous Fish Restoration Program (AFRP), which includes a goal of doubling the population of anadromous fish and the restoration of fish, wildlife, and habitat purposes. In addition, between 368 TAF and 815 TAF of water normally diverted into the Central Valley were redirected to remain as instream flows on the Trinity River. The CVPIA also directed Reclamation to obtain water from willing sellers for use on wildlife refuges identified in the *Evaluation of Groundwater Potential for Incremental Level 4 Refuge Water Supply* (Reclamation, 2004a) and the San Joaquin Basin Action Plan [CVPIA Section 340b(d)]. The water to be obtained amounted to approximately 422 TAF of Level 2 water (which is considered a firm supply to meet current management needs) and 133 TAF of Level 4 water (Reclamation, 2004a). The water was to provide an additional refuge water supply to achieve an optimal supply for full habitat development.

For a period after the primary water dams were built in California, reservoirs were kept relatively full, and the cold water released from the hypolimnion (the cold, non-circulating layer of water that lies below the thermocline in a thermally stratified lake) provided cooler summer water in the downstream reaches.

Temperatures in the Sacramento River for spawning areas below Keswick Dam must be kept near 56 degrees Fahrenheit (°F) to allow salmon and steelhead incubation and smolt survival. Experts disagree on the range of temperatures that various ESUs of salmon need for survival in different life stages. These requirements are further complicated by the number of different species inhabiting the spawning area and the life stage of each of these species. For instance, Central Valley steelhead have different freshwater incubation and rearing requirements than do several salmon species because steelhead require longer periods in fresh water. Thus, juvenile steelhead may be present in the Sacramento River spawning grounds when fall-run Chinook salmon are beginning to spawn, and each may have independent water supply and water quality needs.

Since the early 1980s, reservoirs have been drawn down further because of increased water demands, resulting in warmer water releases and higher egg mortality rates. The warmer water temperatures have especially harmed winter-run Chinook salmon, which spawn in spring and summer. To address this problem, special modifications were made to Shasta Dam to allow for the release of cooler water from the hypolimnion, even when water levels in the reservoir are drawn down. The CALFED ERP seeks to acquire new sources of water to improve conditions for the spawning, rearing, and migration of myriad fish species in the Sacramento River and the Delta. Further needs exist to reduce the impacts of water diverted from the Sacramento River and to provide cooler water for fish spawning habitat.

Four seasonal runs of Chinook salmon occur in the Sacramento River drainage area, with each run being defined by a combination of adult migration timing and spawning, juvenile residency, and smolt migration periods. Facilities constructed to support water diversions cause straying or direct losses of fish and can increase the exposure of juvenile fish to predation.

The NODOS Investigation will address the ability to change systemwide operations, including operations associated with the Upper Sacramento River, to improve flows for anadromous fish migration and provide cooler water for fish spawning habitat.

Ecosystem Restoration

As part of CALFED, the ERP has developed an integrated systems approach that aims to reverse the fundamental causes of decline in fish and wildlife populations by recognizing the natural forces that created historic habitats and using these forces to help regenerate habitats. The ERP has identified more than 600 programmatic actions to improve ecological health. The ecosystem restoration measures considered for NODOS are not restricted to meeting the ERP objectives; however, implementing the measures in a way that achieves the ERP objectives will notably enhance the benefits to fish and other aquatic species. The NODOS planning team identified ERP objectives that can be supported by implementing a NODOS project. The team prioritized actions with input from a Sacramento River Flow Regime Technical Advisory Group, which included environmental advocacy groups, academics, and representatives from Federal and California water resource and wildlife agencies.

Considerable benefits to fish and other aquatic species can be achieved by accomplishing the ecosystem restoration objectives identified through the CALFED ERP (CALFED, 2000c and 2000d). Furthermore, NODOS can benefit anadromous fish and other aquatic species by providing additional flows in the Sacramento River for environmental purposes and increasing the cold water storage pool at Shasta Lake. Ecosystem restoration actions supported by NODOS initial alternatives include the following.

- Improve the reliability of cold-water carry-over storage at Shasta Dam.
- Increase supplemental flows for cold water releases for salmon and steelhead between Keswick and RBDD.
- Reduce diversions at Red Bluff to provide water into the TC Canal and at Hamilton City to provide water into the GCID Canal during July, August, and September. The priority is to reduce diversions at Glenn-Colusa Irrigation District (GCID). This concept is designed to minimize diversion effects to fish during critical fish migration periods.
- Improve the reliability of cold water carry-over storage at Folsom Reservoir and stabilize flows in the American River.
- Modify spring flows into a “snowmelt pattern” in years with peak storm events in late-winter and early-spring, from Red Bluff to Colusa.

The snowmelt pattern would be designed to increase the success of cottonwood cohorts.

- Stabilize fall flows to avoid abrupt reductions from Keswick to Red Bluff (assumes 6,000-cfs target from October through January and 4,500-cfs target for September). This concept is designed to avoid adverse conditions for spawning fall-run Chinook salmon (i.e., egg desiccation).
- Provide a flow event by supplementing normal operating flows from Shasta and Keswick Dams in March during years when no flow event has occurred during winter or is expected to occur.
- Provide a March Delta outflow from the natural late-winter and early-spring peak inflow from the Sacramento River. This outflow should be at least 20,000 cfs for 10 days in dry years, at least 30,000 cfs for 10 days in below-normal water years, and 40,000 cfs for 10 days in above-normal water years.
- Provide a minimum flow of 13,000 cfs on the Sacramento River below Sacramento in May of all but critical years.

Delta Water Quality: Problems, Needs, and Opportunities

According to the *California Water Plan Update 2005: A Framework for Action* (DWR, 2005a), more than 10 percent of the total miles of California's rivers and streams, and about 15 percent of its lake acreage, are listed as impaired. Groundwater samples analyzed from all 10 hydrologic regions (as designated in the California Water Plan [DWR, 1998]) indicated that 5 percent to 42 percent of public water-supply wells exceeded one or more drinking water standards, depending on the region. Seawater intrusion in the Delta and in coastal aquifers, agricultural drainage, and imported Colorado River water are considered potential causes of increased salinity in all types of water supplies, adversely affecting many beneficial uses. Degraded water quality limits the uses of water supply and increases treatment costs.

Improved water quality in the Bay-Delta is needed for drinking water, agriculture, and environmental restoration. *Our Vision for the California Delta (*Delta Vision Blue Ribbon Task Force, 2008) emphasized the need for California to encourage equitable access to higher quality water sources and to seek to reduce conflict among water users for diversion from the highest water quality locations. This report also emphasized the importance of meeting water quality standards in both storage and conveyance systems. The composition requirements of each end use vary, but the guiding elements of a Bay-Delta water quality "needs assessment" are salinity, toxins, and drainage.

The Bay-Delta system is the diversion point for drinking water for millions of Californians, and it is critical to California's agricultural sector. Typically, the months of April through July are most favorable with respect to the Delta as a source of drinking water. Outflow from natural runoff is usually high enough during this period to push seawater out of the Delta. This period is also outside of the peak loading time related to agricultural drainage. Addressing fishery concerns has resulted in a shift in exports from these higher quality spring months to the typically lower quality fall months, with the corresponding degradation in delivered water quality.

All Delta fisheries are sensitive to a variety of water quality constituents. For example, Delta smelt require a water source with an electrical conductivity measurement (ECw) of less than 12,000 ECw to reproduce. The X2 salinity gradient, a Delta management tool, is defined as the distance in kilometers from the Golden Gate Bridge to where the tidally averaged near-bottom salinity is 2 parts per thousand. SWRCB D-1641 requires X2 implementation from February to June to improve habitat protection for fish in the Delta. The intent of the X2 requirement is to maintain adequate transport flows to move Delta smelt away from the influence of the CVP/SWP water diversions and into low-salinity rearing habitat in Suisun Bay and the lower Sacramento River. It is hypothesized that the survival of Delta smelt increases as the X2 moves past Collinsville and downstream toward San Francisco Bay. In addition, the ideal temperature of Delta water for Delta smelt is 71.6°F, but they cannot survive if water temperatures exceed 77°F. Accordingly, there is a need to provide fresh water of sufficient quality and temperature to meet biological needs, such as those of the Delta smelt. The NODOS Investigation is evaluating the methods to improve water quality by providing increased flows of high quality water during periods when water quality is impaired. This would be achieved by increased releases from other reservoirs and/or releases directly from NODOS to the Sacramento River.

Hydropower Generation: Problems, Needs, and Opportunities

According to the California Energy Commission (CEC), California's electrical peak demand is caused largely by summertime air conditioning loads. Traditionally, loads are served by natural-gas-powered electrical generating facilities, but responsiveness programs using alternative forms of energy creation may be effective in balancing supply and demand. Hydropower is most abundant during winter and spring because its existence is typically tied to increased flows on major waterways. A NODOS project would use power during times of relative abundance and produce relatively clean hydropower during times of scarcity.

As population increases in the Sacramento Valley and throughout California, demands for electricity will continue to grow. This demand for electricity drives the need for new electrical supplies, such as hydropower, or demand responsiveness programs, such as off-peak pumping at power generating facilities. While offsetting the power needs of offstream storage pumping, the NODOS Investigation will explore the ancillary benefits that hydropower generation can offer to the statewide power grid.

Recreation: Problems, Needs, and Opportunities

Recreation in the Primary Study Area includes hiking, fishing, camping, boating, mountain biking, and off-road vehicle use. Generally, large metropolitan areas, such as nearby Sacramento, have high demands for water-oriented recreational opportunities. Some of these demands are served by reservoirs on the western slope of the Sierra Nevada. However, as population increases in the Sacramento Valley, demands for flat water, river, and land-based recreation are expected to increase.

Flood-Damage Reduction and Emergency Water Delivery: Problems, Needs, and Opportunities

Improvements to the water management system may provide opportunities to increase flood protection through better coordination of the reservoirs in the Sacramento Valley region. Even as an offstream reservoir with substantial diversion capabilities, the Sites Reservoir complex cannot remove enough water from the Sacramento River during high flow events to meaningfully affect flood damage reduction efforts downstream. Rather, Sites Reservoir may allow for additional flood reservation storage at other onstream reservoirs within the region. The flood reservation space of Folsom, Oroville, and Shasta could be increased, and the water supply commitments from those onstream reservoirs could be met by an offstream Sites Reservoir.

In case of a levee failure in the Delta, Sites Reservoir might be able to release water to help mitigate the damage by providing freshwater to move or help stabilize the intrusion of seawater into the Delta. The relative location of a Sites Reservoir equipped with a direct conduit to the Sacramento River would allow the water released from Sites Reservoir to reach the Delta almost two days sooner than water released from Lake Shasta.

Planning Objectives

The primary and secondary planning objectives for the NODOS Investigation are based on the identified problems, needs, and opportunities. These planning objectives incorporate national and study-specific objectives.

National Goals

The primary national goal of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the nation’s environment, pursuant to national environmental statutes, and applicable Executive Orders and other Federal planning requirements. Regional, environmental, and social effects also are considered in the Federal planning process.

California Goals

In addition to the national goals and requirements, California's objective for the feasibility study is to provide technical and financial information to implementing agencies. Key factors agencies must consider are whether the NODOS project can be implemented to assure public health and safety and whether it can provide statewide benefits (e.g., water supply reliability, water quality, ecosystem restoration) at a reasonable cost. In the California process, a feasibility study and an EIR are required for project environmental compliance under CEQA and to identify permitting and mitigation requirements. Reclamation and DWR are preparing a joint EIS/EIR for the NODOS Investigation.

Specific Planning Objectives

On the basis of the identified problems, needs, and opportunities in the Primary Study Area, three primary and three secondary planning objectives were developed to guide the formulation of solutions, in the form of alternatives plans. Primary planning objectives are the first priority that alternatives must address; secondary objectives are to be fulfilled by opportunities that should be considered in the plan formulation process, to the extent possible, in meeting the primary objectives.

In summary, the following problems, needs, and opportunities have been determined for the NODOS Investigation.

- Demand for current and future water supplies and water supply reliability has increased.
- Dams, levees and diversions have affected the survivability of anadromous fish and other aquatic species.
- Water quality in the Delta has become increasingly degraded.
- Opportunity exists to provide ancillary hydropower generation benefits to the statewide grid.
- Opportunity exists to provide additional recreation in the Sacramento Valley.
- Opportunities may exist to increase flood protection in the Sacramento Valley through improvements in the water system.

Primary Planning Objectives – Alternatives will be formulated to address the following objectives:

- Increase water supplies to meet existing contract requirements, including improved water supply reliability, and provide greater flexibility in water management for agricultural, M&I, and environmental users;

- Increase the survival of anadromous fish populations in the Sacramento River, as well as the survivability of other aquatic species; and
- Improve drinking and environmental water quality in the Delta.

Secondary Planning Objectives – To the extent possible, while meeting the primary planning objectives, the NODOS Investigation will recognize opportunities to accomplish the following:

- Provide ancillary hydropower benefits to the statewide power grid;
- Develop additional recreational opportunities in the Primary Study Area; and
- Create incremental flood-damage reduction opportunities in support of major northern California flood-control reservoirs.

Planning Principles

In addition to the specified objectives, constraints, and other criteria, planning principles result from regional policies, practices, and conditions. Several examples, reflected in this NODOS PFR, are for use in formulating, evaluating, and comparing alternatives. These principles include the following.

- Alternatives and their major elements are to be consistent with the identified planning constraints.
- A direct geographical, operational, and physical dependency must exist between major components of alternatives.
- Alternatives should address, at a minimum, each of the identified primary planning objectives and, to the extent possible, the secondary planning objectives.
- Measures to address secondary objectives should be directly or indirectly related to the primary objectives (that is, plan features should not be independent increments).
- Consideration should be given to recommendations in the CALFED ROD.
- Alternatives should avoid any reduction in flood protection or other adverse hydraulic impacts to areas downstream on the Sacramento River.
- Alternatives should either avoid potential adverse impacts to environmental resources or include features to mitigate unavoidable impacts.
- Alternatives should avoid potential adverse impacts to present or historical cultural resources or include features to mitigate unavoidable impacts.

- Alternatives should not result in a substantial adverse impact to existing or future water supplies, recreation facilities, hydropower generation, or related water resource conditions.
- Alternatives are to be evaluated based on a 100-year period of analysis.
- Costs for alternatives are to reflect current prices and price levels, and annual costs are to include the current federal discount rate and an allowance for interest during construction, operation and maintenance (O&M) costs, power costs, and major replacement costs.
- Alternatives are to be formulated to neither preclude nor enhance the development and implementation of other elements of CALFED or other water resources programs and projects in the Central Valley.
- Alternatives should have a high certainty of achieving the intended benefits and not greatly depend on long-term actions (after the initial construction period) for success.

Planning Constraints

The scope of the plan formulation process is limited by basic constraints specific to the NODOS Investigation, which include the following.

- **Study Authorizations –** As a result of increases in demands for water throughout California, both Reclamation and DWR have been provided authorizations and funding mechanisms for the NODOS Investigation. Congress provided NODOS feasibility study authority to Reclamation in the Consolidated Appropriations Act of 2003 (Public Law 108-7) and reaffirmed this authority in the CALFED Bay-Delta Authorization Act of 2004 (Public Law 108-361). State of California Proposition 204, “The Safe, Clean, Reliable Water Supply Act,” was approved in 1996 and provided funding for feasibility and environmental investigations of offstream storage projects upstream from the Delta. In addition, the State Budget Act of 1998 authorized DWR to continue feasibility and environmental studies pertaining to the Sites Reservoir and alternatives. Subsequent funding was allocated to DWR’s General Fund, as part of the CALFED Integrated Storage Investigations (ISI) program and in November 2002, Proposition 50, the “Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002,” was approved, authorizing funding for surface water storage planning and feasibility studies under CALFED. California funding derives from DWR’s general fund and from California bond funds.
- **Laws, Regulations, and Policies –** Laws, regulations, and policies that must be considered include, but are not limited to, NEPA, Fish and Wildlife Coordination Act, Clean Air Act, CWA, National Historic Preservation Act (NHPA), Federal Endangered Species Act (ESA), and CESA, CEQA, and the CVPIA. The CVPIA of 1992 (Public Law 102-

575) influences water supply deliveries, river flows, and related environmental conditions in the Primary Study Area and Extended Study Area.

- **CALFED ROD –** The CALFED ROD is a general framework for addressing CALFED. It includes program goals, objectives, and projects intended primarily to benefit the Bay-Delta system, its tributaries, and areas that receive water supplies exported from the Delta. In addition to the NODOS Investigation, the PPA in the CALFED ROD includes four other surface water and various groundwater storage projects to help meet water supply needs, improve water quality, stabilize Delta levees, and improve the ecosystem functions of the Bay-Delta system. Developed plans should incorporate the goals, objectives, and programs or projects of the CALFED ROD.
- **Reallocation of Contract Water Supplies –** Federal authorizations for the NODOS Investigation focus on CALFED-related storage studies to provide additional supply reliability and water management flexibility to support CALFED objectives. Federal authorizations do not provide authority to reallocate CVP water supplies among the long-term contractual commitments.

Planning Criteria

Planning criteria facilitate the formulation and evaluation of alternatives. The planning process identified in the P&Gs (WRC, 1983) includes the following four specific criteria for formulating and evaluating alternatives.

(1) **Completeness** is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to the realization of the contributions to the objective.

(2) **Effectiveness** is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

(3) **Efficiency** is the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the nation’s environment.

(4) **Acceptability** is the workability and viability of the alternative plan with respect to acceptance by California and local entities and the public and compatibility with existing laws, regulations, and public policies.

Potential Effects of the Alternative Plans (Benefits and Costs, P&G Accounts)

Potential effects are established to facilitate the evaluation and comparison of the estimated benefits and costs of the alternative plans consistent with the Federal P&Gs, in which they are described as the following four "accounts."

- **National Economic Development –** The NED account displays changes in the net economic value of the national output of goods and services.
- **Environmental Quality (EQ) –** The EQ account displays non-monetary effects on significant natural and cultural resources.
- **Regional Economic Development (RED) –** The RED account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income and employment.
- **Other Social Effects (OSE) –** The OSE account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

Information for the four accounts is limited and incomplete at this PFR phase of the feasibility study. Refinement of the alternatives and their potential effects will be accomplished and addressed in the feasibility report and EIS/EIR during the next phase of the feasibility study.

This page left blank intentionally.

Chapter 3
Resources and Conditions

This chapter defines existing and likely future resources and conditions for those resources in the study area and affected area. This chapter concludes with a discussion of likely future conditions without an implemented NODOS project.

Environmental Setting

The Primary Study Area is shown on figure 3-1. The Sacramento Valley includes Butte, Colusa, El Dorado, Glenn, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, and Yuba Counties. It is dominated by the Sacramento River and the surrounding mountain ranges. The Northern Coast Ranges to the west, the southern Siskiyou Mountains to the north, and the northern Sierra Nevada to the east define the valley’s shape. Most valley rivers are dammed and diverted to provide water for agriculture, industry, residences, and recreation.

Existing Principal Features and Infrastructure

Central Valley Project

Reclamation operates and maintains the CVP, which delivers about seven MAF of water annually to 253 CVP contractors. Initial Federal authorization of the CVP was included in the 1935 Rivers and Harbors Act, and construction began in the late 1930s. When the Rivers and Harbors Act was reauthorized in 1937, Reclamation took over CVP construction and operation with three project purposes:

- To regulate rivers and improve flood control and navigation;
- To provide water for irrigation and domestic use; and
- To generate power.

Under later reauthorizations and through legislation for specific project additions, more project purposes were added, including recreation, fish and wildlife enhancement, and water quality improvements. The CVP supplies irrigation water to the Sacramento and San Joaquin Valleys, to industries in Sacramento, to cities and industries in the eastern and southern San Francisco Bay area, and to fish hatcheries and refuges throughout the Central Valley. The

This page left blank intentionally.

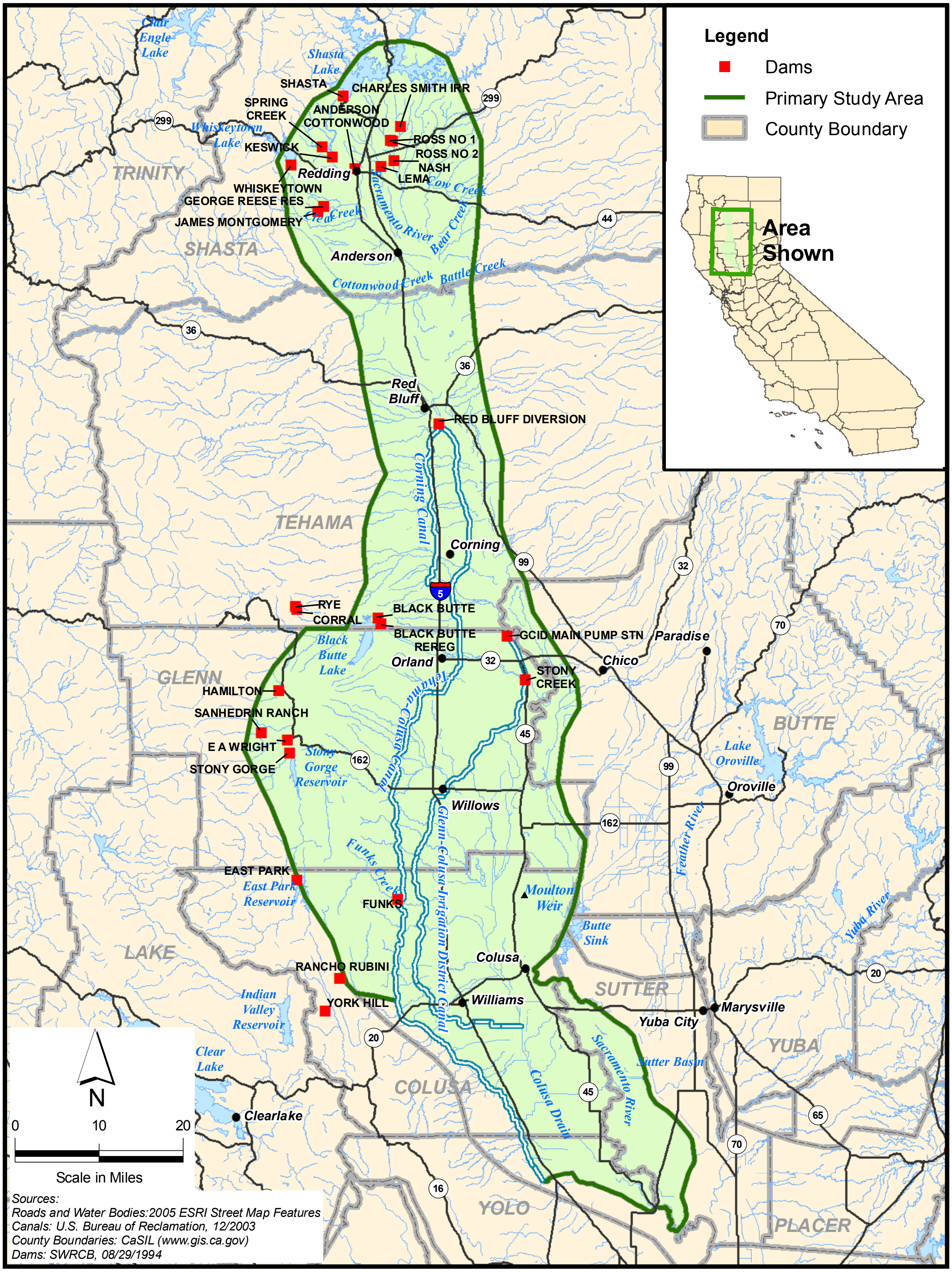


Figure 3-1. Primary Study Area

This page left blank intentionally.

CVP comprises 20 dams and reservoirs, 39 pumping plants, 2 pumping-generating plants, 11 power plants, and 500 miles of major canals, conduits, and tunnels. A major CVP plant in the south Delta is the Jones Pumping Plant, formerly the Tracy Pumping Plant, which conveys water to the Delta-Mendota Canal (DMC). The CVP supplies water for one-third of the agricultural land in California (about 5 million acres) and delivers water to meet the needs of 1 million households in California annually. For average years, the CVP delivers about 7 MAF annually for agricultural use (6.2 MAF), urban use (0.5 MAF), and wildlife refuge use (0.3 MAF) (DWR, 1998; Reclamation and DWR, 2003). The features of the CVP are described hereafter.

Shasta Dam and Reservoir

Shasta Dam and Reservoir are federally owned. Shasta Dam is a concrete, gravity dam on the Sacramento River, about 12 miles northwest of Redding. It controls floodwaters and stores surplus winter runoff for irrigation in the Sacramento and San Joaquin Valleys, maintains navigation flows, provides instream flows for the conservation of fish in the Sacramento River and water for M&I use, protects the Sacramento-San Joaquin Delta from the intrusion of saline ocean water, and generates hydroelectric power.

Shasta Dam is over 600 feet high and is the second largest dam (by mass) in the U.S. Shasta Lake has a capacity of more than 4 MAF and is the largest manmade reservoir in California. The Shasta Power Plant is below Shasta Dam on the Sacramento River. Shasta Reservoir delivers about 55 percent of the total annual water supply developed by the CVP.

Keswick Dam and Reservoir

Keswick Dam and Reservoir are federally owned CVP features. Keswick Dam is on the Sacramento River, about 9 miles downstream from Shasta Dam. It is a concrete gravity structure that contains a 23.8-TAF afterbay for Shasta Lake. The dam stabilizes the uneven water releases from the power plants and has a facility to trap migratory fish that operates with Coleman Fish Hatchery, 25 miles downstream on Battle Creek.

Red Bluff Diversion Dam

The RBDD is a federally owned CVP feature. The RBDD, a concrete gated-weir structure, is on the Sacramento River about 2 miles southeast of Red Bluff in Tehama County (figure 3-1). It diverts water from the Sacramento River to the Corning Canal and the TC Canal. The diversion capacity of the two canals is 3,030 cfs at the headworks.

RBDD operation affects upstream and downstream migrating fish. The dam releases water under the gates, which creates numerous areas of high velocity and turbulence. Although upstream-migrating adult salmonids are able to use the fish ladders, they often are attracted to these high-velocity areas below the dam, rather than the lower flows from the fish ladders. This can block or delay them on their spawning run, resulting in increased stress or mortality of the fish or potentially decreased egg production. The gates completely block any in-migrating green sturgeon because these fish are unable to use the fish ladders.

Sacramento pikeminnow and striped bass also are impeded and tend to congregate below the dam. Out-migrating juvenile salmonids and green sturgeon larvae have to travel either under the gates or down through the fish ladders. These juvenile fish can become disoriented after passing through the high flows under the gates, making them easy prey for Sacramento pikeminnow, striped bass, and other predators congregating downstream from the dam.

Reclamation initiated construction of a drum screen in 1969 and completed the screen in 1971. The screen was intended to prevent fish that passed through the headworks from entering the canals. A bypass system returned the fish to the river.

In 1987, Reclamation began opening the RBDD gates from December 1 until April 1 for winter-run salmon returning to spawn at spawning grounds below Keswick Dam. NOAA Fisheries Service’s inclusion of the winter-run Chinook on the list of threatened species prompted Reclamation to take further action (Reclamation, Undated). Reclamation completed a $17 million renovation of the dam in March 1990, which included a temporary fish ladder in the center of the dam for passage when the gates remained closed (Reclamation, Undated). Renovations did not immediately boost the Chinook population. In 1991, the adult winter-run Chinook count reached a record low of only 191 at RBDD (Reclamation, Undated). The population increased in 1992 and 1993, with counts of 1,180 and 341, respectively. The NOAA Fisheries Service redesignated the winter-run Chinook as endangered in December 1993 (Reclamation, Undated).

Lake Red Bluff

The RBDD, on the Sacramento River about 2 miles southeast of Red Bluff, is the source of Lake Red Bluff. It provides water from the Sacramento River for diversion to the Corning and TC Canals. The RBDD gates-in period, between May 15 and September 14, is implemented to raise Lake Red Bluff to an elevation of 252.5 feet. (When the RBDD gates are in, Lake Red Bluff is formed, and the water level is maintained at elevation 252.5 feet.) At this water level, the lake extends about 6 miles upstream through Red Bluff and contains about 3.9 TAF of water.

Corning Canal and Pumping Plant

The Corning Canal and Pumping Plant are federally owned. The Corning Canal (figure 3-1) diverts water from the TC Canal settling basin, about a half mile downstream from the RBDD, and the Corning Pumping Plant delivers water to locations in Tehama County that are too high to be served from the TC Canal. The Corning Canal is 21 miles long, terminating near Corning in Tehama County.

Tehama-Colusa Canal

The TC Canal is federally owned. The TC Canal receives water from the settling basin at RBDD (figure 3-1). The facilities include a drum screen complex to keep fish out of the canal.

The canal is 110 miles long and serves 14 water districts. Through an O&M agreement with Reclamation, the TCCA operates and maintains the TC Canal, in addition to the Corning Canal. The TC Canal travels south from the RBDD through Tehama, Glenn, and Colusa Counties and into Yolo County. It terminates about 2 miles south of Dunnigan in Yolo County. The initial capacity of the canal is 2,530 cfs, diminishing to 1,700 cfs at the terminus. Canal flows are regulated by Funks Reservoir, located along the canal about 66 miles downstream from RBDD. The canal capacity at Funks Reservoir is 2,100 cfs.

Funks Dam and Reservoir

Funks Dam and Reservoir are federally owned CVP features. Funks Reservoir is formed by an earth-filled dam on Funks Creek in Colusa County, about 7 miles northwest of Maxwell (figure 3-1). The reservoir can hold 2.25 TAF, with a surface area of 232 acres at an elevation of 205 feet. A 40-foot-high compacted earthfill dam impounds the reservoir on the east. The dam forms the downstream bank of the TC Canal as it crosses Funks Creek; it is used to regulate canal demands or releases.

The TC Canal runs through Funks Reservoir with an inlet at the northeastern end, adjacent to the dam spillway, and an outlet to the southeast. The spillway overflow discharge capacity is 25,000 cfs with all gates fully open. Because the watershed receives very little runoff, Funks Reservoir serves as an offstream regulatory reservoir filled by diversions from the Sacramento River via the TC Canal.

Black Butte Reservoir

Black Butte Reservoir, formed by an earth-filled dam, is on Stony Creek, west of Orland, about 24 miles west of the Sacramento River. It is north of Stony Creek, Stony Gorge, and East Park reservoirs (figure 3-1) and is owned and operated by the Corps. Although the Corps completed Black Butte Dam as a separate project in 1963, the Black Butte Integration Act of October 23, 1970, made the dam and reservoir a part of the CVP Sacramento River Division, as the Black Butte Unit.

State Water Project

DWR operates and maintains the SWP, which delivers water to 29 agricultural and urban contractors in the Central Valley, the San Francisco Bay area, the central coast, and southern California. The SWP delivers water for agricultural, municipal, and industrial uses, providing water to 20 million Californians and 660,000 acres of irrigated farmland. It comprises 20 pumping plants, 5 hydro-electric power plants, 33 storage facilities, and more than 660 miles of aqueducts and pipelines.

The SWP operates under long-term contracts with public water agencies from Sutter, Butte, and Plumas Counties in the north to Alameda, Santa Clara, and Napa Counties in the Bay area, through the San Joaquin Valley, and finally to southern California. These agencies, in turn, deliver water to wholesalers or retailers or deliver it directly to agricultural and urban water users. The SWP was designed to deliver about 4.2 MAF of water per year. The maximum that has been supplied in one year is 3.71 MAF (DWR, 1998; Reclamation and DWR, 2003).

SWP facilities include major diversion facilities and pumps (Clifton Court Forebay and Banks Pumping Plant) in the south Delta and the California Aqueduct, which extends from the south Delta to southern California (Reclamation and DWR, 2003). The features of the SWP are described hereafter.

Colusa Basin Drain

The Colusa Basin Drain (CBD), near Knights Landing, provides water for agriculture and other beneficial uses, including wildlife habitat and warm water fisheries (figure 3-1). It collects water from more than 450,000 acres of agricultural land and diverts water from irrigation district canals. The Colusa Drain Mutual Water Company operates the CBD.

Runoff from 11 streams draining the foothill and valley floor watersheds contributes flow to the CBD. The CBD flows southward through Glenn, Colusa, and Yolo Counties and enters the Sacramento River at Knights Landing. The Sacramento River levee system serves to isolate the historic Colusa Basin drainage system except when flood flows on the Sacramento River exceed 300,000 cfs near Ord Ferry. In general, the drain conveys flood flows from November through March and agricultural irrigation and drainage flows from April through October. The northern half of the CBD does not have levees. Beginning south of Colusa, left bank levees extend southward to the drain’s confluence with the Sacramento River. Reclamation Districts 787 and 108 pump the drainage from interior lands that are surrounded by levees to either the Sacramento River or the CBD. The drainage area at State Route (SR) 20 is 973 square miles, and the average annual runoff is 497 TAF.

Glenn-Colusa Irrigation District Canal

The Glenn-Colusa Irrigation District (GCID) owns, operates, and maintains the GCID Canal, a 65-mile-long irrigation canal that supplies water from the Sacramento River (figure 3-1). The water moves into a complex system of more than 900 miles of laterals and drains for delivery to more than 1,200 farms on about 141,000 acres of agricultural land. In addition, GCID delivers water to 20,000 acres of wildlife habitat in the Sacramento, Delevan, and Colusa National Wildlife Refuges (NWRs).

GCID's Hamilton City pump station is at the headworks of the GCID Canal, about 100 miles north of Sacramento. The pump station is on an oxbow off of the main stem. Water passes through the fish screens, where a portion of it is pumped into GCID's main irrigation canal. The remaining flow in the oxbow passes by the screens and then back into the main stem of the Sacramento River.

GCID diverts a maximum of 3,000 cfs from the Sacramento River, with the peak demand in the spring, often at the same time as the peak out-migration of juvenile salmon. GCID, in partnership with Reclamation, completed fish screens at its Hamilton City pump station in 2000. The Corps built a gradient facility on the mainstem to restore and stabilize the river channel and surface water elevations at the fish screen to improve fish passage conditions and screen performance.

Moulton Weir

Operated by DWR's Division of Flood Management, the Moulton Weir is located along the eastern side of the Sacramento River, less than one mile from the historic community of Stegeman. It consists of 46 acres in Colusa County, 10 miles north of Colusa. Under flood-stage conditions, the Moulton Weir allows Sacramento River water to flow overland to the southeast, toward the Butte Sink.

Geology and Soils

Geology

The NODOS Investigation focused on the eastern portion of the Coast Range Geomorphic Province and the northwestern portion of the Great Valley Geomorphic Province.

The Coast Range Geomorphic Province is characterized by a series of north-northwest trending ranges and valleys; few are continuous for more than 100 miles. The province extends about 600 miles from Point Arguello north to the Klamath Range (Norris and Webb, 1990) and varies in width from a few miles to 70 miles.

The Great Valley Geomorphic Province is an almost flat alluvial plain extending from the Tehachapi Mountains in the south to the Klamath Mountains in the north, to the Sierra Nevada in the east and the Coast Ranges in the west. This northwest-trending, asymmetrical structural trough has been filled with a thick accumulation of sediments eroded from the adjacent ancestral Sierra Nevada and Klamath Mountain ranges from the Jurassic to the present. It has a long stable eastern shelf supported by subsurface granite and a short western flank with basin sediments. The western edge has eroded to form a series of northwest-trending, eastward-dipping ridges of sandstone and conglomerate separated by valleys underlain by siltstone and mudstone.

Soils

Soils in the Coast Range foothills are a byproduct of typical erosional processes of the underlying sedimentary rocks. Typical foothill soils are shallow to deep, generally well-drained, with a fine to medium texture. Soil depth on steep slopes is moderate to very thin; slightly weathered sandstone and intensely weathered mudstone can be encountered within just a few inches of the surface. Soil depth increases on the gentler slopes, generally reaching maximum thicknesses along valley bottoms. These deeper soils are more developed, moderately drained, and finer-grained; organic material is more common in the low-lying deeper soils.

Soils in the Sacramento Valley are a byproduct of the underlying weathered alluvial deposits. Most valley soils are alluvial silt loams, clays, and sands deposited by the Sacramento River and tributaries draining the west side of the valley. These soils are typically very deep to moderately deep, poorly drained, fine-textured.

Most of the alluvial soils on the valley floor have high agricultural productivity and are largely designated as Prime agricultural soils. Some soils are limited in their ability to support many forms of agriculture because of alkali problems or drainage problems caused by the presence of a cemented-hardpan layer. These poorly drained soils are particularly well suited for growing rice.

Hydrology

The Sacramento River is the major surface water resource of the Valley; it carries roughly a third of California’s total runoff water. Its headwaters start near Mount Eddy and flow into the Delta. Several major rivers, such as the Pit, McCloud, Feather, Yuba, and American Rivers, drain into the Sacramento River. Part of the Trinity River flow also is diverted to the Sacramento River. Numerous small and large streams flow into the Sacramento River. Precipitation in this region is unevenly distributed within each water year, with most occurring during the winter and least during the summer. The eastern mountain ranges and high plateau regions of the Sacramento River Basin receive large amounts of precipitation as winter snow. The snowmelt is collected in reservoirs near the headwaters of the Sacramento River and all of the major rivers that drain into it. These reservoirs provide water flow during the dry summers and flood control for the Sacramento Valley during heavy rainfall periods (DWR, 2005a). In addition to the natural streams, the GCID and TC Canals, discussed previously under Existing Principal Features and Infrastructure, have a considerable impact on regional hydrology.

The primary hydrologic features of the Primary Study Area are discussed hereafter.

Sacramento River from Keswick to Colusa

Operation of Shasta Lake and the CVP has greatly changed the natural flow of the Sacramento River between Keswick and Chico Landing. Flood peaks are reduced in the winter and spring, and discharges are increased during the summer and fall for irrigation, to maintain instream flows, and for other uses.

The Sacramento River flood channel capacity between Red Bluff and Chico Landing is about 260,000 cfs. The flood channel capacity decreases to about 160,000 cfs downstream from Chico Landing, to about 135,000 cfs below Moulton Weir, and to about 66,000 cfs downstream from Colusa Weir. Floodwaters exceeding the channel capacity between Chico Landing and the Colusa Weir overflow into the Butte Sink area.

Diversions from the Sacramento River upstream from the Feather River average 1.7 MAF annually. Major diversions occur at the RBDD into the TC and Corning Canals and at the GCID's Canal at Hamilton City. Surface water demands along the Sacramento River between Red Bluff and Colusa are more than 2.3 MAF, including water supplies for Sacramento Valley refuges, agricultural activities, and urban uses.

Sacramento River from Colusa to Sacramento and the Sacramento-San Joaquin Delta

The Sacramento River channel downstream from Colusa differs considerably from the section between Keswick and Colusa. The gradient of the river decreases, the channel becomes deeper and narrower, its capacity is smaller, and it has finer bed material (Sacramento River Conservation Area Forum [SRCA], 2003). The river is contained by levees, with excess flow bypassed through spill at the Tisdale, Fremont, and Sacramento Weirs. The bypass flows go into the Sutter Bypass and the Yolo Bypass. The Feather River joins the Sacramento River at Verona, and the American River joins it at Sacramento. The Sacramento River then flows south, joining with the San Joaquin River in the Delta, and out to the Pacific Ocean.

Numerous flow requirements mandated for the Delta, to meet supply and water quality needs. When more than enough water is available in the Delta to meet all of the supply and water quality requirements, the Delta is considered to be in surplus.

Stony Creek

Stony Creek has a drainage area of 780 square miles at the mouth. It is the largest westside Sacramento River tributary between Cottonwood Creek and the CBD.

Funks Creek

Funks Creek flows into Funks Reservoir at the TC Canal. The drainage area of Funks Creek at Funks Dam is 43 square miles. No stream gauge has been placed at Funks Creek; therefore, no information on 100-year discharge is available.

Stone Corral Creek

Stone Corral Creek flows into the NODOS reservoir area. The USGS collected 25 years of stream discharge measurements near the town of Sites from 1958 through 1985 (with interruption). The 100-year discharge was established in a 1987 Colusa Basin flood flow frequency analysis as 7,870 cfs (DWR, 1987). The drainage area of the Stone Corral Creek watershed is 38.2 square miles.

Other Local Creeks

Many small tributaries are in the area considered by the NODOS Investigation. The headwaters of Grapevine Creek are on the western side of the NODOS reservoir area and flow north and into the reservoir area north of Sites-Lodoga Road. Grapevine Creek flows into Funks Creek about 7 miles upstream from Funks Reservoir. The headwaters of Antelope Creek are also on the western side of the NODOS reservoir area, just south of the headwaters of Grapevine Creek. Antelope Creek flows south, then east, and then north through the southern portion of the NODOS reservoir area and joins Stone Corral Creek near the town of Sites. To the north, Hunters Creek flows to the east. Southeast of the NODOS reservoir area is Lurline Creek, which flows to the east. Both Hunters and Lurline Creeks flow into the CBD.

Geomorphology and Sediment Transport

The geomorphology of the Sacramento River varies throughout the region. From the base of Mount Shasta for about 75 miles downstream, to near elevation 300, near the town of Red Bluff, the river is generally constrained from moving laterally by erosion-resistant volcanic and sedimentary formations.

The river in this area is generally narrow and deep, and the floodplain is similarly narrow. From here, the river emerges onto the broad alluvial floodplain of the Sacramento Valley. For the next 100 river miles or so, the Sacramento River historically meandered freely across a wide floodplain. It is generally a single-thread channel bordered by setback levees (California Bay-Delta Authority [CBDA], 2005).

Downstream from Colusa, the Corps and DWR have been stabilizing the channel with rock as part of their flood control responsibilities. Downstream from Sacramento, levees were constructed to confine flows to a relatively narrow channel that would efficiently convey sediment through the system, thereby reducing the dredging necessary to maintain navigation. Today, the Sacramento River downstream from the Primary Study Area is a leveed and largely straightened channel. The river does not meander as it did historically, but generally conveys flows downstream and into overflow bypass channels, as needed (CBDA, 2005).

The geomorphology and sediment transport capacity of the Sacramento River and Stony Creek are determined largely by the flow regime of each water-course. Diversions from these watercourses during the high-flow winter period, to fill off-site storage, could change the accretion and scour of gravels and sediments in the Sacramento River. Winter is an important period for sediment transport because this is when storms initiate gravel movement in the streams tributary to the Sacramento River. Shasta and Keswick Dams interrupt the sediment supply in the Sacramento River; therefore, the sediment from the tributaries is important for the river.

Water Quality

Surface Water Quality

The Sacramento River and its tributaries support fish and wildlife while providing water for drinking, irrigation, and recreation. Most of the water in the Sacramento River and its tributaries comes from snowmelt. This water usually enters the rivers by managed discharges from reservoirs. Because the snow has had little contact time with sediments and is relatively fresh, the Sacramento River and its tributaries generally have low concentrations of dissolved minerals. In some reaches of the river and tributaries, water quality is affected by local activities, such as runoff from agricultural or historical mining operations. Variable climatic conditions and variations in rainfall, coupled with competing demands for water, further affect the aquatic ecology of this basin. Management of the major rivers for the migration and reproduction of Chinook salmon and other anadromous fish is a major concern in the Sacramento River basin.

The SWRCB has conducted several toxicity surveys on different portions of the Sacramento River watershed. SWRCB's *Sacramento River Toxic Chemical Risk Assessment Profile* (SWRCB, 1990) indicated that beneficial uses of water in the Sacramento River watershed are adversely affected by the presence of pollutants and sediments entering the watershed from a variety of sources. The report also identified and described four major sources of chemical pollutants entering the river. These included agricultural drainage, mine drainage (particularly acid mine drainage), urban runoff, and National Pollutant Discharge Elimination System (NPDES) discharges (SWRCB, 1990). Most of the toxicity comes from pesticides and metals. Animal production facilities, range lands, and forest activities (including fire), though not listed, also may pollute the river. Other adverse effects come from sedimentation, high temperatures, altered flow and temperature regimes, the introduction of exotic species, and a loss of habitat.

The Sacramento River downstream from the RBDD, along with its tributaries, was categorized in the CWA 303(d) list as "impaired," largely because of the presence of the organophosphate pesticide diazinon. Diazinon comes from orchards and urban use and is toxic to aquatic organisms. Many growers use alternatives to organophosphate pesticides that also are highly toxic to aquatic organisms.

Elevated concentrations of organochlorine compounds also are present in the Sacramento River. These have been attributed to past agricultural use because the use of organochlorine for pesticides is now illegal.

Mercury from mining operations is the dominant toxic metal in the Sacramento River. Historical mercury mining in the Sierra Nevada and Coast Ranges contributed most of the mercury. Mercury also was used in gold mining operations in these areas. Lead, copper, zinc, and nickel are other metals that have affected the river, particularly from the Spring Creek drainage and other abandoned mines.

The Central Valley Regional Water Quality Control Board (RWQCB) determined that the 25-mile-long reach of the Sacramento River from Keswick Dam downstream to Cottonwood Creek is impaired because the water periodically contains levels of dissolved cadmium, copper, and zinc that exceed safe levels for aquatic organisms. Lead is present at toxic levels across large areas of the watershed; it is attributable primarily to urban runoff. The Sacramento urban area contributes an estimated 5,000 pounds of lead annually to the Sacramento River.

The proposed NODOS project features are located in Tehama, Glenn, and Colusa Counties, west of the Sacramento River, and extend into the Coast Range foothills. The chemical quality of waters is directly related to the geology in the tributary drainage, as well as to agricultural and cattle grazing land uses.

Streams from the coastal sedimentary formation are substantially higher in dissolved solids and conductivity than the Sacramento River.

Numerous physical and chemical parameters were monitored during recent studies by DWR, the Sacramento River Watershed Program (SRWP), and USGS. Although most measured parameters were supportive of beneficial uses and within the limits of established criteria, several parameters exceeded various criteria or could exceed criteria if water were diverted for impoundment in a reservoir. Parameters exceeding or potentially exceeding criteria include the metals aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, zinc, and the nutrient total phosphorus.

Groundwater Quality

This section describes the groundwater quality in Tehama, Glenn, and Colusa Counties.

Tehama County

Measurements of the physical properties of Tehama County groundwater indicated groundwater temperatures ranged from 53°F to 75°F. The pH values ranged from 6.0 to 8.2, and conductivity values varied greatly, ranging from 53 to 986 micromhos per centimeter (µmhos/cm).

Chemical analyses indicate that Tehama County groundwater is generally excellent in quality, with only a few negative aspects. Sodium concentrations in Tehama County groundwater ranged from 4 to 149 milligrams per liter (mg/L). Elevated chloride levels also were found in some wells. Chloride concentrations ranged from non-detectable to 219 mg/L. Elevated boron levels also were found, with concentrations ranging from non-detectable up to 3.2 mg/L. Total dissolved solids (TDS) ranged from 100 to 558 mg/L.

Trace metals were generally low in Tehama County. Iron and manganese had elevated values in a few wells, with the maximum iron value of 440 micrograms per liter (µg/L) and manganese at 120 µg/L. Arsenic and lead concentrations from some wells, though very low, were detected at levels exceeding stringent California Office of Environmental Health Hazard Assessment (OEHHA) Public Health Goals. Some wells where arsenic and lead were not detected may still exceed some current regulatory criteria; laboratory detection limits, at times, were higher than some current criteria levels. Cadmium results were low, with only one well reaching detectable levels. In others, however, the laboratory minimum detection limit was higher than some criteria. Copper levels were low, though 2 wells had concentrations of 180 and 200 µg/L.

Glenn County

A physical measurement of Glenn County groundwater indicates that groundwater temperatures ranged from 64°F to 75°F. The pH values were in the range of 6.5 to 8.4, and conductivity measurements ranged from 213 to 1,265 µmhos/cm.

Chemical analyses of water from wells indicated that Glenn County groundwater was generally good in quality. Sodium concentrations ranged from 11 to 266 mg/L. The levels of TDS were from 126 to 773 mg/L. Boron concentrations were generally low, though two wells had elevated concentrations of 1.1 and 1.2 mg/L.

Trace metals were found only at low concentrations. Several wells had very low arsenic, cadmium, and lead concentrations.

Colusa County

Measurements of physical parameters indicate groundwater temperatures in Colusa County ranged from 61°F to 79°F; pH values ranged from 7.0 to 8.8. Conductivity measurements in the county were generally high, ranging from 210 to 3,760 µmhos/cm, though two wells had extremely high readings of 10,750 and 16,850 µmhos/cm. Twelve wells had conductivity values greater than 2,000 µmhos/cm, and 4 wells had values that were greater than 3,000 µmhos/cm.

Chemical analyses indicated that Colusa County generally had groundwater that was highly mineralized. Sodium concentrations ranged from 13 to 364 mg/L, though two wells had sodium levels of 1,680 and 2,960 mg/L. Sulfate concentrations varied widely, from non-detectable to 900 mg/L from most wells sampled, though two wells had values of 2,347 and 4,900 mg/L. Boron levels were generally low, though numerous wells had elevated levels as high as 2 mg/L. Chloride levels ranged from 3 to 857 mg/L, with two wells having values of 2,400 and 3,640 mg/L. TDS levels ranged from 120 to 2,670 mg/L, with two wells having values of 7,532 and 13,210 mg/L.

Climate and Air Quality

Climatic Conditions

Summers in the northern Sacramento Valley Air Basin (SVAB) are typically hot, with low humidity and prevailing winds from the south. Winters are characterized by rainstorms interspersed with stagnant and sometimes foggy weather. Winter daytime temperatures average in the low 50s, and nighttime temperatures average in the upper 30s. During winter, north winds become more frequent, but winds from the south predominate. Rainfall occurs primarily from late October to early May.

Table 3-1 provides climate summaries for Tehama, Glenn, and Colusa Counties. As shown, the counties are similar in temperature.

Table 3-1. Climatic Conditions in Tehama, Glenn, and Colusa Counties

Parameter	Tehama County[1]	Glenn County[2]	Colusa County[3]
Average Maximum Temperature (ºF)	75.5	74.9	75.0
Average Minimum Temperature (ºF)	50.1	47.5	47.5
Average Total Precipitation (inches)	23.08	18.06	16.32
Average Total Snowfall (inches)	2.1	0.6	0.1

Source: Desert Research Institute, Western Regional Climate Center, 2004.
Notes:
[1] Period of record: 11/1/1933 to 12/31/2003
[2] Period of record: 7/1/1948 to 12/31/2003
[3] Period of record: 10/1/1948 to 12/31/2003

Key:
°F = degrees Fahrenheit

Air Quality

The project would be located in the SVAB, which includes the counties of Butte, Colusa, Glenn, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba, and portions of Placer and Solano. The SVAB is bounded on the north by the Cascade Range, on the south by the San Joaquin Valley Air Basin, on the east by the Sierra Nevada, and on the west by the Coast Range (Feather River Air Quality Management District [FRAQMD], 1998).

The applicable local regulatory districts are the Tehama County Air Pollution Control District (APCD), the Glenn County APCD, and the Colusa County APCD.

The California Air Resources Board (CARB) and the EPA determine whether areas throughout California meet California and national standards. Table 3-2 provides the California and Federal attainment status for the criteria pollutants.

Table 3-2. California and Federal Attainment Status for the Criteria Pollutants for Tehama, Glenn, and Colusa Counties

Pollutant	Tehama County		Glenn County		Colusa County	
	California	Federal	California	Federal	California	Federal
Ozone	N	U/A	N-T	U/A	N/T	U/A
$PM_{2.5}$	U	U	U	U	U	U
PM_{10}	N	U	N	U	N	U
Carbon Monoxide	U	U/A	U	U/A	U	U/A
Nitrogen Dioxide	A	N/A	A	N/A	A	N/A
Sulfur Dioxide	A	N/A	A	N/A	A	N/A
Sulfates	A	N/A	A	N/A	A	N/A
Lead	A	N/A	A	N/A	A	N/A
Hydrogen Sulfide	U	N/A	U	N/A	U	N/A
Visibility Reducing Particles	U	N/A	U	N/A	U	N/A

Source: CARB, 2004; EPA, 2005.

Key:
CARB = California Air Resources Board
EPA = U.S. Environmental Protection Agency
$PM_{2.5}$ = particulate matter greater than 2.5 microns
PM_{10} = particulate matter greater than 10 microns

Codes:
A = attainment
N = nonattainment
N/A = not applicable
U = unclassified
U/A = unclassified Attainment
N-T = nonattainment-transitional

Noise and Vibration

Most areas where project construction would occur are either undeveloped or have agricultural uses. Various sensitive receptors and limited recreational uses are located throughout the vicinity. Existing noise sources are associated with roadway traffic (Interstate 5 [I-5], SR 162, SR 45, SR 32, and SR 20) and railway traffic (the Union Pacific Rail Road [UPRR]). Existing vibration sources are associated primarily with local construction, roadway traffic, and trains.

Ambient noise levels associated with the areas near the Stony Creek Pipeline, GCID Canal, and TC Canal are expected to be very low, given the low levels of public access and use. Roads, agricultural activities (including aerial activities), and recreation, such as hunting, are found throughout the valley and within the nearby wildlife refuge.

Noise sources near the RBDD include recreationists at the Lake Red Bluff Recreation Area, which is adjacent to the dam. Typical noise sources along or near the Sacramento River are associated with boating and other recreational activities that occur at or near the river, traffic on I-5, railway traffic (the UPRR, which parallels I-5), and aircraft noise associated with Redding Municipal Airport.

Existing vibration sources in the vicinity of proposed project features are associated primarily with traffic on local roads, nearby construction, and nearby trains.

Biological Resources

Sacramento River Fish Resources

The Sacramento River supports many resident and anadromous fish. The reach of the Sacramento River between Colusa and Red Bluff supports a wide range of aquatic habitats, from fast-flowing, gravel-bedded reaches with alternating riffles and pools to slow-moving, off-channel sloughs and oxbows with fine sediments. This reach also supports active floodplains that become inundated by high winter flows.

Natural seasonal flow in the Sacramento River is characterized by peaks during winter rain storms, moderate spring flows from snowmelt, and moderately high summer flow. Spring and summer flow regimes differ from central and southern Sierra tributaries. The porous volcanic geology of the Upper Sacramento River watershed results in gradual snowmelt runoff, which reduces spring runoff and sustains relatively high summer flows. Much of the watershed is below the snowline, resulting in relatively high winter flows (CALFED, 2000a).

The variability and magnitude of natural seasonal flows have been greatly altered for irrigation and flood control. The dams and diversions operated by the CVP and local irrigation districts control much of the flow in the Sacramento River. These include Shasta Dam, Keswick Dam, the Trinity and Lewiston Diversions, Whiskeytown Dam, the Spring Creek Debris Dam, the RBDD, and the TC and Corning Canals. Shasta Dam operations have a substantial effect on Sacramento River flow. In addition, the Sacramento River Flood Control Project and Oroville Dam and Reservoir have impacted flows in the lower Sacramento River and Delta. Besides altering flows, these water developments have substantially reduced the quality and availability of habitat for migratory and resident fish species by blocking passage and reducing the delivery of coarse sediment. Other local projects and management actions on the Sacramento River and its tributaries also have influenced flows and water quality (e.g., construction of levees and placement of riprap).

Stony Creek Fish Resources

Fish passage, water temperature and low flows from spring until late fall, and high flashy flows in the winter are major factors limiting fish populations in Stony Creek.

Stony Creek is the largest westside Sacramento River tributary between Cottonwood Creek and the CBD at Knights Landing. Typically, flows in Stony Creek are characterized by high flashy flows in the winter, moderate flows in spring and early summer, and very low flows in late summer and early fall.

Aquatic habitat in Stony Creek has been substantially altered by dams, water diversions, and gravel mining. Three major reservoirs are within the Stony Creek drainage: Black Butte Reservoir, Stony Gorge Dam, and East Park Dam. Black Butte Dam is a complete barrier to upstream fish passage.

Stony Creek has a population of Chinook salmon and steelhead. Based on data collected during 1981 and 1982, DFG estimates that 393 salmon spawned in the creek (Reclamation and DWR, 2006a).

Fish Resources Associated with Funks Creek, Stone Corral Creek, Grapevine Creek, and Antelope Creek

Funks, Stone Corral, Grapevine, and Antelope Creeks originate along the foothills of the Coast Range at about 1,600 feet elevation. The portions of these streams within the NODOS reservoir footprint are characterized by deeply incised channels that are largely devoid of riparian cover as a result of heavy cattle use.

Fishery surveys performed in the reservoir area on Funks, Stone Corral, and Antelope Creeks indicate the presence of several warm-water native and non-native species. These streams are ephemeral within the reservoir footprint and are generally dry by May. None provides cold-water habitat. Several native species were found in these creeks, including California roach, hitch, Sacramento blackfish, Sacramento pikeminnow, Sacramento sucker, sculpin, and a single adult spring-run Chinook salmon. Non-native species found in the reservoir area include: bluegill, green sunfish, mosquito fish, and largemouth bass (Reclamation and DWR, 2006a).

Special-Status Fish Resources

The Sacramento Valley provides habitat for the following special-status species that could be affected by reservoir operations:

- Chinook Salmon Sacramento River Winter-Run ESU—a Federal and California Endangered Species;
- Delta Smelt—a Federal and California Threatened Species;
- Steelhead California Central Valley DPS—a Federal Threatened Species;
- Chinook Salmon Central Valley Spring-Run ESU—a Federal and California Threatened Species;

- Chinook Salmon Central Valley Fall-Run ESU—a Federal Species of Concern;
- North American Green Sturgeon Southern DPS—a Federal Threatened Species and California Species of Special Concern;
- Sacramento Splittail—a California Species of Special Concern;
- River Lamprey—a California Species of Special Concern;
- Longfin Smelt—a California Species of Special Concern; and
- Chinook Salmon Central Valley Late-Fall-Run ESU—a Federal Species of Concern and California Species of Special Concern

Vegetation and Habitat Types

Vegetation communities in Tehama, Glenn, and Colusa Counties, to the west of the Sacramento River, are strongly influenced by precipitation, temperature, soils, aspect, slope, disturbance history, and elevation changes. This area is characterized by a Mediterranean climate of hot dry summers and moderately cold wet winters. About 95 percent of the annual precipitation occurs during the winter and is influenced by the "rain shadow" of the North Coast Ranges, along the western edge of the region. Soils of primarily marine-sedimentary origin also influence vegetation patterns within the region. Vegetation communities in the region encompass riparian forest and riparian scrub along the Sacramento River; annual grasslands and agricultural land in the Sacramento Valley between the Sacramento River and the Coast Ranges; blue-oak-dominated savanna and woodland on the low foothills of the Coast Range; mixed oak/gray pine/ chaparral shrub communities in the lower slopes of the Coast Range; and mixed conifer forests at upper Coast Range elevations.

Localized sites in the foothills support fire-dependent stands of chamise chaparral, as well as more diverse mixed chaparrals. Unique habitats that support specialized plant associations include the vernal pools and swales, found on valley floors or clay terraces, and the low elevation saline/alkaline flats. Unique plant associations adapted to certain soil types include the endemic serpentine floras found mostly in lower Coast Range slopes but also occasionally found on Lodo and other crumbly shale in the lower foothills. Bear Valley, which is situated between the foothills in western Colusa County, just south of the project area, supports spring wildflower displays on its partly serpentinite-derived alluvium. The region falls within The Jepson Manual's "Inner North Coast Range" geographic subdivision of the California Floristic Province (Hickman, 1993), as well as the western edge of the "Sacramento Valley" subdivision of the Great Valley.

Special-Status Plant Species in the Project Area

During field surveys, no Federal- or California-listed plant species were found within the project area.

Two federal sensitive species, which are also California Native Plant Society (CNPS) List 1B species, were found during field surveys within the project area. New occurrences of the adobe lily and red-flowered lotus were found in the western edges of the local project area in blue oak savanna. The red-flowered lotus was not known in the vicinity of Antelope Valley before project surveys. The nearest known occurrences were 7 miles west of the reservoir footprint and more than 20 miles northeast of Stony Creek pipeline (out of the project region).

Ten of the species listed only as CNPS List 1B were reported to occur near the project area (DFG, 2004). Two of these species were found during field surveys; brittlescale and San Joaquin spearscale were found from the eastern edge in alkaline flats. These species are reported from saline/alkaline vernal wetlands or flats in the Sacramento Valley, mostly in and around the Sacramento, Colusa, and Delevan NWRs. Project surveys did locate new occurrences of the bent-flowered fiddleneck CNPS] List 1B) and round-leaved filaree (CNPS List 2) in the vicinity of the town of Sites.

Wildlife Resources

Terrestrial wildlife resources include habitats and their associated invertebrates, reptiles and amphibians, birds, and mammals. A regional habitat analysis was performed using the California GAP Analysis Project (GAP Analysis) (Davis et al., 1998). Classification is based on dominant overstory species and corresponds with the habitat types described by the California Wildlife Habitat Relationships Program (WHR) (DFG, 2002).

The GAP Analysis identified 24 wildlife habitats within the described region. The principal wildlife habitat types include annual grassland, blue oak-foothill pine, blue oak woodland, chamise-redshank chaparral, cropland, irrigated row and field crops, Klamath mixed conifer, mixed chaparral, orchard-vineyard, ponderosa pine, and valley oak woodland.

Fourteen California or federally listed wildlife species (including candidate species) may occur within the region (table 3-3).

Table 3-3. California and Federally Listed Terrestrial Wildlife Species in the Region

Species	Federal Status[1]	California Status[2]
Invertebrates		
Conservancy fairy shrimp (*Branchinecta conservatio*)	E	
Vernal pool fairy shrimp (*Branchinecta lynchi*)	T	
Vernal pool tadpole shrimp (*Lepidurus packardi*)	E	
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	T	

Table 3-3. Continued

Species	Federal Status[1]	California Status[2]
Reptiles and Amphibians		
California red-legged frog (*Rana aurora draytonii*)	T	
California tiger salamander (*Ambystoma californiense*)	T	
Giant garter snake (*Thamnophis gigas*)	T	ST
Birds		
American peregrine falcon (*Falco peregrinus anatum*)		SE
Southern bald eagle (*Haliaeetus leucocephalus*)		SE
Bank swallow (*Riparia riparia*)		ST
Greater sandhill crane (*Grus canadensis tabida*)		ST
Swainson's hawk (*Buteo swansoni*)		ST
Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	C	SE
Willow flycatcher (*Empidonax traillii)*		SE

Source: DFG, 2007
Notes:
[1] Federal Status: T=Threatened, E=Endangered, C=Candidate
[2] California Status: ST=California-Listed Threatened, SE=California-Listed Endangered
Key:
DFG = California Department of Fish and Game

The northern spotted owl, willow flycatcher, and Pacific fisher are not expected to occur within western Glenn and Colusa Counties. During field studies, researchers documented the presence of 3 of the 14 species: the giant garter snake, southern bald eagle, and Swainson's hawk. Wintering sandhill cranes (possibly the California-listed greater sandhill cranes) were observed within western Glenn and Colusa Counties. Although no adult beetles were observed, emergence holes were documented for the VELB.

Cultural Resources

The following sections briefly summarize the prehistoric resources, ethnography, traditional cultural properties, and Indian Trust Assets in the vicinity of the TC and GCID Canals and in the western portion of Glenn and Colusa Counties.

Prehistoric Resources in the Project Region and Area

Prehistoric resources are the material remains of human activities that pre-date contact with non-Native Americans. Such resources include village sites, temporary campsites, lithic scatters, roasting pits/hearths, bedrock milling features (such as hunting blinds), and burials. Human occupation in Glenn and Colusa Counties may extend back 10,000 years before present (BP) or more.

An inventory report of western Glenn and Colusa Counties was completed by White et al. (2005). The report, which outlines the results of the inventory conducted by the California State University at Chico Archaeological Research Program, indicates that 92 prehistoric sites were recorded, including middens, bedrock mortar sites, lithic scatters, and groundstone tool sites. In addition, 181 prehistoric isolates were recorded, including flake stone tools, debitage, manos, metates, pestles, portable and bedrock mortars, battered cobbles, and anvil stones.

Ethnography

At the time of European contact with Native Americans of California, the primary groups known to have occupied the Sacramento River Basin included the Achumawi, Atsugewi, Konkow, Maidu, Nisenan, Nomlaki, Yana, Patwin, and Wintu speakers. These peoples settled primarily along streams and rivers and used a large range of native plants and animals for subsistence; they focused primarily on acorns, fish, and deer. Human population density was among the highest in California. Some of the natural features of the region are traditionally considered sensitive or sacred.

The Patwin ethnographically inhabited western Glenn and Colusa Counties and are linguistically classified as part of the Wintun family of the Penutian language stock. The Wintun are separated linguistically and culturally into three major groups from north to south: the Wintu, the Nomlaki, and the Patwin. These three groups represent mutually unintelligible languages. Each language was further subdivided into local dialects, most differentiated laterally into riverine and foothill zones. The Patwin are divided into two distinct groups: the River Patwin who inhabited about 80 miles along the Sacramento River, and the Hill Patwin, who lived in the Coast Range foothills. The River Patwin spoke three distinct dialects: Coru (Colusa area), Saka (Grimes area), and Yo'doi (Knights Landing area).

Traditional Cultural Properties

Some of the natural features of the region are traditionally considered sensitive or sacred. The Konkow and Maidu tribes considered the Sutter Buttes as sacred, and Butte Mountain was the site of the first Hesi ceremony performed by the Nisenan. The Nomlaki consider Lassen Butte to be culturally important. Sutter Buttes and Mount Shasta also are places of cultural importance to the Patwin and Wintu.

Indian Trust Assets (ITAs)

The Colusa, Cortina, and Grindstone Rancherias and the Paskenta Band of Nomlaki Indians are located in the NODOS Investigation area. Descriptions of the ITAs for each of these tribes are included in table 3-4.

Table 3-4. Tribes and Indian Trust Assets in the Project Region[1]

Tribe Name	Trust Instrument	Indian Trust Assets Description
Chachil Dehe Band of Wintu Indians of the Colusa Rancheria	Congressional legislation establishing the Rancheria. Acts of June 21, 1906 (34 Stat. 325-333) and April 30, 1908 (35 Statute 70-76) and the Act of June 18, 1934 (48 Statute 984)	The Colusa Rancheria has Tribal trust land, groundwater wells, and other on-reservation land-use rights typical of land held in trust for the Tribes by the U.S. Colusa also has a 1,500-acre farm contiguous to trust land. The farm is not within the trust. Both trust land and the non-trust farm are on the western bank of the Sacramento River.[2]
Cortina Rancheria of Wintu Indians	Congressional legislation establishing the Rancheria. Secretarial Order No. 53589-1907, dated June 26, 1907, and Bureau of Indian Affairs purchase dated July 20, 1907	The Cortina Rancheria has Tribal trust land, groundwater wells, and other on-reservation land-use rights typical of land held in trust for the Tribes by the U.S.[2]
Paskenta Band of Nomlaki Indians	Congressional legislation establishing the Rancheria. Acts of May 25, 1918 (40 Statute 570) and November 2, 1994 (Title III of Public Law108-454; 108 Statute 4793; U.S.C. 1300m-3)	The Paskenta Band has Tribal land, groundwater wells, and other on-reservation land-use rights typical of land held in trust for the Tribes by the U.S.[2]
Grindstone Rancheria	Congressional legislation establishing the Rancheria. Acts of June 21, 1906 (34 Statute 325-333) and April 30, 1908 (35 Statute 70-76), and the Act of June 18, 1934 (48 Statute 984)	The Grindstone Rancheria has Tribal trust land, groundwater wells, and other on-reservation land-use rights typical of land held in trust for the Tribes by the U.S. The Tribe also has a quantified riparian right to water along Stony Creek.[2]

Note:
1 Sources of support data for each of the Tribes include congressional legislation and land records.
2 The Tribe has an unquantified Federal reserved water right, as indicated in Winters v. U.S. (1908). Although the amount of this water right is unquantified, it is assumed that such right exists. Such an unquantified Federal reserved water right is believed to be an Indian Trust Asset.

Key:
U.S.C. = United States Code
V = versus

Historic Resources

Historic resources are physical properties, structures, or built items that post-date written records. These resources include both historic age archaeological sites and architectural structures. Historic archaeological site types include town sites, homesteads, ranches, privy pits, and dumps. Architectural structures include transportation facilities, water conveyance systems, quarries, and ranches.

Historic resources occur throughout western Glenn and Colusa Counties. Most historic sites recorded in the Sacramento Valley consist of local structures, such as houses, schools, libraries, churches, post offices, hotels, railroad stations or related rail transportation features, mines, and bridges.

An inventory report of the area was completed by White et al. (2005). The report outlined the results of the inventory conducted by the California State University at Chico Archaeological Research Program. As a result of these efforts, 72 historic sites were recorded, including homesteads, railroads, cemeteries, and a town site.

Aesthetic and Visual Resources

California's Scenic Highway Program was created by the California State Legislature in 1963 to preserve and protect scenic highway corridors from changes that would diminish the aesthetic value of lands adjacent to highways. Although there are no wild and scenic rivers in the Primary Study Area, it encompasses two scenic highways in Colusa County, Highway 16 and Highway 20. Highway 70 in Butte County, Highway 151 and Lake Boulevard in Shasta County, and Highways 36 and 89 in Tehama County, also considered scenic roadways, are the only other aesthetic resources in the NODOS Primary Study Area.

The construction of dams and reservoirs has substantially changed the visual landscape of the Primary Study Area, specifically in Shasta County. Viewer sensitivity is high in these areas because of high recreational use and easy public access.

The Sacramento River upper watershed retains its oak woodlands, grasslands, forests, and small rural communities despite substantial development along California and Federal highways in the foothills and mountain areas.

Major urban areas in the Primary Study Area include Redding, Anderson, Red Bluff, and the more urbanized area between Keswick Dam and the RBDD (Reclamation, Undated).

Along major transportation corridors, such as I-5, Colusa County has several small towns, including Sites, Williams, Colusa, Arbuckle, Sycamore, and Maxwell. Just outside of these communities are rural residences, open space, agricultural land, potential industrial and commercial land along the I-5 corridor, and recreational areas.

Land Use

Tehama County

Tehama County is bounded by Trinity and Mendocino Counties on the west, Shasta County on the north, Plumas County on the east, Butte County on the southeast, and Glenn County on the south. The county has an area of about 2,950 square miles (1,888,692 acres). Urban and suburban land in the county totaled 29,931 acres in 1999 and included the following land uses: urban residential, commercial, industrial, urban vacant, and urban landscape (table 3-5).

Table 3-5. Tehama County 1999 Urban Category Descriptions

Category	Description	Acres
Urban Residential	Single and multiple family units, and trailer courts	20,834
Commercial	Offices, retailers, lodging, recreational vehicle parking, camp sites, institutions, schools, auditoriums, theaters, churches, stadiums, and miscellaneous commercial types	1,400
Industrial	Manufacturing, extractive activities, storage and distribution areas, sawmills, sewage treatment, waste accumulation sites, and miscellaneous industrial types	1,861
Urban Vacant	Unpaved areas (vacant lots, graveled surfaces, play yards, raw lands within metropolitan areas, etc.) and railroad rights of way; paved areas (parking lots, oiled surfaces, flood control channels, tennis court areas, auto sales lots, etc.); and airport runways	5,194
Urban Landscape	Irrigated lawn, golf course, ornamental landscape, and irrigated and non-irrigated cemetery area	642

County agricultural land, which includes both irrigated and non-irrigated land, totaled 122,214 acres. Irrigated acreage is pasture, grain and hay, truck and berry crops, field crops, deciduous fruits and nuts, subtropical crops, rice, or idle.

Glenn County

Glenn County is bounded by Lake and Mendocino Counties on the west, Tehama County on the north, Butte County on the east, and Colusa County on the south. The county has an area of about 1,315 square miles (841,523 acres).

Urban and suburban land in the county totaled 9,828 acres in 1998, including the following land uses: urban residential, commercial, industrial, urban vacant, and urban landscape (table 3-6).

Table 3-6. Glenn County 1998 Urban Category Descriptions

Category	Description	Acres
Urban Residential	Single- and multiple-family units and trailer courts	2,473
Commercial	Offices, retailers, lodging, recreational vehicle parking, camp sites, institutions, schools, auditoriums, theaters, churches, stadiums, and miscellaneous commercial types	567
Industrial	Manufacturing, extractive activities, storage and distribution areas, sawmills, sewage treatment, waste accumulation sites, and miscellaneous industrial types	1,986
Urban Vacant	Unpaved areas (vacant lots, graveled surfaces, play yards, raw lands within metropolitan areas, etc.), and railroad rights of way; paved areas (parking lots, oiled surfaces, flood control channels, tennis court areas, auto sales lots, etc.); and airport runways	5,194
Urban Landscape	Irrigated lawn, golf course, ornamental landscape, and irrigated and non-irrigated cemetery area	224

County agricultural land, which includes both irrigated and non-irrigated land, totaled 258,716 acres. Irrigated acreage comprises pasture, grain and hay, truck and berry crops, field crops, deciduous fruits and nuts, subtropical, vineyard, rice, and idle.

Colusa County

Colusa County is bounded by Lake County on the west, Glenn County on the north, Butte and Sutter counties on the east, and Yolo County on the south. The county has an area of 1,151 square miles (736,499 acres).

Urban and suburban land in the county totaled 13,533 acres in 1998, including the following land uses: urban residential, commercial, industrial, urban vacant, and urban landscape (table 3-7).

Table 3-7. Colusa County 1998 Urban Category Descriptions

Category	Description	Acres
Urban Residential	Single and multiple family units and trailer courts	3,792
Commercial	Offices, retailers, lodging, recreation vehicle parking, camp sites, institutions, schools, auditoriums, theaters, churches, stadiums, and miscellaneous commercial types	340
Industrial	Manufacturing, extractive activities, storage and distribution areas, sawmills, sewage treatment, waste accumulation sites, and miscellaneous industrial types	1,643
Urban Vacant	Unpaved areas (vacant lots, graveled surfaces, play yards, raw lands within metropolitan areas, etc., and railroad rights of way); paved areas (parking lots, oiled surfaces, flood control channels, tennis court areas, auto sales lots, etc.); and airport runways	5,194
Urban Landscape	Irrigated lawn, golf course, ornamental landscape and irrigated and non-irrigated cemetery area	249

County agricultural land, which includes both irrigated and non-irrigated land, totaled 318,480 acres. Irrigated acreage is pasture, grain and hay, truck and berry crops, field crops, deciduous fruits and nuts, subtropical, vineyard, rice, or idle.

Flood Management

Flooding has plagued the Central Valley throughout history. To allow for more agricultural and urban development along Sacramento Valley waterways, flood-management projects were initiated in the mid 1800s. Repairs and facilities construction continue to the present day to bolster this complicated system.

The flood-management system runs from Shasta Dam to the Delta through the Sacramento Valley. The system is generally made up of three major reservoirs, overflow weirs, control gates, bypass floodways, pumping plants, and levees. The three main reservoirs, Shasta, Oroville, and Folsom, form the backbone of the Valley's flood-management system. In addition to these reservoirs, five bypass floodways can be used to confine floodwaters: Butte Basin, Sutter Bypass, Yolo Bypass, Tisdale Bypass, and Sacramento Bypass. Weirs and gates control the flow of surface water through the system. Pumping plants forcibly redirect surface water, and the levees protect the subsided land behind them.

Recently, concern over the condition of the 1,700 miles of levees in the Sacramento River Basin has resulted in investigations to identify serious levee erosion. Levee repairs have begun at some sites; however, more sites continue to be identified as critical.

Seismic Activity

Glenn and Colusa Counties straddle the boundary between the northern highly faulted Coast Ranges and the relatively stable Sacramento Valley. Seismicity and earthquakes are a regional phenomenon; a moderate to strong seismic event either in western Glenn or Colusa County would affect features in the entire NODOS project area. Table 3-8 lists the location of regionally active faults and potentially active faults as a result of proximity, activity status, date of most recent motion, and maximum moment magnitude (Mmax)[1].

Table 3-8. Regional Faults

Fault	Fault Type	Recency of Movement	Fault Classification	Maximum Moment Magnitude (Mmax)
San Andreas	Strike Slip	Holocene	Active	~8.0
Maacama	Strke Slip	Holocene	Active	6.5
Bartlett Springs	Strike Slip	Holocene	Active	6.6
Coast Range	Normal	Late Pliocene	Not Active	Not Characterized
Green Valley	Thrust	Pre-Late Quaternary	Not Active	Not Characterized
Stony Creek	Thrust	Pre-Late Quaternary	Not Active	Not Characterized
Great Valley	Blind Thrust	Holocene	Assumed to be Active	6.8
Corning	Blind Reverse	Late Pleistocene	Active	Not Characterized
Cleveland Hills	Normal	Holocene	Active	6.7
Cascadia Subduction Zone	Megathrust	Holocene	Active	9

Key:
Mmax = maximum moment magnitude
~ = approximately

[1] The Mmax is the strongest earthquake that is likely to be generated along a fault and is based on empirical relationships of surface rupture length, rupture area, and fault type, all of which are related to the physical size of fault rupture and displacement across a fault.

Most of the historical seismic activity within the region is associated with movement along the Bartlett Springs and Maacama faults and the Corning fault (William Lettis & Associates, 2002). Additional minor seismic activity occurs throughout the region and is generally attributed to compressional forces between the Coast Range geomorphic province and the Great Valley geomorphic province. These minor seismic events occur at moderate depth with no surface expression exhibited.

The Corning fault is considered active (William Lettis & Associates, 2002). The fault trace is not exposed at the surface. The TC Canal crosses the Corning fault south of Orland.

The Phase II Fault and Seismic Hazards Investigation for North of the Delta Offstream Storage Investigations (William Lettis & Associates, 2002) identified several inactive faults. Historically, the project area has a low seismic activity rate. Data from the Northern California Seismic Network database indicate that no seismic event greater than magnitude 4.5 has occurred since 1970. Focal depths are generally deeper than 15 miles.

Recreation

As the population of California continues to grow, so does the demand for water-oriented recreation. Demand for water-side activities at rivers, lakes, and reservoirs, including fishing, swimming, boating, skiing, hiking, and camping, have increased throughout California.

The Sacramento River and distribution canals host fishing and hunting; these are the primary recreational assets in the Sacramento Valley. Pheasant and waterfowl hunting are especially popular, and bass and salmon fishing continue to be favorite pastimes.

Recreational opportunities and levels of recreational facility development vary within the region. Black Butte Lake and East Park, Stony Gorge, and Indian Valley Reservoirs are comparable because they would be similar to a NODOS reservoir in terms of location, vegetation community, elevation, remoteness, and topography. Although they are considerably smaller than a NODOS reservoir, they all have fluctuating water levels, and peak use occurs between March and August (Rischbieter, 1999). A range of facility development exists at these reservoirs, but only Black Butte Lake has more than primitive facilities. Lake Berryessa, Folsom Lake, and Lake Oroville are comparable in size to the NODOS reservoir. Lake Almanor and Clear Lake have a mix of private and public facilities.

The Lake Red Bluff Recreation Area is operated by the Mendocino National Forest and lies adjacent to the RBDD, within the city limits of Red Bluff. According to a study by California State University at Chico, approximately

64,000 people engaged in recreational activities annually in and along the Sacramento River near the RBDD. Most of them used one of three locations: City Park, Ide Adobe State Historical Park, and the boat launch ramp area at the Lake Red Bluff Recreation Area. Most of this use occurred in the summer months during the “gates-in” period (CH2M HILL, 2002).

The Sacramento Valley contains a complex of Federal and California wildlife refuges along the Sacramento River that provide opportunities for fishing, hunting, and wildlife viewing via auto tours and trails. These refuges include the Sacramento, Colusa, and Delevan NWRs. Fishing and hunting account for about 50 percent of the total use. The remaining 50 percent is devoted to hiking and photography (CALFED, 2003).

Navigation, Transportation, and Traffic

The Sacramento River is the largest river in California, with a total length of 327 miles. The river is considered navigable for 301 miles to Keswick Dam; the Sacramento River Deep Water Ship Channel, which is 26 miles long, also is considered navigable.

The main roadways that serve the counties in the Primary Study Area are I-5 and SR 99. These major north-south corridors provide direct access to urban and rural areas throughout California. Other major highways that run in an east-west direction include SR 299 in Shasta County, SR 36 in Tehama County, SR 32 and 162 in Glenn County, and SR 20 in Colusa County.

Public Services and Utilities

Hydropower

Hydropower facilities in the Primary Study Area include Shasta Power Plant at the foot of Shasta Dam and Keswick Power Plant below Keswick Dam.

The Shasta Power Plant is a CVP facility run by Reclamation. It is on the Sacramento River at the foot of Shasta Dam. Water from the dam is released through the 15-foot diameter penstocks (power plant intake pipeline) driving the turbines that operate the five main generating units and two station service units. The Shasta Power Plant is a peaking plant—it produces power on a schedule corresponding to peak electrical system usage, rather than at a constant rate 24 hours per day. Its power is dedicated first to meeting the requirements of the power plant facilities. To drive each turbine at full-generator load, 85 tons of water per second are required. Two 2,500-kilowatt (kW) station service generators are integral to the power plant. Power is generated at 13,800 Volts (V) and stepped up to 230,000 V for transmission to California consumers. The plant's installed capacity is 629,000 kW, and it has an annual average net generation of 2,466 gigawatt-hours (GWh). The energy remaining after meeting CVP needs is marketed to various preferred customers throughout California.

The Keswick Power Plant is a CVP facility run by Reclamation. It is just below Keswick Dam on the Sacramento River. Keswick Dam acts as Shasta Dam's afterbay, stabilizing the water flow released through the Shasta Power Plant. In addition, Keswick Reservoir captures water diverted from the Trinity River through the Trinity River Diversion. Unlike Shasta, the Keswick Power Plant runs throughout the day at a constant rate, providing a uniform release to the Sacramento River. The Keswick Power Plant has three generating units with a combined capacity of 117,000 kW and an average annual net generation of 399.3 GWh.

Water Supply

Total reservoir capacity from Shasta, Oroville, and Folsom Reservoirs in the Sacramento River region is approximately 9.0 MAF. Historically, these reservoirs have been operated to provide agricultural and domestic water supplies, flood-control capacity and, more recently, recreational and instream flows for fish and wildlife.

The Sacramento Valley has a relatively abundant water supply, and most of the M&I water uses are in the Sacramento metropolitan area. Most surface water use in the region is diverted from the American River. The Sacramento River region provides its own M&I water. Water resources in the Sacramento Basin have been developed to meet local agricultural, municipal, and industrial needs.

Socioeconomics and Environmental Justice

The social environment includes local communities and social population groups. Each component of the social environment is defined briefly hereafter, including minority and low-income populations, which are the focus of environmental justice concerns.

The Primary Study Area communities are Sites, Corning, Hamilton, Williams, Maxwell, Orland, Knights Landing, Redding, Red Bluff, Willows, and Colusa. Within these communities, many social and public services are provided, and there is a range of resource-dependent cultural activities. These communities also include a variety of social groups, including the following:

- Business owners and their employees, including the owners and employees of agricultural businesses near the Sacramento River, companies that supply agricultural operations, and businesses that provide services and goods to recreationists who visit the Primary Study Area;

- Property owners and local residents;
- Native Americans;
- Other minority groups;
- Low-income populations;
- Customers of water and power utilities and local irrigation districts; and
- Anglers fishing for salmon, steelhead, and trout in the local waterways.

Each social group has various beliefs, values, and lifestyles. The members of these groups often share several important values and needs, including the following.

- A reliable source of income and a low cost of living.
- Steady employment.
- An economic need to protect the profitability of local businesses that affect their personal income.
- Adequate public services, including education, health services, and crime control.
- Affordable housing.
- An ability to experience a high quality of life, which can be affected by several factors (e.g., commute times, income levels, access to scenic open space, and diverse cultural and recreational opportunities).

Many members of minority and low-income populations are employed by local agricultural operations in the Primary Study Area and are especially susceptible to changes in employment opportunities. Improvements or reductions in water supply reliability or delivery costs, along with changes in power supply reliability costs, can have a major effect on the operating costs and financial health of the businesses for which they work. Changes in the frequency and risk of flooding along the Sacramento River and in the Delta also can affect agricultural operations, their owners, and their employees.

Likely Future Conditions

Identification of the magnitude of potential water resources and related problems and needs in the Primary and Extended Study Areas requires consideration of the existing conditions described in this chapter and anticipated future conditions. A demarcation date of June 1, 2004, was established for the NODOS Investigation to address the requirements of CEQA. Conditions that existed on June 1, 2004, the time of this study, are collectively known as the existing conditions.

Because it takes time to implement an alternative plan, it is very likely that the planning area conditions will differ from current, existing conditions when the project is fully operational. When this happens, the most likely future condition at the time the project becomes operational is called the "base year condition." This base year condition should not be confused with existing conditions. It represents the first year in which benefits of the project are realized. It serves as the base year in estimating the time value of project benefits and costs. For this PFR, the base year is assumed to be 2016—when a potential NODOS project would be completed and become operational.

The "without-project future condition" describes the condition that is expected to prevail in the planning area in the future if no Federal or California action or project is implemented to solve the problems specified in this PFR and feasibility study for NODOS. For the NODOS Investigation, the without-project future condition would extend through 2016, plus a 100-year period of evaluation. The projection of future conditions is based on the most reasonable foreseeable actions that would occur without the project. This includes projects that are currently authorized, funded, permitted, and/or highly likely to be implemented.

For the purposes of this PFR, the without-project future condition is synonymous with the NEPA No Action Alternative and CEQA No Project Alternative.

Several ecosystem restoration, water quality, water supply, and levee improvement projects are present or would have a high likelihood of occurring within the Primary Study Area. Collectively, these efforts might improve water quality in the Delta, water supply, levees, and ecosystems in the Primary Study Area. Following is a list of key projects that are expected to be implemented in the future in and near the study area.

- **Sacramento River National Wildlife Refuge Expansion –** The Sacramento River National Wildlife Refuge Expansion is a land acquisition and habitat restoration program along the Sacramento River between Colusa and Ord Bend.

- **Folsom Dam Modifications –** Modifications to Folsom Dam include enlarging existing outlets, constructing new low-level outlets to increase releases during lower pool stages, and revising the surcharge storage space in the reservoir.

- **Environmental Water Account –** The EWA was authorized as a cooperative short-term management program to protect fish in the Bay-Delta estuary through changes in the SWP/CVP operations with no uncompensated water costs to project users. The program received extended authorization through 2010 under the Water Supply, Reliability, and Environmental Improvement Act (2004).

- **Water-Use Efficiency (WUE) –** CALFED seeks to accelerate the implementation of the cost-effective actions of its WUE program to conserve and recycle water throughout California. As with the EWA, some form of this program may develop and continue into the long-term future.

- **Water Transfers –** Through the development of an effective water transfer market, CALFED aims to stretch existing water supplies by promoting transfers from willing sellers to buyers while protecting other water users, local economies, and the environment. DWR, Reclamation, and SWRCB have signed an MOU and are implementing the CALFED Water Transfer Program.

- **South Delta Improvements Program –** Reclamation and DWR are the Lead Agencies for the SDIP. The objectives of the SDIP are to provide more reliable, long-term export capability by California and Federal water projects, to protect local diversions, and to reduce impacts on San Joaquin River salmon. The SDIP consists of two major components: a physical/structural component and an operational component. The physical/structural component includes the construction and operation of permanent operable gates at up to four locations in south Delta channels to protect fish and meet the water level and water quality needs of local irrigation diversions; channel dredging to improve water conveyance; and modifications of local diversions. The operational component considers increasing the permitted diversion rate at Clifton Court Forebay from 6,680 cfs to 8,500 cfs. This potential increase is not included in the likely future condition. Reclamation and DWR plan to implement the proposed actions under SDIP in two separate and distinct stages. The Final EIS/EIR for SDIP (Reclamation and DWR, 2006) identified a preferred alternative for gate construction and operation, channel dredging, and agricultural diversion relocation (Stage 1 actions). The Final EIS/EIR included a range of alternatives for increasing the maximum diversion limit at the Banks Pumping Plant up to 8,500 cfs (Stage 2 action) but did not identify a preferred alternative. DWR and Reclamation will hold public workshops and forums around California to gather further public input before identifying a preferred alternative for increasing the diversion limit to 8,500 cfs. Once the preferred 8,500-cfs alternative has been identified, it will be submitted to the public for further review/comment, and a final decision regarding the Stage 2 action will be made by Reclamation and DWR in a ROD/Notice of Determination (NOD).

- **Trinity River Restoration Plan –** The *Record of Decision, Trinity River Mainstem Fishery Restoration and Environmental Impact Statement/Environmental Impact Report* is being implemented (U.S. Department of the Interior, 2000). This includes reducing annual exports from the Trinity River to the Sacramento River from 74 to 52 percent.

- **Phase 8 Short-Term Agreement –** It is highly likely that some of the 45 projects identified in the Phase 8 Short-Term Settlement Agreement (SVWMP, 2002) will be implemented, including the dedication of a portion of water to various environmental needs. In addition, it is likely that the portion of the water not requiring the construction of new infrastructure will be made available.

- **Operations Criteria and Plan Biological Assessments –** Reclamation and DWR completed an update to the 2004 OCAP BAs to reflect recent operational and environmental changes occurring throughout the CVP/SWP system and submitted them to NOAA Fisheries Service and the Service describing and evaluating the updated criteria in August 2008. In addition to current operations, the BA considered several proposed future actions, including increased flows in the Trinity River system, permanent barriers in the South Delta, the SWP/CVP Intertie, the Freeport Regional Water Project, and various operational changes. Reclamation received biological opinions from NOAA Fisheries Service in October 2004 (NOAA Fisheries Service, 2004) and the Service in February 2005 (U.S. Department of the Interior, Fish and Wildlife Service, 2005), and thereby completed its 2004/2005 Section 7 ESA consultations. The terms and conditions specified in the biological opinions established the instream habitat conditions and operational requirements that Reclamation and DWR must maintain as part of the integrated CVP/SWP operations.

  Given the numerous changed circumstances since the 2004/2005 OCAP BA consultations (e.g., Delta smelt population decline; newly designated critical habitat for Central Valley steelhead, Central California Coast steelhead, and spring-run Chinook salmon; and new listing of the Southern District Population Segment of North American green sturgeon), in 2006, Reclamation requested initiation of Section 7 ESA consultation with both NOAA Fisheries Service and the Service. It is expected that both consultations will be complete by spring 2009.

- **Delta Vision –** The objective of the Delta Vision process is to develop a durable vision for sustainable management of the Sacramento–San Joaquin Delta. The Delta Vision Blue Ribbon Task Force released a final report, *Our Vision for the California Delta* (2008), and a strategic plan to implement the vision is scheduled for release by October 2008. This PFR does not currently address a "changed Delta," but the feasibility report and EIS/EIR will, to the extent possible, conform to the policy decisions and recommendations from the Delta Vision Process and the Blue Ribbon Task Force recommendations.

- **Bay Delta Conservation Plan –** A comprehensive conservation plan is being developed for the Sacramento–San Joaquin Delta. Conservation strategy options incorporate a structural approach to convey water for environmental and water supply purposes along with habitat restoration opportunities in the Delta and Suisun Marsh. An NOP for an EIR/EIS for the plan was released on March 17, 2008. An NOI to prepare an EIR/EIS and conduct scoping meetings was issued by Reclamation, the Service, and NOAA Fisheries Service on April 15, 2008. Altered Delta conveyance was not incorporated into the modeling or evaluation performed in this PFR; however, implementation of the plan would be likely to increase the reliability of a NODOS project by decreasing the vulnerability of the Delta to catastrophic seismic or flood events. A more detailed evaluation of the benefits NODOS could provide toward achieving the objectives of the Bay Delta Conservation Plan will be included in the subsequent feasibility report and EIS/EIR.

Other Projects – Various other projects and programs are expected to be implemented in the future, including CVP contract renewals, the Battle Creek Restoration Project, the Freeport Regional Water Project, and further implementation of the CVPIA (b) (2) water accounting.

The remainder of this chapter describes some of the future changes in physical, environmental, cultural, and socioeconomic conditions expected to occur in the Primary Study Area.

Geology and Soils

In general, it is assumed that future geologic and soil conditions in the Primary Study Area or Extended Study Area would not change considerably.

Hydrology

Anticipated increases in population growth in the Central Valley will increase demands on water resource systems for additional and reliable water supplies, energy supplies, water-related facilities, recreational facilities, and flood-management facilities. Generally, an increase in use decreases streamflow from the point of use upstream and then downstream. This depletion effect is estimated using DWR and Reclamation’s operations simulation model. According to the Current Trends analysis from *The California Water Plan Update 2005: A Framework for Action* (DWR, 2005a), total water use in the Sacramento River hydrologic region will increase by 290 TAF from 2000 to 2030.

Water Quality

The clean water of the Sacramento River and its tributaries protects fish and other aquatic life while providing water for drinking, irrigation, and recreation. Management of surface water bodies for the migration and reproduction of Chinook salmon and other salmonids is a major concern in the Sacramento

River basin. All of these beneficial uses are largely dependent on acceptable water quality.

Several activities have adversely impacted water quality along the Sacramento River and its tributaries, thereby adversely affecting beneficial uses. For instance, increased pumping of Sacramento River surface water increases salinity in the Delta. (The increased pumping reduces river discharge to the Delta, allowing a greater intrusion of higher salinity San Francisco Bay water into the Delta.) Studies have documented increased salt contributions to the Delta from the Sacramento River. Other studies have shown that salinity, metals, pesticides, and other constituents deriving from large areas of the Sacramento River eventually discharge into the Delta. The *Sacramento River Toxic Chemical Risk Assessment Profile* (SWRCB, 1990) and several more recent studies have indicated that beneficial uses in the Sacramento River watershed are adversely affected by the presence of pollutants and sediments entering the watershed from various sources. Additional adverse impacts are attributable to sedimentation, high temperatures, altered flow and temperature regimes, introduction of exotic species, and loss of habitat.

The major reservoirs in the watershed cause changes in flow regime in downstream rivers, and the changes in flow regime effect changes in water temperature. Elevated river water temperatures threaten salmon, steelhead, and other fish and organisms, particularly in the Sacramento River between Keswick Dam and the RBDD. Water temperatures have been impacted in Mill, Clear, Deere, Battle, Butte, and Antelope Creeks and others. Localized fish kills have been attributed to increased water temperatures and temperature variations at several locations in the Sacramento River basin. Water quality conditions are being impacted by the increasing urbanization in the Central Valley and are likely to worsen if flows, temperature, or other water quality parameters important for sustaining anadromous fish and other aquatic organisms are not otherwise maintained.

Climate

Climate in the Primary Study Area and Extended Study Area would not be expected to change substantially by 2030. However, climate change, and its effects on California water resources over the longer term, is an uncertainty that must be acknowledged and addressed in planning documents. Climate would continue to change over time according to global features beyond the scope of the NODOS project. A discussion of the uncertainties associated with climate change and the potential effects climate change could have on the NODOS project is provided in Chapter 8.

Air Quality

Air quality in the Primary Study Area and Extended Study Area would not be expected to change measurably from existing conditions. Air quality would be determined primarily by local industrial, agricultural, and mobile sources external to a NODOS project.

Noise and Vibration

Noise and vibration in the Primary Study Area and Extended Study Area would not be changed in any measurable way.

Hazardous and Toxic Materials

No new hazardous or toxic material issues would be created if a NODOS project were not implemented.

Agricultural Resources

The existing trend of converting agricultural land uses to urban land uses would be expected to continue. It is likely this would be more prevalent in the urbanized areas of the Extended Study Area than in the less urbanized areas of the Primary Study Area.

Biological Resources

Efforts are underway by numerous agencies and groups to restore various biological conditions throughout the Primary Study Area and Extended Study Area. These efforts include elements of the CALFED programs, the Upper Sacramento River Conservation Area program, efforts by The Nature Conservancy and other private conservation groups, and numerous other programs and projects. Accordingly, major areas of wildlife habitat, including wetlands and riparian vegetation areas, could be expected to be protected and restored. However, as population and urban growth continue and land uses are converted to urban centers, many wildlife and plant species, especially those dependent on woodland, oak woodland, and grassland habitats, may be adversely affected.

In the Primary Study Area, all vegetation would be likely to remain as it is today, with most of the area consisting of annual grasslands and smaller areas of blue oak woodland communities and jurisdictional wetlands.

Through the extensive efforts of Federal and California wildlife agencies, populations of special-status species in the Primary Study Area would generally remain the same as under existing conditions. Although increases in anadromous and resident fish populations in the Sacramento River might continue through implementation of projects, some degradation would be likely to occur through actions that reduce Sacramento River flows or elevate water temperatures.

Cultural and Historical Resources

Fossils and artifacts located in the Primary Study Area and Extended Study Area would continue to be subject to collection by recreationalists.

Aesthetic and Visual Resources

In the mostly rural Primary Study Area, the existing landscape would be likely to remain the same; the visual characteristics of the Primary Study Area would be expected to experience very little change in the future. Development would most likely continue to occur in the urban and suburban areas of the Extended Study Area, thereby transforming that landscape.

Land-Use Planning

Development probably would continue in the urban and suburban areas of the Extended Study Area. In the mostly rural Primary Study Area, however, the existing landscape probably would remain rural, with some urban expansion for existing small communities.

Population Growth and Housing

The population of California is estimated to increase from about 35 million in 2000 to about 44 million by 2020 and to nearly 60 million by 2050 (California Department of Finance, 2007). The population of the Sacramento River and San Joaquin River Basins in the Central Valley is expected to increase from approximately 4.4 million people in 2000 to about 7 million by 2020 and to 10 million in 2040 (DWR, 2005a). In the Sacramento River Basin, the population is expected to increase from about 2.6 million to about 3.8 million by 2020, and to 5 million by 2040 (DWR, 2005a). To support these expected population increases, conversion of agricultural and other rural land to urban uses (i.e., housing) is anticipated.

Increases in population also will increase demands for electric, natural gas, water, and wastewater utilities; public services such as fire services, police protection, and emergency services; water-related infrastructure; and communication infrastructure. The increase in population and the aging “baby boomer” generation will increase the need for health services; between 2000 and 2010, many workers will reach 60 years and older. The general migration of retirees and older Americans from the colder northeastern regions to warmer southern regions is expected to continue. While many of the region’s high school graduates will leave the region for colleges and jobs in the San Francisco Bay area and southern California, the region’s abundant outdoor recreational opportunities and moderate housing opportunities are expected to attract increasing numbers of retirees from outside the region. Increasing numbers of residents, in turn, will produce increased employment gains, particularly in the sectors of retail sales, personal services, finance, insurance, and real estate.

As the population of the region continues to grow, recreation is expected to continue to be an important element of the local community and economy in the Primary Study Area. The demands on water also are expected to increase. As already described in the Hydrology section, without the NODOS project, California can expect to experience future water shortages.

Public Health and Hazards

There would be no changes to public health if a NODOS project were not implemented.

Seismic Activity

Faults and seismicity would not be affected if a NODOS project were not implemented.

Flood Management

Flood-management capabilities or capacity without an implemented NODOS project have not been quantified at this stage of the feasibility study.

Recreation

If population growth were to continue at a rate anticipated by several planning studies, the increased population would further impact existing recreational facilities.

Navigation, Transportation, and Traffic

In the future, it is likely that additional transportation routes will be constructed throughout the Extended Study Area to connect the anticipated population increase to the existing transportation infrastructure. It is likely that conditions for navigation will remain unchanged, and the Sacramento River will continue to be navigable to Knight’s Landing.

Public Services and Utilities

As the population of the Central Valley continues to grow, and the need for maintaining a healthy and vibrant industrial and agricultural economy continues, the demand for adequate and reliable water supplies will continue to increase. Updates to the 1998 CWP project a total water shortage in California of 5 MAF in 2030 (7 MAF in a drought year) (DWR, 2005a). It is anticipated that competition for available water supplies will intensify as water demands to support M&I and related urban growth increase relative to agricultural uses.

Socioeconomics and Environmental Justice

It is expected that socioeconomic conditions in the future will continue to be driven by outside factors, regardless of whether a NODOS project is implemented.

Indian Trust Assets

It is expected that the ITAs of the Colusa, Cortina, and Grindstone Rancherias and the Paskenta Band of Nomlaki Indians will remain consistent with those identified in Table 3-4.

Chapter 4
Development of Management Measures

The formulation of initial alternative plans for the NODOS Investigation is an iterative process that was initiated with the CALFED ROD (CALFED, 2000b). The planning process for the NODOS Investigation includes three major phases and related milestone products: the NODOS IAIR (Reclamation and DWR, 2006a), this PFR, and the future feasibility report and EIS/EIR.

The IAIR, which was documentation of the first stage in the planning process, identified several features and activities (structural and non-structural), called management measures, that meet the planning objectives. The IAIR summarized the preliminary screening for the management measures that focused on the evaluation of potential reservoir locations. Recognizing the limited scope of the IAIR and the iterative nature of the planning process, this chapter of the PFR revisits the problems and needs, planning objectives, and planning constraints; it provides a more complete evaluation of management measures, including the identification of additional measures, such as conveyance operations, groundwater and conjunctive use, and others. As the planning process continues after the PFR stage, it is likely that additional measures (i.e., mitigation features) will be considered in the feasibility report and EIS/EIR.

Following this Chapter 4 discussion of management measures, conveyance measures are addressed in Chapter 5. Chapter 6 describes the formulation of initial alternative plans comprising one or more of the measures discussed in Chapters 4 and 5. These alternative plans were formulated to achieve the objectives that were identified in Chapter 2.

The complete process for developing initial alternative plans and the final selection of the recommended plan is illustrated in figure 4-1.

CALFED Evaluation of Alternative Reservoir Locations

CALFED performed an initial evaluation of 52 potential reservoir sites within the larger CALFED solution area (figure 4-2). Further evaluation took place and is documented as part of the NODOS IAIR.

Specifically, CALFED looked for projects that could contribute substantially to its multiple purpose objectives. These included potential sites that could provide broad benefits for water supply, flood control, water quality, and the ecosystem. CALFED eliminated locations providing less than 0.2 MAF of storage and those that conflicted with CALFED solution principles, objectives, or policies.

This page left blank intentionally.

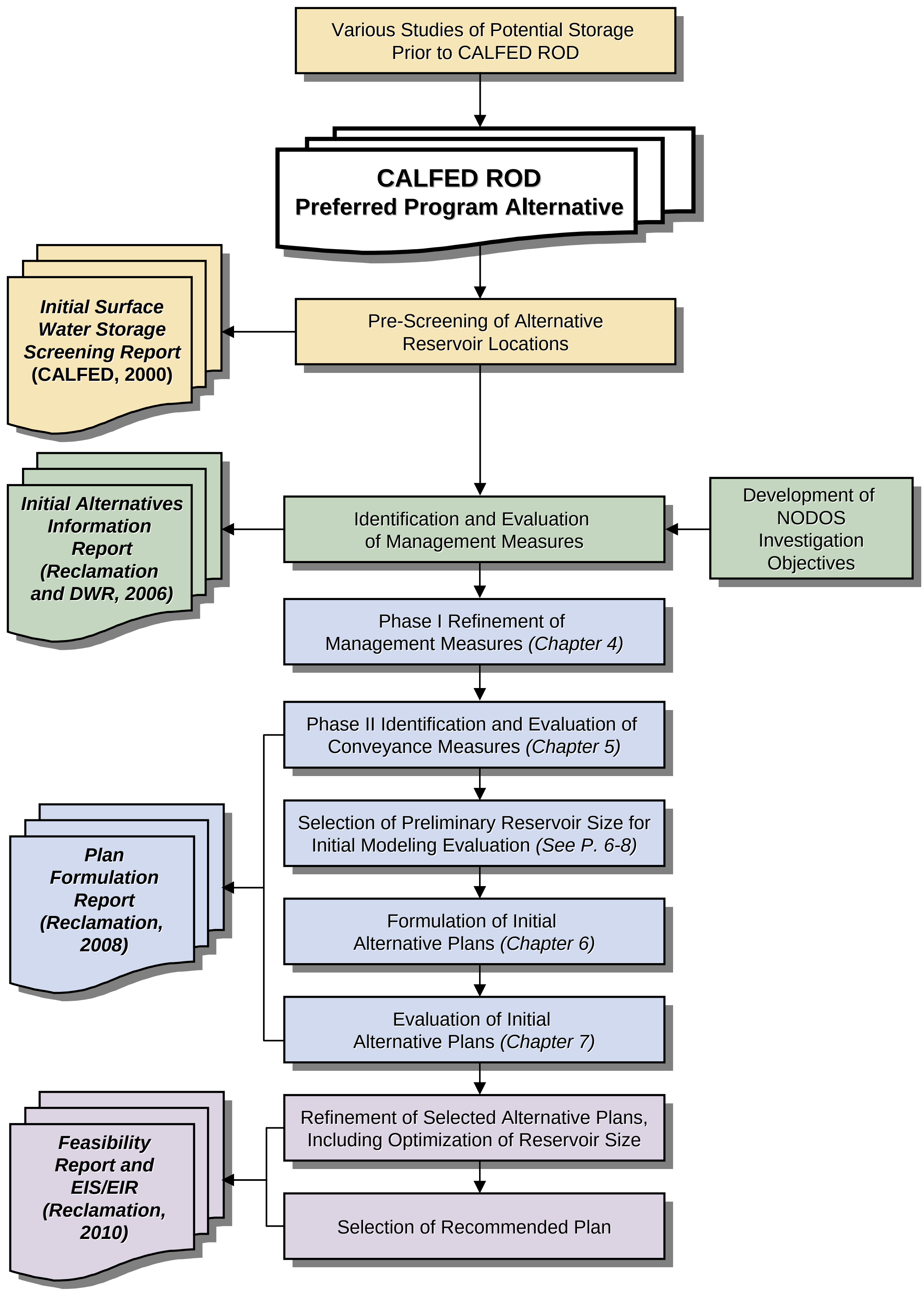


Figure 4-1. NODOS Feasibility Study Process

This page left blank intentionally.

K:\GIS\Projects\NODOS\PFR\Arcmaps\NODOSPFR_Figure42_SurfaceStorageComponent.mxd RK 8/30/07 SAC

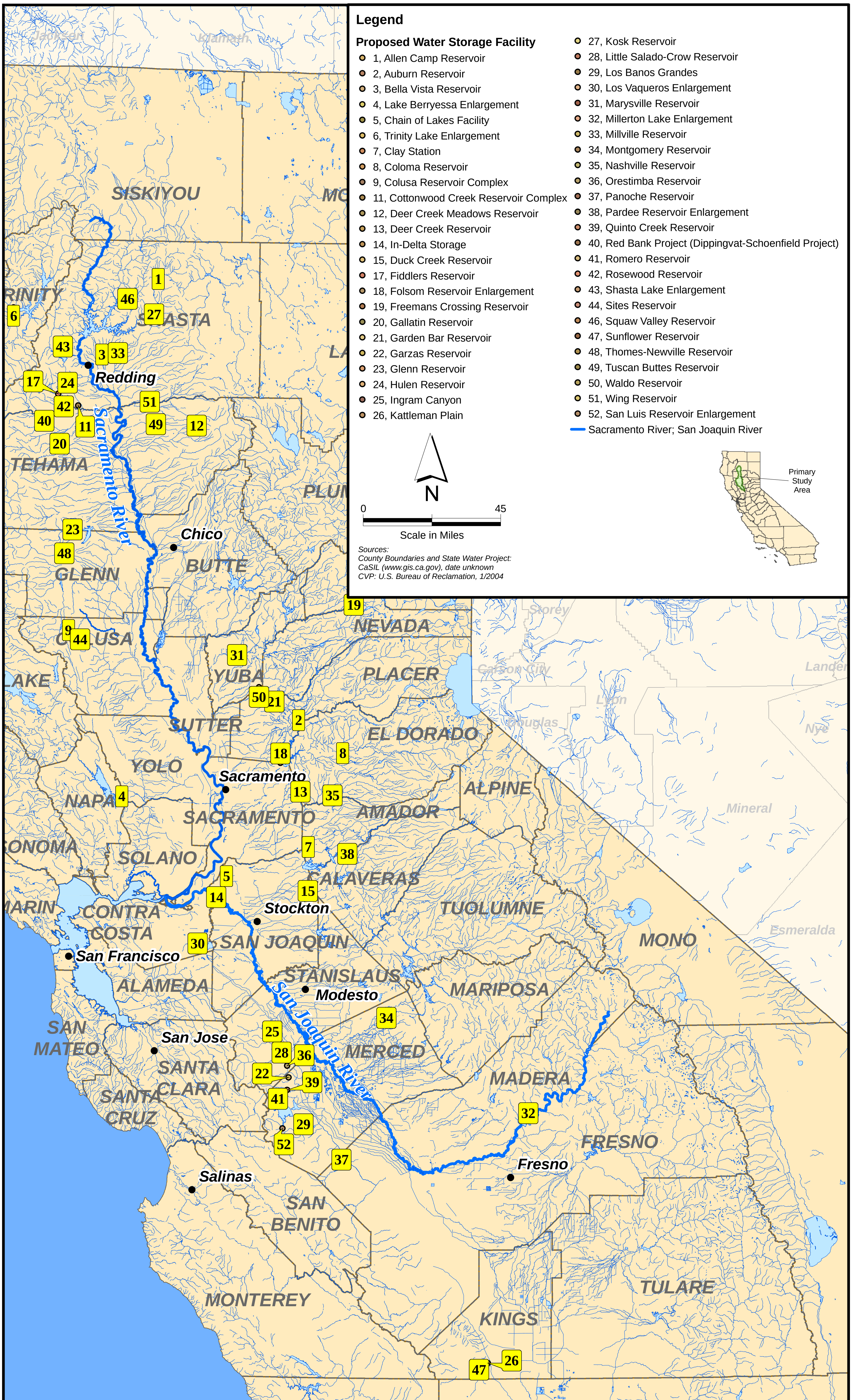


Figure 4-2. Surface Storage Component

This page left blank intentionally.

Of the 52 surface storage sites, 40 were removed from CALFED's list during the initial evaluation process detailed in the *Initial Surface Water Storage Screening Report* (CALFED, 2000e). Reservoir locations not retained for additional CALFED consideration still may be developed for other purposes.

The initial evaluation resulted in the selection of the following 12 surface storage sites for further CALFED consideration:

- Four North-of-the-Delta offstream storage alternatives, including the Red Bank Reservoir, Thomes-Newville Reservoir, Colusa Reservoir, and Sites Reservoir;
- In-Delta storage and enlargement of Los Vaqueros Reservoir;
- Four South-of-the-Delta storage alternatives, including Ingram Canyon Reservoir, Quinto Creek Reservoir, Panoche Reservoir, and Montgomery Reservoir; and
- Enlargement of Shasta Lake (Shasta Dam) and Millerton Lake (Friant Dam).

As a result of subsequent evaluation performed during the initial stage of the NODOS Investigation, the Red Bank project offstream storage alternative was not recommended for further inclusion in the development of measures because of considerable fishery and environmental impacts, as discussed in Appendix F of the IAIR (Reclamation and DWR, 2006a). Following are the issues associated with the Red Bank project.

- The California red-legged frog was observed in the reservoir footprint.
- To provide water supply to the reservoir, this measure would block a portion of the Cottonwood Creek watershed. The Cottonwood Creek watershed is a known anadromous fishery for fall-run and late-fall-run Chinook salmon.
- Cottonwood Creek is the largest un-dammed tributary to the upper Sacramento River, and it is the Sacramento River's most important source of sediment.
- Constructing this facility would require the removal and destruction of blue oaks, mixed oak and pine trees, and chaparral.
- Hydrologic conditions do not favor the Red Bank project unless a diversion dam is constructed across Cottonwood Creek to divert the flow needed to fill the Schoenfield site, which would impede anadromous fish passage and spring-run salmon and steelhead.
- Initial geotechnical investigations indicate the potential for excessive reservoir leakage for this project, compared to other viable measures considered in this study.

Identification and Evaluation of Management Measures

The next step in the formulation process is the identification of management measures, including reservoir locations, to meet the primary planning objectives that were described in Chapter 2 and, to the extent possible, to meet the secondary objectives, as well.

The central element in the evaluation of management measures for the NODOS Investigation is the selection of a reservoir location. Conveyance, operations, and numerous other features are dependent on the reservoir location selected. The IAIR (Reclamation and DWR, 2006a) included a detailed evaluation of the Sites, Colusa, and Newville locations, and a summary of that analysis is provided here. This focused discussion of reservoir locations is followed by a broader analysis of management measures to meet the project objectives.

Evaluation of Sites, Colusa, and Newville Reservoir Locations

- **Sites Reservoir—**Sites Reservoir, which would be about 10 miles west of the town of Maxwell, would be and formed by constructing dams on Stone Corral Creek and Funks Creek. Evaluation of Sites Reservoir has focused on a (maximum) 1.8-MAF reservoir, though a 1.2-MAF reservoir has been considered. A 1.8-MAF Sites Reservoir would require the construction of 9 saddle dams along the southern edge of the Hunters Creek watershed. Diversions from the Colusa Basin Drain, the Sacramento River, and local tributaries would provide potential sources of water supply for the Sites Reservoir project. These water sources have been studied with 14 optional conveyance systems from the Sacramento River and 2 gravity flow conveyance options from Stony Creek.

- **Colusa Reservoir—**Colusa Reservoir, a 3.0-MAF storage project, would include the area inundated by the 1.8-MAF Sites Reservoir plus the adjacent Logan Creek and Hunter Creek watersheds to the north (called the 'Colusa Cell'). The Colusa Cell requires four additional major dams along Logan ridge: One for Logan Creek and three for Hunters Creek and its tributaries. Colusa Reservoir requires seven saddle dams, compared to the nine required for Sites. Water supply source and conveyance options would be essentially the same as for Sites Reservoir, though total conveyance capacity probably would be greater to fill Colusa Reservoir (67 percent greater storage capacity).

- **Newville Reservoir—**Newville Reservoir would be upstream from Black Butte Lake, on the north fork of Stony Creek, 18 miles west of Orland. Alternative reservoir sizes being evaluated are 1.9 and 3.0 MAF. For the purposes of this evaluation, the smaller 1.9-MAF facility will be considered throughout the measures evaluation. Constructing a dam on North Fork Stony Creek and a small saddle dam at Burrows Gap would form the smaller proposed reservoir. Up to five additional saddle dams and a dike would be required for a 3.0-MAF reservoir alternative. Current study challenges include investigating a diversion facility that would allow anadromous fish migration in Thomes Creek while allowing the creek's flood flows to be diverted to Newville Reservoir. Multiple conveyance options are possible using existing infrastructure, such as canals, new infrastructure, such as canals, tunnels, and/or pipelines, or a combination of new and existing mechanisms to provide increased flexibility and reliability in the operation of existing and new infrastructure.

To provide a preliminary economic assessment to compare the average annual cost per yield for the three surface storage measures, costs for the construction of the reservoirs were compared with yield and unit cost per deliverable volume (table 4-1). The estimated average annual cost per yield is similar in magnitude for Sites and Newville Reservoirs. The capital cost of Colusa Reservoir would be approximately 4.4 times that of Sites Reservoir and 6 times that of Newville Reservoir, while the increase in yield over what would be produced by the Sites and Newville Reservoirs is approximately 16 percent. Because of this lack of efficiency, the Colusa Reservoir measure was not recommended as a selected measure for inclusion in the initial alternatives.

Table 4-1. Comparison of Storage, Yield, and Reservoir/Dam Construction Costs

Attribute	Measure		
	Sites Reservoir	Newville Reservoir	Colusa Reservoir
Gross Storage (acre-feet)	1,800,000	1,900,000	3,000,000
Dead Storage (acre-feet)	40,000	50,000	100,000
Capital Cost[1]	$320,250,000	$235,134,000	$1,411,520,000
2005 Capital Cost[2]	$339,500,000	$249,250,000	$1,496,500,000
Estimated Average Annual Cost[3]	$17,500,000	$13,000,000	$77,000,000
Estimated Average Annual Yield[4] (acre-feet)	274,000	275,000	328,000
Average Annual Cost / Yield (acre-feet)	$64 / acre-foot	$47 / acre-foot	$235 / acre-foot

Notes:

[1] Cost of major dam(s) only includes clearing and grubbing, foundation preparation, and embankment materials. It excludes other costs, such as lands, easements, rights-of-way, relocations, conveyance, or recreation. The basis year for costs is 2004.

[2] Average construction cost increase in California for 2004-2005 was 6.019%, rounded to the nearest $250,000 (California Construction Cost Index).

[3] A – average annual cost based on P = Project Life Cost ($2005), i = 5.125%, and n = 100 years (current amortization rate used by Reclamation). Formula is:

$$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$ where:

A = average annual cost
P = present-day total capital investment (project life capital cost)
i = annual amortization rate
n = number of amortization periods

[4] Based on SWP/CVP only (excludes local) (CALFED, 2000e).

Key:

CALFED = CALFED Bay Delta Program
CVP = Central Valley Project
SWP = State Water Project

The next step in the measures evaluation involved consideration of the environmental impacts associated with the Sites and Newville Reservoir locations. Table 4-2 presents the ecological and cultural attributes of several EQ resources. Potential effects of the two reservoirs on these resources are displayed using quantity indicators.

Table 4-2. Relative Environmental Impacts Comparison

Preliminary Site Survey Results by Biological/Ecological Attributes	Sites Reservoir	Newville Reservoir
Wetland (acres)	249	**525**
Riparian (acres)	75	**476**
Blue oak woodland (acres)	924	**2,532**
Valley oak woodland (acres)	4	**104**
Valley elderberry longhorn beetle		
No. of elderberry stems greater than 1-inch diameter	684	**1,204**
No. of elderberry stems with emergence holes	18	**222**
Total number of bird species	**160**	146
Number of California and Federal bird species of concern	**25**	19
Prehistoric cultural resource components	45	**240+**
Historic cultural resource components	27	**65+**

Note:
The larger value of the two for each attribute considered is highlighted by **bold** text

The review of potential environmental impacts for the Sites Reservoir and Newville Reservoir measures indicates a much greater impact potential for the Newville Reservoir. With the exception of potential impacts to the number of California and Federal bird species of concern, possible project-related impacts for all of the other biological/ecological attributes are higher for Newville Reservoir. Because of the scope of environmental impacts and the high cost of associated mitigation, it was decided not to recommend the Newville Reservoir measure for inclusion in the initial alternatives.

To support the evaluation described, the three offstream surface storage alternatives were grouped by common attributes (table 4-3).

Table 4-3. Common Attributes of Reservoir Alternative Locations

Reservoir Alternative Locations	Common Attributes
Sites, Newville, and Colusa Reservoirs	The dominant natural plant community in the Sites, Newville, and Colusa Reservoir areas is California annual grassland.
	Habitat for the VELB occurs throughout the Primary Study Area. VELB emergence holes were found, but no adult beetles were observed at any of the proposed reservoir sites.
	No threatened or endangered amphibians were found within the Sites, Newville, or Colusa Reservoir areas. (Amphibian surveys were not conducted at the Newville Reservoir area during the current efforts. Findings for the Newville Reservoir were from studies conducted in the early 1980s.)

Table 4-3. Continued

Reservoir Alternative Locations	Common Attributes
Sites, Newville, and Colusa Reservoirs (Cont'd)	Review of existing databases indicated that nine California and federally listed avian species could be found within the counties covering the western side of the Sacramento Valley and foothills. Three of these species were identified during field surveys, including sporadic wintering use by both adult and immature bald eagles, which have been documented at each of the reservoir sites.
Newville Reservoir	Jurisdictional wetlands and waters of the U.S. are present in all candidate reservoir areas. The Newville Reservoir area, with 413 acres of jurisdictional wetlands and 231 acres of other waters of the U.S., has the most acreage of all the reservoir areas.
	Thomes Creek was surveyed in 1980-81, in 1981-82, and in 1999 for the presence of salmon and steelhead. Fall and late fall-runs of salmon and steelhead were seen during these surveys. In the 1999 survey, one adult spring-run Chinook salmon was found.
Sites and Colusa Reservoir	The streams flowing through the Sites Reservoir and Colusa Cell are warm-water streams with poor water quality. These streams do not support habitat for anadromous fish and are generally intermittent in nature. Sampling of game and non-game fishes within these streams found very few fish above 6 inches long, suggesting that fish only rear in these areas. Hitch is the most abundant fish found in both reservoir areas.
Colusa Reservoir	The embankment-to-storage ratio for the Colusa Cell is high, increasing the project cost considerably. This results primarily from the very large embankments required to construct the four main dams and seven saddle dams that will form the Colusa Cell. This large embankment volume increases the cost of the project and the unit cost of water considerably.

Key:
U.S. = United States
VELB = valley elderberry longhorn beetle

Sites Reservoir was considered to have satisfactorily provided benefits for the elements of the planning objectives, with the exception of the habitat element of anadromous fish survival. Based on the ability of Sites Reservoir to address the elements of the primary and secondary objectives, it might be considered as a stand-alone project. However, additional measures could be incorporated to improve the habitat element of the anadromous fish survival objective.

Measures to Address Primary Planning Objectives

The following management measures have been identified to address each of the primary planning objectives. These measures were identified initially in the IAIR (Reclamation and DWR, 2006a) and subsequently refined in study team meetings through the PFR process.

Water Supply

Various potential water management measures were identified to address the primary water supply objective. This objective includes increasing water supplies, water supply reliability, and Sacramento Valley water management flexibility for agricultural, M&I, and environmental purposes, including the CALFED EWA, the ERP, and other programs. Table 4-4 identifies the measures considered, their potential to address the primary objective, and whether they were retained or not recommended for further consideration.

The water supply measures identified were separated into eight categories: (1) surface water storage, (2) reservoir reoperation, (3) groundwater storage, (4) conjunctive water management, (5) coordinated operation and precipitation enhancement, (6) demand reduction, (7) water transfers and purchases, and (8) conveyance and Sacramento-San Joaquin River Delta (Delta) export.

Surface Water Storage

Sites Reservoir – Sites Reservoir (figure 4-3) would be about 10 miles west of the town of Maxwell. Construction of Sites Reservoir would contribute directly to the primary planning objectives, and previous studies have shown that the project would be technically feasible. This measure was retained for further development.

Colusa Reservoir – A detailed discussion of the surface storage management measure precedes this summary. Colusa Reservoir (figure 4-3), a 3.0-MAF storage project, would include the area inundated by the 1.8-MAF Sites Reservoir. The Colusa Reservoir would affect twice the land area of Sites Reservoir, with little increase in project benefits. In addition, water from the Colusa Reservoir would have a much higher unit cost, in part because of the larger amount of earthwork required for dams and appurtenant structures. This reservoir site would require substantial embankment construction to impound a sufficient quantity of water, resulting in considerable project expenses; this would translate into higher unit costs for stored water. This measure was not recommended for inclusion in the initial alternatives as a result of its greatly reduced efficiency.

Newville Reservoir – A detailed discussion of the surface storage management measure precedes this summary. Newville Reservoir (figure 4-3) would be upstream from Black Butte Lake, 18 miles west of Orland. The static lift (pumping) above the TC Canal that would be required for this measure would be the highest of the three new storage projects. The Newville Reservoir project's environmental impacts would be much greater. The public disclosure of these findings has reduced local interest and support for any Newville Reservoir project. In addition, private landowners within the reservoir footprint are opposed to giving access to property for the purpose of collecting data for further analyses. As a result of the greater environmental impacts and the lack of local support to advance this measure, the Newville Reservoir measure was not recommended for inclusion in the initial alternatives.

Table 4-4. Management Measures to Address Water Supply Needs

Management Measures Considered	Potential to Address Primary Objectives	Status/Rationale
Surface Water Storage		
Construct Sites Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	High potential to meet all components of this primary objective.	Retained – Measure is consistent with primary planning objectives and would contribute directly to secondary planning objectives.
Construct Colusa Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	High potential to meet all components of this primary objective.	Not recommended – Measure would affect twice the land area impacted by Sites Reservoir with minimal increase in benefits, resulting in a much higher unit cost for water.
Construct Newville Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	High potential to meet all components of this primary objective.	Not recommended – Measure would have considerable environmental impacts, including impacts to jurisdictional wetlands and impacts to fall run salmon and steelhead.
Raise Shasta Dam	Moderate to high potential to increase water supply reliability.	Not recommended – Measure is being considered as part of the Shasta Lake Water Resources Investigation and a separate feasibility study under Public Law 96-375.
Construct new conservation storage reservoir(s) upstream from Shasta Reservoir	Low potential – Several sites/projects would provide only marginal increases to water supply reliability.	Not recommended – Measure would provide only marginal increases to water supply reliability, coupled with higher unit costs, inconsistency with CALFED evaluation criteria, and lack of local support.
Construct new conservation storage on other tributaries to the Sacramento River downstream from Shasta Dam	Moderate potential – Several sites/projects (e.g., Auburn Dam) would increase system water supply reliability.	Not recommended – Measure would provide only marginal increases to water supply reliability, coupled with higher unit costs, and inconsistency with CALFED evaluation criteria.
Construct new conservation water storage south of the Sacramento-San Joaquin Delta	Moderate potential for surface water storage projects (upper San Joaquin River) to increase water supply reliability for CVP, primarily in the San Joaquin Valley and Tulare Lake Basin.	Not recommended – Measure is outside of the Primary Study Area. Los Vaqueros expansion and San Joaquin River storage investigations are proceeding separately.
Increase total or seasonal conservation storage at other CVP/SWP/local facilities	Moderate potential – Would require several projects to contribute to water supply reliability (e.g., raise dams for both Folsom and Berryessa).	Not recommended – Measure would not be an efficient alternative to NODOS, given a substantially higher unit cost for increased water supply. Known efforts to increase space in other northern California CVP and SWP reservoirs have been rejected by CALFED.
Reservoir Reoperation		
Increase effective conservation storage space in existing north-of-the-Delta storage facilities by increasing the efficiency of reservoir operation for water supply reliability	Moderate to high potential for incremental increase in water supply reliability at Shasta Reservoir.	Not recommended – Measure is being considered through the Shasta Lake Water Resources Investigation and a separate feasibility study under Public Law 96-375.
Increase conservation storage space in existing north-of-the-Delta storage facilities by reallocating space from flood control	Low potential –Considerable space would have to be reallocated to improve water supply reliability.	Not recommended – Measure would have very low potential for implementation, given adverse impacts on flood control.
Increase conservation pool in existing north-of-the-Delta storage facilities by encroaching on dam freeboard	Low potential – Very small space increase would be possible.	Not recommended – Measure would have very limited potential to encroach on existing freeboard above gross pool (only 9.5 feet at Shasta). It would have a high relative cost to resolve uncertainty issues related to encroachment.
Groundwater Storage		
Construct offstream groundwater facilities near the Sacramento River downstream from Shasta Dam	Low to moderate potential – Would provide limited increase in water supply with moderate increase in water supply reliability. Benefits would be realized only at a local level.	Not recommended – Measure would not effectively contribute to water quality or anadromous fish survivability objectives. If implemented on a large scale, increased groundwater pumping might have negative impacts on stream flow and temperature in the Sacramento River. This alternative also would have considerable legal and public acceptance challenges because of water rights issues and potential third-party impacts.
Develop a large-scale aquifer storage and recovery project in the Primary Study Area	Moderate potential to enhance system yield for water users.	Not recommended – Measure would involve unproven technology on a scale comparable to NODOS and could have adverse third-party impacts. This alternative also would have considerable legal and public acceptance challenges.
Conjunctive Water Management		
Develop additional groundwater storage south of the Sacramento-San Joaquin River Delta	Moderate potential to enhance system yield for many potential uses.	Not recommended – Measure would be located outside of the Primary Study Area.
Increase opportunities for conjunctive use of surface and groundwater storage near the Sacramento River, downstream from Shasta Dam	Moderate to high potential to enhance system yield for many potential uses.	Retained – Measure is consistent with primary planning objectives. Combination of several measures would provide opportunities for conjunctive use.

Table 4-4. Continued

Management Measures Considered	Potential to Address Primary Objectives	Status/Rationale
Coordinated Operation and Precipitation Enhancement		
Improve Delta export and conveyance capability through coordinated CVP and SWP operations	Moderate potential to enhance system yield when combined with new offstream storage. High potential to help increase water supply reliability south of the Delta.	Not recommended – JPOD[1] is being actively pursued in other programs and is therefore part of the future no action condition. Measure is not an alternative to increasing water supply reliability north of the Delta. It does not address planning objectives or constraints/principles/criteria.
Implement additional precipitation enhancement	Low potential to improve drought-period water supply reliability.	Not recommended – Measure would not be an effective alternative to new storage. It would offer very limited potential to benefit drought-period water supply reliability. Current levels of enhancement are included in the No Action Alternative.
Demand Reduction		
Implement water-use efficiency methods	Moderate potential to benefit overall California water supply reliability.	Retained – Although water-use efficiency does not increase water supplies, conservation is being actively pursued as part of the CALFED program. Conservation must be considered as an element of any plan addressing the future of water in California. The measure is retained as a complementary action in the No Action Alternative.
Retire agricultural lands	Moderate potential – Would reduce water demand rather than increase ability to meet projected future demands.	Not recommended – Measure would not be an alternative to new storage. It would not address planning objectives and constraints/criteria. Land retirement test programs are being performed by Reclamation. On a large scale, it could have substantial negative impacts on agricultural industry.
Water Transfers and Purchases		
Transfer water between users and source shift (use groundwater in lieu of surface water)	Very low potential – Would not generate a sufficient increase in water supply reliability.	Retained – Measure would not be an alternative to new water sources or a reliable substitute for new storage with NODOS. The measure is likely to be accomplished with or without additional efforts to develop new sources and is retained as a complementary action in the No Action Alternative.
Conveyance and Delta Export		
Extend Tehama-Colusa Canal to Vacaville	Low potential – Would not improve the water supply reliability of existing contractors.	Not recommended – Measure would not be an alternative to new storage north of the Delta. It would not sufficiently address the planning objective for water supply reliability. The focus for the NODOS planning study is on improving supply reliability for existing contractors, not establishing new contracts.
Expand Banks Pumping Plant	Moderate potential to help increase water supply reliability south of the Delta.	Not recommended – Measure would not be an alternative to new storage north of the Delta. It would not address the planning objectives or constraints/principles/criteria. It is likely to be accomplished with or without additional efforts to develop new sources.
Construct California Aqueduct intertie	Moderate potential to help increase water supply reliability south of the Delta.	Not recommended – Project is being actively pursued by other CALFED programs. It would not be an alternative to increasing water supply north of the Delta. It would not address planning objectives or constraints/principles/criteria. It is likely to be accomplished with or without additional efforts to develop new sources.

Notes:
[1] The joint operation of the two projects (SWP and CVP) is commonly referred to as the JPOD.

Key:
CALFED = CALFED Bay-Delta Program
CVP = Central Valley Project
JPOD = joint point of diversion
NODOS = North of the Delta Offstream Storage
SWP = State Water Project

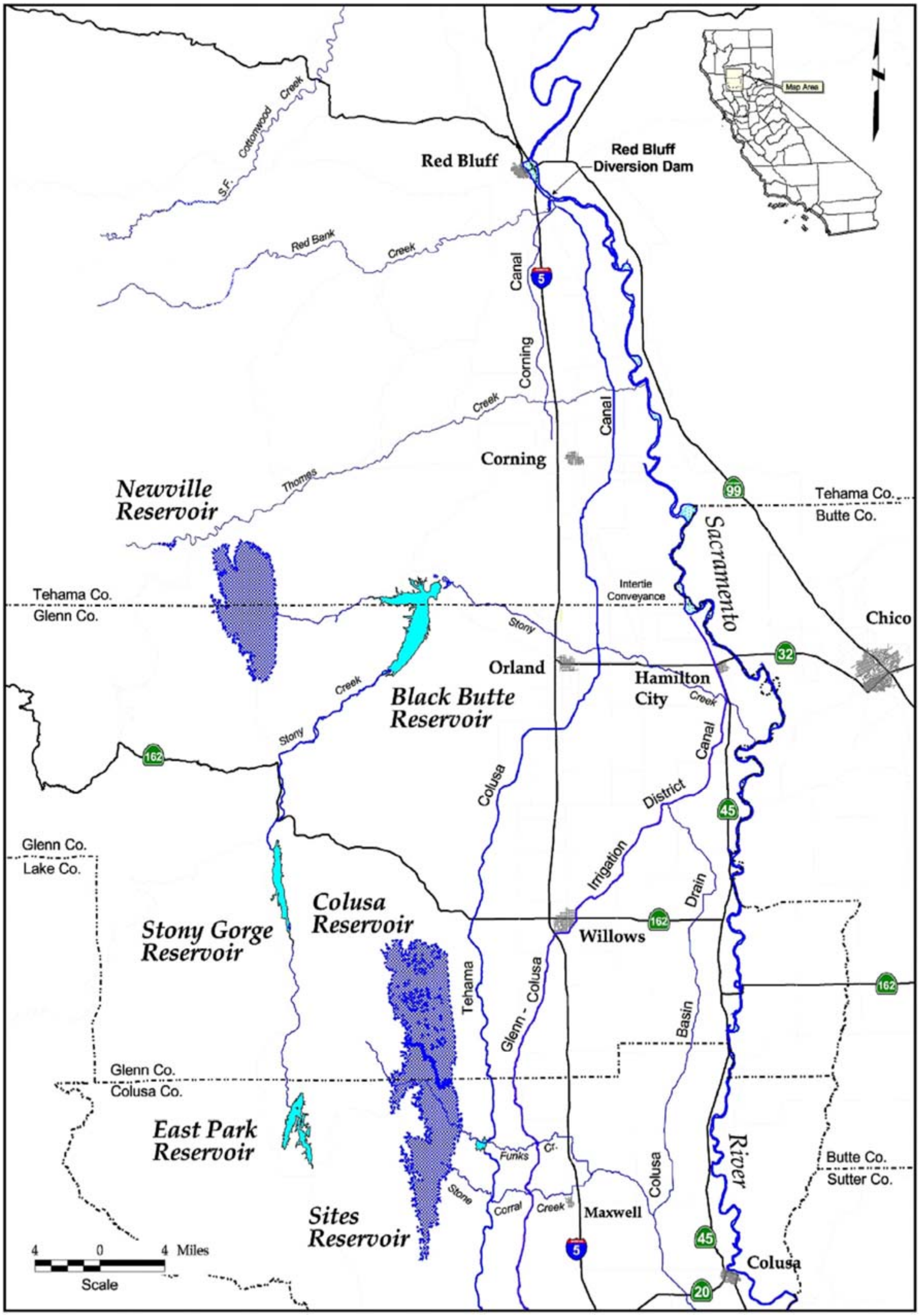


Figure 4-3. Alternative Offstream Locations for NODOS

This page left blank intentionally.

Increase Conservation Storage Space in Shasta Reservoir by Raising Shasta Dam – This measure would consist of increasing the amount of available space for conservation storage in Shasta Reservoir by raising Shasta Dam. Raising Shasta Dam could increase water supply reliability for Sacramento Valley users, the SWP, and the CVP, improve Delta water quality, contribute to ecosystem restoration, and provide water to support the EWA.

Raising Shasta Dam is being considered separately in a feasibility study authorized by Public Law 96-375; therefore, raising Shasta Dam was not recommended for further consideration for the NODOS Investigation.

Construct New Conservation Storage Reservoir(s) Upstream from Shasta Reservoir – This measure would consist of constructing dams and reservoirs at one or more locations upstream from Shasta Lake, primarily for increased water conservation storage and operational flexibility. Numerous reservoir storage projects have been considered, and many have been constructed in the water shed upstream from Shasta Lake. These potential project sites would be capable of only marginally improving water supply reliability to the CVP. An additional offstream storage site at Goose Valley, near Burney, was considered; however, the likely costs to develop the project would exceed water supply benefits by at least 2 to 1. Further, though larger project sizes at the Goose Valley site are physically feasible, there is little potential for water to fill the facility.

Accordingly, this site was not considered further, and this measure was not recommended for further consideration in the NODOS Investigation.

Construct New Conservation Storage on Other Tributaries to the Sacramento River Downstream from Shasta Dam – Numerous onstream surface water storage projects along tributaries to the Sacramento River downstream from Shasta Dam have been investigated in past studies. Several of those projects could contribute substantially to increasing water supply reliability, including the Cottonwood Creek Project (1.6 MAF on Cottonwood Creek north of Red Bluff), the Auburn Dam Project (up to about 2.3 MAF on the Middle Fork American River near Sacramento), and the Marysville Lake Project (920,000 AF on the Yuba River near Marysville). Although each of these potential projects could contribute considerably to increasing the water supply reliability of the CVP and SWP systems, California and local interests have rejected them as potential candidates for new water sources. Each has been eliminated from further consideration primarily because it would not contribute to the primary planning objectives or because it would have overriding environmental issues and opposition. This measure was not recommended for further consideration in the NODOS Investigation.

Construct New Conservation Surface Water Storage South of the Delta – Numerous surface water storage sites have been identified in the past along the eastern and western sides of the San Joaquin Valley and in areas to the east of the Delta, near Stockton. Potential onstream storage site projects include enlarging Pardee Reservoir on the Mokelumne River, enlarging and modifying Farmington Dam on Littlejohns Creek, and enlarging Friant Dam on the upper San Joaquin River. Numerous potential offstream storage site projects also have been considered in the San Joaquin Valley, including Los Vaqueros enlargement, Ingram Canyon Reservoir, Quinto Creek Reservoir, and Panoche Reservoir. Most of the potential onstream or offstream storage projects south of the Delta were not recommended for further consideration in this study because they would not contribute to the planning objectives of the NODOS Investigation or be as efficient or effective as NODOS. Separate feasibility-scope investigations for both the Los Vaqueros enlargement and upper San Joaquin River storage investigations were authorized in Section 215 of Public Law 108-7. These studies are independent of the NODOS Investigation and address specific planning objectives that, while unique to their geographic areas, differ from those of the NODOS Investigation.

Increase Total or Seasonal Conservation Storage at Other CVP/SWP/Local Facilities – This measure would consist primarily of providing additional conservation storage space in other major CVP and/or SWP reservoirs in the Sacramento River watershed by enlarging existing dams and reservoirs. Candidate projects include additional storage in facilities such as Lake Berryessa on Putah Creek, Folsom Reservoir on the American River, Trinity Lake on the Trinity River, and Lake Oroville on the Feather River. All known efforts to increase storage space in other northern California CVP or SWP reservoirs were rejected by CALFED and local interest groups. For these reasons, and because this measure would not address all NODOS Investigation objectives or constraints, this measure was not recommended for further consideration.

Reservoir Reoperation

Increase the Effective Conservation Storage Space in Existing North-of-the-Delta Facilities by Increasing the Efficiency of Reservoir Operations for Water Supply Reliability – This measure would consist of changing the flood control operations of Shasta Dam, Oroville Dam, Folsom Dam, or other facilities north of the Delta without reducing the maximum flood pool. The goal would be to increase water supply reliability. This measure would focus on revising the operation rules for flood control so that the facilities could be managed more efficiently for flood control, thereby freeing some seasonal storage space for water supply. This measure is, in part, being considered through the Shasta Lake Water Resources Investigation and a separate feasibility study under Public Law 96-375. The potential for increased water supply reliability through reoperation efficiencies for flood control is limited. This measure would not fully address the NODOS Investigation objectives and was not recommended for further consideration in this investigation.

Increase the Conservation Storage Space in Existing North-of-the-Delta Facilities by Reallocating Space from Flood Control – This measure would consist of decreasing the maximum seasonal flood control storage space in existing reservoirs north of the Delta and dedicating that space to water supply reliability in the CVP. This would result in an increase in the frequency of flooding and flood damage along the downstream Sacramento River. This measure was not recommended for further consideration primarily because of its adverse impacts on flood control.

Increase the Conservation Pool in Existing North-of-the-Delta Facilities by Encroaching on Dam Freeboard – This measure would consist of increasing the conservation storage space by raising the gross pool elevation without raising the dams. It is estimated that major modifications to dams and appurtenances would be required to allow operational encroachments on the design freeboard of the dams, only to gain a small potential increase in water supply yield. This measure was not recommended for further development, primarily because it has low potential to effectively address the planning objective.

Groundwater Storage

Construct Groundwater Storage Facilities near the Sacramento River, Downstream from Shasta Dam – This measure would involve using groundwater banking opportunities in the Primary Study Area to increase water supply and water supply reliability for users in the Primary Study Area. DWR data show that Sacramento Valley aquifers are generally fully recharged during years of normal participation (DWR, 2003a). Therefore, groundwater banking areas are not as prevalent in northern California as they are in other areas (e.g., the San Joaquin Valley). Reclamation, DWR, and others have pursued ongoing groundwater programs, such as the SVWMP and Phase 8, to study and optimize the use of groundwater resources. The SVWMP and EWA seek to include all likely and willing participants in the Primary Study Area and may represent the maximum groundwater participation at this time. The projects within these programs have been developed to pursue additional water supply in the Sacramento Valley and are currently under study to ensure that any additional groundwater extraction under these programs would not violate the basin management objectives established in local groundwater management plans. Additional stand-alone groundwater storage facilities under NODOS (requiring approximately 400 TAF of yield) would challenge existing resources and groundwater programs, violate groundwater basin management objectives, and open basins to unnecessary risks (e.g., overdraft, water quality degradation, etc.). As an alternative, using groundwater extracted under existing groundwater programs in conjunction with a NODOS surface water reservoir would provide enhancements in water supply reliability without the challenges and risks of the stand-alone alternative. Therefore, the stand-alone groundwater alternative was not recommended for further consideration.

Develop a Large-Scale Aquifer Storage and Recovery (ASR) Project In the Study Area – This measure would consist of injecting and storing water in a suitable aquifer when excess surface water was available and recovering stored water during times when it was needed.

The Central Valley RWQCB, presiding over an ASR pilot project in Roseville, identified two general issues of concern: potential aquifer water quality degradation, and contamination from chlorine disinfection byproducts. In addition, California water rights laws may impact ASR system implementation by creating additional permitting requirements (e.g., one permit to divert the water, one permit to store the water, and one permit to extract the water), limiting the amount and timing of water availability or requiring the ASR facility to show that operations would not impact more senior water rights holders.

Construction and O&M costs for a system in the Primary Study Area without extensive pilot testing would have very large uncertainty and might be prohibitive. Therefore, the feasibility of implementing and permitting an ASR system in the Primary Study Area, while meeting the NODOS Investigation objectives, is equally uncertain. Currently, an ASR alternative to surface water storage is not supportable, and this alternative for the NODOS Investigation was not recommended for further consideration.

Conjunctive Water Management

Develop Additional Conservation Groundwater Storage South of the Delta – This measure would consist of either developing new groundwater recharge projects south of the Delta or contributing to existing recharge projects. This measure would have limited potential to allow water released from NODOS to be stored temporarily south of the Delta for later use during critical dry periods. Conjunctive use of water in the DMC or California Aqueduct is being pursued actively in other CALFED programs. This measure would not be as effective or efficient in meeting the primary objective for water supply as new storage in NODOS, and it would not benefit anadromous fish in the Sacramento River. Accordingly, this measure was not recommended for further consideration in the NODOS Investigation.

Increase Opportunities for Conjunctive Use of Surface and Groundwater Storage Near Sacramento River Downstream from Shasta Dam – This measure would consist of using groundwater storage and/or transfers in conjunction with new surface storage. It would include developing operational strategies to coordinate groundwater use within existing programs with a potential north-of-the-Delta offstream-storage project. Operations of a NODOS project would be coordinated with the SVWMP, the EWA, the Yuba Accord Conjunctive Use Program, the Drought Risk Reduction Investment Program, the Dry Year Program, and transfers from willing sellers to buyers. A NODOS project would offer greater flexibility to the system by providing a place to “park” or store SVWMP/EWA water until it was needed or there was available pumping capacity at the Delta Pumps. This alternative has the potential to address the primary planning objectives and is consistent with CALFED ROD goals for water storage (CALFED, 2000b).

Coordinated Operation and Precipitation Enhancement

Improve Delta Export and Conveyance Capability Through Coordinated CVP and SWP Operations – This measure would consist primarily of improving Delta export and conveyance capability through more effectively coordinating the management of surplus flows in the Delta. A specific application of the measure is the joint point of diversion (JPOD). JPOD operations would allow Federal and California water managers to use excess or available capacity in their respective south Delta diversion facilities at the Tracy and Banks pumping plants. This measure is being investigated separately by Reclamation and DWR. This measure was not recommended for further consideration in the NODOS Investigation because it would not address the primary planning objectives effectively, and it is likely to be implemented, in some form, independent of the NODOS project.

Implement Additional Precipitation Enhancement – Precipitation enhancement is a process by which clouds are stimulated to produce more rainfall or snowfall than they do naturally.

Precipitation enhancement is not a short-term remedy for droughts because supply increases can only be achieved during years when it would otherwise rain or snow naturally—in other words, in above-average precipitation years. Accordingly, precipitation enhancement is not an alternative to new system storage, which focuses on conserving water in wetter years for use in dryer years. This measure was not recommended for further consideration in the NODOS Investigation primarily because it would not address the planning objectives and is not an alternative to NODOS.

Demand Reduction

Implement Water-Use Efficiency Methods – Potential critical impacts to agricultural and urban resources resulting from water shortages could be reduced through WUE methods. The *California Water Plan Update 2005: A Framework for Action* (DWR, 2005a) identified a variety of agricultural and urban WUE measures. Supporting information to the plan is contained in the *CALFED Bay-Delta Program Water Use Efficiency Element, Water Use Efficiency Comprehensive Evaluation* (CALFED, 2006). This CALFED document indicated that the potential for recovering what are currently deemed irrecoverable agricultural losses in the Sacramento and San Joaquin River basins could be about 142,000 AF on an average annual basis, with resulting unit costs of about $200 per AF. Larger amounts are technically feasible; however, the cost to achieve these amounts increases considerably. The report also identified various urban WUE programs with the potential to reduce average annual urban water use by about 1.1 million acres per year by 2030 through a series of BMPs.

WUE would help reduce demands and should be vigorously pursued by CALFED and local interests to help offset future shortages in water supplies. Accordingly, the concept of WUE was retained as an element of the No Action Alternative.

Retire Agricultural Lands – Although the equivalent unit cost of water for this measure might be competitive with other potential water sources, this measure was not recommended for further consideration, primarily because it is likely that it would have only a limited ability to help meet future water demands outside of the San Joaquin Valley. There might be a limited ability to successfully apply this measure at costs similar to the cost for less productive lands, and this measure would not address the other planning objectives of the NODOS Investigation.

Water Transfers and Purchases

Transfer Water Between Users and Source Shifting – Transfers and source shifting would not generate new water for the CVP. They would simply transfer surface water from a seller willing to forgo surface water use, for a time, to a willing buyer. In addition, ongoing infrastructure limitations on conveying water from north to south of the Delta are expected to encourage the most feasible and reliable water transfers to be implemented under future no action conditions. Any remaining opportunities for transfers probably would be small, include high uncertainties, be difficult to implement, and be more costly. Consequently, this measure was retained as a complementary action, but it was not considered to be a long-term reliable substitute for new storage in NODOS.

Conveyance and Sacramento – San Joaquin River Delta (Delta) Export

Extension of the Tehama-Colusa Canal to Vacaville – The TC Canal could be extended to Vacaville to deliver water to additional service areas. However, extending the TC Canal does not deliver water to the locations required to meet the NODOS primary objectives of increased survivability of anadromous fish and other aquatic species or Delta water quality improvement. This measure also would result in adverse environmental impacts. Therefore, this measure was not recommended for further consideration under the NODOS Investigation.

Expand Banks Pumping Plant – The current allowable pumping capacity at the SWP Banks Pumping Plant is 6,680 cfs. Until the resolution of OCAP biological opinion issues, Reclamation and DWR are suspending efforts to construct fish protection features under the SDIP to allow an increase in the allowable pumping capacity to 8,500 cfs during certain seasonal periods. This measure is being considered separately under the SDIP, and it does not contribute to meeting the NODOS planning objectives. Therefore, it was not recommended for further consideration in the NODOS Investigation.

Construct Delta Mendota Canal/California Aqueduct Intertie – The pumping capacity of the CVP Tracy Pumping Plant into the DMC is 4,600 cfs. However, given canal capacity limitations, the effective capacity is limited to 4,200 cfs. Reclamation is studying the construction of an intertie that consists of a pipeline connection between the DMC and the California Aqueduct (CA) with a 450-cfs pumping plant at the DMC that would allow water to be pumped from the DMC to the CA via an underground pipeline. Because the CA is approximately 50 feet higher in elevation than the DMC, up to 900 cfs could be conveyed from the CA to the DMC using gravity flow. However, because this measure would not contribute to the planning objectives of NODOS or identified plan formulation constraints, principles, and criteria, it was not viewed as a potential alternative to new storage in the NODOS Investigation. Accordingly, it was not recommended for further consideration.

Anadromous Fish Survivability

Various potential water management measures were identified to address the primary objective of increasing the survival of anadromous fish populations in the Sacramento River and increasing the health and survival of other aquatic species. Table 4-5 identifies measures considered and whether they were retained or deleted. Following is a brief discussion of the array of measures considered, which are separated into three broad categories: improved fish habitat; improved water flows and quality; and improved fish migration.

This section summarizes the rationale for retaining or not retaining measures for further consideration, as presented in table 4-5.

Improved Fish Habitat

Restore Abandoned Gravel Mines Along the Sacramento River – Instream gravel mining has contributed to the degradation of aquatic and floodplain habitat. These activities have created large artificial pits at various locations in the Primary Study Area that disrupt natural geomorphic processes and riparian regeneration. High fish mortality from stranding and unnatural predation occurs in many abandoned pits that either lose their connections with the river during low-flow periods or otherwise interfere with effective fish passage between the river and mine area.

This measure would consist of acquiring, restoring, and reclaiming several inactive gravel mining operations along the Sacramento River to create valuable aquatic and floodplain habitat. This measure was retained for potential further development as part of the NODOS Investigation because it may have the potential to successfully address the primary objective of anadromous fish survival.

This page left blank intentionally.

Table 4-5. Management Measures to Address Anadromous Fish Survivability

Management Measures Considered	Potential to Address Primary Objectives	Status/Rationale
Improved Fish Habitat		
Restore abandoned gravel mines along the Sacramento River	Moderate to high potential – Addresses primary planning objective.	Retained – Increased potential to address the primary objective and high likelihood of success. Consistent with other anadromous fish programs and high likelihood for local interest. Provides benefits for aquatic and floodplain/riparian habitat.
Construct instream aquatic habitat downstream from Keswick Dam	Moderate to high potential – Addresses primary planning objective.	Retained – Increased potential for combining with other measures. Relatively low initial cost but high O&M costs. Difficult to construct and maintain. Low certainty for long-term success.
Replenish spawning gravel in the Sacramento River	Moderate to high potential - Addresses primary planning objective.	Retained – Increased potential for combining with other measures. Demonstrated benefits that continue as gravel moves downstream. Low initial cost but very high annual cost relative to initial cost. Concerns over induced downstream impacts on agricultural facilities. Depends on long-term commitment to regular and recurring project replacement for success.
Construct instream fish habitat on tributaries to the Sacramento River	Low to moderate potential – Benefits planning objective.	Not recommended – Substantial benefit to tributaries. Relatively low initial cost but high O&M costs. Difficult to construct and maintain. Low certainty for long-term success. Independent of hydraulic/hydrologic conditions in upper Sacramento River and does not contribute directly to improved ecological conditions along mainstem Sacramento River.
Remove instream sediment along Middle Creek, an intermittent tributary to the Sacramento River between Keswick Dam and Redding	Low potential – Indirectly benefits planning objective.	Not recommended – Substantial benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and does not contribute directly to improved ecological conditions along mainstem Sacramento River. High uncertainty, given increased need for long-term remediation.
Rehabilitate inactive instream gravel mines along Stillwater and Cottonwood Creeks	Low potential – Indirectly benefits planning objective.	Not recommended – Substantial benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and does not contribute directly to improved ecological conditions along mainstem Sacramento River.
Restore the streambed near the ACID siphon on Cottonwood Creek	Low potential – Indirectly benefits planning objective.	Not recommended – Substantial benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and does not contribute directly to improved ecological conditions along mainstem Sacramento River.
Improve Water Flows and Quality		
Improve flow from a new conservation offstream surface storage facility at Sites Reservoir	High potential to meet all components of primary objective.	Retained – Consistent with primary planning objectives and contributes directly to secondary planning objectives.
Improve flow from a new conservation offstream surface storage facility at Colusa Reservoir	High potential to meet all components of primary objective.	Not recommended – Affects twice the land area impacted by Sites Reservoir with minimal increase in benefits.
Improve flow from a new conservation offstream surface storage facility at Newville Reservoir	High potential to meet all components of primary objective.	Not recommended – Has adverse environmental impacts, including impacts to jurisdictional wetlands and impacts to fall run salmon and steelhead.
Modify existing storage facilities in the upper Sacramento River Valley, such as Shasta Reservoir, for temperature control	Low to moderate potential to contribute to planning objective by improving temperatures for anadromous fish.	Not recommended – Consistent with primary planning objective. Modifications to Shasta are being considered through a separate feasibility study.
Enlarge Shasta Lake cold water pool	Moderate to high potential – Directly contributes to planning objective by improving water temperature conditions for anadromous fish.	Not recommended – Consistent with primary objective and goals of CALFED, but modifications to Shasta are being considered through a separate feasibility study.
Modify storage and release operations at existing storage facilities in the upper Sacramento River Valley, such as Shasta Reservoir, to improve flow conditions	Moderate to high potential – Directly contributes to planning objective by improving flow conditions for anadromous fish.	Not recommended – Consistent with goals of CALFED, but modifications to Shasta are being considered through a separate feasibility study.
Modify TCCA, GCID, and ACID diversions to reduce flow fluctuations	Moderate potential – Reduced flow fluctuations would benefit anadromous fish, directly contributing to planning objective.	Not recommended – As a stand-alone measure, conflicts with the other primary planning objective of water supply reliability.
Increase instream flows on Clear, Cow, and Bear Creeks	Low potential – Indirectly benefits planning objective on Sacramento River.	Not recommended – Independent of hydraulic/hydrologic conditions in upper Sacramento River.
Construct a storage facility on Cottonwood Creek to augment spring instream flows	Low potential – Indirectly benefits planning objective on Sacramento River.	Not recommended – Independent of hydraulic/hydrologic conditions in upper Sacramento River. Adverse environmental impacts expected to exceed benefits.
Transfer existing storage from water supply in reservoirs in the upper Sacramento River Valley to cold water releases	Low potential to benefit anadromous fish, but with negative impact on water supply reliability.	Not recommended – Violates basic plan formulation criteria; causes reduction in water supply reliability without the development of a replacement supply.
Remove Shasta Dam and Reservoir	Very low potential to benefit anadromous fish, with major adverse impacts to all other planning objectives.	Not recommended – Violates basic plan formulation criteria, and no known project or projects can replace the lost benefits provided by Shasta and Keswick Dams, reservoirs, and appurtenant facilities at any price.

Table 4-5. Continued

Management Measures Considered	Potential to Address Planning Objective	Status/Rationale
Other Measures to Improve Fish Migration		
Improve fish trap below Keswick Dam	Low to moderate potential – Directly contributes to planning objective by reducing mortality and supplying more fish to hatcheries.	Not recommended – Helps fish populations but does not contribute to favorable conditions for sustained spawning and rearing of anadromous fish.
Screen diversions on Old Cow and Cow Creeks	Moderate potential – Indirectly benefits planning objective on Sacramento River.	Not recommended – Substantial benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in the upper Sacramento River and does not contribute to improved ecological conditions along the mainstem of the river.
Remove or screen diversions on Battle Creek	Moderate potential – Indirectly benefits planning objective on Sacramento River.	Not recommended – Substantial benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and does not contribute to improved ecological conditions along mainstem Sacramento River.
Construct a fish barrier at Crowley Gulch on Cottonwood Creek	Moderate potential – Indirectly benefits planning objective on Sacramento River.	Not recommended – Substantial benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and does not contribute to improved ecological conditions along mainstem Sacramento River.
Construct a migration corridor from the Sacramento River to the Pit River	Low potential – High uncertainty regarding the potential to successfully benefit area resources.	Not recommended – Extremely high cost. Multiple physical obstructions to effective fish passage, even after implementation. Very low certainty of success.
Improve fish passage at RBDD	Moderate potential to improve fish migration along upper Sacramento River.	Not recommended – Being independently evaluated by Reclamation and TCCA.
Re-operate the CVP to improve overall fish management	Low potential to improve anadromous fish survival along upper Sacramento River.	Not recommended – See previous measure regarding RBDD. Issues regarding reoperating facilities on Trinity River addressed in Trinity River Record of Decision (U.S. Department of the Interior, 2000). Any further modification within that system violates planning criteria for NODOS.
Construct a fish ladder on Shasta Dam	Very low potential for marginal benefit to anadromous fish on upper Sacramento River.	Not recommended – Extremely high cost, relatively small benefit on limited stream system, and very low potential for physically implementing a workable ladder.
Reintroduce anadromous fish to areas upstream from Shasta Dam	Low potential for marginal benefit to anadromous fish on upper Sacramento River.	Not recommended – Likely high cost, low potential for successful recapture of out-migrants, and potential for major impacts to existing warm and cold water species in upper river.

Key:
ACID = Anderson Cottonwood Irrigation District
CALFED = CALFED Bay-Delta Program
CVP = Central Valley Project
GCID = Glenn-Colusa Irrigation District
O&M = operation and maintenance
RBDD = Red Bluff Diversion Dam
TCCA = Tehama-Colusa Canal Authority

Construct Instream Aquatic Habitat Downstream from Keswick Dam – Keswick Dam is the uppermost barrier to anadromous fish migration on the Sacramento River. Releases from the dam have scoured the channel, and the dam blocks passage of gravels, bed sediments, and woody debris that were historically replenished by upstream tributaries. As a result, aquatic habitat is poor for the spawning and rearing of anadromous fish, and predation can be high because instream cover is lacking. Despite these unfavorable channel conditions, cold-water releases from Keswick Dam attract large numbers of spawning fish to this reach. This measure would consist of constructing aquatic habitat in and adjacent to the Sacramento River downstream from Keswick Dam to encourage the use of this reach by anadromous fish for reproduction. This measure was retained for potential further development because it has a high likelihood of success in helping to achieve the primary objective.

Replenish Spawning Gravel in the Sacramento River – Gravel suitable for spawning has been identified as an important influencing factor in the recovery of anadromous fish populations in the Sacramento River. Several programs, including CALFED and the AFRP, are proceeding with gravel replenishment on the Sacramento River in selected locations. With the exception of the CVPIA (b)(13) program, these programs represent single applications at discrete locations. This measure would consist of helping to replenish spawning-sized gravel in the Sacramento River between Keswick Dam and Red Bluff on a long-term basis. This measure was retained for potential further development because it has a high likelihood for success in helping to achieve the primary objective.

Construct Instream Fish Habitat on Tributaries to the Sacramento River – This measure would consist of improving instream aquatic habitat along the lower reaches of tributaries to the Sacramento River. Various structural techniques would be employed to trap spawning gravels in deficient areas, create pools and riffles, provide instream cover, and improve overall instream habitat conditions. Both perennial and intermittent streams would be potential candidates for structural habitat improvements. This measure was not recommended for further development as part of the NODOS Investigation primarily because it is a separate and independent action.

Remove Instream Sediment along Middle Creek – This measure would consist of implementing a sediment removal and control program along Middle Creek, an intermittent tributary to the Sacramento River between Keswick Dam and Redding. Lower Middle Creek supports spawning runs of rainbow trout, steelhead, and salmon. This measure was not recommended for further development primarily because it is a separate and independent action.

Rehabilitate Inactive Instream Gravel Mines along Stillwater and Cottonwood Creeks – This measure would consist of rehabilitating ecological conditions in former instream gravel mining sites along Stillwater Creek. Restoring these gravel mines could help Stillwater Creek provide additional seasonal habitat for various anadromous and resident fish. This measure was not recommended for further development primarily because it is a separate and independent action.

Restore the Streambed near the ACID Siphon on Cottonwood Creek – This measure consists of restoring the streambed near the ACID siphon on Cottonwood Creek to prevent degradation of this anadromous fish migration corridor. This measure was not recommended for further development primarily because it is a separate and independent action.

Improved Water Flows and Quality

Improve Flow from a New Offstream Conservation Storage Facility at Sites Reservoir – Offstream storage allows changes in the timing, magnitude, and duration of diversions from the Sacramento River. These changes could reduce or eliminate diversion effects and help assure the appropriate flows necessary for critical life stages for anadromous fish and riparian habitat. This measure was retained for potential further development because it has a high likelihood for success in helping to achieve the primary objective.

Improve Flow from a New Offstream Conservation Storage Facility at Colusa Reservoir – Offstream storage allows changes in the timing, magnitude, and duration of diversions from the Sacramento River. These changes could reduce or eliminate diversion effects and help assure the appropriate flows necessary for critical life stages for anadromous fish and riparian habitat. The Colusa Reservoir measure would affect twice the land area of the Sites Reservoir measure, with little increase in project benefits. Therefore, this measure was not recommended for further consideration in the NODOS Investigation.

Improve Flow from a New Offstream Conservation Storage Facility at Newville Reservoir – Offstream storage could reduce or eliminate diversion effects and help assure the appropriate flows necessary for critical life stages for anadromous fish and riparian habitat. However, the Newville Reservoir measure has greater potential for environmental impacts than the Sites Reservoir measure. Construction of the Newville Reservoir measure would jeopardize fall and late-fall runs of salmon and steelhead observed in Thomes Creek during past field surveys. As a result of the greater environmental impacts and the lack of local support to advance this measure, the Newville Reservoir measure has not been recommended for further consideration.

Modify Existing Storage Facilities in the Upper Sacramento River Valley for Temperature Control – The Shasta Dam temperature control device (TCD) could allow operators to make selective releases from various reservoir depths to regulate water temperatures to benefit anadromous fish in the upper Sacramento River. This measure could: improve the performance of the existing facility; complement other measures under consideration to raise Shasta Dam; and complement measures to improve aquatic spawning habitat in the

Sacramento River. This measure was not recommended for further consideration because it is being addressed in a separate feasibility study under Public Law 96-375.

Enlarge Shasta Lake Cold Water Pool – Cold water released from Shasta Dam greatly influences water temperature conditions on the Sacramento River between Keswick and Red Bluff, and it can have an extended influence on river temperatures farther downstream. This measure would consist of enlarging the cold water pool by either raising Shasta Dam and enlarging the minimum operating pool or increasing the seasonal carryover storage in Shasta Lake. NODOS could increase the carryover storage. Raising Shasta Dam was not recommended for further consideration because it is being addressed in a separate feasibility study under Public Law 96-375.

Modify Storage and Release Operations at Existing Storage Facilities in the Upper Sacramento River Valley to Improve Flow Conditions – In addition to water temperature, flow conditions in the upper Sacramento River are important in addressing anadromous fish needs. This measure would consist of enlarging Shasta Dam and modifying seasonal storage and releases to benefit anadromous fisheries. This measure also could include release changes during the flood season to permit "pulse flows" and other releases that could improve aquatic habitat conditions. This measure was not recommended for further consideration because it is being addressed in a separate feasibility study under Public Law 96-375.

Modify TC Canal, GCID Canal, and ACID Diversions to Reduce Flow Fluctuations – This measure would consist of modifying operations at existing diversions to irrigation districts to reduce extreme flow fluctuations and their resulting impacts on anadromous fish. However, negative impacts on water deliveries from the diversions would conflict with the second primary objective of increasing water supply reliability. Therefore, this measure, as a stand-alone action, was not recommended for further development primarily because of potential impacts to water supply reliability. Modifications to diversions continue to be considered as part of the operations strategy for new offstream storage measures.

Increase Instream Flows on Clear, Cow, and Bear Creeks – This measure would consist of increasing instream flows on Clear, Cow, and Bear Creeks during critical periods to support anadromous fish that spawn in the creek. This measure was not recommended for further development primarily because it would not contribute directly to increasing anadromous fish survival within the Primary Study Area.

Construct a Storage Facility on Cottonwood Creek to Augment Spring Instream Flows – This measure would consist of constructing a dry dam or offstream storage facility on upper Cottonwood Creek to support flows for spring-run Chinook salmon. A storage facility would allow late-spring and summer releases for spring-run Chinook salmon and improve overall seasonal aquatic conditions. This measure was not recommended for further development primarily because it is an independent action. In addition, it would not contribute directly to increasing anadromous fish survival within the Primary Study Area, and it is highly likely that this measure would have considerable and overriding adverse environmental impacts on the Cottonwood Creek watershed.

Transfer Existing Shasta Reservoir Storage from Water Supply to Cold Water Releases – This measure would consist of reoperating the existing Shasta Dam and Reservoir for anadromous fishery resources. Operational priority for the increased flows would be given to managing the existing cold water pool in Shasta Reservoir. This measure was not recommended for further consideration primarily because it would violate at least one of the planning criteria concerning the potential to adversely impact existing project purposes. In addition, it is likely that the existing CVP water contractors would not be willing to pay for the water loss, and no entities have been identified that would be willing to pay.

Remove Shasta Dam and Reservoir – This measure would consist of removing the existing Shasta Dam and Reservoir to benefit anadromous fishery resources. The Shasta Division of the CVP provides supplemental irrigation services to almost one-half million acres of land in California's Central Valley. It also provides water for M&I purposes and power generation amounting to about 680,000 kW. In addition, Shasta Dam helps reduce flooding over a large area along the Sacramento River. Estimates of flood damages prevented by Shasta Dam and Reservoir during the major storms of 1995 and 1997 were about $3.5 and 4.3 billion, respectively. Although the potential benefit to anadromous fish resources along the upper Sacramento River might be sizeable (numerous studies would be required to define the potential benefits and disadvantages to the fisheries), these benefits would by no means begin to approach the monetary benefit associated with the existing project. No known project or projects could replace the benefits provided by Shasta and Keswick Dams, Reservoirs, and appurtenant facilities at any price. This measure was not recommended for further consideration primarily because it would violate at least one of the planning criteria concerning the potential to adversely impact existing project purposes.

Improved Fish Migration

Improve Fish Trap Below Keswick Dam – Keswick Dam is an upstream barrier to fish migration on the Sacramento River. Although this measure has the potential to contribute to the primary planning objective of increasing anadromous fish populations in the upper Sacramento River, it would not necessarily contribute to increasing the survival of anadromous fish in the upper Sacramento River. This measure was not recommended for further development primarily because it would not improve spawning and rearing conditions necessary for the natural and sustainable reproduction of anadromous fish in the upper Sacramento River.

Screen Diversions on Old Cow and Cow Creeks – This measure would consist of screening diversion intakes in the Cow Creek watershed to reduce fish mortality. This measure might reduce salmonid mortality at diversions within the Cow Creek watershed. However, this measure was not recommended for further development primarily because it is an independent action and would not contribute directly to increasing anadromous fish survival within the Primary Study Area.

Remove or Screen Diversions on Battle Creek – This measure would consist of removing or screening diversions and other water control facilities on Battle Creek to allow full use of the watershed's high-quality, cold-water spawning habitat. This measure was not recommended for further development primarily because it is an independent action and would not contribute directly to increasing anadromous fish survival within the Primary Study Area.

Construct a Fish Barrier at Crowley Gulch on Cottonwood Creek – This measure would consist of constructing a fish barrier at the mouth of Crowley Gulch on Cottonwood Creek to eliminate the stranding of adult fall-run Chinook. This measure was not recommended for further development primarily because it is an independent action and would not contribute directly to increasing anadromous fish survival within the Primary Study Area.

Construct a Migration Corridor from the Sacramento River to the Pit River – This measure would consist of providing passage to spawning areas upstream from Shasta Dam for anadromous fish from the Sacramento River. One concept would include connecting the upper Pit River to the Sacramento River. This and similar measures were not recommended for further consideration primarily because of the high cost for complex infrastructure, the major impacts to other facilities and extensive long-term O&M requirements, and the high uncertainty of the potential to achieve and maintain successful fish passage and spawning.

Improve Fish Passage at Red Bluff Diversion Dam – The two primary fish passage issues associated with the RBDD are the delay and blockage of adults migrating upstream and the impedance and losses of juveniles migrating downstream. Potential solutions to these problems are being considered as part of the Red Bluff Diversion Dam Fish Passage Improvement Project (FPIP). This is a cooperative effort led by Reclamation and the TCCA. The potential improvements are intended to provide a long-term solution to relieve conflicts between fish passage and agricultural diversion needs. Several alternatives are being considered, including: completely removing the barrier to fish by removing the gates and then constructing pumps to divert water into the TC Canal; improving the existing fish ladders; and constructing a bypass channel. Reclamation and TCCA have reissued the draft EIS/EIR, and the final EIS/EIR is scheduled for completion in 2008. This measure was not recommended for further development under the NODOS Investigation because it is being considered as a separate project pursuant to CVPIA. This project is assumed to be included in the No Action Alternative. If this project is not implemented as part of the FPIP, the NODOS Investigation would reconsider this measure for inclusion in the action alternatives in the feasibility report and EIS/EIR.

Reoperate the CVP to Improve Overall Fish Management – This measure would include reoperating all of the CVP facilities in the upper Sacramento River system to improve anadromous fish resources. This measure was not recommended for further consideration because reoperation of CVP facilities may adversely impact other project objectives.

Construct a Fish Ladder on Shasta Dam – This measure would include constructing a fish ladder on Shasta Dam to allow the passage of anadromous fish to access Shasta Lake and approximately 40 miles of the upper Sacramento River, about 24 miles of the lower McCloud River, and various small creeks and tributaries to Shasta Reservoir. This measure was not recommended for further consideration because of the estimated high cost of constructing and operating the fish ladder, the low likelihood for success in getting the fish to successfully ascend the ladder, and the likely major impacts to existing warm and cold water species in the upper river reaches.

Reintroduce Anadromous Fish to Areas Upstream from Shasta Dam – This measure would include trapping anadromous fish along the Sacramento River immediately downstream from Keswick Dam, transporting the fish by tanker truck from the Delta to areas along the upper Sacramento River near Volmers, and releasing the fish in the upper Sacramento River to spawn. It also would include trapping the potential out-migrating fish and transporting them to the Sacramento River near Keswick for release into the lower river. This measure was not recommended for further consideration because of the high cost to implement the plan, its low likelihood for success, given the inability to recapture the out-migrants, and likely major impacts to existing warm and cold water species in the upper river.

Drinking Water Quality

The various potential water management measures identified to address the primary objective of improving water quality in the Delta for M&I users fall into two major categories, increased flow to improve Delta water quality, and source water treatment improvements. Table 4-6 identifies the measures considered and whether or not they were retained.

Table 4-6. Management Measures to Address Drinking Water Quality

Management Measures Considered	Potential to Address Primary Objectives	Status/Rationale
Increased Flow to Improve Delta Water Quality		
Improve water quality by increasing flows to the Delta from new conservation offstream surface storage at Sites Reservoir	High potential to meet all components of primary objective.	Retained – Consistent with primary planning objectives and contributes directly to secondary planning objectives.
Improve water quality by increasing flows from new conservation offstream surface storage at Colusa Reservoir	High potential to meet all components of primary objective.	Not recommended – Would affect twice the land area impacted by Sites Reservoir with minimal increase in benefits. This would result in a much higher unit cost for water.
Improve water quality by increasing flows from new conservation offstream surface storage at Newville Reservoir	High potential to meet all components of primary objective.	Not recommended – Would have adverse environmental impacts, including impacts to jurisdictional wetlands and fall run salmon and steelhead.
Extend Tehama-Colusa Canal to Cache Creek to provide flow from NODOS to the Delta	Low potential – Releases from NODOS storage to Cache Creek offer far less benefit to water quality than releases to the Sacramento River because of water quality degradation in Cache Creek. Releases to the creek could further mobilize mercury to the Delta.	Not recommended – Construction would have adverse environmental impacts and provide minimal benefit to water quality as a result of mercury contamination in Cache Creek. Releases would be constrained by capacity limitations on Cache Creek flows.
Source Water Treatment Improvements		
Implement treatment/supply of agricultural drainage water	Very low potential to improve water supply reliability for agricultural uses.	Not recommended – Not a viable alternative to new water storage. Very high unit water cost.
Construct desalination facility	Low potential – Although it provides a growing source for urban water supplies in California, it has low potential to address NODOS planning objectives.	Not recommended – Would not address other planning objectives. Very high unit water cost.

Key:
NODOS = North of the Delta Offstream Storage

This page left blank intentionally.

Increased Flow to Improve Delta Water Quality

Improve Water Quality by Increasing Flows from New Conservation Offstream Surface Storage at Sites Reservoir – Offstream storage could provide additional flow to the Delta to augment Delta outflow and improve water quality during periods of poor water quality. Offstream storage could allow changes in the timing, magnitude, and duration of diversions from the Sacramento River. This measure was retained for potential further development because it has a high likelihood of success in helping to achieve both primary objectives.

Improve Water Quality by Increasing Flows from New Conservation Offstream Surface Storage at Colusa Reservoir – Offstream storage could provide additional flow to augment Delta outflow and improve water quality during periods of poor water quality. However, the Colusa Reservoir would affect twice the land area of Sites Reservoir, with little increase in project benefits. In addition, water from the Colusa Reservoir would have a much higher unit cost, in part because of the larger amount of earthwork required for dams and appurtenant structures. This measure was not recommended for further consideration because of its greatly reduced efficiency.

Improve Water Quality by Increasing Flows from New Conservation Offstream Surface Storage at Newville Reservoir – Offstream storage could provide additional flow to augment Delta outflow and improve water quality during periods of poor water quality. However, Newville Reservoir would have adverse environmental impacts, including jurisdictional impacts, to fall run salmon and steelhead. The public disclosure of these finding has reduced local interest and support for any Newville project formulation. In addition, private landowners within the reservoir footprint are opposed to giving access to their property for the purpose of collecting data for further analyses. As a result of the greater environmental impacts and the lack of local support to advance this measure, the Newville Reservoir measure was not recommended for further consideration.

Extend TC Canal to Cache Creek to provide flow from Sites Reservoir to the Delta – This measure would involve extending the TC Canal to Cache Creek or installing a pipeline from the TC Canal to Cache Creek. Water could then be released from NODOS into Cache Creek to flow into the Sacramento River. Cache Creek has water quality issues, including high concentrations of mercury in sediments. Most sediment releases currently occur under high flow conditions during the wet season. Any water quality benefits from discharging water from NODOS to Cache Creek are overshadowed by the mobilization of mercury-laden sediments during July through September. This alternative would face substantial public and agency resistance; therefore, it was not recommended for further consideration in the NODOS Investigation.

Source Water Treatment Improvements

Implement Treatment/Supply of Agricultural Drainage Water – This measure would consist of collecting agricultural drainage water from farms along the Sacramento and San Joaquin Rivers and treating the drainage water for reuse. Major elements of this measure probably would include an agricultural drainage collection system, pre-treatment of drainage water, desalination facilities, ancillary facilities associated with desalination and brine disposal, and conveyance of treated water to end users. In addition, removal of total organic carbon (TOC) and pesticides, plus supplementary disinfection, might be required before municipal agencies would consider using the treated agricultural runoff as a potable water supply. While this measure might have the potential to provide some water supply reliability to urban users, it would be far too costly for agricultural users. This would be costly to implement and operate initially; in addition, there would be problems relative to brine disposal, and this measure probably would be unacceptable to stakeholders and the public. Accordingly, this measure was not recommended for further evaluation.

Construct Desalination Facility – This measure would consist of constructing seawater or brackish surface or groundwater desalination plants to supplement existing water supplies and help offset future demands. In addition, a conveyance system would be needed to transport the desalinated water to the customer or to the water agency distribution systems. Although technological advances have substantially decreased treatment costs, desalination remains costly compared with most other water sources. Even with continual improvement in membrane technology, energy costs can account for as much as one-half of the total cost of desalination.

Desalination is energy intensive; with rising power costs, it is expected to continue to be relatively expensive. Even if the unit cost for a base supply plant is reduced measurably, desalination by itself would not be likely to be superior to other potential water sources in addressing the primary planning objective of agricultural water supply reliability in the NODOS Investigation. This measure was not recommended for further evaluation primarily because it would not be an alternative to new storage and because its unit costs would be far greater than new supplies from NODOS or other sources.

Measures to Address Secondary Planning Objectives

This section identifies management measures that address each of the secondary planning objectives.

Ancillary Power Benefits

Various potential water management measures were identified to address the secondary objective of exploring the ancillary benefits that hydropower generation can offer to the statewide energy grid. Benefits to hydropower generation deriving from these measures would be ancillary and would not be intended to contribute substantially to the statewide grid.

Modify Existing/Construct New Generation Facilities at Shasta Dam to Take Advantage of Increased Hydraulic Head

This measure would consist of modifying the hydropower generation facilities at Shasta Dam to take advantage of any increases in water surface elevations resulting from dam enlargement, if applicable. Almost all releases from Shasta and Keswick Dams are made through their generating facilities. Raising Shasta Dam would allow flood release reductions in winter and would allow water to pass through the generators later in the year, when the water usually would be more valuable. Further, with higher surface-water elevation, greater energy levels (head) would be available to operate the turbines. With the greater total head, a need might exist to replace the existing power facilities, including turbines and penstocks, especially with large dam raises (e.g., 100- or 200-foot raises). This measure was not recommended for further consideration because it is being addressed in a separate feasibility study under Public Law 96-375.

Construct New Hydropower Generation Facilities on Tributaries to the Sacramento River Downstream from Shasta Dam

This measure would consist of constructing new hydropower facilities to increase electrical generation capabilities. This measure was not recommended for further consideration because it would not contribute, either directly or indirectly, to addressing the primary objectives and because it could be accomplished independently of the NODOS Investigation.

Construct New Hydropower Facilities for Sites Reservoir

Providing hydropower facilities at the new reservoir would help offset energy usage and the cost of pumping into the reservoir. Ancillary benefits would be provided to the local and statewide power grid. Construction of Sites Reservoir would contribute directly to the primary planning objectives, and previous studies have shown that the project would be technically feasible. This measure was retained for further development.

Construct New Hydropower Facilities for Colusa Reservoir

Providing hydropower facilities at the new reservoir would help offset energy usage and the cost of pumping into the reservoir. Ancillary benefits would be provided to the local and statewide power grid. However, the Colusa Reservoir would affect twice the land area of Sites Reservoir, with little increase in project benefits. Therefore, this measure was not recommended for further consideration.

Construct New Hydropower Facilities for Newville Reservoir

Providing hydropower facilities at the new reservoir would help offset energy usage and the cost of pumping into the reservoir. Ancillary benefits would be provided to the local and statewide power grid. However, Newville Reservoir would have greater potential environmental impacts than Sites Reservoir. As a result of the greater potential environmental impacts and the lack of local support to advance this measure, the Newville Reservoir measure was not recommended for further consideration.

Recreation Opportunities

Construct Recreation Facilities at New Reservoir

This general measure was identified for recreational opportunities, including the following:

- Personal water craft use;
- Fishing;
- Canoeing/kayaking;
- Swimming;
- Camping;
- Hiking and backpacking;
- Wildlife viewing;
- Picnicking; and
- Interpretive programs.

Flood-Damage Reduction

Increase Flood Control Storage Space in Shasta, Oroville, and/or Folsom Reservoirs

This measure would consist of increasing the flood control storage space in existing reservoirs by substituting the existing water conservation storage space with storage in the NODOS project. The resulting vacant seasonal space would be used for increased flood control. Incremental flood control storage at a NODOS Reservoir would function as ancillary storage for other major flood control storage facilities; the reservoir would capture early reservoir releases dictated by operational actions taken in response to forecasted storm events. The ability to provide incremental flood control storage at a NODOS facility would be predicated on available storage space in the facility, the degree of accuracy in the forecast, the operating capacity of the NODOS conveyance system at the time of the forecast, and the ability to modify operational criteria at other major northern California flood storage facilities. Therefore, this measure is recommended for further consideration in the NODOS Investigation.

Implement Nonstructural Flood Damage Reduction Measures

Typical nonstructural (or nontraditional) flood damage reduction measures could include the following:

- Flood-proofing (temporary or permanently closing structures, raising existing structures, and constructing small walls or levees around structures);
- Floodplain evacuation (moving the structure and its contents to a safer site);
- Development of restrictions (restricting future building in flood-prone areas); and
- Flood warning (flood forecasting, warning, evacuation, and post-flood reoccupation and recovery).

This measure was not recommended for further consideration primarily because it is an independent action and would not be directly related to accomplishing the primary planning objectives. Programs are already in place through California and Federal agencies to address flood hazard mitigation.

Implement Traditional Flood Damage Reduction Measures

Various structural methods to reduce flood damages include constructing levees or modifying the flood-carrying capacity of a river system. This measure was not recommended for further consideration because it is an independent action and would not be directly related to accomplishing the primary or other secondary planning objectives. Programs are already in place through California and Federal agencies to address flood hazard mitigation.

Measures Summary

Table 4-7 identifies the measures that best address the primary and secondary planning objectives. Measures carried forward best address the objectives for the NODOS Investigation, given the consideration of planning constraints and criteria. It is recognized that measures for the secondary objectives must be refined and evaluated during the next stage of the feasibility study and addressed in the feasibility report and EIS/EIR. Measures that were not recommended for further consideration at this stage might be reconsidered in the future as mitigation measures or other plan features. Similarly, additional measures may be added to alternative plans as they are formulated. One other measure, Implement Water Use Efficiency, is retained as a complementary action in the No Action Alternative.

Table 4-7. Management Measures Retained to Address Primary and Secondary Objectives

Primary Objectives	Management Measures
Water Supply and Reliability	Construct Sites Reservoir, a new conservation offstream surface storage facility, near the Sacramento River, downstream from Shasta Dam
	Increase opportunities for conjunctive use of surface and groundwater storage near Sacramento River, downstream from Shasta Dam
	Implement water-use efficiency methods
	Transfer water between water users, and source shift (use groundwater in lieu of surface water)
Anadromous Fish Survival	Restore abandoned gravel mines along Sacramento River
	Construct in-stream aquatic habitat downstream from Keswick Dam
	Replenish spawning gravel in Sacramento River
	Improve flow from a new conservation offstream surface storage facility at Sites Reservoir
Water Quality	Improve water quality by increasing flows to the Delta from a new conservation offstream surface storage at Sites Reservoir
Secondary Objectives	**Management Measures**
Ancillary Power Benefits	Construct new hydropower facilities for Sites Reservoir
Recreation	Construct recreation facilities at the new reservoir
Flood Damage Reduction	Increase flood control storage space in Shasta, Oroville, and/or Folsom Reservoirs

Chapter 5
Development of Conveyance Management Measures

The formulation and evaluation of potential conveyance measures was deferred until the evaluation of reservoir locations was completed in Chapter 4. As described in that chapter, Sites Reservoir is the recommended surface storage management measure of the NODOS Investigation. This chapter presents the initial evaluations and screening of various measures for conveying water to and from Sites Reservoir (see table 5-1 and figure 5-1), providing a "short list" of conveyance management measures to carry forward in the NODOS Investigation. The chapter concludes with a section on additional considerations that support the conclusions.

Table 5-1. Original Conveyance Measures Considered

Conveyance Facility	Source	Capacity Description
GCID Canal	Sacramento River at Hamilton City	Existing 1,800-cfs capacity Expand to 3,000-cfs capacity Expand to 4,000-cfs capacity Expand to 5,000-cfs capacity
TC Canal	Sacramento River at Red Bluff	Existing 2,100-cfs capacity Modify to 2,700-cfs capacity Expand to 4,000-cfs capacity Expand to 5,000-cfs capacity
Delevan Pipeline	Sacramento River Opposite Moulton Weir	1,500-cfs capacity 2,000-cfs capacity 3,000-cfs capacity 4,000-cfs capacity 5,000-cfs capacity
Colusa Basin Pipeline	Colusa Basin Drain	1,000-cfs pipeline capacity 3,000-cfs pipeline capacity
Stony Creek Pipeline	Stony Creek at Black Butte Afterbay	1,000-cfs capacity 2,100-cfs capacity

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
TC = Tehama-Colusa

Conveyance is an especially important offstream surface storage element. Because Sites Reservoir is not located on a major stream, water must be delivered both to and from the reservoir. As a result, conveyance management measures will address several diversion and conveyance facilities to transport water to Sites Reservoir and other conveyance measures to deliver water from Sites Reservoir to service areas or locations with various water resources needs and uses.

This page left blank intentionally.

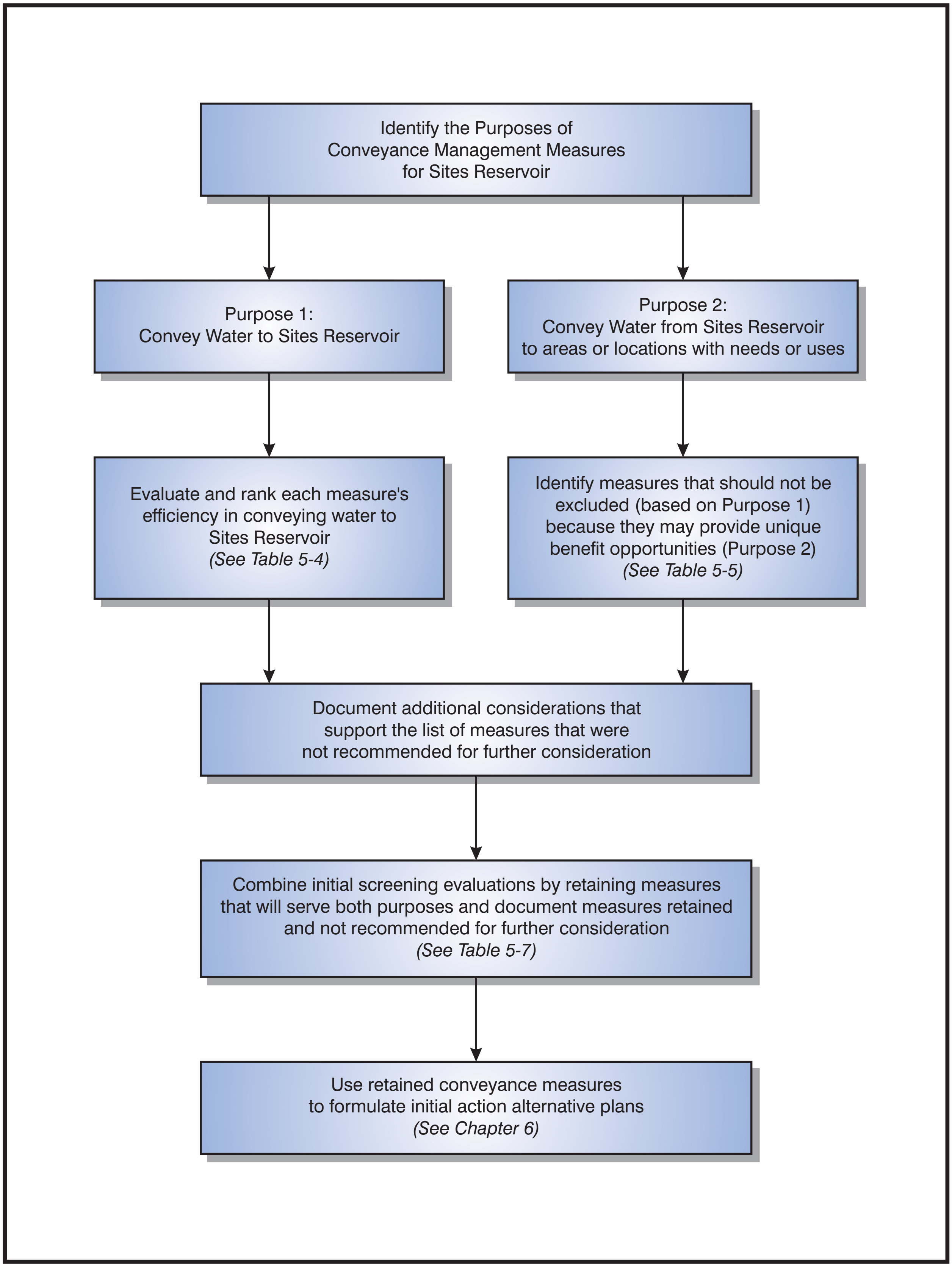


Figure 5-1. Process to Screen Conveyance Management Measures

This page left blank intentionally.

Conveyance Measures Considered

Conveyance measures originating from the Sacramento River include the GCID Canal, the TC Canal, and a new pipeline (called the Delevan Pipeline) (figure 5-2). The Delevan Pipeline intake at the Sacramento River would be located opposite Moulton Weir. Tributary source conveyance measures include a new pipeline from the CBD and a new pipeline from Stony Creek, originating at the Black Butte afterbay and connecting to the TC Canal below Orland. Each of these 5 proposed conveyance measures has a range of capacity sizes. As a result, 17 conveyance measures were identified for consideration and evaluation (table 5-1) and designs and cost estimates were developed for each of the 17. A conceptual graphical representation of these original conveyance measures is shown on figure 5-3. The initial designs and cost estimates for each of the 17 original conveyance management measures were considered individually, without consideration of how measures could be combined or integrated with other conveyance measures into a plan. Possible combinations and integration are discussed later in this chapter.

Additional details for each of the original conveyance measures, by facility, follow.

GCID Canal Measures

The GCID Canal is an earth-lined canal. It has an existing capacity of 3,000 cfs near its diversion and about 1,800 cfs near a proposed terminal regulating reservoir (TRR). All GCID Canal conveyance measures require a TRR and a pipeline connecting to Funks Reservoir on the TC Canal. The pipeline connecting the TRR and Funks Reservoir, the Delevan Pipeline, and the Colusa Basin Pipeline all use the same alignment. Only minor modifications to the pumping plant and fish screen on the Sacramento River are required for the 1,800-cfs and 3,000-cfs measures. The 3,000-cfs GCID Canal measure also would require substantial earthwork to expand the capacity of the canal to the TRR. The 4,000- and 5,000-cfs conveyance management measures require major modifications to the GCID Canal, fish screen, and pumping plant. GCID Canal measures also will facilitate delivery of Sites Reservoir water to the GCID service area, facilitating an integrated operation with the CVP.

TC Canal Measures

The TC Canal is a concrete-lined canal with an existing capacity of 2,100 cfs to Funks Reservoir. TC Canal measures assume that new fish screens and a pumping plant at the Sacramento River would be implemented as part of the FPIP at the RBDD. In addition, designers found that the TC Canal capacity could be increased up to 2,700 cfs using the existing canal prism near Funks; however, this would require several improvements along the length of the canal,

This page left blank intentionally.

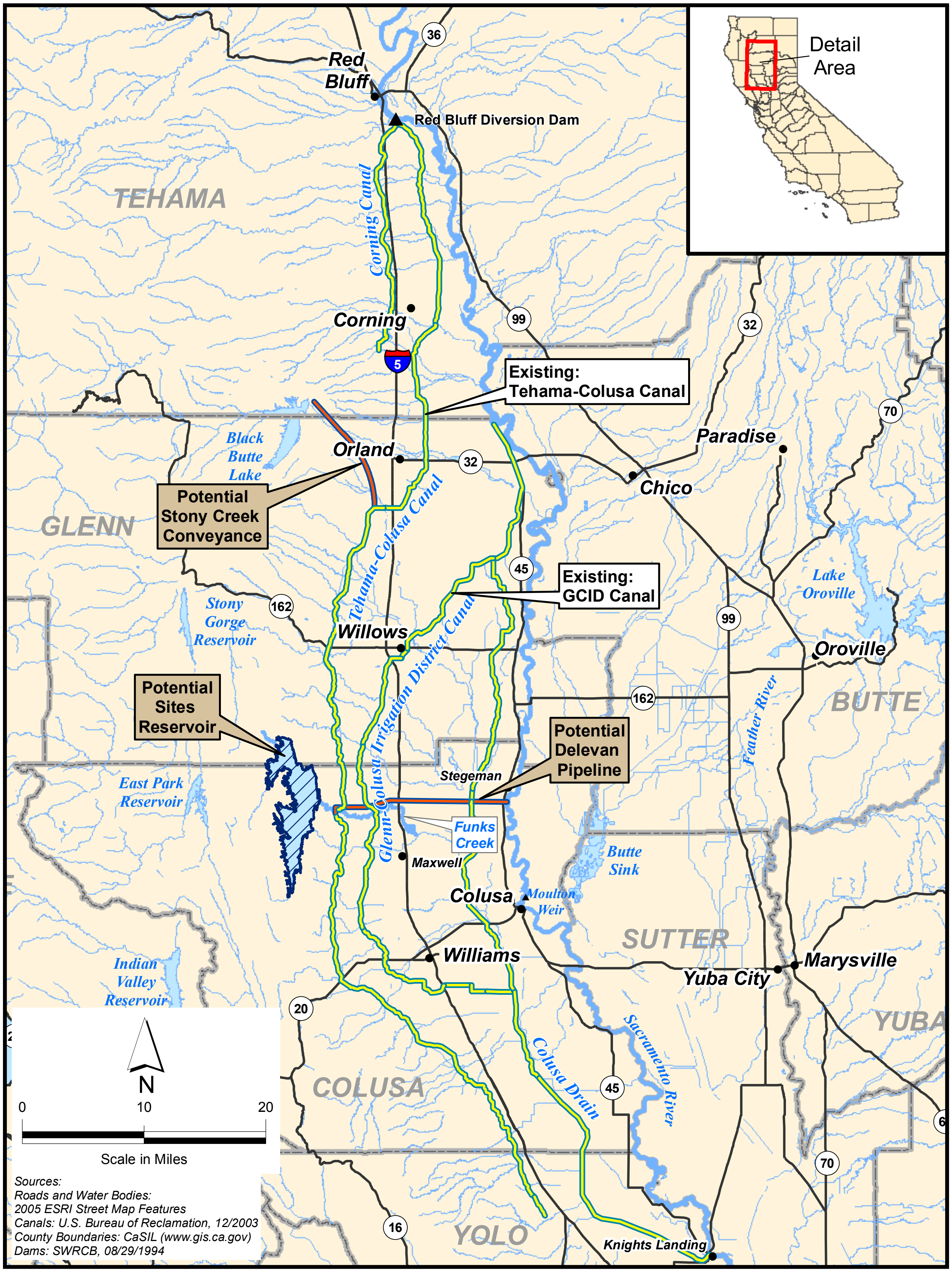


Figure 5-2. NODOS Conveyance Alternatives

This page left blank intentionally.

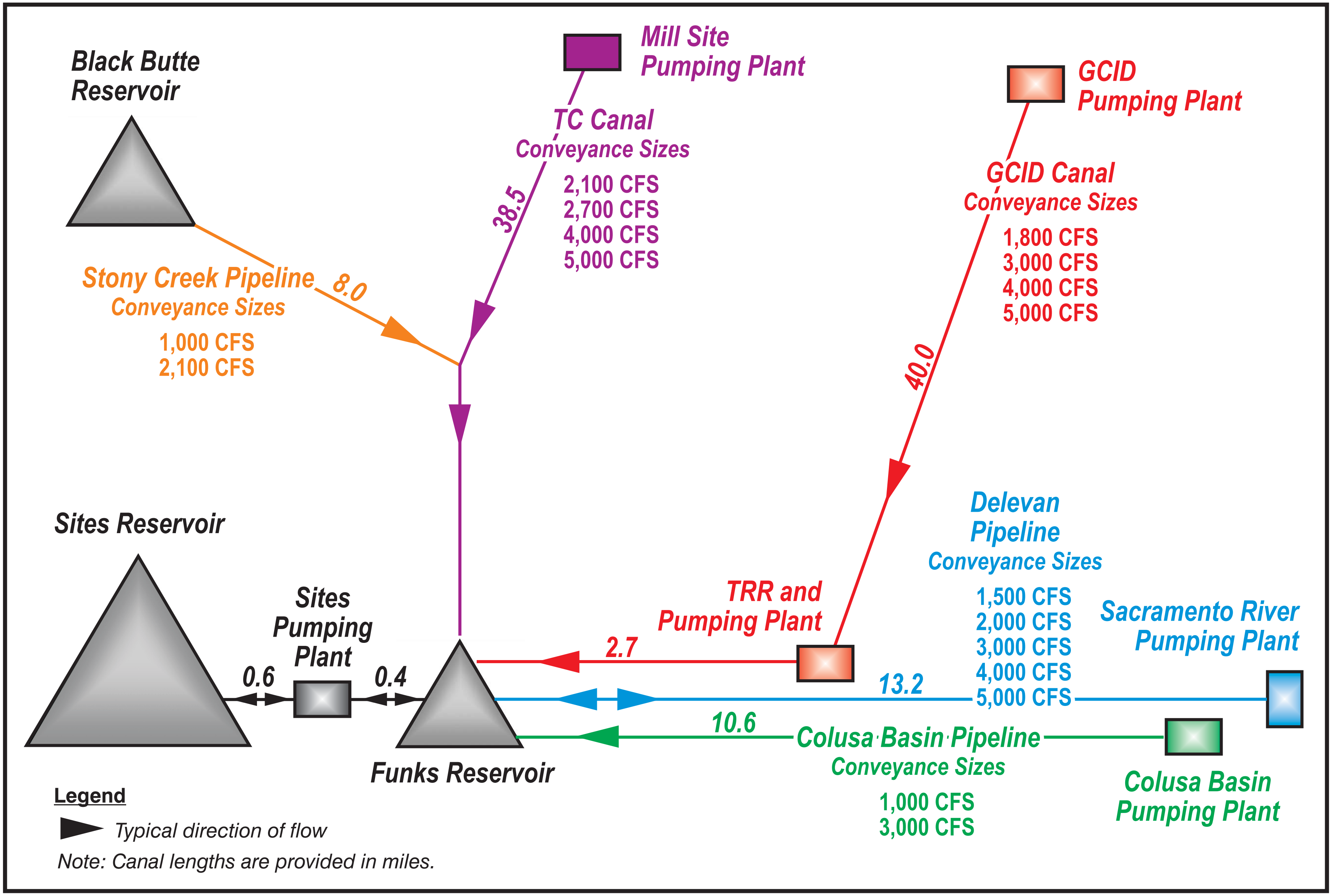


Figure 5-3. Original Conveyance Measures

This page left blank intentionally

such as modifications at road and water crossings to convey additional capacity. Expansion of the TC Canal beyond 2,700 cfs would require substantial reconstruction and expansion of the canal prism. Designs were developed for 4,000 and 5,000 cfs.

Delevan Pipeline Measures

The Delevan Pipeline was designed to provide the shortest conveyance distance from the Sacramento River to Funks Reservoir. The 1,500-cfs Delevan Pipeline requires two 10-foot diameter pipes. The remaining four Delevan Pipeline measures require one 12-foot diameter pipe for each 1,000 cfs. Diversion facilities include pumps and fish screens. Delevan Pipeline measures also can be used to release water back to the Sacramento River to meet downstream needs directly or facilitate an integrated operation with the CVP and SWP.

Colusa Basin Pipeline Measures

The 1,000- and 3,000-cfs Colusa Basin Pipeline measures rely on a similar design and use the same alignment as the Delevan Pipeline but divert water from Colusa Basin Drain. Fish screens and pumps are required.

Stony Creek Pipeline Measures

Stony Creek Pipeline is a proposed new pipeline that would convey flows from the Black Butte Afterbay on Stony Creek to the TC Canal. The 1,000- and 2,000-cfs pipeline options would take advantage of conveyance space in the lower portion of the TC Canal.

Important Considerations When Evaluating Conveyance Measures

The conceptual representation of the conveyance management measures shown on figure 5-3 reveals several important attributes that must be considered. First, both the TC Canal measures and Stony Creek Pipeline measures require capacity in the lower portion of the TC Canal (from Orland to Funks Reservoir). These measures cannot use the same capacity in the lower TC Canal at the same time. Therefore, the cost to expand the capacity of the lower portion of the TC Canal below Orland also has been estimated. These designs and estimates for expanding capacity in the portion of TC Canal below Orland have been sized the same as the full expansions of the length of the canal (i.e., 2,700 cfs and 4,000 cfs). This provides an estimate of the cost to provide conveyance for TC Canal measures and Stony Creek Pipeline measures at the same time.

All measures have been designed to convey water to Funks Reservoir. Consequently, they can be compared directly to determine their relative performance in conveying water to storage. By contrast, each measure’s ability to convey water from Sites Reservoir storage to areas of need or use varies. Any conveyance measure plan would facilitate delivery of water to a portion of the TC service area, since Sites Reservoir uses Funks Reservoir on the canal as an afterbay. Consequently, Stony Creek Pipeline and TC Canal measures, for example, do not provide any additional conveyance to areas of need or use. Conveyance management plans should be formulated using the characteristics of individual measures and the integration requirements associated with combining conveyance measures.

Formulation of Conveyance Management Plans

The conveyance measures (see Table 5-2 and figure 5-4) include five different water source locations that can be combined in numerous ways to provide sufficient inflow to reliably fill Sites Reservoir. A complete conveyance management plan requires some combination of conveyance management measures. Preliminary operation simulations indicate that 3,000 to 6,000 cfs of total inflow capacity to Funks Reservoir is needed to fill Sites Reservoir reliably.

Table 5-2. Original Sites Reservoir Conveyance Measure Capacities and Estimated Costs

Facility and Capacity	Conveyance Capacity (cfs)	Cost[1] (millions)
TC Canal – 2,100 cfs	2,100	$0
TC Canal – 2,700 cfs	2,700	$110.9
Stony Creek Pipeline – 2,100 cfs	2,100	$168.3
Stony Creek Pipeline – 1,000 cfs	1,000	$87.9
GCID Canal – 1,800 cfs	1,800	$178.5
GCID Canal – 3,000 cfs	3,000	$302.3
GCID Canal – 5,000 cfs	5,000	$552.3
TC Canal – 4,000 cfs	4,000	$398.2
GCID Canal – 4,000 cfs	4,000	$463.8
Colusa Basin Pipeline – 3,000 cfs	3,000	$362.9
TC Canal – 5,000 cfs	5,000	$556.5
Colusa Basin Pipeline – 1,000 cfs	1,000	$145.9
Delevan Pipeline – 5,000 cfs	5,000	$917.2
Delevan Pipeline – 4,000 cfs	4,000	$747.2
Delevan Pipeline – 3,000 cfs	3,000	$574.3
Delevan Pipeline – 2,000 cfs	2,000	$421.4
Delevan Pipeline – 1,500 cfs	1,500	$364.9

Note:
[1] Costs are 2007 preliminary construction cost estimates and do not include mitigation, engineering, or administrative costs.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
TC = Tehama-Colusa

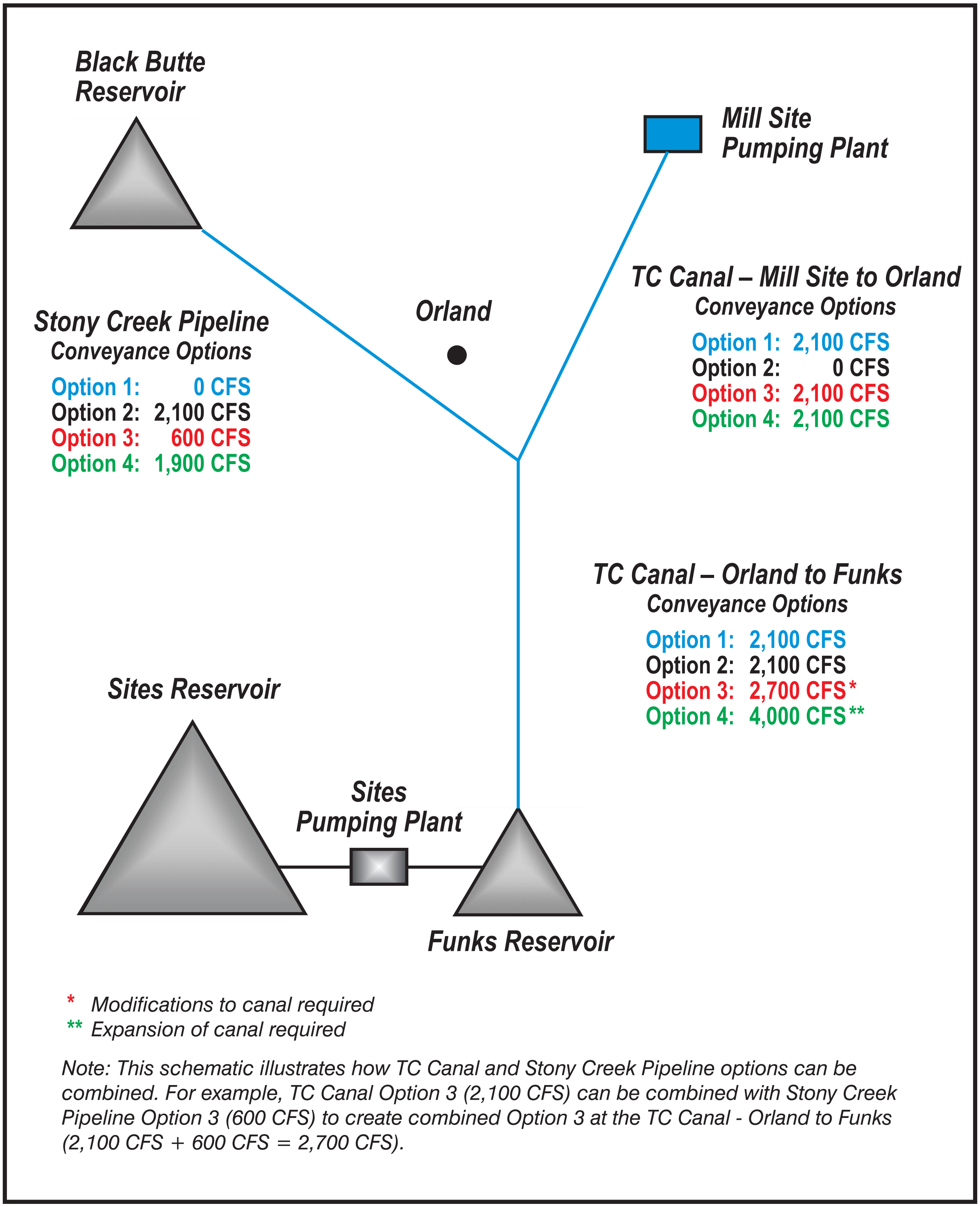


Figure 5-4. Potential Conveyance Measure Combinations for TC Canal and Stony Creek Pipeline

This page left blank intentionally.

A first comparison of conveyance measures (table 5-2) includes a listing of the conveyance measure capacities at Funks Reservoir and the measure design costs. Costs are rounded to the nearest one hundred thousand dollars.

Initial Evaluations of Conveyance Measures

The purpose of these initial evaluations is to narrow the number of conveyance measures and distinct alternative plans to be evaluated with the operations model. Following are two initial evaluations. The first evaluation assesses the conveyance efficiency for each measure in transporting water to the reservoir. The second assesses the ability of measures to convey water from the reservoir to service areas or locations with various water resource needs and beneficial uses.

Efficiency of Conveyance to Reservoir

Conveyance measure efficiency can be determined by comparing the incremental cost and capacity of individual measures. Measures should be selected in a prescribed order by determining the incremental cost per incremental capacity of each measure. For example, the TC Canal 4,000-cfs measure can only be selected after the TC Canal 2,700-cfs measure has been selected. The evaluation should only consider the *incremental* increase in capacity and the *incremental* increase in cost. In this example, the TC Canal 4,000-cfs measure provides an incremental capacity of 1,300 cfs (4,000 cfs minus 2,700 cfs). The incremental cost is $398.2 million minus $110.9 million, or $287.3 million. The incremental efficiency of the TC Canal 4,000-cfs measure is $221,000 per cfs. (To illustrate the effect of accounting for the total capacity and total cost of measures, rather than incremental, the efficiency of the 4,000-cfs measure, allowing bias from the 2,100-cfs and 2,700-cfs measures, is $398.2 million per 4,000 cfs, or $99,600 per cfs. This example can be followed by referencing information in tables 5-2 and 5-3.) The incremental conveyance capacity, the incremental cost, and the incremental efficiency are calculated for each of the 17 measures and displayed in table 5-3. In this way, each conveyance measure is evaluated independently, and efficient plans can be developed.

Review of the efficiencies indicated on table 5-3 by incremental cost per cfs indicates that the TC Canal 2,100-cfs measure is selected first because it is the most efficient conveyance measure, at no cost for 2,100 cfs. After the TC Canal 2,100-cfs measure is selected, available measures include either expanding the TC Canal to the next size or selecting another pipeline or canal to convey water to Sites Reservoir.

Table 5-3. Conveyance Measure Efficiency (Incremental Capacity and Incremental Cost)

Facility and Capacity	Incremental Conveyance Capacity (cfs)	Incremental Cost[1] (millions)	Incremental Efficiency (Cost per cfs of Capacity)
TC Canal – 2,100 cfs	2,100	$0	$0
TC Canal – 2,700 cfs	600	$110.9	$184,800
TC Canal – 4,000 cfs	1,300	$287.3	$221,000
TC Canal – 5,000 cfs	1,000	$158.3	$158,300
GCID Canal – 1,800 cfs	1,800	$178.5	$99,200
GCID Canal – 3,000 cfs	1,200	$123.8	$103,200
GCID Canal – 4,000 cfs	1,000	$161.5	$161,500
GCID Canal – 5,000 cfs	1,000	$88.5	$88,500
Stony Creek Pipeline – 1,000 cfs	1,000	$87.9	$87,900
Stony Creek Pipeline – 2,100 cfs	1,100	$80.4	$73,100
Colusa Basin Pipeline – 1,000 cfs	1,000	$145.9	$145,900
Colusa Basin Pipeline – 3,000 cfs	2,000	$217.0	$108,500
Delevan Pipeline – 1,500 cfs	1,500	$369.8	$246,500
Delevan Pipeline – 2,000 cfs	500	$51.6	$103,200
Delevan Pipeline – 3,000 cfs	1,000	$152.9	$152,900
Delevan Pipeline – 4,000 cfs	1,000	$172.9	$172,900
Delevan Pipeline – 5,000 cfs	1,000	$170.0	$170,000

Note:
[1] Costs are the 2007 preliminary construction cost estimates and do not include mitigation, engineering, or administrative costs.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
TC = Tehama-Colusa

As indicated previously, not all of the remaining conveyance measures are independent. More specifically, all of the remaining TC Canal and Stony Creek Pipeline measures rely on conveyance capacity in TC Canal below Orland. The Stony Creek Pipeline measures have been modified to accommodate TC Canal design limitations. The 1,000-cfs measure has been modified to 600 cfs and the 2,100-cfs measure has been modified to 1,900 cfs to take advantage of 2,700-cfs and 4,000-cfs capacity, respectively, in the lower portion of TC Canal. These modifications are required since the first 2,100 cfs of TC Canal capacity is dedicated now to the TC Canal 2,100-cfs measure.

Measures available for second selection include the TC Canal 2,700-cfs measure, the GCID Canal 1,800-cfs measure, the Stony Creek 600-cfs measure, the Colusa Basin Pipeline 1,000-cfs measure, and the Delevan Pipeline 1,500-cfs measure. Of these measures available for selection, the GCID Canal 1,800-cfs measure is most efficient (ranked second), at $99,200 per cfs, and is selected next. After this selection, the next measures available are the same as in the previous step, except the GCID Canal 1,800-cfs measure is replaced by the GCID Canal 3,000-cfs measure. Of these measures, the GCID Canal 3,000-cfs measure is most efficient at $103,200 per cfs (ranked third). This process continues until all 17 measures have been selected, as shown in table 5-4.

Table 5-4. Conveyance Measure Selection Based on Integrated Incremental Capacity and Cost

Facility and Capacity	Incremental Conveyance Capacity (cfs)	Incremental Cost[1] (millions)	Incremental Cost per cfs of Capacity
1. TC Canal – 2,100 cfs	2,100	$0	$0
2. GCID Canal – 1,800 cfs	1,800	$177.2	$99,200
3. GCID Canal – 3,000 cfs	1,200	$125.1	$103,200
4. Colusa Basin Pipeline – 1,000 cfs	1,000	$145.9	$145,900
5. Colusa Basin Pipeline – 3,000 cfs	2,000	$217.0	$108,500
6. GCID Canal – 4,000 cfs	1,000	$161.5	$161,500
7. GCID Canal – 5,000 cfs	1,000	$88.5	$88,500
8. TC Canal – 2,700 cfs	600	$110.9	$184,800
9. Stony Creek Pipeline – 600 cfs	600	$115.8	$193,000
10. Stony Creek Pipeline – 1,900 cfs	1,900	$173.5	$133,500
11. TC Canal – 4,000 cfs	1,300	$287.3	$221,000
12. TC Canal – 5,000 cfs	1,000	$158.3	$158,300
13. Delevan Pipeline – 1,500 cfs	1,500	$369.8	$246,500
14. Delevan Pipeline – 2,000 cfs	500	$51.6	$103,200
15. Delevan Pipeline – 3,000 cfs	1,000	$152.9	$152,900
16. Delevan Pipeline – 4,000 cfs	1,000	$172.9	$172,900
17. Delevan Pipeline – 5,000 cfs	1,000	$170.0	$170,000

Note:
[1] Costs are the 2007 preliminary construction cost estimates and do not include mitigation, engineering and administrative costs.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
TC = Tehama-Colusa

The efficiencies of the TC Canal 2,700-cfs measure and the Stony Creek Pipeline 600-cfs measure both provide 600 cfs of incremental capacity at similar costs. Their efficiencies were close (table 5-4). At ranks 8 and 9, it appears unlikely that either measure would be needed to develop a conveyance management measure plan. The cost of that additional capacity in the lower portion of the TC Canal has been included in both measures for this evaluation. If it becomes necessary later to select between the two measures, a more comprehensive evaluation of the effectiveness and efficiency of each is recommended. Furthermore, the remaining TC Canal enlargement and Stony Creek Pipeline measures have all been chosen based on the selection of TC Canal 2,100 cfs first. The investigation does not anticipate needing to consider any of these lower ranked measures.

Conveyance from Reservoir to Service Areas or Locations with Various Water Resource Needs and Uses

The prior evaluation focused on each conveyance measure's ability to convey water to storage. The following evaluation will consider the ability of measures to convey water to service areas or locations with varying water resource needs and uses. Ultimately, the ability of a conveyance measure to transport water to needs and uses will be evaluated with an operations model.

For Sites Reservoir, three general methods can be used to facilitate the delivery of water to areas of need and use.

- First, water can be delivered directly from Sites Reservoir to meet local needs in the vicinity of the existing GCID and TC Canals. Needs are defined as currently unmet uses for water.
- Second, Sites Reservoir can deliver water locally in an integrated way (e.g., water supply exchanges) with CVP operations, thereby facilitating an ability to meet additional needs throughout the Bay-Delta system. Any Sites Reservoir plan would be connected to Funks Reservoir and therefore to the TC Canal. This connection would facilitate some integration with the CVP, independent of the conveyance measures selected. Additional connection to and integration with the CVP would be facilitated by the GCID Canal measures. The benefits resulting from this type of integrated exchange operation relate directly to the amount of water served to the local area by Sites Reservoir that previously was served by the CVP's other facilities. Sites Reservoir can serve CVP contractors that were previously served by other CVP facilities. In exchange, the CVP can serve the primary objectives of this project without affecting current uses.
- Third, the Delevan Pipeline measures offer the unique ability to release water into the Sacramento River directly from Sites Reservoir. The Delevan Pipeline measures also would facilitate the ability to meet additional needs throughout the Bay-Delta system. Water released from the Delevan Pipeline could provide downstream benefits for Delta water quality and water supply reliability for CVP, SWP, EWA or a similar program, and Level 4 refuge supply. These resource needs can be met directly by conveying water through the Delevan Pipeline to the Sacramento River for downstream uses and needs. The Delevan Pipeline 1,500-, 2,000-, and 3,000-cfs measures will be retained because preliminary operation simulations indicated that these measures would provide significant and unique benefits that may not be possible by either of the first two methods already discussed.

Design release capacity of conveyance pipelines from Funks Reservoir to the Sacramento River is estimated to be 75 percent of the pipeline pumping capacity associated with pumping from the river to Funks Reservoir. Table 5-5 shows the conveyance measures retained to allow the investigation of the benefits associated with direct conveyance to the Sacramento River and each measure's release capacity to the river.

Table 5-5. Conveyance Measures Retained to Allow Investigation of Benefits Associated with Direct Conveyance to the Sacramento River

Conveyance Management Measure (Capacity to Pump Water into Sites Reservoir)	Measure Capacity (from Funks Reservoir to Sacramento River)
(A)	**0.75 (A)**
Delevan Pipeline – 1,500 cfs	1,125 cfs
Delevan Pipeline – 2,000 cfs	1,500 cfs
Delevan Pipeline – 3,000 cfs	2,250 cfs

Key:
cfs = cubic feet per second

In the following chapters, a variety of conveyance management plans are evaluated using an operation simulation of the water resources system with and without Sites Reservoir. The ability of conveyance measures to accomplish the second purpose cannot be determined without an operation simulation. These simulations will determine the effectiveness of the NODOS project with and without the Delevan Pipeline. The evaluation provides an understanding of the significance of additional benefits that can be accomplished by direct delivery of water to the Sacramento River compared to conveyance management plans using only exchange operations. This analysis also allows an evaluation of the alternative sizes proposed for the Delevan Pipeline. As shown in the initial evaluation in this chapter, the pipeline is relatively expensive for conveyance to the reservoir. Therefore, additional benefits must be substantial to overcome the pipeline costs.

Conveyance Management Measure Recommendations

Table 5-6 shows conveyance management measures retained, as well as those not recommended for further consideration. The efficiency cost-capacity analysis supports retaining the TC Canal 2,100-cfs measure and the GCID 1,800-cfs measure. Three Delevan Pipeline measures (1,500-cfs, 2,000-cfs, and 3,000-cfs) are retained to allow further investigation of the importance of providing direct release capacity to the Sacramento River that could be accomplished uniquely with the Delevan Pipeline. If a Delevan Pipeline measure is included in a reservoir plan with existing capacity canals, total diversion capability would range from 5,400 to 6,900 cfs. Neither the Stony Creek Pipeline 600-cfs measure or the TC Canal 2,700-cfs measure was recommended for further consideration, based on their inefficiency. If an expanded TC Canal (capacity greater than 2,700 cfs) appears more favorable in subsequent phases of the NODOS feasibility study, a detailed investigation of these two measures should be completed.

Table 5-6. Conveyance Measures Retained and Conveyance Measures Not Recommended for Further Consideration

Conveyance Measures Retained	
TC Canal	Existing 2,100-cfs capacity
GCID Canal	Existing 1,800-cfs capacity
Delevan Pipeline	1,500-cfs capacity 2,000-cfs capacity 3,000-cfs capacity
Conveyance Measures Not Recommended for Further Consideration	
GCID Canal	Expand to 3,000-cfs capacity Expand to 4,000-cfs capacity Expand to 5,000-cfs capacity
TC Canal	Modify to 2,700-cfs capacity Expand to 4,000-cfs capacity Expand to 5,000-cfs capacity
Delevan Pipeline	4,000-cfs capacity 5,000-cfs capacity
Colusa Basin Pipeline	1,000-cfs pipeline capacity 3,000-cfs pipeline capacity
Stony Creek Pipeline	1,000-cfs capacity 2,100-cfs capacity

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
TC = Tehama-Colusa

This recommendation leaves five conveyance measures (table 5-6) for continuing consideration in the NODOS Investigation. These measures can be combined to provide a range of conveyance measures to Funks Reservoir, with up to 6,900-cfs total capacity, for use in initial alternative development. In addition, the conveyance measures retained will allow for an evaluation of benefits associated with various conveyance measures, as already described.

These recommendations do not preclude reconsideration, at a later date, of conveyance measures not recommended for further investigation. If operations studies indicate that additional capacity is necessary to more efficiently convey water to the reservoir, the initial evaluation of efficiency of conveyance to the reservoir indicates that the GCID Canal 3,000-cfs measure should receive first consideration. The evaluation of initial alternative plans in Chapter 7 will provide a preliminary assessment of the ability of Delevan Pipeline measures to provide unique benefit opportunities. The initial alternative plans do not include the Delevan Pipeline 3,000-cfs measure. The apparent effectiveness of the Delevan Pipeline 1,500-cfs and 2,000-cfs measures will be determined through evaluation of the initial alternatives. The potential effectiveness of the Delevan Pipeline 3,000-cfs measure will be evaluated based on these initial results. If a larger Delevan Pipeline still appears viable after these initial evaluations, a 3,000-cfs measure should be investigated.

Additional Considerations Supporting Initial Evaluation Recommendations

The following additional considerations also are noted and generally support the screening already described.

- ***Water Quality*.** The water from the CBD is considered to be of relatively poor quality when compared to Sacramento River water, and it is therefore less desirable. The CBD is the single largest source of agricultural return flows to the Sacramento River; as a result, it has elevated values for alkalinity, electrical conductivity (EC), and TDS. Nitrogen and phosphorus concentrations also are generally higher in the CBD. Water taken from the CBD into Sites Reservoir and then released back through the conveyance system could result in water quality impacts to local agricultural users and create a new point source of relatively lower quality water if discharged from the Delevan Pipeline into the Sacramento River. Neither Colusa Basin Pipeline measure is recommended for further consideration, based on efficiency. This recommendation is further supported by relatively poor water quality and associated environmental impacts.

- ***Agricultural Land*.** California's desire to preserve agricultural land is reflected in the California Land Conservation Act, also known as the Williamson Act. The effectiveness of the Williamson Act is often measured by the amount of prime agricultural land (as defined in the Act) in the program. Expansion of the GCID Canal (4,000- and 5,000-cfs options) would require the acquisition of temporary and permanent rights-of-way (ROWs). The 4,000- and 5,000-cfs measures for the GCID Canal would require approximately 1,890 acres of land during construction. Permanent land area acquired for the canal expansion would be 940 acres, of which 727 acres are classified as prime agricultural land. The 4,000- and 5,000-cfs measures for the GCID Canal are not recommended for further consideration based on efficiency. The impacts to prime agricultural land associated with these facilities further support not recommending the larger GCID Canal measures. Similar impacts to agricultural land are associated with the expansion of the TC Canal: 2,468 acres of agricultural land were determined to be within 100 feet of the project footprint; of these, 1,244 acres are classified as prime agricultural land. Again, these impacts also support the recommendation not to consider these measures further based on efficiency, as previously described.

- ***Environmental Effects.*** As already noted, measures that expand the existing canals would affect large land areas, temporarily and permanently. Some environmental effects of land conversions associated with expanding the TC Canal and the GCID Canal to 4,000 or 5,000 cfs have been identified preliminarily.

  Environmental reconnaissance surveys of TC Canal expansion areas have identified vernal pool invertebrates, tiger salamander, and vernal pool plants (in at least 21 vernal pools) within 100 feet of the expansion project fence line. At least two vernal pools were found on both sides of the TC Canal at the same mile marker. Vernal pools were found east of Corning and near Funks Reservoir. Approximately 170 elderberry stems greater than one-inch in diameter were found at ground level, which is considered habitat for VELB. Effects to salmon and steelhead related to siphon enlargements at some nearby streams are likely; these would affect construction timing and require mitigation. TC Canal is partially within the range of the giant garter snake near Orland, and expansion of the existing canal beyond 2,700 cfs might result in the loss of giant garter snake habitat. Swainson's hawk nesting habitat also extends into a portion of the TC Canal alignment; numerous nests have been recorded along the canal. Additional environmental impacts include roughly 64 acres of jurisdictional wetlands (including vernal pools) located primarily at the culvert crossings and siphon locations. Although ponds and toe drains also occur, they might require mitigation if the large expansions were implemented.

  The environmental reconnaissance of TC Canal expansion areas also determined that midden soils are present in several locations; these are frequently associated with long-term occupation and human remains. There is an historical community under TC Canal, near SR 162. As a rough estimate, up to 30 buildings are within 100 feet of the TC Canal, and numerous farmhouses and buildings are within 100 feet of the TC Canal between Orland and Red Bluff.

  Environmental reconnaissance surveys limited to within 100 feet of the potential GCID expansion project footprint, on both sides and at siphon locations, have indicated approximately 286 elderberry stems greater than 1 inch in diameter at ground level, which is considered habitat for VELB. Effects to salmon and steelhead related to siphon enlargements are likely on some nearby streams; their presence would affect construction timing and require mitigation. The GCID Canal alignment is entirely within the range of the giant garter snake; the canal itself and areas within 100 feet are considered habitat (at least 945 acres). A Swainson's hawk nesting habitat can be found in the Central Valley portion of the GCID Canal; there are numerous records of nests along the canal. Additional environmental impacts include approximately 35 acres of jurisdictional wetlands (including vernal pools) located primarily at the culvert crossings and siphon locations. Although ponds and toe drains also occur, they might require mitigation if a canal expansion project were implemented.

The expansion study areas and adjacent lands have not been surveyed for cultural resources; however, the GCID Canal qualifies as an historic structure. Records searches indicate 11 historic sites within 1 mile of the GCID Canal and no recorded prehistoric sites. Several graves within a portion of the Willows cemetery are within 100 feet of the existing GCID Canal footprint; expansion might require the relocation of a portion of this cemetery. As a rough estimate, 10 buildings are within 100 feet of the GCID Canal (mostly houses in Willows).

A summary of the potential issues and impacts that might result from enlarging the GCID Canal or TC Canal to 4,000 or 5,000 cfs is provided in table 5-7. The environmental issues associated with both TC Canal and GCID Canal expansions also support the recommendation not to consider these measures further based on efficiency.

Table 5-7. Summary of Potential Issues and Impacts from Enlarging TC Canal or GCID Canal to 4,000 or 5,000 cfs

Environmental Permits/Documentation Potentially Required
NEPA Compliance
CEQA Compliance
Federal ESA or CESA Compliance (Consultation, Biological Assessment)
DFG Streambed Alteration Agreement
Clean Water Act 404 Compliance
Clean Water Act 401 Compliance
RWQCB Storm Water Permit
Federal 106 (Cultural/Historic Resources) Compliance
Potential Environmental Issues
Impacts to Prime Farmland, Unique Farmland, or Farmland of Statewide Importance
Impacts to Lands Under Williamson Act Contracts
Impacts to Jurisdictional Wetland Habitats and Waters of the U.S.
Impacts to Wildlife Migration or Movement
Impacts Related to Short-Term Noise, Air Quality, or Traffic Increases

Table 5-7. Continued

California and Federally Listed Species Potentially Impacted
Bald eagle
Bank swallow
Swainson's hawk
Mountain plover
Greater sandhill crane
Giant garter snake
California tiger salamander
Central Valley spring-run Chinook salmon
Central Valley steelhead
Western yellow-billed cuckoo
Winter-run Chinook salmon
Green sturgeon
Conservancy fairy shrimp
Valley elderberry longhorn beetle
Vernal pool fairy shrimp
Vernal pool tadpole shrimp
Greene's tuctoria
Hoover's spurge
Hairy Orcutt grass
Slender Orcutt grass
Palmate-bracted birds beak
Potential Impacts to Cultural and Historical Resources
Impacts to Housing (Necessitating Relocation)

Key:
DFG = California Department of Fish and Game
CEQA = California Environmental Quality Act
CESA = California Endangered Species Act
cfs = cubic feet per second
ESA = Endangered Species Act
GCID = Glenn-Colusa Irrigation District
NEPA = National Environmental Policy Act
RWQCB = Regional Water Quality Control Board
TC = Tehama-Colusa

Chapter 6
Formulation of Initial Alternative Plans

This chapter describes the development of initial alternative plans that have been formulated to achieve the NODOS objectives. Following a discussion of the NEPA No Action Alternative (CEQA No Project Alternative), and after the presentation of common features, each of the eight initial action alternative plans is generally described, including short discussions of how objectives are achieved and of the plan's unique features. Figure 6-1 describes the process used to develop the initial alternative plans.

Initial Alternative Plans

Instead of developing an exhaustive list of plans to account for the vast array of potential measure combinations and sizes, this phase of the formulation process focused on developing an array of nine different initial alternative plans to address the primary planning objectives, constraints, and criteria. Although these initial alternative plans focus on single planning objectives, each contributes somewhat to all three of the primary planning objectives (table 6-1). The following initial alternative plans were developed from the retained measures:

- A No Action (NEPA)/No Project (CEQA) Alternative;
- Three initial action alternative plans with a water supply focus (WS1A, WS1B, and WS1C);
- Two initial action alternative plans with an environmental enhancement focus to improve the survival of anadromous fish and other aquatic species (AF1A and AF1B);
- One initial action alternative plan that blends water supply (with enhanced M&I use) with environmental enhancement (WSFQ); and
- Two initial action alternative plans with a water quality focus (WQ1A and WQ1B).

Table 6-1 displays the initial alternative plans, along with the conveyance and retained measures included in each. Table 6-2 shows the yield targets (percent) for each beneficiary category for each initial action alternative plan. The yield targets are used by CalSim-II modeling to allocate the storage in Sites Reservoir to provide the benefits. The yield targets for each of the beneficiaries vary among the action alternatives, depending on the focus and priorities of beneficiaries in each action alternative. The actual percentage of the yield for the beneficiaries in each action alternative may differ slightly from the yield targets because of operations constraints (e.g., pumping and conveyance capacity limits, storage capacity, etc).

This page left blank intentionally.

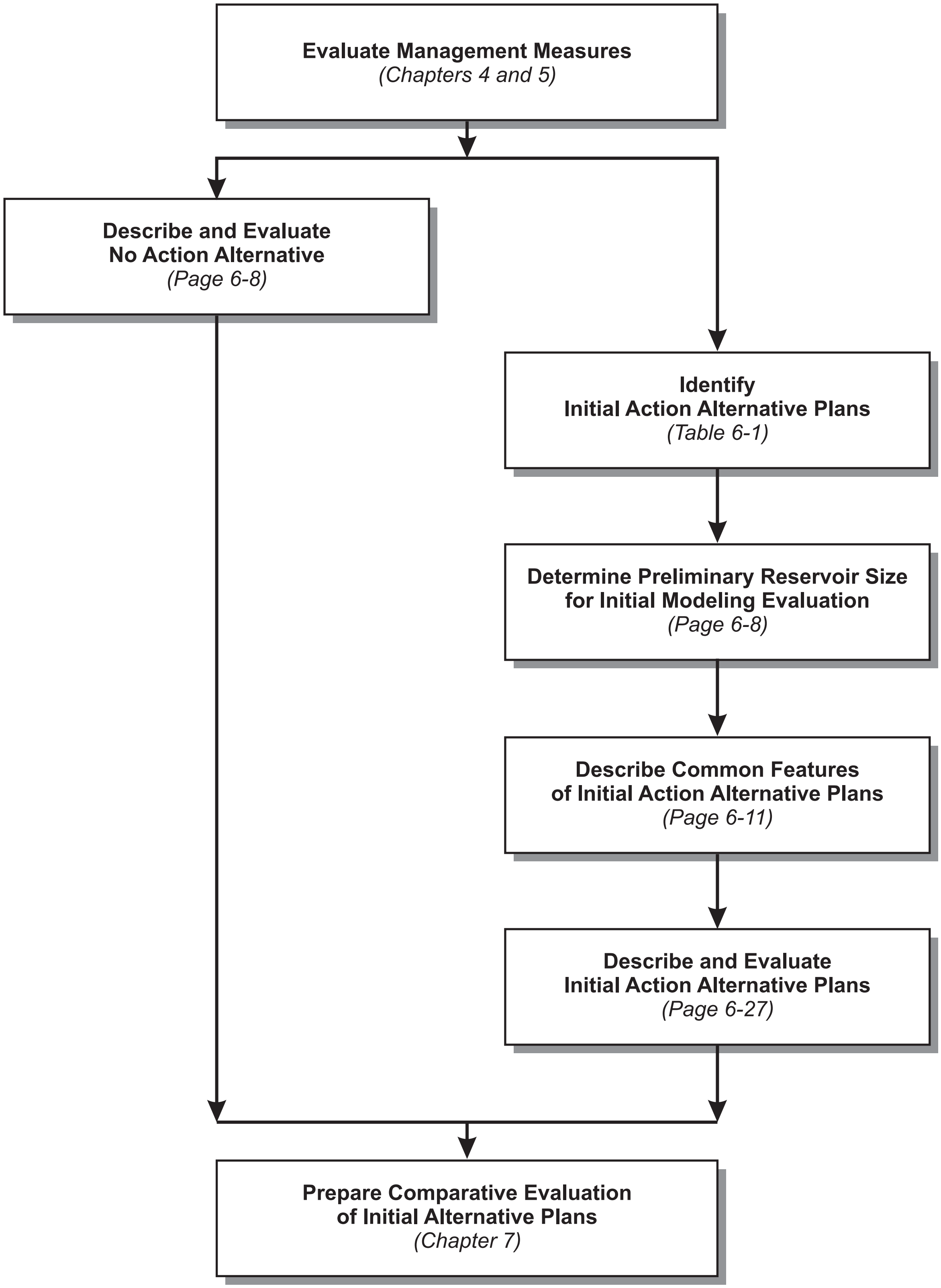


Figure 6-1. Development Process for Initial Alternative Plans

This page left blank intentionally.

Table 6-1. Selected Measures Included in Initial Alternative Plans

Initial Alternative Plans	Conveyance	Measures Retained										
		Primary Objectives								Secondary Objectives		
		Water Supply				Anadromous Fish and Aquatic Species Survivability			Water Quality			
		New Offstream Storage at Sites Reservoir	Conjunctive Use	Water Transfers	Water Use Efficiency	Restore Abandoned Gravel Mines	Improve Instream Aquatic Habitat	Replenish Spawning Gravel	Improve Flows to Delta from New Storage	Hydropower	Recreation	Flood Damage Reduction
No Action/No Project Alternative	N/A		X	X	X							
WS1A – Reliance on Existing Canals	1,800-cfs GCID Canal 2,100-cfs TC Canal	X	X	X	X				X	X	X	X
WS1B – New 1,500-cfs Pipeline	1,800-cfs GCID Canal 2,100-cfs TC Canal 1,500-cfs Pipeline Diversion 1,125-cfs Pipeline Release	X	X	X	X				X	X	X	X
WS1C – New 2,000-cfs Pipeline	1,800-cfs GCID Canal 2,100-cfs TC Canal 2,000-cfs Pipeline Diversion 1,500-cfs Pipeline Release	X	X	X	X				X	X	X	X
AF1A – New 1,500-cfs Pipeline	1,800-cfs GCID Canal 2,100-cfs TC Canal 1,500-cfs Pipeline Diversion 1,125-cfs Pipeline Release	X	X	X	X	X	X	X	X	X	X	X
AF1B – New 2,000-cfs Pipeline	1,800-cfs GCID Canal 2,100-cfs TC Canal 2,000-cfs Pipeline Diversion 1,500-cfs Pipeline Release	X	X	X	X	X	X	X	X	X	X	X
WSFQ – New 2,000-cfs Pipeline with Fish Enhancements	1,800-cfs GCID Canal 2,100-cfs TC Canal 2,000-cfs Pipeline Diversion 1,500-cfs Pipeline Release	X	X	X	X	X	X	X	X	X	X	X
WQ1A – New 1,500-cfs Pipeline	1,800-cfs GCID Canal 2,100-cfs TC Canal 1,500-cfs Pipeline Release	X	X	X	X				X	X	X	X
WQ1B – New 2,000-cfs Pipeline	1,800-cfs GCID Canal 2,100-cfs TC Canal 2,000-cfs Pipeline Diversion 1,500-cfs Pipeline Release	X	X	X	X				X	X	X	X

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
N/A = not applicable
TC = Tehama Colusa

This page left blank intentionally.

Table 6-2. Yield Target[1] for Each Beneficiary Category (percent)

Beneficiary	Plan Formulation Yield Targets (%)[2]							
	WS1A	**WS1B**	**WS1C**	**AF1A**	**AF1B**	**WSFQ**	**WQ2A**	**WQ1B**
Water Supply (Agriculture, M&I, and Environmental)								
Urban and Agricultural	65	65	65	40	40	50	50	50
Local (non-CVP)	3	3	3	3	3	0	3	3
SWP	30	30	30	20	20	30	25	25
CVP	10	10	10	7	7	5	10	10
Environmental								
Level 4 Refuge	8	8	8	5	5	5	5	5
EWA	14	14	14	5	5	10	7	7
Water Quality (Urban and Restoration)	15	15	15	15	15	30	30	30
Ecosystem Restoration	20	20	20	45	45	20	20	20
TOTAL	100	100	100	100	100	100	100	100

Notes:

[1] Targets allocated based on operational priorities of alternatives.
[2] Percentages developed using professional judgment for initial modeling evaluation.

Key:

CVP = Central Valley Project
EWA = Environmental Water Account
M&I = municipal and industrial
SWP = State Water Project

Cost Estimates

The investigations, designs, and cost estimates described in the PFR are considered to be preliminary at this stage of the feasibility study. While some technical aspects, such as geological investigations, designs, and cost estimates for the components of the NODOS project, such as Sites Reservoir, Funks Reservoir enlargement, and TC Canal and GCID Canal modifications, are at a feasibility level of detail, other features, such as the Sacramento River Pumping Generating Plant and the new Delevan Pipeline, are at a pre-feasibility level of detail. The NODOS environmental studies and economic and financial evaluations have not advanced to a stage commensurate with technical feasibility studies.

The costs are based on May 2007 price levels. Total investment cost is the sum of total construction costs and interest during construction (IDC) costs. The IDC cost is computed using Reclamation-defined practices and is based on an estimated construction period of 7 years for all plans. Total investment cost is annualized over the project's assumed 100-year lifespan, using the Federal interest rate of 4.875 percent to compute interest and amortization. Total annual cost is the sum of interest and amortization and estimated annual O&M costs.

Selection of Preliminary Reservoir Size for Initial Modeling Evaluation

The initial action alternative plans assume a reservoir size of 1.8 MAF; the size of the reservoir for the plans will be refined later in the feasibility study process using CalSim-II modeling runs and benefit analyses.

A starting point of 1.8 MAF assumes constructing Sites Reservoir to provide the greatest water supply yield. Under this scenario, the maximum reservoir elevation is constrained to 520 feet, based on a review of the reservoir rim topography, site geology, the presence of geologic features trending through the reservoir rim, and a cursory evaluation of the relationship between embankment volume and reservoir storage from water surface elevations of 480 to 560 feet. A review of the reservoir rim indicated that reservoir elevations above 540 feet probably would require grouting of the lower saddle areas along the relatively steep ridges of the eastern rim, to ensure the project would perform satisfactorily. This treatment, combined with the increasing relationship between embankment material volume and reservoir surface elevations, probably would result in larger unit costs (reservoir cost/AF of storage) for reservoir elevations above 540 feet. Therefore, the reservoir alternatives below elevation 540 feet are considered to be more economical on a unit cost basis. In addition, detailed geologic and geotechnical evaluations have not been performed on lower elevation areas of the eastern rim. Therefore, a maximum elevation of 520 feet was selected to ensure that the proposed size of Sites Reservoir would be technically feasible. Limiting the maximum reservoir elevation to 520 feet also provides assurance that unknown conditions on the relatively steeper slopes of the eastern reservoir rim would not result in large increases in project costs during the later stages of design.

No Action Alternative (NEPA)/No Project Alternative (CEQA)

For the purposes of this PFR, the terms No Action Alternative, No Project Alternative, and “Without Project Future Conditions” are considered synonymous. The No Action Alternative is a legitimate plan that is compared against the action alternatives. Under the No Action Alternative, no actions would be taken to provide storage north-of-the-Delta to improve water supply or to enhance the survivability of anadromous fish or drinking water quality in the Delta. Assumptions regarding California’s water resources systems have been developed through a collaborative process known as Common Assumptions, a joint effort of DWR, Reclamation, and the Bay-Delta Authority. Key assumptions regarding the No Action Alternative include the following.

- For the No Action Alternative, it was assumed that operations at RBDD would be modified to improve fish passage. Potential solutions to improve fish passage and reduce predation on out-migrating juvenile salmonids and green sturgeon larvae downstream from the dam are being considered as part of the RBDD FPIP. This cooperative effort, led by Reclamation and the TCCA, is considering several alternatives to develop a long-term solution to relieve conflicts between fish passage and agricultural diversion needs. If a project is selected before the NODOS Investigation is completed, it will be fully integrated into the No Action Alternative for the feasibility report. Because this is being evaluated independently, costs associated with the fish passage improvements were not included in any action alternative.

- The No Action Alternative does not include potential expansion of the Sacramento River NWR.
- Modifications to Folsom Dam to increase releases during lower pool stages, or revising the surcharge storage space in the reservoir, are not currently included in the No Action Alternative. This assumption will be reassessed for the feasibility report.
- Enlargement of Shasta Lake is not included in the No Action Alternative.
- For the NODOS PFR, an existing Banks pumping capacity limit of 6,680 cfs was assumed. The operational component of the SDIP that considers increasing the permitted pumping capacity at Banks Pumping Plant from 6,680 cfs to 8,500 cfs is not included in the No Action Alternative. The final EIS/EIR for the SDIP was completed in December 2006, but neither a ROD nor a Notice of Determination (NOD) was filed because of issues regarding pelagic organism decline, Delta sustainability, and the Delta Vision process. The SDIP assumption will be reassessed in the feasibility report.
- The EWA has been extended through 2010 under the Water Supply, Reliability, and Environmental Improvement Act (2004) and is included in the No Action Alternative.
- The No Action Alternative includes WUE to conserve and recycle water throughout California.
- The MOU between Reclamation, DWR, and SWRCB for implementing the CALFED Water Transfer Program is included in the No Action Alternative.
- Changes to the operating environment of the CVP and SWP are anticipated to result from the development of the long-term OCAP biological opinions scheduled for spring 2009. The resulting effects on operations are not included in the No Action Alternative. The new OCAP biological opinions will specify operations criteria that will be included in the feasibility study.

Anticipated increases in population growth in the Central Valley and throughout California would increase demands on water resource systems. As discussed in Chapter 2, it is estimated that the demand for water in the future will exceed available supplies and intensify competition for available water, especially during multiple year droughts. Following are the consequences of the No Action Alternative relative to the objectives of the NODOS Investigation.

- **Water Supply and Reliability –** The demand for water in the Central Valley and throughout California would exceed the available supply. Increasing demand would be associated primarily with anticipated population growth, again in the Central Valley and throughout California. As noted in the *California Water Plan Update 2005: A Framework for Action*, “the biggest challenge for California water resources management remains making sure that water is in the right places at the right time. This challenge is at its greatest during dry years” (DWR, 2005a). The water plan recognizes that, from a management perspective, improving water supply reliability must focus on getting drought supply to specific communities, users, and uses that are vulnerable to unreliable drought water supplies. Many water conservation measures have been implemented to reduce the effects of drought. In addition to WUE measures, conjunctive groundwater management also is likely to increase through substitution and transfer programs. As stated, WUE and water transfer are complementary actions to a NODOS project, and those with a reasonable certainty of being implemented in the future are assumed to be included in the No Action Alternative. Ongoing groundwater programs, such as the SVWMP, and local/regional water agencies will continue to study groundwater resources and management in the Primary Study Area and to pursue optimization of groundwater use. Further increased demands that exceed the practicable use of groundwater will restrict agricultural uses unless cost-efficient new sources are developed. This would result in adverse economic impacts to the Central Valley and elsewhere in California.

- **Anadromous Fish Survival –** Several measures have been implemented to improve the survival of anadromous fish. The magnitude and timing of releases from Shasta Dam have been modified to benefit anadromous fish. Gravel has been introduced to create spawning areas and spawning habitat on tributary streams. However, other actions have reduced the potential benefits of these actions. For example, the final *Record of Decision, Trinity River Main Stem Fishery Restoration and Environmental Impact Statement/Environmental Impact Report* (U.S. Department of the Interior, 2000) reduces flows to Keswick Reservoir and the Sacramento River. This constrains operations at Shasta, impacting all beneficiaries, including flows for temperature control for fish. Additional water supplies and other actions are needed to ensure sustained improvements in anadromous fish populations in the upper Sacramento River.

- **Water Quality –** The Bay-Delta system provides important habitat for fish and wildlife and is the diversion point for drinking water for millions of Californians and millions of acres of farmland. The salts entering the Bay-Delta system from the ocean and from some San Joaquin Valley return flows decrease the utility of Bay-Delta system waters for drinking water. Typically, the months of February through June are most favorable with respect to the Delta as a source of drinking water, relative to water quality. Outflow from natural runoff is usually high enough during this period to push seawater out of the Delta. This period is also outside of the peak loading time from agricultural drainage. Fishery concerns have resulted in a shift in exports from these higher-quality spring months to lower-quality fall months, with a corresponding degradation in delivered water quality. SWRCB Decision 1641 includes flow and water quality objectives associated with the Delta and operation of SWP and CVP facilities. These requirements provide protection for the beneficial uses already described that rely on the Delta, including M&I, agricultural, and fish and wildlife. The No Action Alternative would maintain compliance with current regulatory requirements and would not include supplemental Delta outflow to improve water quality beyond what is currently required for the beneficial uses described.

Common Features of the Initial Action Alternative Plans

Several features are common to the remaining eight initial action alternative plans from the NODOS Investigation. These features, all of which are considered integral to the performance of NODOS, include the implementation of:

- Sites Reservoir;
- Sites Pumping Plant;
- Funks Reservoir enlargement;
- Minor modifications to GCID Canal intake fish screens at Hamilton City;
- Modifications to GCID Canal;
- GCID Canal terminal regulating reservoir;
- Road and utility relocations;
- Transmission lines and substation requirements;
- Hydroelectric facilities;
- Recreation facilities;
- Ecosystem restoration account features; and
- Sites Reservoir operations strategy.

Sites Reservoir

The reservoir configuration used for the initial evaluation of alternatives would have a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet mean sea level (msl), and an inundation area of 14,000 acres (the size of the reservoir would be optimized in the feasibility study). The minimum operating water surface would be at elevation 320 feet. The reservoir would require construction of Golden Gate Dam on Funks Creek, Sites Dam on Stone Corral Creek, and nine saddle dams on the northern end of the reservoir, between the Funks Creek and Hunters Creek watersheds (see figure 6-2). These dams all would be zoned earth rockfill embankment type dams; previous investigations have indicated that this type of dam would be the most economical. However, a study of dam types will be conducted in the preliminary design phase to ensure the selection of the most economical and technically feasible dam types for all of the Sites Reservoir dams.

Golden Gate Dam would be constructed on Funks Creek, approximately 1 mile west of Funks Reservoir. The proposed dam embankment would have a crest elevation of 540 feet, a crest length of 2,250 feet, a maximum height of 310 feet above the streambed, and a total embankment volume of 10,590,000 cubic yards.

Sites Dam would be constructed on Stone Corral Creek, approximately one-quarter mile east of the town of Sites and 8 miles west of the town of Maxwell. The dam embankment would have a crest elevation of 540 feet, a crest length of 850 feet, a maximum height of 290 feet above the streambed, and a total embankment volume of 3,836,000 cubic yards.

Nine saddle dams would be required at the northern end of Sites Reservoir, between the Funks Creek and Hunters Creek watersheds, roughly along the Glenn-Colusa County line. Saddle Dam Nos. 1, 2, 4, and 9 are generally characterized as small-sized dams, with heights ranging from about 40 to 50 feet. Saddle Dam Nos. 3, 5, 6, 7, and 8 are generally characterized as medium-sized dams, with heights ranging from about 70 to 130 feet. Saddle Dam Nos. 3, 5, and 8 are the tallest and largest of the nine proposed saddle dams, with embankment volumes of about 3.5, 1.5, and 1.9 million cubic yards, respectively.

For the pumping capacities considered, the emergency spillway selected for the preliminary studies would consist of one 7-foot diameter concrete pipe buried in the abutment or bottom of Saddle Dam No. 4 and sized primarily to accommodate inspection and maintenance. The invert of the spillway inlet would be at elevation 526 feet, 6 feet above the normal maximum pool. Saddle Dam No. 4 would be within a sheltered cove, which would prevent wind-driven waves from entering the spillway inlet structure when the reservoir water surface was at or near the maximum elevation of 520 feet.

Sites Pumping Plant

The Sites Pumping Plant would lift water from Funks Reservoir into Sites Reservoir. Currently, Funks Reservoir operates in coordination with the TC Canal, between elevation 205 feet and elevation 208 feet. Each alternative action plan would require a different pumping capacity. The pumping plant would house a combination of 680 cfs and 350 cfs units to meet the needs of the alternative action plans. In each plan, an additional 680-cfs unit would be provided for standby.

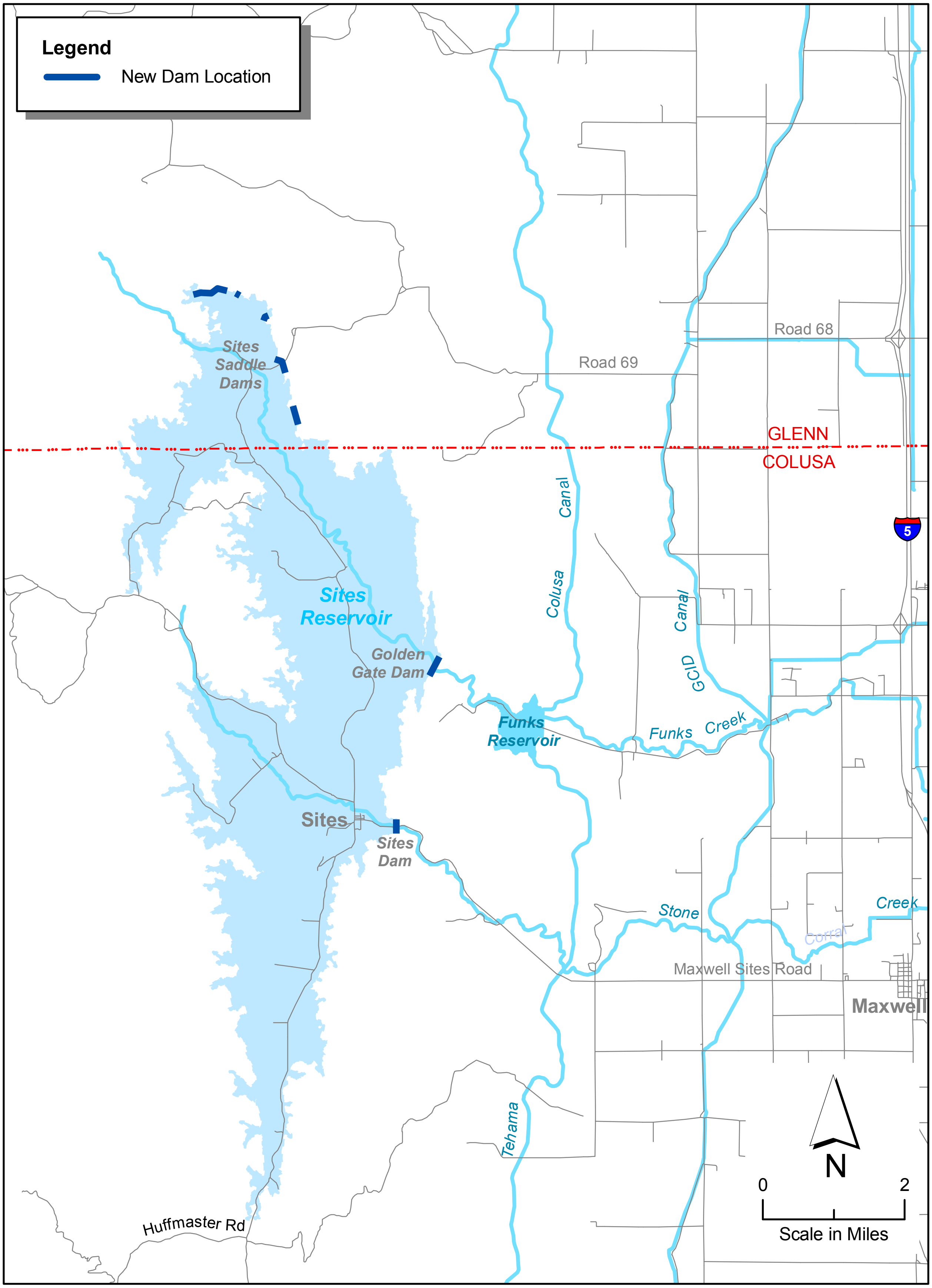
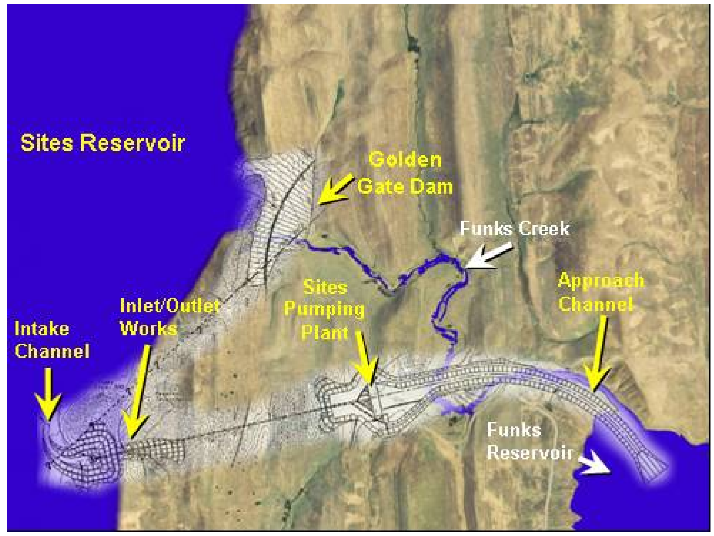


Figure 6-2 Sites Reservoir New Dam Locations

This page left blank intentionally.



Sites Pumping Plant
Source: DWR, 2007

The proposed Sites Pumping Plant would be approximately 3,300 feet southeast of (downstream from) Golden Gate Dam. The location and layout, including the plant/control building and conveyances, were determined on the basis of hydraulic and plant equipment requirements, foundation conditions, and the orientation of local faults. The final plant location should be determined by establishing a point of economic balance between the cost of the required excavation, tunnel length, and discharge lines, and the cost of long-term pumping.

The approach channel between Funks Reservoir and the Sites Pumping Plant would have a zero slope. The pumping plant would operate with tailwater elevations between 204 feet and 207 feet during pumping, and coordination with the conveyance facilities would be required to maintain the tailwater elevations in Funks Reservoir. The Sites Pumping Plant would be a conventional, indoor-type pumping plant, with an in-line arrangement of vertical pumping units. The pumping plant would have a reinforced concrete substructure and a steel superstructure, with the draft tube invert at elevation 170 feet.

Funks Reservoir Enlargement

Funks Reservoir is on Funks Creek, about 7 miles northwest of Maxwell, in Colusa County. The existing Funks Reservoir, constructed in 1975 by Reclamation, has 2,250 AF of total design storage capacity covering a surface area of 232 acres at elevation 205 feet. An earthfill dam with a crest elevation of 214 feet impounds the reservoir on the east. The dam forms the eastern bank of the TC Canal as it crosses Funks Creek. An inlet is located at the northeastern end, adjacent to the dam spillway, and at an outlet to the southeast. Both have a gated release structure. The TC Canal requires an operational elevation of Funks Reservoir between 204 feet and 206.25 feet. The spillway overflow discharge capacity is 25,000 cfs with all gates fully open.

Funks Reservoir would be modified to provide increased storage capacity to operate the conveyance system and regulate flows for the proposed Sites Pumping Plant. As designed, the active storage capacity of Funks Reservoir is 1,170 AF. To accommodate total inflow pumping capacities ranging from 3,900 cfs to 5,900 cfs, total active storage volumes from 1,300 to 5,290 AF were considered and analyzed. Selection of the enlarged reservoir capacity depends on the total inflow from the proposed conveyance options and the design capacity of the Sites Pumping Plant.

Funks Reservoir would serve as a forebay and afterbay for Sites Reservoir and would be used to regulate inflows and releases. For the proposed conveyance option, the TC Canal would be widened and modified upstream from Funks Reservoir to dissipate inflow energy before entering the reservoir.

Modifications to GCID Canal Intake Fish Screens

Glenn-Colusa Irrigation District Canal Intake
Source: DWR, 2007

The original GCID fish screen structure, built in 1972, consisted of 40 drum-screen assemblies mounted in separate bays within the 480-foot-long reinforced concrete structure. The drum screens were retrofitted in 1993 with flat plate screens and a new cleaning system. In 2001, a 525-foot extension of the fish screen structure was completed to meet current fish screen performance criteria. New brush-cleaning systems were installed on both the new and the original portions of the fish screen. The complete structure now consists of 85 bays with 12-foot by 12-foot fish screen panels mounted in each bay. Solid steel panels, called barrier panels, close off the portion of the bay between the top of the screen panel and the structure's top deck. The existing total screen area is 11,400 square feet (ft^2), which provides approximately 3,760 cfs of diversion capacity with river levels at or above the top of the screen panels. Normal operating conditions are based on a maximum diversion rate of 3,000 cfs, with a minimum river level of 136.5 feet msl at the screens, which leaves about 1 foot of screen area exposed above the water surface.

The existing structure has a crest elevation of approximately 155.5 feet msl, based on the barrier panel top elevation. At river levels above the crest elevation, water can flow into the forebay without passing through the fish screens. The river flow rate for this condition is approximately 120,000 cfs. The return period (average occurrence) of flows equal to or greater than 120,000 cfs is about 1 in 5 to 1 in 10 years. By raising the screen crest height, the facility could operate at or above a river flow rate of 120,000 cfs and could provide additional operating days and increased diversion quantity per season. The average increase in operating time with the proposed fish screen crest raise would be approximately 10 days. The new crest elevation is based on providing a consistent crest height across the entire length of the structure, including the north and south abutments. The maximum river level for diversion would be elevation 159.0 feet, with a corresponding river flow of about 150,000 cfs. At river flows above 150,000 cfs, the entire area surrounding the GCID Canal Main Pump Station would be subject to nuisance flooding, prevent controlled diversions into the forebay, and make any higher target for operating criteria impractical.

Modifications to GCID Canal

Minor reshaping along the lower 13 miles upstream from the TRR would be required to obtain a reliable capacity of 1,800 cfs. Siphons, check structures, and bridges were evaluated to determine whether modification or complete replacement would be needed to ensure proper operation. Five siphons along the GCID Canal convey Main Canal flows under major cross drainages, such as Stony Creek. Two options were considered to increase siphon capacity: adding more siphon barrels and modifying the inlet/outlet structures; or complete replacement. The choice to modify or completely replace was made based on the age and condition of the existing siphon and the required capacity increase. Only the railroad siphon would require replacement. Seven check structures located along the GCID Canal are used to control water levels in the canal. Only the Tuttle Creek check structure would require replacement. There are 32 bridges along the project length, varying from minor farm service bridges to a bridge on I-5. One bridge at Delevan Road would require replacement.

GCID Canal Terminal Regulating Reservoir

Water conveyed down the GCID Canal would be conveyed into a future TRR. A new pump station, the TRR-to-Funks Pump Station, would then convey the water from the TRR via a new pipeline up to the existing Funks Reservoir. The TRR would be required to provide operational storage for the TRR-to-Funks Pump Station to balance out normal and emergency flow variations between the upstream GCID Canal Pump Station, the 40 miles of connecting canal, and the TRR-to-Funks Pump Station.

The TRR, a shallow reservoir to provide operational storage for the GCID Canal-to-Funks Pump Station, as necessary, would be created on the valley floor next to the Main Canal by a combination of excavation and embankment. The general location of the TRR would be based on the requirement to have gravity flow from the Main Canal into the TRR. The TRR capacity would be based on the need to provide normal transient operating storage for the TRR-to-Funks Pump Station and emergency storage to absorb flows from the Main Canal following an emergency shutdown of the TRR-to-Funks Pump Station. Major appurtenance features would include a Main Canal transition bay, a connecting channel from the Main Canal to the TRR, and a flow control inlet structure. The reservoir would have a storage capacity of 2,000 AF and a square footprint covering approximately 200 acres, with bottom dimensions of approximately 2,900 feet by 2,900 feet. The depth would be approximately 17 feet, with a maximum embankment height of approximately 21 feet.

Road and Utility Relocations

Sites Reservoir would inundate portions of Maxwell Sites Road and Sites-Lodoga Road, blocking travel between Maxwell and Lodoga (figure 6-3). These roads are owned by Colusa County. Approximately 6 miles of the gravel Huffmaster Road, south of the town of Sites, also would be inundated. Huffmaster Road is a private road that provides access to properties mostly within the Sites Reservoir area. The project would include five new recreation areas, and road access to these sites also would be needed. In addition to road relocation costs, the project would require the relocation of utilities, including gas pipelines, power lines, telephone lines, and cable service. The service lines to a microwave station adjacent to the reservoir site also would require relocation.

Four alternative road alignments, including two with bridge segments over the reservoir and two that route around the reservoir without a bridge, are being considered. The bridge routes would provide more direct access, with reduced travel times, compared to the road routes without the bridges around the northern or southern ends of the reservoir. To identify the preferred route, all variables must be evaluated, including construction costs, O&M costs, travel times, environmental issues, and the identification of the most frequent road users. Users would include weekend recreational traffic and daily traffic (e.g., travel to and from school). At a later stage of project development, additional roads would be included in the road alignment alternatives to provide access to potential recreation areas and project facilities.

Transmission Lines and Substation Requirements

Operation of the project pumping plants would require power. The Sites Pumping/Generating Station has a maximum generating capacity of 150 megawatts (MW) of power. A 230-kilovolt (kV) substation could be built within 0.25 mile of the transmission corridor. The first alternative configuration would require a four-breaker ring bus substation; the alternative configuration would require a six-breaker ring bus substation.

Transmission lines coming from the substations generally would follow the pipelines to each of the pump stations. There would be 3 miles of transmission lines from the substation to the Sites Reservoir (pumping/generating) Pump Station and 1.2 miles of transmission lines from the substation to the Glenn-Colusa Pump Station.

Hydroelectric Facilities

To provide the secondary benefits associated with hydropower, hydroelectric facilities would be added to many of the pumping plants as feasible. In general, the addition of ancillary hydropower to the grid would help mitigate some of the power consumption costs associated with this offstream facility. Water would

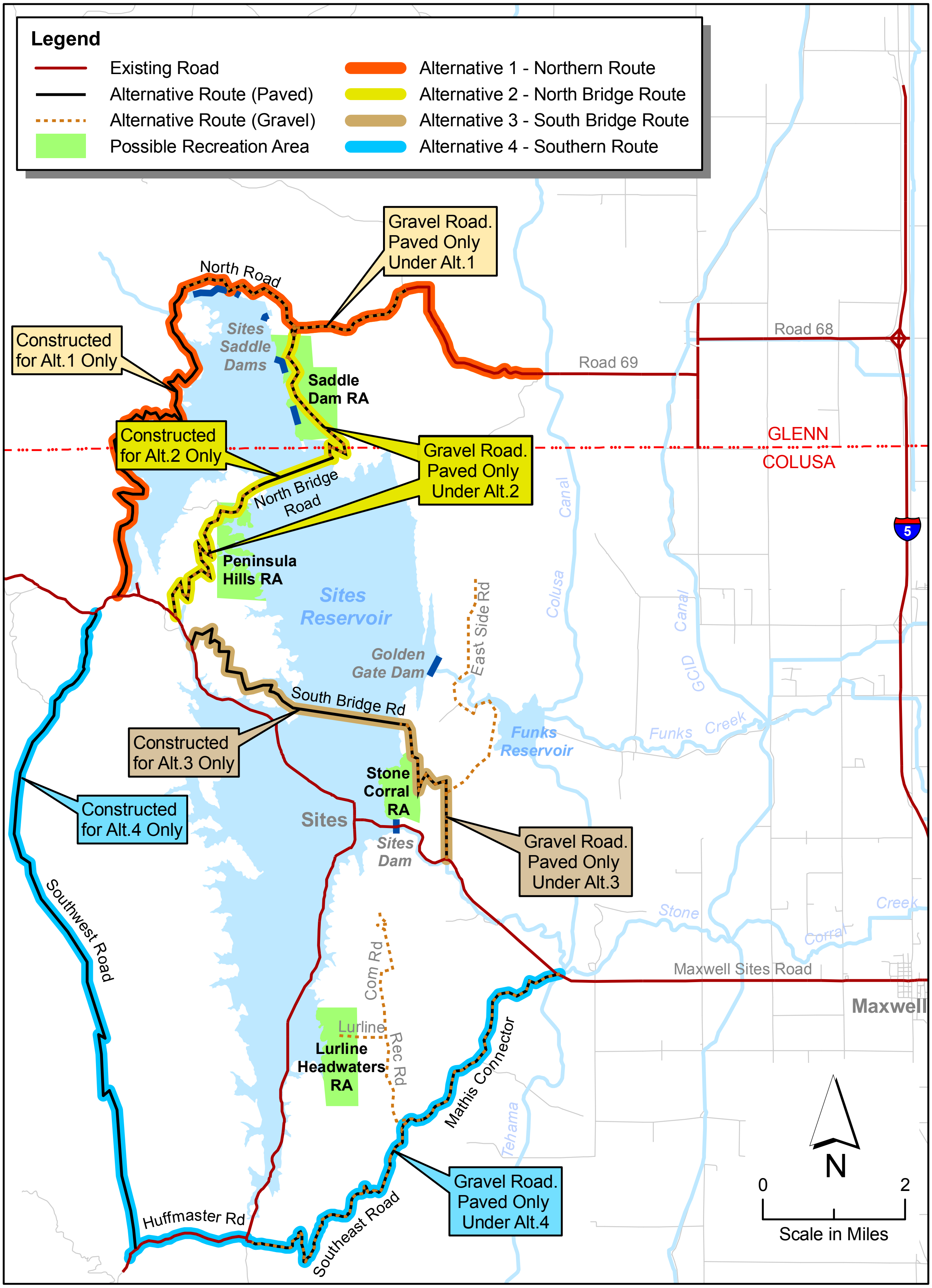


Figure 6-3 Sites Reservoir Road Relocation Route Alternatives

This page left blank intentionally.

be pumped into Sites Reservoir primarily during the winter, and water would be released primarily during the summer and fall, thereby producing hydropower when power demands and costs are typically higher. At this stage of planning, hydroelectric facilities have been designed and costed for the Sites Pumping Plant, the TRR Pumping Plant, and the Sacramento River Pumping Plant for the new pipeline. While every initial action alternative plan includes hydroelectric facilities, sizing of the facilities is based on the release capacity and head at the various locations. Currently, the operation of the hydroelectric facilities is based on water deliveries from Sites Reservoir, which was determined by water use within the system. This operation may be refined later to optimize the use of the hydroelectric facilities based on variability in the market cost of power.

Recreation Facilities

Sites Reservoir, at 1.8 MAF, would be the seventh largest reservoir in California, and preliminary studies indicate that additional recreation opportunities in the area probably are needed. DWR developed some conceptual recreation facilities options that could be implemented as part of a Sites Reservoir plan. Recreational activities and uses for Sites Reservoir would be offered at up to five recreation areas: Stone Corral, Sites Saddle Dams, Peninsula Hills, Antelope Island, and Lurline Headwaters Recreation Areas. Each of the initial action alternative plans would include the five recreation areas and would provide visitors with options for hiking, boating, overnight camping, fishing, swimming, and day-use picnicking. Facilities to be included for these activities would consist of boat launch sites, picnic tables, campfire rings and barbeques for overnight camping, restrooms, trails, designated swimming and fishing areas, and parking. As proposed, Peninsula Hills Recreation Area has a maximum potential for up to 200 campsites available to users, while Stone Corral and Lurline Headwaters each have a maximum potential for up to 50 campsites, and Antelope Island has a maximum potential for up to 12 campsites.

Ecosystem Restoration Account Features

NODOS provides a unique opportunity to provide the first firm asset ecosystem restoration account (ERA) in California managed by California and/or the Federal government and dedicated to restoration actions beyond regulatory requirements. As part of CALFED, the ERP has developed an integrated systems approach based on reversing the fundamental causes of decline in fish and wildlife populations by recognizing the natural forces that created historic habitats and using these forces to help regenerate habitats. The ERP was not designed as mitigation for CALFED projects; instead, it is intended to fulfill the objectives of improving ecological processes and increasing the amount and quality of habitat, equal with other program goals related to water supply reliability, water quality, and levee system integrity.

The ERP has identified over 600 programmatic actions to improve ecological health. The ERP advocates an adaptive management implementation strategy that supports the flexible use of environmental water. This adaptive approach has been accommodated in NODOS planning by dedicating a NODOS storage allocation to ERP objectives (an ERP pool or account), and then giving resource managers the ability to adjust priorities based on the monitoring of implemented actions, as well as potential new priorities. The NODOS planning team identified ERP objectives that could be supported by implementing a NODOS project and prioritized actions with input from a Sacramento River Flow Regime Technical Advisory Group. The list of potential ERP objectives includes both tributary actions and Delta actions. This group included environmental advocacy groups, academics, and representatives from Federal and California water resource and wildlife agencies. Ultimately, NODOS planners adopted a short list and longer list (as in AF1A and AF1B) of ERP objectives that were incorporated into the operations strategy for the initial action alternative plans (see table 6-3).

Table 6-3. NODOS Ecosystem Restoration Account (ERA) Objectives

Description	Initial Action Alternative Plans			
	WS1A	AF1A, AF1B	WSFQ	WS1B, WS1C, WQ1A, WQ1B
ERP Objectives (ERA Short List)				
Improve the reliability of cold-water carry-over storage at Shasta Lake (from the 2000 CALFED ERP Plan, Sacramento River Zone, Central Valley Stream Temperatures, Target 1 / Action 1) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Increase supplemental flows for cold water releases for salmon and steelhead between Keswick and RBDD (from the 2000 CALFED ERP Plan, Sacramento River Zone, Central Valley Stream Temperatures, Target 1—use Nov. 1997 AFRP targets) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Reduce diversions at Red Bluff to provide water into the TC Canal and at Hamilton City to provide water into the GCID Canal during July, August, and September. Priority is to reduce diversions at GCID. This concept is designed to minimize diversion effects to fish during identified critical periods (from the 2000 CALFED ERP Plan, Sacramento River Zone, Water Diversion, Target 1 / Action 1C) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Improve the reliability of cold water carry-over storage at Folsom Reservoir and stabilize flows in the American River (from the 2000 CALFED ERP Plan, American River Basin Zone, Central Valley Stream-flow, Targets 1, 2, and 3) (CALFED, 2000c and 2000d).	✓	✓	✓	✓

Table 6-3. Continued

Description	Initial Action Alternative Plans			
	WS1A	**AF1A, AF1B**	**WSFQ**	**WS1B, WS1C, WQ1A, WQ1B**
Modify spring flows into a "snowmelt pattern" in years with peak storm events in late-winter and early-spring, from Red Bluff to Colusa. The snowmelt pattern would be designed to increase the success of cottonwood cohorts, specifically (from the 2000 CALFED ERP Plan, Sacramento River Zone, Riparian and Riverine Aquatic Habitats, Target 1 / Action 1C) (CALFED, 2000c and 2000d).	✓	✓	✓	✓
Stabilize fall flows to avoid abrupt reductions from Keswick to Red Bluff (assumes November 1997 AFRP flow targets). This is intended to reduce adverse conditions for spawning fall-run Chinook salmon (U.S. Fish and Wildlife Service, 1997).			✓	
Stabilize fall flows to avoid abrupt reductions from Keswick to Red Bluff (assumes 6,000-cfs target from October through January and 4,500-cfs target for September). This concept is designed to avoid adverse conditions for spawning fall-run Chinook salmon (i.e., egg desiccation) (from the 2000 CALFED ERP Plan, Sacramento River Zone, Central Valley Stream-flow, Target 2 / Action 2) (CALFED, 2000c and 2000d).		✓		✓
ERP Objectives (ERA Long List – ERA Short List Plus Actions Below)				
Provide a flow event by supplementing normal operating flows from Shasta and Keswick Dams in March during years when no flow event has occurred during winter or is expected to occur. Flow events would be provided only when sufficient inflow to Lake Shasta was available to sustain the prescribed releases. This action could be refined by evaluating its indirect costs and the overall effectiveness of achieving objectives, which are 8,000 to 10,000 cfs in dry years and 15,000 to 20,000 cfs in below-normal years (from the 2000 CALFED ERP Plan, Sacramento River Zone, Central Valley Stream-flow, Action 1 / Target 1) (CALFED, 2000c and 2000d).		✓		
Provide a March Delta outflow from the natural late-winter and early-spring peak inflow from the Sacramento River. This outflow should be at least 20,000 cfs for 10 days in dry years, at least 30,000 cfs for 10 days in below-normal water years, and 40,000 cfs for 10 days in above-normal water years. Wet-year outflow is generally adequate under the present level of development (from the 2000 CALFED ERP Plan, Sac-SJ Delta Zone, Central Valley Stream-flow, Target 1) (CALFED, 2000c and 2000d).		✓		
Provide a minimum flow of 13,000 cfs on the Sacramento River below Sacramento in May of all but critical years (from the 2000 CALFED ERP Plan, Sac-SJ Delta Zone, Central Valley Stream-flow, Target 4) (CALFED, 2000c and 2000d).		✓		

Key:

AFRP = Anadromous Fish Restoration Program
CALFED = CALFED Bay-Delta Program
cfs = cubic feet per second
ERA = NODOS Ecosystem Restoration Account
ERP = CALFED Ecosystem Restoration Program
GCID = Glenn-Colusa Irrigation District
NODOS = North-of-the-Delta Offstream Storage
RBDD = Red Bluff Diversion Dam
Sac-SJ = Sacramento-San Joaquin
TC = Tehama-Colusa

In addition to the restoration account described, the Delta water quality action also will improve pelagic habitat conditions. The water quality action improves water quality for agricultural, urban, and environmental diversions from the Delta and for several pelagic species, including Delta smelt. However, the Delta water quality action does not use the restoration account, at this point.

Sites Reservoir Operations Strategy

Current operating rules for releases from Shasta Dam to the Sacramento River are governed by temperature and instream flow requirements, contractual obligations, Delta water quality and outflow requirements, and flood control. Flood control releases are prescribed by the U.S. Army Corps of Engineers, as described in *Report on Reservoir Regulation for Flood Control, Shasta Dam and Lake* (U.S. Army Corps Engineers, 1977). This report specifies the amount of storage for flood control purposes in Shasta Lake and determines how to make releases through the spillway. For the evaluation of NODOS action alternatives, a generally consistent operations strategy was used for each. The operations strategy is reflected in the operations simulation modeling that is the primary planning tool to determine many of the project benefits and impacts. The ability of each action alternative to implement this strategy effectively is subject to each action alternative’s specific primary objective focus, the conveyance options included, and the coordinated operation of Sites Reservoir with other existing facilities. The strategy has three components: (1) criteria for meeting primary objectives; (2) determination of Keswick releases; and (3) determination of Sites Reservoir releases.

Each action alternative would be operated to meet three primary objectives, but priorities assigned to each objective would vary, depending on the focus of the action alternative—water supply, survival of anadromous fish, or Delta water quality. The modeled reservoir and the system operations use the alternative operating rules through a wide range of hydrologic and operational conditions. A set of criteria is used to determine how the model operates the project for each primary beneficiary. Water supply-related operations are determined through forecast-based decisions. Anadromous fish operations are determined through a collection of flow/storage thresholds and forecast-based decisions. Delta water quality operations are determined through water quality conditions and storage thresholds.

Throughout the operations, the following two parameters are evaluated to determine strategy implementation: Shasta Lake storage condition and Keswick releases (including Shasta Lake releases and imports from the Trinity River); and Sites Reservoir storage and Sites Reservoir releases to local water supply diversions and to the Sacramento River.

For most actions associated with the objective of improved survival of anadromous fish and other species, the performance of the action alternative depends on the decisions regarding Shasta Lake storage and Keswick releases. Changes in Keswick releases require like changes in the import of Trinity River flows, or releases of Shasta Lake storage, or some combination of both. To achieve an optimal condition for anadromous fish in the Sacramento River between Keswick and Red Bluff, releases from Shasta Lake must be managed accordingly. The releases of Shasta Lake storage are sometimes limited by the amount of storage available in Shasta Lake. Storage availability is a consequence of what releases were made for preceding actions and other requirements.

For actions associated with improved water supply and Delta water quality, the performance of the action alternative depends on the decisions regarding Sites Reservoir storage and releases. The releases from Sites Reservoir to the Sacramento River are often constrained by the capacity to convey water to the river or to offset diversions from the river (through serving local water supply needs directly from Sites Reservoir). The releases of Sites Reservoir storage are sometimes limited by the amount of storage available in Sites Reservoir. Storage availability is constrained by the releases made for preceding actions and requirements.

To optimize the performance of Sites Reservoir for all primary objectives, Shasta Lake, Lake Oroville, and Sites Reservoir releases are coordinated. For each action alternative, the reduction of diversions at Red Bluff and Hamilton City are determined by the coordination of operations. Diversion reductions are a means to increase flows in the lower Sacramento River by consequently increasing releases from Sites Reservoir to local water supply users who would otherwise have diverted from the Sacramento River at Red Bluff or Hamilton City.

For each action alternative, the extent to which operations at Sites Reservoir, Shasta Lake, and Lake Oroville are coordinated depends on the primary objective focus and the conveyance options used. The action alternatives that focus on the survival of anadromous fish dictate greater changes to Keswick Dam releases and therefore to Shasta Lake releases. The action alternatives that have a lesser capacity to convey water from Sites Reservoir to the Sacramento River must rely more on Shasta Lake and/or Lake Oroville releases to meet the increased summer and fall Delta exports (for water supply) and Delta outflows (for water quality).

Summary of Common Features

A summary of the common features of the initial action alternative plans under analysis as part of the PFR process is provided in table 6-4.

Table 6-4. Summary of Common Features of NODOS Initial Action Alternative Plans

Sites Reservoir	Gross Storage Capacity – 1.8 MAF Water Surface Elevation – 520 feet msl Minimum Operating Pool – 320 feet msl Inundation Area – 14,000 acres
Golden Gate Dam (Sites Reservoir)	Location – Funks Creek Earth Rockfill Embankment Dam Crest Length – 2,250 feet Maximum Height – 310 feet Embankment Volume – 10,590,000 cubic yards
Sites Dam (Sites Reservoir)	Location – Stone Corral Creek Earth Rockfill Embankment Dam Crest Length – 850 feet Maximum Height – 290 feet Embankment Volume – 3,836,000 cubic yards
Saddle Dams (Sites Reservoir)	Location - North End from Funks Creek to Hunters Creek Earth Rockfill Embankment Dams Dams 1, 2, 4, 9 – 40 to 50 feet high Dams 3, 5, 6, 7, 8 – 70 to 130 feet high
Emergency Spillway (Sites Reservoir)	Location – Saddle Dam 4 Diameter – 7 feet Inlet Elevation – 526 feet
Sites Pumping Plant	Location – Downstream from Golden Gate Dam Capacity – Varies
Funks Reservoir	Active Storage Volume – 1,300 to 5,290 AF Pumping Capacity – 3,900 to 5,900 cfs
GCID Canal Fish Screens	Modified Crest Elevation – 159.0 feet msl Maximum Operating Flow – 150,000 cfs
GCID Canal	Existing Capacity at Funks Reservoir (With Minor Reshaping) – 1,800 cfs
TC Canal	Existing Capacity at Funks Reservoir – 2,100 cfs
GCID Canal Terminal Regulating Reservoir	Capacity – 2,000 AF Footprint – 200 acres Depth – 17 feet Maximum Embankment Height – 21 feet
Ecosystem Restoration Account	See table 6-3
Road Relocations and Access Roads	Road Alignments Additional Roads
Utility Relocations	Four- or Six-Breaker Ring Configuration Transmission Lines
Hydroelectric Facilities	
Recreation Facilities	Five Recreation Areas
Sites Reservoir Operations Strategy	Reservoir Operations Developed and Formulated with Facilities to Provide Optimum Benefits for Each Project Objective

Key:

AF	=	acre-foot	msl	=	mean sea level
cfs	=	cubic feet per second	NODOS	=	North-of-the-Delta Offstream Storage
GCID	=	Glenn-Colusa Irrigation District	TC	=	Tehama Colusa
MAF	=	million acre-feet			

Alternative WS1A (Reliance on Existing Canals)

Initial Action Alternative Plan WS1A (Alternative WS1A) (see table 6-5 and figure 6-4) would focus on meeting the primary objective for water supply by constructing Sites Reservoir and relying on the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir.

Table 6-5. WS1A Major Components and Operations Prioritization

Major Components of WS1A	Details of Major Components
Operations Priority 1. SWP contractors 2. CVP contractors 3. Local water supply 4. Level 4 water supply for wildlife refuges 5. EWA or similar future program demands 6. Delta water quality 7. ERA short list (see table 6-3) of Sacramento River restoration actions	
Sites Reservoir	Reservoir configuration used for the initial evaluation of alternatives has a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet msl, and an inundation area of 14,000 acres (the size of the reservoir will be optimized in the feasibility study).
TC and GCID Canals Used to Convey Water to Sites Reservoir	Canals currently used to convey water to TCCA and GCID service areas.
Modifications to GCID Canal	Minor modifications to the fish screens for GCID.
	Minor reshaping of 13 miles of the canal.
	Replacement of 1 siphon, 1 check, 1 bridge.
	Installation of a TRR.
	Installation of a pipeline from the TRR to Funks Reservoir.

Key:
CVP = Central Valley Project
ERA = Ecosystem Restoration Account
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
SWP = State Water Project
TC = Tehama Colusa
TCCA = Tehama-Colusa Canal Authority
TRR = terminal regulating reservoir

Alternative WS1A would use the common features already described. WS1A could deliver water from Sites Reservoir to the local GCID and TC service areas. By coordinating Sites Reservoir operations with Shasta Lake and Lake Oroville, benefits would be achieved throughout the CVP and SWP systems and the associated watersheds. The highest priorities of Alternative WS1A would be to improve the water supply reliability of SWP and CVP contractors and local TC Canal water users, to provide long-term water supplies for the EWA, and to meet wildlife refuge Level 4 water supply targets.

This page left blank intentionally.

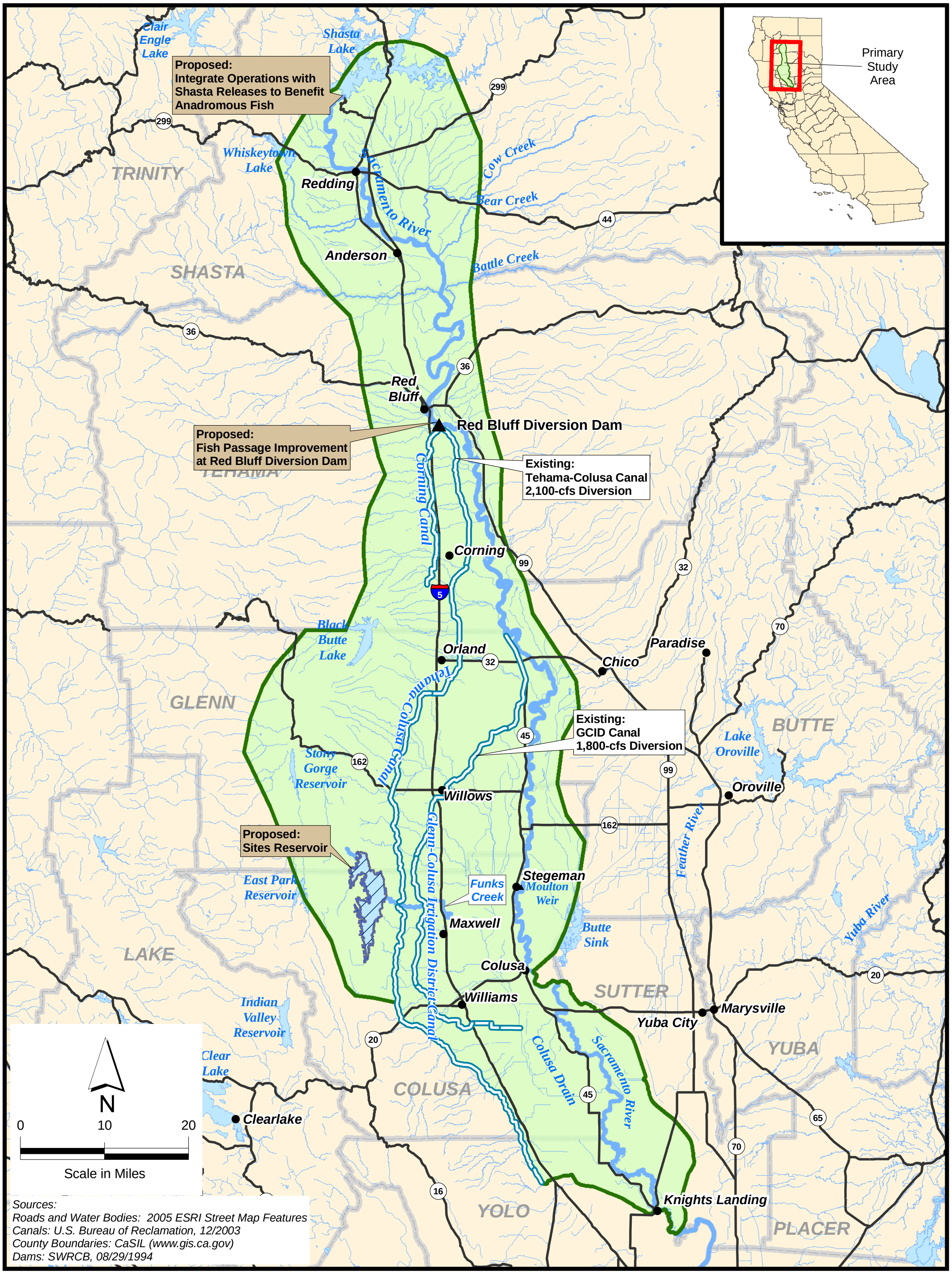


Figure 6-4. WS1A-Water Supply with Reliance on Existing Canals

This page left blank intentionally.

Sites Reservoir, through direct release to the TC and GCID Canals, could deliver water to serve up to half of the TCCA and GCID contractors' service areas that, without Sites Reservoir, would be delivered entirely by direct diversion from the Sacramento River. These deliveries would facilitate coordinated operations with other CVP and SWP reservoirs, additional deliveries to contractors, and other NODOS benefits. Improved local water supply reliability for the TC Canal users could be delivered directly from Sites Reservoir. Other benefits associated with the CVP, including supply reliability to south-of-Delta contractors, the EWA, and Level 4 water supplies to wildlife refuges, would require coordinated operation with Shasta Lake. Benefits associated with the SWP, including improvements to contractor reliability and the EWA, would be accomplished by coordinating operations with Oroville Reservoir, as well.

Operations of Sites Reservoir would be coordinated with the operation of Shasta Lake to provide benefits to anadromous fish in the Sacramento River and water quality in the Delta, as well. Conveyance would terminate at an enlarged Funks Reservoir that would serve as a forebay and afterbay for the Sites Pumping Plant and be used to regulate demands or releases from Sites Reservoir. The Sites Pumping Plant would lift water from Funks Reservoir into Sites Reservoir. For modeling purposes, operations under Alternative WS1A were prioritized as presented in table 6-5.

For the initial alternative action plan analysis, a 1.8-MAF reservoir was used in CalSim II modeling runs to assess potential benefits to water users. The size of the reservoir would be optimized in the feasibility study.

Alternative WS1B (New 1,500-cfs Diversion and 1,125-cfs Release Pipeline)

Alternative WS1B (see table 6-6 and figure 6-5) would focus on meeting the primary objective of water supply by constructing Sites Reservoir. It would include a new conveyance (pumping plant and pipeline) from the Sacramento River to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir.

In WS1B, the Delevan Pipeline would provide capacity for a 1,500-cfs diversion with a 1,125-cfs release. Alternative WS1B would use the common features already described. This initial action alternative plan would provide diversion from the Sacramento River at three locations and release back to the river at the Delevan Pipeline diversion location. This release capability would facilitate direct benefits "downstream," primarily in the Delta. The coordinated operation would provide additional benefits associated with the integration of Sites Reservoir storage into existing system operations. The highest priorities of Alternative WS1B would be to improve the reliability of water supply to SWP and CVP contractors and local TC Canal water users, to provide long-term water supply for the EWA, and to meet Level 4 water supply targets for wildlife refuges.

Table 6-6. WS1B Major Components and Operations Prioritization

Major Components of WS1B	Details of Major Components
Operations Priority 1. SWP contractors 2. CVP contractors 3. Local water supply 4. Level 4 water supply for wildlife refuges 5. EWA or similar future program demands 6. Delta water quality 7. ERA short list (see table 6-3) of Sacramento River restoration actions	
Sites Reservoir	Reservoir configuration used for the initial evaluation of alternatives has a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet msl, and an inundation area of 14,000 acres (the size of the reservoir will be optimized in the feasibility study).
New Delevan Pipeline	Would provide an additional 1,500-cfs diversion and capacity to release up to 1,125 cfs to the Sacramento River opposite the Moulton Weir. The new pipeline would be constructed parallel to Delevan Road to convey water from the Sacramento River west to the TC Canal just before connecting to Funks Reservoir.
TC and GCID Canals Used to Convey Water to Sites Reservoir	Canals currently used to convey water to TCCA and GCID service areas.
Modifications to GCID Canal	Minor modifications to the fish screens for GCID.
	Minor reshaping of 13 miles of the canal.
	Replacement of 1 siphon, 1 check, 1 bridge.
	Installation of a TRR.
	Installation of a pipeline from the TRR to Funks Reservoir.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
ERA = Ecosystem Restoration Account
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
SWP = State Water Project
TC = Tehama Colusa
TCCA = Tehama-Colusa Canal Authority
TRR = terminal regulating reservoir

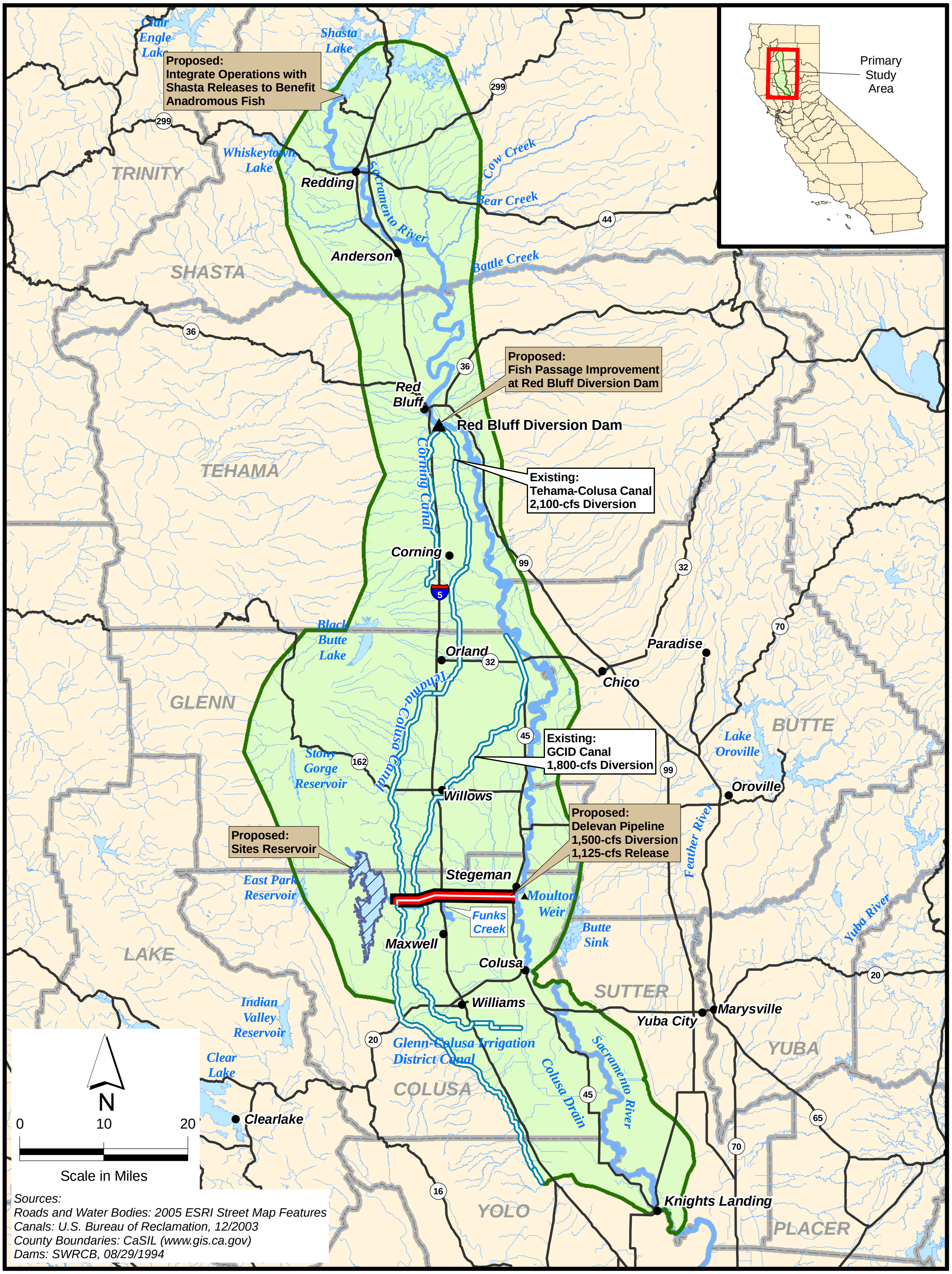


Figure 6-5. WS1B-Water Supply with Conjunctive Use of Groundwater and 1,500-cfs Pipeline

This page left blank intentionally.

Benefits to TC Canal users could be delivered directly from Sites Reservoir through the TC Canal. Other benefits would derive from a combination of direct delivery through the Delevan Pipeline and coordinated operations with existing reservoirs.

Operations of the reservoir would be integrated with the operation of Shasta Dam to provide benefits to anadromous fish between Keswick Dam and the RBDD.

Alternative WS1C (New 2,000-cfs Diversion and 1,500-cfs Release Pipeline)

Alternative WS1C (see table 6-7 and figure 6-6) would focus on meeting the primary objective of water supply. It would include the Delevan Pipeline to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir. Alternative WS1C would use the common features already described. In Alternative WS1C, the Delevan Pipeline would be formulated with the capacity for a 2,000-cfs diversion and a 1,500-cfs release. The highest priorities of this alternative would be to improve the reliability of water supply to SWP and CVP contractors and local TC Canal users, to provide long-term water supplies for the EWA, and to meet Level 4 water supply targets for wildlife refuges. Conveyance would terminate at an enlarged Funks Reservoir that would serve as the forebay and afterbay for the Sites Pumping Plant and be used to regulate demands or releases from Sites Reservoir. The Sites Pumping Plant would lift water from Funks Reservoir into Sites Reservoir. For modeling purposes, operations under Alternative WS1C were prioritized as presented in table 6-7.

The operation of Sites Reservoir would be integrated with the operation of Shasta Dam as described in the Sites Reservoir Operations Strategy to reduce summer irrigation diversions, provide flows to improve fish passage and water temperatures between Keswick Dam and Red Bluff, improve the reliability of the cold water pool at Shasta Lake, and improve conditions for riparian establishment (shaded riverine aquatic habitat [SRAH] and large woody debris).

Table 6-7. WS1C Major Components and Operations Prioritization

Major Components of WS1C	Details of Major Components
Operations Priority 1. SWP contractors 2. CVP contractors 2. Local water supply 4. Level 4 water supply for wildlife refuges 5. EWA or similar future program demands 6. Delta water quality 7. ERA short list (see table 6-3) of Sacramento River restoration actions	
Sites Reservoir	Reservoir configuration used for the initial evaluation of alternatives has a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet msl, and an inundation area of 14,000 acres (the size of the reservoir will be optimized in the feasibility study).
New Delevan Pipeline	Would provide an additional 2,000-cfs diversion capacity to release up to 1,500 cfs to the Sacramento River opposite the Moulton Weir. The new pipeline would be constructed parallel to Delevan Road to convey water from the Sacramento River west to the TC Canal just before connection to Funks Reservoir.
TC and GCID Canals Used to Convey Water to Sites Reservoir	Canals currently used to convey water to TCCA and GCID service areas.
Modifications to GCID Canal	Minor modifications to the fish screens for GCID.
	Minor reshaping of 13 miles of the canal.
	Replacement of 1 siphon, 1 check, 1 bridge.
	Installation of a TRR.
	Installation of a pipeline from the TRR to Funks Reservoir.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
ERA = Ecosystem Restoration Account
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
SWP = State Water Project
TC = Tehama Colusa
TCCA = Tehama-Colusa Canal Authority
TRR = terminal regulating reservoir

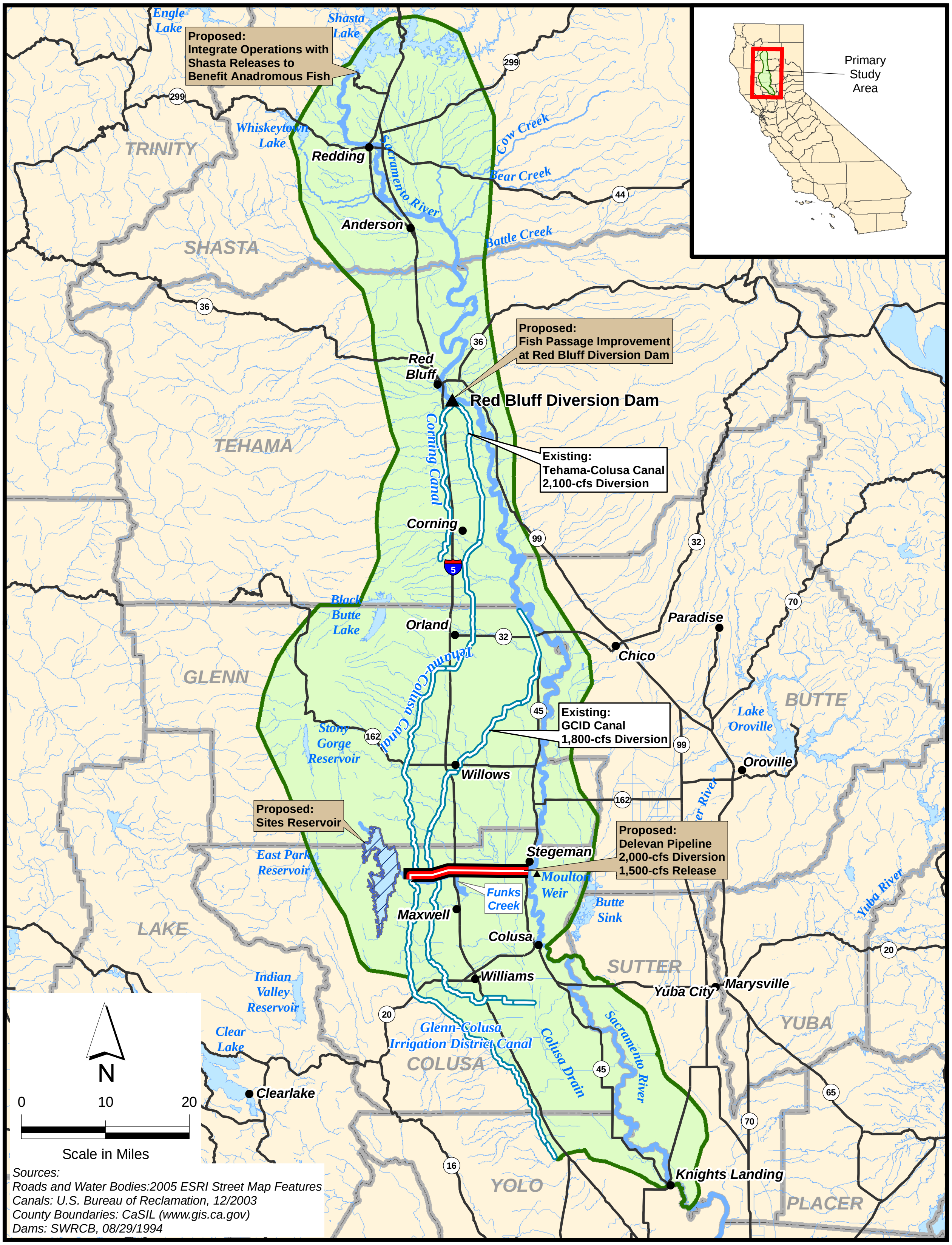


Figure 6-6. WS1C-Water Supply with 2,000-cfs Pipeline

This page left blank intentionally.

Alternative AF1A (New 1,500-cfs Pipeline with Enhanced Ecological Benefits)

Alternative AF1A (see table 6-8 and figure 6-7) would focus on meeting the primary objective of anadromous fish survival by using Sites Reservoir to provide additional flexibility in water management that would benefit anadromous fish. Alternative AF1A would include the common features previously described and the Delevan Pipeline (1,500-cfs diversion) to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir (table 6-8). The Delevan Pipeline capacity in AF1A would provide up to 1,125-cfs release capacity to the Sacramento River.

Table 6-8. AF1A Major Components and Operations Prioritization

Major Components of AF1A	Details of Major Components
Operations Priority 1. ERA long list (see table 6-3) of river and Delta restoration actions 2. SWP contractors 3. CVP contractors 4. Local water supply 5. Level 4 water supply for wildlife refuges 6. Delta water quality 7. EWA or similar future program demands	
Sites Reservoir	Reservoir configuration used for the initial evaluation of alternatives has a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet msl, and an inundation area of 14,000 acres (the size of the reservoir will be optimized in the feasibility study).
New Delevan Pipeline	Would provide an additional 1,500-cfs diversion capacity to release up to 1,125 cfs to the Sacramento River opposite the Moulton Weir. The new pipeline would be constructed parallel to Delevan Road to convey water from the Sacramento River west to the TC Canal just before connecting to Funks Reservoir.
TC and GCID Canals Used to Convey Water to Sites Reservoir	Canals currently used to convey water to TCCA and GCID service areas.
Modifications to GCID Canal	Minor modifications to the fish screens for GCID.
	Minor reshaping of 13 miles of the canal.
	Replacement of 1 siphon, 1 check, 1 bridge.
	Installation of a TRR.
	Installation of a pipeline from the TRR to Funks Reservoir.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
ERA = Ecosystem Restoration Account
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
SWP = State Water Project
TC = Tehama Colusa
TCCA = Tehama-Colusa Canal Authority
TRR = terminal regulating reservoir

This page left blank intentionally.

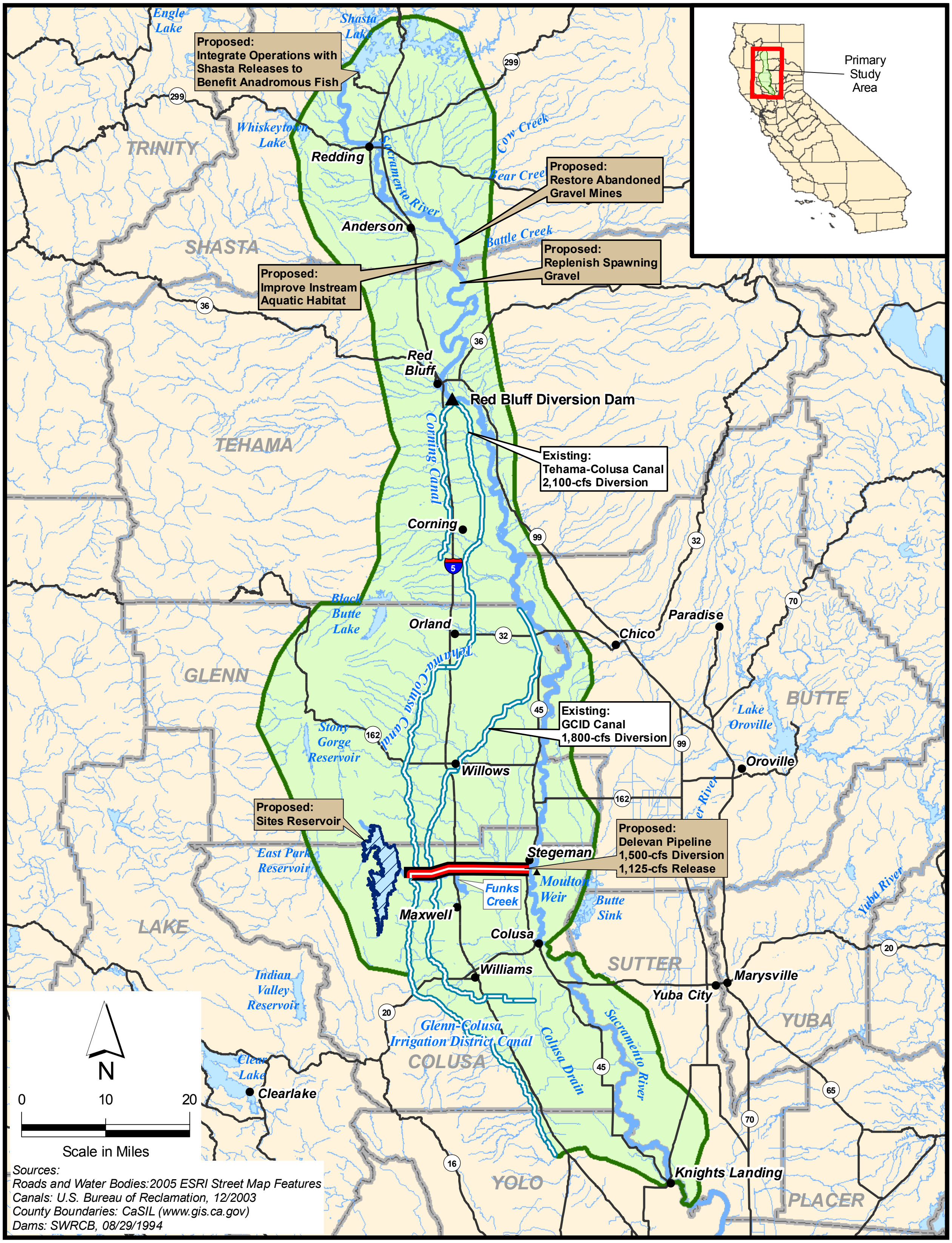


Figure 6-7. AF1A-Water Supply with 1,500-cfs Pipeline

This page left blank intentionally.

Conveyance would terminate at an enlarged Funks Reservoir that would serve as forebay and afterbay for the Sites Pumping Plant and be used to regulate demands or releases from Sites Reservoir. The Sites Pumping Plant would lift water from Funks Reservoir into Sites Reservoir.

Alternative AF1A also incorporates the following three measures to benefit anadromous fish.

- **Abandoned Gravel Mine Restoration: A**lternative AF1A would include acquiring, restoring, and reclaiming inactive gravel mining sites along the Sacramento River near the Primary Study Area (figure 6-8). The stream channel and floodplain would be filled and recontoured to emulate natural conditions. Side channels and other features might be created to encourage spawning and rearing and prevent stranding.
- **Spawning Gravel Replenishment:** Alternative AF1A would include replenishing spawning-sized gravel in the Sacramento River between Keswick Dam and Red Bluff. Gravel would be transported and injected into the Sacramento River.
- **Instream Aquatic Habitat Improvements:** Alternative AF1A would include restoring instream habitat along the lower arms of the Sacramento River (figure 6-9). This component would include improving shallow, warm water habitat by installing artificial fish cover, such as anchored complex woody structures and boulders, and planting water-tolerant and/or erosion-resistant vegetation near the mouths of tributaries. This initial action alternative plan also would include improving and restoring instream aquatic habitat using various structural techniques to trap spawning gravel in deficient areas, create pools and riffles, provide instream cover, and improve overall instream habitat conditions. Treatments could include installing gabions, log weirs, boulder weirs, and other anchored structures. Spawning and rearing habitat would be created by installing instream cover, such as large root wads, and drop structures, boulders, gravel traps, and/or logs that would cause scouring and help clean gravel.

This page left blank intentionally.

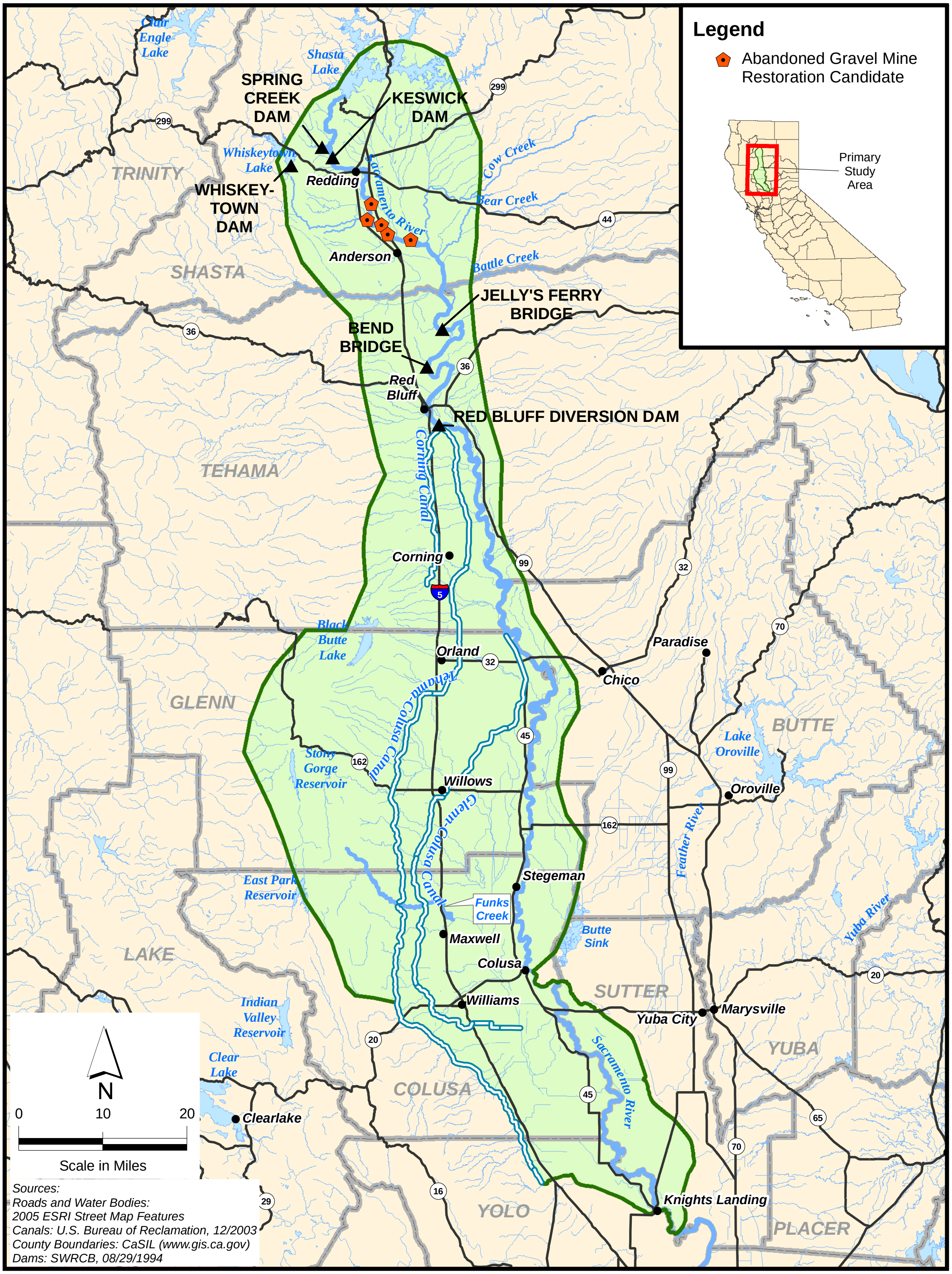


Figure 6-8. Abandoned Gravel Mine Restoration Candidates

This page left blank intentionally.

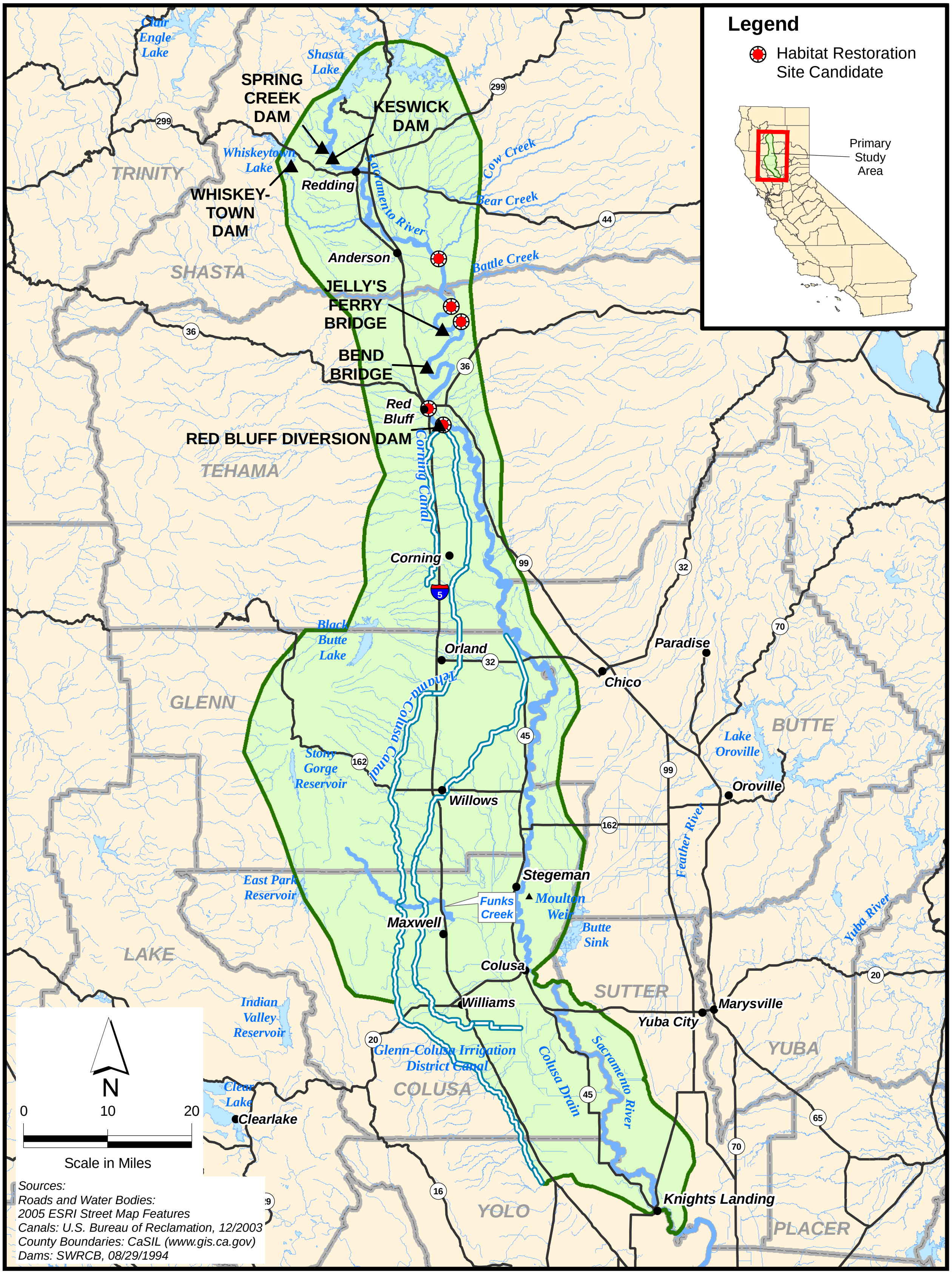


Figure 6-9. Habitat Restoration Site Candidates

This page left blank intentionally.

Alternative AF1B (New 2,000-cfs Diversion and 1,500-cfs Release Pipeline)

Alternative AF1B (see table 6-9 and figure 6-10) would focus on meeting the primary objective of anadromous fish survival by using Sites Reservoir to provide additional flexibility in water management that would benefit anadromous fish. Alternative AF1B includes the common features previously described and the Delevan Pipeline (2,000-cfs diversion) to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) to convey water to and from the reservoir. The Delevan Pipeline in AF1B would provide up to 1,500-cfs release capacity to the Sacramento River.

Table 6-9. AF1B Major Components and Operations Prioritization

Major Components of AF1B	Details of Major Components
Operations Priority 1. ERA long list (see table 6-3) of river and Delta restoration actions 2. SWP contractors 3. CVP contractors 4. Local water supply 5. Level 4 water supply for wildlife refuges 6. Delta water quality 7. EWA or similar future program demands	
Sites Reservoir	Reservoir configuration used for the initial evaluation of alternatives has a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet msl, and an inundation area of 14,000 acres (the size of the reservoir will be optimized in the feasibility study).
New Delevan Pipeline	Would provide an additional 2,000-cfs diversion and capacity to release up to 1,500 cfs to the Sacramento River opposite the Moulton Weir. The new pipeline would be constructed parallel to Delevan Road to convey water from the Sacramento River west to the TC Canal, just before connecting to Funks Reservoir.
TC and GCID Canals Used to Convey Water to Sites Reservoir	Canals currently used to convey water to TCCA and GCID service areas.
Modifications to GCID Canal	Minor modifications to the fish screens for GCID.
	Minor reshaping of 13 miles of the canal.
	Replacement of 1 siphon, 1 check, 1 bridge.
	Installation of a TRR.
	Installation of a pipeline from the TRR to Funks Reservoir.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
ERA = Ecosystem Restoration Account
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
SWP = State Water Project
TC = Tehama Colusa
TCCA = Tehama-Colusa Canal Authority
TRR = terminal regulating reservoir

This page left blank intentionally.

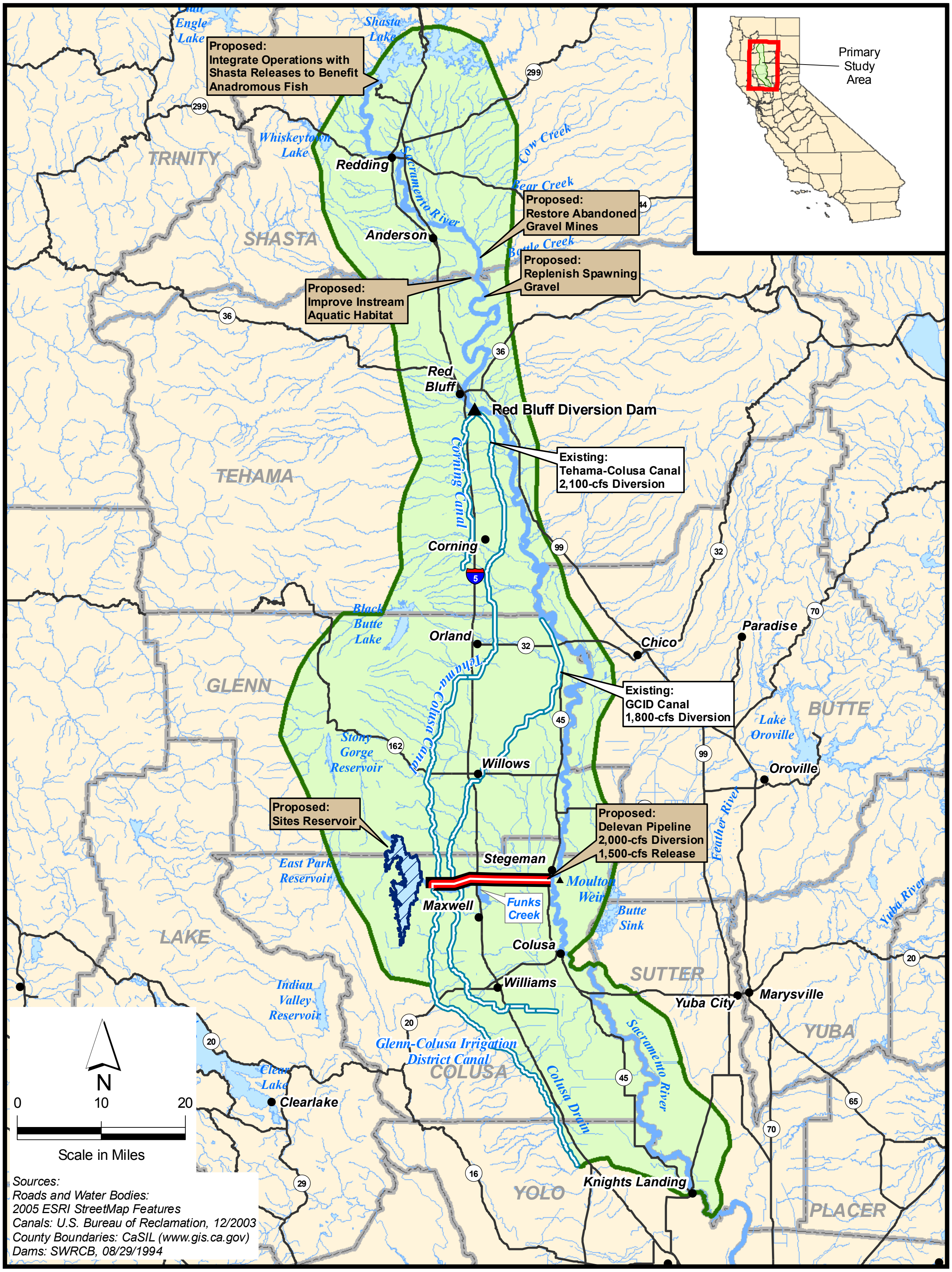


Figure 6-10. AF1B-Anadromous Fish Enhancement with 2,000-cfs Pipeline

This page left blank intentionally.

Alternative AF1B also would incorporate the following three measures to benefit anadromous fish.

- **Abandoned Gravel Mine Restoration:** Alternative AF1B would include acquiring, restoring, and reclaiming inactive gravel mining sites along the Sacramento River near the Primary Study Area. The stream channel and floodplain would be filled and recontoured to emulate natural conditions. Side channels and other features might be created to encourage spawning and rearing and prevent stranding.
- **Spawning Gravel Replenishment:** Alternative AF1B would include replenishing spawning-sized gravel in the Sacramento River between Keswick Dam and Red Bluff. Gravel would be transported and injected into the Sacramento River.
- **Instream Aquatic Habitat Improvements:** Alternative AF1B would include restoring instream habitat along the lower arms of the Sacramento River. This component would include improving shallow, warm water habitat by installing artificial fish cover, such as anchored complex woody structures and boulders, and planting water-tolerant and/or erosion-resistant vegetation near the mouths of tributaries. Alternative AF1B also would include improving and restoring instream aquatic habitat using various structural techniques to trap spawning gravel in deficient areas, create pools and riffles, provide instream cover, and improve overall instream habitat conditions. Treatments might include installing gabions, log weirs, boulder weirs, and other anchored structures. Spawning and rearing habitat would be created by installing instream cover, such as large root wads, and drop structures, boulders, gravel traps, and/or logs that would cause scouring and help clean gravel.

Alternative WSFQ (New 2,000-cfs Diversion and 1,500-cfs Release Pipeline with Fish Enhancements)

Alternative WSFQ (see table 6-10 and figure 6-11) would focus on meeting the primary objectives of water supply and water quality by releasing water to the Sacramento River to increase Delta outflows during the summer and fall. The priorities of Alternative WSFQ would be to improve both water quality and the reliability of water supply to SWP and CVP contractors, to provide long-term water supply for the EWA, and to meet Level 4 water supply targets for wildlife refuges and Delta water quality improvements. Alternative WSFQ would include the common features previously described and the Delevan Pipeline (2,000-cfs diversion with 1,500-cfs release) to supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion), to convey water to and from the reservoir (table 6-10). Conveyance would terminate at an enlarged Funks Reservoir that would serve as forebay and afterbay for the Sites Pumping Plant and be used to regulate demands or releases from Sites

Reservoir. The Sites Pumping Plant would lift water from Funks Reservoir into Sites Reservoir. Operations of the reservoir would be integrated with the operation of Shasta Dam to provide benefits to anadromous fish between Keswick Dam and RBDD.

Table 6-10. WSFQ Major Components and Operations Prioritization

Major Components of WSFQ	Details of Major Components
Operations Priority 1. SWP contractors 2. Delta water quality 3. CVP contractors 4. Level 4 water supply for wildlife refuges 5. EWA or similar future program demands 6. ERA short list (see Table 6-3) of Sacramento River restoration actions, but not including stabilization of fall flows	
Sites Reservoir	Reservoir configuration used for the initial evaluation of alternatives has a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet msl, and an inundation area of 14,000 acres (the size of the reservoir will be optimized in the feasibility study).
New Delevan Pipeline	Would provide a new point of diversion (2,000 cfs) and release to the Sacramento River (up to 1,500 cfs)
TC and GCID Canals Used to Convey Water to Sites Reservoir	Canals currently used to convey water to TCCA and GCID service areas.
Modifications to GCID Canal	Minor modifications to the fish screens for GCID.
	Minor reshaping of 13 miles of the canal.
	Replacement of 1 siphon, 1 check, 1 bridge.
	Installation of a TRR.
	Installation of a pipeline from the TRR to Funks Reservoir.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
ERA = Ecosystem Restoration Account
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
SWP = State Water Project
TC = Tehama Colusa
TCCA = Tehama-Colusa Canal Authority
TRR = terminal regulating reservoir

Alternative WSFQ also would incorporate the following three measures to benefit anadromous fish.

- **Abandoned Gravel Mine Restoration:** Alternative WSFQ would include acquiring, restoring, and reclaiming inactive gravel mining sites along the Sacramento River near the Primary Study Area. The stream channel and floodplain would be filled and recontoured to emulate natural conditions. Side channels and other features might be created to encourage spawning and rearing and prevent stranding.

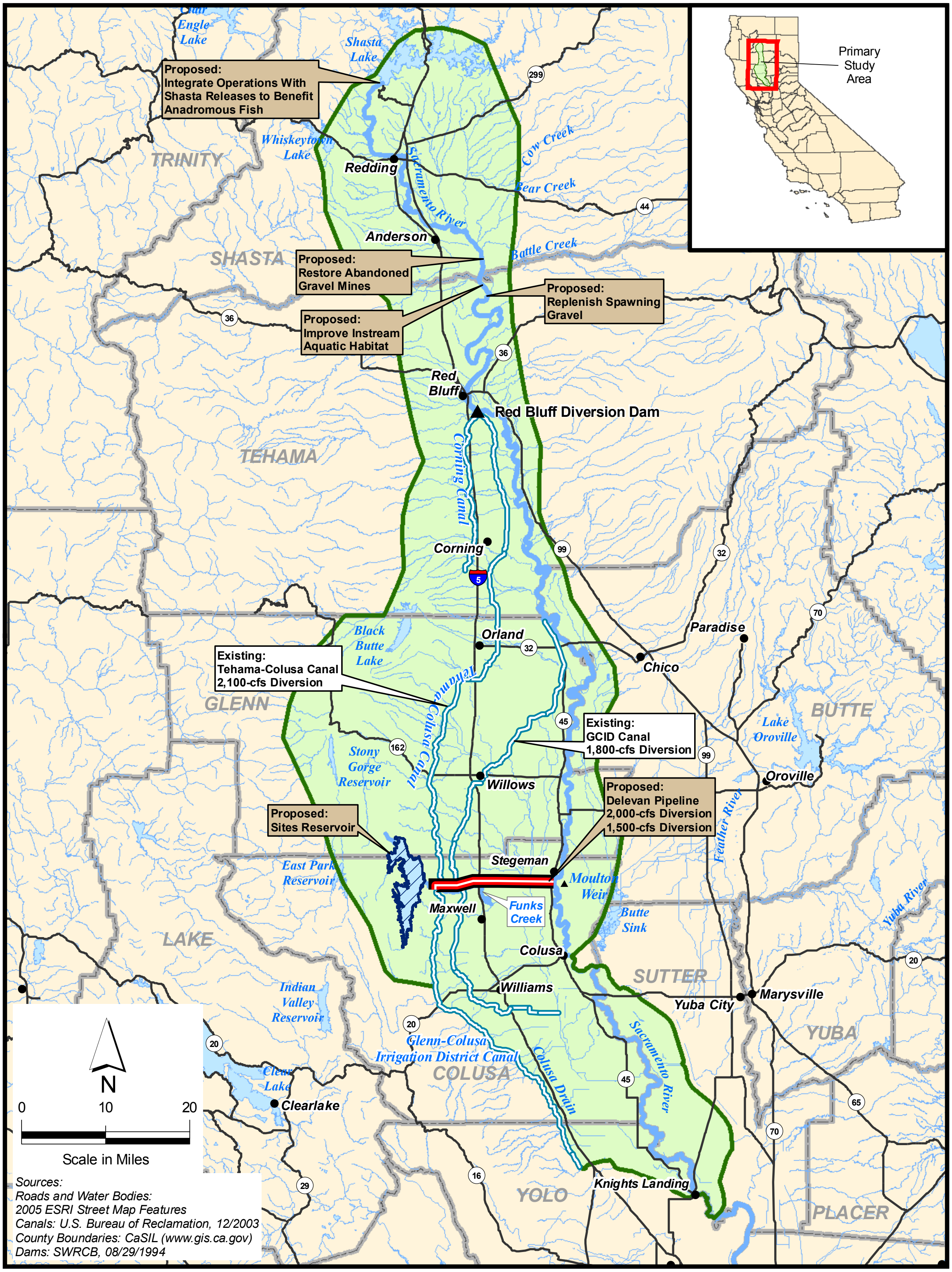


Figure 6-11. WSFQ-Water Supply with Fish Enhancement and 2,000-cfs Pipeline

This page left blank intentionally.

- **Spawning Gravel Replenishment:** Alternative WSFQ would include replenishing spawning-sized gravel in the Sacramento River between Keswick Dam and Red Bluff. Gravel would be transported and injected into the Sacramento River.
- **Instream Aquatic Habitat Improvements:** Alternative WSFQ would include restoring instream habitat along the lower arms of the Sacramento River. This component would include improving shallow, warm-water habitat by installing artificial fish cover, such as anchored complex woody structures and boulders, and planting water-tolerant and/or erosion-resistant vegetation near the mouths of tributaries. This initial action alternative plan also would include improving and restoring instream aquatic habitat using various structural techniques to trap spawning gravel in deficient areas, create pools and riffles, provide instream cover, and improve overall instream habitat conditions. Treatments might include installing gabions, log weirs, boulder weirs, and other anchored structures. Spawning and rearing habitat would be created by installing instream cover, such as large root wads, and drop structures, boulders, gravel traps, and/or logs that would cause scouring and help clean gravel.

Alternative WQ1A (New 1,500-cfs Release Pipeline)

Alternative WQ1A (see table 6-11 and figure 6-12) would focus on meeting the primary objective of water quality by releasing water to the Sacramento River to increase Delta outflow during the summer and fall months. Alternative WQ1A would use the common features already described and a new release-only Delevan Pipeline (table 6-11). The pipeline would be designed to release up to 1,500 cfs to the Sacramento River. The reservoir would be filled using the existing TC Canal and GCID Canal. Operations of the reservoir would be integrated with the operation of Shasta Dam to provide benefits to anadromous fish between Keswick Dam and Red Bluff. Conveyance would terminate at an enlarged Funks Reservoir that would serve as the forebay and afterbay for the Sites Pumping Plant and be used to regulate demands or releases from Sites Reservoir. The Sites Pumping Plant would lift water from Funks Reservoir into Sites Reservoir.

Table 6-11. WQ1A Major Components and Operations Prioritization

Major Components of WQ1A	Details of Major Components
Operations Priority 1. Delta water quality 2. SWP contractors 3. CVP contractors 4. Local water supply 5. Level 4 water supply for wildlife refuges 6. EWA or similar future program demands 7. ERA short list (see table 6-3) of Sacramento River restoration actions	
Sites Reservoir	Reservoir configuration used for the initial evaluation of alternatives has a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet msl, and an inundation area of 14,000 acres (the size of the reservoir will be optimized in the feasibility study).
New Delevan Pipeline	Would allow releases to the Sacramento River (up to 1,500 cfs) but would not serve as a diversion for additional water to fill Sites Reservoir.
TC and GCID Canals Used to Convey Water to Sites Reservoir	Canals currently used to convey water to TCCA and GCID service areas.
Modifications to GCID Canal	Minor modifications to the fish screens for GCID.
	Minor reshaping of 13 miles of the canal.
	Replacement of 1 siphon, 1 check, 1 bridge.
	Installation of a TRR.
	Installation of a pipeline from the TRR to Funks Reservoir.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
ERA = Ecosystem Restoration Account
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
SWP = State Water Project
TC = Tehama Colusa
TCCA = Tehama-Colusa Canal Authority
TRR = terminal regulating reservoir

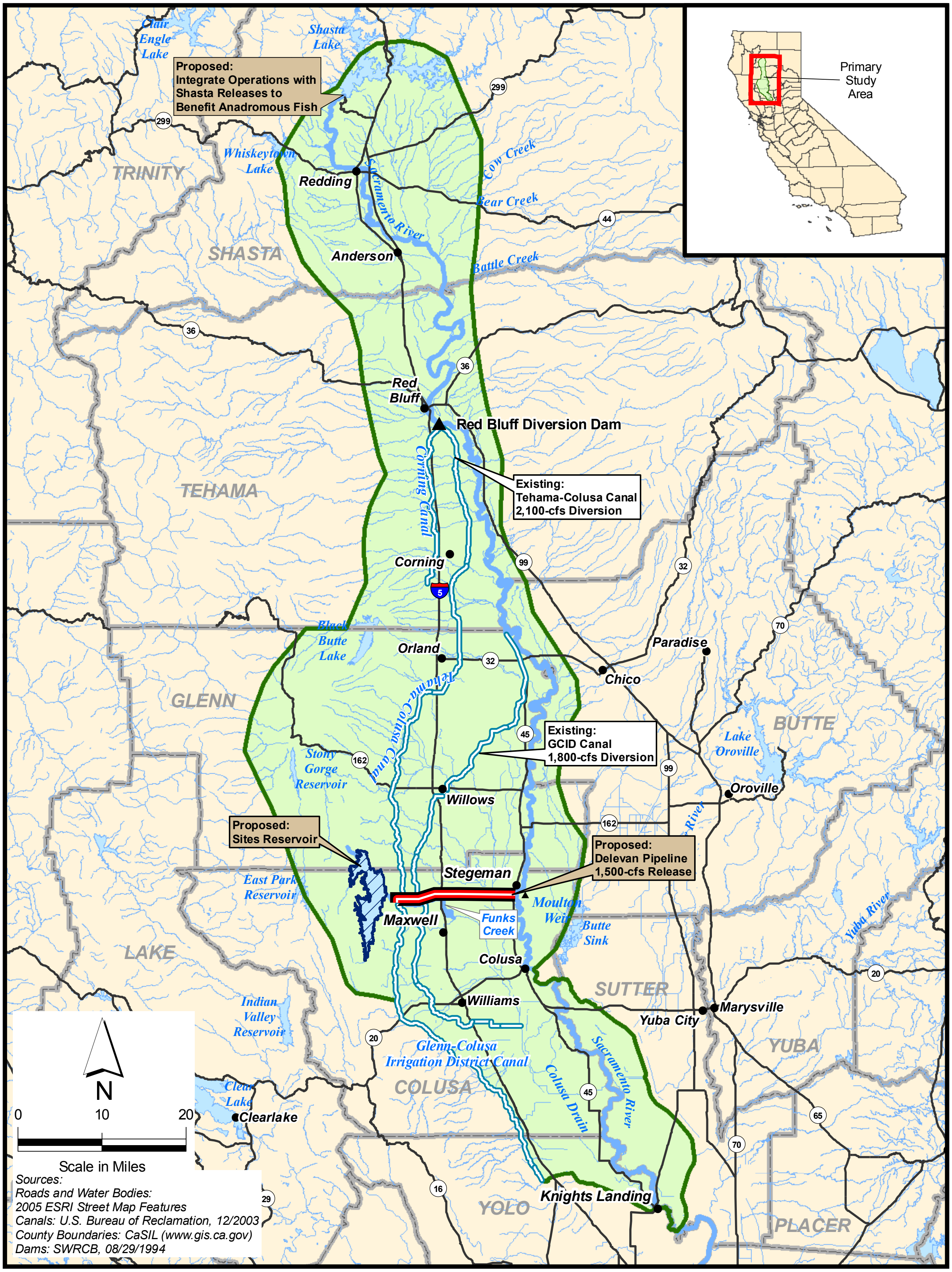


Figure 6-12. WQ1A-Water Quality with 1,500-cfs Pipeline

This page left blank intentionally.

Alternative WQ1B (New 2,000-cfs Diversion and 1,500-cfs Release Pipeline)

Alternative WQ1B (see table 6-12 and figure 6-13) would use the common features already described and would include the Delevan Pipeline capable of a 2,000-cfs diversion with a 1,500-cfs release that would supplement the existing TC Canal (2,100-cfs diversion) and GCID Canal (1,800-cfs diversion) in conveying water to and from the reservoir (table 6-12). Alternative WQ1B would focus on meeting the primary objective of water quality by releasing water to the Sacramento River to increase Delta outflows during the summer and fall months. Conveyance would terminate at an enlarged Funks Reservoir that would serve as the forebay and afterbay for the Sites Pumping Plant and be used to regulate demands or releases from Sites Reservoir. The Sites Pumping Plant would lift water from Funks Reservoir into Sites Reservoir. Operations of the reservoir would be integrated with the operation of Shasta Dam to provide benefits to anadromous fish between Keswick Dam and Red Bluff.

Table 6-12. WQ1B Major Components and Operations Prioritization

Major Components of WQ1B	Details of Major Components
Operations Priority 1. Delta water quality 2. SWP contractors 3. CVP contractors 4. Local water supply 5. Level 4 water supply for wildlife refuges 6. EWA or similar future program demands 7. ERA short list (see table 6-3) of Sacramento River restoration actions	
Sites Reservoir	Reservoir configuration used for the initial evaluation of alternatives has a storage capacity of 1.8 MAF, a maximum water surface elevation of 520 feet msl, and an inundation area of 14,000 acres (the size of the reservoir will be optimized in the feasibility study).
New Delevan Pipeline	Would provide a new point of diversion (2,000 cfs) and release to the Sacramento River (up to 1,500 cfs).
TC and GCID Canals Used to Convey Water to Sites Reservoir	Canals currently used to convey water to TCCA and GCID service areas.
Modifications to GCID Canal	Minor modifications to the fish screens for GCID.
	Minor reshaping of 13 miles of the canal.
	Replacement of 1 siphon, 1 check, 1 bridge.
	Installation of a TRR.
	Installation of a pipeline from the TRR to Funks Reservoir.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
ERA = Ecosystem Restoration Account
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
SWP = State Water Project
TC = Tehama Colusa
TCCA = Tehama-Colusa Canal Authority
TRR = terminal regulating reservoir

This page left blank intentionally.

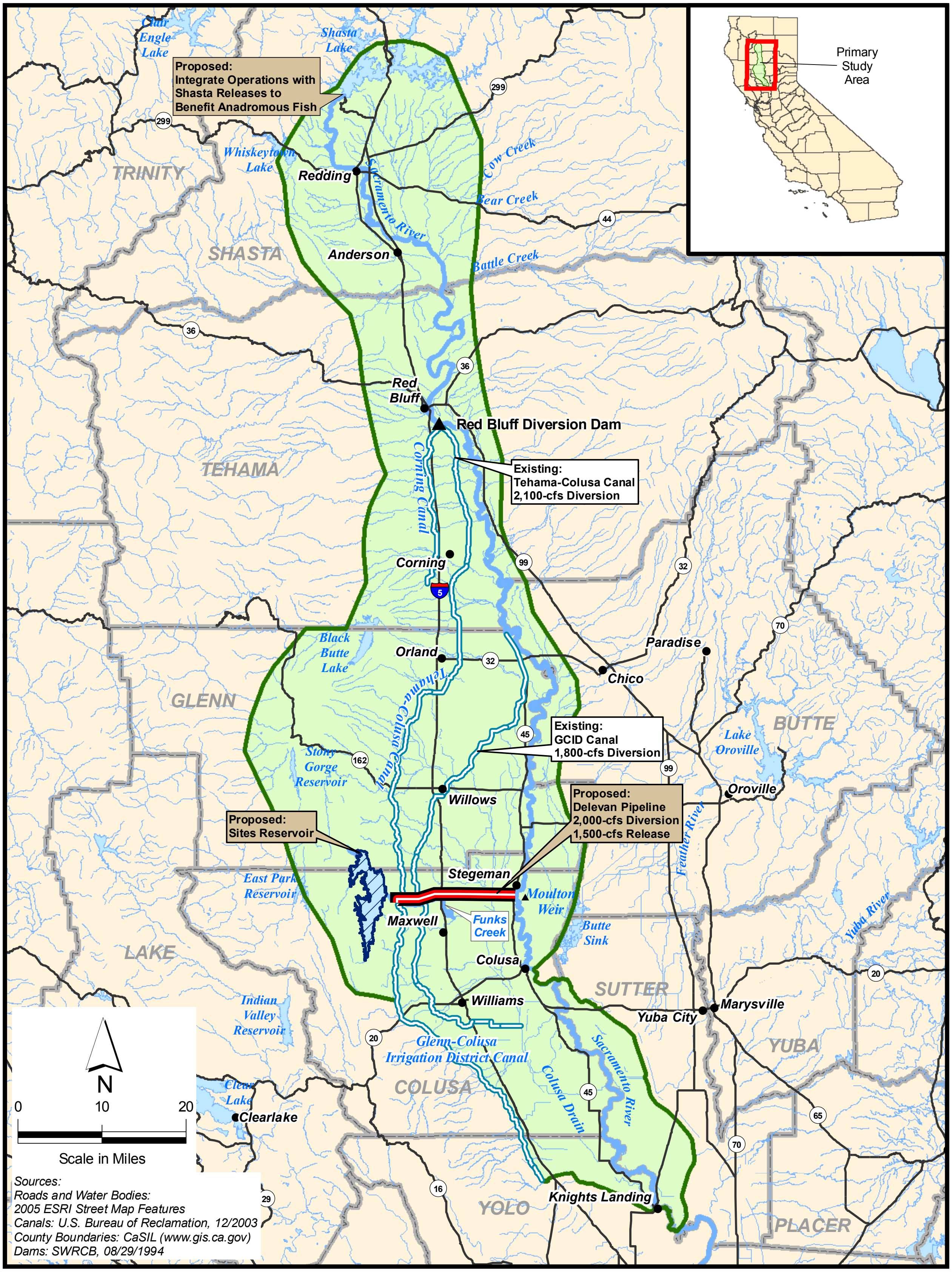


Figure 6-13. WQ1B-Water Quality with 2,000-cfs Pipeline

This page left blank intentionally.

Chapter 7
Evaluation and Comparison of Initial Alternative Plans

This chapter begins with a discussion of the potential accomplishments of each of the action alternative plans. This is followed by an evaluation of the No Action Alternative and initial action alternative plans relative to the planning objectives and constraints. The criteria used are the P&G criteria (WRC, 1983) of completeness, effectiveness, efficiency, and acceptability (see figure 7-1). This is a preliminary evaluation; it is limited by the information available at this phase of the feasibility study.

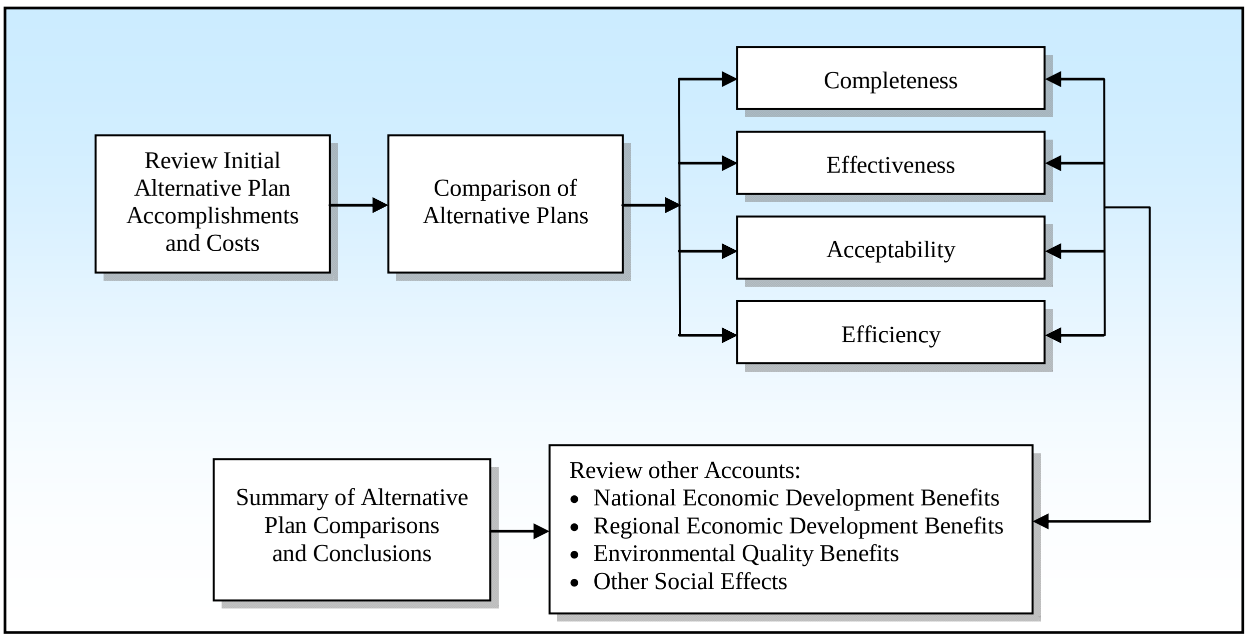


Figure 7-1. Alternative Evaluation and Comparison Process

Preliminary estimated costs, including O&M costs and IDC, are annualized using the fiscal year 2007 Federal discount rate of 4.875 percent for 100 years. These annualized costs are compared to the expected annual benefits of the initial alternative plans.

This chapter includes economic benefit estimates for most project accomplishments. These benefits were estimated from economic models available at the time. NED, RED, EQ, and OSE accounts are addressed to assist in the evaluation and display of the effects of the initial alternative plans. Consideration of the NED account is required (WRC, 1983). Other information that is required by law or that will have a material bearing on the decision-making process is included in the RED, EQ, and OSE accounts.

Initial Alternative Plan Accomplishments

This section discusses the potential accomplishments of each of the initial action alternative plans relative to the primary and secondary objectives. The objectives and constraints for the PFR are discussed in Chapter 2. The accomplishments are used subsequently to evaluate the relative strengths and weaknesses of each plan. The costs presented for each initial action alternative plan are preliminary and subject to change in the feasibility report. Table 7-1 summarizes the accomplishments and estimated costs and benefits for each of the initial action alternative plans.

Accomplishments and Costs for Initial Action Alternative Plan WS1A (Reliance on Existing Canals)

Water Supply and Reliability – Initial Action Alternative Plan WS1A (Alternative WS1A) would provide Level 4 water supply for refuges and the EWA and improve water supply reliability for local water users (e.g., TCCA and potentially GCID service areas) and the SWP and CVP contractors. The long-term and driest periods average increases in water supply (agricultural and M&I and environmental Level 4 supply for refuges and EWA) would be 336 TAF/year and 273 TAF/year, respectively. Water supply benefits of this alternative would be achieved by releases from Shasta Lake and Lake Oroville through exchange and coordinated/integrated operations. As part of the exchange and coordinated/integrated operations with Shasta Lake, water from Sites Reservoir, through direct release to the GCID Canal and TC Canal, would be delivered to serve up to half of the GCID and TCCA contractor's service areas downstream from Funks Reservoir that, without Sites Reservoir, would be delivered entirely by direct diversion from the Sacramento River.

Anadromous Fish Survival – The primary anadromous fish benefit from this alternative would derive from the reduction of summer diversions at the Hamilton City GCID Canal and at the TC Canal at Red Bluff. The combined average annual reduction of diversions is 280 TAF. Diversions at the two intakes would increase from November through March during the Sites Reservoir filling period. The priority is to reduce diversions at the GCID Canal during the irrigation season to reduce predation downstream from the GCID Canal intake. There could be increases in critically dry years in cold-water carryover storage at Shasta Lake; however, the likelihood of end-of-September storage is unchanged from the Future No Action Alternative.

Water Quality – This alternative would coordinate operations with Shasta Reservoir to provide increased flows in July through September to improve water quality in the Delta. The average annual release for Delta water quality from Shasta Lake would be 74 TAF/year, which would result in average reductions of 2 percent for EC, 2 percent for TDS concentrations, 3 percent for chloride concentrations, and 3 percent for bromide concentrations, in Banks Pumping Plant exports.

Table 7-1. Summary of Relative Accomplishments of Initial Action Alternative Plans and Estimates of Preliminary Costs and Benefits

Item	WS1A	WS1B	WS1C	AF1A	AF1B	WSFQ	WQ1A	WQ1B
Objectives and Accomplishments								
Water Supply[1] Increase (Driest Periods Average Increase/ Average Annual Increase) (TAF/year)	273 / 336	316 / 368	361 / 382	166 / 184	144 / 189	262 / 276	241 / 225	301 / 276
Anadromous Fish Rating[2]	Low	Medium	Medium	High	High	Medium	Medium	Medium
Water Quality Improvement[3]	Low	Low	Low	Low	Low	High	High	High
Hydropower Generated Long Term (in GWh)	105	147	153	152	157	150	128	151
Recreation[4]	**High**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**
Flood Damage Reduction and Emergency Water[5]	**Low**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**
Economics ($ millions)[6]								
Construction Cost	$2,138.1	$2,936.7	$3,021.8	$2,951.2	$3,036.4	$3,036.4	$2,664.5	$3,021.8
Total Annual Cost	$134.2	$183.0	$188.1	$184.1	$189.3	$189.0	$166.1	$188.1
Annual Benefits	$113.11	$151.96	$154.94	$107.69	$110.80	$214.85	$144.42	$183.20
Net Benefits (Annual Benefits – Annual Cost)	-$21.09	-$31.04	-$33.16	-$76.41	-$78.50	+$25.85	-$21.68	-$4.9

Notes:

1 Water supply increases exceed the No Action Alternative and include supplies for agriculture, M&I, and environmental (Level 4 and EWA). Driest periods average is the average quantity for the combination of periods of May 1928 through October 1934, October 1975 through September 1977, and June 1986 through September 1992. Average annual is for the period of October 1922 through September 2003.

2 Anadromous fish rating is based on the ability to meet flow and temperature objectives in the Sacramento River and the number of ecosystem restoration features in the alternative.

3 Reductions in conductivity and TDS, bromide, and chloride concentrations were approximately doubled for the two WQ alternatives in modeling simulations.

4 Ranking based on ability of alternatives to support flat water recreation at Sites Reservoir.

5 Ranking based on ability of alternatives to provide emergency flushing flows in the event of catastrophic levee failure in the Delta.

6 All costs and benefits are preliminary and subject to revision in the feasibility report.

Key:

EWA = Environmental Water Account
GWh = gigawatt-hour
M&I = municipal and industrial
TAF = thousand acre-feet
TDS = total dissolved solids
WQ = water quality
μmhos/cm = micromhos per centimeter

Hydropower Benefits, Recreation, and Flood Damage Reduction – This alternative would include a new hydropower generation facility between Sites Reservoir and Funks Reservoir. The new facility would generate a long-term annual average of 105 GWh and an annual average of 86 GWh during the driest periods. Alternative WS1A would be a net consumer of energy (-351 GWh/ year). Additional analysis is needed to determine the effect of Sites Reservoir on levels in Shasta Lake; however, the effect should be positive, in general, since Sites Reservoir would provide increased storage in Shasta Lake during extended dry periods. Recreational benefits might include wildlife viewing, camping, and flat water activities. Storage in Sites Reservoir might provide small ancillary benefits in flood damage reduction through coordinated flood-control operations with other reservoirs. With no conveyance to directly release water back to the Sacramento River, this alternative would not be able to directly provide flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta.

Preliminary Estimated Costs – The estimated construction cost is $2,138.1 million; the estimated annual cost is approximately $134.2 million (table 7-2).

Table 7-2. WS1A Estimated Construction and Annual Costs ($ Millions)[1]

Item	Cost
Sites Reservoir Dams and Pumping Facilities, Inlet/Outlet, Pumping/Generating Plant, Funks Reservoir and Facilities (1.8 MAF)[2]	1,021.9
GCID Canal Modifications[3]	37.1
TRR Pumping Station and Pipeline (1,800 cfs)	141.4
Delevan Pipeline and Sacramento River Pump/ Generating Station[4]	–
New Electrical Transmission	14.5
Environmental Enhancement[4]	–
Land Acquisition and Right of Way	81.0
Subtotal Contract Costs	**1,295.8**
Mitigation (10%)	129.6
Total Contract Costs (includes 10% unlisted items**)**	**1,425.4**
Scope/Market Conditions Contingency (20%)	285.1
Total Field Costs	**1,710.5**
Non-Contract Costs (25%)	427.6
Total Project Construction Costs (2007 dollars)	**2,138.1**
Interest During Construction - Foregone Investment Value (4.875% Federal Rate)	413.7
Total Capital Cost (2007 dollars)	2,551.8
Interest and Amortization	125.5
Annual Operations and Maintenance (Excludes Replacement Costs)	8.7
Total Annual Cost	**134.2**

Notes:
[1] All costs are preliminary and subject to revision in the feasibility report.
[2] Includes: Sites Dam, Reservoir Clearing, Golden Gate Dam, 9 Saddle Dams, Long Tunnel and Multi-Level Inlet/Outlet, Sites Pumping/Generating Plant 4,000 cfs, Funks Reservoir Modification 4,000 cfs, Southern Bridge Route and Roads, Recreational Facility.
[3] GCID Upgrade 1,800-cfs Option (headgate, tuttle check, TRR siphon), TRR, TRR Pumping/Generating Plant and Pipeline (1,800 cfs).
[4] N/A this alternative.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
N/A = not applicable
TRR = terminal regulating reservoir

Accomplishments and Costs for Initial Action Alternative Plan WS1B (Existing Canals and New 1,500-cfs Diversion/1,125-cfs Release Pipeline)

Water Supply and Reliability – The long-term and driest periods average increases in water supply (agricultural and M&I and environmental Level 4 supply for refuges and EWA) would be 368 TAF/year and 316 TAF/year, respectively. Inclusion of the 1,500-cfs intake capacity/1,125-cfs release capacity Delevan Pipeline would enable releases from Sites Reservoir directly to the Sacramento River.

Anadromous Fish Survival – The combined average annual reduction of summer diversions at the Hamilton City GCID Canal and at the TC Canal at Red Bluff is 236 TAF. The likelihood of end-of-September storage exceeding 1.9 MAF in Shasta Lake is reduced by 3.7 percent over the Future No Action Alternative.

Water Quality – Inclusion of the Delevan Pipeline would enable Sites Reservoir to make direct releases to the Sacramento River for export and Delta water quality improvements. The addition of the pipeline would increase the water quality benefits in the Delta. Given the limited release capacity of the Delevan Pipeline, water exchanges and coordinated operations with Shasta Lake would be needed to provide releases for Delta water quality improvements during July through September. This alternative would reduce the average EC by 2 percent and the reduce the concentrations of TDS, chlorides, and bromides in Banks Pumping Plant exports by 2 percent, 4 percent, and 4 percent, respectively. The average release from Sites Reservoir and Shasta Lake for Delta water quality improvement would be 84 TAF/year.

Recreation, Hydropower, and Flood Damage Reduction – This alternative would include new hydropower generation facilities between Sites Reservoir and Funks Reservoir, between Funks Reservoir and the TRR, and a turbine in the Delevan Pipeline to further increase power generation. These new facilities would generate a long-term annual average of 147 GWh and an annual average of 137 GWh during the driest periods. The net consumption of energy throughout the entire system is 460 GWh/year. The reservoir would provide opportunities for hiking and camping and limited opportunities for fishing and boating. Storage in Sites Reservoir might provide small ancillary benefits in flood-damage reduction through coordinated flood-control operations with other reservoirs. The diversions off of the Sacramento River would not be large enough to reduce peak flows; however, Sites Reservoir could improve flood protection for the Sacramento River Basin by increasing flood control reservation space in existing reservoirs through the exchange of storage capacity at Sites Reservoir. This alternative would include a 1,125-cfs release capacity through the Delevan Pipeline that could provide some flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta. Although this is not a large release, the proximity of Sites Reservoir to the Delta would make this an important feature because of the improved response time (flows would reach the Delta faster than they would from other upstream reservoirs).

Preliminary Estimated Costs – The estimated construction cost is $2,936.7 million; the estimated annual cost is approximately $183.0 million (table 7-3).

Table 7-3. WS1B Estimated Construction and Annual Costs ($ Millions)[1]

Item	Cost
Sites Reservoir Dams and Pumping Facilities, Inlet/Outlet, Pumping/Generating Plant, Funks Reservoir and Facilities (1.8 MAF)[2]	1,124.7
GCID Canal Modifications[3]	37.1
TRR Pumping Station and Pipeline (1,800 cfs)	141.4
Delevan Pipeline and Sacramento River Pumping/Generating Station[4]	369.8
New Electrical Transmission	22.9
Environmental Enhancement[5]	–
Land Acquisition and Right of Way	84.0
Subtotal Contract Costs	**1,779.8**
Mitigation (10%)	178.0
Total Contract Costs (includes 10% unlisted items)	**1,957.8**
Scope/Market Conditions Contingency (20%)	391.6
Total Field Costs	**2,349.4**
Non-Contract includes Permitting (25%)	587.3
Total Construction Costs (2007 dollars)	**2,936.7**
Interest During Construction - Foregone Investment Value (4.875% Federal Rate)	568.9
Total Capital Cost (2007 dollars)	**3,505.6**
Interest and Amortization	**172.4**
Annual Operations and Maintenance (Excludes Replacement Costs)	10.6
Total Annual Cost	**183.0**

Notes:
1 All costs are preliminary and subject to revision in the feasibility report.
2 Includes: Sites Dam, Reservoir Clearing, Golden Gate Dam, 9 Saddle Dams, Long Tunnel and Multi-Level Inlet/Outlet, Sites Pumping/Generating Plant 6,000 cfs, Funks Reservoir Modification 6,000 cfs, Southern Bridge Route and Roads, Recreational Facility.
3 GCID Upgrade 1,800-cfs Option (headgate, tuttle check, TRR siphon), TRR, TRR Pumping/Generating Plant and Pipeline (1,800 cfs).
4 Delevan Pipeline and Sacramento River Pumping/Generating Plant (1,500-cfs diversion), Connection to Electrical Grid.
5 N/A this alternative.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
N/A = not applicable
TRR = terminal regulating reservoir

Accomplishments and Costs for Initial Action Alternative Plan WS1C (Existing Canals and New 2,000-cfs Diversion/1,500-cfs Release Pipeline)

Water Supply and Reliability – The long-term and driest periods average increases in water supply (agricultural and M&I and environmental Level 4 supply for refuges and EWA) would be 382 TAF/year and 363 TAF/year, respectively. Inclusion of the 2,000-cfs Delevan Pipeline would enable releases throughout the year from Sites Reservoir directly to the Sacramento River.

Anadromous Fish Survival – The combined average annual reduction of diversions at the Hamilton City GCID Canal and at the TC Canal at Red Bluff is 233 TAF. The likelihood of end-of-September storage exceeding 1.9 MAF in Shasta Lake is reduced by 1.2 percent over the Future No Action Alternative.

Water Quality – This alternative would reduce the average EC by 2 percent and reduce the concentrations of TDS, chlorides, and bromides in Banks Pumping Plant exports by 2 percent, 4 percent, and 4 percent, respectively. The average release from Sites Reservoir and Shasta Lake for Delta water quality improvement would be 91 TAF/year.

Recreation, Hydropower, and Flood Damage Reduction – This alternative would include new hydropower generation facilities between Sites Reservoir and Funks Reservoir and between Funks Reservoir and the TRR and a turbine in the Delevan Pipeline to further increase power generation. These new facilities would generate a long-term annual average of 153 GWh and an annual average of 134 GWh during the driest periods. The net consumption of energy by all facilities is 471 GWh/year. The reservoir would provide opportunities for hiking and camping and limited opportunities for fishing and boating. The diversions off of the Sacramento River would not be large enough to reduce peak flows; however, Sites Reservoir could improve flood protection for the Sacramento River Basin by increasing flood control reservation space in existing reservoirs through the exchange of storage capacity at Sites Reservoir. This alternative would include a 1,500-cfs release capacity through the Delevan Pipeline that could provide some flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta.

Preliminary Estimated Costs – The estimated construction cost is $3,021.8 million; the estimated annual cost is approximately $188.1 million (table 7-4).

Table 7-4. WS1C Estimated Construction and Annual Costs ($ Millions)[1]

Item	Cost
Sites Reservoir Dams and Pumping Facilities, Inlet/Outlet, Pumping/Generating Plant, Funks Reservoir and Facilities (1.8 MAF)[2]	1,124.7
GCID Canal Modifications[3]	37.1
TRR Pumping Station and Pipeline (1,800 cfs)	141.4
Delevan Pipeline and Sacramento River Pumping/Generating Station[4]	421.4
New Electrical Transmission	22.9
Environmental Enhancement[5]	–
Land Acquisition and Right of Way	84.0
Subtotal Contract Costs	**1,831.4**
Mitigation (10%)	**183.1**
Total Contract Costs(includes 10% unlisted items)	**2,014.6**
Scope/Market Conditions Contingency (20%)	402.9

Table 7-4. Continued

Item	Cost
Total Field Costs	**2,417.5**
Non-Contract Costs includes Permitting (25%)	604.4
Total Construction Costs (2007 dollars)	**3,021.8**
Interest During Construction - Foregone Investment Value (4.875% Federal Rate)	584.9
Total Capital Cost (2007 dollars)	**3,606.8**
Interest and Amortization	177.3
Annual Operations and Maintenance (Excludes Replacement Costs)	10.8
Total Annual Cost	**188.1**

Notes:
[1] All costs are preliminary and subject to revision in the feasibility report.
[2] Includes: Sites Dam, Reservoir Clearing, Golden Gate Dam, 9 Saddle Dams, Long Tunnel and Multi-Level Inlet/Outlet, Sites Pumping/Generating Plant 6,000 cfs, Funks Reservoir Modification 6,000 cfs, Southern Bridge Route and Roads, Recreational Facility.
[3] GCID Upgrade 1,800-cfs Option (headgate, tuttle check, TRR siphon), TRR, TRR Pumping/Generating Plant and Pipeline (1,800 cfs).
[4] Delevan Pipeline and Sacramento River Pumping/Generating Plant (2,000-cfs diversion), Connection to Electrical Grid.
[5] N/A this alternative.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
N/A = not applicable
TRR = terminal regulating reservoir

Accomplishments and Costs for Initial Action Alternative Plan AF1A (Existing Canals and New 1,500-cfs Diversion/1,125-cfs Release Pipeline with Enhanced Ecological Benefits)

Water Supply and Reliability – The long-term and driest periods average increases in water supply (agricultural and M&I and environmental Level 4 supply for refuges and EWA) would be 184 TAF/year and 166 TAF/year, respectively. Inclusion of the Delevan Pipeline (1,500-cfs diversion, 1,125-cfs release) would enable direct release of water throughout the year from Sites Reservoir to the Sacramento River.

Anadromous Fish Survival – The operational scheme for this alternative would give the highest priority to meeting the full list of ERA objectives (see table 6-3) to benefit anadromous fish. This alternative would achieve an average annual combined 344 TAF Sacramento River diversion reduction at the

Hamilton City GCID Canal and at the TC Canal at Red Bluff. The likelihood of end-of-September storage exceeding 1.9 MAF in Shasta Lake is increased by 1.2 percent over the Future No Action Alternative. Average long-term releases from Keswick Dam would increase by 305 TAF/year. Reclaiming inactive gravel mining sites along the Sacramento River near the Primary Study Area would create valuable aquatic and floodplain habitat. Replenishing gravel suitable for spawning has been identified as an important influencing factor in the recovery of anadromous fish populations in the Sacramento River. Instream aquatic habitat improvements would help provide favorable spawning conditions, and juvenile fish leaving the tributaries would benefit from improved adjacent shoreline habitat. Establishing vegetation also may benefit terrestrial species that inhabit the shoreline of the Sacramento River.

Water Quality – This alternative would reduce the average EC by 2 percent and reduce the concentrations of TDS, chlorides, and bromides in Banks Pumping Plant exports by 2 percent, 3 percent, and 3 percent, respectively. The average release from Sites Reservoir and Shasta Lake for Delta water quality improvement would be 73 TAF/year.

Recreation, Hydropower, and Flood Damage Reduction – This alternative would include new hydropower generation facilities between Sites Reservoir and Funks Reservoir and between Funks Reservoir and the TRR and a turbine in the Delevan Pipeline to further increase power generation. These new facilities would generate a long-term annual average of 152 GWh and an annual average of 137 GWh during the driest periods. The average net consumption of energy for all facilities is 225 GWh/year. The reservoir would provide opportunities for hiking and camping and limited opportunities for fishing and boating. The diversions off of the Sacramento River would not be large enough to reduce peak flows; however, Sites Reservoir could improve flood protection for the Sacramento River Basin by increasing flood control reservation space in existing reservoirs through the exchange of storage capacity at Sites Reservoir. This alternative would include a 1,125-cfs release capacity through the Delevan Pipeline that could provide some flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta.

Preliminary Estimated Costs – The estimated construction cost is $2,951.2 million; the estimated annual cost is approximately $184.1 million (table 7-5).

Table 7-5. AF1A Estimated Construction and Annual Costs ($ Millions)[1]

Item	Cost
Sites Reservoir Dams and Pumping Facilities, Inlet/Outlet, Pumping/Generating Plant, Funks Reservoir and Facilities (1.8 MAF)[2]	1,124.7
GCID Canal Modifications[3]	37.1
TRR Pumping Station and Pipeline (1,800 cfs)	141.4
Delevan Pipeline and Sacramento River Pumping/Generating Station[4]	369.8
New Electrical Transmission	22.9
Environmental Enhancement	8.8
Land Acquisition and Right of Way	84.0
Subtotal Contract Costs	**1,788.6**
Mitigation (10%)	178.9

Table 7-5. Continued

Item	Cost
Total Contract Costs(includes 10% unlisted items)	**1,967.5**
Scope/Market Conditions Contingency (20%)	393.5
Total Field Costs	**2,361.0**
Non-Contract Costs includes Permitting (25%)	590.2
Total Construction Costs (2007 dollars)	**2,951.2**
Interest During Construction - Foregone Investment Value (4.875% Federal Rate)	571.7
Total Capital Cost (2007 dollars)	**3,522.9**
Interest and Amortization	173.2
Annual Operations and Maintenance (Excludes Replacement Costs)	10.9
Total Annual Cost	**184.1**

Notes:
[1] All costs are preliminary and subject to revision in the feasibility report.
[2] Includes: Sites Dam, Reservoir Clearing, Golden Gate Dam, 9 Saddle Dams, Long Tunnel and Multi-Level Inlet/Outlet, Sites Pumping/Generating Plant 6,000 cfs, Funks Reservoir Modification 6,000 cfs, Southern Bridge Route and Roads, Recreational Facility.
[3] GCID Upgrade 1,800-cfs Option (headgate, tuttle check, TRR siphon), TRR, TRR Pumping/Generating Plant and Pipeline (1,800 cfs).
[4] Delevan Pipeline and Sacramento River Pumping/Generating Plant (1,500-cfs diversion), connection to electrical grid.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
TRR = terminal regulating reservoir

Accomplishments and Costs for Initial Action Alternative Plan AF1B (Existing Canals and New 2,000-cfs Diversion/1,500-cfs Release Pipeline)

Water Supply and Reliability – The long-term and driest periods average increases in water supply (agricultural and M&I and environmental Level 4 supply for refuges and EWA) would be 189 TAF/year and 144 TAF/year, respectively. Inclusion of the Delevan Pipeline (2,000-cfs diversion and 1,500-cfs release) would enable the direct release of water throughout the year from Sites Reservoir to the Sacramento River.

Anadromous Fish Survival – The operational scheme for this alternative would give the highest priority to meeting the full list of ERA objectives (see table 6-3) to benefit anadromous fish. This alternative would achieve an average annual combined Sacramento River diversion reduction of 344 TAF at the Hamilton City GCID Canal and at the TC Canal at Red Bluff. The likelihood of end-of-September storage exceeding 1.9 MAF in Shasta Lake is increased by 2.4 percent over the Future No Action Alternative. Average long-term releases from Keswick Dam would increase by 315 TAF/year. Average storage at Shasta and Folsom Lakes also would increase for this alternative, and flows would be stabilized on the Sacramento River, from Keswick to Red Bluff, in the fall and winter during dry years. Reclaiming inactive gravel mining sites along the

Sacramento River near the Primary Study Area would create valuable aquatic and floodplain habitat. Replenishing gravel suitable for spawning has been identified as an important influencing factor in the recovery of anadromous fish populations in the Sacramento River. Instream aquatic habitat improvements would help provide favorable spawning conditions; and juvenile fish leaving the tributaries would benefit from improved adjacent shoreline habitat. Establishing vegetation also might benefit terrestrial species inhabiting the shoreline of the Sacramento River.

Water Quality – This alternative would reduce the average EC by 2 percent and reduce the concentrations of TDS, chlorides, and bromides in Banks Pumping Plant exports by 2 percent, 3 percent, and 3 percent, respectively. The average release from Sites Reservoir and Shasta Lake for Delta water quality improvement would be 76 TAF/year.

Recreation, Hydropower, and Flood Damage Reduction – This alternative would include new hydropower generation facilities between Sites Reservoir and Funks Reservoir and between Funks Reservoir and the TRR and a turbine in the Delevan Pipeline to further increase power generation. These new facilities would generate a long-term annual average of 157 GWh and an annual average of 137 GWh during the driest periods. The net consumption of energy by all facilities is 257 GWh/year. The reservoir would provide opportunities for hiking and camping and limited opportunities for fishing and boating. The diversions off of the Sacramento River would not be large enough to reduce peak flows; however, Sites Reservoir could improve flood protection for the Sacramento River Basin by increasing flood control reservation space in existing reservoirs through the exchange of storage capacity at Sites Reservoir. This alternative would include a 1,500-cfs release capacity through the Delevan Pipeline that could provide some flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta.

Preliminary Estimated Costs – The estimated construction cost is $3,036.4 million; the estimated annual cost is approximately $189.3 million (table 7-6).

Table 7-6. AF1B Estimated Construction and Annual Costs ($ Millions)[1]

Item	Cost
Sites Reservoir Dams and Facilities, Inlet/Outlet, Pumping/Generating Plant, and Funks Reservoir Enlargement[2]	1,124.7
GCID Canal Modifications[3]	37.1
TRR Pumping Station and Pipeline (1,800 cfs)	141.4
Delevan Pipeline and Sacramento River Pumping/Generating Station[4]	421.4
New Electrical Transmission	22.9
Environmental Enhancement	8.8
Land Acquisition and Right of Way	84.0

Table 7-6. Continued

Item	Cost
Subtotal Contract Costs	**1,840.2**
Mitigation (10%)	184.0
Total Contract Costs (includes 10% unlisted items)	**2,024.2**
Scope/Market Conditions Contingency (20%)	404.8
Total Field Costs	**2,429.1**
Non-Contract Costs includes Permitting(25%)	607.3
Total Construction Costs (2007 dollars)	**3,036.4**
Interest During Construction - Foregone Investment Value (4.875% Federal Rate)	588.0
Total Capital Cost (2007 dollars)	**3,624.4**
Interest and Amortization	178.2
Annual Operations and Maintenance (Excludes Replacement Costs)	11.1
Total Annual Cost	**189.3**

Notes:
[1] All costs are preliminary and subject to revision in the feasibility report.
[2] Includes: Sites Dam, Reservoir Clearing, Golden Gate Dam, 9 Saddle Dams, Long Tunnel and Multi-Level Inlet/Outlet, Sites Pumping/Generating Plant 6,000 cfs, Funks Reservoir Modification 6,000 cfs, Southern Bridge Route and Roads, Recreational Facility.
[3] GCID Upgrade 1,800-cfs Option (headgate, tuttle check, TRR siphon), TRR, TRR Pumping/Generating Plant and Pipeline (1,800 cfs).
[4] Delevan Pipeline and Sacramento River Pumping/Generating Plant (2,000-cfs diversion), Connection to Electrical Grid.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
TRR = terminal regulating reservoir

Accomplishments and Costs for Initial Action Alternative Plan WSFQ (Existing Canals and 2,000-cfs Pipeline and Fish Enhancements)

Water Supply and Reliability – The long-term and driest periods average increases in water supply (agricultural and M&I and environmental Level 4 supply for refuges and EWA) would be 276 TAF/year and 262 TAF/year, respectively.

Anadromous Fish Survival – The combined average annual reduction of diversions at the Hamilton City GCID Canal and at the TC Canal at Red Bluff is 208 TAF. The likelihood of end-of-September storage exceeding 1.9 MAF in Shasta Lake is reduced by 2.4 percent over the Future No Action Alternative. Average long-term releases from Keswick Dam would increase by 307 TAF/year. Reclaiming inactive gravel mining sites along the Sacramento River near the Primary Study Area would create valuable aquatic and floodplain habitat. Replenishing gravel suitable for spawning has been identified as an important influencing factor in the recovery of anadromous fish populations in the Sacramento River. Instream aquatic habitat improvements would help provide favorable spawning conditions, and juvenile fish leaving the tributaries would benefit from improved adjacent shoreline habitat. Establishing vegetation also might benefit terrestrial species inhabiting the shoreline of the Sacramento River.

Water Quality – This alternative would reduce the average EC by 5 percent and reduce the concentrations of TDS, chlorides, and bromides in Banks Pumping Plant exports by 5 percent, 8 percent, and 8 percent, respectively. The average release from Sites Reservoir and Shasta Lake for Delta water quality improvement would be 170 TAF/year.

Recreation, Hydropower, and Flood Damage Reduction – This alternative would include new hydropower generation facilities between Sites Reservoir and Funks Reservoir and between Funks Reservoir and the TRR and a turbine in the Delevan Pipeline to further increase power generation. These new facilities would generate a long-term annual average of 150 GWh and an annual average of 153 GWh during the driest periods. The average net consumption of energy for all facilities is 471 GWh/year. The reservoir would provide opportunities for hiking and camping and limited opportunities for fishing and boating. The diversions off of the Sacramento River would not be large enough to reduce peak flows; however, Sites Reservoir could improve flood protection for the Sacramento River Basin by increasing flood control reservation space in existing reservoirs through the exchange of storage capacity at Sites Reservoir. This alternative includes a 1,500-cfs release capacity through the Delevan Pipeline that could provide some flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta.

Preliminary Estimated Costs – The estimated construction cost is $ 3,036.4 million; the estimated annual cost is approximately $189.0 million (table 7-7).

Table 7-7. WSFQ Estimated Construction and Annual Costs ($ Millions)[1]

Item	Cost
Sites Reservoir Dams and Pumping Facilities, Inlet/Outlet, Pumping/Generating Plant, Funks Reservoir and Facilities (1.8 MAF)[2]	1,124.7
GCID Canal Modifications[3]	37.1
TRR Pumping Station and Pipeline (1,800 cfs)	141.4
Delevan Pipeline and Sacramento River Pump/ Generating Station[4]	421.4
New Electrical Transmission	22.9
Environmental Enhancement	8.8
Land Acquisition and Right of Way	84.0
Subtotal Contract Costs	**1,840.2**
Mitigation (10%)	184.0
Total Contract Costs (includes 10% unlisted items)	**2,024.2**
Scope/Market Conditions Contingency (20%)	404.8
Total Field Costs	**2,429.1**
Non-Contract Costs includes Permitting (25%)	607.3

Table 7-7. Continued

Item	Cost
Total Construction Costs (2007 dollars)	**3,036.4**
Interest During Construction - Foregone Investment Value (4.875% Federal Rate)	588.0
Total Capital Cost (2007 dollars)	**3,624.4**
Interest and Amortization	178.2
Annual Operations and Maintenance (Excludes Replacement Costs)	10.8
Total Annual Cost	**189.0**

Notes:
[1] All costs are preliminary and subject to revision in the feasibility report.
[2] Includes: Sites Dam, Reservoir Clearing, Golden Gate Dam, 9 Saddle Dams, Long Tunnel and Multi-Level Inlet/Outlet, Sites Pumping/Generating Plant 5,000 cfs, Funks Reservoir Modification 5,000 cfs, Southern Bridge Route and Roads, Recreational Facility.
[3] GCID Upgrade 1,800-cfs Option (headgate, tuttle check, TRR siphon), TRR, TRR Pumping/Generating Plant and Pipeline (1,800 cfs).
[4] Delevan Pipeline and Sacramento River Pumping/Generating Plant (2,000-cfs diversion), Connection to Electrical Grid.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
TRR = terminal regulating reservoir

Accomplishments and Costs for Initial Action Alternative Plan WQ1A (Existing Canals and New 1,500-cfs Release Pipeline)

Water Supply and Reliability – The long-term and driest periods average increases in water supply (agricultural and M&I and environmental Level 4 supply for refuges and EWA) would be 225 TAF/year and 241 TAF/year, respectively. Inclusion of the Delevan Pipeline would enable releases throughout the year from Sites Reservoir directly to the Sacramento River.

Anadromous Fish Survival – The combined average annual reduction of diversions at the Hamilton City GCID Canal intake and the TC Canal intake at Red Bluff is 197 TAF. The likelihood of end-of-September storage exceeding 1.9 MAF in Shasta Lake is reduced by 1.2 percent over the Future No Action Alternative. Average long-term releases from Keswick Dam would increase by 262 TAF/year.

Water Quality – The operational scheme for this alternative would assign the highest priority to improving Delta water quality for the 6-month period from July through December. This alternative would reduce the average EC by 4 percent and reduce the concentrations of TDS, chlorides, and bromides in Banks Pumping Plant exports by 4 percent, 7 percent, and 8 percent, respectively. The average release from Sites Reservoir and Shasta Lake for Delta water quality improvement would be 169 TAF/year.

Recreation, Hydropower, and Flood Damage Reduction – This alternative would include new hydropower generation facilities between Sites Reservoir and Funks Reservoir and between Funks Reservoir and the TRR and a turbine in the Delevan Pipeline to further increase power generation. These new facilities would generate a long-term annual average of 128 GWh and an annual average of 105 GWh during the driest periods. The average net consumption of energy by all facilities is 243 GWh/yr. The reservoir would provide opportunities for hiking and camping and limited opportunities for fishing and boating. The diversions off of the Sacramento River would not be large enough to reduce peak flows; however, Sites Reservoir could improve flood protection for the Sacramento River Basin by increasing flood control reservation space in existing reservoirs through the exchange of storage capacity at Sites Reservoir. This alternative would include a 1,500-cfs release capacity through the Delevan Pipeline that could provide some flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta.

Preliminary Estimated Costs – The estimated construction cost is $2,664.5 million; the estimated annual cost is approximately $166.1 million (table 7-8).

Table 7-8. WQ1A Estimated Construction and Annual Costs ($ Millions)[1]

Item	Cost
Sites Reservoir Dams and Pumping Facilities, Inlet/Outlet, Pumping/Generating Plant, Funks Reservoir and Facilities (1.8 MAF)[2]	1,021.9
GCID Canal Modifications[3]	37.1
TRR Pumping Station and Pipeline (1,800 cfs)	141.4
Delevan Pipeline and Sacramento River Pumping/Generating Station[4]	316.0
New Electrical Transmission	14.5
Environmental Enhancement[5]	–
Land Acquisition and Right of Way	84.0
Subtotal Contract Costs	**1,614.8**
Mitigation (10%)	161.5
Total Contract Costs (includes 10% unlisted items)	**1,776.3**
Scope/Market Conditions Contingency (20%)	355.3
Total Field Costs	**2,131.6**
Non-Contract Costs includes Permitting (25%)	532.9
Total Construction Costs (2007 dollars)	**2,664.5**
Interest During Construction - Foregone Investment Value (4.875% Federal Rate)	516.4
Total Capital Cost (2007 dollars)	**3,180.8**
Interest and Amortization	**156.4**
Annual Operations and Maintenance (Excludes Replacement Costs)	9.7
Total Annual Cost	**166.1**

Notes:

[1] All costs are preliminary and subject to revision in the feasibility report.

[2] Includes: Sites Dam, Reservoir Clearing, Golden Gate Dam, 9 Saddle Dams, Long Tunnel and Multi-Level Inlet/Outlet, Sites Pumping/Generating Plant 4,000 cfs, Funks Reservoir Modification 4,000 cfs, Southern Bridge Route and Roads, Recreational Facility.

[3] GCID Upgrade 1,800-cfs Option (headgate, tuttle check, TRR siphon), TRR, TRR Pumping/Generating Plant and Pipeline (1,800 cfs).

[4] Delevan Pipeline (1,500-cfs release) is release only; therefore, it does not include electrical connections or pumping plant costs.

[5] N/A this alternative.

Key:

cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
N/A = not applicable
TRR = terminal regulating reservoir

Accomplishments and Costs for Initial Action Alternative Plan WQ1B (Existing Canals and New 2,000-cfs Diversion/1,500-cfs Release Pipeline)

Water Supply and Reliability – The long-term and driest periods average increases in water supply (agricultural, M&I, and environmental Level 4 supply for refuges and EWA) would be 276 TAF/year and 301 TAF/year, respectively.

Anadromous Fish Survival – The combined average annual reduction of summer diversions at the GCID Canal and TC Canal intakes is 233 TAF. The likelihood of end-of-September storage exceeding 1.9 MAF in Shasta Lake is reduced by 1.2 percent over the Future No Action Alternative. Average long-term releases from Keswick Dam would increase by 268 TAF/yr.

Water Quality – The operational scheme for this alternative would assign the highest priority to improving Delta water quality for the 6-month period from July through December. This alternative would reduce the average EC by 5 percent and reduce the concentrations of TDS, chlorides, and bromides in Banks Pumping Plant exports by 5 percent, 9 percent, and 9 percent, respectively. The average release from Sites Reservoir and Shasta Lake for Delta water quality improvements would be 169 TAF/year.

Recreation, Hydropower, and Flood Damage Reduction – This alternative would include new hydropower generation facilities between Sites Reservoir and Funks Reservoir and between Funks Reservoir and the TRR and a turbine in the Delevan Pipeline to further increase power generation. These new facilities would generate a long-term annual average of 151 GWh and an annual average of 147 GWh during the driest periods. The average net consumption of energy for all facilities is 403 GWh/year. The reservoir would provide opportunities for hiking and camping and limited opportunities for fishing and boating. The diversions off of the Sacramento River would not be large enough to reduce peak flows; however, Sites Reservoir could improve flood protection for the Sacramento River Basin by increasing flood control reservation space in existing reservoirs through the exchange of storage capacity at Sites Reservoir. This alternative would include a 1,500-cfs release capacity through the Delevan Pipeline that could provide some flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta.

Preliminary Estimated Costs – The estimated construction cost is $3,021.8 million; the estimated annual cost is approximately $188.1 million (table 7-9).

Table 7-9. Alternative WQ1B Estimated Construction and Annual Costs ($ Millions)[1]

Item	Costs
Sites Reservoir Dams and Pumping Facilities, Inlet/Outlet, Pumping/Generating Plant, Funks Reservoir and Facilities (1.8 MAF)[2]	1,124.7
GCID Canal Modifications[3]	37.1
TRR Pumping Station and Pipeline (1,800 cfs)	141.4
Delevan Pipeline and Sacramento River Pumping/Generating Station[4]	421.4
New Electrical Transmission	22.9
Environmental Enhancement[5]	-
Land Acquisition and Right of Way	84.0
Subtotal Contract Costs	**1,831.4**
Mitigation (10%)	183.1
Total Contract Costs (includes 10% unlisted items)	**2,014.6**
Scope/Market Conditions Contingency (20%)	402.9
Total Field Costs	**2,417.5**
Non-Contract Costs including Permitting (25%)	604.4
Total Construction Costs (2007 dollars)	**3,021.8**
Interest During Construction - Foregone Investment Value (4.875% Federal Rate)	584.9
Total Capital Cost (2007 dollars)	**3,606.8**
Interest and Amortization	177.3
Annual Operations and Maintenance (Excludes Replacement Costs)	10.8
Total Annual Cost	**188.1**

Notes:
[1] All costs are preliminary and subject to revision in the feasibility report.
[2] Includes: Sites Dam, Reservoir Clearing, Golden Gate Dam, 9 Saddle Dams, Long Tunnel and Multi-Level Inlet/Outlet, Sites Pumping/Generating Plant 6,000 cfs, Funks Reservoir Modification 6,000 cfs, Southern Bridge Route and Roads, Recreational Facility.
[3] GCID Upgrade 1,800-cfs Option (headgate, tuttle check, TRR siphon), TRR, TRR Pumping/Generating Plant and Pipeline (1,800 cfs).
[4] Delevan Pipeline and Sacramento River Pumping/Generating Plant (2,000-cfs diversion), Connections to Electrical Grid.
[5] N/A this alternative.

Key:
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
N/A = not applicable
TRR = terminal regulating reservoir

Comparison of Initial Alternative Plans

A critically important element of the plan formulation process is the comparison of the initial alternative plans. This preliminary evaluation is based on consideration of four evaluation criteria identified in the P&Gs (WRC, 1983) for water resources planning. These criteria are (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability.

Completeness

Completeness, with respect to the initial alternative plans formulated by the NODOS Investigation, is the extent to which each initial alternative plan provides and accounts for all necessary investments or other actions by Reclamation or DWR and by local entities to ensure the realization of the planned effects. Other public or private actions crucial to realizing the objectives of the initial alternative plans are identified, as well. Key considerations include the ability of the initial alternative plan to meet all objectives of the NODOS Investigation and the reliability of the project in all types of water years. Key observations include the following.

- The No Action Alternative rates very low. Each initial action alternative plan contributes to meeting all of the primary and secondary objectives.
- The initial action alternative plans do not rely heavily on any other actions. The performance of all of these plans would be enhanced through the implementation of conjunctive-use programs; however, the additional benefits associated with conjunctive use were not included in the modeling effort or benefits determinations used in evaluating alternatives.
- The initial action alternative plans are considered equally reliable from an engineering standpoint. O&M requirements would be reduced for Alternative WS1A, given the absence of the Delevan Pipeline. However, some differences in reliability would be evident under dry conditions. The reliability of Alternative WS1A in meeting all of the primary objectives would be reduced under dry conditions. Alternative WQ1B would be the best performer under dry conditions.

Effectiveness

Effectiveness is the extent to which the initial action alternative plans eliminate the specified problems and achieve the objectives of the NODOS Investigation.

Water Supply and Water Supply Reliability (Primary Objective)

Figure 7-2 shows the exceedance probability of total TCCA deliveries, CVP south-of-the Delta deliveries, and SWP south-of-the-Delta deliveries of each of the initial action alternatives and the No Action Alternative. The exceedance plots provided show the likelihood of increased reliability for TCCA, CVP, and SWP users. Table 7-10 provides a comparative summary of the water supply increases achieved by each initial action alternative plan over the No Action Alternative.

The analysis of this objective includes CVP, SWP, local water supply, Level 4 supply for refuges, and EWA. It does not include additional water released to improve Delta water quality. General observations from review of table 7-10 include the following.

- Alternatives WS1C, WS1B, and WS1A provide the highest average long-term annual water supply, with total water supply increases over the No Action Alternative (382, 368, and 336 TAF/year, respectively).
- Alternative AF1A provides the lowest average long-term annual water supply, with a total water supply increase over the No Action / Alternative of only 184 TAF/year.

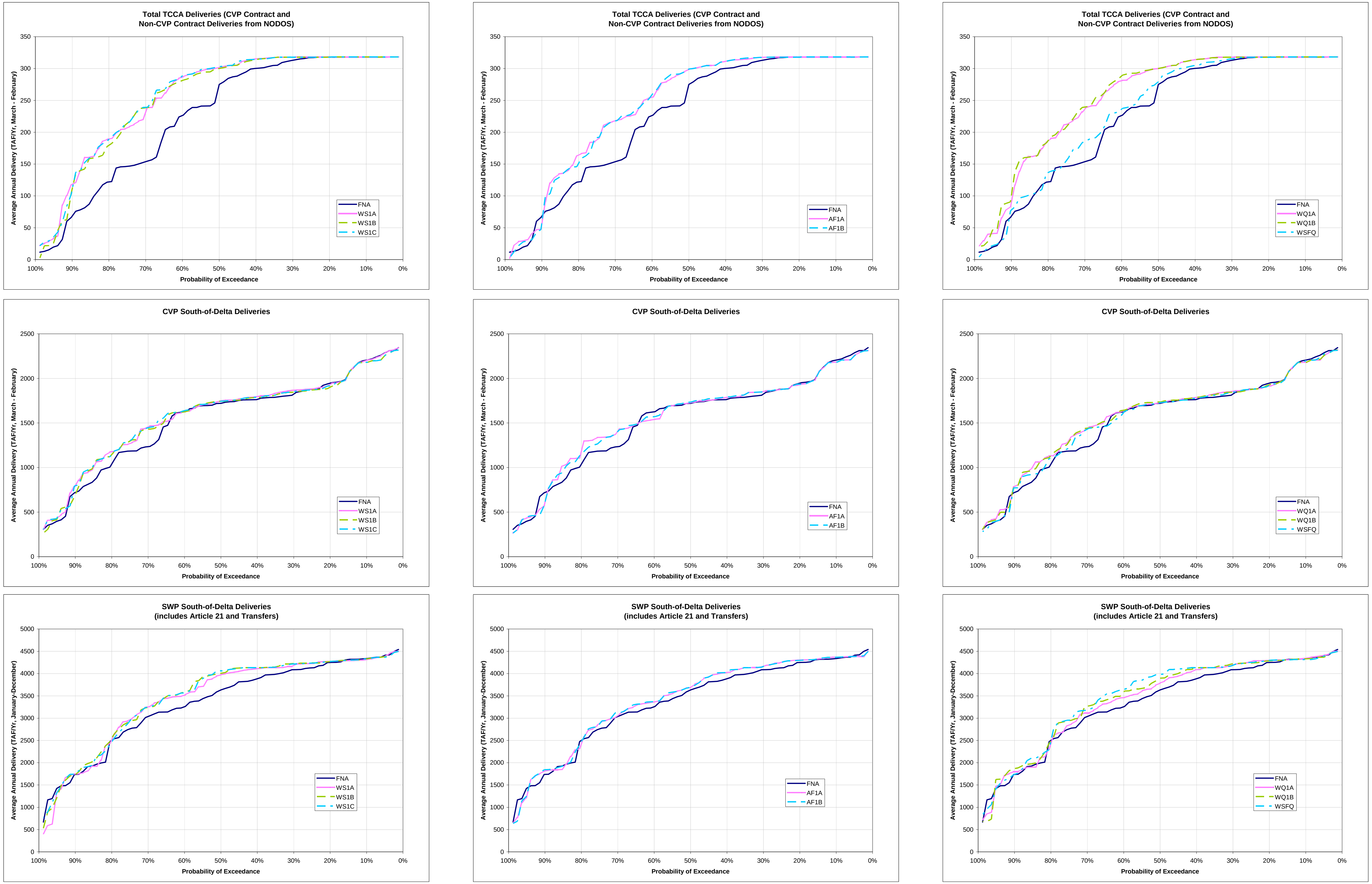


Figure 7-2 Exceedance Plots for Water Supply Reliability

This page left blank intentionally.

Table 7-10. Water Supply Increases[1] (Dry Periods Average Increase[2]/Average Annual Increase) (TAF/year)

Water Supply Locale and Use	WS1A	WS1B	WS1C	AF1A	AF1B	WSFQ	WQ1A	WQ1B
Sacramento Valley								
TCCA Delivery[3]								
TCCA CVP Delivery	19 / 11	14 / 8	19 / 9	8 / 5	4 / 4	6 / 5	16 / 7	14 / 9
TCCA Non-CVP Delivery	35 / 20	30 / 21	32 / 23	19 / 15	18 / 14	1 / 1	35 / 23	36 / 23
CVP Agriculture (includes TCCA CVP Delivery)	21 / 12	15 / 10	22 / 11	9 / 5	5 / 5	7 / 6	18 / 8	16 / 10
CVP M&I	2 / 0	1 / 1	2 / 1	0 / 0	0 / -0	0 / 0	1 / 0	1 / 0
Bay Area								
CVP Agriculture	4 / 2	3 / 2	4 / 2	2 / 1	1 / 1	1 / 1	3 / 1	3 / 1
CVP M&I	3 / 1	2 / 1	4 / 2	0 / 0	0 / 0	1 / 0	3 / 1	2 / 1
SWP M&I	4 / 12	9 / 14	8 / 14	5 / 7	6 / 7	13 / 15	5 / 8	11 / 12
San Joaquin Valley								
CVP Agriculture	105 / 41	81 / 32	110 / 41	50 / 23	28 / 21	30 / 13	86 / 34	79 / 32
CVP M&I	0 / 0	0 / 0	1 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
SWP Agriculture	16 / 20	36 / 29	32 / 27	19 / 15	20 / 17	50 / 32	19 / 17	38 / 26
South and Central Coast								
SWP M&I	0 /84	55 / 111	60 / 111	27 / 46	30 / 51	105 / 116	34 / 62	72 / 92
Total Ag and M&I								
CVP, SWP, and Local Supply	**190 / 192**	**232 / 221**	**275 / 232**	**131 / 112**	**108 / 116**	**208 / 184**	**204 / 154**	**258 / 197**
Environmental								
Level 4 Supply for Refuges	32 / 56	24 / 55	26 / 55	11 / 23	11 / 24	15 / 35	15 / 31	17 / 35
EWA	51 / 88	60 / 92	62 / 95	24 / 49	25 / 49	39 / 57	22 / 40	26 / 44
Total – All Users	273 / 336	316 / 368	363 / 382	166 / 184	144 / 189	262 / 276	241 / 225	301 / 276

Notes:

[1] Increases from the No Action Alternative. See table 6-2 for beneficiary target allocations. See Operations Priority in tables 6-4 through 6-11 for basis of CVP/SWP allocation.

[2] Driest periods increases are the average quantity for the combination of the periods May 1928 through October 1934, October 1975 through September 1977, and June 1986 through September 1992. Average annual increases are based on average quantities for October 1922 through September 2003.

[3] For purposes of preliminary evaluations in this PFR phase, TCCA deliveries were used to model local deliveries. This is subject to change as additional modeling studies are made for the feasibility study and report.

Key:

CVP = Central Valley Project
EWA = Environmental Water Account
M&I = municipal and industrial
PFR = Plan Formulation Report
SWP = State Water Project
TAF = thousand acre-feet
TCCA = Tehama-Colusa Canal Authority

Water supply reliability is also improved by reductions in groundwater pumping to reduce overdraft. The greatest reductions are for alternatives WS1A, WS1B, and WS1C which reduce groundwater pumping by 70, 64, and 70 TAF per year, respectively. Alternatives WQ1A and WQ1B provide reductions of 54 and 64 TAF per year, respectively. Lesser reductions in pumping of 39, 38, and 37 TAF per year, respectively, are achieved by alternatives AF1A, AF1B, and WSFQ.

Water Quality (Primary Objective)

Improved water quality in the Sacramento-San Joaquin Bay-Delta was evaluated in terms of the ability of each alternative to reduce the adverse effects of salinity on drinking water quality and other beneficial uses. By improving water quality in the Bay-Delta, it is also expected that a subsequent decrease in treatment cost of exported water would be realized.

The X2 location is the distance in kilometers (km) from the Golden Gate Bridge to the location where salinity in the Delta is two parts per thousand. Regulatory standards are defined for maintaining the X2 location downstream from specific locations in the western Delta for a predefined number of days. Table 7-11 shows the change in X2 location for dry and critical years. Figures 7-3, 7-4, 7-5, and 7-6 show the average X2 position by month for the long-term average, wet and above normal years, below normal years, and dry and critical years. The greatest improvement is during the fall in dry and critical years, where the X2 location is shifted by 1 to 3 km inland.

Table 7-11 Change in X2 Location During Dry and Critical Years[1] (km)

	WS1A	WS1B	WS1C	AF1A	AF1B	WSFQ	WQ1A	WQ1B
Oct	-1	-2	-2	-1	-1	-2	-2	-3
Nov	0	0	-1	0	0	-1	-1	-1
Dec	0	0	0	0	0	-1	0	-1
Jan	1	0	0	0	0	0	0	0
Feb	1	1	1	1	1	1	1	1
Mar	1	1	1	1	1	1	1	1
Apr	1	1	1	0	0	1	1	1
May	0	0	0	0	0	0	0	0
Jun	0	0	0	-1	-1	0	0	0
Jul	0	0	0	0	0	0	0	0
Aug	-1	-1	-1	-1	-1	-1	-1	-1
Sep	-1	-1	-1	-1	-1	-2	-2	-2

Note:

[1] Negative numbers (decrease in distance) indicate X2 is closer to the Golden Gate Bridge than the Future No Action Alternative, whereas positive numbers (increase in distance) indicate X2 is further from the Golden Gate Bridge than the Future No Action Alternative.

Key:

km = kilometer

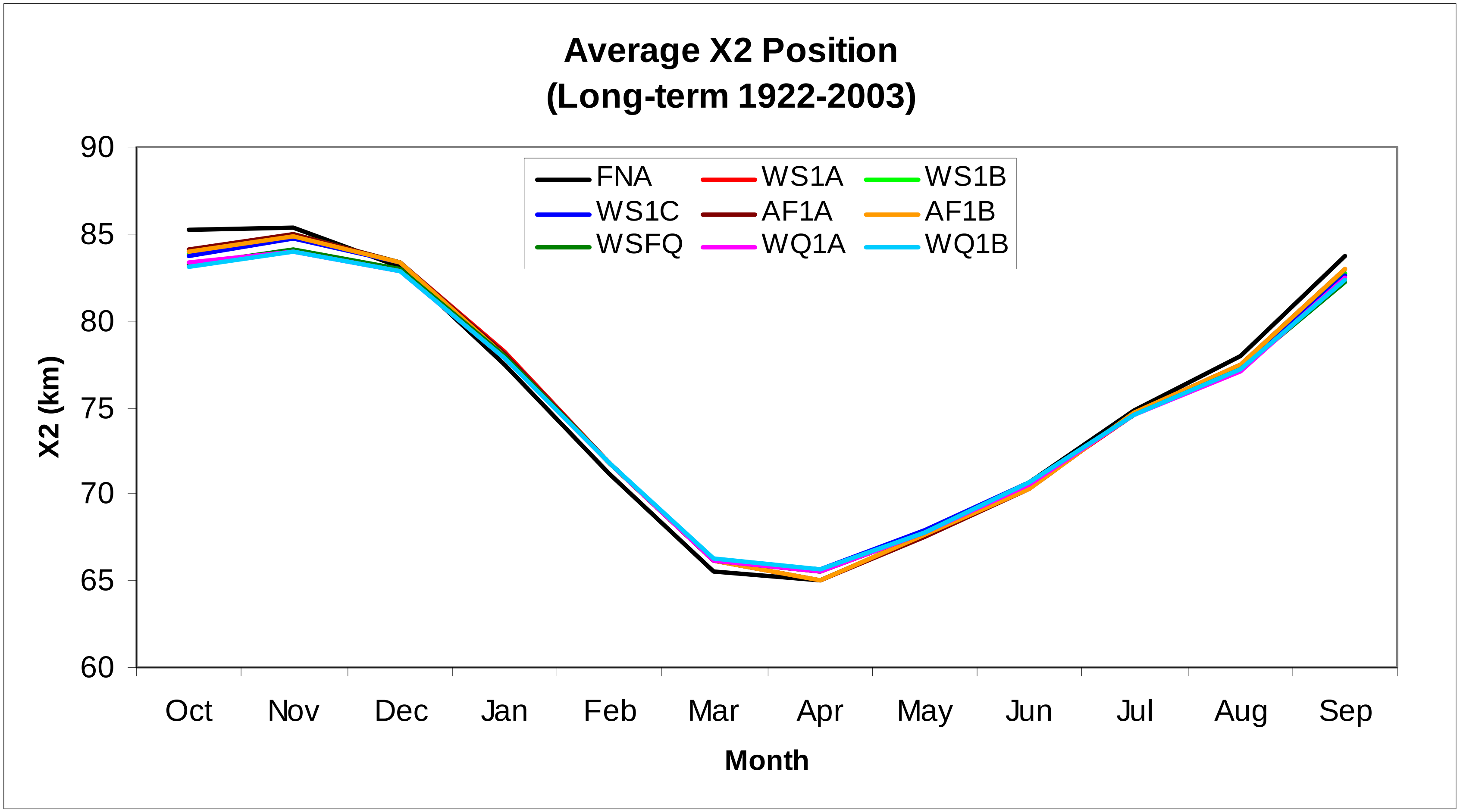


Figure 7-3. Change in Long-Term Average X2 Position for All Initial Alternatives Compared to the Future No Action (FNA) X2 Position

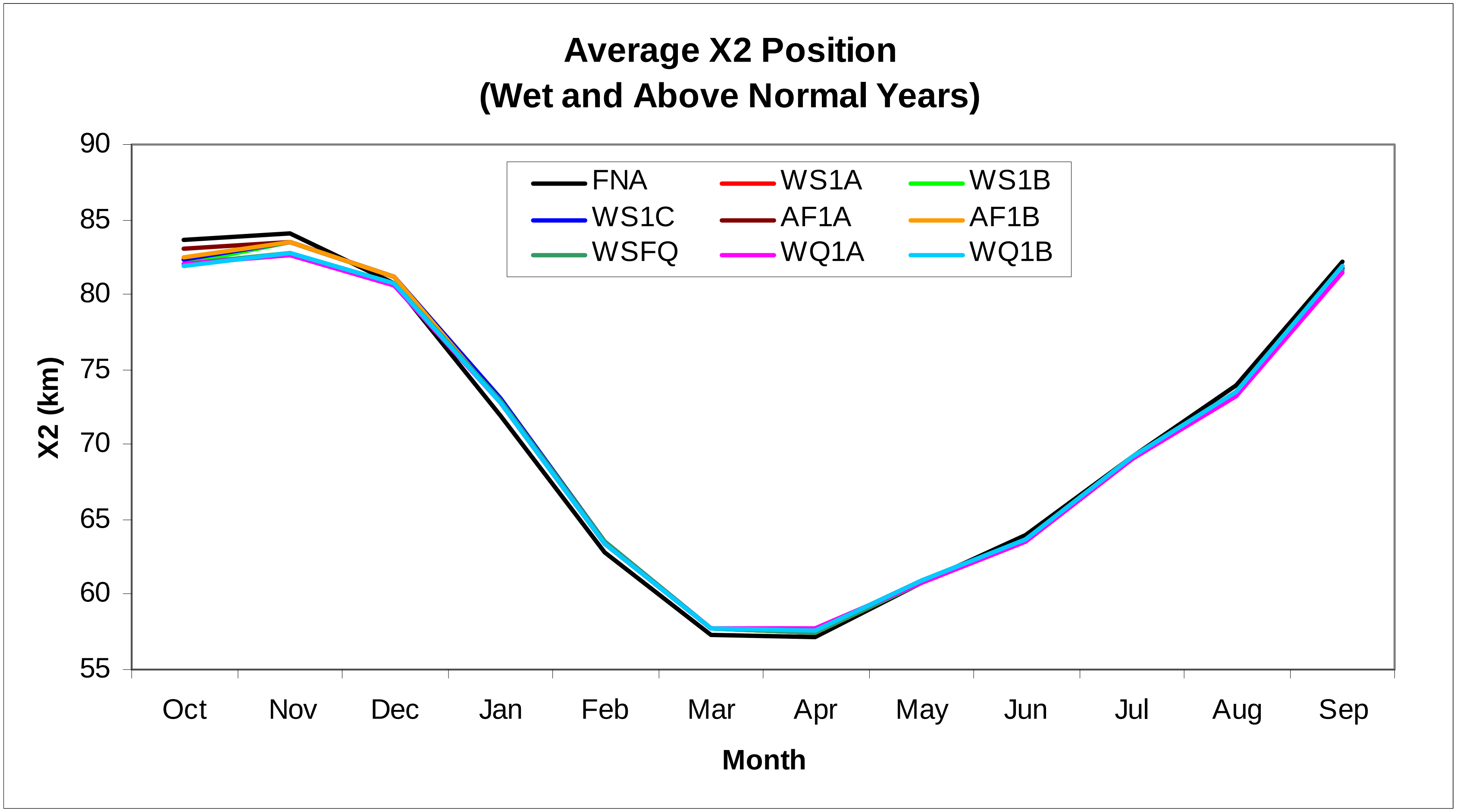


Figure 7-4. Change in X2 Position during Wet and Above Normal Years for All Initial Alternatives Compared to the Future No Action (FNA) X2 Position

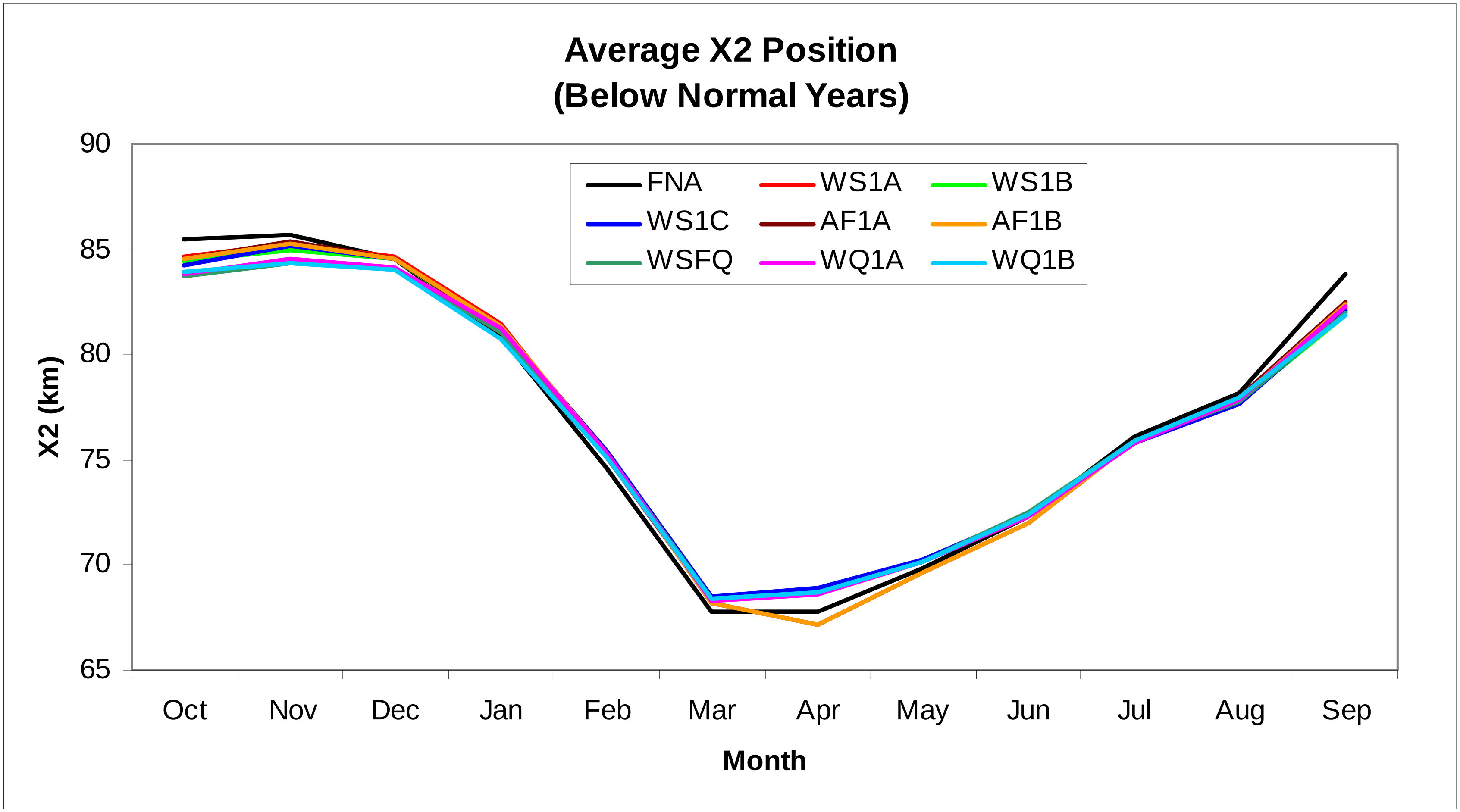


Figure 7-5. Change in X2 Position during Below Normal Years for All Initial Alternatives Compared to the Future No Action (FNA) X2 Position

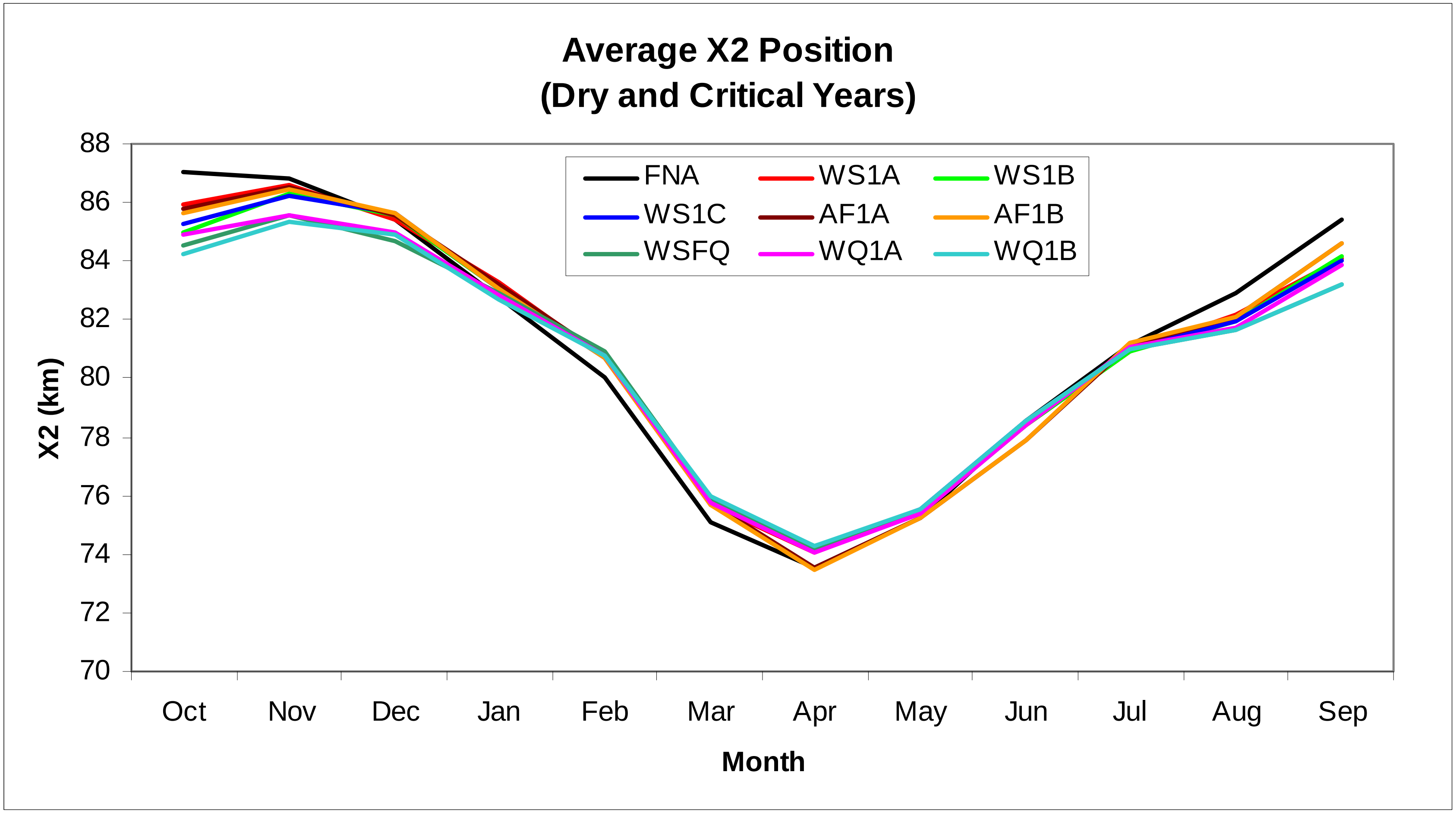


Figure 7-6. Change in X2 Position during Dry and Critical Years for All Initial Alternatives Compared to the Future No Action (FNA) X2 Position

Relative impacts to salinity were evaluated by comparing simulated EC, TDS, and chloride concentrations (see table 7-12). Impacts on water quality for all alternatives are illustrated on figure 7-7. Relative impacts related to a decrease in toxic effects of disinfectant byproducts were evaluated by comparing simulated bromide concentrations. Key observations from table 7-12 include the following.

- Simulations predict that the implementation of all project alternatives would result in some reduction to average EC, TDS, and chloride concentrations at the Banks Pumping Plant and would, therefore, achieve some degree of improvement to salinity in water available for export.
- Water quality alternatives WSFQ, WQ1A and WQ1B would provide substantially greater reduction in salinity, bromides, and chlorides than the other project alternatives.

In summary, initial action alternative plans WSFQ, WQ1A, and WQ1B best meet the objective of improving Delta water quality.

Survival of Anadromous Fish and Other Aquatic Species (Primary Objective)

The NODOS project alternatives include an ERA that would be used to provide water for restoration actions within the Bay-Delta watershed. The account is conceived to provide first-of-its-kind-in-California firm water assets, owned and managed by the State and/or Federal government, for restoration actions beyond regulatory requirements. The initial NODOS formulations include a set of restoration actions associated with the Sacramento River, including, for example, an improved temperature regime below Shasta Lake, reduced diversions, and stabilization of flows for anadromous fish. Alternatives AF1A, AF1B, and WSFQ include several habitat restoration programs, including restoration of gravel mines, improvement of instream habitat, and replenishment of spawning gravels.

Conceptual development of the restoration account includes an adaptive management approach to restoration actions. This adaptive approach could mean support for experimental actions or the ability to refine actions as scientific understanding of ecosystem processes improve. In addition, restoration managers may determine that a different set of actions have priority over the existing actions and that the restoration account’s assets should be allocated to meeting higher priority objectives.

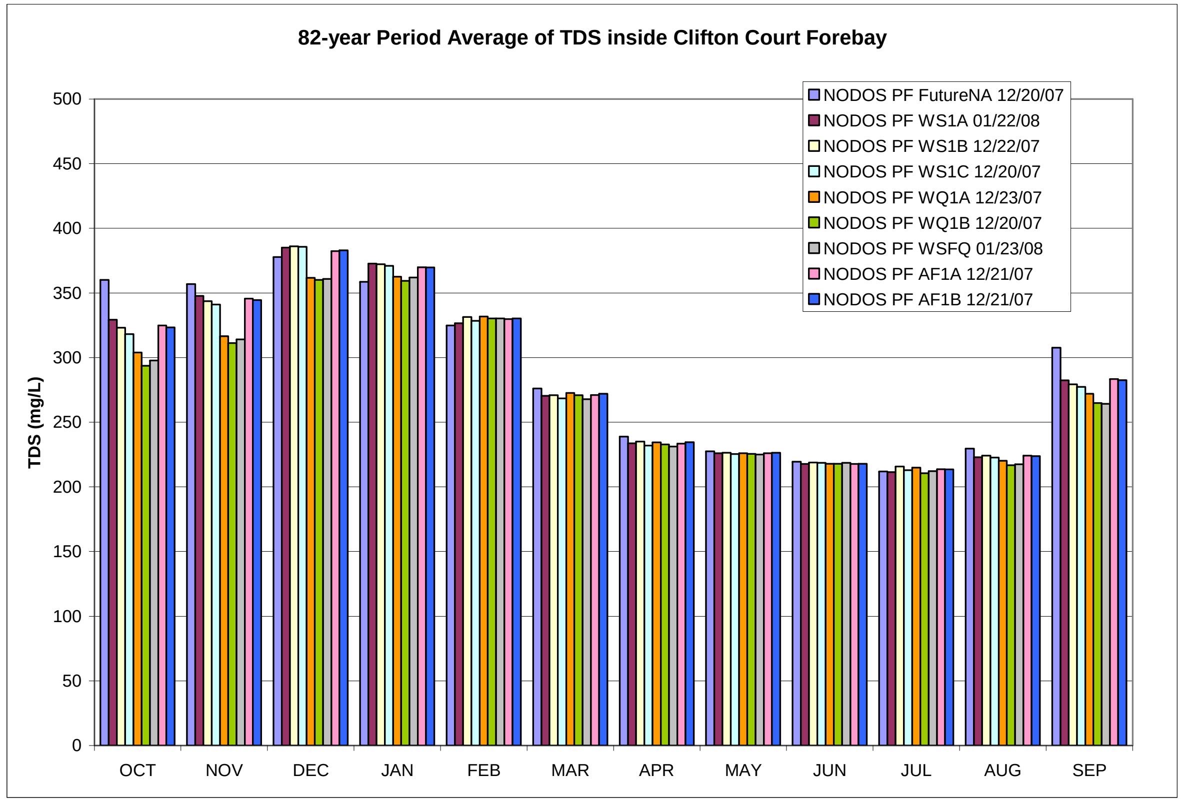
Each alternative plan would result in some modifications to the operation of Shasta, Oroville, and Folsom Reservoirs. These modifications would result in changes in flows that would affect the temperature and habitat downstream from these reservoirs; water temperatures are one of the principle drivers for salmonid production.

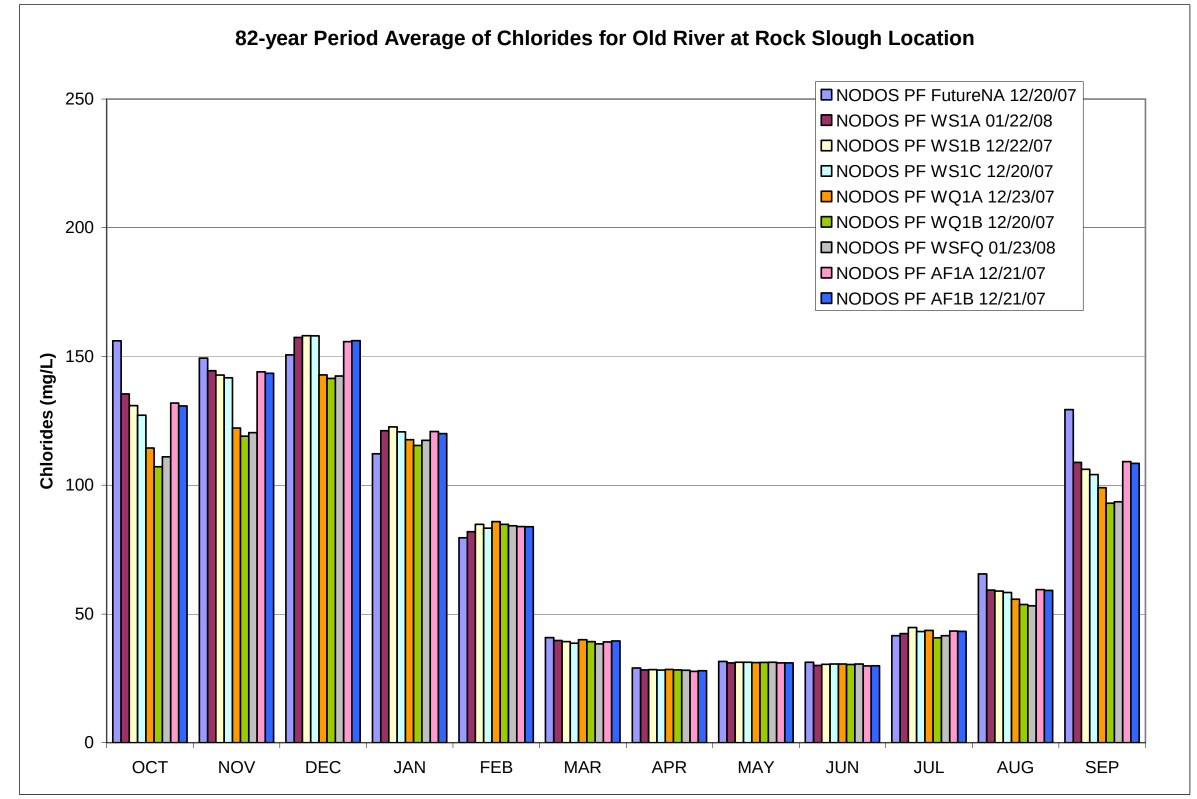
Table 7-12. Quality of Banks Pumping Plant Exports (Weighted Average of all Values of Monthly Simulation)

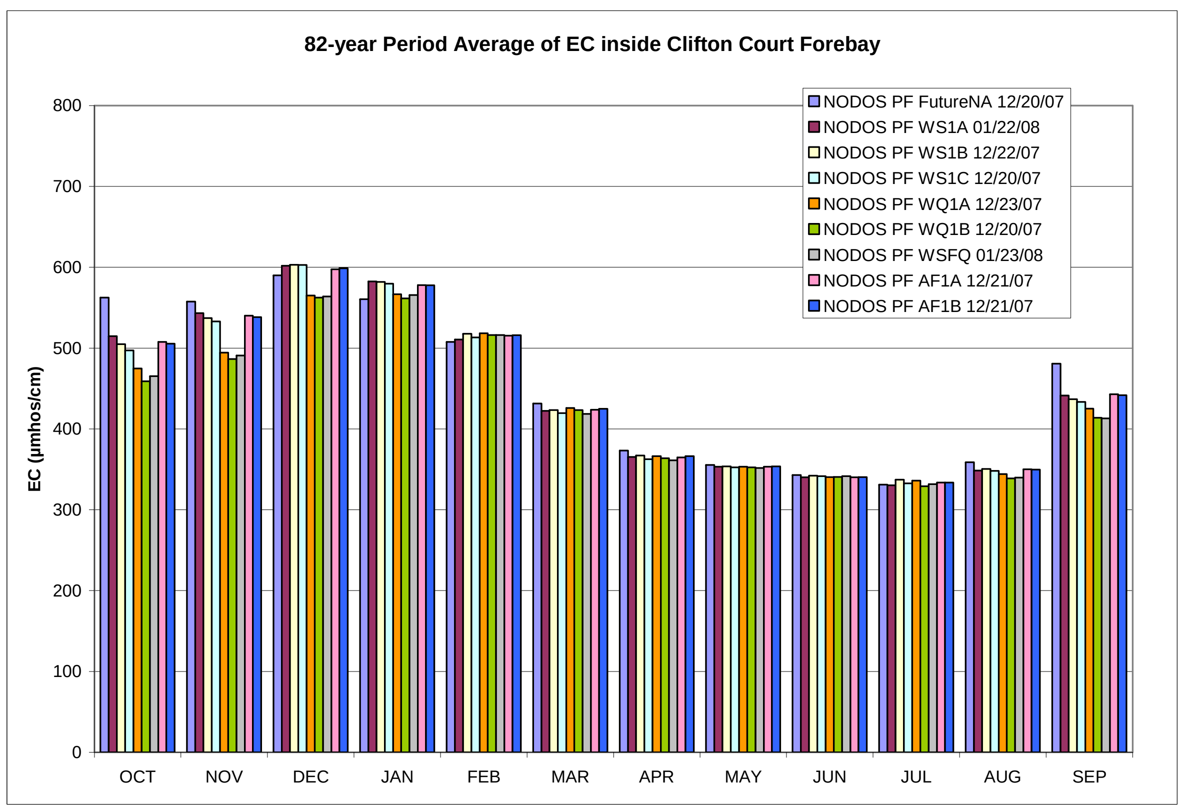
Simulated Using DSM2 Parameter	Alternatives								
	FNA	WS1A (% Difference from FNA)	WS1B (% Difference from FNA)	WS1C (% Difference from FNA)	AF1A (% Difference from FNA)	AF1B (% Difference from FNA)	WSFQ (% Difference from FNA)	WQ1A (% Difference from FNA)	WQ1B (% Difference from FNA)
EC (μmhos/cm)	442.7	435.5 (-2)	434.6 (-2)	431.3 (-3)	434.9 (-2)	434.1 (-2)	434.1 (-5)	423.2 (-4)	418.9 (-5)
TDS (mg/L)	283.3	276.6 (-2)	278.1 (-2)	276.0 (-3)	278.3 (-2)	277.8 (-2)	269.3 (-5)	270.9 (-4)	268.1 (-5)
Chloride (mg/L)	76.15	73.16 (-4)	73.83 (-3)	72.90 (-4)	73.92 (-3)	73.71 (-3)	69.93 (-8)	70.60 (-7)	69.36 (-9)
Bromide (mg/L)	.0.248	0.238 (-4)	0.240 (-3)	0.237 (-4)	0.241 (-3)	0.240 (-3)	0.227 (-9)	0.229 (-8)	0.225 (-9)

Key:

EC = electrical conductivity
FNA = Future No Action
mg/L = milligrams per liter
TDS = total dissolved solids
μmhos = micromhos per centimeter







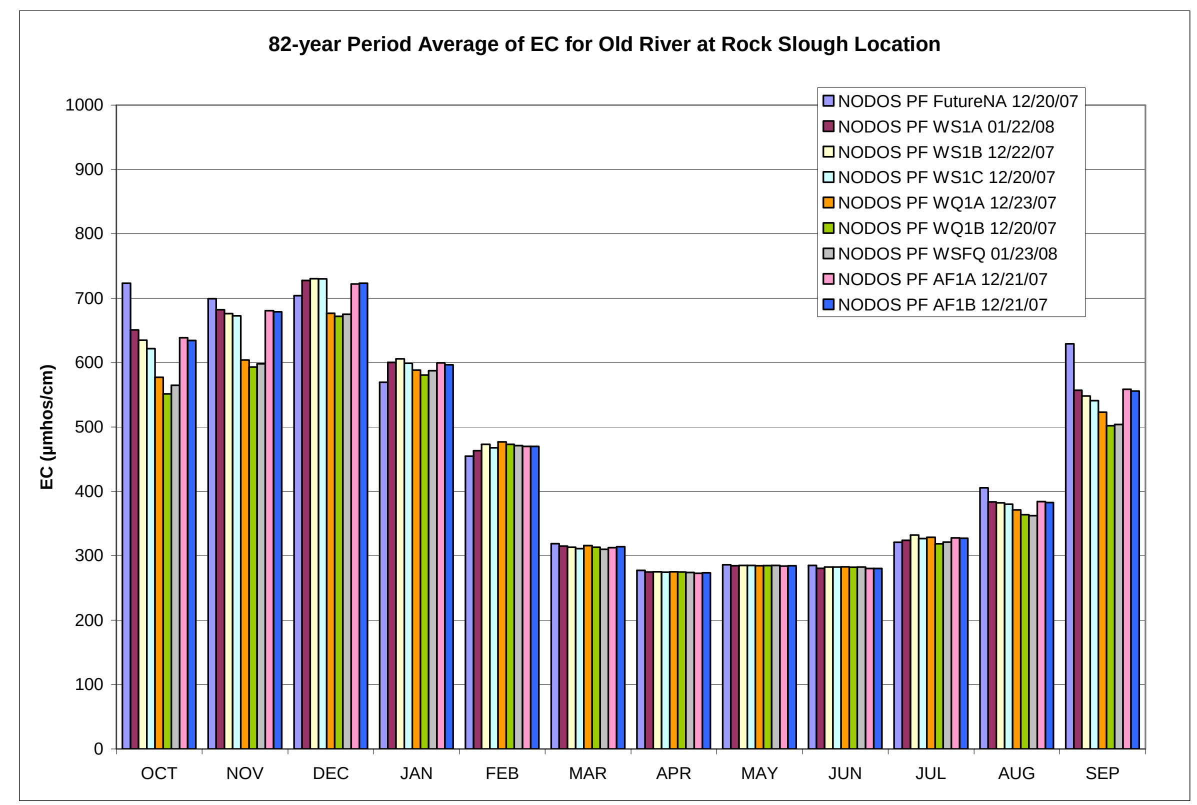


Figure 7-7 Water Quality Plots for all Initial Alternatives

This page left blank intentionally.

The relative effectiveness of the various alternative plans was evaluated based on the performance of the ecosystem restoration actions, including improvements in temperature in the upper Sacramento River, and improvements in Delta outflow in March (table 7-13). This ranking system assumes that increasing diversion rates at all of the diversions would not result in substantial mortality associated with these diversions. This assumption is based on ongoing studies at GCID, and it further assumes that recent changes to reduce predation rates will be successful.

Table 7-13. Effect of Initial Action Alternatives on Anadromous Fish and Aquatic Resources

	WS1A	WS1B	WS1C	WQ1A	WQ1B	AF1A	AF1B	WSFQ
Habitat Enhancements	N	N	N	N	N	SB	SB	SB
Increased Diversions	SA	SA	SA	SA	SA	SA	SA	SA
ERA Level 1 Benefits[1]	SB	SB	SB	SB	SB	SB	SB	SB
ERA Level 2 Benefits[2]	NA	NA	NA	NA	NA	SB	SB	NA
Sacramento River Temperatures	SA	SA	SA	N	SA	SB	SB	SB
Delta Habitat Water Quality	SB	SB	SB	SB	SB	SB	SB	SB
Overall	N	N	N	N	N	SB	SB	SB

Notes:
[1] Objectives identified in table 6-3 that all initial action alternatives would address.
[2] Additional objectives identified in table 6-3 that only some initial action alternatives would address.

Key:
ERA = Ecosystem Restoration Account
ERP = Environmental Restoration Program
LB = Large Beneficial Effect
N = Neutral
NA = non-applicable
SA = Slight Adverse Effect
SB = Slight Beneficial Effect

The SALMOD model projects that these alternatives would provide for better production of spring- and winter-run Chinook in drought periods, especially in the periods from 1930 to 1935 and 1988 to 1993; however, these benefits did not necessarily manifest themselves in shorter drought periods, such as 1977 to 1978. Key observations include the following.

- The two anadromous fish alternative plans (AF1A and AF1B) would provide greater benefits for fisheries than the remaining alternatives. Alternative WSFQ also includes fish habitat enhancements, but the operations are not quite as beneficial to fish as those for AF1A and AF1B.
- The remaining alternatives would provide substantially lower potential benefits to aquatic resources.

In addition to benefiting anadromous fish and aquatic species in the Sacramento River Basin, NODOS also would benefit aquatic species in the Delta. By providing an increase in Delta outflow, NODOS would help maintain an X2 position at 80 km (immediately west of Collinsville) from May to December (see figures 7-3 through 7-6). This would increase Delta smelt habitat and may reduce entrainment and improve food availability.

Ancillary Benefits of Hydropower Generation (Secondary Objective)

Although each of the project alternatives would be a net consumer of power, they also would have the ability to generate electricity when water is released from the reservoir. Table 7-14 summarizes the total power that would be generated at the Sites Reservoir complex generating facilities under each alternative. The results show that alternatives with conveyance to the Sacramento River would produce more power than Alternative WS1A, which does not have conveyance to the Sacramento River.

Table 7-14. Long-Term Total Power Generated (GWh)

	WS1A	WS1B	WS1C	AF1A	AF1B	WSFQ	WQ1A	WQ1B
Power Generated (GWh)	105	147	153	152	157	150	128	151

Key:
GWh = gigawatt-hour

It should be noted that while none of the initial action alternatives is intended to contribute a large supply of additional power to the statewide grid, the Sites Reservoir complex is capable of adding power to the statewide grid during the summer, and power generation facilities would help offset the power usage and provide some ancillary power benefits to the local or state power grid.

Recreation (Secondary Objective)

Several recreational opportunities, such as hiking, boating, camping, fishing, and swimming in the immediate vicinity of Sites Reservoir, would be provided at comparable levels by all initial action alternative plans.

The NODOS project would affect flatwater, or reservoir-based, recreation in the following ways:

- Opportunity for recreation at Sites Reservoir; and
- Impacts on water levels at Shasta Lake, Lake Oroville, and Folsom Lake.

Operating strategies will be employed to mitigate any impacts to recreation at Shasta Lake, Lake Oroville, and Folsom Lake (these impacts are not expected to be adverse and should be generally beneficial).

For initial evaluation in this PFR, differentiation of flatwater recreational opportunities focused on the average annual water surface elevation at Sites Reservoir. At full pool, Sites Reservoir would store 1.8 MAF at an elevation of 520 feet. The maximum surface area of the reservoir would be 14,130 acres. The reservoir would be fully useable for recreation. At a water surface elevation of 480 feet, the reservoir surface area would be almost 90 percent of the maximum surface area and would still be fully useable. This is based on an assumption that boat launch ramps would be functional to an elevation of 400 feet (Rischbieter and Elkins, 2000). Initial action alternative plan WS1A would maintain a reservoir level at or above 440 feet on the most frequent basis (78 percent) and would experience less drawdown than the other initial action alternative plans. All of the other initial action alternative plans would be generally similar in performance, relative to each other.

In future phases of the feasibility study, recreation will be analyzed for specific times of year, such as summer, but for this report average annual water surface elevations were used for the initial evaluation of recreation opportunities.

Flood-Damage Reduction and Emergency Water (Secondary Objective)

Water storage in Sites Reservoir could provide flood-damage reduction benefits through coordination with other reservoirs. The diversions off of the Sacramento River would not be large enough to affect the magnitude of the peak flows meaningfully, but through coordination with other reservoirs and accurate forecasting, water could be held in Sites Reservoir in-lieu of water in other reservoirs to create flood-control storage space in other reservoirs. All of the alternatives would provide almost equivalent performance in meeting this objective.

With no direct release back to the Sacramento River, Alternative WS1A would have no direct ability to provide flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures of multiple islands within the Delta. The remaining seven alternatives, all of which have the Delevan Pipeline, could provide some flushing flows in the event of catastrophic levee failures. Although this would not be a large release, the proximity of Sites Reservoir to the Delta would make this an important feature because of the improved response time (flows would reach the Delta faster than they would from existing upstream reservoirs).

Acceptability

Acceptability assesses the degree of acceptance by Federal, California, and local entities and the public. It considers compatibility with existing laws, regulations, and public policies. A strategy for future public and stakeholder outreach has been developed (see Section 9) to evaluate the acceptability of the alternative plans. At this stage in the planning process, it appears that all initial action alternative plans would be ranked similarly. Key issues affecting all alternatives are likely to include the following.

- Affected property that would be inundated by Sites Reservoir;
- Impacts to cultural resources from the construction of Sites Reservoir;
- Opportunities for new recreational facilities associated with Sites Reservoir;
- Benefits to water supply and water supply reliability;

- Benefits to wildlife, habitat, and fisheries; and
- Benefits to water quality.

Efficiency

Efficiency is the extent to which the initial action alternative plans are the most cost-effective means of alleviating the specified problems and realizing the project objectives, consistent with protecting the environment. This section addresses the environmental consequences of constructing and operating the NODOS project and the following section, Summary of Potential Effects, provides a comparative evaluation of the monetary costs and benefits associated with each plan.

Environmental Impacts and Mitigation

Most of the adverse impacts identified for the NODOS project would be associated with the construction of the reservoir and conveyance facilities.

Many of the adverse impacts would be associated with features common to all of the alternatives. The level of short-term, construction-related, potential impacts to air quality, traffic, cultural resources, land use, biology, and water quality would be slightly greater for alternatives in which the amount of construction disturbance was greater. However, these impacts generally are considered short-term, could be addressed through mitigation, and therefore are not likely to determine the selected alternative.

Table 7-15 summarizes the potential impacts and environmental consequences that are key differentiators between alternative plans.

Table 7-15. Differentiating Potential Impacts and Mitigations for Initial Action Alternative Plans

Resource Area	Potential Impact Description	Applicable Plans	Potential Mitigation
Physical Environment			
Geomorphology, Sedimentation, and Erosion	Additional Delevan Pipeline diversion of 0.7% to 4.4% of the river flow on average. Releases might create potential for river channel scour.	All except WS1A	Requires further analysis.
Water Quality	Scour and sedimentation from the Delevan Pipeline could increase downstream turbidity and sedimentation.	All except WS1A	Outlet structure should be engineered to reduce or eliminate scour.
Water Quality	Increase in turbidity and pollutant discharge during gravel mine restoration and replenishment of spawning gravel.	AF1A, AF1B, WSFQ	Comply with conditions of 404, 401, and 1602 Permits.
Biological Environment			
Aquatic and Fishery Resources	Potential for losses from impingement or entrainment from Delevan Diversion.	All except WS1A	State-of-the-art fish screen proposed for Delevan Pipeline to mitigate entrainment.

Summary of Potential Effects

The P&Gs (WRC, 1983) identify four "accounts" to display the potential effects for the evaluation of alternatives (NED, RED, EQ, and OSE). A preliminary analysis of NED benefits is provided in tables 7-16 and 7-17. Other information that is required by law or that will have a material bearing on the decision-making process is considered in the other accounts (EQ, RED, and OSE).

Table 7-16. Annual NED Benefits by Initial Action Alternative Plans[1]

	Alternatives (Preliminary, 2007 $ Million)							
Annual Benefit	**WS1A**	**WS1B**	**WS1C**	**AF1A**	**AF1B**	**WSFQ**	**WQ1A**	**WQ1B**
Water Supply								
Agricultural	$10.22	$9.57	$10.64	$6.10	$5.94	$5.85	$8.18	$9.39
Urban[2]	$50.07	$74.38	$73.52	$38.12	$42.55	$94.41	$46.75	$76.65
Other Urban[3]	$8.26	$17.25	$17.68	$6.46	$6.46	$20.72	$11.04	$15.48
EWA	$13.19	$13.94	$14.36	$7.19	$7.27	$8.72	$5.95	$6.71
Refuges	$12.64	$12.21	$12.28	$5.27	$5.15	$7.68	$6.78	$7.88
Total	**$94.38**	**$127.35**	**$128.48**	**$63.14**	**$67.37**	**$137.38**	**$78.70**	**$116.11**
Water Quality								
Urban	$8.44	$10.61	$12.34	$8.01	$7.71	$22.05	$16.36	$20.53
Other Urban	$1.00	$1.80	$2.17	$1.01	$0.87	$3.60	$2.85	$3.08
Fisheries Restoration and Enhancement								
Upstream	$2.55	$6.95	$6.67	$18.04	$18.47	$11.58	$9.44	$8.16
Delta	$12.20	$17.75	$18.62	$14.92	$15.93	$52.36	$38.03	$43.52
Recreation	$17.01	$16.79	$16.49	$17.34	$17.13	$17.81	$14.54	$17.34
Hydropower	-$22.47	-$29.29	-$29.83	-$14.77	-$16.68	-$29.93	-$15.50	-$25.54
Total	**$113.11**	**$151.96**	**$154.94**	**$107.69**	**$110.80**	**$214.85**	**$144.42**	**$183.20**

Notes:
[1] All costs and benefit calculations are preliminary estimates and subject to update and refinement in the feasibility report.
[2] Urban – Urban water users in the South Coast and South Bay hydrologic regions.
[3] Other Urban – Urban water users in the Central Coast and interior southern California outside of South Coast and South Bay.

Key:
EWA = Environmental Water Account
NED = National Economic Development

Table 7-17. Annual NED Benefits and Annual Costs by Initial Action Alternative Plans[1]

	Initial Action Alternative Plans (Preliminary $ Millions)							
Measure	**WS1A**	**WS1B**	**WS1C**	**AF1A**	**AF1B**	**WSFQ**	**WQ1A**	**WQ1B**
Annual Benefits	$113.11	$151.96	$154.94	$107.69	$110.80	$214.85	$144.42	$183.20
Annual Costs	$134.20	$183.00	$188.10	$184.10	$189.30	$189.00	$166.10	$188.10
Net Benefits (Benefits – Costs)	-$21.09	-$31.04	-$33.16	-$76.41	-$78.50	+$25.85	-$21.68	-$4.90

Note:
[1] All costs and benefit calculations are preliminary estimates and subject to update and refinement in the feasibility report.

Key:
NED = National Economic Development

- The NED account shows changes in the economic value of the national output of goods and services.
- The RED account shows the regional incidence of NED effects, income transfers, and employment effects.
- The EQ account shows effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that cannot be measured in monetary terms.
- The OSE account shows urban and community impacts and effects on life, health and safety.

Table 7-16 summarizes all NED benefits for each initial action alternative plan in millions of dollars annually; values are annualized assuming the project has been completed and is operating at full capacity.

Total annual benefits are greatest for WSFQ and least for AF1A. Water supply benefits are higher than those for any other project purpose for all initial action alternative plans, with WSFQ the highest at $137 million and AF1A the lowest at $63 million.

For the PFR, it has been assumed that the value of water supply dedicated for ecosystem restoration purposes in the Sacramento River is consistent with the value of EWA’s north-of–the-Delta water purchases. For ecosystem restoration benefits in the Delta, the value of the water used to augment Delta outflow is assumed to be equal to the weighted average value of water supply for south-of-the-Delta urban, agricultural, Level 4 supply for refuges, and EWA.

Hydropower benefits are negative because they capture the net energy consumption throughout the entire water delivery system that would be employed by the NODOS project. These costs exceed the value of power generation associated with the reservoir.

A preliminary comparison of annual NED values for the initial action alternative plans is shown in table 7-17. The largest net benefits are provided by WSFQ. Net benefits are negative for the remaining alternatives. Additional investigation is required to provide more rigorous quantification of the physical benefits and economic values. Some of the ecosystem restoration and water quality benefits have not been quantified. Additional development of analytical tools and methodologies is presently underway to more fully quantify both the ecosystem restoration and water quality economic benefits for the feasibility study.

Regional Economic Development Account

RED impacts can be determined at both the California and regional levels. With additional water supply, the value of agricultural output increases because the

NODOS project would increase supplies of project water and reduce crop idling for water transfers to environmental and urban water users. RED impacts will be developed further in the next stage of the feasibility study, and results will be presented in the feasibility report.

Environmental Quality Account

Assessment of ecosystem restoration benefits is a complex analysis that puts a financial value on the benefits derived from protecting and enhancing aquatic and terrestrial species and their habitat. While it may be comparatively easy to quantify the direct costs associated with many ecosystem actions, evaluating the benefits derived by society is not a simple matter. Reclamation and DWR are engaged in ongoing efforts to develop new modeling tools and additional analytical methods to quantify the number of fish protected as a direct result of NODOS actions listed in each of the NODOS alternatives.

The operations strategies for the NODOS alternatives were developed to meet specific ecosystem restoration objectives (table 6-3).

A summary of potential EQ benefits is provided in table 7-18. The aquatic resources analysis found that all of the water supply and water quality alternatives would have a slight beneficial effect on anadromous fish runs.

The anadromous fish alternatives would have more of a beneficial effect on anadromous fish runs in the upstream (Sacramento River) area, but these alternatives provide less water supply for Delta outflow than some other alternatives. For every alternative, it was assumed that 100 TAF/year of the upstream fisheries water supply would be required to offset the effects of upstream project operations. For the anadromous fish alternatives, about 125 TAF/year more are provided for upstream flow, but only 73 to 76 TAF/year are provided for Delta outflow. For alternatives other than the anadromous fish alternatives, only 17 to 76 TAF/year above the offset are provided for upstream flow, but anywhere from 74 to 170 TAF/year are provided for Delta outflow.

It is generally assumed that ESA recovery must occur with or without NODOS. This means that water supplies for recovery would be provided with or without NODOS. Therefore, benefits of water use that are lost because of water acquisitions for fish in the No Project Alternative are avoided by providing water for fish using the project. For both upstream and Delta fishery water, the value of water was based on its opportunity cost.

Table 7-18. Summary of Potential Environmental Quality Benefits

Resource Area	Potential Impact Description	Applicable Plans
Physical Environment		
Geomorphology, Sedimentation, and Erosion	Reduce erosion in lower Sacramento River associated with reducing peak flood flows.	All
Water Quality	Improve water quality in lower Sacramento and Delta.	All
Water Quality	Improve water quality in Extended Study Area.	All
Biological Environment		
Aquatic and Fishery Resources	Improve cold water carry-over storage at Shasta Dam.	All
Aquatic and Fishery Resources	Provide supplemental flows for cold water releases between Keswick and RBDD.	All
Aquatic and Fishery Resources	Reduce diversions at RBDD into TC Canal and at GCID Canal from July through September.	All
Aquatic and Fishery Resources	Stabilize fall flows from Keswick to RBDD to avoid abrupt reductions assuming November 1997 AFRP flow targets.	WSFQ
Aquatic and Fishery Resources	Stabilize fall flows from Keswick to RBDD with 6,000-cfs target from October through January and 4,500 cfs for September.	WS1B, WS1C, WQ1A, WQ1B, AF1A, AF1B
Aquatic and Fishery Resources	Improve cold water carryover storage at Folsom Lake and stabilize flows in American River.	All
Aquatic and Fishery Resources	Modify spring flows into snowmelt pattern with peak storm in late winter and early spring from RBDD to Colusa to benefit cottonwoods.	All
Aquatic and Fishery Resources	Provide flow event supplementing normal flows from Shasta and Keswick in March, when no winter flow event has occurred.	AF1A, AF1B
Aquatic and Fishery Resources	Provide a March Delta outflow from late winter through early spring peak inflow from the Sacramento River.	AF1A, AF1B
Aquatic and Fishery Resources	Provide a minimum flow of 13,000 cfs on the Sacramento River below Sacramento in May of all but critical years.	AF1A, AF1B
Aquatic and Fishery Resources	Improve water temperature in the Sacramento River in compliance with NOAA Fisheries Service temperature criterion of 56°F.	AF1A, AF1B, WSFQ
Aquatic and Fishery Resources	Create new warm water fish habitat in Sites Reservoir.	All
Aquatic and Fishery Resources	Fish enhancements (abandoned gravel mine restoration, instream aquatic habitat improvement, replenishing spawning gravel, and improving fish habitat in mainstem Sacramento).	AF1A, AF1B, WSFQ
Wildlife	Contribute to Level 4 water supply, benefiting wildlife refuges.	All

Key:
AFRP = Anadromous Fish Restoration Program
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
NOAA = National Oceanic and Atmospheric Association
RBDD = Red Bluff Diversion Dam
TC = Tehama Colusa
°F = degrees Fahrenheit

If the threatened and endangered species populations were to increase because of the project, then application of non-use values instead of water cost savings would be appropriate. Many studies have suggested that people have non-use values for endangered fish that are much larger than the potential water acquisition cost savings counted here.[1]

There is a degree of uncertainty about the fisheries restoration benefits. Only some of the physical effects of the project have been measured. It is likely that some of the physical effects would be negative for some anadromous fish runs. Furthermore, some assumptions for the No Action Alternative are not clear at this time, and the selection of these assumptions could have large effects on the benefits estimates.

NODOS also can be used to provide a flexible ERA for restoration actions within the Bay-Delta watershed. The account is conceived to provide first-of-its-kind-in-California firm water assets, owned and managed by California and/or the Federal government for restoration actions beyond regulatory requirements. This restoration account would employ an adaptive management approach to restoration actions. The account could support experimental actions in a flexible way that refines actions as scientific understanding of ecosystem processes improve. This approach would enable restoration managers to reallocate restoration account assets if they determine that a different set of actions have priority over the existing actions.

Following is a set of restoration actions focused on Delta species and ecosystem processes that may be supported with water from Sites Reservoir. These actions are derived from multiple sources, including the CALFED ERP and Delta Regional Ecosystem Restoration Implementation Plan, the Delta Vision Delta Ecosystem Restoration Plan, and DWR’s Pelagic Fish Action Plan. Many of these actions are also considered in the Resources Agency’s Bay Delta Conservation Plan. The Action 1 objective, described hereafter, is supported in all of the initial action alternative plans using the water quality objective described previously. In current formulations, water from the restoration account is not used to achieve this objective, even though there is an apparent ecosystem restoration benefit. As the feasibility study and plan formulation progress, additional exploration of these Delta restoration actions may be warranted, and these actions may be included explicitly in NODOS restoration account actions as part of an alternative plan.

1. **Maintain X2 West of Collinsville during May – December (summer/fall).** An increase in Delta outflow, by maintaining an X2 position at 80 km from May to December, would increase Delta smelt habitat and may reduce entrainment and improve food availability. Water from NODOS could support this action directly.

[1] See for example Fisher et al., 1991; Layton, 2001; Loomis, 1996; Olsen et al., 1991.

2. **Provide Flows through Yolo Bypass into Cache Slough (summer).** Flows in Yolo Bypass currently flow upstream in summer to meet several user needs in the Bypass. Maintaining positive flow would provide downstream transport of high food web productivity associated with the Bypass into the Delta. Water from NODOS could be provided to the Bypass from the ERA using a number of optional infrastructure and water delivery changes. Infrastructure and/or operational modifications would be required to provide summertime deliveries using Knights Landing Ridge Cut, Fremont Weir, or Sacramento Weir. In addition, it is likely that fish passage from the Bypass to the River would require improvement with additional infrastructure. Another option is to exchange water with Yolo or Solano County users and allow additional flow from Cache and Putah creeks to flow through the Bypass. Under these options, deliveries would be made from NODOS by extending the TC Canal.

3. **Manage Flooding in North Delta for Seasonal Floodplain Habitat.** These actions would increase the area and time of inundation within the Yolo Bypass and the Cosumnes River floodplain to increase plankton production to support juvenile, adult, and egg production of Delta smelt. NODOS could contribute to an action associated with the Yolo Bypass. This action probably would require infrastructure and/or operational modifications to allow additional water into the Bypass; the concept also may require land-use modifications.

4. **Relocate North Bay Aqueduct Intake on Barker Slough and Relocate Large Local Agricultural Intakes.** These two intake relocation actions would shift net flow downstream and mitigate drinking water dissolved organic carbon issues. These actions would be part of a larger effort to restore the tidal marsh in the Cache Slough complex. NODOS could provide alternative intake locations with a reliable Delta-independent diversion for the North Bay Aqueduct (NBA) contractors and agricultural users. One option is to extend the TC Canal to the NBA pipeline. Another option is to provide exchange water to Solano agricultural Putah Creek users and then use Solano Project water as a replacement for NBA users.

5. **Yolo Bypass Enhancements.** Actions include: (1) add operable structure to Fremont Weir to allow lower Sacramento River flows into Bypass (2) enhance fish passage through Fremont Weir for multiple species (salmon, steelhead, sturgeon); (3) enhance Lower Putah Creek local floodplain; (4) enhance connectivity, fish passage, and agricultural access along toe drain/Lisbon Weir; (5) update fish ladder at Fremont Weir; and (6) provide localized floodplain enhancement, such as along toe drain. Actions will provide: (1) Increased inundation frequency to yearly or biannual; (2) Improved quality and availability of juvenile salmonid rearing habitat; (3) Improved quality and availability of

splittail spawning and rearing habitat; (4) Improved primary production exports to lower Sacramento River/west Delta; (5) Improved salmon and splittail access to Putah Creek; (6) Improved fish passage at Fremont weir; and (7) Improved migratory and resident bird habitats.

Ongoing discussions regarding restoration in the Bypass indicate a strong connection between infrastructure and water supply. A new and reliable supply dedicated to users within the Bypass may help facilitate an implementation plan. If additional reliable water were available in the Bypass, water could be delivered to Bypass water users and thereby make the tidal Lisbon Weir (which is a fish barrier) unnecessary. A check dam near the Putah Creek confluence with the toe drain also could be operated in a more fish-friendly way if sufficient water supply were made available to users currently dependent on the dam.

6. **Increase Spring Delta Outflows.** An increase in total Delta outflow during the February to June period in “below normal,” “dry,” and “critically dry” water years would create low-salinity habitat (i.e., 1 to 3 parts per thousand salinity) in Suisun Bay. The action would increase the amount of low-salinity open-water habitat; facilitate downstream transport of sediment, nutrients, prey, and anadromous and estuarine juvenile fish; and promote improved abundance and survival of multiple fish and aquatic invertebrate species. NODOS could support these supplemental outflows directly.

7. **Experiment with Targeted Salinity Intrusions to Control Invasive Species and Promote Fish Populations.** This action is designed to test the effectiveness of promoting conditions that support desirable aquatic species, such as Delta smelt, and control Brazilian waterweed, water hyacinth, and asian clam. NODOS could support experimental flow strategies as described here. The restoration account could support experimental flow strategies in many locations (especially below the CVP and SWP reservoirs) within the Bay-Delta watershed.

EQ benefits will be developed further in the next stage of the feasibility study, and results will be presented in the feasibility report and EIS/EIR.

Other Social Effects Account

Table 7-19 summarizes potential positive OSE. Potential OSE also include the following:

- Temporary construction-related benefits might derive to local communities, with limited opportunities for long-term, operation-related employment.

Table 7-19. Summary of Potential Other Social Effects Benefits

Resource Area	Potential Impact Description	Applicable Plans
Socioeconomic Environment		
Environmental Justice	No disproportionate impacts to disadvantaged groups were identified for any alternative.	
Land Use		
Land Use	Conversion of natural and irrigated grassland and pasture into Sites Reservoir.	All
Recreation and Public Access	Increased recreation opportunities from new reservoir, including 1,350 acres of shoreline lands.	All
Water Supply	Long-term increases in CVP and SWP water supply reliability.	All
Power and Energy	Increased contribution to the power grid during on-peak demand from new hydropower generation facilities.	All

Key:

CVP = Central Valley Project
SWP = State Water Project

- There could be potential short-term adverse effects for those directly affected by construction.
- Storage in Sites Reservoir would provide ancillary benefits in flood-damage reduction.
- Over 14,000 acres of land would have to be acquired for Sites Reservoir and proposed facilities; relocation of affected people and property would be required.
- Potential impacts to ITAs must be identified and assessed collaboratively with the federally recognized Tribes and Bureau of Indian Affairs.

OSE will be developed further in the next stage of the feasibility study, and results will be presented in the feasibility report and EIS/EIR.

Summary of Comparisons of Initial Alternative Plans and Conclusions

Table 7-20 summarizes the evaluation of the plans with respect to the four criteria. Each plan is complete and effective in addressing the NODOS Investigation planning objectives and constraints. Additional investigation is required to provide more rigorous quantification of the physical benefits and economic values.

The comparison of alternative plans is primarily based on a qualitative analysis at this stage of the iterative planning process. Additional refinement and detailed analyses to provide more rigorous quantification of the physical benefits, economic values, and associated effects and impacts will be undertaken in the feasibility report and EIS/EIR.

PFR Alternatives Recommended for Additional Investigation in the Feasibility Report

- No Action Alternative
- Initial Action Alternative Plan WSFQ
- Initial Action Alternative Plan WS1A
- Initial Action Alternative Plan WQ1B

Table 7-20 presents a qualitative comparison and ranking of alternative plans that uses the criteria of completeness, effectiveness, efficiency, and acceptability, based on information available at this stage of the feasibility study. This preliminary comparison ranks alternative plans WSFQ and WQ1B higher than the other plans.

Estimated monetary benefits and costs for the action alternative alternative plans are shown in Table 7-16. Alternative WSFQ has benefits greater than costs and also offers the greatest total benefits of any of the alternatives considered. It clearly warrants additional evaluation and analysis in the next stage of the feasibility study.

This page left blank intentionally.

Table 7-20. Summary Comparison of Comprehensive Plans

Alternative	Comparison Criteria				Relative Ranking
	Completeness	**Effectiveness**	**Efficiency**	**Acceptability**	
No Action Alternative	Addresses none of the planning objectives. Reliability is very low under dry conditions.	Does not address any of the primary objectives.	By taking no action, problems and needs will continue to increase, resulting in either more costly actions or water supply shortages.	Does not address any of the CALFED goals.	
Relative Rank	*Very Low*	*None*	*None*	*Very Low*	*Very Low*
WS1A	Addresses all objectives, but reliability is low for all objectives under dry conditions. O&M requirements are simplified by the absence of the Delevan Pipeline.	Modeling results demonstrate the absence of the Delevan Pipeline diversion would substantially reduce water supply under dry conditions. Provides moderate improvement in Delta water quality and an overall low benefit to anadromous fish and aquatic resources. Provides low hydropower benefit. Reservoir benefits recreation because it is typically full. Absence of Delevan Pipeline eliminates direct ability to provide emergency flushing flows.	Impacts are short-term and can be mitigated. Annual benefits are moderate ($113M). Has lowest construction cost of any alternative, but a negative net benefit (-$21M).	Consistent with the goals of CALFED for various programs, including water supply reliability, water quality, and ecosystem restoration.	
Relative Rank	*Low*	*Low*	*Moderate*	*Moderate*	*Moderate*
WS1B	Addresses all objectives. Has high reliability for water supply, moderate reliability for supporting anadromous fish, and low reliability for Delta water quality improvements.	Highly effective in improving water supply and water supply reliability. Provides moderate improvement in Delta water quality and an overall low benefit to anadromous fish and aquatic resources. Provides low hydropower and recreation benefits. Provides moderate flood damage reduction and emergency flushing water supply.	Impacts are short-term and can be mitigated. Has highest annual benefits ($152M). Has moderate construction cost and negative net benefit (-$31M).	Consistent with the goals of CALFED for various programs, including water supply reliability, water quality, and ecosystem restoration.	
Relative Rank	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*Moderate*[1]
WS1C	Addresses all objectives. Has high reliability for water supply, moderate reliability for supporting anadromous fish, and low reliability for Delta water quality improvements.	Highly effective in improving water supply and water supply reliability. Provides moderate improvement in Delta water quality and an overall low benefit to anadromous fish and aquatic resources. Provides low hydropower and recreation benefits. Provides moderate flood damage reduction and emergency flushing water supply.	Impacts are short-term and can be mitigated. Has moderate annual benefits ($155M). Has moderate construction cost and negative net benefit (-$33M).	Consistent with the goals of CALFED for various programs, including water supply reliability, water quality, and ecosystem restoration.	
Relative Rank	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*Moderate*
AF1A	Addresses all objectives. Has high reliability for supporting anadromous fish and moderate reliability for water supply and Delta water quality improvements.	Moderately effective in improving water supply and water supply reliability. Provides moderate improvement in Delta water quality and an overall high benefit to anadromous fish and aquatic resources. Provides moderate hydropower and low recreation benefits. Provides moderate flood damage reduction and emergency flushing water supply.	Impacts are short-term and can be mitigated. Has lowest annual benefits ($108M). Has moderate construction cost and negative net benefit (-$76M).	Consistent with the goals of CALFED for various programs, including water supply reliability, water quality, and ecosystem restoration.	
Relative Rank	*Moderate*	*Moderate*	*Low*	*Moderate*	*Moderate*[1]
AF1B	Addresses all objectives. Has high reliability for supporting anadromous fish and moderate reliability for water supply and Delta water quality improvements.	Moderately effective in improving water supply and water supply reliability. Provides moderate improvement in Delta water quality and an overall high benefit to anadromous fish and aquatic resources. Provides moderate hydro-power and low recreation benefits. Provides moderate flood damage reduction and emergency flushing water supply.	Impacts are short-term and can be mitigated. Has lower annual benefits ($111M). Has moderate construction cost and negative net benefit (-$78M).	Consistent with the goals of CALFED for various programs, including water supply reliability, water quality, and ecosystem restoration.	
Relative Rank	*Moderate*	*Moderate*	*Low*	*Moderate*	*Moderate*
WSFQ	Addresses all objectives. Has high reliability for water supply and water quality improvements. Reliability is moderate for supporting anadromous fish.	Highly effective in improving water supply and water supply reliability. Provides high improvement in Delta water quality. Has an overall high benefit to anadromous fish and aquatic resources. Provides moderate hydro-power and low recreation benefits. Provides moderate flood damage reduction and emergency flushing water supply.	Impacts are short-term and can be mitigated. Has high annual benefits ($214M). Has moderate construction cost and positive net benefit ($26M).	Consistent with the goals of CALFED for various programs, including water supply reliability, water quality, and ecosystem restoration.	
Relative Rank	*High*	*High*	*High*	*Moderate*	*High*

Table 7-20. Continued

Initial Alternative	Comparison Criteria				Relative Ranking
	Completeness	**Effectiveness**	**Efficiency**	**Acceptability**	
WQ1A	Addresses all objectives. Has high reliability for Delta water quality improvement and moderate reliability for water supply and supporting anadromous fish.	Moderately effective in improving water supply and water supply reliability. Provides great improvement in Delta water quality. Has an overall low benefit to anadromous fish and aquatic resources in the Sacramento River, but more significant benefit to Delta habitat. Provides moderate hydropower and low recreation benefits. Provides moderate flood damage reduction and emergency flushing water supply.	Impacts are short-term and can be mitigated. Has lower annual benefits ($144M). Has moderate construction cost and negative net benefit (-$22M).	Consistent with the goals of CALFED for various programs, including water supply reliability, water quality, and ecosystem restoration.	
Relative Rank	*Moderate*	*Moderate*	*Moderate*	*Moderate*	*Moderate*
WQ1B	Addresses all objectives. Has high reliability for Delta water quality improvement and water supply and moderate reliability for supporting anadromous fish.	Highly effective in improving water supply and water supply reliability. Provides high improvement in Delta water quality. Has an overall low benefit to anadromous fish and aquatic resources in the Sacramento River, but higher benefit to Delta habitat. Provides low hydropower and recreation benefits. Provides moderate flood damage reduction and emergency flushing water supply.	Impacts are short-term and can be mitigated. Has second highest annual benefits ($183M). Has moderate construction cost and a slightly negative net benefit (-$5M).	Consistent with the goals of CALFED for various programs, including water supply reliability, water quality, and ecosystem restoration.	
Relative Rank	*High*	*High*	*Moderate*	*Moderate*	*Moderate to High*

Note:
[1] The feasibility report will consider combining features from the initial alternatives to enhance completeness and improve net benefits. Particular emphasis will be placed on combining alternatives (e.g., WS1B and AF1A) to maximize benefits to both water supply and the survivability of anadromous fish and other aquatic species.

Key:
CALFED = CALFED Bay-Delta Program
M = million
O&M = operation and maintenance

Alternative WQ1B has costs that are only slightly greater than benefits. It merits additional investigation to better define the design, costs, and benefits. This would include additional characterization of ecosystem benefits to the Delta and water quality benefits to agriculture south of the Delta.

Alternative WS1A is ranked third among the alternative plans when comparing benefits to costs. It has the third highest benefit to cost ratio. This plan's benefit to cost ratio could change substantially if the reservoir size were optimized. This alternative is also the least expensive of the alternatives considered. Because it lacks the Delevan Pipeline, it is very distinct from the other alternatives and can provide a broader basis of alternative comparison in subsequent phases of the feasibility study.

As a result of these factors, this preliminary evaluation ranks WSFQ, WQ1B, and WS1A the highest. These action alternatives and the No Action Alternative provide a reasonable array of alternative plans for further refinement and detailed analysis in the feasibility report and EIS/EIR, to meet the requirements of the P&G (WRC, 1983), NEPA, CEQA, and other pertinent Federal, State of California, and local laws, regulations, and policies.

Future evaluations may include the optimization of any of the alternatives carried forward from the PFR. When all relevant analyses have been completed, a Recommended Plan will be identified in the final feasibility report and EIR/EIR.

The engineering, design, and cost estimates for the initial alternative plans in this PFR are preliminary and subject to change. This is an interim product of the ongoing feasibility study; it is not a decision document. Reclamation and DWR are continuing to refine and evaluate alternative plans and related cost estimates as part of the iterative process that will culminate in the feasibility report and EIS/EIR.

This page left blank intentionally.

Chapter 8
Planning and Implementation Considerations

This chapter identifies several considerations that will be evaluated further during the remaining stages of the feasibility study and the preparation of the feasibility report and EIS/EIR. These considerations include:

- Data, analysis, and operations uncertainties;
- Native American Tribes and cultural resources;
- Property owners' land and water rights;
- Regulatory requirements for environmental compliance; and
- Preliminary cost allocation.

Many of these considerations represent planning and potential implementation issues that the NODOS Investigation will seek to resolve through an active program of stakeholder and public participation. It is not anticipated, at this time, that the resolution of the planning issues will alter the results presented in this PFR.

A preliminary cost allocation is provided to estimate the share of financial costs for initial action alternative WSFQ (Alternative WSFQ). The estimated costs and benefits are preliminary and are subject to change during the next phase, the preparation of the feasibility report and EIS/EIR.

Data, Analysis, and Operations Uncertainties

During the development of the NODOS PFR, study team participants identified the following uncertainties that required making reasonable assumptions based on engineering and scientific judgment:

- Data uncertainties, such as Delta sustainability and climate change;
- Analysis uncertainties, such as anadromous fish population; and
- Operations uncertainties, such as future systems operations.

These uncertainties are discussed in this section and will be considered later in the NODOS Investigation.

Data Uncertainties

Delta Sustainability

Delta sustainability has received attention since Hurricane Katrina destroyed the lower-lying neighborhoods of New Orleans, Louisiana. Many of California's policymakers realize that the Sacramento-San Joaquin Delta could be subject to devastating damage and loss from an earthquake, similar to what New Orleans experienced from Hurricane Katrina. Potential threats, termed "first-order drivers of change," were described by Mount, Twiss, and Adams (2006), and these are expected to influence future resource management in the Delta. Six drivers are mentioned:

- Soil subsidence;
- Sea-level rise;
- Regional climate change and changing precipitation patterns;
- Catastrophic events (e.g., earthquakes, floods);
- Invasive species and food web changes; and
- Upstream and in-Delta urbanization and population growth.

Climate change also might increase the frequency and magnitude of winter floods and have effects on applied water rates for Delta farms, as a result of changes in evapotranspiration rates. These changes in environmental condition also can affect plant and animal species and habitats in the Delta.

Two policy-driven efforts are charged with looking at long-term management options. The Delta Vision effort was launched by the Governor in the fall of 2006. In January 2008, the Delta Vision Blue Ribbon Task Force completed a report, *Delta Vision—Our Vision for the California Delta*. This report was prepared in conjunction with a broad range of stakeholders and the independent Blue Ribbon Task Force. The Blue Ribbon Task Force is developing a strategic plan to craft a comprehensive program for implementation. However, it is fully expected that preliminary "no regrets" actions based on this report will either begin or continue.

The CALFED program is developing alternative management strategies to meet its water supply, water quality, levee and environmental goals for the Delta. This PFR does not currently address a "changed Delta," but the feasibility study report will, to the extent possible, be consistent with the policy decisions and recommendations from the Delta Vision process and the Blue Ribbon Task Force's recommendations. The NODOS Investigation team will consider and incorporate recommendations from both Delta Vision and the Blue Ribbon Task Force into its planning efforts and evaluate how this project can contribute to resolving sustainability issues.

Climate Change

Another major hydrologic uncertainty in the Primary Study Area is the potential effects of climate change on the Sierra Nevada mountain snowpack, sea level rise, and evapotranspiration in California. Climate change could cause warmer winters with less snow and more rain, resulting in more late winter and early spring runoff but less late spring and early summer runoff. Less summer moisture available for crops would increase the need for more irrigation water during the growing season, and additional water deliveries might be required to support agriculture. Climate change is also expected to raise sea levels, which would make the Bay-Delta more vulnerable to sea water intrusion, impact water quality and water deliveries, and increase the risk of levee failure and flooding.

An increase in the frequency and magnitude of winter floods would jeopardize flood control efforts by requiring changes in reservoir operation and evacuation of storage to maintain the flood control reservation pool. Increased reservoir releases would increase flows in rivers and tributaries, placing the levee systems at risk of failure and increasing the risk of flooding. Drinking water quality and water quality for the environment may be negatively impacted as upstream reservoirs make releases earlier in the water years, putting at risk the ability of reservoirs to recover storage to maintain the cold water pool. This would affect river temperatures as releases were made, particularly releases during summer months.

In 2005, the Governor established a Climate Action Team to guide the reporting required under Executive Order S-3-05, which calls for reports every 2 years on potential climate change effects in several areas, including water resources. In July 2006, DWR published a Technical Memorandum Report to fulfill the requirements of the Executive Order. The report was a joint effort by Reclamation and DWR, forming the Climate Change Work Team, to provide information to managers on the potential effects and risks of climate change on California’s water resources (DWR, 2006a).

Based on the results of the climate change scenario models presented in the memorandum report, shifts in seasonal and annual average runoff greatly affect SWP and the CVP delivery capabilities (DWR, 2006a). The report concluded that, to meet the challenges to water resources resulting from climate change, physical, regulatory, and operational flexibilities in the SWP and CVP systems will be required to maintain delivery capabilities (DWR, 2006a). The report also indicated that more runoff during winter, as a result of climate change, will increase the conflict between water supply and flood control uses of the North-of-the-Delta reservoirs (DWR, 2006a). According to the report, resolution of this conflict lies in better storm forecasting technology, allowing for earlier flood releases, or in increased storage capacity (DWR, 2006a).

Temperature models for instream temperature analysis, used in conjunction with the modeling of climate change scenarios as part of the 2006 report, indicated the annual average warming of river temperatures at several key locations

(DWR, 2006a). According to the report, more analysis is still required to fully consider climate change effects in project planning studies. This report recommends that future studies consider measures to relieve the negative impacts of climate change (DWR, 2006a).

The feasibility report and EIS/EIR will include a greenhouse gas emission analysis and a sensitivity analysis evaluating the potential effects of climate change on project impacts and benefits.

Analysis Uncertainties

Anadromous Fish Population

Anadromous fish are highly affected by changes in their surroundings, especially elevated temperatures and low flows. Trying to predict fish survival is difficult because of the many factors that influence it. The SALMOD model used to predict fish survival for this PFR contains assumptions with varying levels of uncertainty. A key uncertainty stems from SALMOD's use of the same number of returning spawners in each year of the simulation. This does not allow for population growth over time; the estimated benefits are seen only in the number of survivors in a given year.

A life-cycle model for winter-run salmon is in development to evaluate the effects (positive and negative) of Sites Reservoir operations on winter-run salmon in the feasibility report.

Operations Uncertainties

The PFR analyses and model runs performed for the No Future Action Alternative and the various NODOS action alternatives were based on assumptions of other projects that are reasonably expected to be implemented in the future. The results of the models and evaluations, as part of this PFR, will change if the assumptions regarding implemented projects change. Also, if there are changes in Delta exports resulting from the revised OCAP biological opinion to be issued in late 2008 or new ESA listings for aquatic species, expected future operations will change. These project uncertainties are explained hereafter, as are additional project uncertainties that may affect system operations, including Delta sustainability, pelagic organism decline, and climate change impacts.

Pelagic (Open Water) Organism Population Decline in the Delta

A major concern in the Delta is the health of pelagic (open water) organisms, including: Delta smelt, a species listed as threatened under the CESA and Federal ESA; threadfin shad; longfin smelt; and striped bass. Longfin smelt is a native fish that is currently listed as a species of concern under the CESA, and it has been designated as a candidate species for threatened or endangered status under the CESA. In the fall of 2004, Delta fish surveys registered sharp declines in these four pelagic species. Subsequent surveys have confirmed the trend, raising concerns that Delta smelt risk extinction, and longfin smelt risk extirpation.

A technical team is examining the causes of the pelagic organism decline. This PFR includes restoration actions designed to protect pelagic organisms, and new and/or refined operational strategies will be evaluated for inclusion in the feasibility report and EIS/EIR.

Environmental Water Account

The EWA is a component of the long-term comprehensive plan adopted in the CALFED ROD (CALFED, 2000b). The EWA was established to provide water for the protection, restoration, and recovery of fish, beyond the regulatory baseline, and to provide water supply reliability to the SWP and CVP water users. The EWA protects the fish of the Bay-Delta estuary by augmenting stream flows and Delta outflows and curtailing pumping at the Banks and Jones Pumping Plants at fish-sensitive times, such as during critical life-history stages and when too many fish are being killed at the pumps. The water is made up to the SWP and CVP contractors by acquiring alternative water supplies from willing sellers or through CVP and SWP operational changes. The acquired water is used to repay the CVP and SWP contractors whose supplies have been interrupted by actions taken to benefit fish.

In 2004, Reclamation, the Service, NOAA Fisheries Service, DWR, and DFG initiated the preparation of a Long-Term EWA EIS/EIR. The Long-Term EWA EIS/EIR focused on existing and new strategies for increasing water sources available to EWA through 2030, including shifting water sources, purchasing stored reservoir water, groundwater substitution and banking, cropland idling, conservation, recycled water, and desalination.

In 2006, the completion of the Long-Term EWA EIS/EIR was put “on hold.” The five EWA agencies agreed that completion of the Long-Term EWA Draft EIS/EIR should be postponed until multiple environmental and program-related documents, including ongoing investigations into the Delta pelagic organism decline and the Bay-Delta Conservation Plan, were completed. The EWA agencies will extend the existing EWA program until these uncertainties are resolved. This PFR includes EWA assets. Unlike the current EWA Program that relies on annual budget appropriations, NODOS would provide a fixed asset for EWA and provide a stable source of supply for environmental water.

Fish Passage Improvements at RBDD

For this PFR, the Without Project Condition/No Action Alternative assumes that the TC Canal will be capable of diverting water from the Sacramento River without the operation of the RBDD. The dam will be replaced with a state-of-the-art facility, including pumps and fish screens. For purposes of this document, “gates out” operation (for 10 months out of the year) at RBDD was assumed to supply water from the Sacramento River to Sites Reservoir via the TC Canal. This will improve fish passage along the Sacramento River with the following new features/measures:

- New Mill Site Main Pumping Plant with capacity of 1,780 to 2,080 cfs;
- New fish screen in the existing Research Pumping Plant (RPP);
- Improvements to existing headworks and fish screens for the TC Canal; and
- Installation of an additional 320 cfs pump at the RPP.

Reclamation publicly circulated the Draft RBDD Fish Passage Improvement Project EIS/EIR in October 2002 (Reclamation, 2002). In 2007, the document was recirculated for any additional comments due to the length of lapsed time since its original release in 2002 and the recent selection of a Preferred Alternative. The Final EIS/EIR is being prepared. As a result, NODOS is assuming that the new TC Canal features and measures will be constructed before NODOS, and they are considered a part of the Without Project Condition/No Action Alternative. If this project is not implemented as part of the FPIP, the NODOS Investigation would reconsider this measure for inclusion in the action alternatives.

Banks Pumping Plant Permitted Capacity

The SDIP proposed to increase the permitted limit for water diversions into Clifton Court Forebay. The SWP Banks Pumping Plant has an installed pumping capacity of 10,300 cfs. Flow diverted from the Delta into Clifton Court Forebay is limited currently, by permit, to 6,680 cfs, with two exceptions: during July through September, an additional 500 cfs is allowed for the EWA, and during winter, the San Joaquin River flow is above 1,000 cfs. Increasing the permitted limit for diversions into Clifton Court Forebay from 6,680 cfs to 8,500 cfs would provide opportunities to increase water deliveries to the SWP and CVP contractors and for environmental uses south of the Delta by improving the operational flexibility of the Banks Pumping Plant (Reclamation and DWR, 2006b). A Final EIS/EIR for the SDIP was completed in December 2006, but neither a ROD nor a NOD has been filed.

As a result, the Without Project Condition/No Action Alternative assumes that the Banks Pumping Plant pumping capacity limit will remain at 6,680 cfs. In the event that operational criteria in the future modify this pumping limit assumption, NODOS will reassess the operational strategy of potential alternatives with respect to their potential benefits and reliability for users south of the Delta.

Judge Wanger's Ruling on Delta Smelt and the Need for a 2008 OCAP Biological Opinion

On August 31, 2007, U.S. District Court Judge Wanger ruled from the bench in the Natural Resources Defense Council v. Kempthorne, to remand (but not vacate) the 2005 Fish and Wildlife Service biological opinion for Delta smelt back to the Service to prepare a new opinion (expected in late 2008). Judge Wanger also issued a prohibitory injunction against Reclamation and DWR for operating the SWP and CVP inconsistent with actions the judge had ordered based upon proposals submitted by the parties. Those actions include enhanced surveys and monitoring, operational constraints from late December 2007 through June 2008, and prohibitions on temporary barrier installation.

The judge gave the parties' time to review the official transcripts and prepare a draft final order, including findings of fact and conclusions of law. The judge asked for a joint submission but advised that he would accept competing proposals and resolve the differences. The judge reserved to Reclamation and DWR "the right on reasonable notice to deviate from the prescriptive remedies, if necessary to protect public health, safety and the human environment." During the hearing, the judge had indicated that public health, safety, and human environment concerns were not necessarily limited to the maintenance of emergency water supplies for schools, hospitals, or fire departments, but could include, depending upon the circumstances, effects related to agricultural land fallowing and/or subsidence from increased groundwater pumping necessitated by the absence of project water. On December 14, 2007, an interim remedial order was issued to provide additional protection of the federally listed Delta smelt pending completion of a new biological opinion for the continued operation of the CVP and SWP. The interim remedial order requires the Service to complete a new biological opinion. Impacts of the December 14, 2007, ruling are not modeled in this PFR. The NODOS feasibility report and EIS/EIR will be revised to reflect the new OCAP biological opinions, when they are available.

Potential Ruling on 2004 OCAP Salmon and Steelhead Biological Opinion

A hearing was held on October 3, 2007, in Judge Wanger's court on the merits of a companion lawsuit—Pacific Coast Federation of Fishermen's Associations v. Gutierrez—challenging the 2004 OCAP salmon and steelhead biological opinion issued by the NOAA Fisheries Service. Plaintiffs allege similar types of deficiencies with this biological opinion as with the 2005 Fish and Wildlife Service biological opinion for Delta smelt, with particular emphasis on alleged adverse impacts to species and habitat caused by changes to cold-water temperature management (i.e., elimination of Shasta carryover storage requirement and movement of temperature compliance point on the Sacramento River).

The judge had ruled earlier in this case that, contrary to plaintiff's allegations, the OCAP biological opinion was not a "final agency action" by Reclamation, and therefore did not trigger the need to prepare an EIS under NEPA. A final

Federal court order was issued April 16, 2008, stating that it was not within the Court's prerogative or competence to determine whether CVP operations will or will not jeopardize the winter- and spring-run Chinook salmon or steelhead or their habitat, but these determinations are the responsibility of the NOAA Fisheries Service and Reclamation. The biological opinion was determined to be incomplete because it did not analyze the recovery of the three species, the impacts of climate change over the next 25 years, or the impacts on critical habitat. Reclamation was back in court in summer 2008, but the judge deferred a ruling. At the time of publication of this PFR, hearings are scheduled to begin September 4, 2008, to address any remedies and whether the existing biological opinion should be remanded without vacatur.

Native American Tribes and Cultural Resources

The NODOS study team has been coordinating with Native American Tribes (including the Colusa Indian Rancheria, Cortina Indian Rancheria, Grindstone Indian Rancheria, and the Paskenta Band of Nomlaki Indians) in the proposed Sites Reservoir area. The study team met regularly with Tribal representatives through March 2004, on an informal basis, to provide updates on the NODOS Investigation and to encourage input from the Tribes on issues of concern. Through the completion of the IAIR, eight coordination meetings were held with Tribal representatives; these were in addition to the Tribal scoping meeting and one field tour of the proposed Sites Reservoir, facilities locations, and cultural resource sites.

In 2004, Reclamation provided funding to the four Tribes to develop appraisal-level Tribal water resource studies to assess future water needs and availability in the context of how NODOS could benefit or affect the Tribes' water resources. The studies were not intended to be an analysis of Tribal water rights claims; instead, they were intended to appraise future water needs and availability and whether NODOS could impair or enhance that water availability.

As the NODOS Investigation proceeds, coordination with the Tribes will continue, and briefings will be provided whenever milestones are reached. Formal Section 106 consultation will be initiated when a preferred alternative is identified and the area of potential effects is determined.

The NODOS Investigation feasibility report and EIS/EIR will be in compliance with the NHPA, Section 106, and will include a description of supporting analyses, coordination, studies, mitigations, and impacts.

Property Owners' Land and Water Rights

Lands in the proposed area of the Sites Reservoir would be inundated. Consequently, assessments have been initiated to determine the extent of impacts to lands and structures and potential mitigations. Reclamation and DWR staff have had numerous meetings with the landowners to brief them on the proposed project features and the status of the investigation. These meetings allow landowners opportunities to voice concerns. The landowner meetings will continue as the investigation proceeds and when milestones are reached.

Should a NODOS project be authorized, private property acquisitions in the affected area will adhere to the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 and the Uniform Relocation Act Amendments of 1987. The acts aim for fair and equitable treatment of persons displaced by a project so that they do not suffer disproportionately as a result of a program designed to benefit the public.

If the NODOS project is authorized for implementation, it would be subject to the laws, policies, and regulations of the SWRCB. Reclamation and DWR would be required to obtain new water rights or to amend its existing water right permits from the SWRCB for diverting water from the surface water sources and for storing water in the proposed reservoir before project construction could be initiated. In addition, the NODOS project would be required to identify, analyze and develop mitigation measures for any negative impacts on the existing water right holders, in their ability to divert water from the surface water sources, that might result from the implementation of the project. Such analysis would be conducted in compliance with SWRCB laws, policies, and regulations. Also, the NODOS project would result in higher flow in the Sacramento River at different times of the year, from water releases from the proposed reservoir. Reclamation and DWR would seek appropriate provisions from the SWRCB to ensure that such additional flows in the river from the water releases from the proposed reservoir are protected from diversions by the water right holders downstream from the project, to ensure such water reaches the Delta and achieves its intended purposes.

Regulatory Requirements for Environmental Compliance

Reclamation is the Lead Agency for NEPA compliance. All products of the NODOS Investigation will be compliant with CEQA under the guidance of DWR, California's Lead Agency. Reclamation and DWR will be required to obtain various permits and regulatory approvals and to comply with several environmental and historic preservation laws before initiating any project construction.

Regulatory requirements that may affect the implementation of a NODOS project include the following:

- Corps – CWA Section 404 Individual Permit; Rivers and Harbors Act, Section 10 Permit
- Service/NOAA Fisheries Service – Federal ESA, Section 7 consultation
- Service/ NOAA Fisheries Service/DFG – Fish and Wildlife Coordination Act Report
- State Historic Preservation Office/Advisory Council on Historic Preservation (SHPO/ACHP) – NHPA, Section 106
- RWQCB – CWA Section 401 Water Quality Certification
- RWQCB and SWRCB – Water rights and NPDES permit
- DFG – CESA Section 2081(b): Incidental Take Permit or 2080.1 Consistency Determination
- DFG – Fish and Game Code Section 1602 Streambed Alteration Agreement

A summary of these major permits is provided in table 8-1. The alternative plans considered in the PFR may be subject to other regulatory conditions that may affect the development of the alternatives. These additional laws, policies, and plans are provided in table 8-2.

Table 8-1. Summary of Regulatory Requirements that Might Affect Project Implementation

Agency and Associated Permit or Approval	Recommended Prerequisites for Submittal	Estimated Review Time
	Federal	
Corps CWA Section 404 Individual Permit Rivers and Harbors Act Section 10 Permit	• Application • ASIP for submittal to NOAA Fisheries Service/DFG • Section 401 Water Quality Certification permit or application • NEPA documentation (environmental compliance documents) • Section 106 compliance documentation • 404(b)(1) Wetland delineation • Alternatives analysis • Mitigation and monitoring plan	24 months
Service/NOAA Fisheries Service Federal ESA Section 7 Consultation	• Regular informal technical consultation • ASIP • Draft environmental compliance document	12 months
Service/NOAA Fisheries Service/DFG Fish and Wildlife Coordination Act Report	• Regular informal technical consultation • ASIP • Draft environmental compliance document	12 months

Table 8-1. Continued

Agency and Associated Permit or Approval	Recommended Prerequisites for Submittal	Estimated Review Time
	Federal (cont'd)	
SHPO/ACHP NHPA, Section 106	• Cultural Survey Report • Documentation of consultation with Native American representatives	9 months
	California	
RWQCB CWA Section 401 Water Quality Certification	• Application • Fish and Game Code Section 1602 Application • CWA Section 404 permit or application • Draft environmental compliance documents • Mitigation and monitoring plan (if needed)	6 months
RWQCB/SWRCB Water rights (petition for diversion) and NPDES discharge	• Application • NEPA documentation	12 months
DFG CESA Section 2081(B): Incidental Take Permit and/or 2080.1 Consistency Determination	• Informal technical consultation • Application, if requesting a 2081 Incidental Take Permit • Biological opinion and incidental take statement, if requesting a consistency determination (preferred approach)	6 months after biological opinion issued
DFG Fish and Game Code Section 1602 Streambed Alteration Agreement	• Application • Section 401 Water Quality Certification permit or application • CWA Section 404 permit or application • Draft environmental compliance documents • Mitigation plan	9 months

Key:

ACHP = Advisory Council on Historic Preservation
ASIP = Action Specific Implementation Plan
DFG = California Department of Fish and Game
CESA = California Endangered Species Act
CWA = Clean Water Act
ESA = Endangered Species Act
NEPA = National Environmental Policy Act
NHPA = National Historic Preservation Act
NOAA = National Oceanic and Atmospheric Association
NPDES = National Pollutant Discharge Elimination System
RWQCB = Regional Water Quality Control Board
SHPO = State Historic Preservation Office
SWRCB = State Water Resources Control Board

Table 8-2. Summary of Applicable Laws, Policies, and Regulations that Might Affect the Project

Level	Laws, Policies, and Regulations
Federal	Federal Endangered Species Act
	Section 404 of the Clean Water Act
	Rivers and Harbors Act Section 10
	National Historic Preservation Act, Section 106
	Migratory Bird Treaty Act
	Fish and Wildlife Coordination Act
	Executive Order 11990 (Wetlands Policy)

Table 8-2. Continued

Level	Laws, Policies, and Regulations
Federal (cont'd)	Executive Order 11988 (Flood Hazard Policy)
	Executive Order 12898 (Environmental Justice Policy)
	Indian Trust Assets
	Farmland Protection Policy
	Federal Transit Administration
	Essential Fish Habitat
	Executive Order 11312 (National Invasive Species Management Plan)
	National Wild and Scenic Rivers System
	Federal Land Use Policies
	Federal Energy Regulatory Commission
	U.S. Coast Guard
California	Clean Water Act Section 401
	California Endangered Species Act
	California Fish and Game Code – Fully Protected Species
	California Fish and Game Code Section 1602 – Streambed Alteration
	Porter-Cologne Water Quality Control Act
	California Native Plant Society Species Designations
	Reclamation Board Encroachment Permit
	California Water Rights
	State Lands Commission Land Use Leases
	State of California General Plan Guidelines
	California Department of Transportation
	California Land Conservation Act of 1965 (Williamson Act)
	California Native Plant Protection Act
	California Department of Boating
	California Scenic Highway Program
	California Wild and Scenic Rivers Act
Local	County Air Quality Management District Authority to Construct and Permit to Operate
	County Zone Plan
	County Department of Public Works Encroachment Permit
	County General Plan
	Other Local Permits and Requirements

Note:
"County" refers to Glenn, Colusa, and Tehama Counties.
Key:
U.S. = United States

Preliminary Cost Allocation Considerations

Cost allocation is the process of apportioning the total project financial costs and repayment responsibilities among the purposes served by the plan. This section provides a preliminary example of the allocation of costs, using Alternative WSFQ as an example. It is recognized that these assumptions, responsibilities, and cost estimates are preliminary and subject to change during the completion of the feasibility report.

Basic steps associated with cost allocation include the following.

- Identifying costs to be allocated; and
- Allocating costs to project purposes.

Costs to be allocated in this exercise are construction costs, IDC, engineering and planning costs, construction supervision costs, land costs, mitigation costs, O&M costs, and net power costs. It should be noted that cost allocation is a financial exercise rather than an economic evaluation. Consequently, project costs presented in the cost allocation may differ slightly from the costs presented in the economic analysis.

Once all project costs have been identified, they are allocated to project purposes. The federally preferred method of cost allocation, Separable Cost – Remaining Benefits (SCRB) is used (WRC, 1983). Costs allocated to each purpose are the sum of the separable cost for that purpose and a share of the joint costs. Separable costs are costs that are required because a purpose is included in a multipurpose project. Joint costs are the project costs remaining after subtracting the sum of the separable costs. Under the principles of the SCRB, joint costs are allocated among purposes in proportion to their remaining justifiable costs after the separable cost of each purpose is subtracted from its justifiable costs. Justifiable costs are the lesser of the benefits provided by a specific purpose or the least-cost alternative method of obtaining the same physical benefit.

The cost allocation process is designed so that costs associated with project purposes can be apportioned to beneficiaries for repayment. Once costs are allocated to appropriate purposes, they can be apportioned to the Federal government and non-Federal sponsor(s) based on specific project authorization and/or established Federal cost-sharing laws and regulations. Federal costs are designated as either reimbursable or non-reimbursable. Reimbursable costs are those that, through some form of initial cost sharing, repayment, or other financial agreement, are repaid to the government. Non-reimbursable costs are those borne entirely by the Federal government. Based on existing legislation, costs allocated to irrigation and M&I water supply, fish and wildlife mitigation, flood-damage reduction and emergency water, and hydropower purposes are either fully or partly reimbursable by project beneficiaries. Existing legislation that provides cost-sharing relationships for purposes that may be included in NODOS is summarized in table 8-3.

Table 8-3. Existing Authorities for Federal Financial Participation in Multipurpose Water Resources Projects

Purpose	Pertinent Legislation	Description
Water Supply (Irrigation)	Reclamation Project Act of 1939	Reimbursable. Costs allocated to irrigation are repaid by users to the extent they are able to repay. Those costs users are unable to repay are paid by CVP power contractors and are collected by the Western Area Power Administration.

Table 8-3. Continued

Purpose	Pertinent Legislation	Description
Water Supply (M&I)	Reclamation Project Act of 1939, as amended	Reimbursable. It provides for allocating cost to CVP M&I water contractors (including IDC and interest on investment).
Water Quality	Federal Water Pollution Control Act Amendment of 1961 (Public Law 87-88) Federal Water Pollution Control Act (Clean Water Act of 1972, as amended)	Stipulated Federal agencies consider storage to regulate stream flow for water quality purposes when planning for any reservoir. Water quality area-wide benefits are not reimbursable.
Hydropower	Reclamation Project Act of 1939	Reimbursable. Similar to M&I water supply. Repayment is discussed in Section 9(c) of the Act
Fish and Wildlife Enhancement	Federal Water Project Recreation Act (PL 89-72)	Act provided Reclamation authority to do fish and wildlife mitigation and enhancement. Mitigation is reimbursable; enhancement is nonreimbursable
Flood Control	Reclamation Project Act of 1939.	Nonreimbursable, unless directly appropriated or allocated to the Department of the Interior. Discussed in Section 9(c) of the Act
Recreation	Federal Water Project Recreation Act of 1965 (Public Law 89-72), as amended by the Reclamation Recreation Management Act (Public Law 102-575, Title XXVIII)	Outdoor recreation is also allowed with non-Federal costs of 50% for separable capital costs and 100% for O&M.

Key:
CVP = Central Valley Project
IDC = interest during construction
M&I = municipal and industrial
O&M = operation and maintenance

Preliminary Cost Allocation for Alternative WSFQ

The preliminary cost allocation for WSFQ, using the SCRB method, is summarized in table 8-4. Table 8-5 shows a preliminary estimate of the allocation of costs for WSFQ. As shown, the allocation of costs includes costs to accomplish the three primary planning objectives.

The key assumptions used for this SCRB analysis include the following.

1. Ecosystem Restoration justifiable expenditures and Water Quality justifiable expenditures are each assumed to be equal to their separable costs. These benefit levels are the minimum required to justify the inclusion of these purposes in the project.
2. Water Supply benefits are those estimated in the PFR. Improvements to CalSim II and Least Cost Planning Simulation Model (LCPSIM) will change these benefit levels in the feasibility level studies.

Table 8-4. Alternative WSFQ Separable Cost Determination by Objective (All Costs Updated to Present Values [2007 USD])

Total Storage Capacity of Sites Reservoir (TAF)	1800									
Sites Reservoir Base Construction Cost w/out IDC, O&M and Power	$3,036,000,000									
Sites Reservoir Base Capital Cost w/out O&M and Power	$3,624,000,000		Base Case without Objective 1		Base Case without Objective 2		Base Case without Objective 3		Base Case without Objective 4	
Sites Reservoir Total Cost	$3,830,000,000		Water Supply Reliability (Local, SWP, CVP, Level 4, and EWA)		Water Quality (Drinking and environmental)		Ecosystem Restoration (Fish Passage, Cold Water Pool at Shasta, Timing of Diversion, Stabilize Fall Flows, Modify Spring Flows)		Reservoir Recreation	
Total Yield of Sites Reservoir (TAF)										
Long-Term Average	622									
Driest Periods Average	523									
All costs have been updated to present values (2006 USD)	Base Case Sites Reservoir									
Storage Allocated to Purpose (TAF)			778		457		415		No Storage Allocation	
New Storage Capacity with excluded purpose (TAF)			1022		1343		1385		1800	
Annual Yield or Releases (TAF/year)										
Long-Term Average			276		170		176		-	
Driest Periods Average			258		192		73		-	
New Annual Yield or Releases with Excluded Purpose (TAF/year)										
Long-Term Average			346		452		446		-	
Driest Periods Average			364		430		549		-	
Facilities	Size	Cost ($ million)	Size	Cost ($ million)	Size	Cost ($ million)	Size	Cost ($ million)	Size	Cost ($ million)
Sites Dam	1.80 MAF	75.7	1.02 MAF	45.2	1.34 MAF	57.3	1.39 MAF	59.1	1.80 MAF	75.7
Golden Gate Dam	1.80 MAF	210.5	1.02 MAF	111.6	1.34 MAF	139.3	1.39 MAF	144.1	1.80 MAF	210.5
9 Saddle Dams	1.80 MAF	144.4	1.02 MAF	10.4	1.34 MAF	45.8	1.39 MAF	52.9	1.80 MAF	144.4
Reservoir Clearing	1.80 MAF	1.4	1.02 MAF	0.8	1.34 MAF	1.1	1.39 MAF	1.1	1.80 MAF	1.4
Sites Pumping/Generating Plant	6000 cfs	299.5	3407 cfs	211.4	4477 cfs	247.6	4617 cfs	252.3	6000 cfs	299.5
Funks Reservoir Modification	6000 cfs	70.8	3407 cfs	25.7	4477 cfs	44.3	4617 cfs	46.7	6000 cfs	70.8
Funks Reservoir Bypass (fixed cost)		11.7		11.7		11.7		11.7		11.7
Delevan Pipeline and Sacramento River Pumping/Generating Station	2000 cfs	421.4	1136 cfs	332.4	1492 cfs	369.1	1539 cfs	373.9	2000 cfs	421.4
Long Tunnel and Multi-Level Inlet/Outlet (fixed cost)	6000 cfs	112.4	6000 cfs	112.4	6000 cfs	112.4	6000 cfs	112.4	6000 cfs	112.4
Southern Bridge Route and Roads (fixed cost)		192.3		192.3		192.3		192.3		192.3
Recreational Facility (fixed cost)		5.9		5.9		5.9		5.9		0.0
TC Canal Modifications (fixed cost)	2100 cfs	0.0	2100 cfs	0.0	2100 cfs	0.0	2100 cfs	0.0	2100 cfs	0.0
GCID Canal Modifications (fixed cost)	1800 cfs	37.1	1800 cfs	37.1	1800 cfs	37.1	1800 cfs	37.1	1800 cfs	37.1
TRR Pumping Station & Pipeline (fixed cost)		141.4		141.4		141.4		141.4		141.4
New Electrical Transmission		22.9		22.9		22.9		22.9		22.9
Environmental Enhancement (fixed cost)	- -	8.8	- -	8.8	- -	8.8	- -	8.8	- -	8.8
Land Acquisition and Right of Way (fixed cost)	- -	84.0	- -	84.0	- -	84.0	- -	84.0	- -	84.0
Subtotal Contract Costs ($ millions)		1840.2		1353.9		1520.7		1546.5		1834.3
Mitigation (10%)		184.0		135.4		152.1		154.6		183.4
Total Contract Costs (includes 10% unlisted items)		2024.2		1489.3		1672.8		1701.1		2017.8
Scope/Market Conditions Contingency (20%)		404.8		297.9		334.6		340.2		403.6
Total Field Costs		2429.1		1787.1		2007.4		2041.3		2421.3
Non-Contract Costs (25%)	1.80 MAF	607.3	1.02 MAF	446.8	1.34 MAF	501.8	1.39 MAF	510.3	1.80 MAF	605.3
Total Construction Costs		3036.4		2233.9		2509.2		2551.7		3026.6
Interest During Construction ($ millions)	1.80 MAF	588.0	1.02 MAF	432.3	1.34 MAF	486.0	1.39 MAF	494.0	1.80 MAF	586.0

Table 8-4. Continued

Facilities	Size	Cost ($ million)	Size	Cost ($ million)	Size	Cost ($ million)	Size	Cost ($ million)	Size	Cost ($ million)
Total Capital Costs		*3624.4*		*2666.2*		*2995.2*		*3045.7*		*3612.6*
Present Worth of Operations and Maintenance	1.80 MAF	205.4	1.02 MAF	116.6	1.34 MAF	153.3	1.39 MAF	158.0	1.80 MAF	205.4
Total Project Costs ($ millions)		3829.8		2782.8		3148.5		3203.7		3818.0

Note:
[1] Costs presented in this PFR are preliminary and subject to revision and refinement in the feasibility report.

Key:
cfs = cubic feet per second
CVP = Central Valley Project
EWA = Environmental Water Account
GCID = Glenn-Colusa Irrigation District
IDC = interest during construction
MAF = million acre-feet
O&M = operations and maintenance
SWP = State Water Project
TAF = thousand acre-feet
TC = Tehama-Colusa
TRR = terminal regulating reservoir
USD = U.S. dollars

Table 8-5. Preliminary Cost Allocation Summary for Alternative WSFQ ($Million Net Present Value)

Category	Purpose				
	Water Supply	Water Quality	Ecosystem Restoration	Reservoir Recreation[1]	Totals
Benefits for Each Purpose	$2,452.2	$458.1	$1,141.0	$317.7	$4,369
Separable Costs	$1,047.0	$681.3	$626.0	$11.7	$2,366
Remaining Benefits (Benefits Less Separable Costs)	$1,405.2	$0.0	$514.9	$0.0	$1,920.2
Percent (Distribution of Remaining Benefits)	73.2%	0.0%	26.8%	0.0%	100.0%
Allocated Joint Costs	$1,071.2	$0.0	$392.5	$0.0	$1,463.7
Total Allocated Costs (Separable Costs Plus Allocated Joint Costs)	$2,281.5	$458.1	$1,078.4	$11.7	$3,829.8
Overall Percent Cost Allocation	59.6%	12.0%	28.2%	0.3%	100%

Note:
[1] For Federal projects, the maximum cost allocated to recreation is equal to its separable costs.

This page left blank intentionally.

Chapter 9
Findings and Future Actions

This chapter summarizes the major findings, to date, from the NODOS Investigation and describes key future actions. Historic and future public and stakeholder outreach activities also are summarized.

Findings

This PFR finds that there is a potential Federal and State of California interest in a NODOS project to meet objectives associated with the M&I, agricultural, and environmental water supply reliability; anadromous fish survival; power; incremental flood control storage; and recreation. The degree and magnitude of the Federal and State of California interest in a NODOS project will be confirmed and quantified in the next stage of the feasibility report, EIS/EIR, and supporting documentation.

Alternatives to be analyzed further include the following.

- **No Action Alternative/No Action Project (Federal/California):** The Federal and California governments would take no additional action to implement new offstream water storage in the Sacramento River basin north of the Delta to address water supply reliability problems and needs in the Central Valley of California, help increase anadromous fish survival in the Sacramento River, improve water quality in the Delta, or increase hydropower generation, recreation opportunities, or flood control through storage north of the Delta.
- **Initial Action Alternative Plan WS1A (Alternative WS1A):** This plan would include the construction of Sites Reservoir and the use of the existing TC Canal and GCID Canal to fill and empty the reservoir. Operations would be integrated with those of Lake Shasta to benefit water quality and anadromous fish and other aquatic species. Operations would be prioritized to maximize water supply reliability benefits.
- **Initial Action Alternative Plan WSFQ (Alternative WSFQ):** This plan would augment Sites Reservoir with the Delevan Pipeline to provide for a new 2,000-cfs diversion and 1,500-cfs release capacity. It would include habitat enhancements to benefit anadromous fish and other aquatic species. Operations would be prioritized to maximize the contribution to ecosystem restoration program benefits.

- **Initial Action Alternative Plan WQ1B (Alternative WQ1B):** This plan would augment Sites Reservoir with the Delevan Pipeline to provide for a new 2,000-cfs diversion and 1,500-cfs release. Operations would be prioritized to maximize water quality improvements.

Findings to date from the NODOS Investigation include the following.

- Each initial action alternative plan addresses the primary and secondary planning objectives.
- The initial analysis of net benefits determined that Alternative WSFQ would be economically feasible. Alternative WSFQ has the highest net benefits; however, Alternative WS1A has the lowest cost, and Alternative WQ1B provides additional water quality benefits that are of interest to local stakeholders. Therefore, all three, or optimizations of these three, will be considered further.
- Each of the initial action alternative plans would contribute directly to the CALFED objectives for water. Increased releases to the Sacramento River during dry periods would improve water quality consistent with the CALFED objective. Each action alternative includes ecosystem restoration components consistent with CALFED. Another CALFED objective, improving the Sacramento-San Joaquin River Delta levee system integrity, would receive indirect benefit from the additional flood storage provided in the flood protection system.
- At this time, environmental impacts are estimated to be generally comparable between the initial action alternatives; almost all are potentially mitigable. It is estimated that, in future studies, some impacts may be found to remain considerable and unavoidable, despite mitigation measures.
- Engineering design and cost estimates for the initial action alternative plans in this PFR are preliminary and subject to change. This PFR is an interim product of the ongoing feasibility study; it is not a decision document. Reclamation and DWR are continuing to refine and evaluate alternative plans and related cost estimates as part of an iterative planning process that will culminate in a recommended plan in a feasibility report and EIS/EIR. This document may be used as a basis for discussions among potential project sponsors and concerned stakeholders. It is recognized that details and costs may change in subsequent documents and when they are considered at higher agency review levels and/or approved by executive and legislative decision makers responsible for authorization of a NODOS project.

Future Actions

The feasibility report, EIS/EIR, and supporting documentation will develop the initial action alternative plans in greater detail and refine costs, estimate benefits, evaluate environmental impacts, and identify a recommended plan for implementation. Consideration among Reclamation, DWR, the CALFED Bay-Delta Authority, and other appropriate stakeholders will continue to further define the issues and solicit support during the ongoing feasibility study, feasibility report, EIS/EIR, and supporting documentation.

Several key future actions have been identified as part of the remaining phases of the NODOS Investigation, including refining and evaluating the alternative plans, identifying a recommended plan, preparing a schedule, and continuing to obtain the involvement of California and local agencies. These actions are summarized in the following sections.

Future Feasibility Study Stages and Activities

The next major steps in the NODOS Investigation will be to refine and evaluate alternative plans for further consideration in the draft and final feasibility report and EIS/EIR. As the feasibility study process continues, the alternatives will become more defined and be optimized. Other important future actions include the following.

- Coordinating among Reclamation, DWR, the CALFED Bay-Delta Authority, and other appropriate stakeholders to better define the issues and solicit their support;
- Completing engineering, economic, and environmental studies to support the NEPA/CEQA process and agency coordination and consultation;
- Identifying the potential effects (beneficial and adverse) and mitigation features of the alternative plans;
- Refining designs, costs, and benefits for the alternative plans, optimizing reservoir size, performing cost allocation studies, and defining the selection and rationale for a recommended plan;
- Completing the environmental compliance and financial requirements for Federal and non-Federal project sponsors; and
- Preparing and publishing a draft and final feasibility report and EIS/EIR for public review and decision making by the California Legislature and U.S. Congress.

Schedule

Figure 9-1 identifies future milestones for the NODOS Investigation. A draft feasibility report and EIS/EIR is currently scheduled for Washington-level review in early 2009. This release date is shown on the schedule of major actions required to complete the feasibility study, along with future milestones leading to project implementation, on figures 9-1 and 9-2, respectively. The final feasibility report is scheduled to be provided for Washington-level review through Reclamation in January of 2010. If congressional authorization occurs in 2011, detailed project designs might be initiated in that year. Real estate acquisitions and project construction might be initiated as early as 2014. The initial phase of construction would include acquiring real estate interests, continuing detailed design work, acquiring necessary permits, and performing minor relocations.

State of California Study Involvement

DWR has been California's Lead Agency in the planning and feasibility study development. As a potential partner in this project, California must determine its interest by actively participating in the development of project objectives, alternatives, and associated technical, environmental, and economic analyses. California must determine the degree to which the study objectives of ecosystem restoration (consistent with the CALFED ecosystem restoration objectives), water quality improvement, climate change, flood control, and recreation are considered broad public benefits.

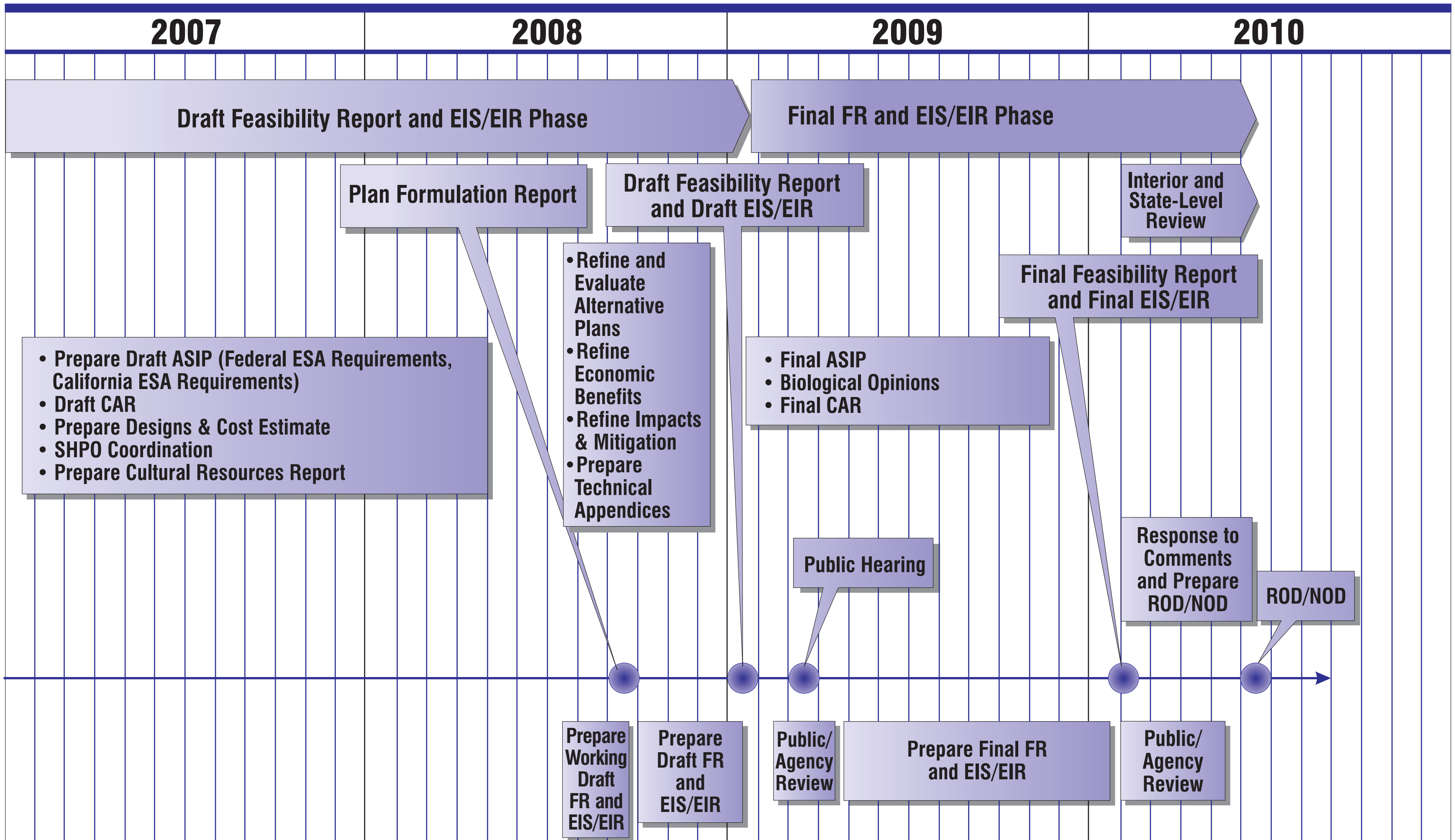
In addition, California will continue to actively coordinate with potential local partners to balance the appropriate mix of Federal, California, and local project participation. It is the responsibility of California and Federal agencies to identify potential local partners and to provide them with data and analyses that will assist them in making an informed decision in regard to becoming a project sponsor. In the future, California also will have to work actively with local partners to refine alternatives and develop cost-sharing agreements and finance plans.

Proposition 84

Proposition 84 provides funds for natural resource and environmental protection programs in California. It authorizes $5.39 billion in general obligation bonds, payable from California's general fund for water-related projects. Of those funds, $1.5 billion are allocated for safe drinking water, water quality, and other water projects within the Sacramento-San Joaquin Delta.

Governor's Strategic Growth Plan

In 2005, the Governor and legislature initiated the first phase of a comprehensive Strategic Growth Plan (SGP) to address California's critical infrastructure needs over the next 20 years. In November 2006, the voters approved the first installment of that 20-year vision to rebuild California. In January 2007, the Administration proposed additional funding to augment existing funding for the SGP through 2016. These new investments in water management will address



ASIP = Action Specific Implementation Plan
CAR = Fish and Wildlife Coordination Act Report
EIR = Environmental Impact Report
EIS = Environmental Impact Statement
ESA = Endangered Species Act
FR = Feasibility Report
NOD = Notice of Determination
ROD = Record of Decision
SHPO = State Historic Preservation Officer

Note: *All of the milestones show when documents are assumed to be sent for Washington-level review by the Commissioner of the Bureau of Reclamation, Secretary of the Interior, and Office of Management and Budget (OMB) before they may be returned for revision or approved for public release.*

Figure 9-1. Estimated NODOS Investigation Schedule

This page left blank intentionally.

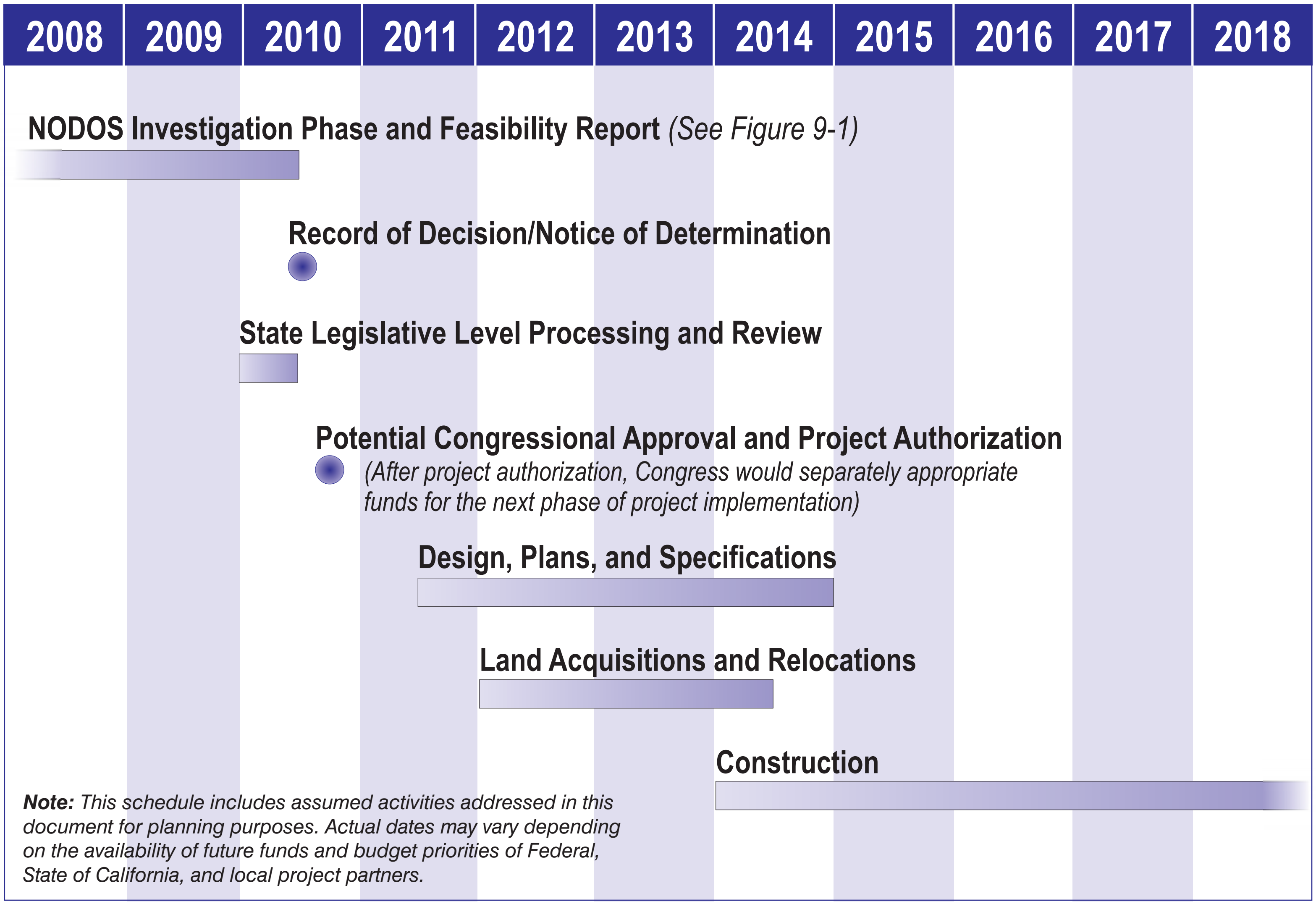


Figure 9-2. Estimated NODOS Project Implementation Schedule

This page left blank intentionally.

population growth, climate change, and environmental needs (DWR, 2007). The new proposal includes funding for the construction of new water storage in California. The legislature continues to develop a comprehensive water bond package that includes funding for the public benefits portion of the surface storage projects studied by both DWR and Reclamation.

Study Management and Public Involvement

This section describes the public and agency involvement and stakeholder outreach conducted as part of the NODOS Investigation and discusses plans for future public and stakeholder involvement. A feasibility study requires the acquisition of primary data and the participation of public agencies and entities and the general public in the development of a recommended plan.

DWR and Reclamation have briefed local entities and held public workshops throughout the course of the NODOS Investigation. Following adoption of the CALFED ROD, scoping was initiated for the NODOS EIS/EIR. The scoping process was used to help identify the range of actions, alternatives, mitigation measures, and potential effects to be analyzed in depth in the environmental documentation.

The first of two CALFED ROD milestones directed Reclamation and DWR to enter an MOU with local water interests and to develop a joint planning program. Beginning in November 2000, 12 local, 2 California, and 3 Federal entities signed an MOU and began meeting to provide local, California, and Federal input into NODOS planning. MOU signatories are shown in table 9-1.

Table 9-1. NODOS MOU Signatory Parties

California Department of Fish and Game	Provident Irrigation District
California Department of Water Resources	Reclamation District Number 108
Colusa Drain Mutual Water Company	Sutter Mutual Water Company
County of Colusa	Tehama-Colusa Canal Authority
Glenn-Colusa Irrigation District	The Service
Maxwell Irrigation District	U. S. Bureau of Reclamation, Mid-Pacific Region
Natomas Mutual Water Company	Western Area Power Administration
Orland Unit Water User’s Association	Yolo County Flood Control and Water Conservation District
Princeton Cordora Glenn Irrigation District	

Key:
MOU = memorandum of understanding
NODOS = North-of-the-Delta Offstream Storage
U.S. = United States

Scoping

On November 5, 2001, the NOP was filed with the State Clearinghouse, and on November 9, 2001, the Federal NOI was published in the *Federal Register*. The NOI and NOP notified the public of the proposal, announced the dates and locations of public meetings, and solicited public comments to help guide development of the pending EIS/EIR, pursuant to NEPA and CEQA. Public notification also was made through direct mailings to local landowners near the Sites and Newville Reservoir locations and by advertisements in four local newspapers, prior to the public meetings. In addition, a news release was placed on the DWR Web site homepage. The formal scoping process for the NODOS Investigation began with the publication of the NOI and NOP and concluded on February 8, 2002. During the 2001–2002 scoping period, one Tribal and three public scoping meetings were held.

The study team received 57 comments that addressed program alternatives. Some comments were specific suggestions related to the types or range of alternatives, such as water-use efficiency, conjunctive use, land fallowing, wastewater reclamation and recycling, and Shasta reservoir enlargement, which should be considered in the environmental documents. Others discussed more generally what alternatives should or should not be developed, or what some of the possible benefits or impacts might be for certain alternatives. A complete summary of the comments received during the scoping period can be found in the *North-of-the-Delta Offstream Storage Investigation Scoping Report* (Reclamation and DWR, 2002).

In addition to the comments received by the NODOS study team, there was additional involvement with interagency organizations (California and Federal), a technical advisory group (TAG), stakeholders, a technical workgroup, Native American Tribes, the Bay-Delta public advisory committee, and landowners.

Interagency Coordination and Involvement

An interagency team consisting of technical staff members from Reclamation, DWR, DFG, NOAA Fisheries Service, and the Service was formed in May 2002. The team’s purposes were to review the completed biological field surveys for Sites Reservoir and to discuss the following issues: the scope and level of analysis for Federal ESA and CESA compliance; how to deal with changes in species survey protocols for a long-term planning effort; a strategy for evaluating downstream impacts; and mitigation planning. The interagency team will continue to meet as the investigation proceeds.

Sacramento River Flow Regime Technical Advisory Group

At the request of the NODOS project management team, the Sacramento River TAG was formed in 2002. The TAG held meetings regularly from 2002 through 2004. The TAG was asked to consider the flow regime of the upper Sacramento River. Specifically, the TAG was asked to help identify potential NODOS flow regime impacts and benefits and to improve the overall understanding of the flow regime of the Sacramento River and related ecosystem processes. The TAG consisted of the NODOS study team, technical staff members from other California and Federal agencies, technical staff members from various environmental interest groups, and university researchers. With input from the TAG, the NODOS study team prepared the administrative draft *Sacramento River Flow Regime Status Report* (Reclamation and DWR, 2007), which is currently being revised. The report describes the historic changes in the Sacramento River flow regime and presents preliminary concepts that might improve the habitat and ecological processes of the Sacramento River, both with and without an implemented NODOS project. The report also documents the need for additional studies related to flow regime and ecosystem processes.

Stakeholders/Interested Parties Briefings

The NODOS study team provided briefings to stakeholder groups and interested parties between September 2003 and February 2004. The briefings included presentations and discussions on the NODOS planning objectives, technical studies underway, potential benefits and impacts, and the status of the NODOS Investigation. Briefings were provided to the following groups:

- Bay-Area Environmental Water Caucus;
- Chico Environmental Caucus;
- Colusa County Board of Supervisors;
- Glenn County Board of Supervisors;
- Sacramento River Conservation Area Forum;
- San Luis and Delta-Mendota Water Authority;
- State Water Contractors; and
- Tehama County Flood Control and Water Conservation District.

Briefings to stakeholders and interested parties will continue as the NODOS Investigation proceeds and will be presented at the time key milestones are reached.

California Bay-Delta Public Advisory Committee, Water Supply Subcommittee, Briefings

The NODOS study team has been briefing the Water Supply Subcommittee regularly on the planning and status of the NODOS Investigation, modeling tool development (Common Assumptions), and technical findings. The Water Supply Subcommittee meetings are open to the public. Reclamation and DWR staff members, staff members from other California and Federal agencies, environmental interest groups, water-user groups, and members of the public typically attend the meetings. Briefings to the Water Supply Subcommittee will continue as the investigation proceeds.

Common Assumptions Ad Hoc Stakeholder Technical Workgroup

At the request of the Water Supply Subcommittee in October 2003, an ad hoc technical stakeholder workgroup was formed to help provide informed feedback to Water Supply Subcommittee members. Feedback was to be on the Common Assumptions activities, specifically those relating to the development of the Common Assumptions "common model" package. The ad hoc workgroup consists of technical participants from environmental interest groups and water user groups. The common model package is a suite of models (hydrologic, hydraulic, hydrodynamic, water quality, temperature, and economic) that will be adapted to represent the NEPA and CEQA conditions for the NODOS and all other CALFED surface-water storage and conveyance investigations. To date, the NODOS study team and the Common Assumptions technical team have held five meetings with the ad-hoc group to provide updates and technical information on Common Assumptions activities.

Coordination with Native American Representatives

The NODOS study team has been coordinating with Native American Tribes (including the Colusa Indian Rancheria, Cortina Indian Rancheria, Grindstone Indian Rancheria, and the Paskenta Band of Nomlaki Indians) in the Sites Reservoir area. The study team met regularly with Tribal representatives through March 2004, on an informal basis, to provide updates on the NODOS Investigation progress and to encourage input from the Tribes on issues of concern. Through the completion of the IAIR (Reclamation and DWR, 2006a), eight coordination meetings, in addition to the Tribal scoping meeting and one field tour of the Sites Reservoir, facilities, and cultural resource sites, were held with Tribal representatives.

In 2004, Reclamation provided funding to the four Tribes to develop appraisal-level Tribal water resource studies to assess future water needs and availability within the context of how NODOS could benefit or impact the Tribes' water resources. The studies were not intended to be an analysis of Tribal water rights claims; instead, they were intended to appraise future water needs and availability and whether NODOS potentially impairs or enhances that water availability.

As the NODOS Investigation proceeds, coordination with the Tribes will continue, and briefings will be provided whenever key milestones are reached. Formal consultation will be initiated when a preferred alternative is identified and the Area of Potential Effects is determined.

Landowners' Meetings

Reclamation and DWR staff members have had numerous meetings with landowners in the Sites Reservoir location to brief them on the proposed project features and the status of the investigation. These meetings allow landowners opportunities to voice issues of concern. The landowners' meetings will continue as the investigation proceeds and when major milestones are reached.

Study Area Tours

DWR staff members conduct tours of the proposed Sites Reservoir location for agency staff and interested stakeholders, as needed. During each tour, DWR staff provide updates on the investigation status and technical findings. The tours provide interested parties with firsthand views of the area and the locations of proposed facilities. DWR staff members will continue to conduct tours for interested parties as the investigation proceeds.

Public and Stakeholder Outreach/Coordination

There are two components to the outreach strategy: the first addresses the needs of the PFR phase of the project; the second looks at the long-term outreach needs of the NODOS Investigation, including the feasibility report and EIS/EIR phases.

Plan Formulation Report Outreach

Outreach will include the following elements.

- Prior to release of the PFR:
  - Update the stakeholder list;
  - Review and update the project Web sites; and
  - Determine stakeholder briefing audiences and format (initially, it is estimated that there will be six stakeholder briefings).
- Following release of the PFR, conduct stakeholder briefings to:
  - Update stakeholders on the progress of the NODOS Investigation;
  - Present information contained in the PFR;
  - Request input, as appropriate, for the continued development of the investigation; and
  - Provide a schedule, including milestones and opportunities for providing input and future briefings.

Outreach to the broader general public will continue through the development of the feasibility report and EIS/EIR. The PFR will be posted to the project Web sites, and a postcard will be distributed to the mailing list announcing the availability of the final document.

Feasibility Report and EIS/EIR Outreach

The outreach strategy for the feasibility report includes public meetings at critical milestones, as well as activities needed to satisfy NEPA and CEQA requirements for public review and comment. Meeting NEPA and CEQA requirements fits well within the outreach framework already established for NODOS. Outreach will include public hearings on the Draft EIS/EIR.

In addition, public information/workshops and stakeholder briefings at critical points in the development of the investigation will be scheduled to ensure audiences are aware of study developments.

Stakeholder Engagement

As discussed, overall stakeholder engagement will be geared toward providing stakeholders with various ways to stay informed on study progress and to provide input on the NODOS Investigation. Engagement efforts will include providing outreach materials and information and soliciting stakeholder comment at critical milestones throughout the study.

All outreach efforts will focus on informing stakeholders about the project, ascertaining concerns through opportunities to comment, and demonstrating how input has been incorporated into the various stages of the study. In addition, all stakeholders and the public will be provided with access to well-planned, well-produced information pieces that clearly state the technical issues of the NODOS Investigation in a way that will be understood. To promote public participation, information will be accessible through Internet access to a project Web site, at publicly accessible community venues (public libraries), at public meetings, and by direct request to Reclamation or DWR.

A specific meeting plan for each stakeholder briefing and/or public meeting will be developed to describe the type of meeting (stakeholder briefing, open house, workshop, public hearing, etc.), deliverables that will be needed for the meeting (announcements, fact sheets, displays, presentations), and the roles and responsibilities of key participants. Meeting plans will outline the timeframe for developing, reviewing, and revising meeting materials, notifications, and presentations and will identify key time constraints for providing meeting notifications and internal information reviews.

Mailing Lists and Contact Tracking

Reclamation's VOCUS database will serve as the primary database for the mailing list. Interested parties can join the NODOS mailing list by registering at Reclamation's project Web site (http://www.usbr.gov/mp/nodos). Mailing list information will include: first and last name, address, telephone number, e-mail address, official title (if applicable), and affiliation. Additional contact points and information will be added to the database, as necessary.

Web Site Development

Both Reclamation and DWR currently maintain their respective project Web sites (Reclamation: http://www.usbr.gov/mp/nodos; DWR: http://www.storage.water.ca.gov/). Reclamation's Web site includes information on completed documents and reports and public involvement. As stated in the previous section, interested parties can join the NODOS mailing list on Reclamation's Web site. The new DWR Web site divides information on NODOS into two parts: NODOS frequently asked questions (FAQs) and a project overview. The project overview has four modules (Modules 3 and 4 will be added after the PFR is released):

- **Module 1 – Planning and Timeline:** Description of the planning process, including reports, completed and ongoing studies and documentation, analytical tools, and a planning schedule.
- **Module 2 – Facilities (Engineering):** Descriptions of all of the physical features of the NODOS project.
- **Module 3 – Operations and Benefits (Environmental):** Descriptions of operations and potential project benefits.
- **Module 4 – Construction Cost Estimates (Economic):** Pre-feasibility level construction cost estimates.

This page left blank intentionally.

References

CALFED, 2000a. CALFED Bay-Delta Program Final Environmental Impact Statement/Environmental Impact Report. July.

CALFED, 2000b. CALFED Bay-Delta Program, Programmatic Record of Decision. August.

CALFED, 2000c. *Ecosystem Restoration Program Plan.* Vol.1, Ecological Attributes of the San Francisco Bay-Delta Watershed, Final Programmatic EIR/EIS Technical Appendices. July.

CALFED, 2000d. *Ecosystem Restoration Program Plan.* Vol. II, Ecological Management Zone Vision, Final Programmatic EIR/EIS. July.

CALFED, 2000e. Initial Surface Water Storage Screening Report. August.

CALFED, 2002. CALFED Bay Delta Program's Environmental Water Account Facts and Background. Accessed at: http://calwater.ca.gov/Programs/EnvironmentalWaterAccount/FactSheet.htm

CALFED, 2003. Environmental Water Account Draft Environmental Impact Statement/Environmental Impact Report. Volume 1. July.

CALFED, 2006. CALFED Bay-Delta Program Water Use Efficiency Element, Water Use Efficiency Comprehensive Evaluation.

CALFED, Undated. EWA web site, accessed at: http://calwater.ca.gov/Programs/EnvironmentalWaterAccount/Environmental Water Account.htm

California Air Resources Board (CARB), 2004. California Air Resources Board, Northern Sacramento Valley Air Basin 2003 Air Quality Attainment Plan. March.

California Bay-Delta Authority, 2005. *Sacramento River-Chico Landing Subreach Habitat Restoration Draft EIR*. Accessed at: http://www.delta.dfg.ca.gov/erp/docs/signature/sac/draft/04.3_hydrology.pdf

California Department of Boating and Waterways, 2002. *California Boating Facilities Needs Assessment*. October.

California Department of Finance, 2004 and 2006. County Population Estimates and Components of Change by County, July 1, 2000-2005. Sacramento, California. March.

California Department of Finance, 2007. Population Projections by Race/ Ethnicity for California and its Counties, 2000–2050. July.

California Department of Fish and Game (CDFG), 1991. *Lower Yuba River Fisheries Management Plan.*

CDFG, 2000. *Central Valley Salmon and Steelhead Harvest Monitoring Project. 2000 Angler Survey*. Prepared by K. Murphy, T. Schroyer, M. Harris, and D. Massa. The Resources Agency.

CDFG, 2001. California Natural Diversity Database.

CDFG, 2002. California Wildlife Habitat Relationships Program.

CDFG, 2004. California Natural Diversity Database.

CDFG, 2007. California Natural Diversity Database.

California Department of Water Resources (DWR), 1957. DWR Bulletin 3, the California Water Plan.

DWR, 1984. *Middle Sacramento River Spawning Gravel Study*, Appendix: River Atlas. DWR Northern District, Red Bluff, CA.

DWR, 1987. Colusa Basin Flood Flow Frequency Analysis. March.

DWR, 1996a. Reconnaissance Survey – Sites Offstream Storage Project.

DWR, 1996b. Groundwater Levels in the Sacramento Valley Groundwater Basin: Glenn County, Northern District Memorandum.

DWR, 1998. *The California Water Plan*. Bulletin 160-98, Appendix 6A, Regional Water Budgets with Existing Facilities and Programs. November.

DWR, 2000. North of the Delta Offstream Storage Investigation Progress Report. July.

DWR, 2002. The Sacramento and San Joaquin River Basins Comprehensive Study Interim Report. December.

DWR, 2003a. *California's Groundwater*. Bulletin 118. Update 2003. October.

DWR, 2003b. Sacramento River Basinwide Water Management Plan. Groundwater Hydrology. January.

DWR, 2005a. California Water Plan Update 2005: A Framework for Action. December.

DWR, 2005b. The Municipal Water Quality Investigations Program Summary and Findings from Data Collected October 2001 through September 2003. July.

DWR, 2006a. Progress on Incorporating Climate Change into Management of California's Water Resources. Technical Memorandum Report, pp 4-24–4-50. July.

DWR, 2006b. Description of Department of Water Resources Compliance with State Water Resources Control Board Water Right Decision 1641, Response to Senate Bill 1155, Enacting California Water Code Section 138.10. January. Accessed at : http://baydeltaoffice.water.ca.gov/announcement/D1641_final.pdf

DWR, 2006c. North-of-the-Delta Offstream Storage Investigation Initial Alternatives Information Report, Appendix D, Biological Surveys. May.

DWR, 2006d. North-of-the-Delta Offstream Storage Investigation Initial Alternatives Information Report, Appendix G, Potential Reservoir Sites. May.

DWR, 2006e. North-of-the-Delta Offstream Storage Project EIR/EIS. Unpublished. October.

DWR, 2006f. Shasta Lake Water Resources Investigation.

DWR, 2007. *California Strategic Growth Plan – Flood Control, Water Supply, and Conveyance*. January.

California Native Plant Society (CNPS), 1994. Inventory of Rare and Endangered Vascular Plants of California. February.

California Regional Water Quality Control Board (RWQCB), 1990. *The Sacramento River Toxic Chemical Risk Assessment Profile*. May.

RWQCB, Central Valley Region, 2002a. Upper Sacramento River TMDL for Cadmium, Copper, and Zinc. April.

RWQCB, Central Valley Region, 2002b. Section 303(d) List of Water Quality Limited Segments. Approved July 2003.

CH2M HILL, 2001. Fish Passage Improvement Program Preliminary Design Report, Phase II. Vol. II.

CH2M HILL, 2002. Draft Environmental Impact Statement/Environmental Impact Report, Fish Passage Improvement Project at the Red Bluff Diversion Dam. August.

Colusa County, 1989. *Colusa County General Plan*. January.

Davis, F., P. Stine, D. Stoms, M. Borchert, and A. Hollander, 1995. Gap Analysis of the Actual Vegetation of California: 1. The Southwestern Region. *Madroño*, 42:40-7.

Davis, F., D. Stoms, A. Hollander, K. Thomas, P. Stine, D. Odion, M. Borchert, J. Thorne, M. Gray, R. Walker, K. Warner, and J. Graae, 1998. *The California Gap Analysis Project*. Final Report. University of California, Santa Barbara. Available at: http://www.biogeog.ucsb.edu/projects/gap/gap_rep.html.

Delta Vision Blue Ribbon Task Force, 2008. *Our Vision for the California Delta*, Final Report. January.

Desert Research Institute, Western Regional Climate Center, 2004. Western U.S. Climate Summaries. Accessed at: http://www.wrcc.dri.edu/ClimSum.html

Dwyer, A., 2000. *Easy Waters of California, North.* GBH Press, Windsor, CA.

EPA, 2005. Criteria Air Pollutant Information and Attainment Investigation. April.

Feather River Air Quality Management District (FRAQMD), 1998. *Indirect Source Review Guidelines.*

Fisher, A., W. Hanemann, and A. Keeler, 1991. Integrating Fishery and Water Resource Management: A Biological Model of a California Salmon Fishery. *Journal of Environmental Economics and Management*. Vol. 20, No. 3, pp. 234-261.

Glenn-Colusa Irrigation District, 2007. Glenn-Colusa Irrigation District Web site, accessed in 2007 at: http://www.gcid.net

Grover, A., 2006. Personal communication, California Department of Fish and Game.

Hickman, J. (ed.), 1993. *The Jepson Manual: Higher Plants of California*. University of California Berkeley Press.

Intergovernmental Panel on Climate Change (IPCC), 2006. *National Greenhouse Gas Inventories.* Volume 4, Agriculture, Forestry, and Land Use.

Larry Walker Associates, 1997. *Sacramento River Watershed Mercury Control Planning Project*. Prepared for the Sacramento Regional County Sanitation District.

Layton, R., 2001. Alternative Approaches for Modeling Concave Willingness to Pay Functions in Conjoint Valuation. *American Journal of Agricultural Economics*, Vol. 83(5), pp. 1314-1320.

Loomis, J., 1996. Measuring the Economic Benefits of Removing Dams and Restoring the Elwha River: Results of a Containment Valuation Survey. *Water Resources Research* 32(2), pp. 441-447.

Mount, J., R. Twiss, and R. Adams, 2006. The Role of Science in the Delta Visioning Process: A Report of the Delta Science Panel of the CALFED Science Program. Public Review Draft. July.

NOAA Fisheries Service, 2004. Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan. October. Accessed at: http://swr.nmfs.noaa.gov/sac/myweb8/biOpFiles/2004/Biological_Opinion_Long-Term-Central_Valley_Project_and_State_Water_Project_Operation_Criteria_and_Plan.pdf

NOAA Fisheries Service (National Marine Fisheries Service), 1997. *Proposed Recovery Plan for Sacramento River Winter-Run Salmon.*

NOAA, Undated. Red Bluff Municipal Airport, CA, United States Weather Station. Accessed in 2006 at: http://www.noaa.gov

Norris, R., and R. Webb, 1990. *Geology of California*. Second Edition. John Wiley and Sons. New York.

Northern California Water Association, 2006. *Sacramento Valley Integrated Regional Water Management Plan.* Public Draft. August.

Olsen, D., J. Richards, and R. Scott., 1991. Existence and Sport Values for Doubling the Size of Columbia River Basin Salmon and Steelhead Runs. River 2(1), pp. 44–56.

Pacific Fishery Management Council (PFMC), 2006a. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery, as Amended through Amendment 19. (Draft showing changes under Amendment 18 not yet approved.) Portland, Oregon.

PFMC, 2006b. Appendix A. Historic Ocean Salmon Fishery Effort and Landings.

Reclamation, 1964. West Sacramento Canal Unit Report.

Reclamation, 2004a. Evaluation of Groundwater Potential for Incremental Level 4 Refuge Water Supply. July.

Reclamation, 2004b. Long-Term Central Valley Project Operations Criteria and Plan. June.

Reclamation, 2006. Shasta Lake Water Resources Investigation, Plan Formulation Report. Administrative Draft. September.

Reclamation, 2007. Reclamation Web site accessed in 2007 at: http://www.usbr.gov/dataweb/dams

Reclamation, 2008. *Environmental Water Account Final Supplemental Environmental Impact Statement/Environmental Impact Report – to the EWA Final EIS/EIR*. March.

Reclamation, Undated. CVP Sacramento River Division Web site. Accessed in 2006 at: http://www.usbr.gov/dataweb/html/sacramento.html

Reclamation and DWR, 2002. North-of-the-Delta Offstream Storage Investigation Scoping Report. October.

Reclamation and DWR, 2003. *Management of the California State Water Project*. Bulletin 132-05. December.

Reclamation and DWR, 2006a. North-of-the-Delta Offstream Storage Investigation Final Initial Alternatives Information Report. May.

Reclamation and DWR, 2006b. *South Delta Improvements Program EIS/EIR.* Final. December.

Reclamation and DWR, 2006c. *Management of the California State Water Project*. Bulletin 132-05. December.

Reclamation and DWR, 2007. *Sacramento River Flow Regime Status Report.* Administrative Draft.

Reclamation and Tehama-Colusa Canal Authority, 2002. *Fish Passage Improvement Project at the Red Bluff Diversion Dam Draft EIS/EIR.*

Reclamation and Yuba County Water Agency (YCWA), 2007. *Draft EIS/EIR for the Proposed Lower Yuba River Accord*.

Reclamation, DWR, CDFG, USFWS, NOAA Fisheries Service, 2004. Final Environmental Impact Statement (EIS)/Environmental Impact Report (EIR) CALFED Environmental Water Account. January.

Rischbieter, D., 1999. *Sites Reservoir Alternative-Recreation Requirements and Opportunities*. Department of Water Resources Memorandum Report. July.

Rischbieter, D., and R. Elkins, 2000. CALFED Bay-Delta Program, Integrated Storage Investigations, North of the Delta Offstream Storage Investigation Progress Report. Appendix J, Recreation Requirements and Opportunities, Sites Reservoir Alternative. April.

Roach, B., and J. Loomis, 1996. *A Travel Cost Analysis of Angler Benefits by Target Species Along Four California Rivers*. Final report prepared for Jones and Stokes Associates, Sacramento, California.

Sacramento River Conservation Area Forum (SRCA), 2003. *Sacramento River Conservation Area Handbook*.

Sacramento Valley Water Management Program (SVWMP), 2001a. Sacramento Valley Water Management Settlement Agreement Short-Term Work Plan. October.

Sacramento Valley Water Management Agreement (SVWMA), 2001b. *Sacramento Valley Water Management Agreement Report.*

SVWMP, 2002. *Sacramento Valley Water Management Short-Term Settlement Agreement.* Short-Term Agreement to Guide Implementation of Short-Term Water Management Actions to Meet Local Water Supply Needs and to Make Water Available to the SWP and CVP to Assist in Meeting the Requirements of the 1995 Water Quality Control Plan and to Resolve Phase 8 Issues. December.

State of California, Department of Finance, 2004. Population Projections by Race/Ethnicity, Gender and Age for California and Its Counties, 2000-2050, Sacramento, California. May.

State of California, Department of Finance, 2006. E-5 Population and Housing Estimates for Cities, Counties and the State, 2001-2006, with 2000 Benchmark, Sacramento, California. May.

State Water Resources Control Board (SWRCB), 1990. Sacramento River Toxic Chemical Risk Assessment Profile.

SWRCB, 1995. Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. May.

U.S. Army Corps of Engineers, 1977. *Report on Reservoir Regulation for Flood Control, Shasta Dam and Lake.*

U.S. Census Bureau, 2000. Demographic data. Accessed at: http://www.census.gov/main/www/cen2000.html

U.S. Census Bureau, 2005. *Quick Facts*.

U.S. Department of the Interior, 1999. Title 34 of Public Laws 102-575, Central Valley Project Improvement Act, *Federal Register*, Vol. 64, No. 152, August.

U.S. Department of the Interior, 2000. Record of Decision, Trinity River Mainstem Fishery Restoration and Environmental Impact Statement/Environmental Impact Report. December.

U.S. Department of the Interior, 2002. *Fish Passage Improvement Project at the Red Bluff Diversion Dam, Tehama County, California*.

U.S. Department of the Interior, 2008. Fish Passage Improvement Project at the Red Bluff Diversion Dam EIS/EIR. May.

U.S. Department of the Interior and Reclamation, 1991. Planning Report/Final Environmental Impact Statement, Shasta (Outflow) Temperature Control Device. Page IV-8.

U.S. Fish and Wildlife Service, 1997. *Final Administrative Proposal on the Management of Section 3406(b)(2) Water*.

U.S. Fish and Wildlife Service, 2005. *Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan*. (Biological Opinion.) February.

U.S. Water Resources Council (WRC), 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. March.

White, G., L. Westwood, K. Hillman, J. Kraft, A. DeGeorgey, E. Henderson, and E. Dwyer, 2005. Archaeological Reconnaissance of the Proposed Sites Reservoir Viewshed Area of Potential Effects, Colusa and Glenn Counties, California. Prepared for DWR, Northern District. May.

William Lettis & Associates, Inc. (WLA), 2002. Phase II Fault and Seismic Hazards Investigation for North of the Delta Offstream Storage Investigations. September.