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North-of-the-Delta Offstream Storage Investigation Initial Alternatives Information Report

May 2006

NORTH-OF-THE-DELTA OFFSTREAM STORAGE INVESTIGATION

FINAL
INITIAL ALTERNATIVES INFORMATION REPORT

Prepared For:

California Department of Water Resources
Division of Planning and Local Assistance
901 P Street
Sacramento, CA 95814

Bureau of Reclamation
Mid Pacific Region
Federal Office Building
2800 Cottage Way
Sacramento, CA 95825

Prepared By:

URS

2870 Gateway Oaks Drive, Suite 150
Sacramento, CA 95833

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ABBREVIATION AND ACRONYM LIST

Accord	Bay-Delta Accord
ACID	Anderson Cottonwood Irrigation District
AF	acre-feet
AFRP	Anadromous Fish Restoration Project
Agreement	Sacramento Valley Water Management Agreement
Banks Pumping Plant	Harvey O. Banks Pumping Plant
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin River Delta
BCWC	Battle Creek Watershed Conservancy
BDPAC WSS	Bay-Delta Advisory Committee Water Supply Subcommittee
BLM	Bureau of Land Management
BMP	best management practice
CALFED	California Bay-Delta Program
CalTrout	California Trout
CBDA	California Bay-Delta Authority
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
cfs	cubic feet per second
COA	Coordinated Operations Agreement
Comp Study	Sacramento and San Joaquin River Basins Comprehensive Study
Corps	United States Army Corps of Engineers
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
Delta	Sacramento-San Joaquin River Delta
DOI	Department of Interior
DWR	Department of Water Resources
ECw	electrical conductivity measurement
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EQ	environmental quality
ERP	Ecosystem Restoration Program
ESA	Endangered Species Act
ESU	evolutionarily significant units
EWA	Environmental Water Account
FERC	Federal Energy Regulatory Commission
FS	feasibility study
FY	fiscal year
GCID	Glenn-Colusa Irrigation District

ABBREVIATION AND ACRONYM LIST (Continued)

IAIR	Initial Alternatives Information Report
IEP	Interagency Ecological Program
ISI	Integrated Storage Investigations
JPOD	joint point of diversion
kW	kilowatt
KRCD	Kings River Conservation District
M&I	municipal and industrial
MAF	million acre-feet
MOU	Memorandum of Understanding
NED	national economic development
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NODOS	North-of-the-Delta Offstream Storage
NOI	Notice of Intent
NOP	Notice of Preparation
O&M	operation and maintenance
OCAP	Operations Criteria and Plan
OSE	other social effects
PEIS/EIR	Programmatic Environmental Impact Statement/Environmental Impact Report
PFR	Plan Formulation Report
P&Gs	*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*
PM_{10}	particulates less than 10 microns
PMT	Project Management Team
PPA	Preferred Program Alternative
Progress Report	Final Draft North-of-the-Delta Offstream Storage Investigation Progress Report (July 2000)
RBDD	Red Bluff Diversion Dam
RCD	Resource Conservation District
Reclamation	United States Department of the Interior Bureau of Reclamation
RED	regional economic development
RHJV	Riparian Habitat Joint Venture
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SDIP	South Delta Improvements Program
SWAG	Sacramento Watershed Action Group
SWP	State Water Project
SWRCB	State Water Resources Control Board

ABBREVIATION AND ACRONYM LIST (Continued)

TAF	thousand acre-feet
TAG	technical advisory group
TC Canal	Tehama-Colusa Canal
TCCA	Tehama-Colusa Canal Authority
TNC	The Nature Conservancy
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VELB	valley elderberry longhorn beetle
WCB	Wildlife Conservation Board
WUE	water use efficiency
°F	degrees Fahrenheit

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EXECUTIVE SUMMARY

Key IAIR Topics

- Definition of the study area
- Identification of resource problems, needs, and opportunities
- Development of planning objectives and constraints
- Screening of measures
- Additional screening of surface storage measures
- Formulation of initial alternatives

The North-of-the-Delta Offstream Storage (NODOS) Investigation is a Feasibility Study being performed by the California Department of Water Resources (DWR) and the United States Department of the Interior, Bureau of Reclamation (Reclamation), in partnership with local interests and pursuant to the CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/EIR) Record of Decision (CALFED, 2000). The NODOS Investigation is evaluating potential offstream surface water storage projects in the upper Sacramento River Basin that could improve water supply and reliability, enhance anadromous fish survival, and provide high-quality water for agricultural, municipal and industrial (M&I), and environmental uses. The NODOS Investigation is one of five surface water storage studies recommended in the CALFED PEIS/EIR Record of Decision (CALFED, 2000).

The NODOS Investigation is being performed in phases. This Initial Alternatives Information Report (IAIR) identifies, discusses, and screens measures to address the problems and needs and then introduces the development of potential initial alternatives for further consideration. Potential initial alternatives will be incorporated into and refined in the subsequent Plan Formulation Study, which will culminate in a Plan Formulation Report for the NODOS Investigation. Conclusions and recommendations will evolve to incorporate the results of future technical evaluations as the investigation progresses. The final phase in the process will be a Feasibility Study report/EIS/EIR, with supporting environmental documentation consistent with the federal *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&Gs) (WRC, 1983); Reclamation directives; DWR guidance; and applicable environmental laws. DWR and Reclamation are coordinating the NODOS Investigation with the California Bay-Delta Authority, which provides general oversight and coordination of CALFED activities. DWR and Reclamation also coordinate with the California Bay-Delta Public Advisory Committee, which in turn advises the U.S. Secretary of the Interior regarding implementation of the CALFED program. NODOS planning also will be consistent with the CALFED program solution principles and implementation commitments described in the Record of Decision.

BASIS OF INVESTIGATION

The development and management of additional water supply can alleviate several problems and meet several needs within the Sacramento River Basin and more widely, throughout California. These problems include water supply reliability, increasing water supply needs, limited operational flexibility of the existing water resources system, unfavorable conditions for migrating anadromous fish and other aquatic species, and impaired water quality. In addition, opportunities may exist for hydropower generation, recreation, and flood control storage.

Major existing water resources projects that influence NODOS planning and its potential capabilities include Reclamation's Central Valley Project (CVP), California's State Water Project (SWP), and the United States Army Corps of Engineers' Sacramento River Flood Control Project. In addition, two ongoing programs in the Central Valley significantly influence the NODOS Investigation: the Central Valley Project Improvement Act and the California Bay-Delta Program, which is responsible for implementing the CALFED Bay-Delta PEIS/EIR and Record of Decision.

In one of the most ambitious integrated water management plans in the nation, the CALFED Bay-Delta Program set forth objectives and actions to provide good water quality, restore habitat and ecological function in the San Francisco Bay/Sacramento-San Joaquin River Delta, and continue to meet the water needs of farms and cities. The program recognized early on that its plan must include the means for fully integrating California's water supply system to provide more reliable water supplies and to meet competing needs. The program also noted that additional storage is crucial to successfully meeting those needs. Storage is one of 12 program elements designed to meet the following program objectives: water supply reliability, levee system integrity, water quality, and ecosystem restoration. All aspects of the CALFED Program are interrelated and interdependent. More specifically, many of the elements are complementary to, or directly related to, storage.

STUDY AREA EMPHASIS

The primary study area for the NODOS Investigation encompasses the Upper Sacramento River and the Northern Sacramento Valley. Because of the potential influence of the NODOS Investigation on other programs and projects, primarily in the Central Valley, the extended study area includes the Sacramento-San Joaquin River Delta (Delta) and the CVP and SWP service areas (Figure ES-1).

STUDY AUTHORIZATION

As a result of increases in demands for water supplies throughout California, both DWR and Reclamation have maintained active authorizations and funding mechanisms for the NODOS Investigation. Congress provided NODOS Feasibility Study authority to Reclamation in the Consolidated Appropriations Act, 2003 (Public Law 108-7) and reaffirmed this authority in the Water Supply, Reliability, and Environmental Improvement Act, 2004 (Public Law 108-361). DWR currently operates full feasibility and study authority as part of the CALFED Bay-Delta Program. State funding has been derived from both DWR's general fund and through state bond funds.

PROBLEMS, NEEDS, AND OPPORTUNITIES

Additional water supply in the Upper Sacramento River basin could be used to respond to several water resources problems, needs, and opportunities. These are briefly summarized hereafter.

Water Supply Reliability – Reliability is one of four primary interrelated objectives of the CALFED program. Reliably delivering water to meet urban, environmental, and agricultural needs requires the availability and timely delivery of water where it is needed.

Problems and Needs

- Water supply reliability
- Water supply
- Water management flexibility
- Anadromous fish survival
- Water quality
- Environmental

Opportunities

- Hydropower generation
- Recreation
- Flood control

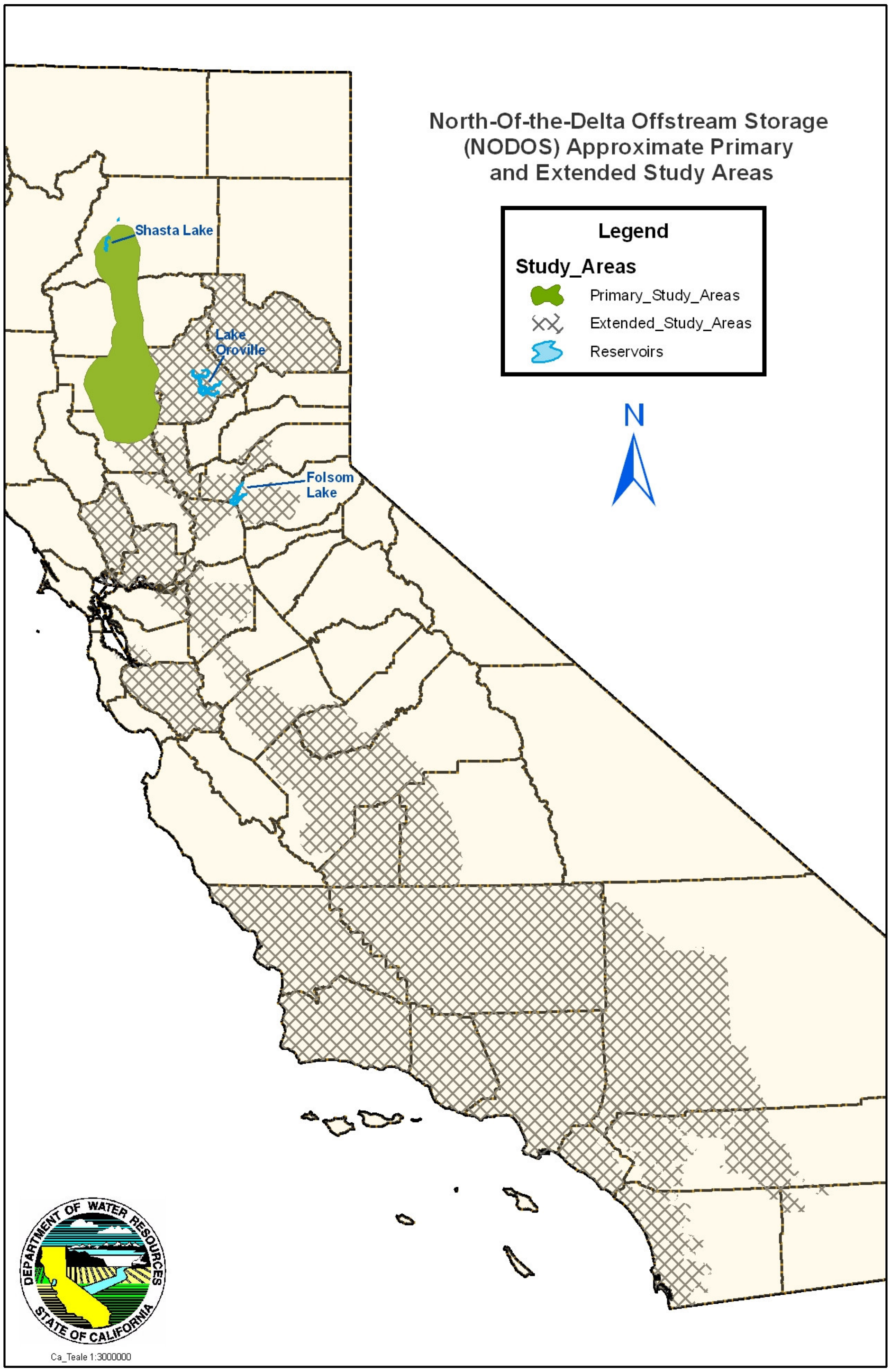

Figure ES-1. Potential NODOS Primary and Extended Study Areas

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Water Supply – The Preferred Program Alternative in the CALFED Record of Decision identified a need for up to 6 million acre-feet of new storage in California, including up to 3 million acre-feet of storage north of the Delta. The California Water Plan Update 2005 presents three plausible demand scenarios for 2030. For the three scenarios, statewide water demand ranges from a reduction of about 0.4 million acre-feet per year to an increase of 4.0 million acre-feet per year. For all three scenarios, 2 million acre-feet per year of water will be needed by 2030 to reduce groundwater overdraft statewide. To meet the need of eliminating statewide groundwater overdraft, the demands for the three scenarios increased from 1.6 to 6.0 million acre-feet.

Water Management Flexibility – As water use and the recognition of environmental water needs have increased, so have conflicting demands for limited water supplies in a highly constrained and regulated system. Water management (operational) flexibility can create significant benefits for the system including, but not limited to, more rapid response to meeting urban, agricultural, and environmental water quality regulatory standards; rapid response to unexpected and unpredicted incidents (such as potential levee breaks that can shut down the SWP, CVP, and Bay Area export operations); and more options and means to meet aquatic flow standards and provide aquatic restoration benefits in the valley rivers and in the Delta (while maintaining supply reliability to other urban, agricultural, and environmental beneficial water uses).

Anadromous Fish Survival – Over the years, dams, levees, and water operations have changed the landscape of the Sacramento River and have altered natural flow regimes by changing the frequency, magnitude, and timing of flow. Dams have blocked access to over 80% of spawning and rearing habitat historically available to Chinook salmon and steelhead. There are many other issues that affect the survival of anadromous fish, including reduction of organic material and sediment movement; degradation of downstream spawning and rearing habitat; unfavorable water conditions, such as increased turbidity, temperature, dissolved oxygen, bromide, chloride, and nitrogen, caused by inactive and abandoned mine drainage; and discharges from agricultural and M&I areas. These changes affect all fish species in the rivers, Delta, and Bay. Salmon and steelhead are particularly susceptible to poor water conditions. The listing of several fish species in the Sacramento River and Delta, under state and federal species protection laws, has greatly affected systemwide water supply operations. Each listed species has specific water supply requirements that affect local, state, and federal projects, including managed releases to meet species' needs. Timing reservoir releases to meet critical needs is difficult because Lake Shasta and Lake Oroville are many miles away from targeted reaches further downstream in the Sacramento River or in the Delta.

Water Quality – Improving Delta water quality is one of the four CALFED Bay-Delta Program objectives. The Delta is a source of drinking water for over 20 million Californians, and it provides vital habitat for over 750 plant and animal species. The water quality program goal is to improve Delta water quality beyond current regulatory requirements for all beneficial uses, including urban, agricultural, and environmental.

Environmental – Current water supply storage on the Sacramento River limits the amount of water available for environmental purposes. A need exists to ensure water supplies for the environment and provide the flexibility in the system necessary to improve environmental conditions in the Sacramento River and the Delta. Further needs exist to reduce the impacts of water diverted from the Sacramento River and to deliver cooler water for fish spawning habitat. Providing storage north of the Delta would allow water to be diverted from the Sacramento River during periods when outflows and water quality are less problematic for endangered, threatened, or sensitive species.

Hydropower Generation – In addition to offsetting the power needs of offstream storage pumping, the NODOS Investigation will explore the potential ancillary benefits that hydropower generation may offer to the statewide energy grid.

Recreation – Recreational use and opportunity are currently very limited within the study area, and demands for water-oriented recreational opportunities in the Sacramento River basin are high. Some of these demands are served by reservoirs on the western slope of the Sierra Nevada Mountains. However, as population increases in the Sacramento Valley, demands for flat water, river, and land-based recreation are expected to increase.

Flood Control Storage – Water system improvements may generate opportunities to increase flood protection by allowing better coordination of various Sacramento region reservoirs to provide for additional flood storage space at selected onstream reservoirs, including Folsom, Oroville, and Shasta.

PLANNING OBJECTIVES

The identified problems and needs were translated into primary and secondary (opportunity) planning objectives, as described hereafter.

Primary Objectives – The NODOS Investigation will formulate alternatives specifically to address the following primary objectives:

- Increasing water supplies, water supply reliability, and Sacramento Valley water management flexibility for agricultural, M&I, and environmental purposes, including CALFED programs such as Delta water quality, the Environmental Water Account (EWA), and the Ecosystem Restoration Program (ERP), to help meet California's current and future water demands, with a focus on offstream storage; and
- Increasing the survival of anadromous fish populations in the Sacramento River, as well as the health and survivability of other aquatic species.

To the extent possible while meeting the primary planning objectives, the NODOS Investigation will explore features to maximize the following opportunities, which are considered secondary objectives:

- Providing ancillary hydropower benefits to the statewide power grid;
- Developing additional recreational opportunities in the study area; and
- Creating incremental flood control storage opportunities in support of major northern California flood control reservoirs.

Table ES-1 summarizes the problems, needs, and opportunities related to the NODOS Investigation objectives.

RESOURCE MANAGEMENT MEASURES SCREENING

Following the development of the planning objectives, constraints, and criteria for the NODOS Investigation, potential resource management measures were identified and evaluated to determine which measures would be considered in formulation of initial alternatives. A resources management measure is a feature or activity, structural or non-structural, that addresses a specific planning objective.

Table ES-1

Problems, Needs, and Opportunities Relative to Planning Objectives

Problems and Needs	Planning Objectives
Water Supply Reliability – Reliably delivering water to meet urban, environmental, and agricultural requirements requires both the availability and timely delivery of water to where it is needed.	Increase water supply reliability for agricultural, M&I, and environmental purposes by enhancing water management flexibility for the Sacramento Valley.
Water Supply – Current and future demands for water in California exceed available supplies during many years. The Preferred Program Alternative in the CALFED Record of Decision identified a need for up to 6 million acre-feet of new storage in California, including up to 3 million acre-feet of storage north of the Bay-Delta.	Increase water supplies for agricultural, M&I, and environmental purposes to help meet California's current and future water demands.
Water Management Flexibility – As water use and recognition of environmental water needs have increased, so have conflicting demands for limited water supplies in a highly constrained and regulated system. Water management (operational) flexibility can create significant benefits for the system including, but not limited to more rapid response to meeting urban, agricultural and environmental water quality regulatory standards; rapid response to unexpected and unpredicted incidents such as Delta levee breaks that can shut down the SWP, CVP, and Bay Area export operations in the Delta; and more options and means to meet aquatic flow standards and provide aquatic restoration benefits in the valley rivers and in the Delta.	Enhance water management flexibility by providing additional diversion, storage, and delivery opportunities.
Anadromous Fish Recovery – Water resources facilities and operations including levees, dams, and diversions have affected the survivability of anadromous and other fish populations associated with the Sacramento River and Delta. Other negative effects are related to land use changes, habitat conversion, and water quality degradation due to introduced impurities. Four anadromous and two resident fish species have received state or federal designations as threatened, endangered, or of special concern.	Increase the survival of anadromous fish populations in the Sacramento River and improve the health and survivability of other aquatic species.
Water Quality – The Delta is a source of drinking water for over 20 million Californians and provides vital habitat for over 750 plant and animal species. The CALFED water quality program goal is to improve Delta water quality beyond current regulatory requirements for all beneficial uses, including urban, agricultural, and environmental uses.	Improve Delta water quality.
Environmental – Water managers need more effective tools to strategically acquire, store, transfer, and release water in response to real-time ecosystem needs. Flexibility in the state's water delivery system is necessary for providing water at critical times to meet environmental needs.	Provide increased water supplies, water supply reliability, and management flexibility for environmental purposes, including CALFED programs such as Delta water quality, EWA, and ERP.
Opportunities	**Planning Objectives**
Hydropower Generation – 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 energy grid.	Provide hydropower generation capacity for the Sacramento River basin to offset energy usage and pumping costs, potentially contributing ancillary benefits to the statewide grid.
Recreation – Recreational use and opportunity are currently very limited within the study area, and demands for water-oriented recreational opportunities in the Sacramento River basin are high. Some of these demands are served by reservoirs on the western slope of the Sierra Nevada Mountains. However, as population increases in the Sacramento Valley, demands for flat water, river, and land-based recreation are expected to increase.	Develop additional recreational opportunities in the study area.
Flood Control Storage – Improvements to the water system may provide opportunities to increase flood protection by allowing better coordination of various Sacramento region reservoirs to provide additional flood storage space at selected on-stream reservoirs, including Folsom, Oroville, and Shasta.	Provide incremental flood control storage opportunities.

Potential resource management measures were identified as part of previous studies, programs, and projects to address problems, needs, and opportunities in the study area. In the programmatic Record of Decision, CALFED included a Storage component to investigate surface, conjunctive, and groundwater storage programs. The NODOS study team incorporated CALFED's surface and groundwater approach to storage by including both as potential measures to address NODOS objectives. The NODOS Investigation will rely significantly upon information from the CALFED groundwater storage investigations under DWR, as potential groundwater storage measures in the study area are conceived and evaluated. Groundwater storage measures will be evaluated in a more comprehensive manner in the PFR, as additional information becomes available from CALFED's groundwater storage investigations.

DWR and Reclamation are identified as lead implementing agencies for the CALFED surface storage investigation. The 52 surface storage sites first identified by the CALFED Storage Program were revisited as part of the NODOS Investigation to determine whether some should be included as NODOS Investigation measures. These sites were evaluated for their ability to address the planning objectives. This screening activity resulted in the identification of four viable surface storage measures suitable for continued IAIR consideration. These four measures were added to the broader range of measures identified in Section 6 of this IAIR for comparison and screening against the NODOS Investigation objectives.

The identified measures were evaluated for their ability to address the primary and secondary planning objectives. The resource management measures were screened for their ability to address at least one planning objective without adverse impact on other planning objectives. Measures were analyzed for the degree to which they would fulfill a specific planning objective, and they were rated on a scale from low to high.

Measures deleted from this investigation will not be precluded from reconsideration in future study activities. Measures that do not directly address the planning objectives may be reconsidered for inclusion in future alternative plans as possible mitigation elements or ancillary plan features.

Tables ES-2 and ES-3 summarize the measures that best address the primary and secondary planning objectives, respectively. A comprehensive description of all the measures considered is located in Section 6 of this IAIR.

Table ES-2

Retained Measures that Address the Primary Objectives

Primary Objective	Resource Management Measure
Water Supply and Reliability	Construct new conservation offstream surface storage at the Sites Reservoir site
	Construct new conservation offstream surface storage at the Newville Reservoir site
	Construct new conservation offstream surface storage at the Colusa Reservoir site
	Develop groundwater storage near the Sacramento River, downstream from Shasta Dam
Anadromous Fish Survival	Restore abandoned gravel mines along the Sacramento River
	Construct in-stream aquatic habitat downstream from Keswick Dam
	Replenish spawning gravel in the Sacramento River
	Construct new conservation offstream surface storage at the Newville Reservoir site
	Construct new conservation offstream surface storage at the Colusa Reservoir site

Table ES-2
(Continued)

Primary Objective	Resource Management Measure
Anadromous Fish Survival (Continued)	Construct new conservation offstream surface storage at the Sites Reservoir site
	Improve fish passage at Red Bluff Diversion Dam
	Develop groundwater storage near the Sacramento River, downstream from Shasta Dam

Table ES-3

Retained Measures that Address the Secondary Objectives

Secondary Objective	Resource Management Measure
Hydropower Generation	Construct new hydropower generation facilities on Sites Reservoir
	Construct new hydropower generation facilities on Colusa Reservoir
	Construct new hydropower generation facilities on Newville Reservoir
Recreational Opportunities	Construct new conservation storage on tributaries to the Sacramento River downstream from Shasta Dam
	Construct new conservation offstream surface storage at the Newville Reservoir site
	Construct new conservation offstream surface storage at the Colusa Reservoir site
	Construct new conservation offstream surface storage at the Sites Reservoir site
Incremental Flood Control Storage Opportunities	Provide incremental flood control storage at Newville Reservoir through re-operation of other major northern California reservoir(s).
	Provide incremental flood control storage at Colusa Reservoir through re-operation of other major northern California reservoir(s).
	Provide incremental flood control storage at Sites Reservoir through re-operation of other major northern California reservoir(s).

The three offstream storage measures, groundwater storage measure, and other measures, generally dealing with spawning area or habitat improvement, were retained as potential measures that might address anadromous fish survival. The measures that involve spawning area and habitat improvements, however, do not address the primary objective for increased water supply and reliability.

All of the storage measures could support multiple objectives. New yield developed by increasing storage for the Sacramento River system could be used for any or all of the primary objectives. Measures were evaluated based on their ability in developing and managing water supplies to contribute to increasing water supply reliability; improve Delta water quality; provide a reliable source of water supply for the EWA; enhance anadromous fish passage and aquatic restoration; provide storage and operational benefits for other CALFED programs; and increase water flow-related benefits for the ERP. The storage measures can address both planning objectives, but could also be combined with other measures to increase the benefits of an alternative plan.

All retained measures will be evaluated and possibly packaged to develop alternative plans that best address the primary planning objectives and, to the extent possible, the secondary planning objectives.

The study of potential storage measures is part of a larger CALFED program to address four objectives for managing water resources in California: water supply reliability, levee system integrity, water quality, and ecosystem restoration. As stated previously, storage is one of 12 program elements designed to achieve these four CALFED objectives. The program elements are also conceived to be interrelated and interdependent so that elements can be implemented in a complementary and non-competitive fashion. Other program elements are assumed to be implemented consistent with program implementation guidelines. CALFED complementary actions (Water Use Efficiency [WUE] and Transfers) are described in Section 3 of this IAIR and will be implemented concurrently; therefore, they will be included in all NODOS alternatives, including the No-Action alternative and the initial alternatives described later. Because these complementary actions are already included in all the alternatives, CALFED complementary actions are not included in the list of measures to achieve NODOS objectives. More specifically, the concurrent CALFED Common Assumptions effort will assume implementation of both WUE and Transfers so that, ultimately, the NODOS investigation will assume WUE and Transfers in the No-Action Alternative and all NODOS alternatives.

FURTHER MEASURES SCREENING

For the development of initial alternatives, the measures retained were further evaluated for their ability to address the planning objectives while maximizing project benefits and minimizing any adverse effects to the study area.

The retained groundwater storage measure, development of groundwater storage downstream from Shasta Dam, would likely address the primary objectives but none of the secondary objectives. Groundwater measures downstream from Shasta Dam will be evaluated in more detail during the Plan Formulation process.

The three north-of-the-Delta offstream surface storage alternatives offer a range of potential water supply reliability benefits, but would serve similar project purposes. Because all of the projects are upstream from the Delta and adjacent to the Sacramento River, the kinds of benefits, such as supplemental yield for various uses and reduced diversions from the Sacramento River during peak local delivery periods, will vary primarily in scale. All of these project alternatives have been investigated in the past. Current studies updated and augmented past studies as needed, to allow comparative evaluation. Figure ES-2 shows the locations of the initial offstream storage alternative sites evaluated in the IAIR.

The offstream surface storage measures were compared with respect to their total capital construction cost, their yield, and their unit cost per deliverable volume. This comparison helped identify, on an annualized basis, the relative cost-effectiveness of each measure. Comparative costs for Sites, Colusa, and Newville Reservoirs were prepared to show the difference in total reservoir dam cost for each of the three reservoirs. The total dam cost (in 2004 dollars) for Sites Reservoir was calculated at $320,250,000 with Colusa Reservoir at $1,411,520,000 and Newville Reservoir at $235,134,000. These costs do not include land acquisitions, easements, rights-of-way, relocations, appurtenant structures, conveyances, road relocations, or recreation facilities.

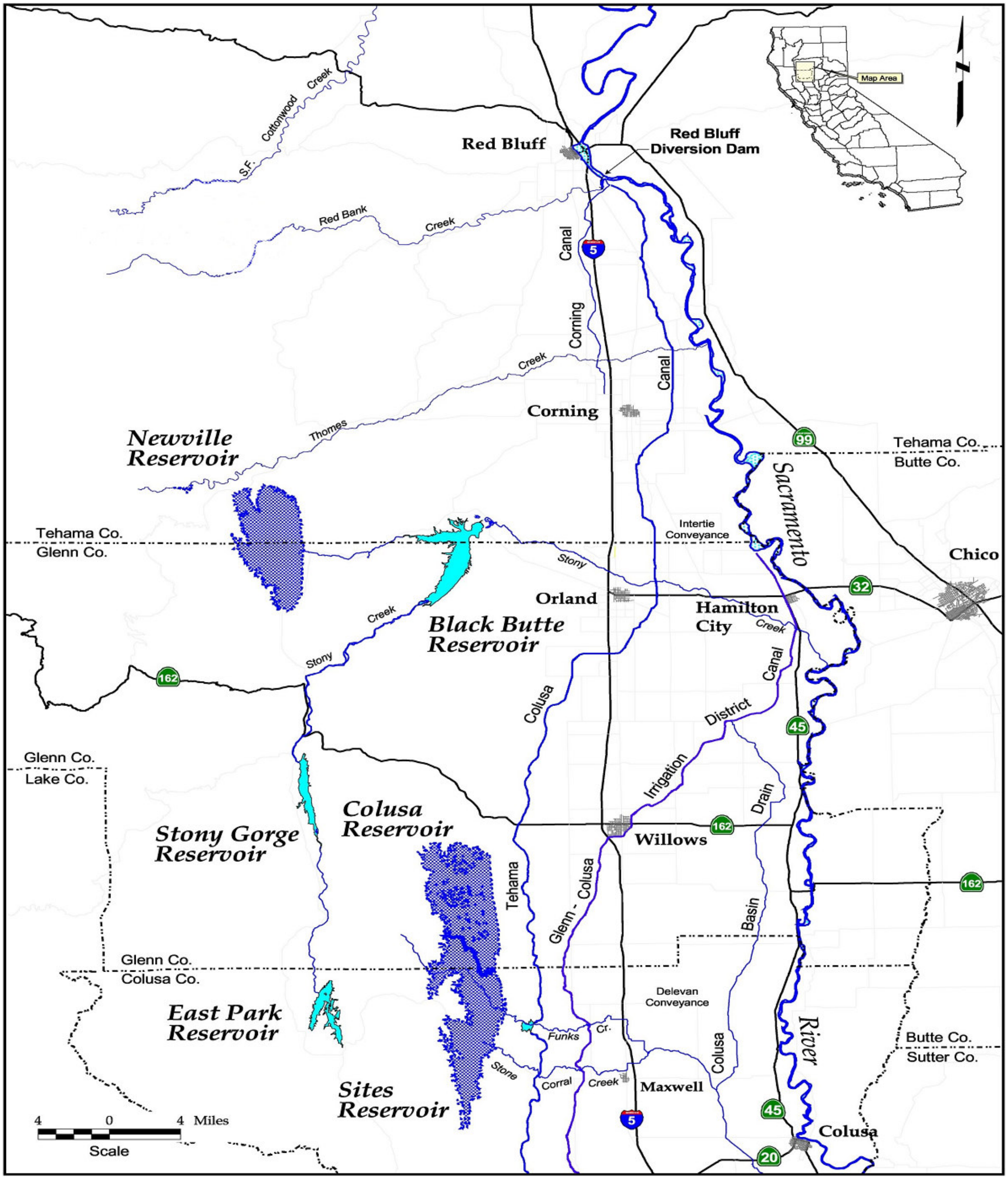

Figure ES-2. NODOS Initial Offstream Storage Alternatives

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A preliminary economic assessment compared the average annual cost per yield for the three surface storage measures. The estimated average annual cost per yield was similar in magnitude for Sites and Newville Reservoirs, but was comparatively excessive for Colusa Reservoir. Sites Reservoir average annual cost per unit yield is approximately 36% greater than Newville Reservoir. By contrast, Colusa Reservoir's average annual cost per unit yield is about 367% greater than Sites Reservoir and about 500% greater than Newville Reservoir. In addition, the capital cost of Colusa Reservoir is approximately 4.4 times that of Sites Reservoir, and 6 times that of Newville Reservoir, while the increase in yield is only around 19%.

Therefore, with respect to the federal planning criterion on "efficiency," Colusa Reservoir is being dismissed from further consideration as a potential, viable measure for this IAIR.

Sites and Newville were next compared to each other with respect to their potential impact on environmental/ecological attributes. Table ES-4 summarizes the potential environmental impacts associated with Sites Reservoir and Newville Reservoir. (Bold text is used to highlight the larger value of the two for each attribute considered.)

Table ES-4

Relative Environmental Impacts Comparison

Preliminary Site Survey Results (Biological/Ecological Attribute)	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		
# of Elderberry stems > 1 inch diameter	684	**1,204**
# of Elderberry stems with emergence holes	18	**222**
Total # of bird species	**160**	146
# of state and federal bird species of concern	**25**	19
Prehistoric cultural resource components	45	**240+**
Historic cultural resource components	27	**65+**

The initial review and comparison of potential environmental impacts between Sites and Newville Reservoirs indicates a significantly greater impact potential for Newville. With the exception of potential impacts on the number of state and federal bird species of concern, possible project-related impacts for all the other biological/ecological attributes are higher for Newville Reservoir. Therefore, at this time, the Newville Reservoir measure is being dismissed from further consideration as a potential, viable measure for this IAIR.

After preliminary assessment of these three offstream surface storage alternatives, the most promising off-stream surface storage alternative is Sites Reservoir. The Colusa and Newville Reservoirs were deleted from further consideration due to their greater environmental and economic considerations, as described above.

The Sites Reservoir alternative would be located in north-central Colusa County and south-central Glenn County, west of the community of Maxwell. The proposed reservoir would have a storage capacity of up to 1.8 million acre-feet. Excess flows from the Sacramento River and its tributaries are potential water supply sources for Sites Reservoir.

Based on the initial screening of the offstream surface storage measures, the Sites Reservoir project was carried forward as a surface storage measure that addressed the primary objective of water supply and reliability. The measures that involve spawning area and habitat improvements, however, will likely be packaged with Sites Reservoir to develop alternatives that maximize benefits to anadromous fish survival during development of the initial alternatives. Groundwater storage downstream of Shasta Dam may also satisfy the NODOS primary objectives, but has not undergone the same level of analysis as the surface storage measures. The groundwater measure will be further developed and evaluated as part of plan formulation.

STRATEGY FOR THE DEVELOPMENT OF INITIAL ALTERNATIVES

Initial alternatives will be formulated using retained resource management measures. During the development of the initial alternatives, different strategies to address the primary planning objectives, constraints, and criteria will be explored. To develop initial alternatives, Sites Reservoir and groundwater storage measures will be combined with other measures retained in the initial screening process and will be evaluated with varying project features, such as conveyance, groundwater storage, and operational scenarios.

Conveyance types or methods for Sites Reservoir will involve (1) using existing canals and associated infrastructure, (2) building a new pipeline and intake from the Sacramento River, and (3) combining the two. Existing versus new facilities, as well as sizing (capacity), will be investigated with respect to meeting the primary objectives of NODOS in the Plan Formulation phase. For the IAIR, it was assumed that conveyance elements were economically justifiable, constructible, and operable and that any environmental impacts associated with improvements could be avoided or mitigated.

The combination of measures, conveyance, groundwater storage, and system operations determines the total benefit available from a NODOS project. Depending on how the system is operated, any combination of measures and conveyance will yield different benefits (i.e., water quality, environmental, and/or water supply benefits). The Plan Formulation phase will analyze operating the system as an integral part of the alternatives analysis.

The following initial alternative operational scenarios will be carried forward into the Plan Formulation Report for further development into detailed initial alternatives:

- Initial Alternative A – Environmental Focus;
- Initial Alternative B – Water Quality Focus;
- Initial Alternative C – Water Supply Focus; and
- No-Action Alternative (as required, in the federal P&Gs).

As indicated in Chapters 3 and 6 of this IAIR, all alternatives will include the CALFED complementary actions WUE and Transfers. These CALFED program commitments are reflected in the Common Assumptions process so that the CALFED complementary actions are included implicitly in each alternative, including the No-Action and initial alternatives introduced above.

STUDY MANAGEMENT AND PUBLIC INVOLVEMENT

A study management structure has been developed for the NODOS Investigation that consists of the Project Management Team (PMT) (a subset of the Memorandum of Understanding Partnership) and the Study Team, as described below:

- Project Management Team – DWR, Reclamation, California Department of Fish and Game, U.S. Fish and Wildlife Service, Glenn-Colusa Irrigation District, and Tehama-Colusa Canal Authority, all signatories of the Sites Memorandum of Understanding, serve as members of the PMT. The PMT provides overall guidance to the Study Team for the NODOS Investigation. In addition, the PMT periodically consults with and reports to the Memorandum of Understanding Partners about planning activities.
- Study Team – The Study Team consists of the Project Managers of DWR and Reclamation and technical experts from various disciplines. The Study Team manages the investigation and directs work performed; coordinates study results into the overall NODOS Investigation; and directs and coordinates public, agency, and stakeholder involvement.

The Project Managers participate in the Project Management Team and the Study Team to provide a communication link between the two teams. Technical work groups are established as needed and focus on specific study areas, such as environmental studies, engineering studies, benefit analysis, impact analysis, and hydraulic and hydrologic modeling.

A federal feasibility study requires acquisition of primary data and the participation of public agencies and entities and the general public in order to develop a preferred plan from a range of alternative courses of action, that meets recognized needs, problems, and opportunities associated with the planning area of concern. Public involvement has been an integral part of the NODOS investigation. To encourage general public and stakeholder participation and satisfy the public involvement requirements of National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA), the NODOS Investigation includes public outreach activities and information dissemination. The Study Management and Public Involvement section of this IAIR describes past public involvement in the NODOS Investigation and discusses plans for future public and stakeholder involvement.

DWR has 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 significant effects to be analyzed in depth in the environmental documentation.

FUTURE ACTIONS

The next major step in the Feasibility Study process is to refine the retained management measures and further develop the initial alternatives into a set of detailed alternative plans. The emphasis of upcoming studies will be on hydraulic and hydrologic system modeling, designs and cost estimates, economic analysis, and environmental impact evaluations and documentation. Major emphasis also will be placed on the continued communication of study findings to other agencies, identified stakeholder groups, and involved groups and individuals.

The next product of the investigation is the Plan Formulation Report, scheduled for completion in fall 2007, followed by the Feasibility Study Report. Based on completing a draft Feasibility Study Report, which will consist of an integrated federal decision document and draft EIS and EIR in spring 2008, it is estimated that the final Feasibility Study will be completed in winter 2008. Assuming Congressional authorization to construct, detailed project design could be initiated in 2008 or 2009, followed by initiation of construction, acquisition of necessary permits, and minor relocations. It is likely that the construction period would range from four to six years, depending on the plan selected and the available funding.

FEDERAL INTEREST IN CONTINUING WITH A PLAN FORMULATION STUDY

This IAIR concludes there is a potential federal interest in continuing the NODOS Investigation for a potential project to meet objectives associated with municipal and industrial, agricultural, and environmental water supply reliability; anadromous fish survival; power; incremental flood control storage; and recreation. Because there is federal participation in the EWA, a federal interest may exist in having storage north of the Delta to accomplish these goals. The type, degree and magnitude of the federal interest in a NODOS project will be confirmed and quantified in future planning phases, including the Plan Formulation Study and the Feasibility Study.

The Plan Formulation Study will develop the initial alternatives in greater detail and will refine costs, estimate benefits, provide a preliminary evaluation of environmental impacts, and identify a tentatively preferred alternative and final array of alternatives to consider in the Feasibility Study. Consideration by Reclamation, DWR, CALFED, and other appropriate stakeholders will continue to further define the issues and solicit support in future planning study activities.

1. INTRODUCTION AND BACKGROUND

Key IAIR Topics

- ❖ Definition of the study area
- ❖ Identification of resource problems, needs, and opportunities
- ❖ Development of planning objectives and constraints
- ❖ Screening of measures
- ❖ Additional screening of surface storage measures
- ❖ Formulation of initial alternatives

The State of California Department of Water Resources (DWR) and the Department of the Interior (DOI), Bureau of Reclamation (Reclamation), in partnership with local water interests, are investigating North-of-the-Delta Offstream Storage (NODOS) opportunities. This Initial Alternatives Information Report (IAIR) for the NODOS Investigation describes the planning process used to assess and compare the initial alternative offstream surface water storage projects in the Northern Sacramento Valley.

An IAIR is an essential part of the federal planning process. DWR has completed several technical studies that provide the information required for the analysis performed in this IAIR. Consequently, this IAIR documents existing data, including information and reports that have been developed by DWR and others, and provides additional analyses as needed to meet the requirements of the federal planning process within the study area.

This IAIR describes the:

- ❖ Background and scope for the federal Feasibility Study (FS);
- ❖ Problems, needs, opportunities, planning objectives, criteria, and constraints;
- ❖ Scope and major features of initial alternatives considered;
- ❖ Initial set of alternatives to be considered in more detail in subsequent stages of the FS; and
- ❖ Target scope, schedule, and costs of major tasks to be accomplished to complete the FS.

This report will serve to help determine whether a federal interest exists in NODOS. It also will help serve as a basis for completing the Plan Formulation Report (PFR) and the FS and FS Report.

1.1 PURPOSE OF INVESTIGATION

The purpose of this investigation is to identify and screen alternatives for NODOS to improve water supply reliability, increase the survival of anadromous fish populations in the Sacramento River, and provide storage and operational benefits for other CALFED Bay-Delta programs (CALFED), including Sacramento-San Joaquin River Delta (Delta) water quality, the Environmental Water Account (EWA), and the Ecosystem Restoration Programs (ERP).

1.2 STUDY AUTHORIZATION

The following subsections summarize the state and federal authority over the NODOS Investigation, as well as funding sources for the program.

1.2.1 State

Proposition 204, "The Safe, Clean, Reliable Water Supply Act," was approved in 1996. The proposition provided $10 million in funding for feasibility and environmental investigations of offstream storage projects upstream from the Delta that would provide storage and flood-control benefits in an environmentally sensitive and cost-effective way (Chapter 6, Article 2, Section 78656). In 1997, DWR used a portion of Proposition 204 funds to complete a two-year reconnaissance study of NODOS.

The State Budget Act of 1998 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. Subsequent funding was allocated to DWR's General Fund, as part of the CALFED Integrated Storage Investigations (ISI) program.

In November 2002, Proposition 50, the "Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002," was approved. It authorized $50 million for surface water storage planning and feasibility studies under CALFED. Subsequently, Proposition 50 has been the source of state funding as part of CALFED.

1.2.2 Federal

DOI received the following authorizations to undertake feasibility studies for the NODOS Investigation:

- Division D, Title II, Section 215 of Public Law 108-7 Consolidated Appropriations Resolution, 2003 dated February 20, 2003. This legislation specifies the following: *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. These storage studies should be pursued along with ongoing environmental and other projects in a balanced manner.*
- Title II, Section 211 of Public Law 108-137 dated December 1, 2003 (Fiscal Year [FY] 2004 Appropriation). This legislation specifies the following: *The Secretary of the Interior, in carrying out CALFED-related activities, may undertake feasibility studies for Sites Reservoir. The storage study should be pursued along with ongoing environmental and other projects in a balanced manner.*
- Title I, Section 103 of Public Law 108-361 Water Supply, Reliability, and Environmental Improvement Act, dated October 25, 2004, provided the following approval and authorizations.
    - Approved the CALFED Record of Decision (ROD), dated August 28, 2000, as a general framework for addressing the CALFED Bay-Delta Program, including its components relating to water storage. In selecting activities and projects, the Secretary of the Interior and the heads of the federal agencies must consider whether the activities and projects have multiple benefits (Section 103(a)(1)).
    - Authorized the Secretary of the Interior to carry out the activities of the CALFED Bay-Delta Program set forth in the CALFED ROD, subject to cost-share and other provisions if the activity has been (1) subject to environmental review and approval, as required under applicable federal and state law; and (2) approved and certified by the relevant federal agency, following consultation and coordination with the Governor of California, to be consistent with the ROD (Section 103(b)).
    - Authorized the Secretary of the Interior to carry out planning and feasibility studies for the Sites Reservoir in Colusa County to the extent authorized under the reclamation laws, the Central Valley Project Improvement Act (CVPIA), the Fish and Wildlife Coordination Act,

the Federal Endangered Species Act of 1973, and other applicable law (Section 103(d)(1)(A)(ii)(I)).

1.3 STUDY AREA

The primary study area for the NODOS Investigation encompasses the Upper Sacramento River and the Northern Sacramento Valley. Figure 1-1 shows the NODOS primary study area, which includes the watersheds flowing into the Upper Sacramento River from Colusa, Tehama, Glenn, Sutter, and Butte Counties. These watersheds cover 26,000 square miles.

Given the potential influence of the additional surface storage facility on other programs and projects within the Central Valley, an extended study area also has been identified for the NODOS Investigation. The extended study area includes the Sacramento River Watershed, the Delta, and the State Water Project (SWP) and Central Valley Project (CVP) service areas.

California's Central Valley is home to over 4 million people and a wide variety of fish and wildlife, including about 180 special-status plant and animal species. The Sacramento and San Joaquin River Basins provide drinking water for over two-thirds of Californians. Agriculture is the most significant segment of the region's robust economy. The Central Valley is a major source of reliable, high-quality crops marketed to the nation and the world.

1.4 PURPOSE AND SCOPE OF THE IAIR

The primary purpose of this IAIR is to document the decision-making of DWR and Reclamation and explain the formulation of initial alternatives to address planning objectives established for the NODOS Investigation. Detailed alternative plans will be developed subsequently from the initial alternatives, during the next phases of the FS. The report includes the following topics.

- ❖ Description of existing and likely future water resources and related conditions in the study area, and related problems, needs, and opportunities being addressed in the study.
- ❖ Development of planning objectives to address identified problems, needs, and opportunities.
- ❖ Identification of the planning constraints, guiding principles, and criteria for the FS.
- ❖ Development of resources management measures to address planning objectives.
- ❖ Formulation and evaluation of initial project alternatives, including a "no-action" alternative, that comply with the CALFED ROD and do not conflict with CALFED objectives, solution principles, or policies. The plan formulation and evaluation process must comply with the Federal *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&Gs) (WRC, 1983).
- ❖ Potential alternatives and the screening process used to identify a recommended set of initial alternatives to be further developed in the FS.
- ❖ Identification of potential major future actions for the FS.

This IAIR will be used as an initial component of the FS. Conclusions and recommendations regarding further evaluations are expected to evolve as the FS progresses. The federal FS Report documents decisions through an iterative planning process and may recommend a specific project to Congress for authorization. A federal FS requires the acquisition of primary data and the participation of public agencies and entities and the general public in order to develop a preferred plan from a range of alternative courses of action that meets recognized needs, problems, and opportunities associated with the planning area of concern. The FS identifies cost and benefits, project beneficiaries, cost allocation, ability to pay, financing, impacts and tradeoffs, and environmental compliance. Normally, the FS is integrated with compliance with the National Environmental Policy Act (NEPA), Fish and Wildlife Coordination Act, Endangered Species Act, National Historical Preservation Act, and other related environmental and cultural resource laws. These activities will culminate in an integrated feasibility planning report/NEPA/California Environmental Quality Act (CEQA) document.

1.5 EXISTING AGREEMENTS

The following subsections summarize existing agreements affecting the NODOS Investigation.

1.5.1 Clean Water Act Section 404 Memorandum of Understanding

The ROD includes a Memorandum of Understanding (MOU) between Reclamation, United States Environmental Protection Agency (EPA), the United States Army Corps of Engineers (Corps), and DWR regarding compliance with the Clean Water Act Section 404. Although the Corps cannot issue a 404 Permit based on the programmatic evaluations, the signatories agreed that the programmatic investigations contribute to the overall 404 evaluations.

1.5.2 Sites Reservoir Memorandum of Understanding

As directed by the CALFED ROD to develop a joint planning program through a MOU, DWR, Reclamation, 12 local water interests, and three other federal and state agencies signed a MOU in 2000 to cooperatively investigate north-of-the-Delta offstream storage.

1.6 REPORT ORGANIZATION

The following sections comprise this IAIR:

- Section 1. Introduction and Background
- Section 2. Related Studies, Projects, and Programs
- Section 3. Without Project Conditions
- Section 4. Problems, Needs, and Opportunities
- Section 5. Plan Formulation Approach
- Section 6. Resource Management Measures
- Section 7. Initial Alternatives
- Section 8. Future Actions
- Section 9. Summary of Findings
- Section 10. Study Management and Public Involvement
- Section 11. References
- Appendix A. Local Climate and Water Resources
- Appendix B. Geology and Soils

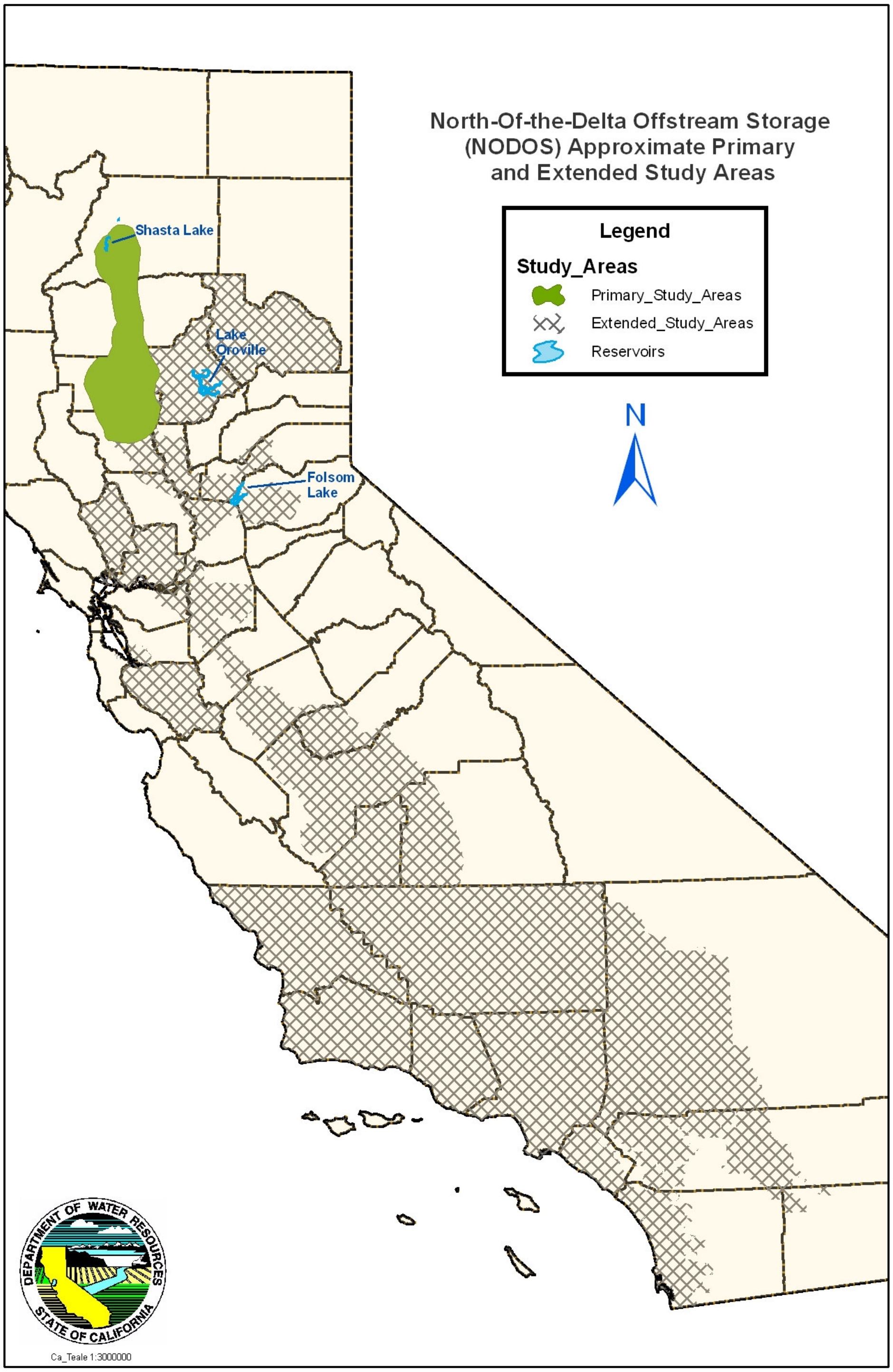

Figure 1-1. NODOS Study Areas

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- Appendix C. Botanical Surveys
- Appendix D. Biological Surveys
- Appendix E. Cultural Resource Surveys
- Appendix F. Preliminary Measures Screening – CALFED and NODOS Investigations
- Appendix G. Potential Reservoir Sites

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2. RELATED STUDIES, PROJECTS, AND PROGRAMS

This section presents the related activities of various federal and state agencies and numerous local working groups and private organizations in the study area. Many of these entities, including Reclamation, DWR, the California Bay-Delta Authority (CBDA), and the Corps, are currently performing or implementing studies, projects, and programs that are relevant to the NODOS Investigation.

2.1 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 in the study area, Reclamation has a significant effect on existing and future environmental resources in the region. Ongoing projects or continuing programs relevant to the primary study area are described below.

2.1.1 Central Valley Project

The CVP is the largest surface water storage and delivery system in California, with a geographic area covering 35 of California's 58 counties. The project includes the following elements:

- Twenty reservoirs, with a combined storage capacity of approximately 11 million acre-feet (MAF);
- Eight power plants and two pump-generating plants, with a combined generation capacity of approximately 2 million kilowatts (kW); and
- Approximately 500 miles of major canals and aqueducts.

The CVP supplies water to more than 250 long-term water contractors in the Central Valley, the Santa Clara Valley, and the San Francisco Bay Area. Shasta Reservoir currently supplies over 55% of the total annual water supply for the CVP.

Approximately 90% of CVP water is delivered to agricultural users, including prior water rights holders. The CVP has the potential to supply about 7 MAF annually to agricultural and municipal and industrial (M&I) customers and for environmental purposes. Of this 7 MAF, approximately 6.2 MAF is for agricultural uses, 0.5 MAF is for urban users, and 0.3 MAF is for wildlife refuges. Municipal CVP customers include the cities of Redding, Sacramento, Folsom, Tracy, and Fresno; most of Santa Clara County; and the northeastern portion of Contra Costa County. The CVP also provides flood control, navigation, power, recreation, and water quality benefits.

Operation of the CVP is directed by several regulatory requirements and agreements. Prior to passage of the CVPIA, operation of the CVP was affected by State Water Resources Control Board (SWRCB) Decisions 1422 and 1485 (D-1422 and D-1485) and the Coordinated Operations Agreement (COA). Decisions 1422 and 1485 identify minimum flow and water quality conditions at specified locations that are to be maintained in part through operation of the CVP. The COA specifies the responsibilities shared by the CVP and California's SWP for meeting the requirements of D-1485. In December 1994, representatives of the state and federal governments and urban, agricultural, and environmental interests agreed to implementation of the San Francisco Bay/Sacramento-San Joaquin River Delta (Bay-Delta) protection plan through the SWRCB to protect the ecosystem of the Bay-Delta Estuary. The Draft

Bay-Delta Water Control Plan, released in May 1995, superseded D-1485. Coordinated operations of the CVP and SWP continue to be based on the COA.

2.1.2 Operational Influences

CVP operations are influenced by general operating rules, regulatory requirements, and facility-specific concerns and requirements. Inflow and release requirements are the principal elements influencing reservoir storage. Operational decisions consider not only conditions at individual reservoirs but also downstream flow conditions at other project reservoirs. Storage space south of the Delta that can only be filled with water exported from the Delta is a major operational consideration involving the geographic distribution of water; it will impact the operation of a potential north-of-the-Delta project. Other factors that influence the operation of CVP reservoirs and, consequently, would influence a potential NODOS Investigation project include flood-control requirements, carryover storage objectives, lake recreation, power production capabilities, cold-water reserves, and pumping costs.

Rivers below some CVP dams support both resident and anadromous fisheries and recreation. While resident fisheries are slightly affected by release fluctuations, anadromous fisheries (e.g., salmon and steelhead) are the most sensitive and are present year-round downstream from some CVP facilities. Maintaining water conditions favorable to spawning, incubation, rearing, and out-migration of juvenile anadromous fish is one of the main objectives of CVP operations. CVP operations are coordinated to anticipate and avoid streamflow fluctuations during spawning and incubation, whenever possible.

2.1.3 CVP Water Users

During development of the CVP, the United States entered into long-term contracts in the Central Valley with many major water rights holders who belong to three major groups: (1) Sacramento River Settlement Contractors, (2) San Joaquin River Exchange Contractors, and (3) Water Service Contractors.

Members of Sacramento River Settlement Contractors primarily claim water rights on the Sacramento River. Because of the significant influence on flows in the Sacramento River, controlled by Shasta Dam, these water right claimants entered into contracts with Reclamation. Most of the agreements established the quantity of water the contractors are allowed to divert from April through October without payment to Reclamation and a supplemental CVP supply allocated by Reclamation.

San Joaquin River Exchange Contractors are contractors who receive CVP water from the Delta via the Mendota Pool. Under exchange contracts, the parties agreed not to exercise their San Joaquin River water rights in exchange for a substitute CVP water supply from the Delta. These exchanges allowed for water to be diverted from the San Joaquin River for use by water service contractors in the San Joaquin Valley and Tulare Lake Basin.

Before construction of the CVP, many irrigators on the western side of the Sacramento Valley, on the eastern and western sides of the San Joaquin Valley, and in the Santa Clara Valley relied primarily on groundwater. With completion of CVP facilities in these areas, irrigators signed agreements with Reclamation for delivery of CVP water as a supplemental supply. Several cities also have similar contracts for M&I supplies; these irrigators and cities are known as CVP Water Service Contractors. CVP water service contracts are between the United States and individual water users or districts and provide for an allocated supply of CVP water to be applied for beneficial uses.

2.1.4 Central Valley Project Improvement Act

The CVPIA was signed into law in October 1992. The general purposes of the CVPIA, as identified by Congress in Section 3402, include the following:

- Protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California;
- Address impacts of the CVP on fish, wildlife, and associated habitats;
- Improve the operational flexibility of the CVP;
- Increase water-related benefits provided by the CVP to the State of California through expanded use of voluntary water transfers and improved water conservation;
- Contribute to the State of California's interim and long-term efforts to protect the Bay-Delta Estuary; and
- Achieve reasonable balance among competing demands for CVP water, including water requirements for fish and wildlife, agriculture, M&I, and power contractors.

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 numerous specific measures and programs to meet the new project purpose and also directed the Secretary of the Interior to operate the CVP consistent with these purposes. The following sections of the CVPIA are important to the NODOS Investigation:

- Those focused on the dedication of a portion of CVP yield for environmental purposes;
- The Anadromous Fish Restoration Program (AFRP), which included a goal of doubling the natural production of anadromous fish in Central Valley rivers and streams;
- The Restoration Fund;
- Urban water supply reliability;
- Water transfers;
- Refuge water supplies;
- Restoration of the San Joaquin, Trinity, and Stanislaus Rivers; and
- A stakeholder process.

2.2 CALFED BAY-DELTA PROGRAM

The CALFED Bay-Delta Program is a cooperative effort among state and federal agencies and California's environmental, urban, and agricultural communities. The Governor of California and the President of the United States initiated work on the program in 1995 to address environmental and water management problems associated with the Bay-Delta system. CALFED has taken a broad approach to addressing four problem areas: (1) water quality, (2) ecosystem quality, (3) water supply reliability, and (4) levee system integrity. Many of the problems and solutions in the Bay-Delta system are interrelated. Program implementation began following circulation of the final Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/EIR) and signing of the ROD in August 2000.

The Preferred Program Alternative (PPA) in the CALFED ROD consists of programmatic elements that set the long-term direction of the CALFED program to meet its Mission Statement and objectives. The PPA has several interrelated programs and includes a series of actions to execute the programs. Implementation of the CALFED programs depends on authorization and funding from participating state and federal agencies. The PPA is expected to take 25 to 30 years to complete. Implementation is roughly divided into several stages, with Stage 1 lasting seven years.

In 2003, the State of California formed the CBDA to oversee the implementation of the CALFED Bay-Delta Program and to work cooperatively with 25 state and federal agencies to implement the CALFED PPA. The California Bay-Delta Act of 2003 established the CBDA as the new governance structure and charged it with providing accountability; ensuring balanced implementation, tracking, and assessment of CALFED Program progress; using sound science; assuring public involvement and outreach; and coordinating and integrating related government programs.

The CALFED Bay-Delta Program covers 12 major elements:

- Water Quality;
- Science;
- Water Management;
- Ecosystem Restoration;
- Levee System Integrity;
- Water Use Efficiency;
- Water Transfer;
- Watershed;
- Storage;
- Conveyance;
- Environmental Water Account; and
- Governance.

All aspects of the CALFED Bay-Delta Program are interrelated and interdependent. The success of all of the elements depends upon expanded and strategically managed storage. No single program element can address the problems, nor is any one element seen as a stand alone alternative to the others; all 12 program elements are essential.

2.2.1 CALFED Bay-Delta Program Mission Statement, Objectives, and Solution Principles

The mission of the CALFED Bay-Delta Program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system.

CALFED developed the following solution objectives:

- Provide good water quality for all beneficial uses;
- Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species;

- ❖ Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system; and
- ❖ Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees.

In addition, any CALFED solution must satisfy the following six solution principles:

- ❖ **Reduce Conflicts in the System –** Solutions will reduce major conflicts among beneficial uses of water.
- ❖ **Be Equitable –** Solutions will focus on solving problems in all problem areas. Improvements for some problems will not be made without corresponding improvements for other problems.
- ❖ **Be Affordable –** Solutions will be implementable and maintainable within the foreseeable resources of the program and stakeholders.
- ❖ **Be Durable –** Solutions will have political and economic staying power and will sustain the resources they were designed to protect and enhance.
- ❖ **Be Implementable –** Solutions will have broad acceptance and legal feasibility and will be timely and relatively simple to implement, compared with other alternatives.
- ❖ **Have No Significant Redirected Impacts –** Solutions will not solve problems in the Bay-Delta system by redirecting significant negative impacts, when viewed in their entirety, within the Bay-Delta or to other regions of California.

2.2.2 CALFED Programs

Major CALFED programs consist of Storage, Conveyance, Water Transfer, Environmental Water Account, Water-Use Efficiency, Water Quality, Levee System Integrity, and Ecosystem Restoration and Watershed Management. These programs are described below:

- ❖ **Storage** – The Water Storage Program seeks to develop additional storage capacity to help meet the needs of California's growing population and to provide increased system flexibility to help improve water quality and restore ecosystems. The program consists of increasing the storage capacity at existing reservoirs and strategically located offstream sites and implementing major expansion of groundwater storage. CALFED is looking at five major surface storage projects and additional groundwater storage to obtain broad water benefits. The five major surface storage projects include: Enlargement of Shasta Lake, 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 state and federal projects. The SDIP is comprised of two major components: (1) a physical/structural component that includes operable gates at up to four locations, channel dredging to improve conveyance, and modification of 24 agricultural diversions and (2) an operational component that includes raising the permitted diversion limit into the SWP Clifton Court Forebay from 6,680 cubic feet per second (cfs) to 8,500 cfs. The SDIP Draft EIS/EIR was released October 2005.

- **Water Transfer** – Potential water transfers are being evaluated to minimize the effects of a drought. Work is continuing on promoting an effective water transfer market that protects water rights, the environment, and local economies.
- **Environmental Water Account** – The EWA Program consists of two primary elements: (1) assisting fish population recovery for at risk native fish species and (2) increasing water supply reliability by reducing uncertainty associated with fish recovery actions. The EWA is aimed at adding flexibility to the state's water delivery system for providing water at critical times to meet environmental needs without water supply impacts on cities, farms, and businesses. The EWA gives water managers the tools to acquire, store, transfer, and release water strategically to respond to real-time ecosystem needs. By providing water that otherwise would not be available, EWA helps to resolve one of the Bay-Delta's most fundamental conflicts: the competing water needs of the environment and people. The EWA buys water from willing sellers or diverts surplus water when safe for fish, then EWA banks, stores, transfers, and releases the water as needed to protect fish and to compensate water users. The 2004 EWA Record of Decision (ROD) and Notice of Determination implement the EWA Flexible Purchase Alternative described in the final EIS/EIR through December 31, 2007. The CALFED ROD defined the EWA as a four-year program, unless EWA agencies agree to a program extension.
- **Water-Use Efficiency** – The goal of the Water-Use Efficiency Program is to aggressively make the best use of existing water supplies through defining appropriate water measurement, certifying urban best management practices (BMPs), and refining quantifiable objectives for agricultural water-use efficiency. The program supports local water conservation and recycling projects. Savings achieved by the Water-Use Efficiency Program will be accomplished through incentive-based, voluntary programs.
- **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. Among other projects, 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, agricultural lands, and environmental and aquatic habitat, primarily in the Delta.
- **Ecosystem Restoration and Watershed Management** – The ERP consists of improving the ecological health of the Bay-Delta watershed through restoring and protecting habitats, ecosystem functions, and native species. Primary program elements include (1) an annual grant program to fund local projects for habitat restoration, fish passage, invasive species management, and environmental water quality; (2) habitat restoration in the Delta and its tributary watersheds; (3) stream flow augmentation in upstream areas through voluntary water purchases; (4) fish passage improvements through modification or removal of dams, improved bypasses, and ladders; (5) integration of flood management and ecosystem restoration; (6) support for efforts to manage watersheds that affect the Bay-Delta system, development of watershed assessments and plans, and implementation of specific watershed conservation, maintenance, and restoration actions; and (7) management of the EWA.

2.2.3 Notice of Initiation of Federal Feasibility Studies

The CALFED Bay-Delta Program completed the Final Programmatic EIS/EIR in July 2000. The programmatic EIS/EIR identified potential surface reservoir sites and many possible groundwater storage sites. CALFED agencies adopted a ROD for the program in August 2000.

The ROD identified five surface storage projects to be pursued during the first stage of the CALFED program. Reclamation received feasibility study authority for three of those projects in the Omnibus Appropriations Act of 2003 (Public Law 108-7). Reclamation issued a Notice of Initiation of Federal Feasibility Studies on September 30, 2003, indicating that federal feasibility studies have been initiated for the NODOS Investigation, Los Vaqueros Expansion, and Upper San Joaquin River Basin Storage Investigation.

Specifically for NODOS, the Notice of Initiation of Federal Feasibility Studies indicated that according to the ROD and Public Law 108-7, up to 1.9 MAF of offstream storage at the proposed Sites Reservoir or other locations in the Sacramento Valley are being investigated. The proposed project would work with other projects in a balanced way to enhance water management flexibility, increase the reliability of supplies, reduce diversions on the Sacramento River during critical fish migration periods, and provide storage and operational benefits to other CALFED programs including Delta water quality and the EWA.

2.3 PROGRAM MANAGEMENT BY THE BUREAU OF LAND MANAGEMENT

DOI's Bureau of Land Management (BLM) is responsible for the administration of natural resources, lands, and mineral programs on approximately 250,000 acres of public land in northern California. BLM lands within the study area are located predominantly west of the Sacramento River and include 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 numerous restoration and conservation projects in area watersheds, including the Clear Creek Floodplain Restoration Project. BLM also has a responsible role in implementing the Northwest Forest Plan.

Over 40,000 acres of public lands along the Sacramento River between Redding and Red Bluff have been proposed for designation as National Conservation Areas. Designation as a National Conservation Area prevents construction of dams or other instream infrastructure and ensures continued public access to the lands. Other areas that have been proposed as National Conservation Areas or National Wilderness Destinations within the primary study area include the Backbone/Sugarloaf wilderness area, the Girard Ridge area (northeast of Shasta Lake), the Devil's Rock area adjacent to Squaw Creek near Shasta Lake, and the Beegum area in the Cottonwood Creek watershed. The BLM determined that 25 miles of the Sacramento River and about 7 miles of Paynes Creek are eligible for National Wild and Scenic River status, and BLM has acquired roughly 17,000 acres in the Sacramento River Bend management area. Congressional action is required to confirm these proposed designations.

2.4 NOAA FISHERIES SALMON AND STEELHEAD PROPOSED RECOVERY PLAN

National Oceanic and Atmospheric Administration (NOAA) Fisheries has designated critical habitat for the federally listed winter-run Chinook salmon to be the Sacramento River from Keswick Dam downstream to the Golden Gate Bridge. The Central Valley recovery planning domain also includes Central Valley spring-run Chinook salmon, Central Valley steelhead, and federal candidate species fall/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* (NMFS, 1997), presents restoration goals and actions, some of which would be applied within the NODOS Investigation study area. Proposed elements include the following.

- **Provide suitable water temperatures for spawning, egg incubation, and juvenile rearing between Keswick Dam and Red Bluff –** Actions include operating the CVP to consistently attain water temperature objectives, operating and maintaining temperature control curtains at Whiskeytown and Lewiston reservoirs, and regulating the river and reservoir system using a comprehensive temperature monitoring program and model.
- **Reduce pollution in the Sacramento River from Iron Mountain Mine –** Actions include alleviating pollution problems from the mine during winter-run incubation periods, treating and/or controlling heavy metal waste prior to discharge to the Sacramento River, diluting heavy metal waste discharges through effective water management, eliminating scouring of toxic metal-laden sediments in Spring Creek and Keswick reservoirs, and monitoring metal concentrations and waste flows.
- **Provide optimum flows in the Sacramento River between Keswick Dam and Chipps Island** – Actions include maintaining flows of 5,000 to 5,500 cfs from October through April, when possible; eliminating adverse flow fluctuations by modifying Anderson Cottonwood Irrigation District (ACID) dam operations, or by modifying or replacing the facility; and inventorying and assessing water withdrawal sites and taking action to increase stream flows.
- **Protect and maintain gravel resources in the Sacramento River and its tributaries between Keswick Dam and Red Bluff –** Actions include restoring and replenishing spawning gravel in the Sacramento River, implementing a plan to protect natural sources of spawning gravel along the Sacramento River and its tributaries, and controlling excessive silt discharges from tributary watersheds to protect spawning gravel.

Some of these actions are ongoing or are currently under study.

2.5 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY IRON MOUNTAIN MINE RESTORATION

EPA is involved in remediation and cleanup activities 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 significantly impacted the Spring Creek watershed and caused fish kills 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. Remedial actions taken to date have significantly reduced acid and metal contamination in surface water. Additional planned activities include construction of an acid mine drainage treatment plant in the Boulder Creek watershed.

2.6 UNITED STATES ARMY CORPS OF ENGINEERS SACRAMENTO VALLEY PROGRAMS

Numerous projects, programs, and studies by the Corps affect the Sacramento River and its tributaries. Flood control projects range from various 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 (Comp Study) made recommendations for actions that could influence flood damage reductions and ecosystem restoration conditions along the Sacramento and San Joaquin Rivers. These actions and a strategy for implementation were provided in an Interim Report developed in December 2002. The recommendations of the Comp Study may be incorporated into future studies.

2.7 CALIFORNIA DEPARTMENT OF WATER RESOURCES PROJECTS AND PLANS

This section presents DWR programs and projects that could affect the NODOS Investigation.

2.7.1 State Water Project

The SWP was authorized in 1959 and designated to readjust geographical imbalances between California's water resources and water needs. The project extends from Plumas County in the north to Riverside County in the south. Completed project elements include 23 dams and reservoirs, 6 power plants, 17 pumping plants, and 533 miles of aqueduct. The principal storage feature of the SWP is Lake Oroville, with a gross pool capacity of 3.5 MAF. Lake Oroville is on the Feather River, about 4 miles northeast of Oroville. Water released from Oroville Dam flows through the Feather and Sacramento Rivers to reach the Delta. The SWP delivers water to service areas of the Feather River basin, San Francisco Bay area, San Joaquin Valley, Tulare basin, and southern California. Major SWP conveyance facilities in the Central Valley include the North Bay, South Bay, and California aqueducts. The North Bay Aqueduct diverts water from the north Delta, near Cache Slough, for agricultural and M&I uses in Napa and Solano Counties. The South Bay and California aqueducts carry water from the Delta to the San Francisco Bay area and to southern California, respectively. In the southern portion of the Delta, the Harvey O. Banks (Banks) Pumping Plant lifts water into the California Aqueduct from the Clifton Court Forebay. At 444 miles, the California Aqueduct is the state's largest and longest water conveyance system, beginning at Banks Pumping Plant and extending to Lake Perris, south of Riverside in southern California.

The SWP has contracted a total of 4.23 MAF for average annual delivery in the San Joaquin Valley, central coast, and San Francisco and south coast areas. Of this amount, about 2.5 MAF is designated for the SWP water users in southern California, nearly 1.36 MAF for the San Joaquin Valley, and the remaining 370,000 acre-feet (AF) for San Francisco Bay, the central coast, and Feather River areas.

SWP contracts involve the Feather River Settlement Contractors and SWP Contract Entitlements. The Feather River Settlement Contractors are water users who hold riparian and senior appropriative rights on the Feather River. SWP Contract Entitlements are contracts executed in the early 1960s that established the maximum annual water amount (entitlement) that each long-term contractor may request from the SWP.

2.7.2 California Water Plan

The State DWR prepares and publishes the California Water Plan Update through its Bulletin 160 series. Seven versions of the plan were published between 1966 and 1998. These previous plans assessed California's agricultural, environmental, and urban water uses and associated supplies and then determined a current and future shortage or gap between supplies and uses. The 1998 plan also included a list of water management options that could be implemented to meet identified shortages.

The recently released 2005 Update was prepared using a collaborative process, with a 65-member advisory committee, an extended review forum, and input from the public. California Water Plan Update 2005 identifies pressing issues and includes a strategic plan presenting goals, policy recommendations, and actions to ensure sustainable water uses and reliable water supplies in the face of uncertainty and change. These uncertainties are recognized in the development of three 2030 water demand scenarios that demonstrate how numerous factors significantly influence future water demands.

The 2005 Update's direction for water management through 2030 includes three foundational actions to ensure sustainability and two initiatives for water resources reliability. Actions to ensure sustainability include (1) use water efficiently, (2) protect water quality, and (3) support environmental stewardship. Initiatives to ensure the reliability of water resources include (1) implement integrated regional water management and (2) maintain and improve statewide water management systems. The Water Plan Update also includes water balances for California, showing water uses and supplies for three recent years. The 2005 Update directs local, regional and state decision makers to select from a listing of 25 water resource management strategies available for potential use.

2.8 CALIFORNIA DEPARTMENT OF FISH AND GAME RESTORATION AND RECOVERY PROGRAMS

The California Department of Fish and Game (CDFG) 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 (ESA). CDFG participates in conservation planning, environmental compliance and permitting, coordinated resource management planning, and restoration and recovery programs. CDFG is involved in numerous investigations, projects, and monitoring activities in the study area, including fish passage, riparian restoration, and aquatic habitat restoration. The Wildlife Conservation Board (WCB), established under CDFG, administers a capital outlay program for wildlife conservation and related recreation projects.

2.9 INTERAGENCY ECOLOGICAL PROGRAM ON PELAGIC ORGANISM DECLINE

Over the last few years, abundance indices calculated by the Interagency Ecological Program (IEP) show unexpected declines in numerous pelagic fishes and zooplankton in the Upper San Francisco Estuary (the Delta and Suisun Bay). The recent low levels were unexpected, given the relatively moderate winter-spring flows of the past several years. The abundance indices have shown record or near record lows for delta smelt, striped bass, longfin smelt, and threadfin shad at various life stages. Monitoring has also indicated a substantial decrease in several species of zooplankton that serve as the primary food source for pelagic fishes during some stages of development. Studies on the decline of pelagic organisms represent an interdisciplinary, multi-agency effort including staff from CDFG, DWR, Reclamation, EPA, the United States Geological Survey (USGS), and the University of California campus in Davis, CA. IEP develops annual work plans to augment monitoring, perform new data analyses, and conduct special studies to investigate threats to pelagic fish and their prey. Conceptual modeling conducted by the IEP indicate that at least three factors, individually or in combination, contribute to lower pelagic productivity: (1) toxins, (2) invasive species, and (3) water project operations (IEP, July 2005).

2.10 SWRCB PHASE 8 DELTA WATER QUALITY REQUIREMENTS

After many years of struggling to develop water quality standards for the Delta, the Bay-Delta Accord (Accord) was signed by multiple partners in 1994. The Accord set water quality standards and required the SWRCB to determine which water users would be responsible to meet these standards. In 1995, SWRCB adopted a Water Quality Control Plan and proceeded to implement the Phase 8 requirements affecting Sacramento Valley water users. DWR and Reclamation, as operators of state and federal export projects, respectively, have claimed that certain water rights holders in the Sacramento Valley must cease diversions or release water from storage to help meet water quality standards in the Delta. Sacramento Valley users have claimed that their water use has not contributed to any water quality problems in the Delta and, as senior water rights holders and water users within the watershed and counties of origin, they are not responsible for meeting these standards.

Rather than continue these adversarial proceedings, Sacramento Valley water users, DWR, Reclamation, and export water users agreed to defer Phase 8 and instead, work in a more cooperative spirit to meet water supply, quality, and environmental needs in areas of origin and throughout California. This cooperation is evidenced in the Sacramento Valley Water Management Agreement (Agreement). The Agreement consists of four successive agreements: (1) Stay Agreement, (2) Short-Term Settlement Agreement, (3) Short-Term Project Implementation Agreements, and (4) Long-Term Agreements. The Agreement includes a process to resolve Phase 8 and related issues and a set of milestones for implementing short- and long-term projects. The Agreement also specifically identifies Sites Reservoir and Shasta Enlargement as potential long-term projects.

As part of the Short-Term Settlement Agreement, active parties developed a long-term work plan and expanded program to guide implementation of the Long-Term Agreements. The Short-Term Agreement will continue to 2014 or until it is replaced by the Long-Term Agreement. The Short-Term Agreement includes the following provisions.

- DWR and Reclamation remain obligated under a SWRCB order to meet Delta water quality standards during the term of the agreement.
- Unmet demands should be met in the Sacramento Valley, including 25,000 AF of CVP water supplies for use along the Tehama-Colusa Canal and assurances that Feather River supplies can be used in the Sutter Bypass/Butte Slough region during dry years.

During development of the Short-Term Agreement, a work plan was developed. The Short-Term Agreement work plan identified and evaluated approximately 45 projects (i.e., projects that could be implemented within one to two years), including conjunctive management and surface storage reoperation projects. These projects will be developed to provide up to 185,000 AF of capacity during below-normal, dry, and critically dry years. This capacity will be dedicated to two equal blocks. The first block (up to 92,500 AF) will be made available for local use within the local agency boundary. If this water is not needed locally, it will be made available to the CVP and SWP at a negotiated rate. The second block of water (up to 92,500 AF) will be provided to the SWP and CVP for Water Quality Control Plan relief.

2.11 OTHER FEDERAL, STATE, AND LOCAL PROGRAMS AND PROJECTS

Numerous other federal, state, and local programs and projects influence the development of water resources projects and programs in the Central Valley.

2.11.1 Sacramento River Conservation Area Program

California Senate Bill 1086 called for a management plan for the Sacramento River and its tributaries to protect, restore, and enhance both fisheries and riparian habitat. The Sacramento River Conservation Area Program has an overall goal of preserving remaining riparian habitat and reestablishing a continuous riparian ecosystem along the Sacramento River between Redding and Chico, and reestablishing riparian vegetation along the river from Chico to Verona. The program is to be accomplished through an incentive-based, voluntary river management plan. The Upper Sacramento River Fisheries and Riparian Habitat Management Plan, January 1989 (Resources Agency of California, 1989), identifies specific actions to help restore the Sacramento River fishery and riparian habitat between the Feather River and Keswick Dam. *The Sacramento River Conservation Area Forum Handbook* (Sacramento River Conservation Area Forum, 2003) is a guide to implementing the program.

The Keswick Dam to Red Bluff portion of the conservation area includes areas within the 100-year floodplain, existing riparian bottomlands, and areas of contiguous valley oak woodland, totaling approximately 22,000 acres. The 1989 fisheries restoration plan recommended several actions specific to the study area, including:

- Fish passage improvements at Red Bluff Diversion Dam (under way, project Draft EIS/EIR released August 2002);
- Modification of Spring Creek Tunnel intake for temperature control (completed);
- Spawning gravel replacement program (ongoing);
- Development of side-channel spawning areas, such as those at Turtle Bay in Redding (ongoing);
- Structural modifications to the ACID dam to eliminate short-term flow fluctuations (completed);
- Maintaining instream flows through coordinated operation of water facilities (ongoing);
- Improvements at the Coleman National Fish Hatchery (partially complete);
- Measures to reduce acute toxicity caused by acid mine drainage and heavy metals (ongoing);
- Various fisheries improvements on Clear Creek (partially complete);
- Flow increases, fish screens, and revised gravel removal practices on Battle Creek (beginning summer 2006); and
- Control of gravel mining, improvements of spawning areas, improvements of land management practices in the watershed, and protection and restoration of riparian vegetation along Cottonwood Creek.

2.11.2 Riparian Habitat Joint Venture

The Riparian Habitat Joint Venture (RHJV) was initiated in 1994 and includes signatories from 18 federal, state, and private agencies. The RHJV promotes conservation and the restoration of riparian habitat to support native bird population through three goals:

- Promote an understanding of the issues affecting riparian habitat through data collection and analysis;
- Double riparian habitat in California by funding and promoting on-the-ground conservation projects; and
- Guide land managers and organizations to prioritize conservation actions.

RHJV conservation and action plans are documented in the Riparian Bird Conservation Plan (RHJV, 2000). The conservation plan targets 14 “indicator” species of riparian-associated birds and provides recommendations for habitat protection, restoration, management, monitoring, and policy. The report notes habitat loss and degradation as one of the most important factors causing the decline of riparian birds in California. RHJV has participated in monitoring efforts within the Sacramento National Wildlife Refuge Complex and other conservation areas. 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 study area in general.

2.11.3 Resource Conservation Districts

There are numerous resource conservation districts (RCDs) within the study area. Once known as Soil Conservation Districts, RCDs were established under California law with a primary purpose to implement local conservation measures. Although RCDs are locally governed agencies with locally appointed, independent boards of directors, they often have close ties to county agencies and the National Resource Conservation Service. 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 RCD and the Tehama County RCD. 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.

2.12 OTHER PROGRAMS BY PRIVATE ORGANIZATIONS

There are many other programs and private organizations related to NODOS Investigation. Several groups have been active in the study area in the past decade and have helped in fishery recovery and watershed restoration. Several groups closely tied to the NODOS Investigation are described in this section.

- **Sacramento Watersheds Action Group** – The Sacramento Watersheds Action Group (SWAG) is a nonprofit corporation that secures funding for, designs, and implements projects that provide watershed restoration, streambank and slope stabilization, erosion control, watershed analysis, and road removal. SWAG has successfully worked with local groups, agencies, and organizations to fund and complete restoration projects on the Sacramento River and tributaries downstream from Keswick Dam. Their projects include development of the Sulphur Creek Watershed Analysis and Action Plan, the Whiskeytown Reservoir Shoreline Erosion Control Project, the Sulphur Creek Crossing Restoration Project, and the Lower Sulphur Creek Realignment and Riparian Habitat Enhancement Project. SWAG is a potential local sponsor for watershed restoration actions in the study area.
- **Sacramento River Watershed Program** – The Sacramento River Watershed Program is an effort to bring stakeholders together to share information and work together to address water quality and other water-related issues within the Sacramento River watershed. The group is funded congressionally through EPA. The program's primary goal is "to ensure that current and potential uses of Sacramento River watershed resources are sustained, restored, and where possible, enhanced while promoting the long-term social and economic vitality of the region."

  The Sacramento River Watershed Program manages grants for the Sacramento River Toxic Pollutants Control Program; performs extensive water quality monitoring, data collection, and data management for the watershed; and is instrumental in the study and monitoring of toxic pollutants. Although the program does not implement restoration projects, it is a potential provider of technical information for future water quality improvement programs in the study area.

- **Battle Creek Watershed Conservancy** – The Battle Creek Watershed Conservancy (BCWC) is actively involved in monitoring actions connected to the Battle Creek Salmon and Steelhead Restoration Project. BCWC participates in numerous working groups associated with projects on Battle Creek, including the Battle Creek Working Group, Adaptive Management Working Group, Coleman National Fish Hatchery meetings, Spring-Run Group, Steelhead Group, and CALFED Watershed Program Workgroup. BCWC administered the first phase of projects on Battle Creek, including conservation easements, noxious weed controls, and restoration in the lower watershed. The group is a potential partner in future restoration actions in the Battle Creek watershed.
- **Butte Creek Watershed Conservancy** – The Butte Creek Watershed Conservancy was formed in September 2005 to encourage the preservation and management of the Butte Creek watershed through cooperation between landowners, water users, recreational users, conservation groups, and local, state, and federal agencies. The Butte Creek Watershed Conservancy received non-profit status in November 1996 and shortly after prepared a MOU with 24 signatories to establish a voluntary and cooperative agreement to create the Butte Creek Watershed Management Strategy. The Butte Creek Watershed Conservancy working with Ducks Unlimited, the California Waterfowl Association, and other stakeholders developed alternatives to improve fish passage in the Butte Sink, Butte Slough, and Sutter Bypass sections of Butte Creek while maintaining the viability of agriculture, seasonal wetlands, and other habitats.
- **Sacramento River Preservation Trust –** The Sacramento River Preservation Trust is a private, nonprofit organization active in environmental education and advocacy to preserve the natural environmental values of the Sacramento River. The Trust has participated in various conservation and land acquisition projects, including securing lands for the Sacramento River National Wildlife Refuge. Although the group has had limited activity in the study area, it is pursuing designation of a portion of the Sacramento River between Redding and Red Bluff as a National Conservation Area (see previous discussion on BLM activities).
- **Shasta Land Trust –** The Shasta Land Trust is a regional, nonprofit organization dedicated to conserving open space, wildlife habitat, and agricultural land. The Trust works with public agencies and private landowners and is funded primarily through membership dues and donations. It employs various voluntary programs to protect and conserve valuable lands using conservation easements, land donations, and property acquisitions. Current efforts include work in the Cow Creek and Bear Creek watersheds. The Shasta Land Trust has purchased or negotiated conservation easements in Fenwood Ranch of southern Shasta County and various properties east of Redding. The Trust is a potential local partner for restoration activities in the Shasta Dam to Red Bluff subarea.
- **The Trust for Public Land** – The Trust for Public Land is a national, nonprofit organization involved in preserving lands with natural, historic, cultural, or recreational value, primarily through conservation real estate. The Trust's Western Rivers Program has been involved in conservation efforts along the Sacramento River between Redding and Red Bluff (the BLM's Sacramento River Bend Management Area), Battle Creek, Paynes Creek, Inks Creek, and Fenwood Ranch in Shasta County. The group promotes public ownership of conservation lands to ensure public access and enjoyment.
- **Cantara Trustee Council –** The Cantara Trustee Council administers a grant program that has provided funding for numerous environmental restoration projects in the primary study area, including programs in the Fall River watershed, Sulphur Creek, upper Sacramento River, Middle

Creek, lower Clear Creek, Battle Creek, Salt Creek, and Olney Creek. The Cantara Trustee Council is a potential local sponsor for future restoration actions in the primary study area. The Cantara Trustee Council includes representatives from CDFG, the United States Fish and Wildlife Service (USFWS), the Central Valley Regional Water Quality Control Board (RWQCB), California Sportfishing Protection Alliance, and Shasta Cascade Wonderland Association.

- **The Nature Conservancy –** The Nature Conservancy (TNC) is a private, nonprofit organization involved in environmental restoration and conservation throughout the United States and the world. TNC approaches environmental restoration primarily through strategic land acquisition from willing sellers and obtaining conservation easements. Some of the lands are retained by TNC for active restoration, research, or monitoring activities, while others are turned over to government agencies such as USFWS or CDFG for long-term management. Lower in the Sacramento River Basin, the TNC has been instrumental in acquiring and restoring lands in the Sacramento River National Wildlife Refuge and managing several properties along the Sacramento River. It also has pursued conservation easements on various properties at tributary confluences, including Cottonwood and Battle Creeks. Within the study area, TNC manages the McCloud River Preserve and lands within the Lassen Foothills Project.
- **California Trout –** California Trout (CalTrout) is a private, nonprofit organization with a mission to protect and restore wild trout and steelhead and their waters throughout California. CalTrout conservation priorities include the Wild Trout Campaign, grazing reform on public lands, hydropower and dam regulation, and the Steelhead Recovery Campaign. In 1999, CalTrout completed the Conservation Plan for the New Millennium (CalTrout, 1999), which sets forth restoration policies and details site-specific restoration projects or actions to support steelhead and trout fisheries statewide. CalTrout focuses much of its efforts on flow regulation, including the operation of dams and hydropower facilities to benefit native fisheries. CalTrout has been involved in numerous Federal Energy Regulatory Commission (FERC) dam relicensing projects, including current relicensing efforts on the Pit and Hat Rivers. Other activities include stream restoration and protection projects. CalTrout is a potential partner in future fisheries restoration programs in the study area.

2.13 COMMON ASSUMPTIONS FOR CALFED SURFACE WATER STORAGE PROJECTS

Both DWR and Reclamation are completing planning feasibility studies for other elements of the PPA described in the CALFED ROD. In addition to NODOS, Reclamation has initiated federal feasibility studies for the Los Vaqueros Reservoir Expansion, Upper San Joaquin River Basin Storage Investigation, and the Shasta Lake Water Resources Investigation. DWR has completed a draft FS Report for the In-Delta Storage Project; however, Reclamation currently lacks FS authority for the In-Delta Storage Project. These other efforts are noted because of the interdependence of these elements with the NODOS Investigation in comprising the PPA.

DWR and Reclamation, in coordination with the California Bay-Delta Authority, initiated the Common Assumptions process to develop consistency and improve efficiency among the surface storage investigations. While each of these investigations addresses a unique purpose to meet different combinations of water supply reliability, water quality, and environmental needs, all of the investigations share some common requirements that include completing planning reports and feasibility studies and associated alternatives analyses to comply with CEQA, NEPA, and Clean Water Act Section 404 requirements. To ensure that the surface storage project teams use consistent assumptions and analytical approach, the Common Assumptions effort will define the CEQA (existing) and NEPA (future no-action) baseline conditions and develop common analysis tools, common model codes, common policy decisions, common regulatory assumptions, common analytical approaches and methodologies, and common reporting metrics for model results for use by the storage investigations in the Plan Formulation and Feasibility Study Reports.

3. WITHOUT-PROJECT CONDITIONS

Defining existing resource conditions and how these conditions might need to change in the future is one of the most important aspects of any water resources investigation. The magnitude of change influences the scope of the problems, needs, and opportunities, as well as the possible actions taken to address them. Identification of the magnitude of potential water resource problems and related problems and needs in the study area, is based on the existing conditions and how these conditions could change in the future. In addition, environmental impacts will be evaluated for state and federal environmental documents based on conditions with and without a NODOS project. State and federal environmental laws have somewhat different requirements related to without-project conditions and analysis of environmental impacts.

- NEPA requirements – For an EIS, impacts associated with a reasonable range of alternatives, including a no-action alternative, are evaluated for future conditions. Actions that can be reasonably expected to occur in the future are included in discussion and analyses, for development of the EIS. This often includes projects and actions that are currently authorized, funded, permitted, and/or highly likely to be implemented.
- CEQA requirements – For an EIR, the no-project alternative is to be evaluated, assuming "existing conditions" or conditions at the time the Notice of Preparation was issued. An EIR should also discuss future no-project conditions that are reasonably expected to occur.

The future conditions analysis associated with identifying and meeting problems, needs, and opportunities and environmental impact analysis will be based on similar assumptions. The future conditions are based mostly on extensions of existing conditions.

A reliable and realistic portrayal of future without-project conditions is essential to NODOS and the CALFED surface storage investigations in general. The uncertainty of the state's water resources future is demonstrated in the three "plausible" 2030 water demand scenarios described in the 2005 California Water Plan Update. These scenarios indicate a range of 2030 demands that vary by almost 4.5 MAF, depending significantly on variable assumptions related to implementation of the CALFED complementary actions. In this report, CALFED complementary actions consist of implementation of specific CALFED program elements including Water Use Efficiency (i.e., conservation and recycling) and Water Transfers.

As progress continues under CALFED's programmatic implementation guidance, the surface storage investigations seek to describe as clearly as possible implementation of these other essential CALFED program elements. The assumptions related to the future of each of these elements, or CALFED complementary actions, will affect first the future without-project conditions and then consequently, potential project benefits and impacts. These investigation assumptions indicate that these CALFED complementary actions will be implemented with or without NODOS implementation in this case.

The Bay-Delta Program envisioned all of the CALFED complementary actions would be implemented concurrently to achieve the breadth and depth of benefits identified within the CALFED solution area. The complementary nature of these CALFED actions is explicitly described in the ROD:

> *All aspects of the CALFED Program are interrelated and interdependent. Ecosystem restoration is dependent upon water supply and conservation. Water supply depends upon water use efficiency and consistency in regulation. Water quality depends upon*

improved conveyance, levee stability and healthy watersheds. The success of all of the elements depends upon expanded and more strategically managed storage.

The ROD description of the Storage Program in the Preferred Program Alternative is also helpful, noting that, "groundwater and surface water storage can be used to improve water supply reliability, provide water for the environment at times when it is needed most, provide flows timed to maintain water quality, and protect levees through coordinated operation with existing flood control reservoirs." In addition, "storage will be developed and constructed, together with aggressive implementation of water conservation, recycling, an improved water transfer market, and habitat restoration, as appropriate to meet CALFED Program goals."

CALFED, Reclamation, and DWR ultimately initiated the Common Assumptions process to provide a reliable picture of California's water resources future that will significantly rely on implementation of all CALFED's complementary actions listed above. Common Assumptions is developing a comprehensive water resources future with quantitative estimates of CALFED complementary actions that reflects these CALFED program commitments. In addition, Common Assumptions is tracking implementation of non-CALFED water resources actions that may need to be integrated into the without-project future condition. A more detailed description of each CALFED complementary action is included in Section 3.2.7.

3.1 EXISTING CONDITIONS

Existing physical, biological, social and economic, land use, water supply, cultural, transportation, and recreation conditions are described in this section, focusing on the primary study area. Additional information on these existing conditions and those in the extended study area, including the Sacramento-San Joaquin Delta and the SWP and CVP service areas, will be contained in future documents for the NODOS Investigation.

3.1.1 Physical Environment

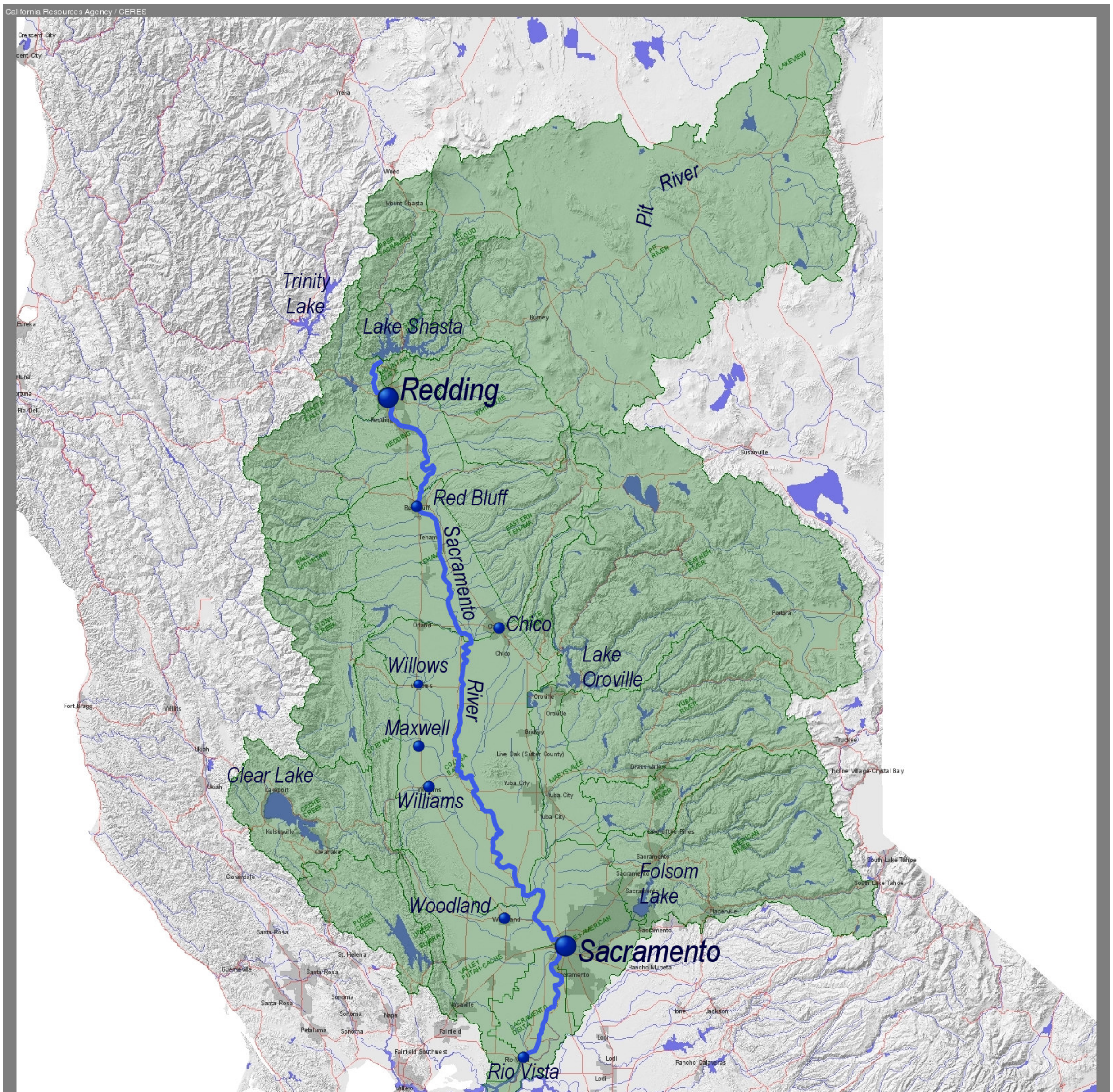
Alternative reservoir locations for the NODOS project are all within the Coast Range foothills along the western edge of the northern Sacramento Valley. Figure 3-1 illustrates the watersheds of the Sacramento River. Relevant watershed information associated with the river is also shown on the figure.

3.1.1.1 Topography

The physical topography of the watersheds draining the eastern side of the Coast Range toward the Sacramento Valley is diverse. The topography encompasses steep, rugged, mountainous terrain within the upper watersheds, rolling foothills in the proposed project areas, and relatively flat alluvial terrain as the watersheds enter the Sacramento Valley. Elevations range from less than 40 feet above sea level on the valley floor to over 8,000 feet along the Coast Range divide.

3.1.1.2 Climate

The climate of the watersheds draining into the western Sacramento Valley is typically Mediterranean (detailed descriptions are provided in Appendix A). Winters are rainy and relatively mild, with only occasional freezing temperatures at the lower elevations; summers are comparatively dry and hot. The rainy season normally begins in September and continues through March or April. Rains may continue for several days at a time, but are usually gentle. Summer rains are rare, as are thunderstorms and



Sacramento River Hydrologic Region Statistics

- Area – 27,246 square miles
- Average annual precipitation – 36.7 inches
- Year 2000 population – 2,593,110
- Year 2030 projected population – 4,569,490
- Total reservoir capacity – 16,146 thousand-acre feet
- Year 2000 irrigated agriculture – 2,037,900 acres

Figure 3-1. Sacramento River Watershed

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hailstorms. Thunderstorms occur about 10 days per year in the Sacramento Valley, occasionally producing high-intensity rainfall of short duration. Most precipitation is associated with migrant storms that move across the area during winter. Snow is the dominant form of precipitation above the 5,000-foot elevation and persists on northern- and eastern-facing slopes into the early summer.

Because the majority of precipitation falls in the winter months, many local streams are ephemeral with little or no flow from July through October. However, these streams tend to respond rapidly to significant rainfall events. Flash flooding with substantial overland flow has been observed. Flows recorded at the stream gage on Stone Corral Creek in the western Sacramento Valley are representative of the flow variability in these small ephemeral streams. Annual discharge varied from zero in 1972, 1976, and 1977 to 39,930 AF in 1963, and it averages 6,500 AF. Monthly flows in excess of 15,000 AF have been documented.

3.1.1.3 Geology and Soils

Rock underlying the NODOS primary study area is part of the Great Valley geomorphic province, which is mostly sandstone, mudstone, and conglomerate. The Great Valley geomorphic province is bounded to the west by the Coast Ranges province, to the north by the Klamath Mountains province, to the northeast by the Cascade Range province, and to the east by the Sierra Nevada province (Appendix B provides a detailed description of geology and soils).

The NODOS primary study area has very few groundwater resources. The area is underlain by the Great Valley Sequence rocks and locally by Quaternary terrace deposits. Groundwater is found in fractures in the Great Valley Sequence and in the sands and gravels in the terrace deposits. Springs occur where the terrace deposits terminate or where water-bearing fractures encounter the surface. Several springs also occur in the Great Valley Sequence rocks, where faults create subsurface dams that cause groundwater to reach the surface. Not all fractures or faults contain groundwater, nor do all terrace deposits have groundwater.

3.1.1.4 Air Quality

Air Pollution Control Districts have been established for Colusa, Glenn, and Tehama Counties. Each county monitors similar contaminants, including ozone and particulate matter. Detailed site-specific air quality information is not available. Colusa County is a non-attainment area for both particulates less than 10 microns in size (PM_{10}) and ozone, under state and federal criteria. Tehama County is considered a moderate non-attainment area for both ozone and PM_{10} under the California Clean Air Act; however, levels of both contaminants there are within federal criteria. Glenn County air quality meets both state and federal air quality standards for ozone and PM_{10}.

3.1.2 Biological Resources

The following subsections identify biological resources, such as vegetation, aquatic and fishery, and wildlife resources, within the study area.

3.1.2.1 Vegetation

The watersheds of Sacramento Valley west-side streams contain a variety of vegetative communities (botanical surveys are summarized in Appendix C). These include white fir, Klamath mixed conifer, Douglas fir, ponderosa pine, closed-cone pine-cypress, montane hard wood conifer, montane hardwood, blue oak woodland, valley oak woodland, blue oak foothill pine, montane riparian, valley foothill riparian, montane chaparral, mixed chaparral, chamise-redshank chaparral, annual grassland, and cropland.

Vegetation within the primary study area for NODOS is varied by the influence of local soils, geology, microclimate, hydrology, aspect, and elevation, as well as other physical and biological factors. Grassland habitat frequently occurs throughout the study area. This upland plant community of herbaceous annual grasses and herbs is characteristically composed of many non-native species and a limited number of native species. Species composition is highly variable among stands and throughout the growing season. Vernal pools and swales within the annual grassland community support unique assemblages of native wetland plant species.

Chaparral communities occur in varying amounts at or near each of the proposed project locations. These stands frequently occur in a continuous canopy with little or no understory. Other shrub and tree species, including poison oak and manzanita, form a mosaic in some chaparral stands.

Riparian vegetation is associated with both intermittent and permanent streams. Common riparian overstory species include Fremont's cottonwood, willow, and Mexican elderberry.

Two types of oak woodland were identified within the primary study area: valley oak woodland and blue oak woodland. Valley oak woodlands are found along the major tributaries and valley bottoms. This vegetative community may include other native tree and shrub species. Blue oak woodland occurs at or near each of the proposed projects. Blue oak is the dominant or sole canopy species in these woodlands. An annual grassland understory is common, and a shrub layer composed of manzanita and wedgeleaf ceanothus can occur. Blue oak woodlands occur primarily on moderately rocky to well-drained slopes. Limited amounts of wetlands occur within the areas suitable for new storage facilities.

3.1.2.2 Aquatic and Fishery Resources

The watersheds of the North Coast Range draining east toward the Sacramento Valley contain native and non-native species, warm-water and coldwater species, and anadromous and resident fish species. At least 24 species of fish are present in these watersheds. Several state or federally listed fish species occur in the region, including steelhead and various runs of Chinook salmon. Coldwater habitats are present in the upper watersheds of the major streams, including Cottonwood Creek and Beegum Gulch.

Several environmental surveys have been conducted in the primary study area to verify the existence of various species. Fishery evaluations have been performed at various tributaries to the Sacramento River, including Antelope, Stone Corral, Funks, Logan, Hunters, Minton, Thomes, Cottonwood, and Red Bank and the Colusa Basin Drain. Antelope, Stone Corral, Funks Logan, Hunters and Minton Creeks are all ephemeral streams and do not provide coldwater habitat, nor do these streams provide suitable rearing habitat for anadromous species.

Thomes Creek below Paskenta usually dries up except for a few residual pools scattered along the streambed during the late summer, making it impossible for resident adult fish to live there throughout the summer months. Some adult game fish such as largemouth bass and smallmouth bass, bluegill, and green sunfish ascend the creek from the Sacramento River during the late spring and early summer to use these pools as spawning areas. The Lower Thomes Creek watershed contained a diverse assemblage of fish species that included runs of fall-run, late fall-run and spring run Chinook salmon and steelhead.

Runs of fall-run, late fall-run, and spring-run Chinook salmon in lower Cottonwood Creek and spring-run Chinook salmon and steelhead in South Fork Cottonwood Creek have been identified.

Fall-run Chinook salmon ascend Cottonwood Creek and spawn in late October through November and spawn in from the mouth to the confluence of North Fork Cottonwood Creek. Late fall-run Chinook salmon migrate up Cottonwood Creek and spawn in January. Spring-run Chinook salmon migrate up Cottonwood Creek in April and spend the summer in deep pools in South Fork Cottonwood Creek, Beegum Gulch, and North Fork Cottonwood Creek. Most are found in Beegum Gulch. Some young Chinook salmon from the Sacramento River use the lower reach of Cottonwood Creek from Interstate-5 to the mouth for rearing during the summer and fall.

Steelhead have been identified within the Red Bank Creek watershed.

The most significant findings of the studies were the presence of fall-run Chinook salmon, late fall-run Chinook salmon, spring-run Chinook salmon, and steelhead in Cottonwood Creek. The presence of steelhead in Red Bank Creek was also a significant finding.

Appendix D provides greater detail on fisheries survey results.

3.1.2.3 Wildlife

A wide variety of wildlife species use habitat within the primary study area either seasonally or year-round. Surveys are ongoing for the presence of state and federally listed species. However, substantially less information has been collected on non-listed species density and distribution.

State or federally listed wildlife species have been studied and documented. These include wintering bald eagles (state endangered, federal threatened), wintering sandhill cranes (state threatened), a migrating bank swallow (state threatened), and one red-legged frog (federal threatened). Numerous federal species of concern, California Species of Special Concern, federal Migratory Nongame Birds of Management Concern, or candidate species occur within the primary study area.

Several CDFG harvest species occur within the primary study area. Upland game includes black-tailed deer, black bear, feral pig, gray squirrel, wild turkey, California and mountain quail, and mourning dove. Waterfowl use is generally restricted to winter use of stock ponds, small lakes, and refuges, including the Sacramento National Wildlife Refuge Complex. Limited wood duck and mallard nesting also occurs within stock ponds and along the stream channels where adequate brooding water exists.

According to the California Natural Diversity Database maintained by CDFG, several federally listed invertebrate species may occur within the primary study area. These species include valley elderberry longhorn beetle, vernal pool fairy shrimp, conservancy fairy shrimp, and vernal pool tadpole shrimp (see Appendix D).

3.1.3 Socioeconomic Resources

Existing social and economic resources described in this section include population, employment, local government, and utilities and public services.

California's population is projected to increase from 36.5 million to about 48 million by 2030 and to nearly 55 million by 2050. The population of the Sacramento and San Joaquin River basins portions of the Central Valley is expected to increase from approximately 4.4 million people in 2000 to about 7 million people by 2020 and to 10 million in 2040. 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.

In California, counties, school districts, fire districts, water districts, and other special districts provide local government services. The local governmental units operating within the Sacramento River Valley had combined revenue of almost $8.8 billion, based on 1997 census data.

California has the largest and most diverse economy in the nation, with an annual gross state product of more than a trillion dollars, which represents 13.5% of the gross national product of the United States (State of California Commerce and Economic Development Program Web site). The state's economy is based on agriculture, mineral extraction, biotechnology, telecommunications, computer technology, electronic products, transportation equipment (particularly aerospace products), fabricated metal products and machinery, food processing, business services, and tourism. The economy of the central and northern counties of the Central Valley is based on lumbering, the manufacturing of wood products, farming, and food processing. The northern and central counties of the Central Valley have rates of unemployment varying from 4.1% (Solano County) to 17.6% (Colusa County).

Various departments within the cities and counties of the Sacramento River Valley provide fire protection, police protection, and emergency services to members of their communities. A vast network of utility generation/transmission systems and service providers exists across all regions of the study area, supplying urban and rural areas with power, water, and emergency services. Other significant infrastructure consists of hydroelectric and natural gas-fired generating facilities, transmission lines, substations, distribution lines, fiber optic and cable lines, and communication towers. Pipelines, storage areas, and compressor stations also are located in the Sacramento Valley.

3.1.4 Land Use

The watersheds draining the eastern slope of the Coast Range are subject to a variety of land use practices. Upper elevations are primarily commercial forest lands and managed for timber production, outdoor recreation, and grazing. Foothill areas are currently managed primarily for livestock grazing. Some foothill valleys support dryland grain or orchard production. Mineral extraction activities have occurred historically in various locations throughout foothill and mountain areas. Sacramento Valley portions of the watersheds support a wide variety of agricultural uses, including livestock grazing, irrigated grain and truck crops, and orchards.

3.1.5 Water Supply

As described in the California Water Plan Update 2005, a big challenge now and for the future is to assure that water is in the right places at the right times. Challenges will be greatest during dry years. Water dedicated to the environment is curtailed sharply in these years. Greater reliance on groundwater during dry years results in higher costs for many users. At the same time, water users who have already increased efficiency may find it more challenging to achieve additional water use reductions during droughts. As competition grows among water users, water management during dry years will become more complex and, at times, contentious.

From a statewide perspective, California meets most of its water management objectives in most years. Water conservation, recycling, and infrastructure improvements, such as storage and conveyance facilities, have helped to ensure most urban demands are met. Except in multiyear droughts, most urban areas have sufficient supplies for existing populations. Cities use about the same amount of applied water today as they did in the mid-1990s, but they accommodate 3.5 million more people. Water conservation and demand reduction strategies are expected to continue playing a prominent role in achieving future goals (DWR, 2006).

In addition, most agricultural water demands in the Sacramento Valley are met in average water years. Farmers have learned to grow more crops per acre-foot of applied water by improving productivity and efficiency. For example, from 1980 to 2000, the annual statewide harvest increased by 40% measured in tons of crops per acre-foot of applied water. However, in some areas, water sources once used for agriculture are now used for urban needs, environmental restoration, and groundwater replenishment. Even in average water years, some growers forego planting and other agricultural operations because they lack a firm water supply.

However, environmental requirements are not always met, though a considerable amount of water is dedicated to restoring ecosystems. Many flow regimes no longer resemble natural hydrographs, largely because of efforts to manage water storage and diversions to meet competing demands. Ecosystem needs and their response to flow, however, are not sufficiently understood, but significant scientific advancement is taking place. Improvements are being made with ecosystem needs integrated with water management and project operations.

Table 3-1, California Water Balance Summary, illustrates how water supply changes in below-average, above-average, and average years, as well as where the water is distributed.

California has not experienced the hardships and environmental pressures of a prolonged statewide drought since the early 1990s, but similar or worse conditions of unreliable water supplies will recur. During long or extreme droughts, water supplies are less reliable, heightening competition and at times leading to conflicts among water users. Water quality is degraded, making it difficult and costly to make it drinkable. Business and irrigated agriculture are adversely affected, jeopardizing California's economy. Ecosystems are strained, jeopardizing sensitive and endangered plants, animals, and habitats. Groundwater levels decline, and many rural residents who depend on small water systems or wells run short of water.

California's most severe recorded drought statewide occurred in 1976 and 1977. Two consecutive years with little precipitation (the fourth driest and the driest year in recorded history) left California with record low storage in its surface reservoirs and dangerously low groundwater levels. Socioeconomic and environmental impacts were very severe during these extreme drought conditions. The total loss from this drought exceeded $2.5 billion ($6.5 billion in today's dollars).

The most recent prolonged statewide drought lasted six years, from 1987 to 1992. During the drought's first five years, the groundwater extractions in San Joaquin Valley exceeded the recharge by 11 million AF, which caused increased land subsidence in some areas. DWR studies indicate that from 1990 to 1992, the drought resulted in reduced gross revenues of about $670 million to California agriculture. Energy utilities were forced to substitute hydroelectric power with more costly fossil-fuel generation at an estimated statewide cost of $500 million in 1991. The drought also adversely affected snow-related recreation businesses; some studies suggest a loss of about $85 million during the winter of 1990 to 1991.

Since the drought of 1987 to 1992, many notable changes, increases in water demands, changes in regulations, and improvements in conservation and infrastructure, have occurred that will alter the impacts of future droughts. In addition, the following factors will have an effect.

- California's population has increased to about 36.5 million people as of July 1, 2004.
- The SWRCB adopted Decision 1630 in 1995, which requires higher flows to protect the Delta.
- Completion of construction of the Coastal Aqueduct (DWR), Morongo basin pipelines (Mojave Water Agency), Diamond Valley Lake (Metropolitan Water District), Los Vaqueros Reservoir

(Contra Costa Water District), and five large-scale groundwater recharge/storage projects should add flexibility in operating the water system.

- Despite the increase in population, advances in water conservation and recycling, combined with infrastructure improvements, including new storage facilities, have helped meet most demands. Cities use about the same amount of applied water today as they did in the mid-1990s, but they accommodate 3.5 million more people.
- The Colorado River Quantification Settlement Agreement has been adopted, limiting Southern California's access to Colorado River water.

3.1.6 Cultural Resources

Several historic and prehistoric sites occur within the primary study area. Prehistoric settlement in the project area was constrained by the limited food and fuel resources and the scarcity of water. However, the area would have been important for seasonal hunting and gathering forays. The larger and more permanent villages were situated along the lower reaches of the bigger streams and on the knolls and natural levees along the Sacramento River.

Information on historic sites, features, and standing structures is incomplete at this time. Working ranches, occupied buildings, and towns have constrained the scope of investigations performed to date. There are known cemeteries within the primary study area that would have to be relocated if affected by a future project. As a result of some detailed, site-specific investigations, these focused cultural resources surveys have identified resources within the study area that require more detailed study in the future (see Appendix E).

3.1.7 Transportation

U.S. Interstate 5 provides the primary north-south corridor throughout the study area. Colusa County Road, Glenn County Roads 60 and 69, State Highway 162, and Tehama County Roads provide access to the west of Interstate 5. There are small airports in the cities of Willows, Red Bluff, and Orland, and a larger airport in Redding.

3.1.8 Recreation

Recreational activities within watersheds of the streams flowing through the project areas include hiking, hunting, fishing, camping, boating, mountain biking, and off-road vehicle use. Most of these activities occur primarily on public lands in the Mendocino National Forest and associated private timberlands. Little public access into the foothills private grazing lands occurs. However, public recreation areas are present within the foothills portion of the Stony Creek watershed at Black Butte Lake and Stony Gorge and East Park Reservoirs. Waterfowl and upland game bird hunting are the primary recreational use activities within the Sacramento Valley portions of these watersheds.

Recreational use and opportunity are currently very limited within the primary study area. Almost all lands are privately owned and posted against trespass, thus preventing general public access. Recreational activities that do occur are primarily by landowner families, their friends, and employees. Upland game birds (dove, quail, and pheasant); black-tailed deer; and feral pigs are the most commonly hunted species within the primary study area. Commercial hunting operations for feral pig, blacktailed deer, and wild turkey may operate on individual landholdings. Numerous stock ponds within the potential project areas are large enough to support bass, catfish, and sunfish. Angling pressure for these ponds appears to be generally low.

Table 3-1

California Water Balance Summary

(Source: DWR, 2006)

	State Summary (MAF)			Sacramento River (TAF)			San Joaquin River (TAF)		
	1998 (171%)[a]	2000 (97%)[a]	2001 (72%)[a]	1998 (168%)[a]	2000 (105%)[a]	2001 (67%)[a]	1998 (171%)[a]	2000 (97%)[a]	2001 (72%)[a]
Total supply (precipitation and imports)	336.9	194.7	145.5	90,351	58,217	36,564	40,727	28,497	20,010
Total uses, outflows, and evaporation	331.1	200.5	159.8	86,859	59,469	40,124	38,922	28,527	22,707
Net storage changes in state	**5.8**	**-5.8**	**-14.3**	**3,492**	**-1,252**	**-3,560**	**1,805**	**-30**	**-2,697**
Distribution of dedicated supply (includes reuse) to various applied water uses									
Urban uses	7.8 (8%)	8.9 (11%)	8.6 (13%)	727.3 (3%)	859.6 (4%)	877.2 (5%)	562.5 (5%)	594.0 (5%)	622.8 (6%)
Agricultural uses	27.3 (29%)	34.2 (41%)	33.7 (52%)	6,458.2 (27%)	8,713.9 (38%)	8,567.1 (45%)	5,458.1 (47%)	7,034.1 (57%)	7,154.2 (67%)
Environmental water[b]	59.4 (63%)	39.4 (48%)	22.5 (35%)	16,397.8 (70%)	13.487.6 (58%)	9,587.7 (50%)	5,604.5 (48%)	4,637.1 (38%)	2.930.1 (27%)
Total dedicated supply	**94.5**	**82.5**	**64.8**	**23,583.3**	**23,061.1**	**19,032.0**	**11,625.1**	**12,265.2**	**10,707.1**

maf = million acre-feet
taf = thousand acre-feet

[a] Percent of normal precipitation. Water year 1998 represents a wet water year; 2000 represents an average water year; 2001 presents a drier water year.
[b] Environmental water includes instream flows, wild and scenic flows, required Delta outflow, and managed wetlands water use. Some environmental water is reused by agricultural and urban water users.

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There are also recreational opportunities near the Red Bluff Diversion Dam on the Sacramento River. Red Bluff Reservoir is located 2 miles southeast of the city of Red Bluff. From May 16 through September 14, the operable gates of the Red Bluff Diversion Dam are closed forming the seasonal lake, Lake Red Bluff. This seasonal lake is approximately 3 miles long with approximately 200 surface acres. Lake Red Bluff provides a cold-water fishery for trout, steelhead, and salmon, and other recreational opportunities in the form of sailing, jet skiing, water skiing, and drag boat racing. Lake Red Bluff is home to the Nitro Nationals Drag Boat Festival.

3.2 FUTURE WITHOUT-PROJECT CONDITIONS

Identification of the magnitude of potential water resources and related problems and needs in the study area is based not only on the existing conditions described in this chapter, but also on an estimate of how these conditions may change in the future. The future without-project condition is a projection of the most reasonably foreseeable actions that will occur if no project is implemented over the life of the project. Future without-project conditions will be used to assess and discuss environmental effects in compliance with CEQA and NEPA.

3.2.1 Physical Environment

Basic physical conditions in the study area are expected to remain relatively unchanged in the future. No changes to area topography, geology, or soils are foreseen. From a geomorphic perspective, ongoing restoration efforts along rivers are expected to marginally improve natural riverine processes. Without major physical changes to the river systems, hydrologic conditions will probably remain unchanged. There is growing concern that the region’s hydrology will be altered by global climate change. Scientific work in this field of study is continuing. The potential effects on California’s hydrology and management of its water resources need to be evaluated. This investigation will integrate relevant information as new tools and analyses become available.

Much effort has been expended to control the levels and types of herbicides, fungicides, and pesticides that can be used in the environment. Efforts are under way to better manage the quality of runoff from urban environments to the major stream systems. However, water quality conditions are expected to remain generally unchanged and similar to existing conditions. Air pollutants in the study area will continue to be influenced by urban and agricultural land uses. As the population continues to grow, and agricultural lands are converted to urban centers, a general degradation of air quality conditions could occur.

With California’s population projected growth to nearly 46 million by the year 2020, California’s demand on groundwater will increase significantly. In many basins, the ability to use groundwater optimally will be affected by overdraft and water quality. Groundwater pumping will continue to increase in response to growing urban and agricultural demands. Over the long term, groundwater extraction cannot continually meet the portion of water demands that are not met by surface water supplies without causing negative impacts on the groundwater basin. Groundwater overdraft is the condition of a groundwater basin in which the amount of water withdrawn by pumping over the long term exceeds the amount of water that recharges the basin. Overdraft can lead to increased extraction costs, land subsidence, water quality degradation, and environmental impacts. It is estimated that overdraft is between 1 million and 2 million AF annually statewide, with most of the overdraft occurring in the Tulare Lake, San Joaquin River, and Central Coast hydrologic regions (DWR, 2003). A serious consequence of long-term groundwater overdraft is land subsidence, or a drop in the natural land surface. Land subsidence can result in a permanent loss of aquifer storage space and may cause damage to public facilities, such as canals, utilities, levees, pipelines, and roads.

3.2.2 Biological Environment

Significant efforts are under way by numerous agencies and groups to restore various biological conditions throughout the study area, including elements of the CALFED program, the Upper Sacramento River Conservation Area program, efforts by TNC and other private conservation groups, and numerous other programs and projects. Accordingly, major areas of Sacramento Valley wildlife habitat, including wetlands and riparian vegetation areas, are expected to be protected and restored. However, as population and urban growth continue and land is converted to urban uses, many wildlife species especially dependent on agricultural habitats, such as rice fields, may be impacted.

Implementation programs and projects in the Sacramento Valley to help restore fisheries resources also are being pursued. Although significant increases in anadromous and resident fish populations in the Sacramento River are likely to continue through the implementation of projects, such as the Battle Creek Restoration Project, these gains may be offset as a result of other actions, such as a reduction in Sacramento River flows, with elevated water temperatures, as a result of reduced diversions of cooler water from the Trinity River. Accordingly, populations of anadromous fish are expected to remain generally similar to existing conditions. In addition, significant efforts of federal and state wildlife agencies supporting populations of special-status species in the riverine and nearby areas will generally remain similar to those under existing conditions.

3.2.3 Socioeconomic Conditions

Based on 2000 population statistics, the population of California will increase 30% by 2020 and 70% by 2040, whereas the population of the Sacramento Valley will increase 45% by 2020 and 90% by 2040. California’s population is estimated to increase from about 35 million in 2000 to nearly 60 million by 2040. The population of the Sacramento Valley is expected to increase from approximately 2.6 million people in 2000 to about 5 million in 2040. To support these expected increases in population, some conversion of agricultural and other rural land to urban uses is anticipated. The modification and expansion of existing traffic routes in the Central Valley also is anticipated in response to the growing population.

Anticipated increases in population growth in the Central Valley will result in increased demands on water resources systems for additional and reliable water supplies, energy supplies, water-oriented facilities, recreational facilities, and flood damage reduction facilities.

3.2.4 Energy and Power

Recent trends in electricity use are driven by economics and population growth, while average consumption per customer has not changed much. California electricity peak demand levels generally fluctuate with summer temperature variations. California faces several options in its efforts to ensure a balance between supply and demand. Traditionally, loads are served by generating facilities. However, because California’s electric peak demand is almost completely caused by summertime air conditioning loads that show sharp peaks, reductions in demand due to demand responsiveness programs may be effective in balancing supply and demand. Substantial monetary, environmental and system performance benefits may result from using demand responsiveness to ensure California’s electricity system remains reliable (California Energy Commission, 2002).

3.2.5 Cultural Resources

Any paleontological, historical, archeological, or ethnographic resources currently being affected by erosion associated with water-level fluctuations in Funks Reservoir and resource sites contiguous to streams or watercourses (within the NODOS Investigation study area) will continue to be affected. Fossils and artifacts located around the perimeter of the study area will continue to be subject to collection by recreationalists.

3.2.6 Recreation

Recreational activities within watersheds of the streams flowing through the project areas will remain relatively unchanged and will still include hiking, hunting, fishing, camping, boating, mountain biking, and off-road vehicle use. Recreation will continue to remain on public lands in the Mendocino National Forest and associated private timberlands and public recreation areas within the Stony Creek watershed.

Recreational use and opportunity will remain very limited within the primary study area because almost all the land is privately owned and posted against trespass.

There is potential for some loss of recreation near the Red Bluff Diversion Dam. To improve fish passage at the Red Bluff Diversion Dam, there may be action to reprogram the operable gates of the Dam with a different flow schedule.

3.2.7 CALFED Complementary Actions

The relationship between CALFED complementary actions and the surface storage investigations (including NODOS) is described in the CALFED ROD and the introduction to this section. These actions will complement any surface storage alternative considered in the planning process. The surface storage investigations assume that these actions will be implemented in a complementary manner to storage and are therefore incorporated into the Common Assumptions evaluation and the future without-project condition. New surface storage is not included in the future without-project condition. These complementary actions include the following.

- ❖ Water Use Efficiency – CALFED seeks to accelerate implementation of cost-effective actions of its WUE program to conserve and recycle water throughout the state. As with the EWA, it is believed that some form of this program will develop and continue into the long-term future.
- ❖ Water Transfers – CALFED seeks to stretch existing water supplies by promoting transfers from willing sellers to buyers. DWR, Reclamation, and SWRCB have signed an MOU and are implementing the CALFED Water Transfer Program.

3.2.8 Water Resources Infrastructure/Operations

Several significant projects are expected to be implemented in the future in and near the primary study area and are included in the analysis of meeting problems, needs, and opportunities as well as NEPA and CEQA impact analysis associated with future conditions (for consideration with or without the addition of a new storage facility north of the Delta). These projects include the following.

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

- Folsom Dam Modifications – Modifications consist of 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 is a cooperative short-term management program to provide protection to fish of the Bay-Delta estuary through changes in the SWP/CVP operations with no uncompensated water costs to project water users. The program appears to be successful and is being evaluated as a long-term action.
- South Delta Improvements Program – DWR and Reclamation are the lead agencies for the SDIP. The SDIP objectives are to provide for more reliable long-term export capability by state and federal water projects, protect local diversions, and reduce impacts on San Joaquin River salmon. The SDIP includes construction of an operable gate at the head of Old River, construction of up to three operable gates in south Delta channels, and an increase in the permitted pumping capacity at Banks Pumping Plant from 6,680 cfs to 8,500 cfs during certain periods. Because the SDIP is still in the planning stage and has not been approved, it may or may not be included in the future without-project condition. The decision on whether to include SDIP in the future without-project condition will be made in the Plan Formulation phase. A draft EIS/EIR was released in November 2005.
- Trinity River Restoration Plan – The December 2000 ROD for the Trinity River Restoration Plan is being implemented. This includes reducing annual exports to the Sacramento River from 74% of Trinity River flows 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 will be implemented, including dedication of a portion of 185,000 AF of water for environmental needs. It is likely that the portion of the water not requiring construction of new infrastructure will be made available. The Phase 8 Short Term EIS/EIR is scheduled for release in Summer 2006.
- Operations Criteria and Plan (OCAP) – Numerous actions contained in the 2004 revision to the 1992 OCAP will be implemented to address how the CVP and SWP would be operated in the future, as several projects come on line and as water demands increase.
- Other Projects – Various other projects and programs are expected to be implemented in the future, including the Battle Creek Restoration Project, CVP contract renewals, Freeport Regional Water Project, and further implementation of the CVPIA (b) (2) water accounting.

4. PROBLEMS, NEEDS, AND OPPORTUNITIES

Problems and Needs

- Water supply reliability
- Water supply
- Water management flexibility
- Anadromous fish survival
- Water quality
- Environmental

Opportunities

- Recreation
- Hydropower generation
- Flood control

The most significant elements of any water resources investigation are identifying the scope and magnitude of problems to be solved and discovering and articulating the needs and opportunities to be addressed for all affected resources. This requires the concise and accurate identification of existing resource conditions (provided in Section 3.0) and associated trends or changes to these conditions in the future. The identification of problems, needs, and opportunities provides a foundation for formulating alternative plans to solve the problems and needs and realize opportunities. This section presents the discovery and significance of existing resource conditions associated with the NODOS Investigation.

While the problems and needs presented in this section are described as water system problems, inherent to these are some of the problems and needs of other areas, discussed in this section as "opportunities."

4.1 WATER SUPPLY RELIABILITY

According to the California Water Plan 2005 Update (DWR, 2006), the biggest challenge facing California water resources management remains making sure that water is in the right places at the right times. As expected, this challenge is at its greatest during dry years when surface water available for all beneficial uses is greatly decreased. Those water users with access to alternate supplies, such as groundwater, utilize them, often at higher costs. Water users already incorporating water-use efficiency measures may find it more challenging to achieve additional water-use reductions. Water flows for instream uses, such as fisheries and water quality, generally are reduced in accordance with dry-year step-down provisions contained in the requirements or standards requiring the flows.

As competition grows among water users, management of the highly constrained and regulated water system becomes more challenging, complex, and, at times, contentious. 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 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 run short of water. Local, regional, state, 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.

The Upper Sacramento River and Northern Sacramento Valley suffer from a water supply reliability problem associated with the consistent and expedited delivery of water to downstream environmental, agricultural, and urban users. Present conditions along the Upper Sacramento River at times delay the delivery of water to specified locations at designated times.

Reliability is defined as delivering water to a particular location, for a beneficial purpose, with a desired quality, at a particular time. For example, the Ecosystem Restoration Program may require a certain quantity and quality of water to be delivered to a particular point at a particular time to meet a specified environmental need (e.g., to provide spawning habitat for Delta smelt or longfin smelt). Reliable delivery of water to meet this need requires that the water be available and that California's water system be able to deliver it where it is needed at the appropriate time. CALFED couples this requirement with the need for environmental restoration in the Bay-Delta system.

Water supply reliability is one of four primary interrelated objectives of the CALFED Program. Water supply reliability integrates the water supply elements of storage, conveyance, and quality. The CALFED ROD specifically addressed the linkage of storage to successful implementation of all other CALFED program elements:

> *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.*

Therefore, the basic need being investigated by the NODOS Study Team is improvement of the water supply systems in the Sacramento Valley Region and California to more reliably serve all the beneficial uses that rely upon it. This would reduce the competition and conflict over how water resources are used and allocated.

4.2 WATER SUPPLY

The CALFED PPA 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 Bay-Delta drainage produces an average annual runoff of approximately 22 MAF. Total reservoir capacity in this drainage area is approximately 15 MAF, including 2.4 MAF of capacity in Trinity Lake, which captures runoff from a 692-square-mile drainage area outside of the Bay-Delta watershed.

The California Water Plan Update 2005 (DWR, 2006) presents three plausible demand scenarios for 2030. The water demand associated with year 2000 and the three 2030 water demand scenarios for average water years are shown in Table 4-1. For all three scenarios, 2 MAF per year of water will be needed by 2030 to eliminate groundwater overdraft statewide.

As shown in Table 4-1, for the three baseline scenarios, statewide water demand ranges from a reduction of about 0.4 MAF per year to an increase of 4.0 MAF per year. Additionally, to meet the need of eliminating statewide groundwater overdraft, demands for the three scenarios increase from 1.6 to 6.0 MAF. These demands cannot be used as direct indicators of future shortages. Some areas of the state have existing or planned resources to provide for these projected needs; many areas do not. New urban demand, driven by projected population increases, makes up a majority of future demand increases. Agricultural demand decreases significantly in each scenario.

There is additional information in the Water Plan Update related to describing the state's water resources needs. For example, an additional 1 MAF of currently unmet environmental demand has been identified, including flows recommended by CALFED's Ecosystem Restoration Program and CVPIA's Anadromous Fish Restoration Program and refuge water supply. In the demand summary above, 50% of that amount is

Table 4-1

Water Demand Under Three Future Scenarios (MAF)

Water Demand	2000	Year 2030 by Scenario		
		Current Trends	Less Resource Intensive	More Resource Intensive
Urban	8.9	11.9	10.3	14.7
Agricultural	34.2	30.8	31.4	32.4
Environmental	39.4	39.9	40.4	39.4
Total	**82.5**	**82.6**	**82.1**	**86.5**
Demand Change (2000-2030)		**-0.1**	**-0.4**	**4.0**
Eliminate Groundwater Overdraft		2.0	2.0	2.0
Demand Change (including overdraft)		**1.9**	**1.6**	**6.0**

shown in the Current Trends scenario, 100% is shown in the Less Resource Intensive scenario, and no additional environmental demand is shown for the More Resource Intensive scenario. Water supplies for these additional environmental demands have not been identified.

Shortages can occur within the Sacramento River basin under normal conditions, and the demand for water is rising. The Sacramento Region's CVP contractors and settlement contractors are subject to dry-year deficiencies. These contractors seek a greater degree of water supply reliability. Direct diversions to contractors often conflict with the needs of sensitive species, thereby shortening the available diversion period. CVP operations within the basin are especially vulnerable to droughts. According to several CALFED CALSIM simulations, full contract deliveries to CVP agricultural water service contractors north of the Delta can only be made in 75% of the years, based on recent conditions.

Because the Bay-Delta diversions supply approximately 75% of the water used in California, regional water shortages affect the entire state. CVP water supply conditions south of the Delta are even more problematic. By the year 2020, full contract deliveries to agricultural water service contractors will occur in approximately 50% of the years, based on recent conditions, while full contract deliveries for south of Delta municipal contractors will occur in 70% of the years. These forecasts indicate the need to augment water supplies for Delta exporters.

Water supply reliability simulations indicate that the SWP also lacks long-term reliability. Maximum contractual obligations for the SWP from Delta pumping stations are approximately 4.1 MAF. Of this maximum contract amount, the SWP has delivered a maximum contract amount of 3.2 MAF in 2000, or approximately 78%. According to reliability simulations, 3.0 to 4.1 MAF will be requested in 2021, depending on weather and associated hydrologic conditions. Average water delivery using historic hydrology and 2021 level demands is 3.1 MAF, approximately 75% of the maximum contract amount. The lowest SWP delivery during this simulation is 800 thousand acre-feet (TAF), only 19% of the maximum contract amount. This again illustrates the conclusion from the Water Plan Update that drought conditions present the most significant challenge to water managers.

4.3 WATER MANAGEMENT FLEXIBILITY

Because of highly seasonal precipitation and the fact that annual runoff can vary greatly from year to year, California has developed an elaborate network of storage and delivery systems to supply cities, farms, businesses, and the environment with adequate water year-round. A need exists to improve California's water management (operational) flexibility to provide improved statewide water supply reliability and improved access to affordable water supplies. As both urban and agricultural water use and recognition of environmental water needs have increased, so have conflicting demands for limited water supplies in a highly constrained and regulated system. Water management flexibility can create significant benefits for the system including, but not limited to, more rapid response to meeting all urban, agricultural, and environmental water quality regulatory standards; rapid response to unexpected and unpredicted incidents, such as Delta levee breaks that can shut down the SWP, CVP, and Bay Area export operations in the Delta; and means to meet aquatic flow standards and provide aquatic restoration benefits in the valley rivers and in the Delta (while maintaining supply reliability to other urban, agricultural, and environmental beneficial water uses).

As noted previously, there is growing concern amongst scientists and water managers associated with potential impacts of global warming on California's water resources. One of the more significant impacts identified is related to the state's reliance on Sierra and Trinity snowpack storage. Estimates of a 3-degree Celsius rise in temperature in California would raise snow levels up to 1,500 feet, with a corresponding loss of up to 5 MAF of April 1 snowpack storage. The system flexibility afforded by additional reservoir storage could mitigate the loss of snowpack storage resulting from global climate change.

The Bay-Delta system diversion point provides the water supply for a wide range of in-stream, riparian, and other beneficial uses, including drinking water for millions of Californians and irrigation water for agricultural land. As both water use and the recognition of environmental water needs have increased during the past several decades, conflicts have increased among users of Bay-Delta water. In response to declining fish and wildlife populations, water flow and timing requirements have been established for certain fish and wildlife species. Over the past decade, several protective actions, including the CVPIA and the 1995 Bay-Delta Water Quality Control Plan, have reduced the ability of the SWP and CVP to contribute to statewide water supply reliability. These protective actions have restricted SWP and CVP operational flexibility, affecting the quantity, quality, and timing of deliveries from the projects. CALFED has estimated that these two protective actions have reduced water contract deliveries by over 1,000,000 AF annually during dry periods.

There are water shortage losses that demand-management measures cannot prevent, such as compromised water quality, loss of crop yield from delayed or inadequate irrigation, or loss of fish because of reduced stream flow or increased water temperature. These issues highlight the need for system flexibility, allowing water to be available at the proper time and place, and for the duration it is needed. This flexibility is essential to capitalize on the ability to carry water over from one year to the next.

4.4 CVP, CALFED, AND RELATED ENVIRONMENTAL CONCERNS

The need and opportunity for Sacramento River and Bay-Delta ecosystem restoration are well documented by the CALFED program and others. Providing storage north of the Delta would allow water to be diverted from the Sacramento River during periods when outflows and water quality are less problematic for endangered, threatened, or sensitive species.

The CVPIA redefined the purposes of the CVP to include protection, restoration, and enhancement of fish, wildlife, and associated habitats and protection of the Bay-Delta Estuary as having equal priority with other purposes. The CVPIA required the dedication of an additional 800,000 AF of CVP yield to the restoration of fish, wildlife, and habitat purposes and redirected between 368,000 to 815,000 AF of water normally diverted into the Central Valley to remain as instream flows on the Trinity River (DOI, 1999). The average (weighted by water-year class probability) annual water volume required for the Trinity River is estimated at approximately 594,500 AF. The CVPIA also directed Reclamation to provide full Level 4 supplies from willing sellers to wildlife refuges identified in the Refuge Water Supply Plan and the San Joaquin Basin Action Plan, amounting to approximately 129,000 AF of additional refuge water supply. CVPIA also includes dedicating a portion of the CVP yield to the Anadromous Fish Restoration Program, which includes a goal of doubling anadromous fish in the Central Valley and streams. These operational mandates for environmental purposes reduced Sacramento River and Bay-Delta CVP supplies.

Current water supply storage on the Sacramento River limits the amount of water available for environmental purposes. The CALFED ERP seeks to acquire new sources of water to improve conditions for spawning, rearing, and migration of myriad fish species in the Sacramento River and the Delta. New storage supplies could provide the means to meet CVPIA Refuge Water Supply and other in-Delta environmental objectives. Accordingly, a need exists to provide water supplies for the environment and provide the flexibility in the system necessary to improve environmental conditions 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.

4.5 ANADROMOUS FISH SURVIVAL

Today, less than 5% of the approximately 500,000 acres of riparian forest that historically fringed the Sacramento River remains. Most of the land adjacent to the river is protected by levees, such as the river section from the Chico Landing to the Delta. In addition to levees, upstream development has changed the landscape of the Sacramento River. Dams have blocked access to over 80% of spawning and rearing habitat historically available to Chinook salmon and steelhead.

In addition to blocking the spawning migrations of Chinook salmon and steelhead, the operations of upstream dams and in-Delta pumping facilities and diversions have altered natural flow regimes by changing the frequency, magnitude, timing, and direction of flow. These changes could affect all fish species in the rivers, Delta, and Bay. Salmon and steelhead are particularly susceptible to poor water conditions.

There are many other issues that affect the survival of anadromous fish. Reservoirs created by dams act as settling basins for coarse sediment and organic material, diminishing sediment movement and degrading downstream spawning and rearing habitat. Inactive and abandoned mine drainage have created conditions that are toxic to aquatic species, as well have discharges from urban and M&I areas. Agricultural areas can discharge potentially harmful herbicides and pesticides. Discharges from any source can also increase turbidity. Water temperature conditions that adversely affect downstream species have been created by removal of riparian vegetation, reservoir operations, agricultural drainage, and channel modification (CALFED, 2000).

Turbidity, temperature, dissolved oxygen, bromide, chloride, and nitrogen affect these species in each aspect of their reproductive cycle. For example, temperatures in the upper Sacramento River spawning beds must be kept near 56 degrees Fahrenheit (°F) to allow salmon and steelhead incubation and smolt survival.* 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 fresh water incubation and rearing requirements than do several salmon species because they 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.

These requirements have altered water management operations in the Sacramento River and the Bay-Delta. For a period after the large dams were constructed, reservoirs were kept relatively full, and the cold water released from the hypolimnion provided cooler summer temperatures in the downstream reaches. Since the early 1980s, however, reservoirs have been drawn down farther 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.

At present, a need exists within the NODOS Investigation area for the ability to change system-wide operations to improve the adequacy of anadromous fish migration flows. Four seasonal runs of Chinook salmon occur in the Central Valley system or, more accurately, in the Sacramento River drainage area, with each run being defined by a combination of adult migration timing, spawning period, juvenile residency, and smolt migration periods. Fish losses have been the prominent indicator of Bay-Delta environmental decline. Facilities constructed to support water diversions cause straying or direct losses of fish and can increase exposure of juvenile fish to predation.

The following fish species are among those affected by water operations in the Sacramento River and Bay-Delta: the federally and state endangered winter-run Chinook salmon, the federally and state threatened Delta smelt, the federally threatened Central Valley steelhead evolutionary significant units (ESU), the federally and state threatened Central Valley spring-run Chinook salmon, the green sturgeon listed as a California Species of Special Concern, and the federally threatened Sacramento splittail. 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, river lamprey, white sturgeon, and American shad. Further, several non-fish species have the potential to be impacted by system-wide water operations, such as the western pond turtle and the valley elderberry longhorn beetle, both federally and state endangered species that depend on riparian habitat in the Delta and Sacramento River.

As illustrated in this section, historical water management practices have greatly affected anadromous fish survival, but in turn, species water requirements affect current water operations. The listing of several fish species in the Sacramento River and Delta under state and federal species protection laws has greatly influenced system-wide water supply operations. Each listed species has specific water supply requirements that mandate state and federal projects manage releases to meet species' needs. Timing reservoir releases to meet critical needs is difficult because Lake Shasta and Lake Oroville are many miles away from targeted reaches further downstream or in the Delta.

In 1966, the gates on the Red Bluff Diversion Dam (RBDD) remained in place all year. In 1986, the gates were raised from early December to late March to accommodate federally endangered winter-run Chinook salmon. By 1996, the current pattern of eight months of gates-out operation was in force. Water

* Experts disagree on the range of temperatures that various evolutionarily significant units (ESUs) of salmon need for survival in different life stages.

cannot be diverted into the Tehama-Colusa Canal when the gates are raised; thus, when irrigation demands begin in earnest in late March and April, operational constraints reduce the Tehama-Colusa Canal Authority's (TCCA's) ability to meet demand for irrigation water.

In the Delta, water management also has been impacted by fishery requirements. Delta pumps must cease pumping when threats to salmon and Delta smelt livelihood exist. Adjustments of pumping operations in the Delta to meet broad environmental objectives have further constrained water supplies. In 1978, the SWRCB adopted Decision 1485 (D-1485), setting water quality standards, export limitations, and minimum flow rates for both the SWP and CVP. These conditions sought to simultaneously protect all beneficial uses in the Bay-Delta. Later SWRCB decisions, such as D-1641 and the Bay-Delta Water Quality Control Plan (D-95-06), further constrained pumping operations in pursuit of the same objectives. All of these conditions continue to affect supply reliability for all uses in the Sacramento River and Bay-Delta, including environmental uses.

4.6 WATER QUALITY

Nonpoint-source pollution, including urban and agricultural runoff, is the largest contributor of human-induced contamination of surface water and groundwater in the state. Regarding surface water, about 13% of the total miles of California's rivers and streams and about 15% of its lake acreage are listed as impaired. Regarding groundwater, samples analyzed from all 10 hydrologic regions showed that 5 to 42% of public water supply wells exceeded one or more drinking water standards, depending on the region. The exceedance was usually for inorganic chemicals or radioactivity and, in particular, nitrate, which presents a known health risk. Largely agricultural or industrial regions had high percentages of exceedances for pesticides and volatile organic chemicals, respectively. Seawater intrusion in the Delta and in coastal aquifers, agricultural drainage, and imported Colorado River water can increase salinity in all types of water supplies, adversely affecting many beneficial uses. The quality of California water is of particular and growing concern. Degraded water quality can limit, or make very expensive, some water supply uses or options because the water must be pretreated.

The NODOS Investigation study area currently has a need for improved water quality. Improved water quality in the Bay-Delta is needed for drinking water, agriculture, and environmental restoration. Water quality is a function of the physical and chemical composition of a source of water supply. 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.

Water of a specific quality and temperature is also required to ensure species survival and sustain habitat in the Bay-Delta system to support a diversity of fish and wildlife populations. 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 in order to reproduce. The survival of Delta smelt increases as the Delta's "X2" line (the line in the Delta connecting points with a salinity concentration of 2 parts per million) moves downstream toward San Francisco Bay. In addition, the ideal temperature of Delta water for Delta smelt is 71.6°F, but they cannot survive at all if water temperatures exceed 77°F. Accordingly, there is a need to provide water of sufficient quality to meet biological needs, such as those of the Delta smelt. This requirement manifests as the need for a supply of fresh water at a certain temperature and the ability to deliver that supply when it is needed.

The Bay-Delta system is the diversion point of drinking water for millions of Californians and is critical to the state's agricultural sector. Drinking water standards are dynamic. The potential for increasingly stringent drinking water requirements that require new treatment technologies is spurring water providers to seek higher-quality source waters and to address pollution in source waters. The salts entering the Bay-

Delta system from the ocean and from return flows upstream and within the Delta decrease the utility of Bay-Delta system waters for many purposes, including the ecosystem, agriculture, and drinking water. Accordingly, there is a need to improve source water and system-wide operations to meet drinking water quality standards.

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 the peak loading time related to agricultural drainage. Because water supply needs are greatest in these months, given direct demand requirements, the need for enhanced water quality in the NODOS Investigation study area becomes crucial. However, 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. In particular, May and June have proven to be sensitive Delta smelt months, with elevated take at the export pumps.

Increasing Delta outflow in fall months through reservoir releases would reduce other chemical concentrations in Delta drinking water diversions. For example, preliminary modeling studies conducted by CALFED suggest that, depending on the amount of outflow enhancement and assuming some Delta conveyance improvements, peak reduction of bromide in the south Delta in fall months could be in the range of 20% to 30%. With additional storage facilities north of the Delta, peak fall bromide concentrations could be lowered by as much as 30% to 50% in many years, including the driest ones. Export management strategies also could be implemented to reduce organic carbon loads in drinking water diversions. Export reductions during periods of peak organic carbon loading, in February and March, also would benefit Delta fisheries. Accordingly, there is a need to reduce toxin accumulation in Delta drinking water through better upstream water management and water supply augmentation.

Drainage is another aspect of Delta water quality. Urban and agricultural runoff can carry toxins into the Delta that can infiltrate drinking water, be introduced into the aquatic food chain, or remain latent on the bed or banks of a water body. Preventing toxins from entering water sources is a key priority of CALFED. CALFED also acknowledges that removing or diluting toxins with increased non-toxic fresh water flows or flushing them from the Bay-Delta system into the ocean is beneficial. Therefore, there is a need for enhanced water quality to increase flows into the Delta when toxins are most likely to affect fisheries, drinking water quality, or the environment.

4.7 OTHER OPPORTUNITIES

CALFED documents recommend that opportunities to address other regional water resources needs be considered in the evaluation of all potential projects. This investigation will consider opportunities for power generation and recreation, to the extent possible.

4.7.1 Hydropower Generation

According to the California Energy Commission, California's electric peak demand is almost completely caused by summertime air conditioning loads that create sharp peaks in demand. Traditionally, loads are served by generating facilities but responsiveness programs may also be effective in balancing supply and demand. Recent trends in electricity use are driven by economics and population growth. As population increases in the Sacramento Valley and throughout California, demands for electricity will continue to grow rapidly. 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 grid.

4.7.2 Recreation

Recreational activities within watersheds of the streams flowing through the study area include hiking, fishing, camping, boating, mountain biking, and off-road vehicle use. Recreational use and opportunity are currently very limited within the study area, and demands for water-oriented recreational opportunities in the Sacramento River Basin are high. Some of these demands are served by reservoirs on the western slope of the Sierra Nevada Mountains. However, as population increases in the Sacramento Valley, demands for flat water, river, and land-based recreation are expected to increase.

4.7.3 Flood Protection

Improvements to the water management system may provide opportunities to increase flood protection by allowing better coordination of various Sacramento region reservoirs to provide for additional flood storage space at selected on stream reservoirs, including Folsom, Oroville, and Shasta.

4.8 SUMMARY

Table 4-2 summarizes the problems, needs, and opportunities and shows the relationship to the potential planning objectives.

Table 4-2

Problems, Needs, and Opportunities Relative to Planning Objectives

Problems and Needs	Planning Objectives
Water Supply Reliability – Reliably delivering water to meet urban, environmental, and agricultural requirements requires both the availability and timely delivery of water to where it is needed.	Increase water supply reliability for agricultural, M&I, and environmental purposes by enhancing water management flexibility for the Sacramento Valley.
Water Supply – Current and future demands for water in California exceed available supplies during many years. The Preferred Program Alternative in the CALFED Record of Decision identified a need for up to 6 million acre-feet of new storage in California, including up to 3 million acre-feet of storage north of the Bay-Delta.	Increase water supplies for agricultural, M&I, and environmental purposes to help meet California's current and future water demands.
Water Management Flexibility – As water use and recognition of environmental water needs have increased, so have conflicting demands for limited water supplies in a highly constrained and regulated system. Water management (operational) flexibility can create significant benefits for the system including, but not limited to more rapid response to meeting urban, agricultural and environmental water quality regulatory standards; rapid response to unexpected and unpredicted incidents such as Delta levee breaks that can shut down the SWP, CVP, and Bay Area export operations in the Delta; and more options and means to meet aquatic flow standards and provide aquatic restoration benefits in the valley rivers and in the Delta.	Enhance water management flexibility by providing additional diversion, storage, and delivery opportunities.
Anadromous Fish Recovery – Water resources facilities and operations including levees, dams, and diversions have affected the survivability of anadromous and other fish populations associated with the Sacramento River and Delta. Other negative effects are related to land use changes, habitat conversion, and water quality degradation due to introduced impurities. Four anadromous and two resident fish species have received state or federal designations as threatened, endangered, or of special concern.	Increase the survival of anadromous fish populations in the Sacramento River and improve the health and survivability of other aquatic species.
Water Quality – The Delta is a source of drinking water for over 20 million Californians and provides vital habitat for over 750 plant and animal species. The CALFED water quality program goal is to improve Delta water quality beyond current regulatory requirements for all beneficial uses, including urban, agricultural, and environmental uses.	Improve Delta water quality.

Table 4-2
(Continued)

Opportunities	Planning Objectives
Environmental – Water managers need more effective tools to strategically acquire, store, transfer, and release water in response to real-time ecosystem needs. Flexibility in the state's water delivery system is necessary for providing water at critical times to meet environmental needs.	Provide increased water supplies, water supply reliability, and management flexibility for environmental purposes, including CALFED programs such as Delta water quality, EWA, and ERP.
Hydropower Generation – 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 energy grid.	Provide hydropower generation capacity for the Sacramento River basin to offset energy usage and pumping costs, potentially contributing ancillary benefits to the statewide grid.
Recreation – Recreational use and opportunity are currently very limited within the study area, and demands for water-oriented recreational opportunities in the Sacramento River basin are high. Some of these demands are served by reservoirs on the western slope of the Sierra Nevada mountains. However, as population increases in the Sacramento Valley, demands for flat water, river, and land-based recreation are expected to increase.	Develop additional recreational opportunities in the study area.
Flood Control Storage – Improvements to the water system may provide opportunities to increase flood protection by allowing better coordination of various Sacramento region reservoirs to provide additional flood storage space at selected on-stream reservoirs, including Folsom, Oroville, and Shasta.	Provide incremental flood control storage opportunities.

5. PLAN FORMULATION APPROACH

The NODOS Investigation is a joint state-federal study. All elements of the FS Report are being prepared to conform to the federal P&Gs (WRC, 1983). This section presents the plan formulation process and the identified planning criteria (Section 5.1), objectives (Section 5.2), constraints (Section 5.3.1), and principles (Section 5.3.2) used to guide the investigation.

This NODOS IAIR is the first of three documents to be developed for the federal planning process. The next phase of the investigation is the PFR followed by the FS. All of these documents detail the plan formulation process for the NODOS Investigation.

5.1 PLAN FORMULATION PROCESS

The following subsections identify the federal and state planning processes. It should be noted that the plan formulation process is iterative and its steps can be revisited during any stage of the planning process. This IAIR does not represent all steps of the planning process; for example, the federal formulation criteria and accounts will be utilized in subsequent planning stages and documents.

5.1.1 Federal Planning Process

The plan formulation process for federal water resources investigations and projects is defined in the P&Gs. The P&Gs include a six-step process. This process is a structured approach to problem solving that provides a rational framework for sound decision-making (Figure 5-1).

Step 1 *Identifying existing and projected future resource conditions without implementation of a project;*

Step 2 *Defining water resources problems and needs to be addressed;*

Step 3 *Developing planning objectives, constraints, and criteria and an overarching Mission Statement;*

Step 4 *Identifying resource management measures and formulating potential alternative plans to meet planning objectives;*

Step 5 *Comparing and evaluating alternative plans; and*

Step 6 *Selecting a plan for recommended implementation.*

Planning Objectives

Primary Objectives

- ❖ Increasing water supplies, water supply reliability, and Sacramento Valley water management flexibility for agricultural, M&I, and environmental purposes, including CALFED programs, such as Delta water quality, EWA and ERP, to help meet California's current and future water demands, with a focus on offstream storage; and
- ❖ Increasing the survival of anadromous fish populations in the Sacramento River, as well as the health and survivability of other aquatic species.

Secondary Objectives

- ❖ Providing ancillary hydropower generation benefits to the statewide power grid;
- ❖ Developing additional recreational opportunities in the study area; and
- ❖ Providing incremental flood control storage opportunities in support of major northern California flood control reservoirs.

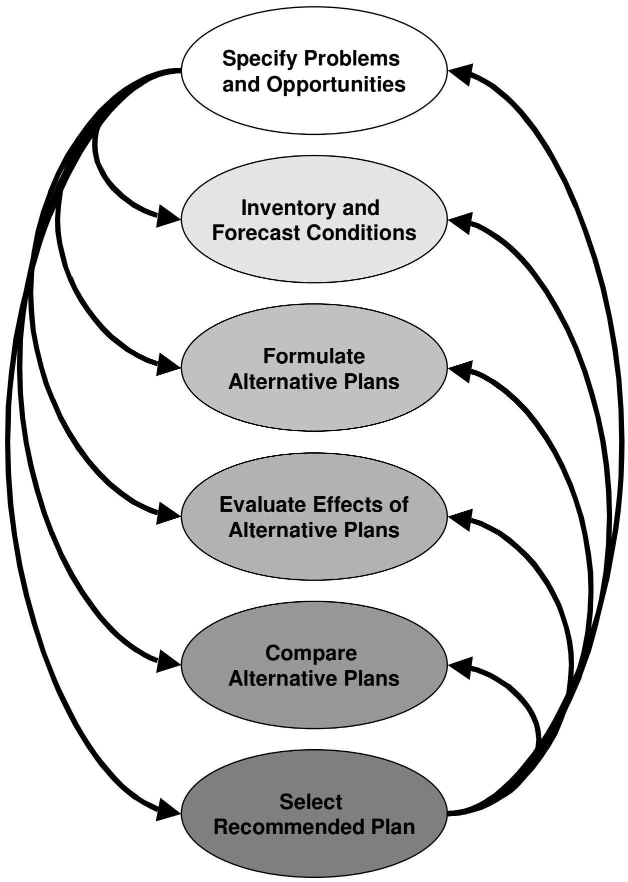

Figure 5-1. Federal Planning Process
Source: United States Army Corps of Engineers

The completed investigation will include an FS and supporting environmental documents consistent with the P&Gs, Reclamation directives, DWR guidance, and applicable environmental laws. To facilitate coordination with other agencies, preparation of the FS will include two interim planning documents: this IAIR and a subsequent PFR. The PFR will present the results of the initial alternatives evaluation and further refine the alternatives. The draft FS will evaluate and compare the final alternatives and identify a recommended plan. A draft EIS/EIR will be included with the draft FS. After the receipt of public comments, the final FS/EIS/EIR will be prepared.

5.1.1.1 Formulation Criteria

Each alternative plan must be formulated with consideration of the following four criteria described in the P&Gs.

- **Completeness –** Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other federal and non-federal entities.
- **Efficiency –** Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the planning objectives.

- **Effectiveness –** Effectiveness is the extent to which the alternative plans contribute to achieving the planning objectives.
- **Acceptability –** Acceptability is the extent to which the alternative plans meet the requirements of applicable laws, regulations, and public policies.

5.1.1.2 Accounts

Four accounts are established to facilitate the evaluation and display of the effects of alternative plans. The national economic development account is required. Other information that is required by law or that will have a material bearing on the federal decision-making process should be included in the other accounts, or in some other appropriate format used to organize information on effects. Following are the four accounts.

- **National Economic Development –** The national economic development (NED) account displays changes in the economic value of national output of goods and services.
- **Environmental Quality –** The environmental quality (EQ) account displays non-monetary effects on significant natural and cultural resources.
- **Regional Economic Development –** The regional economic development (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, employment, output, and population.
- **Other Social Effects –** The other social effects (OSE) account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

The accounts are applied to screen initial alternatives later in the planning process, during Plan Formulation.

5.1.2 State Planning Process

In contrast to the federal process, the State of California's objective for the FS is to provide technical and financial information to implementing agencies. Key factors necessary for agencies to consider are whether the project could be implemented to assure public health and safety and whether the project could provide benefits (e.g., water supply reliability, water quality, ecosystem restoration) at a reasonable cost. In the state process, a state FS is followed by an EIR illustrating project environmental compliance under CEQA, detailed economic evaluations, beneficiary designations, and permitting.

5.1.3 Scoping

As part of the NEPA/CEQA process, federal and state agencies conduct scoping meetings to solicit public comment and input on the range of actions, alternatives, and significant environmental effects, methods of assessment, and mitigation measures to be analyzed in depth in the environmental documents.

In 2002, the Study Team held four scoping meetings and received 57 comments that addressed program alternatives. Scoping comments were incorporated into the NODOS planning process.

5.2 PLANNING OBJECTIVES

On the basis of the previously identified and defined problems and needs in the study area, and with guidance from study authorities, several planning objectives were developed. These objectives are to be used to help guide the formulation of alternatives to address the problems and needs and are separated into primary and secondary objectives as described hereafter. Specific alternatives would be formulated to address the primary objectives. Secondary objectives are opportunities that should be considered in the plan formulation process, but only to the extent possible through the pursuit of the primary planning objectives.

5.2.1 Primary Objectives

Formulate alternatives specifically to address the following.

- Increasing water supplies, water supply reliability, and Sacramento Valley water management flexibility for agricultural, M&I, and environmental purposes, including CALFED programs such as Delta water quality, EWA and ERP, to help meet California's current and future water demands, with a focus on offstream storage; and
- Increasing the survival of anadromous fish populations in the Sacramento River, as well as the health and survivability of other aquatic species.

5.2.2 Secondary Objectives

To the extent possible, through the pursuit of the primary planning objectives, include opportunities to help accomplish the following secondary objectives.

- Providing ancillary hydropower generation benefits to the statewide power grid;
- Developing additional recreational opportunities in the study area; and
- Providing incremental flood control storage to support major northern California flood control reservoirs (i.e., those major, multipurpose reservoirs that include flood control storage).

5.3 PLANNING CONSTRAINTS AND GUIDING PRINCIPLES

Planning constraints and guiding principles for the NODOS Investigation are described in the following subsections.

5.3.1 Constraints

Planning constraints guide the direction of the NODOS Investigation and FS. These constraints include Congressional direction (i.e., study authorizations) and existing water resources projects and programs. Planning constraints, such as biological, cultural, and socioeconomic resources; hydrology; and topography, can also be specific to proposed project locations. Specific planning constraints identified for the NODOS Investigation include the following.

- **Study Authorizations –** Study authorizations provide for feasibility and environmental investigations of offstream storage from the Delta that would provide storage and flood control benefits in an environmentally sensitive and cost-effective manner. In addition, subsequent federal and state authorizations have specifically provided for continuing feasibility studies for Sites Reservoir.

- ❖ **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, Clean Water Act, National Historic Preservation Act, federal and state ESAs, CEQA, and the CVPIA.
- ❖ **CALFED ROD –** The CALFED ROD is a general framework for addressing the CALFED Bay-Delta Program and 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 CALFED Programmatic EIS/EIR PPA includes four other surface water and various groundwater storage projects to help meet water supply needs, improve water quality, stabilize Delta levees, and improve ecosystem functions of the Bay-Delta system. Developed plans should incorporate the goals, objectives, and programs/ projects of the CALFED ROD.
- ❖ **Reallocation of Contract Water Supplies –** As described in Section 2, the CVP is the largest surface water storage and delivery system in California, and it operates under the CVPIA. Federal authorization for the NODOS Investigation focuses on the development of additional water supplies and the management of new and existing supplies to support CALFED objectives. It does not provide authorization to reallocate water supplies to long-term contractual commitments. The IAIR will evaluate approaches to managing existing supplies in conjunction with developing new supplies; however, reallocation of existing supplies will not be included in the plan formulation process. Water operations evaluations that involve the development and management of water supplies for additional releases to the San Joaquin River, will demonstrate that without-project delivery quantities are maintained.

5.3.2 Guiding Principles

Guiding principles used during the plan formulation of the NODOS Investigation and FS can help establish the preferred alternative for addressing the planning objectives. Guiding principles include the planning principles and guidelines identified in the P&Gs, other federal planning regulations, and state and local policies. Specific guiding principles identified for the NODOS Investigation include the following.

- ❖ Alternatives are to be consistent with the identified planning constraints.
- ❖ A direct and significant 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 either directly or indirectly related to the primary objectives (i.e., plan features should not be independent increments).
- ❖ Primary consideration should be given to recommendations in the CALFED ROD.
- ❖ Alternatives should either avoid potential adverse impacts on environmental resources or include features to mitigate unavoidable impacts through enhanced designs, construction methods, and/or facilities operations.
- ❖ Alternatives should avoid potential adverse impacts on present or historical cultural resources or include features to mitigate unavoidable impacts.

- Alternatives are to be formulated and evaluated based on a 100-year analysis period.
- First 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.
- Alternatives are to be formulated to neither preclude nor enhance the development and implementation of other elements of the CALFED program or other water resources programs and projects in the Central Valley.
- Alternatives should have a high certainty for achieving the intended benefits and not depend significantly on long-term actions for success.
- Alternatives should not result in a significant adverse impact on existing water supplies, recreation facilities, hydropower generation, and related water resource conditions.
- Alternatives are to reflect the purposes, operations, and limitations of existing and without-project future projects and programs.

Definitions of Common Planning Terms:

Problems and Needs – Problems and needs can be financial, environmental, technical or legislative constraints or desires of an affected local, state, or federal entity or system. Water and related land resources project plans are formulated to alleviate problems and accommodate needs.

Opportunities – While alleviating problems and meeting needs, opportunities represent a chance for advancement or development in other areas that may benefit from a particular project plan. Water and related land resources project plans are evaluated with respect to their ability to realize opportunities.

Measures – Measures refer to a modification in public policy, an alteration in management practice, a regulatory change, or a new project or program that provides a complete or partial alternative to address water resources problems, needs, and opportunities.

Alternatives – Alternatives are developed by combining measures, either structural or non-structural, to address water resources problems and opportunities to the maximum practicable extent.

6. RESOURCE MANAGEMENT MEASURES

Following the development of the planning objectives, constraints, and criteria for the NODOS Investigation, the next major steps are to identify and evaluate potential resource management measures and to formulate initial alternatives. In conjunction with investigating resource management measures, past studies and investigations were consulted, such as the CALFED Storage element.

This section begins with a summary of the CALFED storage elements, including its findings relevant to viable, developable surface storage sites in California, followed by a review of CALFED's surface storage screening results to determine their relevancy to the NODOS Investigation's primary objectives. Those surface storage sites suitable for consideration as potential NODOS measures are identified and included in the broad range of measures developed by the IAIR study team. The study team identified those candidate measures that appeared most viable to meeting the NODOS objectives by performing an initial, qualitative screening of a broad range of measures. Following the initial screening, additional considerations specific to retained measures are identified, and these retained measures are further screened to ascertain a suite of measures appropriate for consideration in the development of potential initial alternatives.

6.1 DEFINITION OF RESOURCE MANAGEMENT MEASURES

A resource management measure is a feature or activity, structural or non-structural, that addresses a specific planning objective. Potential resource management measures were identified as part of previous studies, programs, and projects to address problems, needs, and opportunities in the study area. The identified measures were evaluated for their ability to address the primary and secondary planning objectives. The ranking of measures was qualitative; the decision-making regarding how well a measure accomplished a specific objective was collectively determined by the IAIR study team. The following sections describe the wide range of measures considered, justification for deleting or retaining measures, and further information on measures that were retained and how the measures might be incorporated into initial alternatives.

6.2 CALFED STORAGE INVESTIGATIONS

DWR began the NODOS Investigation as a reconnaissance-level study in late 1997 as part of the ISI. ISI included three types of investigations: surface storage, conjunctive management and groundwater, and barrier removal (fish passage improvement). ISI was funded to provide information for inclusion in CALFED's programmatic EIS/EIR. In the programmatic Record of Decision, CALFED included a storage component to investigate surface, conjunctive, and groundwater storage programs.

The ROD notes that, "additional storage [is] needed to meet the needs of a growing population and, if strategically located, will provide much needed flexibility in the system to improve water quality and support fish restoration efforts." DWR and Reclamation were directed by the ROD to study five surface storage projects with up to 3.5 MAF of additional capacity, as well as a major expansion of groundwater storage for an additional 0.5 to 1.0 MAF. The NODOS study team has incorporated this surface and groundwater approach to storage by including both as potential measures to address NODOS objectives. Later, when alternatives are redefined during the PFR stage, a NODOS alternative could include groundwater storage, surface storage, or both.

The study team recognizes that many of the CALFED-related objectives under consideration by the NODOS investigation will require integration of new storage into the California's existing water management and infrastructure system. Integration of either surface or groundwater storage will require some modification of existing operations. Indeed, the "much needed flexibility" identified in the ROD clearly indicates changes in operations. These potential operational changes, including their potential benefits and effects, will be evaluated in the PFR and ultimately in the EIS/EIR for the NODOS Investigation.

6.2.1 CALFED Groundwater Storage

The CALFED Programmatic EIS/EIR identified projects in the Sacramento Valley, in the Delta, in the San Joaquin Valley, and in Southern California that could provide 500 TAF to 1 MAF of groundwater storage. The NODOS Investigation will rely significantly upon information from the CALFED groundwater storage investigations, under DWR, as potential groundwater storage measures are conceived and evaluated. The most recently published 2004 CALFED annual report notes that, "significant headway has been made on efforts to expand groundwater storage. More than $240 million in grants and loans has been awarded statewide for more than 160 local groundwater storage and conjunctive use studies and projects. The local cost share on these projects is approximately $900 million. Partnerships with local and regional agencies are ongoing in 18 areas of the state to improve groundwater management and develop conjunctive use projects and programs." The ROD also notes that CALFED agencies intend to support voluntary, locally controlled groundwater projects that are designed to address local water needs first, before considering regional or statewide benefits. Finally, groundwater storage is being included in the Common Assumptions process so that many of the projects being supported by DWR will be included in future no action and NODOS alternative project conditions.

Groundwater storage measures will be evaluated in a more comprehensive manner as additional information becomes available from CALFED's groundwater storage investigations in the PFR.

6.2.2 CALFED Surface Storage

CALFED began an initial screening of 52 potential surface storage sites (the screening process is summarized in Appendix F) to reduce the number of sites to a more manageable number for further CALFED consideration. CALFED criteria eliminated sites providing less than 0.2 MAF of storage, as well as those that conflicted with CALFED solution principles, objectives, or policies. CALFED removed 40 surface storage sites from the list during the initial screening process, as detailed in the Initial Surface Water Storage Screening Report (CALFED, 2000). CALFED specifically looked for projects that could contribute significantly to CALFED's program objectives. These included potential sites that could provide broad benefits for water supply, flood control, water quality, and the ecosystem. Those sites not retained for additional CALFED consideration may still be developed for other purposes.

This CALFED screening resulted in the selection of the following 12 reservoir sites for further CALFED consideration:

- Four north-of-the-Delta offstream storage reservoirs – Red Bank, Newville, Colusa, and Sites;
- In-Delta storage and enlargement of Los Vaqueros Reservoir, which would divert water from the Sacramento-San Joaquin Delta;
- Four south-of-the-Delta storage reservoirs – Ingram Canyon, Quinto Creek, Panoche, and Montgomery; and
- Enlargement of Shasta Lake (Shasta Dam) and Millerton Lake (Friant Dam).

The 52 surface storage sites first investigated by CALFED were revisited for the NODOS Investigation to determine whether some of them should be included as NODOS Investigation measures. The 52 surface storage sites were evaluated for their ability to address the planning objectives in this investigation. This NODOS evaluation of the 52 surface storage sites is also included in Appendix F. This screening activity resulted in the identification of three viable surface storage measures suitable for continued IAIR consideration—Newville, Colusa, and Sites Reservoirs. These offstream surface storage measures have been added to the broader range of measures identified by this IAIR for comparison and screening against the NODOS Investigation objectives.

6.3 RESOURCE MANAGEMENT MEASURES SCREENING

Resource management measures were screened by their ability to address at least one planning objective without adverse impact on other planning objectives. Measures were analyzed for the degree to which they fulfill a specific planning objective and were rated on a scale from low to high. The primary planning objectives consist of a number of elements that can be used to assess the benefits of each measure. The elements are listed below the two primary objectives:

Water Supply and Reliability Objective

- Water supply
- Supply reliability
- Operational flexibility (agriculture, M&I, environment)
- Delta water quality
- EWA
- ERP
- Focus on offstream storage

Anadromous Fish Survivability Objective

- Flow (volume, timing, and location)
- Passage (amount of flow and location)
- Habitat
- Water quality (including temperature and location)
- Benefits to other aquatic species

The secondary objectives are single-element objectives that include:

- Ancillary hydropower generation benefits to the statewide power grid;
- Additional recreational opportunities in the study area; and
- Incremental flood control storage opportunities in support of major northern California flood control reservoirs.

The ranking of measures was qualitative; the decision regarding how well a measure accomplishes a specific objective was partially subjective. The IAIR study team collectively determined the rankings for each measure. A measure was ranked "low" for a specific objective if only a few (or none) of the elements would be accommodated by that measure. An intermediate ranking of "moderate" indicates that approximately half of the elements would benefit from that measure. A ranking of "high" indicates that most (or all) of the elements would benefit. For single-element objectives, a "low" ranking indicates the objective would not be met, a "moderate" ranking indicates partial benefit to that objective, and a "high" ranking indicates significant benefit to that objective. Finally, a determination was made regarding whether or not each measure should be retained for further consideration or deleted from this investigation.

Measures deleted from this investigation are not precluded from reconsideration in future study activities. (Future events may create project or study area conditions that require the resurrection of particular measures discarded under this IAIR investigation.) Measures that do not directly address the planning objectives also may be reconsidered for inclusion in future alternative plans as possible mitigation elements or ancillary plan features, if they provide some incremental benefit deemed acceptable by federal and/or non-federal interests.

6.4 MEASURES TO ADDRESS PRIMARY PLANNING OBJECTIVES

The following subsections identify resource management measures that address the primary planning objectives introduced in Section 5.2 of this report.

6.4.1 Measures to Address Water Supply, Reliability, and Management Flexibility Needs

Various potential water resources management measures were identified to address the primary objective of increasing water supplies, water supply reliability, and Sacramento Valley water management flexibility for agricultural; M&I; and environmental purposes, including CALFED programs such as Delta water quality, EWA, and ERP, to help meet California's current and future water demands, with a focus on offstream storage. Table 6-1 identifies the measures considered, and whether they were retained or deleted from further IAIR consideration.

The study of potential surface storage measures is part of a larger CALFED program to address four objectives for managing water resources in California: water supply reliability, levee system integrity, water quality, and ecosystem restoration. As stated previously, storage is one of 12 program elements designed to achieve these four CALFED objectives. The program elements are also conceived to be interrelated and interdependent so that elements can be implemented in a complementary and non-competitive fashion. All program elements are assumed to be implemented consistent with program implementation guidelines. CALFED complementary actions (WUE and Transfers), described in Section 3, will be implemented concurrently and will, therefore, be included in all NODOS alternatives, including the No-Action alternative and the initial alternatives described later in this report. Because these complementary actions are already included in all the alternatives, CALFED complementary actions are not included in the list of measures to achieve NODOS objectives. More specifically, the CALFED Surface Storage Common Assumptions effort will assume implementation of both WUE and Transfers so that ultimately the NODOS Investigation will assume WUE and Transfers in the No-Action Alternative and all NODOS alternatives.

6.4.2 Measures to Address Anadromous Fish Survival

Various potential water resources 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 6-2 identifies measures considered and whether they were retained or deleted.

6.5 MEASURES TO ADDRESS SECONDARY PLANNING OBJECTIVES

The following subsections identify resource management measures that address the secondary planning objectives.

6.5.1 Measures to Address Increasing Hydropower Generation

Various potential water resources 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 from hydropower considerations under this investigation are ancillary and are not intended as major facilities that provide significant power contributions to the statewide grid.) Table 6-3 identifies measures considered, and whether they were retained or deleted.

6.5.2 Measures to Address Recreation Opportunities in the Study Area

Various potential measures were identified to address the secondary objective of increasing recreational opportunities in the study area. Table 6-4 identifies measures considered, and whether they were retained or deleted.

6.5.3 Measures to Address Flood Control Opportunities in the Study Area

The opportunity may exist to allocate some portion of the NODOS storage facility as incremental flood control storage. Although offstream storage would provide flood control on the small watersheds discharging into a NODOS facility, an additional increment of flood control storage is possible to support major flood control storage facilities in California north of the Delta. In essence, incremental flood control storage could not only support Lake Shasta flood storage capacity but could also, depending on operational actions, support flood control capacities for other northern California facilities, such as Lake Oroville and Folsom Lake.

Incremental flood control storage at a NODOS reservoir would function as ancillary storage for other major flood control storage facilities by capturing early reservoir releases dictated by operational actions taken for forecasted storm events. The ability to provide incremental flood control storage at a NODOS facility would be predicated upon available storage space in the facility, 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. Table 6-5 identifies measures considered, and whether they were retained or deleted.

6.6 SUMMARY OF MEASURES RETAINED FOR FURTHER CONSIDERATION

This section summarizes the measures that best address the primary and secondary NODOS planning objectives and were retained for formulation of initial alternatives. Please note that measures screened at any point during the plan formulation may be reconsidered in the future as mitigation measures or optional features of the plan. Additional measures, not yet considered, also may be added to alternative plans as they are formulated.

6.6.1 Measures that Address the Primary Planning Objectives

Table 6-6 identifies the measures that best address the primary planning objectives.

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Table 6-1

Resource Management Measures to Address Water Supply Needs and Reliability

Resource Management Measure	Potential to Address Planning Objective	Status/Rationale
Construct Sites Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	**High** – Potential for this offstream storage reservoir to meet all components of this primary objective.	**Retained** – Consistent with primary planning objectives and directly contributes to secondary planning objectives.
Construct Colusa Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	**High** – Potential for this offstream storage reservoir to meet all components of this primary objective.	**Retained** – Consistent with primary planning objectives and directly contributes to secondary planning objectives.
Construct Newville Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	**High** – Potential for this offstream storage reservoir to meet all components of this primary objective.	**Retained** – Consistent with primary planning objectives and directly contributes to secondary planning objectives.
Raise Shasta Dam	**Moderate to High –** Measure would increase water supply reliability.	**Deleted –** Measure is being considered through the Shasta Lake Water Resources Investigation and a separate FS.
Increase efficiency of Shasta Reservoir operation	**Low** – Potential for incremental increase in water supply reliability at Shasta Reservoir. Does not meet other objective components.	**Deleted** – There is a low potential for increased water supply reliability. Does not address other planning objectives.
Increase conservation pool in Shasta Reservoir by encroaching on dam freeboard	**Low** – Very small space increase possible.	**Deleted** – Very limited potential to encroach on existing freeboard above gross pool, which is only 9.5 feet. High relative cost to resolve uncertainty issues related to encroachment.
Develop additional groundwater storage south of the Sacramento-San Joaquin River Delta	**Moderate** – Potential to enhance system yield for many potential uses.	**Deleted** – Measure would be located out of the primary study area.
Develop groundwater storage near the Sacramento River, downstream from Shasta Dam	**Moderate to High** – Potential to enhance system yield for many potential uses.	**Retained** – Consistent with primary planning objectives.
Improve Delta export and conveyance capability through coordinated CVP and SWP operations	**Moderate** – Potential to enhance system yield when combined with new offstream storage. Significant potential to help increase water supply reliability south of the Delta.	**Deleted** – JPOD* is being actively pursued in other programs and is therefore part of the without-project condition. Not an alternative to increasing water supply reliability north of the Delta. Does not address planning objectives or constraints/principles/criteria.
Retire agricultural lands	**Moderate** – Would reduce water demand rather than increase ability to meet projected future demands.	**Deleted** – Not an alternative to new storage. Does not address planning objectives and constraints/criteria. Land retirement test programs are being performed by Reclamation. On a large scale, could have significant negative impacts on agricultural industry.
Construct Delta-Mendota Canal/California Aqueduct intertie	**Moderate –** Significant potential to help increase water supply reliability south of the Delta.	**Deleted** – This project is being actively pursued by other CALFED programs. Not an alternative to increasing water supply north of the Delta. Does not address planning objectives or constraints/principles/criteria. Likely to be accomplished with or without additional efforts to develop new sources.
Pursue seawater desalination programs	**Low to Moderate –** Potential to enhance system yield in the coastal regions	**Deleted -** Limited contribution to water supply needs, water supply reliability, and water management flexibility in the Sacramento Valley. Would not address other planning objectives.
Expand Big Dry Creek Reservoir – San Joaquin River Dry Creek Watershed	**Low –** Uncertainty regarding the dam's ability to store more than a few TAF of water.	**Deleted** – Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Given seepage concerns and insufficient inflow, it was uncertain what capacity the reservoir would have. Measure would not address planning objectives.
Raise Pine Flat Dam – Kings River Watershed	**Low –** Measure would not significantly increase water supply reliability.	**Deleted** – Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure would produce increase of only 124 TAF, and CALFED eliminated measures <200 TAF in other screening processes. In addition, measure was not supported by the KRCD, which represents the users of water stored in the Pine Flat Reservoir. The measure does not increase supply to the Sacramento Valley.

* The joint operation of the two projects (SWP and CVP) is commonly referred to as the joint point of diversion (JPOD).

Table 6-1
(Continued)

Resource Management Measure	Potential to Address Planning Objective	Status/Rationale
Construct Mill Creek Reservoir – Kings River Watershed	**Moderate –** Measure would increase water supply reliability in San Joaquin Valley.	**Deleted** – Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure would supply up to 200 TAF, and CALFED eliminated measures <200 TAF in other screening processes. Measure also would cause adverse impacts to an extensive sycamore alluvial woodland. Measure does not increase supply to the Sacramento Valley.
Construct Rogers Crossing Reservoir – Kings River Watershed	**Moderate –** Measure would increase water supply reliability in San Joaquin Valley.	**Deleted** – Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure would supply up to 950 TAF of water. Measure would cause inundation of a Special Management Area and a Wild and Scenic River and would violate expressed Congressional intent. Measure does not increase supply to the Sacramento Valley.
Construct Dinkey Creek Reservoir – Kings River Watershed	**Low –** Measure would not significantly increase water supply reliability.	**Deleted** – Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure would produce an increase of only up to 90 TAF. Measure would adversely affect trout habitat and migration and deplete recreational opportunities in the project area. Measure does not increase supply to the Sacramento Valley.
Construct Dry Creek Reservoir – Kaweah River Watershed	**Low –** Measure would not significantly increase water supply reliability.	**Deleted** – Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure would produce an increase of only up to 70 TAF and would adversely affect rare sycamore alluvial woodland. Measure does not increase supply to the Sacramento Valley.
Construct Hungry Hollow Reservoir – Tule River Watershed	**Moderate –** Measure would increase water supply reliability in San Joaquin Valley.	**Deleted** – Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure would supply up to 800 TAF. Measure would adversely affect rare sycamore alluvial woodland, and dam would be located on extensive young alluvial deposits (poor foundation). Measure does not increase water management flexibility in the Sacramento Valley.
Raise Friant Dam	**Moderate to High –** Measure would increase water supply reliability in San Joaquin Valley.	**Deleted –** Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure does not increase water management flexibility in the Sacramento Valley.
Construct Temperance Flat Reservoir	**Moderate to High –** Measure would increase water supply reliability in San Joaquin Valley.	**Deleted –** Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure does not increase water management flexibility in the Sacramento Valley.
Construct Fine Gold Reservoir	**Moderate to High –** Measure would increase water supply reliability in San Joaquin Valley.	**Deleted –** Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure does not increase water management flexibility in the Sacramento Valley.
Construct Yokohl Valley Reservoir	**Moderate to High –** Measure would increase water supply reliability in San Joaquin Valley.	**Deleted –** Measure is being considered through the Upper San Joaquin River Basin Storage Investigation and a separate FS. Measure does not increase water management flexibility in the Sacramento Valley.

CVP = Central Valley Project
Delta = Sacramento-San Joaquin River Delta
FS = feasibility study
JPOD = joint point of diversion
KRCD = Kings River Conservation District
SWP = State Water Project
TAF = thousand acre-feet

Table 6-2

Resource Management Measures to Address Anadromous Fish Survival

Resource Management Measure	Potential to Address Planning Objective	Status/Rationale
Restore abandoned gravel mines along the Sacramento River	**Moderate to High –** 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 both aquatic and floodplain/riparian habitat.
Construct instream aquatic habitat downstream from Keswick Dam	**Moderate to High –** 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** - 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** – Benefits planning objective.	**Deleted** – Significant 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 would not directly contribute 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** – Indirectly benefits planning objective.	**Deleted** – Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and would not directly contribute 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** – Indirectly benefits planning objective.	**Deleted** – Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and would not directly contribute to improved ecological conditions along mainstem Sacramento River.
Restore the streambed near the ACID siphon on Cottonwood Creek	**Low** – Indirectly benefits planning objective.	**Deleted** – Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and would not directly contribute to improved ecological conditions along mainstem Sacramento River.
Make additional modifications to Shasta Dam for temperature control	**Low to Moderate** – Potential to contribute to planning objective by improving temperatures for anadromous fish.	**Deleted** – Consistent with primary planning objective, but limited potential exists to further modify the temperature control device to benefit anadromous fish with increased storage at Shasta, but modifications to Shasta are being considered through a separate FS.
Enlarge Shasta Lake cold water pool	**Moderate to High** – Directly contributes to planning objective by improving water temperature conditions for anadromous fish.	**Deleted** – Consistent with primary objective and goals of CALFED, but modifications to Shasta are being considered through a separate FS.
Modify storage and release operations at Shasta Dam	**Moderate to High** – Directly contributes to planning objective by improving flow conditions for anadromous fish.	**Deleted** – Consistent with goals of CALFED, but modifications to Shasta are being considered through a separate FS.
Modify ACID diversions to reduce flow fluctuations	**Moderate** – Reduced flow fluctuations would benefit anadromous fish, directly contributing to the planning objective.	**Deleted** – Conflicts with other primary planning objective of water supply reliability.
Increase instream flows on Clear, Cow, and Bear Creeks	**Low** – Indirectly benefits planning objective on the Sacramento River.	**Deleted** – Independent of hydraulic/hydrologic conditions in upper Sacramento River.
Construct a storage facility on Cottonwood Creek to augment spring instream flows	**Low** – Indirectly benefits planning objective on the Sacramento River.	**Deleted** – Independent of hydraulic/hydrologic conditions in upper Sacramento River. Adverse environmental impacts expected to exceed benefits.
Improve fish trap below Keswick Dam	**Low to Moderate** – Directly contributes to planning objective by reducing mortality and supplying more fish to hatcheries.	**Deleted** – Although helps fish populations, does not contribute to favorable conditions for sustained spawning and rearing of anadromous fish.
Remove or screen diversions on Battle Creek	**Moderate** – Indirectly benefits planning objective on the Sacramento River.	**Deleted** – Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and would not contribute to improved ecological conditions along mainstem Sacramento River.
Construct a fish barrier at Crowley Gulch on Cottonwood Creek	**Moderate** – Indirectly benefits planning objective on the Sacramento River.	**Deleted** – Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and would not contribute to improved ecological conditions along mainstem Sacramento River.

Table 6-2

(Continued)

Resource Management Measure	Potential to Address Planning Objective	Status/Rationale
Increase conservation storage space in Shasta Reservoir by raising Shasta Dam	**Moderate –** Potential to improve flow regime on the Sacramento River and benefit temperature control.	**Deleted** – Consistent with primary planning objective and contributes to secondary objectives, but modifications to Shasta Dam are being considered through a separate FS.
Construct new conservation storage reservoir(s) upstream from Shasta Reservoir	**Moderate –** Potential to improve flow regime on the Sacramento River and benefit temperature control.	**Deleted** – Upstream storage sites capable of system wide CVP benefits would be very costly, result in environmental impacts difficult to mitigate, and be inconsistent with the CALFED ROD principles.
Construct Sites Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	**High** – Potential for this offstream storage project to meet all components of this primary objective.	**Retained** – Consistent with primary planning objectives and directly contributes to secondary planning objectives.
Construct Newville Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	**High** – Potential for this offstream storage project to meet all components of this primary objective.	**Retained** – Consistent with primary planning objectives and directly contributes to secondary planning objectives.
Construct Colusa Reservoir, a new conservation offstream surface storage facility near the Sacramento River downstream from Shasta Dam	**High** – Potential for this offstream storage project to meet all components of this primary objective.	**Retained –** Consistent with primary planning objectives and directly contributes to secondary planning objectives.
Construct new conservation surface water storage south of the Sacramento-San Joaquin River Delta	**Low –** Would have little to no benefit to the mainstem Sacramento River.	**Deleted** – Would have little to no benefit to the mainstem Sacramento River.
Improve fish passage at Red Bluff Diversion Dam	**High –** Potential to improve fish passage and provide spawning access.	**Retained** – Substantial benefit to spawning conditions.
Develop additional conservation groundwater storage south of the Sacramento-San Joaquin River Delta	**Moderate** – Potential to enhance conditions for anadromous fish.	**Deleted** – Measures are located out of the primary study area and are being considered in Common Assumptions. Limited contribution compared to storage north of the Delta. Would not contribute to other planning objectives. Potential for subsidence is unknown.
Develop groundwater storage near the Sacramento River, downstream from Shasta Dam	**Moderate to High** – Potential to enhance conditions for anadromous fish.	**Retained** – Use of groundwater storage can be physically and economically effective. Groundwater storage is being considered through CALFED and other programs. DWR is providing financial and technical assistance for some studies associated with expanded use of north-of-the-Delta groundwater storage.

ACID = Anderson Cottonwood Irrigation District
CVP = Central Valley Project
FS = feasibility study
O&M = operations and maintenance
ROD = Record of Decision

Table 6-3

Resource Management Measures to Address Opportunities for Hydropower Generation

Resource Management Measure	Potential to Address Planning Objective	Status/Rationale
Modify existing generation facilities at Shasta Dam to take advantage of increased hydraulic head due to Shasta Dam raise	**Moderate** – Could contribute to planning objective.	**Deleted** – Limited potential to realize an increase in hydropower output from Shasta Dam with increasing size of Shasta Reservoir, but modifications to Shasta Dam are being considered through a separate FS.
Construct new hydropower generation facilities in Sacramento Valley	**Moderate to High** – Would contribute to planning objective.	**Deleted** – Does not address primary planning objectives or constraints/ principles/criteria. Limited potential to find locations and construct new facilities with primary purpose of power generation. Limited potential to augment existing facilities currently without generation capabilities. Limited potential for sizeable gain in hydropower output for those facilities with existing generation capabilities.
Construct new hydropower generation facilities on Sites Reservoir	**Moderate to High** – Would contribute to planning objective.	**Retained** – Could directly contribute to secondary planning objective. Power generation facilities would offset the power usage and cost of reservoir pumping and provide ancillary power benefits to the local or state power grid.
Construct new hydropower generation facilities on Colusa Reservoir	**Moderate to High** – Would contribute to planning objective.	**Retained** – Could directly contribute to the secondary planning objective. Power generation facilities would offset the power usage and cost of reservoir pumping and provide ancillary power benefits to the local or state power grid.
Construct new hydropower generation facilities on Newville Reservoir	**Moderate to High** – Would contribute to planning objective.	**Retained** – Could directly contribute to the secondary planning objective. Power generation facilities would offset the power usage and cost of reservoir pumping and provide ancillary power benefits to the local or state power grid.

FS = feasibility study

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Table 6-4

Resource Management Measures to Address Recreational Opportunities

Resource Management Measure	Potential to Address Planning Objective	Status/Rationale
Construct new conservation offstream surface storage at Newville Reservoir	**Moderate to High** – Increased storage would contribute to increased recreational opportunities.	Retained – Consistent with primary planning objectives and directly contributes to this secondary planning objective.
Construct new conservation offstream surface storage at Colusa Reservoir	**Moderate to High** – Increased storage would contribute to increased recreational opportunities.	Retained – Consistent with primary planning objectives and directly contributes to this secondary planning objective.
Construct new conservation offstream surface storage at Sites Reservoir	**Moderate to High** – Increased storage would contribute to increased recreational opportunities.	Retained – Consistent with primary planning objectives and directly contributes to this secondary planning objective.

FS = feasibility study
PL = Public Law

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Table 6-5

Resource Management Measures to Address Incremental Flood Control Storage Opportunities

Resource Management Measure	Potential to Address Planning Objective	Status/Rationale
Provide incremental flood control storage at Newville Reservoir through re-operation of other major northern California reservoir(s)	**Moderate to High** – Increased storage would contribute to increased flood control storage opportunities in the study area.	**Retained** – Consistent with primary planning objectives and directly contributes to this secondary planning objective.
Provide incremental flood control storage at Colusa Reservoir through re-operation of other major northern California reservoir(s)	**Moderate to High** – Increased storage would contribute flood control storage opportunities in the study area.	**Retained** – Consistent with primary planning objectives and directly contributes to this secondary planning objective.
Provide incremental flood control storage at Sites Reservoir through re-operation of other major northern California reservoir(s)	**Moderate to High** – Increased storage would contribute flood control storage opportunities in the study area.	**Retained** – Consistent with primary planning objectives and directly contributes to this secondary planning objective.

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Table 6-6

Retained Measures that Address the Primary Objectives

Primary Objective	Resource Management Measure
Water Supply and Reliability	Construct new conservation offstream surface storage at the Sites Reservoir site
	Construct new conservation offstream surface storage at the Newville Reservoir site
	Construct new conservation offstream surface storage at the Colusa Reservoir site
	Develop conservation groundwater storage near the Sacramento River, downstream from Shasta Dam
Anadromous Fish Survival	Restore abandoned gravel mines along the Sacramento River
	Construct in-stream aquatic habitat downstream from Keswick Dam
	Replenish spawning gravel in the Sacramento River
	Construct new conservation offstream surface storage at the Newville Reservoir site
	Construct new conservation offstream surface storage at the Colusa Reservoir site
	Construct new conservation offstream surface storage at the Sites Reservoir site
	Improve fish passage at Red Bluff Diversion Dam
	Develop conservation groundwater storage near the Sacramento River, downstream from Shasta Dam

Primary problems in the study area related to the Sacramento River are water supply reliability, Delta water quality, and water management flexibility. Fully addressing these problems will require the development and management of additional water supplies in the Upper Sacramento River Valley Basin. Development and management of new water supplies, consistent with the constraints described in Section 5, can be accomplished with additional storage and resulting changes in project operation. In addition, federal authorization for the NODOS Investigation specifically directs the initiation of feasibility studies for a NODOS storage facility.

The retained storage measures could support multiple primary objectives. New yield developed by increasing storage for the Sacramento River system could be used for any or all of the primary objectives. Measures will be evaluated based on their benefit in developing and managing water supplies to contribute to increasing water supply reliability, improve Delta water quality, provide supplies for the EWA, enhance anadromous fish passage and aquatic restoration, provide storage and operational benefits for other CALFED programs, and increase water flow-related benefits for the ERP. Although groundwater storage and the three surface storage measures can address both planning objectives, all of these could also be combined with other measures to increase the benefits of an alternative plan. Figure 6-1 depicts the three offstream surface storage measures located in the Sacramento Valley north-of-the-Delta.

6.6.1.1 Water Supply and Reliability Measures

Following is a brief description of each water supply and reliability measure:

- **Sites Reservoir** – Sites Reservoir would be located about 10 miles west of the town of Maxwell 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 nine saddle dams along the southern edge of the Hunters Creek watershed. Diversion from the Colusa Basin Drain, the Sacramento River, and local tributaries are 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 two gravity flow conveyance options from Stony Creek.

- **Colusa Reservoir** – Colusa Reservoir is a proposed 3.0 MAF storage project that 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 dams along Logan ridge; one for Logan Creek and three for Hunters Creek and its tributaries. Colusa Reservoir requires seven saddle dams. Water supply source and conveyance options are essentially the same as for Sites Reservoir, though total conveyance capacity probably would be greater to fill Colusa Reservoir.
- **Newville Reservoir** – Newville Reservoir would be located upstream from Black Butte Lake, 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 screening. 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 are 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 floodflows to be diverted to Newville Reservoir. Multiple conveyance options are possible utilizing existing infrastructure (canals); new infrastructure (canals, tunnels and/or pipelines); or a combination of new and existing mechanisms to provide increased flexibility and reliability in operations of both existing as well as new infrastructure.
- **Groundwater storage downstream of Shasta Reservoir** – Development of additional groundwater storage in the Sacramento Valley is being investigated as part of DWR's Conjunctive Water Management Program. The goal of the Conjunctive Water Management Program is to increase water supply reliability statewide through planned, coordinated management and use of groundwater and surface water resources. Local agencies are studying development of groundwater resources with technical and financial support from DWR. This general measure will be refined in the PFR to assess the feasibility of specific groundwater development proposals that can contribute to water supply, reliability, and flexibility needs identified by the NODOS Investigation.

6.6.1.2 Anadromous Fish Survival Measures

The following is a brief description of measures that support anadromous fish survival:

- ***Restore abandoned gravel mines along the Sacramento River*** **–** This measure could benefit the restoration of aquatic and floodplain habitat along the Sacramento River at abandoned instream gravel mine locations. Instream gravel mining has created large, artificial pits that disrupt natural geomorphic processes and riparian regeneration, and former gravel mining sites are typically unsuitable for spawning and rearing. Abandoned gravel pits can cause high fish mortality from stranding and unnatural predation. This measure would include acquiring, restoring, and reclaiming inactive gravel mining sites along the Sacramento River near the project study area to create valuable aquatic and floodplain habitat. The stream channel and floodplain would be filled and recontoured to emulate natural conditions. Side channels and other features could be created to encourage spawning and rearing and prevent stranding. This measure was retained for potential

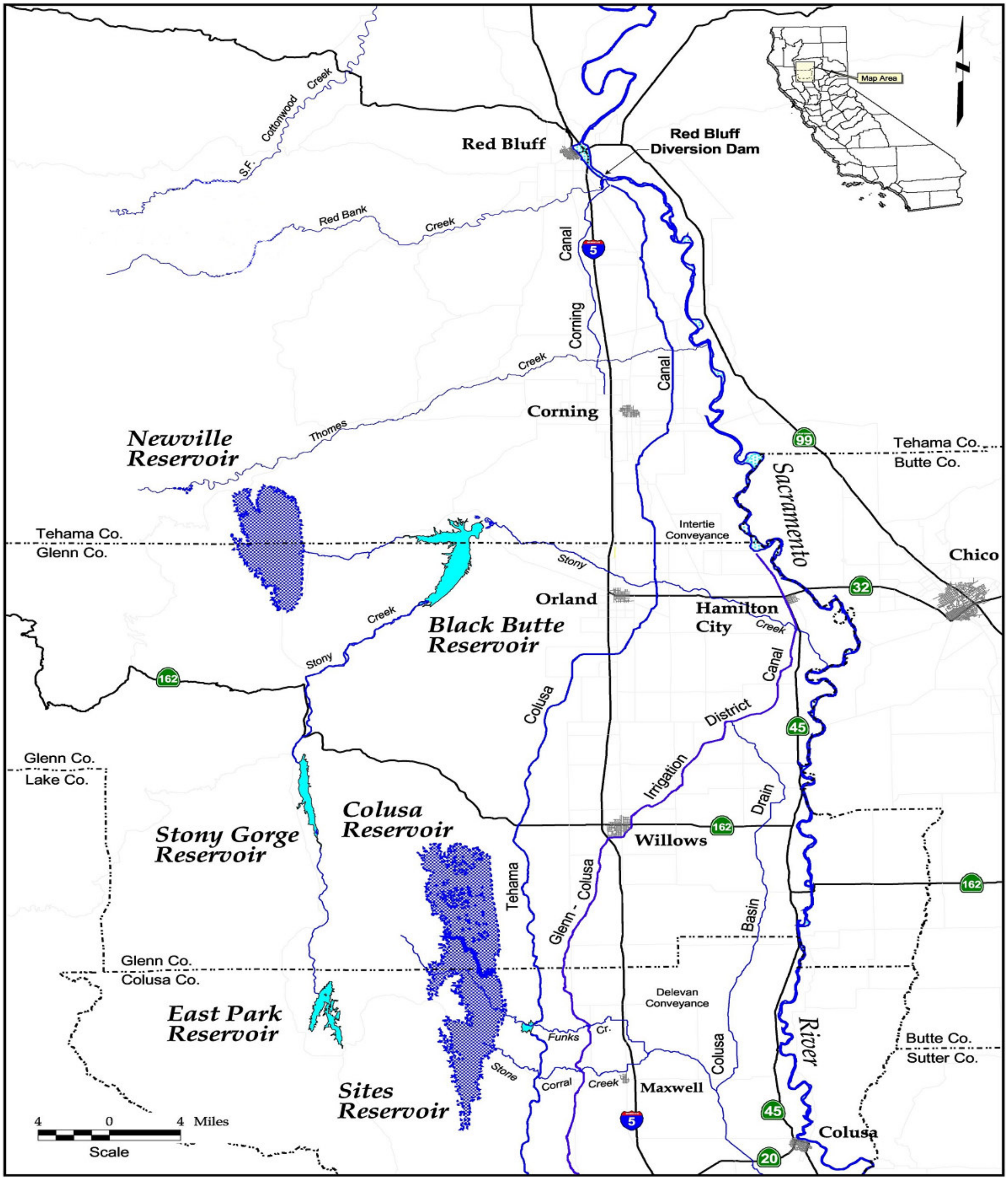

Figure 6-1. Proposed Offstream Storage Locations

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further development because it has a high likelihood for success in helping to achieve the primary objective; in addition, it could be combined with other potential measures related to water supply and reliability.

- ***Construct instream habitat downstream from Keswick Dam –*** Aquatic habitat is poor for spawning and rearing of anadromous fish, and predation can be high because of the lack of instream cover caused by dam releases that have scoured the channel. Keswick Dam is the uppermost barrier to anadromous fish migration on the Sacramento River, and it blocks the passage of gravels, bed sediments, and woody debris that were replenished historically by upstream tributaries. Despite these unfavorable channel conditions, cold water releases from Keswick Dam attract large numbers of spawners to this reach. This measure includes constructing aquatic habitat in and adjacent to the Sacramento River downstream from Keswick Dam by acquiring lands adjacent to the river, conducting earthwork along the riverbank to construct side channels for spawning, and strategically placing instream cover structures within the river channel, including large boulders, anchored root wads, and other natural materials. This measure was retained for potential further development because it has a high likelihood for success in helping to achieve the primary objective; in addition, it could be combined with other potential measures related to water supply and reliability.

- ***Replenish spawning gravel in the Sacramento River –*** Dams, river diversions, gravel mining, and other obstructions have blocked or reduced gravel sources that have historically provided a continuous sources of high-quality gravel to the Sacramento River. Gravel suitable for spawning has been identified as a significant 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. This measure consists of replenishing spawning-sized gravel in the Sacramento River between Keswick Dam and Red Bluff. Gravel would be transported and injected into the Sacramento River. This measure was retained for potential further development because it has a high likelihood for success in helping to achieve the primary objective; in addition, it could be combined with other potential measures related to water supply and reliability. It should be noted that this measure depends on long-term commitment to regular and recurring project maintenance, which may prevent this measure from being integrated into an initial alternative based on further review and evaluation using the federal planning criteria.

- ***Construct new conservation offstream storage at the Newville Reservoir location –*** Newville would be located upstream from Black Butte Lake, 18 miles west of Orland, and would create up to 3.0 MAF. Current study challenges include investigating a diversion facility that would allow anadromous fish migration in Thomes Creek while allowing the creek's floodflows to be diverted to Newville Reservoir. Offstream storage would provide additional supplies for use in the Sacramento Valley watershed during shortages and during below-normal, dry, and critical water years. Offstream storage would allow 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 additional water supply from the Sacramento River also would contribute to statewide supply reliability by augmenting supplies available during dry and critical water years. This measure was retained for potential further development because it has a high likelihood for success in helping to achieve both primary objectives.

- ***Construct new conservation offstream storage at the Colusa Reservoir location –*** Colusa is a proposed 3.0 MAF storage project that would include the area inundated by the 1.8-MAF Sites Reservoir, plus the adjacent Logan Creek and Hunter Creek watersheds to the north. Offstream storage would provide additional supplies for use in the Sacramento Valley watershed during shortages and during below-normal, dry, and critical water years. Offstream storage would allow changes in the timing, magnitude, and duration of diversions from the Sacramento River to reduce or eliminate diversion effects and help assure appropriate flows necessary for critical life stages for anadromous fish and riparian habitat. This additional water supply from the Sacramento River would also contribute to statewide supply reliability by augmenting supplies available during dry and critical water years. This measure was retained for potential further development because it has a high likelihood for success in helping to achieve both primary objectives.

- ***Construct new conservation offstream storage at the Sites Reservoir location –*** Sites Reservoir would be located about 10 miles west of the town of Maxwell and would create 1.8 MAF of new storage. Offstream storage would provide additional supplies for use in the Sacramento Valley watershed during shortages and during below-normal, dry, and critical water years. Offstream storage would allow changes in the timing, magnitude, and duration of diversions from the Sacramento River; the changes could reduce or eliminate diversion effects and help assure appropriate flows necessary for critical life stages for anadromous fish and riparian habitat. This additional water supply from the Sacramento River also would contribute to statewide supply reliability by augmenting supplies available during dry and critical water years. This measure was retained for potential further development because it has a high likelihood for success in helping to achieve both primary objectives.
- ***Improve fish passage at Red Bluff Diversion Dam –*** This measure includes reducing or minimizing the impacts of the RBDD on upstream and downstream migration of juvenile and adult anadromous fish. Feasible alternatives considered involve "gates-in" and "gates-out" scenarios, as well as possible improvements to existing facilities and construction of new fish ladders, fish screens, and pumping facilities. When the RBDD gates are lowered into the Sacramento River ("gates in" position), the elevation of the water surface behind the dam is raised, allowing gravity diversion into the Tehama-Colusa and Corning Canals for delivery to irrigation districts. The "gates-in" position presents a barrier for both upstream- and downstream-migrating fish and may subject juvenile salmonids to increased predation. Raising the gates ("gates-out" position) allows the river to flow unimpeded but precludes gravity diversion into the irrigation canals. This measure was retained for potential further development because it has a high likelihood for success in helping to achieve the primary objective; in addition, it could be combined with other potential measures related to water supply and reliability. This measure has a high likelihood of being implemented through other CALFED programs, which may prevent it from being integrated into an initial alternative based on further review and evaluation.
- **Groundwater storage downstream of Shasta Reservoir** – Development of additional groundwater storage in the Sacramento Valley is being investigated as part of DWR's Conjunctive Water Management Program. The goal of the Conjunctive Water Management Program is to increase water supply reliability statewide through planned, coordinated management and use of groundwater and surface water resources. Additional storage, surface or groundwater, within the Sacramento Valley can support a number of fish restoration actions. This general measure will be refined in the PFR to assess the feasibility of specific groundwater development proposals that can contribute to anadromous fish needs.

6.6.2 Measures that Address the Secondary Planning Objectives

Table 6-7 identifies the measures that best address the secondary planning objectives.

Table 6-7

Retained Measures that Address the Secondary Objectives

Secondary Objective	Resource Management Measure
Hydropower Generation	Construct new hydropower generation facilities on Sites Reservoir
	Construct new hydropower generation facilities on Colusa Reservoir
	Construct new hydropower generation facilities on Newville Reservoir
Recreational Opportunities	Construct new conservation storage on tributaries to the Sacramento River downstream from Shasta Dam
	Construct new conservation offstream surface storage at the Newville Reservoir site
	Construct new conservation offstream surface storage at the Colusa Reservoir site
	Construct new conservation offstream surface storage at the Sites Reservoir site
Incremental Flood Control Storage Opportunities	Provide incremental flood control storage at Newville Reservoir through re-operation of other major northern California reservoir(s)
	Provide incremental flood control storage at Colusa Reservoir through re-operation of other major northern California reservoir(s)
	Provide incremental flood control storage at Sites Reservoir through re-operation of other major northern California reservoir(s)

The following is a brief summary of opportunities to address the secondary planning objectives:

- **Hydropower Generation** – Providing hydropower generation facilities at the retained reservoir facilities will help offset energy usage and the cost of pumping into those facilities, as well as provide ancillary benefits to the local and statewide power grid.
- **Recreational Opportunities** – New conservation storage will help increase the opportunity for recreational activities for the Upper Sacramento Valley. Each of the potential reservoir measures incidentally provides increased opportunities for recreational benefits.
- **Flood Control Storage Opportunities** – Incremental surface storage space allocated to flood control will improve flood protection for the Sacramento River basin upstream of the Delta. By managing timed releases from flood control storage reservoirs where increased early releases to downstream rivers (and the Delta) are offset by capture and storage of commensurate flows into a NODOS facility, flood flows in leveed, agricultural, and/or urbanized regions can be decreased, thereby reducing the potential for flooding and related damages.

6.7 NODOS MEASURES SCREENING

Prior to the development of initial alternatives, the measures retained in the previous section will be evaluated for their ability to address the planning objectives while maximizing project benefits and minimizing any adverse effects to the study area. Table 6-8 summarizes retained measures that will be further evaluated and subsequently used to develop initial alternatives.

Table 6-8

Summary of Resource Management Measures that Address Planning Objectives

Measure	Primary Objective: Water Supply & Reliability	Primary Objective: Anadromous Fish Survivability	Secondary Objective: Hydropower (Ancillary Benefits)	Secondary Objective: Recreation Potential	Secondary Objective: Incremental Flood Control Storage
Construct new conservation offstream surface storage at the Newville Reservoir site	☑	☑	☑	☑	☑
Construct new conservation offstream surface storage at the Colusa Reservoir site	☑	☑	☑	☑	☑
Construct new conservation offstream surface storage at the Sites Reservoir site	☑	☑	☑	☑	☑
Develop groundwater storage downstream of Shasta Reservoir	☑	☑			
Restore abandoned gravel mines along the Sacramento River		☑			
Construct in-stream aquatic habitat downstream from Keswick Dam		☑			
Replenish spawning gravel in the Sacramento River		☑			
Improve fish passage at RBDD		☑			
Construct new conservation storage on tributaries to the Sacramento River downstream from Shasta Dam*				☑	

* Although this measure satisfies the secondary planning objective for recreational opportunities, it does not address the primary planning objectives and will not be carried forward in the NODOS Investigation.

Three of these measures address both the primary and secondary planning objectives and involve construction of new offstream surface storage near the Sacramento River downstream from Shasta Dam. Another measure, groundwater storage downstream of Shasta Reservoir, would likely address the two primary objectives, but none of the secondary objectives. All acceptable measures will be evaluated (and possibly packaged with ancillary features) to develop alternative plans that best address the primary planning objectives and, to the extent possible, the secondary planning objectives. Groundwater storage opportunities downstream of Shasta Dam will be evaluated with more detail and specificity in the PFR.

As described earlier in this chapter and in Appendix F, the study of potential surface storage measures is part of a larger CALFED program to address multiple objectives for managing water resources in California. In Appendix F, the 52 surface storage measures were evaluated for their ability to address the planning objectives for the NODOS investigation. The NODOS Investigation has reviewed CALFED's four potential offstream storage reservoirs on the western side of the Sacramento Valley, north of the Delta. Consistent with the measures screening in this section, three (of the four) offstream storage reservoirs at Newville, Colusa, and Sites have been determined to best address the planning objectives. A more detailed comparison of the offstream surface storage measures is provided in Appendix G.

Consistent with previous studies, storing water in offstream reservoirs during excess flow periods provides more opportunities to increase water storage in an environmentally sensitive way. The stored water then could be made available for beneficial uses, including enhancing water management flexibility, reducing water diversion on the Sacramento River during critical fish migration periods, increasing the reliability of supplies for a significant portion of the Sacramento Valley, and providing storage and operational benefits for other CALFED programs, including Delta water quality and the EWA. These measures could satisfy the planning objectives for the NODOS Investigation.

Three of the four water supply and supply reliability measures are offstream surface storage facilities and involve diverting water out of a major stream and transporting the water through various conveyance systems to a reservoir. A future action for assessing feasibility of offstream storage projects within NODOS will include extensive evaluation of diversion and conveyance facilities to carry water to and from the reservoir. For the IAIR, it is assumed that conveyance elements are economically justifiable, constructible, and operable and that any environmental impacts associated with improvements can be avoided or mitigated.

The following discussion focuses on identifying the surface storage measure that best meets the federal planning criteria and NODOS objectives. In the PFR, the remaining surface storage measures will be compared against a more specific groundwater storage measure.

6.7.1 Additional Considerations of Surface Storage Measures to Address the Water Supply Reliability Objective

The three remaining offstream surface storage measures provide a range of potential water supply reliability benefits and serve similar project purposes. Because all of these surface storage projects are upstream from the Delta and adjacent to the Sacramento River, the kinds of benefits, such as supplemental yield for various uses and reduced diversions from the Sacramento River during the peak local delivery period, will vary primarily in scale. All of the reservoir measures are located within the Coast Range foothills along the western edge of the northern Sacramento Valley (see Figure 6-1). All have been investigated in the past; current studies have updated and augmented these past studies to allow the comparative evaluation of alternatives.

Given that the offstream surface storage measures are similar, several assumptions have been made to simplify comparison of the measures:

- Additional measures screening focuses on the offstream reservoir sites;
- All offstream reservoir sites will have conveyance and connectivity options; and
- All offstream reservoir sites will have comparable anadromous fish measures.

To facilitate the additional measures screening, the offstream storage measures were evaluated and compared based on the above assumptions, as well as previous studies conducted at the proposed reservoir sites.

A detailed comparison of the three offstream storage facilities is provided in Appendix G. The following measures screening discussion summarizes conclusions taken from the detailed comparisons. The screening discusses conclusions applicable to all of the storage facilities and conclusions specific to each of the facilities.

The following list summarizes findings from Appendix G that warrant consideration in screening the measures to identify those most appropriate to the objectives as well as the development of initial alternatives. All three measures possess some common features (bullets 1, 2, and 4 below) requiring further detailed investigations as part of future feasibility study efforts, whereas other features are more specific to a particular site. The following have been grouped by locale to further aid in the screening process.

<u>*Sites, Colusa, and Newville Measures*</u>:

- ❖ The dominant natural plant community in the Sites, Colusa, and Newville Reservoir areas is California annual grassland.
- ❖ Habitat for the valley elderberry longhorn beetle (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, Colusa, or Newville 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.)
- ❖ Review of existing databases indicated that nine state 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.

<u>*Newville Measure*</u>:

- ❖ 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 again 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.

<u>*Sites and/or Colusa Measures*</u>:

- ❖ 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 are the most abundant fish found in both reservoir areas.
- ❖ 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 four main dams and seven saddle dams that would form the Colusa Cell. This large embankment volume increases the cost of the project and the unit cost of water considerably.

6.7.2 Preliminary Capital Cost and Unit Cost Comparison of Offstream Surface Storage Measures

The offstream surface storage measures were compared with respect to their total capital construction costs, their yield, and their unit cost per deliverable volume. This comparison helped identify, on an annualized basis, the relative cost-effectiveness of each measure. The federal P&Gs define efficiency as 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. In principle, this criterion can be applied to the major offstream surface storage facilities assuming other ancillary aspects (conveyance facilities, for example) will be similar in scope and magnitude for each of the measures. A measure of efficiency with respect to the storage reservoirs proper (reservoir dams only) was performed to ascertain a relative comparison of efficiency between each of the storage facilities.

The comparative costs for Sites, Colusa, and Newville Reservoirs (Table 6-9) were calculated to show the difference in total reservoir dam cost for each of the three reservoirs. The total dam cost (in 2004 dollars) for Sites Reservoir was calculated to be $320,250,000; Colusa Reservoir at $1,411,520,000; and Newville Reservoir at $235,134,000.

Table 6-9

Reservoir Dam Costs for Sites, Colusa, and Newville Reservoirs

Project Dams (Height in ft.)	Embankment Volume (Cubic Yards)	Dam(s) Cost (2004$)
Sites (290)	3,800,000	$57,500,000
Golden Gate (310)	10,600,000	$151,000,000
9 Sites Saddle Dams (130)	9,396,992	$111,750,000
Total Dam Cost for Sites Reservoir	**23,796,992**	**$320,250,000**
Sites (290)	3,800,000	$57,500,000
Golden Gate (310)	10,600,000	$151,000,000
Prohibition (230)	11,300,000	$161,025,000
Owens (260)	11,700,000	$166,725,000
Hunters (260)	24,700,000	$351,975,000
Logan (270)	30,600,000	$436,050,000
7 Colusa Saddle Dams (140)	7,337,691	$87,245,000
Total Dam Costs for Colusa Reservoir	**100,037,691**	**$1,411,520,000**
Newville (325)	16,000,000	$228,000,000
1 Newville Saddle Dam (75)	600,000	$7,134,000
Total Dam Costs for Newville Reservoir	**16,600,000**	**$235,134,000**

Embankment volumes for each dam (Table 6-9) were taken from the North-of-the-Delta Offstream Storage Investigation Progress Report (DWR, 2000, Table 3-1, pg. 3-2), except for Sites and Colusa saddle dams, which were taken from Appendix P of the Progress Report. Sites Reservoir dam costs were taken from the Sites Reservoir Engineering Feasibility Report (DWR, 2003) and include such items as foundation preparation, embankment materials, and clearing and grubbing. These costs do not include lands, easements, rights-of-way, relocations, appurtenant structures, conveyance, road relocation or recreation. Using the embankment volumes from the Progress Report and costs from the Sites Engineering Feasibility Report, gross unit costs were calculated for the Sites Reservoir dams. The unit price for Sites Dam (major dam) was determined to be $15.13 per cubic yard, Golden Gate Dam (major dam) was $14.25 per cubic yard, and Sites saddle dams were $11.89 per cubic yard. In applying unit costs to other major NODOS dams, estimators determined that Golden Gate Dam was more similar than Sites Dam, which has considerably less volume than the other major dams. Unit costs were then applied to the other major dams and saddle dams in the Colusa and Newville Reservoirs.

A preliminary economic assessment was performed to compare the average annual cost per yield for the three surface storage measures. As seen in Table 6-10, the estimated average annual cost per yield is similar in magnitude for Sites and Newville Reservoirs, and is excessive for Colusa Reservoir. Sites Reservoir average annual cost per yield is approximately 36% greater than Newville Reservoir. However, Colusa Reservoir's average annual cost per yield is about 367% greater than Sites Reservoir and about 500% greater than Newville Reservoir. In addition, the capital cost of Colusa Reservoir is approximately 4.4 times that of Sites Reservoir, and 6 times that of Newville Reservoir, while the increase in yield is only around 19 percent.

Table 6-10

Comparison of Storage, Yield, and Reservoir/Dam Construction Costs

Attribute	Measure		
	Sites Reservoir	Newville Reservoir	Colusa Reservoir
Gross Storage (AF)	1,800,000	1,900,000	3,000,000
Dead Storage (AF)	40,000	50,000	100,000
Capital Cost[a] ($)	$320,250,000	$235,134,000	$1,411,520,000
2005 Capital Cost[b] ($)	$339,500,000	$249,250,000	$1,496,500,000
Est. Average Annual Cost[c] ($)	$17,500,000	$13,000,000	$77,000,000
Est. Average Annual Yield[d] (AF)	274,000	275,000	328,000
Avg. Annual Cost / Yield ($/AF)	$64 / AF	$47 / AF	$235 / AF

[a] Cost of major dam(s) only including clearing and grubbing, foundation preparation, and embankment materials; excludes other costs such as lands, easements, rights-of-way, relocations, conveyance, or recreation. Basis year of costs is 2004.

[b] Average construction cost increase in California for 2004-2005 was 6.019%; rounded to nearest $250,000. [CA Construction Cost Index].[c]

c Avg. Ann. Cost based on P = Project Life Cost ($2005), n = 100 years, I = 5.125% (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 cap. cost)
i = annual amortization rate
n = number of amortization periods

[d] Based on SWP/CVP only (excludes local); from the 2000 DWR Progress Report.

Therefore, with respect to the federal planning criterion on "efficiency," Colusa Reservoir is being dismissed from further consideration as a potential, viable measure for this IAIR.

6.7.3 Preliminary Environmental Impact Comparison of Offstream Surface Storage Measures

The remaining offstream surface storage measures were next compared with respect to their potential impact to environmental/ecological attributes. The federal P&Gs define acceptability as the workability and viability of the alternative plan with respect to acceptance by State and Local entities and the public and compatibility with existing laws, regulations, and public policies. Policies and regulations mandate due diligence in the consideration of "Environmental Quality" (EQ) relevant to any project of federal interest as established in P&G's four accounts (see Section 5.1.1.2). In reviewing this study's guiding principles (Section 5.3.2), the study team also resolved to avoid or minimize the potential environmental impacts and impacts to potential cultural resources associated with the remaining measures.

Table 6-11 compares the number of potential environmental impacts associated with Sites Reservoir and Newville Reservoir. (The larger value of the two for each attribute considered is highlighted by bold text.)

Table 6-11

Relative Environmental Impacts Comparison

Preliminary Site Survey Results (Biological/Ecological Attribute)	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		
# of Elderberry stems > 1 inch diameter	684	**1,204**
# of Elderberry stems with emergence holes	18	**222**
Total # of bird Species	**160**	146
# of state and federal bird species of concern	**25**	19
Prehistoric cultural resource components	45	**240+**
Historic cultural resource components	27	**65+**

The review of potential environmental impacts between Sites and Newville Reservoirs indicates a significantly greater impact potential for Newville. With the exception of potential impacts to the number of state and federal bird species of concern, possible project-related impacts for all the other biological/ecological attributes are higher for Newville Reservoir. Therefore, at this time, the Newville Reservoir measure is being dismissed from further consideration as a potential, viable measure for this IAIR.

6.7.4 Summary of NODOS Surface Storage Measures Screened from Further Consideration

All three surface storage measures were qualitatively and, to some extent, quantitatively screened in relationship to each other with respect to their expected performance relative to impacts, constructability, and present local and social acceptability. The following measures appear to induce greater impacts, thus reducing their suitability as viable measures for further consideration under the NODOS Investigation. This does not, however, preclude them from either being investigated further in the future, or under some other program and/or future study authorization.

Colusa Reservoir – The proposed Colusa Reservoir meets the primary and secondary planning objectives satisfactorily, with some exceptions. 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 requires significant embankment construction in order to impound a sufficient quantity of water, resulting in considerable project expenses, which translates into higher unit costs for stored water.

Newville Reservoir – The Newville Reservoir alternative satisfactorily meets the investigation's primary and secondary planning objectives. However, Newville Reservoir has greater potential environmental impacts than Sites Reservoir. The Newville footprint would affect in excess of 400 acres of jurisdictional wetlands and over 230 acres of other waters of the U.S. Construction of Newville would jeopardize fall and late-fall runs of salmon and steelhead observed in Thomes Creek during past field surveys. The required static lift (pumping) above the Tehama-Colusa Canal (TC Canal) required for this measure is the highest of the three measures that could utilize the TC Canal for source water (Sites, Colusa and Newville). By comparison to the Sites measure, these environmental impacts are significantly greater and more environmentally damaging. 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 property for the purpose of collecting data for further analyses. As a result of the significantly greater environmental impacts and the lack of local support to advance this measure, the Newville Reservoir measure has been screened from further consideration.

6.7.5 Storage Measures Retained

Sites Reservoir – Based on the Federal P&Gs, the Sites Reservoir alternative meets the planning criteria and satisfactorily meets the NODOS Investigation primary and secondary planning objectives. The CALFED ROD specifically proposes the Sites Reservoir for further technical work, environmental review, and development of cost-sharing arrangements during CALFED Stage 1 implementation, before a decision is made to implement the project as part of the CALFED program. The ROD states that the Sites Reservoir project could enhance water management flexibility in the Sacramento Valley, reduce diversion from the Sacramento River during critical fish migration periods, increase the reliability of water supplies for a significant portion of the Sacramento Valley, and provide storage and operational benefits for other programs, including Delta water quality and the EWA.

Groundwater storage downstream of Shasta Reservoir – Based on the Federal P&Gs, the general measure of developing additional groundwater downstream of Shasta Reservoir appears at this point to meet the planning criteria and satisfactorily meets the NODOS investigation primary planning objectives. This general measure has not received the same level of analysis or assessment as other measures presented in this IAIR. However, this general measure will be refined in the PFR to assess the feasibility of specific groundwater development proposals that can contribute to NODOS investigation objectives.

Evaluation criteria will be developed to quantify additional yield, estimate capital and annual project costs, identify specific institutional arrangements that would be required for implementation, and identify local entities that would implement the project to support NODOS Investigation objectives in subsequent phases of the FS. Those initial alternatives with the greatest potential would be subjected to detailed modeling analyses, including the application of water quality standards and Delta operating rules, to quantify the potential benefits available.

Based on the potential yield that could be developed with additional storage, as described in this report, it is likely that storage actions alone may not be adequate to fully support the needs of the study area, including objectives such as anadromous fish survival. It is likely that other measures will be required to accomplish the planning objectives.

6.7.6 Further Screening of Measures to Address the Anadromous Fish Survival Objective

The three offstream storage measures and other measures, generally dealing with spawning area or habitat improvement, were retained in the previous screening as potential measures that may address anadromous fish survival. Preliminary screening, as described in previous subsections, identified two of the three offstream storage measures (Newville Reservoir and Colusa Reservoir) as either less cost-effective or inducing greater environmental impacts relative to the Sites Reservoir measure. Thus, these two were dropped from further consideration at this time. Although the two discontinued surface storage measures may have the potential to address anadromous fish survival on the Sacramento River mainstem through increased water supply and reliability, other aspects of the projects would adversely affect anadromous fish. Development of groundwater storage downstream of Shasta Dam appears to also support a number of anadromous fish survival actions. This measure will be refined in the PFR to allow more detailed assessment of its ability to support NODOS planning objectives.

The measures that involve spawning area and habitat improvements, however, do not address the primary objective for increased water supply and reliability. It is likely that, during development of the initial alternatives, some combination of these measures will be packaged with Sites Reservoir to develop alternatives that maximize benefits to anadromous fish survival.

6.8 SUMMARY OF REMAINING RESOURCE MANAGEMENT MEASURES

Table 6-12 identifies the measures carried forward into the "Initial Alternatives" formulation process.

Table 6-12

Measures Carried Forward for Development of Initial Alternatives

Planning Objective	Resource Management Measures
Primary: Water Supply and Supply Reliability	• Construct new conservation offstream surface storage at the Sites Reservoir site • Develop groundwater storage downstream of Shasta Dam
Primary: Anadromous Fish Survivability	• Construct new conservation offstream surface storage at the Sites Reservoir site • Develop groundwater storage downstream of Shasta Dam • Restore abandoned gravel mines along the Sacramento River • Construct instream aquatic habitat downstream from Keswick Dam • Replenish spawning gravel in the Sacramento River • Improve fish passage at RBDD
Secondary: Ancillary Hydropower Opportunity	• Construct new conservation offstream surface storage at the Sites Reservoir site
Secondary: Potential Recreation Opportunity	• Construct new conservation offstream surface storage at the Sites Reservoir site
Secondary: Incremental Flood Control Storage	• Construct new conservation offstream surface storage at the Sites Reservoir site

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7.0 DEVELOPMENT OF INITIAL ALTERNATIVE CONCEPTS

Initial alternatives are formulated using retained resource management measures. During the development of the initial alternatives, different strategies to address the primary planning objectives, constraints, and criteria will be explored. This section will further review the measures retained in Section 6 and develop a strategy for developing a range of initial alternatives that will be used in the next stage of planning.

7.1 STRATEGY FOR DEVELOPMENT OF INITIAL ACTION ALTERNATIVES

The strategy of this section is to identify how potential action alternatives will be developed using the range of retained measures that fully address the primary planning objectives and, to the extent possible, the secondary planning objectives.

To facilitate the development of initial action alternatives for the NODOS investigation, three project formulation elements will be combined. First, retained measures from the screening described in Section 6 of this IAIR will be combined to achieve planning objectives. With one remaining surface storage measure, a groundwater measure[1], and five anadromous fish survival measures, alternatives could include anywhere between one and seven measures. Second, the operational benefit mix of alternatives must be identified. Water supply and reliability can provide operational benefits for agriculture, municipal and industrial, and environmental uses. Beyond these traditional categories, CALFED has identified more specific needs, including Delta water quality, the Environmental Water Account, and new instream flows, to support restoration associated with specific streams. Selecting and prioritizing the supply, reliability, and operational elements for a NODOS project is part of the ongoing plan formulation for this investigation. The types of operations selected will significantly affect not only operation of NODOS, but the CVP, SWP and local systems as well. The third major element to refine for the Sites Reservoir measure (with or without a groundwater measure) in this initial alternative phase is conveyance. The NODOS Investigation has considered a range of sources, diversion locations, and capacities. Source, diversion location, and capacity will affect both environmental effects and the efficiency of providing specific benefits.

Each of the three formulation element categories (measures, operations, and conveyance) can generate numerous alternatives. The one offstream surface storage and five anadromous fish survival measures can be combined to determine the best combinations of measures to meet the planning objectives. To facilitate understanding of formulating alternatives for NODOS, this report will describe three illustrative initial alternatives. These three are obviously not comprehensive, but the alternatives were chosen to illustrate the formulation decisions that lie ahead for the investigation.

As a result of the initial screening of the three potential offstream storage sites in Section 6, Sites Reservoir is carried forward as the surface storage measure that addresses the NODOS Investigation primary objectives of increasing water supply, water supply reliability, operational flexibility, and anadromous fish survival. In addition, development of groundwater storage downstream of Shasta Dam has been retained as a general measure for inclusion in initial alternative formulation. In the PFR, the study team will refine this measure so that a more specific assessment of this measure's ability to meet NODOS objectives can be made. This section will focus on combining the Sites Reservoir measure and/or the groundwater storage measure with other measures retained earlier in the initial screening process that further address the primary objective of anadromous fish survival. In addition, conveyance features will be added to the Sites Reservoir package and possibly the groundwater measure. The

[1] Specific groundwater measure(s) have not yet been identified, but will be identified in the plan formulation phase.

measures will be coupled with different conveyance types and operational scenarios to create initial action alternatives that will satisfy all the primary objectives. This will facilitate analysis of the benefits and costs for alternative plans formulated in the PFR.

Conveyance types or methods involve (1) using existing canals and associated infrastructure, (2) a new pipeline and intake from the Sacramento River, (3) a new pipeline or canal from Black Butte Afterbay to TC Canal (referred to as "Stony Creek"), (4) a new Colusa Basin Drain pipeline, (5) conveyance to and from a groundwater storage measure, and (6) a combination of the above. Existing versus new facilities, as well as sizing (capacity), will be investigated with respect to meeting the primary objectives of NODOS in the Plan Formulation phase. For this IAIR, conveyance costs are not included because complete alternatives were not developed. The plan formulation study will develop complete alternatives and include conveyance costs as part of each plan.

The combination of operations, measures, and conveyance together provide a stable base to perform an analysis of benefits. The combination of measures, conveyance, and system operations will significantly determine the total benefit available for an offstream surface storage facility. NODOS can be managed with an emphasis on water quality, the environment, and/or water supply. Depending on how NODOS and the system are operated, different combinations of measures and conveyance will yield different benefits. The Plan Formulation phase will analyze integrating NODOS operations into the existing system as an integral part of the alternatives analysis.

Subsequent sections begin with a recap of the measures retained and packaged with the Sites Reservoir measure and groundwater storage measure, followed by discussions of the conveyance types and preliminary modeling studies of conceptual operation scenarios. Finally, three illustrative initial alternatives are identified and the No-Action alternative is described.

7.2 RETAINED RESOURCE MANAGEMENT MEASURES

To recap previous sections of this IAIR, the primary planning objectives for the NODOS Investigation are:

- ❖ Increasing water supplies, water supply reliability, and Sacramento Valley water management flexibility for agricultural, M&I, and environmental purposes, including CALFED programs such as Delta water quality, EWA, and ERP, to help meet California's current and future water demands, with a focus on offstream storage; and
- ❖ Increasing the survival of anadromous fish populations in the Sacramento River during critical fish migration periods by affecting flow, passage, habitat, and water quality as well as the health and survivability of other aquatic species.

The secondary objectives are:

- ❖ Providing ancillary hydropower generations benefits to the statewide power grid;
- ❖ Developing additional recreational opportunities in the study area; and
- ❖ Providing incremental flood control storage to support major northern California flood control reservoirs.

The measures listed in Table 7-1 were retained following the screening described in Section 6. They will be screened further and used to develop initial alternatives.

Table 7-1

Summary of Measures Retained Through Screening Process

Measure	Primary Objective: Water Supply & Reliability	Primary Objective: Anadromous Fish Survivability	Secondary Objective: Hydropower (Ancillary Benefits)	Secondary Objective: Recreation Potential	Secondary Objective: Incremental Flood Control Storage
Construct new conservation offstream surface storage at the Sites Reservoir site	☑	☑	☑	☑	☑
Develop groundwater storage near the Sacramento River, downstream from Shasta Dam	☑	☑			
Restore abandoned gravel mines along the Sacramento River		☑			
Construct instream aquatic habitat downstream from Keswick Dam		☑			
Replenish spawning gravel in the Sacramento River		☑			
Improve fish passage at RBDD		☑			

As illustrated in Table 7-2, Sites Reservoir can satisfactorily provide 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 may be considered a standalone project. However, additional measures could be incorporated to improve the habitat element of the anadromous fish survival objective.

7.3 CONVEYANCE METHODS FOR INITIAL ALTERNATIVES

A second important project formulation element associated with a NODOS action alternative is conveyance. Since Sites Reservoir is offstream, both water sources and conveyance will be required. The NODOS Investigation team has studied a number of source and conveyance options that could provide water supply for storage in Sites Reservoir. Operations, engineering, and environmental studies associated with the conveyance options are ongoing. Potential sources include the Sacramento River, Stony Creek, and Colusa Basin Drain. All conveyance options will deliver water to Funks Reservoir, which will act as a forebay to Sites Reservoir. Funks Reservoir is currently used as a regulating reservoir on the Tehama-Colusa Canal. The range of conveyance options are identified below, and are organized by source:

Sacramento River:

- Existing or expansion of TC Canal;
- Existing or expansion of Glenn-Colusa Irrigation District Main Canal; and
- New pipeline from opposite Moulton Weir.

Stony Creek:

- New pipeline or canal from Black Butte Afterbay to TC Canal.

Colusa Basin Drain:

- New pipeline in the same alignment as the Sacramento River new pipeline.

Each option above has a range of conveyance capacities so that the conveyance package selected could include anywhere from one to five of the options described. Conceptually, each conveyance option also possesses unique characteristics in its ability to provide the range of benefits and project objectives that will be described in the following section. Ultimately, an assessment of costs, benefits, and environmental effects will determine the selection of conveyance options for the Sites Reservoir project formulation.

Groundwater conveyance to and/or from a groundwater storage facility is yet to be identified. Groundwater storage sites will be evaluated in detail when the Common Assumptions Feasibility Module is developed and groundwater storage can be more fully studied and evaluated. During the plan formulation phase, studies will focus on identification of local and regional alternatives that would be acceptable to local partnerships, and would meet the NODOS objectives either conjunctively with Sites Reservoir or as a groundwater alternative without surface storage. For this report, it is assumed that groundwater storage will connect to the Sacramento River either to fill the groundwater storage and/or to release water from groundwater storage.

7.4 OPERATIONS/BENEFITS SCENARIOS

The next step in the planning process is to define a specific set of operational objectives to formulate detailed alternatives. The alternatives will be evaluated with CALSIM II, the water resources system operations model developed jointly and used by DWR and Reclamation, and DSM2, the Delta hydrodynamics and water quality model developed by DWR. The NODOS Investigation team has developed and completed preliminary operations studies of four conceptual scenarios based on general operational objectives to estimate the potential benefits of NODOS surface storage only. The four conceptual operations scenarios meet all of the four operational objectives: (1) increasing water supply and water supply reliability for the Sacramento Valley and statewide, (2) improving Delta water quality, (3) contributing to the CALFED Ecosystem Restoration Program objectives, and (4) providing storage and water supply for the EWA. However, each scenario has a different emphasis and priority in meeting each of the objectives.

Preliminary CALSIM II modeling results of the four conceptual operations scenarios showed that NODOS has the potential to provide an average annual total water supply benefit of 310 to 470 TAF/year over the long term and 315 to 440 TAF/year during the driest periods. The total water supply is the quantity of water that can be used toward meeting all of the above objectives. The quantity of water provided for the objectives varies, depending on the priority given to each objective.

7.5 NODOS INITIAL ACTION ALTERNATIVE CONFIGURATIONS

Table 7-3 lays out three initial action alternatives, each with a specified operations focus along with a configuration of the elements discussed above. It must be emphasized that these three action alternatives are just an illustrative range for alternative formulation.

Table 7-2

Ability of Retained Measures to Address Elements of the Planning Objectives

	Water Supply and Reliability							Anadromous Fish Survival							
Measure	Water Supply	Supply Reliability	Operational Flexibility	Delta Water Quality	Environmental Water Account	Ecosystem Restoration Program	Focus on Off-Stream Storage	Flow (volume, timing and location)	Fish Passage (amount of flow and location)	Habitat	Water Quality (temp and flow)	Benefits to Other Aquatic Species	Hydropower	Recreation	Incremental Flood Control
Construct new conservation offstream surface storage at the Sites Reservoir	H	H	H	H	H	H	H	H	H	L	H	M	M	H	H
Develop groundwater storage near the Sacramento River, downstream from Shasta Dam	M	M	M	L	H	H	H	M	M	L	L	L	L	L	L
Restore abandoned gravel mines along the Sacramento River	L	L	L	L	L	H	NA	L	L	H	L	H	L	L	NA
Construct instream aquatic habitat downstream from Keswick Dam	L	L	L	L	L	H	NA	L	L	H	L	H	L	L	NA
Replenish spawning gravel in the Sacramento River	L	L	L	L	L	H	NA	L	L	H	L	H	L	L	NA
Improve fish passage at Red Bluff Diversion Dam	L	L	L	L	L	H	NA	L	H	M	M	H	L	L	NA

H = high
L = low
M = medium
NA = not applicable

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Table 7-3

Conceptual Scenarios for Initial Action Alternatives

Initial Alternative Features	Initial Alternative A Environmental Focus	Initial Alternative B Water Quality Focus	Initial Alternative C Water Supply Focus
Measures			
Construct new conservation offstream surface storage at Sites Reservoir (up to 1.8 MAF)	X	X	X
Improve fish passage RBDD	X	X	
Restore abandoned gravel mines along the Sacramento River	X	X	
Construct instream aquatic habitat downstream of Keswick Dam	X		
Replenish spawning gravel in the Sacramento River	X		
Develop conservation groundwater storage near the Sacramento River downstream from Shasta Dam	X		X
Conveyance			
TC Canal		X	
GCID Canal		X	
New Pipeline	X	X	
Stony Creek Diversion	X		
Colusa Basin Drain Diversion	X		
Groundwater storage conveyance to/from Sacramento River	X		X
Operational Priorities			
Environmental	1	3	2
Water Supply	3	2	1
Water Quality	2	1	3

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Initial Alternative A has a conceptual environmental focus and includes the following measures: Sites Reservoir generation of up to 1.8 MAF, Red Bluff Diversion Dam passage improvement, restoration of abandoned gravel mines along the Sacramento River, construction of instream aquatic habitat downstream of Keswick Dam, and replenishment of spawning gravel in the Sacramento River. The conveyance formulation for Sites Reservoir would include the new pipeline from the Sacramento River, Stony Creek diversion and conveyance, and Colusa Basin Drain diversion and conveyance. Operational benefit priorities would list environmental first, water quality second, and water supply third.

Initial Alternative B has a conceptual water quality focus and includes the following measures: Sites Reservoir generation of up to 1.8 MAF, Red Bluff Diversion Dam passage improvement, and restoration of abandoned gravel mines along the river. The Initial Alternative B conveyance for Sites includes TC Canal, Glenn-Colusa Irrigation District (GCID) Main Canal, and the new pipeline from the Sacramento River opposite Moulton Weir. Operational benefit priorities would be water quality first, water supply second, and environmental third.

Initial Alternative C focuses on water supply and includes the following measures: develop groundwater storage near the Sacramento River, downstream from Shasta Dam, replenish spawning gravel in the Sacramento River and construct instream aquatic habitat on river tributaries. Conveyance for Initial Alternative C includes TC Canal, GCID Canal, and Stony Creek diversion and conveyance. Operational benefit priorities would list water supply first, environmental second, and water quality third.

As indicated in Sections 3 and 6, all alternatives will include the CALFED complementary actions WUE and Transfers. These CALFED program commitments are reflected in the Common Assumptions process so that the CALFED complementary actions are included implicitly in each alternative, including the No-Action and initial alternatives described here.

7.6 NO-ACTION ALTERNATIVE

In addition to the initial alternative configurations identified above and consistent with the federal P&Gs, the NODOS Investigation will carry the No-Action alternative through the FS for comparative purposes. Under the No-Action alternative, neither the federal government nor a willing and capable non-federal partner will take any action toward implementing a specific plan north of the Delta to improve water supply reliability for a significant portion of the Sacramento Valley, nor help to increase the sustainability of anadromous fish in the upper Sacramento River, nor help to provide storage and operational benefits to other CALFED programs. However, as noted above, this investigation will assume that WUE and Transfers will be implemented in the No-Action alternative.

Anticipated increases in population growth in the Central Valley will increase demands on water resources systems for additional and reliable water supplies. As discussed in Section 3, it is estimated that the demand for water in the future will significantly exceed available supplies and intensify competition for available water. If new water supplies are not developed, more reliance will be placed on shifting water use away from agricultural use for urban use.

Basic physical conditions in the study area are expected to remain relatively unchanged in the future. From a geomorphic perspective, ongoing restoration efforts along rivers are expected to improve natural riverine processes marginally. Without major physical changes to the river systems, hydrologic conditions will probably remain unchanged. Programs and projects in the Sacramento Valley are being pursued to help restore fisheries resources. Although significant increases in anadromous and resident fish populations in the Sacramento River are likely to continue through implementation of these projects and programs, these gains may be offset by other actions, such as the reduction in Sacramento River flows, and resulting elevated water temperatures, because of reduced diversions of cooler water from the Trinity River. Accordingly, populations of anadromous fish are expected to remain generally similar to the current populations. In addition, significant efforts of federal and state wildlife agencies supporting populations of special-status species in the riverine and nearby areas will generally remain similar to current efforts.

In the future, regardless of efforts to better manage runoff from urban and agricultural environments, water quality conditions are expected to remain generally unchanged and similar to existing conditions.

7.7 PLAN FORMULATION RANGE FOR INITIAL ALTERNATIVES

The following initial alternatives illustrate the plan formulation decisions described above that must be made to develop NODOS alternatives. As noted previously, the CALFED complementary actions (WUE and Transfers) are implicitly included in all alternatives through the Common Assumptions process. In summary, the following initial alternative scenarios will be carried forward into the PFR for further development into detailed initial alternatives:

- Initial Alternative A – Environmental Focus;
- Initial Alternative B – Water Quality Focus;
- Initial Alternative C – Water Supply Focus; and
- No-Action Alternative.

8. STUDY MANAGEMENT AND PUBLIC INVOLVEMENT

This chapter summarizes the study management and public involvement for the NODOS Investigation. Specifically, this chapter describes public and agency involvement and stakeholder outreach to date and discusses plans for future public and stakeholder involvement.

8.1 STUDY MANAGEMENT

As described in previous chapters, DWR and Reclamation are conducting feasibility-level engineering and environmental studies for the NODOS Investigation. CEQA and NEPA require environmental analyses of local, state, and federal actions for feasibility-level studies. For the NODOS Investigation, DWR is the lead agency under CEQA and Reclamation is the lead agency under NEPA.

The first of two CALFED ROD milestones directed DWR and Reclamation to enter a MOU with local water interests and develop a joint planning program. Beginning in November 2000, 12 local, 2 state, and 3 federal entities signed an MOU and began meeting to provide local, state, and federal input in NODOS planning. MOU signatories are listed, as follows:

- California Department of Fish and Game
- California Department of Water Resources
- Colusa Drain Mutual Water Company
- County of Colusa
- Glenn-Colusa Irrigation District
- Maxwell Irrigation District
- Natomas Mutual Water Company
- Orland Unit Water User's Association
- Princeton-Cordora-Glenn Irrigation District
- Provident Irrigation District
- Reclamation District No. 108
- Sutter Mutual Water Company
- Tehama-Colusa Canal Authority
- United States Fish and Wildlife Service
- United States Bureau of Reclamation, Mid-Pacific Region
- Western Area Power Administration
- Yolo County Flood Control and Water Conservation District

For the NODOS Investigation, a study management structure has been developed that consists of the Project Management Team (PMT) (a subset of the MOU Partnership) and the Study Team, as described below:

- Project Management Team – DWR, Reclamation, California Department of Fish and Game, U.S. Fish and Wildlife Service, Glenn-Colusa Irrigation District, and Tehama-Colusa Canal Authority, all signatories of the Sites Memorandum of Understanding, serve as PMT members. The PMT provides overall guidance to the Study Team for the NODOS Investigation. In addition, the PMT periodically consults with and reports to the MOU Partners on planning activities and progress made toward key milestones in environmental review and documentation.
- Study Team – The Study Team consists of the Project Managers from DWR and Reclamation, and technical experts in various disciplines. The Study Team manages the investigation and directs work performed, coordinates study results into the overall NODOS Investigation, and directs and coordinates public, agency, and stakeholder involvement. The Study Team also

maintains project files, tracks expenditures and technical progress, and provides technical study status reports to the Project Management Team.

The Project Managers participate in the Project Management Team and the Study Team, providing a communication link between the two.

Other work groups, such as technical work groups, are established as needed. These work groups focus on specific study areas such as environmental studies, engineering studies, benefit analysis, impact analysis, and hydraulic and hydrologic modeling. Work groups consist of staff members from Reclamation and DWR, and their contractors.

8.2 PUBLIC AND STAKEHOLDER INVOLVEMENT

A federal FS requires acquisition of primary data and the participation of public agencies and entities and the general public to develop a preferred plan from a range of alternative courses of action to meet recognized needs, problems, and opportunities associated with the planning area of concern. Public involvement has been an integral part of this NODOS Investigation. To encourage general public and stakeholder participation and satisfy the NEPA and CEQA public involvement requirements, the NODOS Investigation includes public outreach activities and information dissemination. This section describes past public involvement in the NODOS Investigation and presents plans for future public and stakeholder involvement.

DWR has 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 significant effects to be analyzed in depth in the environmental documentation.

8.2.1 Scoping

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 NOI and NOP notified the public of the proposal, announced the dates and locations of public meetings, and solicited public comments. Public notification was also 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 Website homepage. The formal scoping process for the NODOS Program 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 "*North-of-the-Delta Offstream Storage Investigation Scoping Report"* (October 2002, DWR and Reclamation).

Additional involvement with stakeholders, Native American tribes, state and federal agencies and other groups are briefly described below.

8.2.2 California Bay-Delta Public Advisory Committee Water Supply Subcommittee Briefings

The NODOS Study Team has been briefing the California Bay-Delta Public Advisory Committee Water Supply Subcommittee (BDPAC WSS) regularly on the planning and status of the NODOS Investigation, modeling tool development (Common Assumptions) and technical findings. The BDPAC WSS meetings are open to the public. The meetings are typically attended by DWR and Reclamation staff members, staff members from other state and federal agencies, environmental interest groups, water users groups, and members of the public. Briefings to the BDPAC WSS will continue as the investigation proceeds.

8.2.3 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 study objectives, technical studies underway, potential benefits and impacts, and 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 Delta & Mendota Water Authority
- State Water Contractors
- 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.

8.2.4 Landowners Meetings

DWR and Reclamation staff members have had numerous meetings with the Sites Reservoir landowners 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.

8.2.5 Sacramento River Flow Regime Technical Advisory Group

At the request of the NODOS Project Management Team, the Sacramento River Technical Advisory Group (TAG) was formed in 2002 and 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, as well as 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 state 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 draft *Sacramento River Flow Regime Status Report and Evaluation*. 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 NODOS. The report also documents the need for additional studies related to flow regime and ecosystem processes.

Efforts are underway to reconvene the TAG to expand the study of the flow regime and the ecosystems of the Sacramento River beyond the NODOS study area and develop a plan for improving the river's flow regime and ecosystem.

8.2.6 Interagency Coordination and Involvement

An interagency team consisting of technical staff members from DWR, Reclamation, California Department of Fish and Game, NOAA Fisheries, and U.S. Fish and Wildlife Service was formed in May 2002 to review the completed biological field surveys for Sites Reservoir, to discuss scope and level of analysis for Endangered Species Act compliance and how to deal with changes in species survey protocols for a long-term planning effort, to discuss strategy for evaluating downstream impacts, and to discuss mitigation planning. The interagency team will continue to meet as the investigation proceeds.

8.2.7 Coordination with Native American Representatives

The NODOS Study Team has been coordinating with Native American tribes (including Colusa Indian Rancheria, Cortina Indian Rancheria, Grindstone Indian Rancheria, and Paskenta Band of Nomlaki Indians) in the Sites Reservoir area. The tribes, DWR, and Reclamation developed, "Guiding Principles: Working with Indian Tribes On North-of-the-Delta Offstream Storage," to direct planning activities. The 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, eight coordination meetings, in addition to the tribal scoping meeting and one field tour of the Sites Reservoir and 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' trust water resources. The studies were not intended to be an analysis of tribal water rights claims, but instead 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.

8.2.8 Study Area Tours

DWR staff members have been conducting tours of Sites Reservoir to agency staffs and interested stakeholders. During each tour, the DWR staff provided updates on the investigation status and technical findings. The tours provided interested parties firsthand views of the Sites Reservoir area and locations of proposed facilities. DWR staff members will continue to conduct Sites Reservoir tours for interested parties as the investigation proceeds.

8.2.9 Common Assumptions Ad-Hoc Stakeholder Technical Workgroup

At the request of the BDPAC WSS in October 2003, an ad-hoc technical stakeholder workgroup was formed to help provide informed feedback to the WSS members. Feedback was to be on Common Assumptions activities, specifically, on activities relating to the development of the Common Assumptions “common model” package. The ad-hoc workgroup consists of technical participants from environmental interests groups and water user groups. The common model package is of a suite of models (hydrologic, hydraulic and hydrodynamic, water quality, temperature, and economics) that represent the future no-action baseline condition that NODOS and all other CALFED surface storage projects will use for benefits and impacts analyses in the environmental documents. 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.

8.2.10 Future Public and Stakeholder Involvement Plans

The NODOS Study Team will continue to involve the public, stakeholders, agencies, and Native American tribes in the NODOS Investigation. Meetings and briefings will be held whenever major milestones are reached. When the public draft feasibility report and environmental documents are completed, they will be made available to the public and agencies for review and comment. Public meetings will be held to facilitate public comments on the draft feasibility report and environmental documents.

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9. FUTURE ACTIONS

This chapter summarizes upcoming alternatives formulation activities for the NODOS Investigation, the study and project schedule, and related issues.

9.1 ALTERNATIVES FORMULATION

Developing alternatives is an iterative process. The initial alternatives will be refined as the NODOS Investigation proceeds, to optimize the set of alternatives into plans for detailed evaluation in the PFR. Refinement will include applying the formulation criteria discussed in Chapter 5 to each project alternative before detailed studies are undertaken. From the alternative plans, a tentatively preferred plan will be identified during the Plan Formulation Study for further evaluation in the FS. Other important future actions include the following:

- Complete environmental baseline studies;
- Complete hydrologic, hydraulic, temperature, and related modeling studies and economic evaluations;
- Identify potential impacts and mitigation features of the alternative plans;
- Prepare a PFR describing the alternative plans;
- Develop a tentatively selected plan from the alternative plans;
- Complete designs, cost estimates, and cost allocation studies and define the requirements for non-federal participation in the plan;
- Complete environmental compliance investigations; and
- Prepare and complete an integrated FS (federal decision document and NEPA/CEQA compliance).

9.2 SCHEDULE

A PFR focusing on alternative plans and environmental compliance issues is scheduled for fall 2007. An integrated FS and EIS/EIR draft is scheduled for release to the public and federal agencies for review in spring 2008. The final FS is scheduled to be provided for Washington-level review through Reclamation in winter 2008.

9.3 INVESTIGATION PROCESS FACTORS

As the NODOS Investigation progresses toward potential project implementation, issues will emerge that must be addressed and resolved. Many of these issues or concerns will become better defined and more appropriate for resolution once the alternative plans, and later the tentatively selected plan, have been defined.

Currently, two primary objectives exist for a project resulting from the NODOS Investigation: (1) water supply, reliability, and management flexibility and (2) ecosystem benefits, which include improving anadromous fish survival, improving Delta water quality for aquatic species, and providing potential benefits to other fish species. However, projects supporting secondary objectives, including recreation, incremental flood control storage, and ancillary hydropower, will require further investigation. In addition, cost allocation will indicate financial responsibility(ies) between federal and non-federal partners.

For each potential objective, a non-federal sponsor must be identified that is willing to share in the cost of the objective. Representatives of contractors to the CVP, SWP, and other water supply interests have expressed strong support for the NODOS Investigation. In addition, much interest has been identified for implementing broader recreational opportunities in the northern Sacramento Valley. Identifying specific non-federal sponsor interest in these objectives will be an important factor in future study efforts.

9.4 ADDITIONAL PLAN FORMULATION CONSIDERATIONS

9.4.1 Delta Pelagic Fish Decline

Recent declines in pelagic fish species in the Delta have elevated the concern over the vulnerability of the Delta ecosystem to changes in water use and/or management within the Central Valley. The cause of the decline is unknown, but it is thought to be linked to three dominant factors:

- Water quality impacts (natural as well as manmade);
- Food chain/ecosystem relationships (invasive species); and
- Project or operational changes affecting the ecosystem.

Future NODOS studies need to be cognizant of the roles of operational parameters, or the degrees to which they contribute to these three factors in the Delta. Future studies should determine, if possible, what beneficial contributions NODOS may afford the Delta (and to what extent) in resolving the pelagic fish issues.

9.4.2 Banks Pumping Plant Permitted Capacity

An operational component action of the South Delta Improvements Program proposes to increase the permitted limit for diversions into Clifton Court Forebay. The SWP Banks Pumping Plant has an existing installed pumping capacity of 10,300 cfs. Flow diverted from the Delta into Clifton Court Forebay is limited by permit to 6,680 cfs, with two exceptions: (1) July through September, an additional 500 cfs is allowed for the EWA and (2) during winters, when 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, October 2005).

Conveyance capacity in the South Delta is 6,680 cfs for present-day conditions and assumed to be increased to 8,500 cfs for future without-project conditions. In the event that operational criteria in the future (for whatever reasons) modify or nullify this flow assumption, NODOS plan formulation must reassess the operational flexibility of potential alternatives with respect to their supply to and reliability for users south of the Delta.

10. SUMMARY OF FINDINGS

This chapter summarizes conclusions drawn to this point from the NODOS Investigation and discusses which initial alternatives will continue through the plan formulation process.

10.1 CONCLUSIONS

Currently, the Sacramento River system between Keswick and the Delta is managed by a combination of hydrology; water use; water resources infrastructure; and local, state, and federal regulatory and resource agency operational decisions. A NODOS project would provide the additional system flexibility needed to balance ecosystem, environmental, agricultural, and M&I water uses. This IAIR is based on a preliminary appraisal of relevant water supply reliability issues and offstream surface water storage opportunities. NODOS would store water to provide additional supplies for use in the Sacramento Valley watershed during shortages and during below-normal, dry, and critical water years. This additional water supply from the Sacramento River also would contribute to statewide supply reliability by augmenting supplies available during dry and critical water years to meet 1995 Bay-Delta Water Quality Control Plan requirements and CVPIA water supply improvement objectives. Furthermore, NODOS would provide additional supply for in-Delta and south Delta water users.

A NODOS project would contribute to supply reliability for environmental water management programs, such as the ERP, CVPIA Refuge Water Supply, Environmental Water Program, EWA, Sacramento River Conservation Area Forum (SB 1086), and the SWRCB Water Quality Control Plan for the Upper Sacramento River Valley. NODOS would allow changes in the timing, magnitude, and duration of diversions from the Sacramento River to reduce or eliminate diversion effects and help assure appropriate flows necessary for critical life stages for anadromous fish and riparian habitat. These capabilities also would help achieve the fisheries restoration goals of the CVPIA and the California Steelhead Restoration and Management Plan. Additional water stored upstream from the Delta would provide increased flows during critical times to help reduce salt intrusion from the Delta; increased flows to flush salts, natural organics, and pollutants from the Bay-Delta system; and improved water quality in the Bay-Delta system for all purposes, including ecosystem restoration and drinking water.

Fully addressing problems in the study area requires the development and management of additional water supplies in the Upper Sacramento River Valley Basin through surface, conjunctive, and groundwater storage programs. Development and management of new water supplies could be accomplished with additional storage and resulting changes in project operation. A NODOS alternative could include groundwater storage, surface storage, or both. A retained measure, groundwater storage downstream from Shasta Dam would likely address both primary NODOS objectives, but none of the secondary objectives. Groundwater storage measures will be evaluated in a more comprehensive manner in the PFR as additional information becomes available from CALFED's groundwater storage investigation. Alternative reservoir locations for the NODOS project were considered within the Coast Range foothills along the western edge of the northern Sacramento Valley. Retained surface storage measures supportive of the NODOS primary objectives included three offstream surface storage measures: Sites Reservoir, Colusa Reservoir, and Newville Reservoir. Although the three surface storage measures addressed both primary planning objectives and provided opportunities for realizing the secondary objectives for the NODOS investigation, all three could also be combined with other measures to increase the benefits of an alternative plan.

For the development of initial alternatives, the three storage measures retained, Colusa Reservoir, Newville Reservoir, and Sites Reservoir, were evaluated for their ability to address the planning objectives while maximizing project benefits and minimizing any adverse effects on the study area. Since the offstream storage measures were similar, several assumptions were made to simplify comparison of the measures:

- Additional measures screening focused on the offstream reservoir sites;
- All offstream reservoir sites had conveyance and connectivity options; and
- All offstream reservoir sites had comparable anadromous fish measures.

To facilitate the additional measures screening, the offstream surface storage measures were evaluated and compared based on the above assumptions, as well as previous studies conducted at the proposed reservoir sites.

The offstream surface storage measures were compared with respect to their total capital construction costs, their yield, and unit cost per deliverable volume. A preliminary economic assessment was performed to compare the average annual cost per yield for the three surface storage measures. The estimated average annual cost per yield was similar in magnitude for Sites and Newville Reservoirs, but was excessive for Colusa Reservoir. Sites Reservoir's average annual cost per yield was approximately 36% greater than that for Newville Reservoir. However, Colusa Reservoir's average annual cost per yield was about 367% greater than that for Sites Reservoir, and about 500% greater than that for Newville Reservoir. In addition, the capital cost of Colusa Reservoir was approximately 4.4 times that of Sites Reservoir, and 6 times that of Newville Reservoir, while the increase in yield was only around 19 percent. With respect to the federal planning criterion on "efficiency," Colusa Reservoir was dismissed from further consideration as a potential, viable measure for the IAIR.

The Newville and Sites Reservoirs were next compared for their potential impact to environmental/ ecological attributes. The review indicated a significantly greater impact potential for Newville Reservoir. With the exception of potential impacts on the number of state and federal bird species of concern, possible project-related impacts for all the other biological/ecological attributes were higher for Newville Reservoir. With respect to the federal planning criteria on "acceptability," the Newville Reservoir measure was dismissed from further consideration as a potential, viable measure for the IAIR.

Based on these findings, Sites Reservoir will be packaged with other potential measures to develop the best possible alternatives to address the NODOS planning objectives. In the PFR, Sites Reservoir will be compared against and/or packaged with a more specific groundwater storage measure.

It should be noted this IAIR investigation does not preclude the consideration of other offstream storage opportunities as long as appropriate legal, regulatory, and mitigative measures are incorporated as a part of the alternative options. Further information for the Sites Reservoir alternative was documented in July 2000 in the 18-volume *Integrated Storage Investigations North-of-the-Delta Offstream Storage Investigation Progress Report* (Progress Report) (DWR, 2000). The Progress Report summarized the findings and recommendations of the alternatives screening process, and recommended discontinuing the study of the Red Bank Reservoir and Colusa Reservoir alternatives.

10.2 RECOMMENDATIONS

The environmental documentation process was initiated in November 2001 with the publication of Notices of Intent and Preparation for an EIR/EIS for the NODOS project.

The following initial alternative scenarios will be carried forward into the PFR for further development into detailed initial alternatives:

- Initial Alternative A – Environmental Focus (Sites Reservoir);
- Initial Alternative B – Water Quality Focus (Sites Reservoir);
- Initial Alternative C – Water Supply Focus (Sites Reservoir); and
- No-Action Alternative.

Thus, this initial investigation recommends proceeding to the Plan Formulation Study to further develop, refine, and evaluate these alternatives, as well as the federal No-Action Alternative. The PFR will develop the alternatives in greater detail, including more detailed cost estimates and project benefits. The Plan Formulation Study and PFR will determine whether or not a detailed FS and environmental compliance analysis are recommended.

10.3 FEDERAL INTEREST IN CONTINUING WITH A PLAN FORMULATION STUDY

This IAIR concludes there is a potential federal interest in a NODOS project to meet objectives associated with municipal and industrial, agricultural, and environmental water supply reliability; anadromous fish survival; power; incremental flood control storage; and recreation. Given the federal interest in participating in the EWA, a federal interest may exist in having storage north of the Delta to accomplish these goals. The degree and magnitude of the federal interest in a NODOS project will be confirmed and quantified in future planning phases, including the Plan Formulation Study and the FS.

The Plan Formulation Study will develop these aforementioned alternatives in greater detail and will refine costs, estimate benefits, provide a preliminary evaluation of environmental impacts, and identify a tentatively preferred plan and final array of alternatives to consider in the FS. Consideration among Reclamation, DWR, and CALFED Bay-Delta Authority, and other appropriate stakeholders will continue to further define the issues and solicit support in future planning study activities.

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11. REFERENCES

Balph, M.H., L.C. Stoddart, and D.F. Balph, 1997. A Simple Technique for Analyzing Bird Transect Counts. *Auk* 94:606-6-7.

Brown, C.J., E.D. Smith, J.M. Siperek, N.A. Villa, H.H. Reading, and J.P. Finn, 1983. *Thomes-Newville Unit Fish and Wildlife Evaluation.* California Department of Fish and Game, p 207.

Brown, C.J., J.R. Garcia, and A. Woesner, 1987. *Final Report on Reconnaissance Level Studies at the Dippingvat and Shoenfield Reservoir Site*. California Department of Fish and Game, p 89.

Brown, R.D. and E. Rich, 1961. Geologic Map of the Lodoga Quadrange, Glenn and Colusa Counties, California. U.S. Geological Survey, Oil and Gas Investigation Map OM-210.

CALFED Bay Delta Program, 2000. *Final Programmatic Environmental Impact Statement/ Environmental Impact Report.* July.

California Bay-Delta Authority, 2004. California Bay-Delta Surface Storage Program Progress Report.

California Bay-Delta Program, 2000. Initial Surface Water Storage Screening Report.

California Bay-Delta Program, Date Unknown. Integrated Storage Investigation.

California Energy Commission, 2002. *2002-2012 Electricity Outlook Report.* Final. February.

California Trout, Inc., 1999. *Conservation Plan for the New Millennium*.

California Water Plan Update, 2005.

CDFG, Date unknown. *California Natural Diversity Database*.

CDFG, 1983. *Thomes-Newville Unit Fish and Wildlife Evaluation – A Status Report,* p 207.

Chuber, S, 1961. *Late Mesozoic Stratigraphy of the Elk Creek-Fruto Area, Glenn County, California.* Ph.D. Thesis, Stanford University, p 115.

DWR, 1998. *California Water Plan Update*. Bulletin 160-98.

DWR, 2000. *Integrated Storage Investigations North-of-the-Delta Offstream Storage Investigation Progress Report*. Final Draft. 18 vols. July.

DWR, 2002. *North-of-the-Delta Offstream Storage Investigation Scoping Report*.

DWR, 2003 (update). *California's Groundwater*. Bulletin 118.

DWR, Division of Engineering, 2003. *North-of-the-Delta Offstream Storage Sites Reservoir Engineering Feasibility Study*.

DWR, Division of Engineering, 2004. *North-of-the-Delta Offstream Storage Investigation Newville Reservoir Project Update of Existing and Development of New Reconnaissance Level Designs and Cost Estimates*. Final Draft.

DWR, 2006. *California Water Plan Update*. Bulletin 160-05.

DWR, Date Unknown. *North-of-the-Delta Offstream Storage Investigation Screening Report for the West-Side Storage Alternatives*. Draft.

Earth Sciences Associates, 1980. *Seismic and Fault Activity Study of the Proposed Glenn Reservoir Complex*. Prepared for WDR.

Emlen, J.T., 1971. Population Densities of Birds Derived from Transect Counts. *Auk* 88:323-342.

Helley, E.J. and D.S. Harwood, 1985. Geologic Map of the Late Cenozoic Deposits of the Sacramento Valley and Northern Sierra Foothills, California. U.S. Geological Survey Map MF 1790.

Interagency Ecological Program (IEP), 2005. *2005 Workplan to Evaluate the Decline of Pelagic Species in the Upper San Francisco Estuary.*

Kirby, J.M., 1943. *Sites Region.* California Division of Mines Bulletin 118, pp 606-608.

Moyle, P.B., 1976. *Inland Fishes of California*. University of California Press, Berkeley and Los Angeles, California, pp 162-210.

National Marine Fisheries Service (NMFS), Southwest Region, 1997. *Proposed Recovery Plan for the Sacramento River Winter-Run Chinook Salmon*.

Resources Agency of California, 1989. *Upper Sacramento River Fisheries and Riparian Habitat Management Plan.*

Riparian Habitat Joint Venture (RHJV), 2000. *Riparian Bird Conservation Plan: A Strategy for Reversing the Decline of Birds and Associated Riparian Species in California*.

Sacramento River Conservation Area Forum, 2003. *Sacramento River Conservation Area Forum Handbook.*

Skinner, M. and B. Pavlik, 1994. *California Native Plant Inventory of Rare and Endangered Vascular Plants of California*. Special Publication No. 1. Fifth edition. California Native Plant Society.

U.S. Bureau of Reclamation, 1969 and 1980. Series of memos for the West Sacramento Canal Unit on Engineering Geology of Sites Reservoir Project.

U.S. Bureau of Reclamation and California Department of Water Resources, 2005. *South Delta Improvements Program EIS/EIR*. Draft.

U.S. Department of the Interior (DOI), 1999. *Trinity River Flow Evaluation.* Washington D.C. June.

U.S. Geological Survey, 1996. *Database of Potential Sources for Earthquakes Larger than Magnitude 6 in Northern California*. Open File Report 96-705. Available on Internet.

William Lettis and Associates, 1997. *Seismotectonic Evaluation – Stony Gorge and East Park Dams of the Orlando Project and Monticello Dam of the Solano Project*. Prepared for the U.S. Bureau of Reclamation, p 145. With plates and appendices.

Wong, I.G., et al., 1988 Contemporary Seismicity and Tectonics of the Northern and Central Coast Ranges-Sierran Block Boundary Zone, California. *Journal Geo*. 93, Nos. 87, pp 7,813-7,833.

Water Resources Council (WRC), 1983. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*.

Zeiner, D.C., W. F. Laudenslayer, Jr., K.E. Mayer, and M. White eds, 1990. *California's Wildlife. Volume II: Birds.* State of California, The Resources Agency, Department of Fish and Game, Sacramento, California, p 732.

_____, 1980. *Engineering Geology of the Red Bank Project, Tehama County, California*.

_____, 1978. *West Sacramento Valley Fault and Seismicity Study, Glenn Complex, Colusa Reservoir, Berryessa Enlargement*. Division of Design and Construction, Project Geology Branch, p 43.

_____, 2000. *Phase II Fault and Seismic Hazard Investigation, Basic Data Report for the 1999 Field Season.*

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APPENDIX A

LOCAL CLIMATE AND WATER RESOURCES

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APPENDIX A

Local Climate and Water Resources

Climate

High temperatures occur during July, August, and September, with temperature readings commonly in excess of 100 degrees Fahrenheit (°F). Fog of varying density and duration is common within the Sacramento Valley during winter. However, given the physical topography, dense or persistent fog is much less common in the project areas. Winds occur seasonally, with dry north winds common during the summer and fall, while winds from the south are frequently associated with winter storm events. Winds in excess of 60 miles per hour may occur; however, these events are relatively uncommon and of short duration. Average wind speed at Red Bluff is 8.8 miles per hour, with the strongest winds reported during the winter months. Gross evaporation, the depth of water lost to the atmosphere, averages approximately 70 inches per year in the foothill region.

Average annual precipitation within the Sites and Colusa Reservoir areas is approximately 18 inches and occurs almost exclusively as rain. Average annual precipitation in the Colusa Cell area is slightly higher, with up to 22 inches per year. Snow occurs annually at higher elevations and occasionally within the reservoir areas. Some areas within western Glenn County that range in elevation from 5,000 to 7,000 feet frequently receive between 60 and 75 inches of precipitation per year, primarily as snow. Mean annual temperature in the area of the proposed reservoirs is approximately 62°F. Summer temperatures in excess of 115°F have been documented. The project areas generally have about 220 frost-free days per year, and nearby areas in the Sacramento Valley have about 260 frost-free days per year.

Average annual precipitation in the Thomes-Newville Reservoir area ranges from 20 to 24 inches, primarily as rain. Annual precipitation averages 23.5 inches at Paskenta. The wettest year on record at the Paskenta monitoring location (1982-1983) was 48.4 inches, and the driest (1938-1939) was 8.6 inches. The project area generally has between 220 and 250 frost-free days per year. The average date of the last spring freeze is April 1 at Paskenta. Summer temperatures in excess of 90°F occur approximately 97 days per year, and summer temperatures in excess of 100°F occur annually.

The average annual precipitation in the Red Bank Reservoir area is 25 inches because of the slightly higher elevation and more northern location. Snowfall occurs more frequently here than at the other potential reservoir locations, but it seldom persists for long or contributes significantly to the total annual precipitation. Approximately 175 to 200 frost-free days per year occur in the Red Bank Reservoir area, with the last frost of the spring on or about May 1. Temperature ranges are similar to those described for the other three proposed reservoirs.

Hydrology

Flows in the Thomes Creek watershed fluctuate seasonally. Summer low flows are frequently measured at less than 4 cubic feet per second (cfs), while winter flows often exceed 4,500 cfs. Flows recorded at Paskenta have ranged from zero in 1977 to 37,800 cfs during December 1964. (The December 1964 runoff event was triggered by a major rain-on-snow storm.) Periodic large floods, such as the 1964 event, can result in tremendous bedload movement.

Stream flows within Red Bank and South Fork Cottonwood Creeks are generally greater than stream flows in creeks within the other three proposed reservoir areas. Red Bank Creek stream gaging (measured near Red Bluff – near the confluence with the Sacramento River) indicates an average annual discharge of 35,377 acre-feet (AF), with annual extremes ranging from 988 AF in 1976 to 138,775 AF in 1983.

The surface water quality of streams draining eastward from the Coast Range is generally poor. These streams generally have very high suspended sediment loads because of their metavolcanic bedrock and schist formations, which produce clays that stay in suspension during turbulent flow conditions. Soil disturbance within these watersheds can accelerate erosion and sedimentation processes and lead to increased metal and nutrient concentrations. High concentrations of metals and nutrients are commonly present during both low-flow and storm runoff events. These concentrations frequently exceed water quality criteria established for the protection of beneficial use or the maintenance of aquatic life. Water is generally warm in streams flowing through the proposed reservoir sites. Total phosphorus concentrations are at stimulatory levels for algae.

Groundwater

There are about 280 well completion reports on file with Department of Water Resources (DWR) for the general area of the potential offstream reservoir projects. Approximately 60% of these wells are used for domestic purposes. Irrigation wells and stock watering wells make up 10% each. About 20% of the wells are classified as “other” and are used for monitoring, test wells, or another unknown use. Most of the irrigation wells are just east of the Tehama-Colusa Canal, outside of the area of the Sites and Colusa Reservoir areas, and they have reported depths and yields of about 250 feet and 750 gallons per minute (gpm), respectively. The few wells in or close to the reservoir inundation areas obtain their yield from the Great Valley Sequence rocks. These wells are typically about 50 feet deep and yield less than 10 gpm.

Few of the 170 reported domestic wells are within any of the proposed reservoir inundation areas. Domestic wells in the general area average about 200 feet deep and yield an average of about 10 gpm. These wells are only perforated down to about 150 feet and the rest of the hole depth is apparently used for water storage. The stock wells are shallower and average about 125 feet deep and also yield an average of about 10 gpm. Most of the yield comes from fractures in the Great Valley Sequence rocks.

Landowners within the northern portion of Sites Reservoir and the Colusa Cell report the presence of shallow salt-water deposits. Limited sampling of the springs that feed Salt Lake in the northeastern portion of Sites Reservoir show elevated levels of various minerals and salts. The depth and extent of this highly mineralized groundwater is unknown. The flow from these springs is very limited.

DWR’s Bulletin 118 identifies only one groundwater basin within the immediate area of the proposed projects: the Chrome Town Area adjoining the Thomes-Newville Reservoir area. This is not a true groundwater basin, but a groundwater area. It consists of Quaternary terrace deposits up to about 50 feet thick, which is unusual because terrace deposit thickness in the range of 10 to 20 feet is more common. Most wells in the area obtain their water from either the gravels in the terrace deposits at the contact with the underlying Great Valley Sequence rocks or from the fractures in the Great Valley Sequence rocks. Well yields up to 10 gpm are all that can be expected from this area. Dry wells are not uncommon.

APPENDIX B

GEOLOGY AND SOILS

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APPENDIX B

Geology and Soils

Along the western side of the Sacramento Valley, rocks of the Great Valley province include: Upper Jurassic to Cretaceous marine sedimentary rocks of the Great Valley Sequence; fluvial deposits of the Tertiary Tehama Formation; Quaternary Red Bluff, Riverbank, and Modesto Formations; and Recent alluvium.

Water gaps in the sandstone and conglomerate ridges form the dam sites for all four of the proposed reservoirs. The Great Valley Sequence was formed from sediments deposited within a submarine fan along the continental edge. The sediment sources were the Klamath Mountains and Sierra Nevada to the north and east.

The mudstones of the Great Valley Sequence are typically dark gray to black. Generally, the mudstones are thinly laminated and have closely spaced and pervasive joints. When fresh, the mudstones are hard, but exposed units weather and slake readily. Mudstones generally underlay the valleys.

Fresh sandstones are typically light green to gray; weathered sandstones are typically tan to brown. They are considered to be graywackes in some places because of the percentage of fine-grained interstitial material. Sandstone beds range from thinly laminated to massive. In many places, the sandstones are interlayered with beds of conglomerates, siltstones, and mudstones. Massive sandstones are indurated and hard, with widely-spaced joints, forming the backbone of most of the ridges.

The conglomerates are closely associated with the massive sandstones and consist of lenticular and discontinuous beds varying in thickness from a few feet to more than 100 feet. Conglomerate clasts range in size from pebbles to boulders and are composed primarily of chert, volcanic rocks, granitic rocks, and sandstones set in a matrix of cemented sand and clay. The conglomerates are similar to the sandstones in hardness and jointing.

Tertiary and Quaternary fluvial sedimentary deposits unconformably overlie the Great Valley Sequence. The Pliocene Tehama Formation is the oldest. It is derived from erosion of the Coast Ranges and Klamath Mountains and consists of pale green to tan semiconsolidated silt, clay, sand, and gravel. Along the western margin of the valley, the Tehama Formation is generally thin, discontinuous, and deeply weathered.

The Quaternary Red Bluff Formation consists of reddish poorly sorted gravel with thin interbeds of reddish clay. The Red Bluff Formation is a broad erosional surface, or pediment, of low relief formed on the Tehama Formation between 0.45 and 1.0 million years ago. Thickness varies to about 30 feet. The pediment is an excellent datum to assess Pleistocene deformation because of its original widespread occurrence and low relief. Red Bluff Formation outcrops occur just east of the project sites.

Alluvium is a loose sedimentary deposit of clay, silt, sand, gravel, and boulders. Deposits include landslides, colluvium, stream channel deposits, floodplain deposits, and stream terraces. Quaternary alluvium is a major prospective source of construction materials. Colluvium, or slope wash, consisting mostly of soil and rock, occurs at the face and base of a hill. Landslide deposits are similar but more defined and generally deeper. Landslides occur along the project are but are generally small, shallow debris slides or debris flows. These deposits may be incorporated as random fill in project construction.

Stream channel deposits generally consist of sand and gravel. Potential construction material uses include concrete aggregate, filters, and drains. Floodplain deposits are finer grained and consist of clay and silt. Floodplain deposits may be used for impervious core and for random fill.

The stream terraces form flat benches adjacent to and above the active stream channel. Up to nine different stream terrace levels have been identified. Terrace deposits consist of several to 10 feet of clay, silt, and sand overlying a basal layer of coarser alluvium containing sand, gravel, cobbles, and boulders. Four terrace levels have been given formational names by the U.S. Geological Survey (Helley and Harwood 1985)—the Upper Modesto, Lower Modesto, Upper Riverbank, and Lower Riverbank—and they range in age from 10,000 to several hundred thousand years old.

Soils of the Coast Range and western Sacramento Valley are highly diverse. Mountain soils are generally shallow to deep and well drained to excessively well drained and mostly steep to very steep. Foothill soils are formed from hard, unaltered sedimentary rock and poorly consolidated siltstone of the Tehama Formation. Soils of older alluvial fans and terraces are well drained to poorly drained and have moderate to low permeability. Interior valley basin soils are generally fine textured and poorly drained, with very slow runoff.

Predominant soil associations within the Colusa and Sites Reservoir sites are the Altamont and Contra Costa clay loam series. These are young, eroded and shallow, well to excessively drained clay to clay loam soils that have developed in place over hard sandstone and shale. Runoff is slow to moderate. Erosion is slight to severe, depending on slope and relief. Terrain is nearly level to steep, and in many areas the surface yields many outcrops of the parent material.

The general soil associations of the Thomes-Newville Reservoir area are the Millsholm and Lodo series. The Millsholm series are shallow, well drained, moderately coarse to moderately fine textured clay-loam soils that are formed from sandstone, mudstone, and shale. Terrain is hilly to steep, with numerous outcrops scattered throughout the landscape. In this area, outcrops occur on 30% to 50% slopes where runoff is medium to high, permeability is moderate, and erosion potential is severe. Lodo series are shallow, somewhat excessively drained, shaley-clay loam soils that formed in weathered, hard shale and fine-grained sandstone. In this area, the soils occur on mountainous terrain with slopes ranging from 30% to 65 percent. Runoff is medium to high, permeability is moderate, and erosion potential varies from moderate to severe, depending on slope and relief.

Predominant soil associations within the Schoenfield Reservoir site are the Maymen-Los Gatos-Parrish series and, to a lesser extent, the Sheetiron-Josephine association. The Maymen-Los Gatos-Parrish series are shallow to moderately deep, gravelly to rocky clay loam soils that are formed in hard sandstone and shale and, in some areas, in hard mica schist. These soils occur on slopes ranging from 5% to nearly vertical. Terrain is steep, with deep canyons and narrow ridges. Most soils are well drained to excessively drained, and runoff is rapid to very rapid. Permeability is moderately slow to slow in the Parrish component, moderate to moderately rapid in the Maymen component and moderate in the Los Gatos component. The Sheetiron Josephine associations are well drained, shallow, gravelly loam soils found in strongly sloping to very steep terrain, and they are formed in altered sedimentary and extrusive igneous rock. This series comprises a very small portion of the area.

The general soil associations within the Dippingvat Reservoir are the Millsholm and Lodo series. The Millsholm series are shallow, well drained, moderately coarse to moderately fine textured clay-loam soils that are formed from sandstone, mudstone, and shale. Terrain is hilly to steep, with numerous outcrops found scattered throughout the landscape. In this area, they occur on 30% to 50% slopes where runoff is medium to high, permeability is moderate, and erosion potential is severe. Lodo series are shallow, somewhat excessively drained, shaley-clay loam soils that are formed from weathered, hard shale and fine-grained sandstone. In this area, the soils occur on mountainous terrain with slopes ranging from 30% to 65 percent. Runoff is medium to high, permeability is moderate, and erosion potential varies from moderate to severe, depending on slope and relief.

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APPENDIX C

BOTANICAL SURVEYS

APPENDIX C

Botanical Surveys

Botanical Surveys

Plant communities were mapped and quantified within each reservoir site for broad-scale resource inventory and assessment. Rare plant surveys were conducted in the project inundation areas according to established regulatory agency guidelines and protocols. Under these guidelines, focused habitat-specific surveys were conducted, using wandering transect methodology, between February and October in 1998 and 1999.

Sites

Acreage estimates of mapped dominant vegetation types are presented in Table C-1. California annual grassland was dominant at the Sites Reservoir. Less than 10% of the vegetation in this reservoir area is woodland (*Quercus* sp. or *Pinus sabiniana*), chaparral, or riparian or vegetated wetland (*Eleocharis* sp.). Only 6% (923 acres) of the total inundation area of the Sites Reservoir area supports oak woodland; this would be lost if the project were constructed.

Table C-1

Acreage Estimates of the Dominant Vegetation Communities Mapped Within the Four Offstream Storage Reservoir Alternatives

Vegetation	Acreage by Reservoir			
	Sites	Colusa Cell	Thomes-Newville	Red Bank
Grassland	12,602	13,540	14,492	565
Woodland (Oak)	923	20	1,839	899
Woodland (Foothill Pine)	0	0	0	2,826
Chaparral	5	0	363	98
Riparian	52	37	64	73
Vegetated Wetland	23	15	0	1
Cultivated Grain	277	0	0	0
Vegetation Subtotal	13,882	13,612	16,758	4,462
Other[a]	280	51	315	142
Total Reservoir Acreage	14,162	13,663	17,073	4,604

[a] "Other" refers to disturbed/developed acreage within the inundation elevations.

Colusa Cell

California annual grassland was dominant in the Colusa Cell (Table C-1). Twenty acres of oak woodland was mapped at the Colusa Cell; this would be lost if the project were constructed.

Thomes-Newville Reservoir

Acreage estimates of mapped dominant vegetation types are presented in Table C-1. California annual grassland was dominant at the proposed Thomes-Newville Reservoir site. The Thomes-Newville Reservoir site supports valley and blue oak woodland vegetation in more than 11% (1,839 acres) of the inundation area. There are good quality vernal pools with representation of common vernal pool flora; however, all of the pools were grazed. No high priority species were found in any of the vernal pool habitat.

Thirty-one total occurrences of 4 low priority species and 23 occurrences of 5 priority species were identified in the Thomes-Newville Reservoir site (Table C-2).

Red Bank Reservoir

Foothill pine woodland is the dominant vegetation in the proposed Red Bank Reservoir area. Oak woodland represents approximately 20% (899 acres) of the project area. The total amount of woodland habitat, including foothill pine woodland and oak woodland, constitutes 83% of the vegetative cover. At this site, only 2% of the cover is chaparral scrub, and 12% (565 acres) is annual grassland. Potential habitat exists at this site for the chaparral, valley and foothill woodland, and valley and foothill grassland prioritized species. No vernal pool or alkaline wetland habitat was observed in the Red Bank Reservoir site. In this project area, 10 prioritized plant species were found; 73 populations were found, including 39 priority species populations and 34 populations of low priority species (Table C-2).

Table C-2

Summary of Prioritized Plant Species Found in the Potential Offstream Storage Reservoirs, 1998-1999

Reservoir	Common Name (Scientific Name)[a]	Number of Occurrences[b]	Status[c] USFWS/CNPS
Sites	Fairy candelabra (*Androsace elongata* ssp. acuta)	3	– / List 4
	Hogwallow evax (*Hesperevax caulescens*)	3	-- / List 4
	Hoary navarretia (*Navarretia eriocephala*)	1	-- / List 4
	Tehama navarretia (*Navarretia heterandra)*	3	-- / List 4
Colusa Cell	Fairy candelabra (*Androsace elongata* ssp. acuta)	2	– / List 4
	Hogwallow evax (*Hesperevax caulescens*)	2	-- / List 4
	Hoary navarretia (*Navarretia eriocephala*)	1	-- / List 4
	Tehama navarretia (*Navarretia heterandra)*	1	-- / List 4
Thomes-Newville	Fairy candelabra (*Androsace elongata* ssp. acuta)	13	– / List 4
	Dimorphic snapdragon *(Antirrhinum subcordatum*)	7	—- / 1B
	Jepson's milk-vetch *(Astragalus rattanii* var. *Jepsonianus)*	1	-- / 1B
	Stony Creek spurge (*Chamaesyce ocellata* ssp *rattanii)*	7	-- / List 4
	Adobe lily (*Fritillaria pluriflora)*	12	SC / 1B
	Hogwallow evax (*Hesperevax caulescens*)	4	-- / List 4
	Tehama dwarf flax (*Hesperolinon tehamense)*	2	SC / 1B
	N.California black walnut (Juglans californica var. hindsii)	1	SC / 1B
	Tehama navarretia (Navarretia heterandra)	7	-- / List 4

Table C-2
(CONTINUED)

Reservoir	Common Name (Scientific Name)[1]	Number of Occurrences[2]	Status[3] USFWS/CNPS
Red Bank	Fairy candelabra (*Androsace elongata* ssp.acuta)	1	– / List 4
	Dimorphic snapdragon (*Antirrhinum subcordatum)*	23	-- / 1B
	Jepson's milkvetch (*Astragalus rattanii* var. *jepsonianus*)	*8*	-- / 1B
	Stony Creek spurge (*Chamaesyce ocellata* ssp *rattanii)*	9	-- / List 4
	Brandegee's eriastrum (*Eriastrum brandegeae)*	3	SC / 1B
	Adobe lily (*Fritillaria pluriflora)*	5	SC / 1B
	Woolly meadowfoam *(Limnanthes floccosa* ssp. *floccosa*)	1	--/ List 4
	Jepson's navarretia (*Navarretia jepsonii)*	8	– / List 4
	Tehama navarretia (*Navarretia heterandra)*	11	-- / List 4
	Sickle-fruit jewel-flower *(Streptanthus drepanoides*)	4	– / List 4

[a] Nomenclature corresponds to Skinner and Pavlik, 1994.
[b] Occurrences are defined per California Native Plant Society, 1999, as population findings separated by at least 0.25 mile.
[c] USFWS 1998: SC (species of concern); Skinner and Pavlik, 1994; CNPS IB; (Plants Rare, Threatened, or Endangered in California and Elsewhere); CNPS List 4 (Plants of Limited Distribution).

Wetlands Delineation

The following subsections summarize wetlands delineation at the four inundation areas.

Sites Reservoir

Only 1.4% of the inundation area was identified as jurisdictional wetlands. Of these jurisdictional wetlands identified within the Sites Reservoir footprint (Table C-3), more than 76% are seasonal wetlands. Most of the alkaline wetlands also are "seasonal," but they differ vastly in plant species composition. The alkaline wetlands within the Sites Reservoir are located along a linear zone of deformation potentially associated with the Salt Lake Fault. A small quantity (2 acres) of emergent wetland was identified within the Sites Reservoir area.

Table C-3

Jurisdictional Wetlands And Waters of the U.S. Delineation

Wetlands Type	Acreage by Reservoir			
	Sites Reservoir	Colusa Cell Reservoir	Thomes-Newville Reservoir	Red Bank Reservoir
Alkaline	19	35	3	0
Emergent	2	0	6	included with seasonal
Riparian	22	11	77	76
Seasonal	153	263	304	7
Total Jurisdictional Wetlands	196	309	390	83
Streams	159	111	165	118
Ponds	16	24	66	34
Other Waters	175	135	231	152
Total Waters of U.S.	371	444	621	235
Reservoir Area	14,162	13,664	17,073	4,905

The riparian areas found in the Sites Reservoir area are rarely well developed or large. The largest concentration of riparian habitat is located within the southern portion of the Sites Reservoir.

Many of the vernal pools found within the Sites and Colusa Reservoir areas are manmade (e.g., drainages blocked by roads, stock ponds, or disturbed areas within heavy clay soils) and have very low plant species diversities. Pools occurring along the northeastern edge of the Sites Reservoir tend to be larger and higher in plant species diversity than elsewhere.

Colusa Cell Reservoir

Seasonal wetlands account for more than 84% of the Colusa Cell wetlands (Table C-3). Most of the alkaline wetlands also are "seasonal," but they differ vastly in the plant species composition. The alkaline wetlands within the Colusa Cell are located along a linear zone of deformation potentially associated with the Salt Lake Fault. Emergent wetlands were present within the Colusa Cell in several small areas, but these were not measurable by interpreting aerial photographs.

The riparian areas found in the Colusa Cell were not well developed or large. One large pool with higher plant species diversity occurs within the Colusa Cell.

Thomes-Newville Reservoir

Seasonal wetlands dominate (74%) the wetlands of the Thomes-Newville Reservoir site (Table C-3). Some of the wetland areas are very large and may form complexes with other types of wetlands, including riparian areas. This site also has significant quantities of other wetland types.

Riparian areas account for more than 18% of the Thomes-Newville Reservoir wetlands. Well-developed riparian habitat occurs along several of the main tributaries, though patches of the invasive non-native *Ailanthus altissima* (tree of heaven) occur within some of these stands. Construction of the Thomes-Newville Reservoir would result in the loss of 77 acres of good quality riparian habitat.

One small area of alkaline wetland was identified within the Salt Creek drainage. Other areas adjacent to Salt Creek and some of its tributaries supported alkaline species but were too narrow to map.

Vernal pool complexes, which are areas of concentrated pools and connecting swales, were found in several locations within the reservoir site. These pools were of an overall higher quality when compared to the pools in the Sites and Colusa Reservoir areas.

Red Bank Reservoir

Seasonal and emergent wetlands make up less than 9% of the wetland total for the Red Bank Reservoir (Table C-3). Many of these wetlands are located within or adjacent to small stockponds or are associated with saturated spring-fed areas. Clay soils are relatively rare within the steep terrain that dominates both the Schoenfield and Dippingvat Reservoirs.

Riparian areas dominate (92%) the wetlands of this area. Riparian areas can be found throughout the two reservoirs but are best developed along South Fork Cottonwood Creek and South Fork Red Bank Creek.

No state or federally threatened or endangered plants were found in the four potential reservoir areas during the two-year study. Populations of federal Species of Concern were identified in the Thomes-Newville and Red Bank Reservoir areas. Several rare or limited distribution species also were found in all of the alternative reservoir areas. The Thomes-Newville and Red Bank sites yielded the greatest number of populations of sensitive plant species.

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APPENDIX D

BIOLOGICAL SURVEYS

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APPENDIX D

Biological Surveys

Fish Surveys

CDFG initiated fish studies in 1997. Fish studies were conducted in the tributaries that flow through each of the four proposed project areas. Past studies also were reviewed and evaluated as part of this effort. Results and discussions of findings in past fishery studies and recently conducted surveys of fishery resources in the four proposed reservoir areas are summarized in this section.

Sites and Colusa Cell Reservoirs

Fish studies for the Sites and Colusa Reservoirs include three basic areas: fish resource studies in streams within the proposed reservoirs and within the Colusa Basin Drain, and habitat typing of the dominant streams in the proposed reservoir areas.

Studies of fish in streams that flow through the proposed Sites and Colusa Reservoir areas were conducted in 1998 and 1999. Within the footprint of the potential areas, 36 sample stations were seined to determine fish species composition. The stations were spread out among Hunter, Minton, Logan, Antelope, and particularly Stone Corral and Funks Creeks. Seven farm impoundment ponds in the area also were seined for fish.

In the Sites and Colusa Reservoir areas, 12 species of fishes were caught in 1998 and 1999. Five species were game fishes, and seven species were non-game fishes (Table D-1).

Table D-1

Fish Caught in the Sites Reservoir Area in 1998 and 1999

Common Name	Scientific Name
Bluegill	*Lepomis macrochirus*
California roach	*Hesperoleucus symmetricus*
Chinook salmon	*Oncorhynchus tschawtscha*
Green sunfish	*Lepomis cyanellus*
Hitch	*Lavinia exilicauda*
Largemouth bass	*Micropterus salmoides*
Mosquitofish	*Gambusia affinis*
Red-eared sunfish	*Lepomis microlophus*
Sacramento blackfish	*Porthodon microlepidotus*
Sacramento pike minnow	*Ptychocheilus grandis*
Sacramento sucker	*atostomus occidentalis*
Sculpin sp.	*Cottus sp.*

Hitch were found in all of the creeks in the Sites and Colusa Reservoir areas. Hitch also were present in the greatest numbers. Stone Corral Creek had the greatest diversity of fishes throughout the year, with eight species, including two species of introduced game fish, bluegill, and green sunfish. However, fish densities were lower, particularly for hitch in Stone Corral, than in other creeks. The next most diverse creek, Funks Creek, had only five species of fish, including one introduced game fish, the largemouth bass.

Most fish captured during seining were minnows, members of the Cyprinid family. California roach are the only fish present that are adapted to spending summers in the remaining pools of intermittent streams (Moyle, 1976). Very few fish found while seining, including game fish, were above 5.9 inches long, suggesting that only juvenile fish rear in these areas. Adult fish typically ascend seasonal creeks in the study area in winter and spawn there in early spring. Most of the adults migrate downstream after they spawn.

Three game fish species were found in the seven ponds that were seined: red-eared sunfish, bluegill, and largemouth bass. Red-eared sunfish were found in one pond, bluegill were found in abundance in two ponds, and largemouth bass were found in three ponds out of the seven seined.

No species of concern or threatened or endangered species were found in this study. The species caught during the study are common in California.

Sites Reservoir

Stone Corral Creek. Eleven stations were sampled on Stone Corral Creek between July 15, 1998, and January 6, 1999. Eight species of fish were found in Stone Corral Creek, including two species of game fish, green sunfish, and bluegill.

The fish that occurred at the most stations was the Sacramento pike minnow, followed by the hitch (Table D-2). The density of fish on Stone Corral was relatively low for all species at all stations. Hitch were the dominant species in terms of density (0.8 fish/square yard [yd^2]).

Table D-2

Species Caught at Each Station and Relative Abundance in Stone Corral Creek

Species	Station Sampled											Fish/Yd^2
	1	2	3	4	5	6	7	8	9	10	11	
Bluegill				X								0.002
California roach		X		X								0.020
Green sunfish			X					X	X	X	X	0.030
Hitch		X	X					X	X	X	X	0.800
Mosquitofish				X								0.002
Sacramento blackfish											X	0.200
Sacramento pike minnow			X	X	X	X		X	X		X	0.200
Sacramento sucker			X	X		X					X	0.020

Antelope Creek. Five stations were sampled on Antelope Creek between July 14, 1998, and November 25, 1998. Three species of fish were captured on Antelope Creek: green sunfish, hitch, and Sacramento pike minnow (Table D-3). Hitch were the most abundant fish, with an average density of 3.8 fish/yd^2. The

Sacramento pike minnow and the green sunfish both had a relative abundance of 0.20 fish/yd^2. A single spring-run chinook salmon swam up Antelope Creek in the spring and died in a pool in early summer. Habitat in Antelope Creek does not support salmon because the creek almost dries up each summer. The remaining water is too hot to allow salmon to survive there.

Table D-3

Species Caught at Each Station and Relative Abundance in Antelope Creek

Species	Station Sampled					Fish/Yd^2
	1	2	3	4	5	
Green sunfish		X		X	X	0.2
Hitch	X	X	X	X	X	3.8
Sacramento pike minnow				X	X	0.2

Funks Creek. A total of 15 stations were sampled on Funks Creek between July 22, 1998, and January 8, 1999. Funks Creek had five species of fish, including one introduced game fish, largemouth bass. The most common fish in Funks Creek was the hitch, with an average density of 3.1 fish/yd^2 (Table D-4). Hitch were caught in 11 out of 15 stations seined.

Table D-4

Species Caught at Each Sample Station and Relative Abundance in Funks Creek

Species	Station Sampled															Fish/Yd^2
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Hitch			X	X	X	X	X	X	X	X	X	X	X			3.100
Largemouth bass									X			X				0.001
Sacramento pike minnow				X	X				X				X			0.060
Sacramento sucker					X	X			X	X			X			0.020
Sculpin														X		—

The most diverse sections of Funks Creek sampled were in the lower reaches, stations 5, 6, 9, 10, 12, and 13. In the upper reaches of Funks Creek that were sampled, either fish were lacking or only one species was found. Hitch densities varied widely throughout the creek, and no one area seemed to maintain a higher population.

Colusa Cell Reservoir

Hunters Creek. Three stations were seined on Hunters Creek between July 22, 1998, and August 3, 1998. Only two species of fish were found on Hunters Creek, the mosquitofish and the green sunfish. Both species were found in two of the three stations (Table D-5). Mosquitofish were found in relative abundance, at 3.8 fish/yd^2, but they only occurred in abundance at one station. Green sunfish were found to have an average density of 2.3 fish/yd^2.

Table D-5

Relative Abundance of Fish Caught in Hunters Creek

Species	Fish/Yd^2
Green sunfish	2.3
Mosquitofish	3.8

Minton Creek. Minton Creek was sampled in two locations in August 1998. Hitch were found in one of those stations at a density of 0.5 fish/yd^2.

Logan Creek. Four stations were sampled on Logan Creek in August 1998. Hitch were caught in stations 1 and 2. The average density of hitch in Logan Creek was 0.4 fish/yd^2.

Colusa Basin Drain

The Colusa Basin Drain (CBD) is a natural channel; historically, it has transported water from west side tributaries, such as Willow, Funks, Stone Corral, and Freshwater Creeks, to the Sacramento River. It also has carried overflowing floodwater from the Sacramento River. With the advent of agriculture in the Sacramento Valley, the CBD was channelized and dredged to carry agricultural runoff in addition to natural flows.

The CBD provides little bank cover for fish; however, some instream cover is provided by large and small woody debris. Its banks are scoured by periodic high flows, and roads often run along the dikes that contain the waters of the CBD. The bottom of the CBD is largely mud. Water in the CBD is turbid and warm in the summer, and turbid and cool during the winter. The proposed diversion from the CBD for the Sites and Colusa Reservoirs would be east of the town of Maxwell, along the CBD.

Two fyke nets were placed in the CBD, one upstream from the diversion point and one downstream, to sample fish. Periodic seining, seine and hook, and line sampling also were used to sample fish in the CBD at the upper net location.

A total of 9 game fish and 17 nongame fish were caught (Table D-6). The warmouth (*Lepomis gulosus*) and the largemouth bass *(Micropterus salmoides*), which were caught by United States Geological Survey (USGS) in 1996, were not observed in the recent surveys.

Table D-6

Resident Fish of the Colusa Basin Drain

Common Name	Scientific Name
Game Fish	
Black bullhead	*Ictalurus melas*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Brown bullhead	*Ictalurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Chinook salmon	*Oncorhynchus tschawtscha*

Table D-6
(Continued)

Common Name	Scientific Name
Game Fish (continued)	
Green sunfish	*Lepomis cyanellus*
White catfish	*Ictalurus catus*
White crappie	*Pomoxis annularis*
Nongame Fish	
Big scale logperch	*Percina macrolepida*
California roach	*Hesperoleucus symmetricus*
Carp	*Cyprinus carpio*
Fathead minnow	*Pimephales promelas*
Goldfish	*Carassius auratus*
Hitch	*Lavinia exilicauda*
Inland silversides	*Menidia beryllina*
Mosquitofish	*Gambusia affinis*
Pacific lamprey	*Lampetra tridentata*
Sacramento blackfish	*Orthodon microlepidotus*
Sacramento pike minnow	*Ptycholcheilus grandis*
Sacramento splittail	*Pogonichthys macrolepidotus*
Sacramento sucker	*Catostomus occidentalis*
Sculpin sp.	*Cottus sp.*
Threadfin shad	*Dorosoma pretenense*
Tui chub	*Gila bicolor*
Tule perch	*Hysterocarpus traski*

Thomes-Newville Reservoir

CDFG initiated studies of the impacts on fish and wildlife in the Thomes-Newville Reservoir area in 1979 as part of DWR’s Thomes-Newville Reservoir planning studies. However, the planning studies were halted in 1982. CDFG completed a report of its abbreviated studies in 1983 (Brown et al., 1983). In 1998, CDFG initiated studies of fish and wildlife resources in the Thomes-Newville Reservoir area as part of the North-of-Delta Offstream Storage Program. A brief survey of springrun chinook salmon was conducted during the recent investigations. This section discusses recent findings and recapitulates the effort and results of the 1982 study (Brown et al., 1983).

Seining for juvenile chinook salmon in Stony and Thomes Creeks was done over three years, from 1980 to 1982. Carcasses of chinook salmon were counted to estimate the number of adult salmon in Stony and Thomes Creeks. On June 13, 1979, August 18, 1980, and August 12, 1998, Thomes Creek was surveyed to enumerate spring-run chinook salmon and summer-steelhead. A fyke net was placed in the creek near the mouth of Thomes Creek to capture juvenile and larval Sacramento sucker and Sacramento pike minnows migrating to the Sacramento River. Streams in the footprint of the proposed Thomes-Newville Reservoir were sampled by electrofishing 1981 and 1982.

Thomes Creek

Juvenile Chinook Salmon and Steelhead

Thirteen juvenile chinook salmon were captured by seining during the 1980 sampling period (Table D-7). These fish were caught in lower Thomes Creek from March 20 to May 24, 1980. Six juvenile chinook salmon were captured by seining during the 1981 sampling period. One of these fish was from Coleman National Fish Hatchery.

Table D-7

Juvenile Chinook Salmon Seined from Thomes Creek in 1980 and 1981 (Brown et al., 1983)

Sample Period	Number of Weekly Seining Events	Number of Fish	Average Length of Fish (in)
March 1980	4	5	2.8
April 1980	5	8	2.8
Total 1980	9	13	
March 1981	2	5	4.1
April 1981	1	1	2.3
Total 1981	3	6	

Seven juvenile steelhead were captured by seining in Thomes Creek in 1981. Four of these fish were probably from Coleman National Fish Hatchery. They had rounded fins and deformed dorsal fins, which are a characteristic of hatchery-grown fish.

In 1981, 206 juvenile chinook salmon were captured by fyke netting in Thomes Creek; 20 were from the main stem, and 186 were from the Tehama-Colusa Canal discharge canal (Tables D-8 and D-9).

Table D-8

Fyke Net Catches of Juvenile Chinook Salmon from Main Stem of Thomes Creek in 1981 (Brown et al., 1983)

Sample Period	Hours Fished	Number of Salmon	Average Length of Fish (inches)
February	672	0	0
March	744	9	2.7
April	648	10	3.1
May	336	1	2.7
Total	2,400	20	

Table D-9

Fyke Net Catches of Juvenile Chinook Salmon from the Tehama-Colusa Canal Discharge Channel in Thomes Creek in 1981 and 1982 (Brown et al., 1983)

Sample Period	Number of Fish	Average Length of Fish (inches)
January 1981	1	1.4
February 1981	126	1.3
March 1981	59	1.3
Total 1981	186	
January 1982	2	1.4
February 1982	45	1.4
March 1982	337	1.5
Total 1982	384	

No juvenile chinook salmon or steelhead were captured by seining or fyke netting in the main stem of Thomes Creek during the 1982 sampling period. However, 384 juvenile chinook salmon were captured by fyke netting in the Tehama-Colusa Canal discharge channel. The first fish was captured during the first week of January, but the bulk of the emigration did not occur until the third week of February.

Adult Chinook Salmon

1980-1981 Fall-Run Estimate. Fifty-nine chinook salmon carcasses were tagged during 12 surveys of Thomes Creek. Of these carcasses, 23 were recovered. From these data, an estimated 155 salmon spawned in Thomes Creek during the sampling period. Live fish were first observed in the creek November 11, 1980, but the first carcass was tagged 9 days later. The last carcass was tagged on January 12, 1981.

Of the fish tagged, 57 (97%) were located in the Tehama-Colusa Canal outlet channel. Only two fish (3 percent) were tagged in the mainstem. Observation of six redds and four live fish indicate there was some spawning activity in areas below Henleyville.

1981-1982 Fall-Run Estimates. Thirty-eight chinook salmon carcasses were tagged during 10 surveys of Thomes Creek. Of these carcasses, 20 were recovered. From the data, an estimated 167 salmon spawned in Thomes Creek during the sampling period. All of the fish recovered were located in the Tehama-Colusa Canal outlet channel. No live fish or redd were seen in the mainstem.

1979-1980 Spring-Run Estimates. No adult anadromous salmonid was seen during the June 1979 or August 1980 spring-run chinook salmon surveys in Thomes Creek. Numerous juvenile steelhead and brown trout were seen in the area of the survey, which may indicate that habitat for spring-run chinook salmon or summer steelhead may exist.

1999 Spring-Run Estimates. One adult spring-run chinook salmon was seen during August 1999 diving surveys in Thomes Creek. As in 1980, numerous juvenile steelhead and brown trout were seen in the area of the survey.

1979 Late Fall-Run. The late spawning characteristics of a few chinook salmon indicate that they were of the late fall-run. Those that spawned in late December and January were salmon of this race.

Resident Fish and Migratory Nongame Fish

Twenty-two species of fish were observed in Thomes Creek (Table D-10). CDFG staff developed population and biomass estimates for 13 of these species (Table D-11). Three species were gamefishes ,and 10 were nongame fishes. While steelhead were the most abundant fish above the gorge, Sacramento pike minnow, Sacramento suckers, hardhead, California roach, and speckled dace were the more common fish below the gorge.

Table D-10

Fish Species Found in Thomes Creek in 1982 (Brown et al., 1983)

Common Name	Scientific Name
Bluegill	*Lepomis machrochirus*
Brown bullhead	*Ictalurus nebulosus*
California roach	*Lavinia symmetricus*
Carp	*Cyprinus carpio*
Channel catfish	*Ictalurus punctatus*
Golden shiner	*Notemigomus crysoleucus*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Hardhead	*Mylopharodon conocephalus*
Hitch	*Lavinia exilicauda*
Largemouth bass	*Micropterus salmoides*
Mosquitofish	*Gambusia affinis*
Pacific lamprey	*Lampetra tredentata*
Prickly sculpin	*Cottus asper*
Sacramento pike minnow	*Ptychocheilus grandis*
Sacramento sucker	*Catostomus occidentatlis*
Smallmouth bass	*Micropterus dolomeiu*
Speckled dace	*Rhinicthys osculus*
Steelhead	*Onchorynchus mykiss*
Threespine stickleback	*Gasterosteus aculeatus*
Tule perch	*Hysterocarpus traski*
White catfish	*Ictalurus catus*

Most of the nongame fish that were caught in the reach below the gorge were juveniles, indicating that this reach serves primarily as a spawning and rearing area. Adult Sacramento suckers, Sacramento pike minnow, California roach, and hardhead migrate annually from the Sacramento River into Thomes Creek and its tributaries to spawn. Juveniles that do not emigrate immediately after hatching remain to rear until the following rainy season, when water flows to the mouth.

Table D-11

Average Population Estimates and Biomass Estimates for Fish Caught in Sections of Thomes Creek in 1982 (Brown et al., 1983)

Species	Average Population Estimate	Average Biomass (lb/acre)
Bluegill	3	4.5
California roach	41	10.7
Carp	90	64.2
Goldfish	1	19.2
Green sunfish	14	15.2
Hardhead	47	47.3
Hitch	1	0.4
Largemouth bass	5	8.0
Prickly sculpin	1	1.8
Sacramento pike minnow	337	89.2
Sacramento sucker	143	16.1
Speckled dace	229	16.1
Tule perch	1	0.2

Thomes Creek below Paskenta usually dries up except for a few residual pools scattered along the streambed during the late summer. This makes it impossible for resident adult fish to live throughout the summer months. Some adult game fish, such as largemouth bass, smallmouth bass, bluegill, and green sunfish, ascend the creek from the Sacramento River during the late spring and early summer to use these pools as spawning areas.

Stony Creek

Juvenile Chinook Salmon and Steelhead

During the 1980 sampling period, 181 juvenile chinook salmon were caught by seining (Table D-12). Salmon were first caught during the second week of February, while the last salmon was caught during the first week of May. During the 1981 sampling period, 73 juvenile chinook salmon were captured by seining. Fish were first captured during the third week of February, while the last fish were captured during the second week of April. During the 1982 sampling period, only four juvenile chinook salmon were captured by seining. Two fish were captured during January, and two were captured during the first week of March.

Adult Chinook Salmon

1981-1982 Fall-Run Estimates. Thirty-six chinook salmon carcasses were tagged during five surveys. Of these, 2 were recovered. From these data, CDFG estimates that 393 salmon spawned in Stony Creek during the sampling period. Twenty-five fish (69%) were females, while 11 fish (31%) were males. This represents a male-female ratio of 1:2.3.

Table D-12

Juvenile Chinook Salmon Seined from Stony Creek in 1980, 1981, and 1982 (Brown et al., 1983)

Sample Period	Number of Fish	Average Length of Fish (inches)
February 1980	64	1.7
March 1980	51	1.8
April 1980	60	2.0
May 1980	6	3.0
Total 1980	181	
February 1981	5	1.5
March 1981	64	2.1
April 1981	4	3.0
Total 1981	73	
January 1982	2	3.3
March 1982	2	1.7
Total 1982	4	

Most of the spawning activity was located in lower Stony Creek in the reach between Interstate 5 bridge and the North Diversion Dam. At least 35 redds and 29 carcasses were counted in this area.

Resident Fish Surveys

Six species of fish, two game species and four nongame species, were captured in streams potentially inundated by the Thomes-Newville Reservoir. These streams include North Fork Stony Creek, Salt Creek, and Heifer Camp Creek. Rainbow trout were captured in sections of streams above the inundation line where the water is cool and cover is abundant. California roach, Sacramento pike minnow, Sacramento sucker, carp, and green sunfish were captured in sections of streams below the inundation line. California roach, Sacramento pike minnows, and Sacramento suckers were more abundant species, while carp and green sunfish are relatively uncommon (Tables D-13 and D-14).

Table D-13

Population Estimates for Fish Caught in Selected Sections of Streams Within the Thomes-Newville Reservoir Site in 1983 (Brown et al., 1983)

Species	North Fork Stony Creek	Salt Creek	Heifer Camp Creek
California roach	4	546	120
Carp	1		
Green sunfish	-	13	
Rainbow trout	-	24	8
Sacramento pike minnow	12	24	85
Sacramento sucker	> 2	45	6

Table D-14

Average Biomass Estimates (lb/acre) for Fish Caught in Selected Sections of Streams Within the Thomes-Newville Reservoir Site in 1983 (Brown et al., 1983)

Species	North Fork Stony Creek	Salt Creek	Heifer Camp Creek
California roach	0.9	427.3	72.3
Carp	145.4	-	
Green sunfish	-	33.9	
Rainbow trout	-	74.9	18.7
Sacramento pike minnow	8	339.9	775.1
Sacramento sucker	0.09	88.3	

Upper Salt Creek supports a population of rainbow trout. Nongame fishes were not found in this area and, because of a waterfall, migratory Cyprinids cannot ascend the creek.

Twenty-eight species of fishes were observed in Stony Creek (Table D-15). CDFG staff developed population and biomass estimates for 22 of these species (Table D-16). Nine species were game fish, and 13 were nongame fish. Largemouth bass and bluegill were the most abundant gamefish below Black Butte Reservoir, and channel catfish and white catish were the most abundant game fish above the Sacramento River. Sacramento pike minnows and suckers were found in all stations throughout Stony Creek, were the most abundant, and had the highest biomass for all species of fish. Prickly sculpin were found in all sections but made up a very small portion of the total biomass. Most of the nongame fish that were caught in the reach below Black Butte Reservoir were juveniles, indicating that this reach serves primarily as a spawning and rearing area.

Table D-15

Fish of the Stony Creek Drainage (Excludes Fish Within Newville Reservoir Site) (Brown et al., 1983)

Common Name	Scientific Name
Black bullhead	*Ictalurus melas*
Black crappie	*Pomoxis melas*
Bluegill	*Lepomis machrochirus*
Brown bullhead	*Ictalurus nebulosus*
California roach	*Lavinia symmetricus*
Carp	*Cyprinus carpio*
Channel catfish	*Ictalurus punctatus*
Golden shiner	*Notemigomus crysoleucus*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Hardhead	*Mylopharodon conocephalus*
Hitch	*Lavinia exilicauda*
Largemouth bass	*Micropterus salmoides*
Mosquitofish	*Gambusia affinis*
Pacific lamprey	*Lampetra tridentata*
Prickly sculpin	*Cottus asper*
Rainbow trout	*Onchorynchus mykiss*
Redear sunfish	*Lepomis microlophus*
Sacramento blackfish	*Orthodon microlepidotus*
Sacramento pike minnow	*Ptychocheilus grandis*
Sacramento sucker	*Catostomus occidentatlis*
Smallmouth bass	*Micropterus dolomeiu*
Speckled dace	*Rhinicthys osculus*
Threadfin shad	*Dorosoma petenense*
Threespine stickleback	*Gasterosteus aculeatus*
Tule perch	*Hysterocarpus traski*
White catfish	*Ictalurus catus*
White crappie	*Pomoxis annularis*

Table D-16

Average Population Estimates and Biomass Estimates for Fish Caught in Selected Sections of Stony Creek in 1982 (Brown et al., 1983)

Species	Average Population Estimate	Average Biomass (lb/acre)
Black crappie	8	87.4
Bluegill	19	8.0
Carp	5	64.2
Channel catfish	57	47.3
Goldfish	8	33.9
Green sunfish	7	2.7
Hardhead	9	24.1
Hitch	32	20.5
Largemouth bass	13	11.6
Mosquitofish	3	0.09
Prickly sculpin	57	11.6
Roach	200	54.4
Sacramento pike minnow	146	91.0
Sacramento sucker	96	256.9
Smallmouth bass	5	16.1
Speckled dace	318	41.9
Threadfin shad	2	0.9
Threespine stickleback	3	0.05
Tule perch	6	5.4
White catfish	30	34.8
White crappie	5	17.8

Red Bank

This section describes the results of current and past fish studies conducted on Red Bank and Cottonwood Creeks, the major tributaries of the Red Bank Reservoir area. Past studies date back to 1969. Other studies reviewed include reports prepared by CDFG and DWR in 1972, 1975, 1985, and 1987.

Red Bank Creek

In 1998, CDFG biologists sampled fish at 28 stations within the footprint of Schoenfield Reservoir. Sixteen stations were seined on Red Bank Creek and its tributaries, Dry and Grizzly Creeks. Twelve stations were sampled on Red Bank Creek by electrofishing.

Four species of nongame fish were observed (Table D-17). The most common species of nongame fish found was the California roach (0.588 fish/yd^2) followed by the Sacramento pike minnow (0.158 fish/yd^2)

(Table D-18). Four species of resident game fish also were observed. The most common resident game fish were largemouth bass (0.009 fish/d$_2$). Juvenile steelhead were found in 2 of the 28 stations sampled.

Table D-17

Nongame Fish Observed in Red Bank and Cottonwood Creeks

Common Name	Scientific Name	Cottonwood Creek (1976)	Red Bank Creek (1998)
California roach	*Hesperoleucus symmetricus*	X	X
Carp	*Cyprinus carpio*	X	
Golden shiner	*Notemigonus crysoleucas*	X	
Hardhead	*Mylopharodon conocephalus*	X	
Hitch	*Lavinia exilicauda*	X	
Mosquitofish	*Gambusia affinis*	X	
Pacific lamprey	*Lampetra tridentata*	X	X
Prickly sculpin	*Cottus asper*	X	
Sacramento pike minnow	*Ptychocheilus grandis*	X	X
Sacramento sucker	*Catostomus occidentalis*	X	X
Speckled dace	*Rhinichthys osculus*	X	
Threespine stickleback	*Gasterosteus aculeatus*	X	
Tule perch	*Hysterocarpus traski*	X	

Table D-18

Relative Abundance of Non-Game Fish Caught in Lower Cottonwood Creek, 1976, and in Red Bank Creek, 1998 (Fish/Yd^2)

Common Name	Cottonwood Creek (1976)	Red Bank Creek (1998)
California roach	0.003	0.588
Carp	0.003	
Hardhead	0.022	
Sacramento pike minnow	0.015	0.158
Sacramento sucker	0.006	0.091

Cottonwood Creek

Biologists conducted fisheries surveys of Cottonwood Creek from the confluence of the north fork to the mouth of Cottonwood Creek in 1976 to provide environmental documentation for reservoir planning. Observations were made by diving, seining, fyke netting, and electrofishing. Abundance estimates were made for fish caught by electrofishing. No estimates of abundance were done for fish caught in fyke nets; therefore, these fish were not included in the relative abundance tables.

Thirteen species of nongame fish were observed in Cottonwood Creek (Table D-17). The most common species of resident nongame fish found were hardhead (0.022 fish/yd^2) and Sacramento pike minnow (0.015 fish/yd^2) (Table D-18). Some Sacramento pike minnows and Sacramento suckers migrate to the Sacramento-San Joaquin estuary to rear and return to Cottonwood Creek as adults to spawn.

Biologists observed 10 species of resident game fish in the Cottonwood Creek system in 1976 (Table D-19). The most common resident game fish were bluegill (0.022 fish/yd^2) and green sunfish (0.015 fish/yd^2) (Table D-20). Steelhead were common in the higher reaches of the Cottonwood system, but not common in the lower reaches, while green sunfish and bluegill were more common in the lower reaches surveyed. No estimates of abundance were done for fish caught in fyke nets; therefore, these fish were not included in the relative abundance tables.

Table D-19

Game Fish Observed in Cottonwood Creek, 1976, and in Red Bank Creek, 1998

Common Name	Scientific Name	Cottonwood Creek	Red Bank Creek
Black bullhead	*Ictalurus melas*	X	
Bluegill	*Lepomis macrochirus*	X	
Brown bullhead	*Ictalurus nebulosus*	X	X
Brown trout	*Salmo trutta*	X	
Chinook salmon	*Onchorhynchus tshawytscha*	X	
Green sunfish	*Lepomis cyanellus*	X	X
Largemouth bass	*Micropterus salmoides*	X	X
Smallmouth bass	*Micropterus dolomieui*	X	
Steelhead	*Onchorhynchys mykiss*	X	X
White catfish	*Ictalurus catus*	X	

Table D-20

Relative Abundance of Resident Game Fish Caught in Lower Cottonwood Creek and in Red Bank Creek (Fish/Yd^2)

Common Name	Scientific Name	Cottonwood Creek (1976)	Red Bank Creek (1998)
Bluegill	*Lepomis macrochirus*	0.022	0.001
Brown bullhead	*Ictalurus nebulosus*	0.006	
Green sunfish	*Lepomis cyanellus*	0.015	0.001
Largemouth bass	*Micropterus salmoides*	0.003	0.009
Smallmouth bass	*Micropterus dolomieui*	0.003	

Biologists found populations of juvenile steelhead in South Fork Cottonwood Creek in the Yolla Bolly Wilderness in the summer of 1976. No estimates of populations of juvenile steelhead were made. The

Yolla Bolly Wilderness is well above the proposed Dippingvat Dam site. Adult steelhead were seined from the mouth of Cottonwood Creek in November 1976.

CDFG estimates that Cottonwood Creek supports an average of 1,000 steelhead, based on the best estimates of biologists who were most familiar with Cottonwood Creek. Biologists found juvenile steelhead in the footprint of the proposed Schoenfield Reservoir in Red Bank Creek in 1998. They were found at a density of 0.002 fish/yd^2. Steelhead were found in 2 of 28 stations sampled.

Fall-run chinook salmon ascend Cottonwood Creek and spawn in late October through November. They spawn in Cottonwood Creek from the mouth to the confluence of North Fork Cottonwood Creek. About 53% of fall-run chinook salmon spawn from the mouth of Cottonwood Creek to the Interstate 5 highway bridge; 23% spawn from the Interstate 5 highway bridge to the confluence of Cottonwood Creek and the South Fork Cottonwood Creek; and 24% spawn in Cottonwood Creek between the confluence of the south and north forks. Their young begin migrating after they incubate in January. They migrate downstream from January through May. CDFG estimates that an average of 3,600 fall-run chinook salmon spawn in Cottonwood Creek.

Late fall-run chinook salmon migrate up Cottonwood Creek and spawn in January. Biologists observed them spawning at the mouth of North Fork Cottonwood Creek in January 1976. Late fall-run chinook salmon young that migrate downstream in May and June are much smaller than the fall-run young at that time of year. Young late fall-run chinook salmon were caught in fyke nets near the mouth of Cottonwood Creek in May and June 1976. CDFG estimates that an average of 300 late fall-run chinook salmon migrate up Cottonwood Creek.

Spring-run chinook salmon migrate up Cottonwood Creek in April and spend the summer in deep pools in South Fork Cottonwood Creek, Beegum Gulch, and North Fork Cottonwood Creek. Most are found in Beegum Gulch. Young spring-run chinook salmon migrate downstream from January through May. CDFG estimates that an average of 500 spring-run chinook salmon run up Cottonwood Creek. Some young chinook salmon from the Sacramento River use the lower reach of Cottonwood Creek from Interstate 5 to the mouth for rearing during the summer and fall.

The most significant findings of these studies are the presence of fall-run chinook salmon, late fall-run chinook salmon, spring-run chinook salmon, and steelhead in Cottonwood Creek. The presence of steelhead in Red Bank Creek is also a significant finding.

Amphibian Surveys

Amphibian studies were initiated in 1997 for Sites, Colusa, and Red Bank projects. DFG collected data on occurrence, distribution, and relative abundance of amphibians at the proposed reservoir inundation areas for these projects. All aquatic habitats were categorized as to type of water body (e.g., pond, farm impoundment, vernal pool, or creeks). All ponds were measured for length, width, and depth during the initial assessment. DFG also reviewed past amphibian studies for Red Bank and Thomes-Newville Projects. A summary of the 1997 survey findings and findings of past studies are presented below.

Sites and Colusa Cell Reservoirs

California Red-Legged Frog. Surveys were conducted August 1997 to January 1998, and between the months of May through October 1998. All ponds and creeks in the area were surveyed a minimum of four times during each of these periods. Both night and day surveys were conducted during this time, at least two of each for each habitat site. Day surveys were performed on clear, sunny days with minimal wind.

Night surveys were conducted on warm, still nights from an hour past sunset until midnight. No California redlegged frogs were found during any of these surveys.

California Tiger Salamander. The historic range of California tiger salamanders was established using distribution records. Grasslands, vernal pools, and farm pond impoundments that contained water for only part of the year were examined as potential California tiger salamander habitat sites. All ponds and vernal pools and the surrounding territory were examined for burrows, log debris, type of terrestrial vegetation, use of land and its current condition, embankments, and surrounding topography. Each pond was then seined.

Transect and visual pond inspections were conducted at night, during storms that continued from the day into the night, and when the air temperature was between 7 to 10 degrees Celsius (°C) (45 to 50°F) or warmer during the months of November and March for the 1997-98 and 1998-99 seasons.

Dip netting and seining surveys were done twice a year for each vernal pool and intermittent pond, at least 15 days apart. The first survey was done between March 15 and April 15, and the second between April 15 and May 15. Only ponds that would hold water for at least 10 weeks during the survey time interval were inspected.

No California tiger salamanders were found during any of these surveys.

Surveys of Common Amphibians. General herpetology surveys were done by ground searching near ponds and other habitats, transects, and night driving studies.

A total of five species were found during this survey (Table D-21). The most prevalent species found was the bullfrog, *Rana catesbieana*, with a catch per hour effort ratio of 4.8 (ground searching method only) for adults.

Table D-21

Amphibian Species of the Sites Project Area

Common Name	Scientific Name
Bullfrog	*Rana catesbieana*
California newt	*Taricha torosa*
California slender salamander	*Batrachoseps attenuatus*
Pacific tree frog	*Hylla regilla*
Western toad	*Bufo boreas*

Oak woodland and farm ponds were habitat where the greatest diversity of species was found. All five species of amphibians were found in this type of habitat (Table D-22). Pacific tree frogs were found in all five habitat types.

Table D-22

Amphibian Species Found in Each Habitat Type in the Sites Reservoir Area

Common Name	Scientific Name	Riparian	Oak Woodland	Grassland	Farm Pond	Vernal Pool
Bullfrog	*Rana catesbieana*	X	X	X	X	
California newt	*Taricha torosa*		X		X	
California slender salamander	*Batrachoseps attenuatus*		X		X	
Pacific tree frog	*Hylla regilla*	X	X	X	X	X
Western toad	*Bufo boreas*	X	X	X	X	

Ground searches were the most productive method of locating a variety of amphibians. Representatives of all species found during the study were located via ground searches. Dip netting and seining were particularly effective in capturing semi-aquatic amphibians, especially larval amphibians. Bullfrog larvae were found in riparian habitat, oak woodland, and farm ponds. Both pacific tree frog larvae and western toad larvae were found in farm ponds and vernal pools. Western toad larvae also were found in riparian habitat.

No threatened or endangered amphibians were found in this study. All species caught or observed are regarded as common.

Thomes-Newville Reservoir

Surveys for amphibians at the Thomes-Newville Reservoir area were conducted by CDFG from April 1981 through May 1982 at the request of DWR to provide environmental information for water project planning. No new surveys of amphibians at the Thomes-Newville Reservoir area were undertaken during the recent investigations of offstream storage.

The amphibian surveys were done by ground searching ponds and transects, seining, or night driving studies. Ground searches were done both day and night, but driving surveys were done only at night. Pitfall trapping was also done in the Thomes-Newville Reservoir area surveys. A camera was used to photograph specimens for species verification and to maintain a general record of the find.

This 1981-1982 survey produced observations of seven amphibian species that occur within the habitats in the project area and surrounding areas (Table D-23). No estimate of population sizes was possible because of the small number of recaptures that occurred during the pitfall trapping.

Table D-23

Amphibians Observed in the Thomes-Newville Reservoir Area in 1982

Common Name	Scientific Name
Black salamander	*Aneides flavipunctatus*
Bullfrog	*Rana catesbeiana*
California slender salamander	*Batrachoseps attenuatus*
Foothill yellow-legged frog	*Rana boylei*
Pacific tree frog	*Hyla regilla*
Western spadefoot toad	*Bufo boreas*
Western toad	*Spea hammondi*

Western toads and Pacific tree frogs were found in all habitat types. Some species, such as black salamanders, were much more limited in their distribution (Table D-24).

Table D-24

Amphibian Species Found in the Thomes-Newville Project Area in 1982

Common Name	Scientific Name	Grass-land	Chaparral	Oak Savannah	Pine-Oak Woodland	Riparian	Stream	Standing Water
Black salamander	*Aneides flavipunctatus*				X			
Bullfrog	*Rana catesbeiana*					X	X	X
California slender salamander	*Batrachoseps attenuatus*	X	X	X	X			
Foothill yellowlegged frog	*Rana boylei*					X	X	X
Pacific tree frog	*Hyla regilla*	X	X	X	X	X	X	X
Western spadefoot toad	*Bufo boreas*	X		X				
Western toad	*Spea hammondi*	X	X	X	X	X	X	X

Pitfall traps tended to be selective for amphibians. This trapping method failed to provide any amphibian species not found by at least one other collection method.

Although no amphibian species listed as rare or endangered was found in the project area, two species were found that are considered Species of Special Concern by the State of California because of habitat losses. These species complete their reproductive cycle in both temporary and permanent ponds found throughout the inundation area. Spadefoot toads and foothill yellow-legged frogs occur in the streams coursing through the reservoir site. The presence of these species constitutes a significant finding.

Red Bank Reservoir

CDFG conducted studies of the Red Bank Reservoir area in 1986 and in 1997-1999. The major objectives of these surveys was to search for California redlegged frogs, which are listed as federally threatened, and to conduct general herpetology surveys. Two species listed as federal and California Species of Special Concern that could occur in the area, the foothill yellow-legged frog and western spadefoot toad, were searched for during these surveys.

Historic ranges of the species searched for were established. Physical observations of the present habitat, historic records, and CDFG's Natural Diversity Database also were used to establish the list of potential species that could occur in the Red Bank Reservoir areas. The results of past surveys conducted in the Red Bank Reservoir area also were reviewed.

Surveys were conducted during the fall of 1997 and during the months of May through October 1998 for California red-legged frogs. Surveys were not conducted during the breeding or rearing period of the frogs, to avoid disturbing breeding frogs, eggs, or larvae. All ponds and creeks in the study area were surveyed a minimum of four times during this 5-month period in 1998. Both night and day surveys were conducted during this time, at least two of each for each habitat site. No site was sampled twice within a 24- hour period. Day surveys were performed on clear, sunny days with minimal wind. Night surveys were conducted on warm still nights from an hour past sunset until midnight. Photographs also were taken of the environment in which animals were found, to confirm field notes and to document the state of the habitat at the time it was surveyed.

General amphibian surveys were done by ground searching ponds and transects, seining, or night driving studies. Ground searches were done both day and night. Driving surveys were done only at night. Seining was done during the day. General amphibian surveys were conducted year round throughout the Red Bank Reservoir areas, when the weather was appropriate for amphibian activity.

During these studies, five species of amphibians were found (Table D-25). The most common species of amphibians observed were foothill yellow-legged frogs (14.80/hour) and western toads (13.10/hour). The foothill yellow-legged frogs are a Species of Special Concern.

Table D-25

Relative Abundance of Amphibians Observed in the Red Bank Reservoir Area

Common Name	Scientific Name	Catch per Hour	
		Cottonwood Creek	Red Bank Creek
Bullfrog	*Rana catesbeiana*	0.02	1.06
California red-legged frog	*Rana draytonii*		<0.01
Foothill yellow-legged frog	*Rana boylei*	14.80	3.91
Pacific tree frog	*Hyla regilla*	0.01	1.58
Western toad	*Spea hammondi*	13.10	5.65

The most significant find in the current investigation was the discovery of a California red-legged frog in Sunflower Gulch, a tributary to Red Bank Creek. Another individual was observed in the same location in 1986. Extensive searches failed to find other red-legged frogs in the study area. It is probable that the population of red-legged frogs is very small at the site of the proposed Red Bank Reservoir.

One amphibian species of Special Concern, the foothill yellow-legged frog, was plentiful throughout the Red Bank Reservoir area. They were found in both Red Bank Creek and South Fork Cottonwood Creek.

Reptile Surveys

DWR requested the CDFG to conduct studies of the reptiles in the proposed Sites, Colusa, and Red Bank Reservoir areas. CDFG biologists conducted the sampling in spring and summer of 1998 and 1999. Past reptile studies for the Red Bank and Thomes-Newville Reservoirs also were reviewed.

Sites and Colusa Cell Reservoirs

CDFG biologists looked for western pond turtles, a federal and state Species of Special Concern, when seining or during daytime visual surveys in the project areas. Carapaces (shells) of dead turtles also were noted and measured. During periods of warm weather, biologists watched the creek when possible while traveling to and from work stations, which yielded positive results in locating western pond turtles.

General herpetology surveys were done by ground searching near ponds, transects, and night driving studies. Ground searches were done both day and night, while driving surveys were done only at night. Searching ponds was done during the day. General herpetology surveys were conducted year round throughout the area when the weather was appropriate for reptile activity. A total of 14 reptile species were found during this survey (Table D-26). One Species of Special Concern was found, the western pond turtle. Western pond turtles were found in the project area, as well as outside the reservoir footprint both upstream and downstream. Western fence lizards were the most common reptiles found (Table D-27).

Table D-26

Status of Reptile Species in the Sites and Colusa Reservoir Area

Common Name	Scientific Name	Status	
		State	Federal
Aquatic garter snake	*Thamnophis couchii*		
Common garter snake	*Thamnophis sirtalis*		
Common king snake	*Lampropeltus getula*		
Gopher snake	*Pituohpis catenifer*		
Ring neck snake	*Diadophis punctatus*		
Sharp-tailed snake	*Contia tenuis*		
Southern alligator lizard	*Elgaria muliticoranata*		
Western fence lizard	*Sceloporus occidentalis*		
Western pond turtle	*Clemmys marmorata*	CDFG: SC CDFG: Protected	FSC
Western racer	*Coluber mormon*		
Western rattle snake	*Crotalus viridus*		
Western sagebrush lizard	*Sceloporus graciosus gracilis*		
Western skink	*Eumeces skiltonianus*		
Western terrestrial garter snake	*Thamnophis elegans*		

CDFG = California Department of Fish and Game SC = Species of Special Concern
FSC = Federal Species of Special Concern

Table D-27

Catch Per Hour Effort for Each Survey Method

Common Name	Scientific Name	Searching	Dipnetting	Seining	Night Driving
Aquatic garter snake	*Thamnophis couchii*	0.0005	0.009	0	0
Common garter snake	*Thamnophis sirtalis*	0.02	0.04	0.02	0
Common king snake	*Lampropeltus getula*	0.003	0	0	0
Gopher snake	*Pituohpis catenifer*	0.007	0.009	0	0
Ring neck snake	*Diadophis punctatus*	0.0005	0	0	0
Sharp-tailed snake	*Contia tenuis*	0.0005	0	0	0
Southern alligator lizard	*Elgaria mulilticoranata*	0.005	0	0	0
Western fence lizard	*Sceloporus occidentalis*	0.17	0	0	0
Western pond turtle	*Clemmys marmorata*	0.0009	0	0	0
Western racer	*Coluber mormon*	0.0002	0	0	0
Western rattlesnake	*Crotalus viridus*	0.02	0.009	0.06	0.2
Western sagebrush lizard	*Sceloporus graciosus gracilis*	0.0005	0	0	0
Western skink	*Eumeces skiltonianus*	0.006	0	0	0
Western terrestrial garter snake	*Thamnophis elegans*	0.05	0	0.02	0

Riparian habitat had the greatest diversity of reptiles found (Table D-28). Eleven of the 14 species of reptiles were found in this type of habitat. The common garter snake, gopher snake, and western fence lizard were found in all five habitat types.

Table D-28

Reptile Species Found in Each Habitat Type

Common Name	Scientific Name	Riparian	Oak Woodland	Grass-land	Farm Pond	Vernal Pool	Roads
Aquatic garter snake	*Thamnophis couchii*	X				X	
Common garter snake	*Thamnophis sirtalis*	X	X	X	X	X	
Common king snake	*Lampropeltus getula*	X		X	X		
Gopher snake	*Pituohpis catenifer*	X	X	X	X	X	
Ring neck snake	*Diadophis punctatus*					X	
Sharp-tailed snake	*Contia tenuis*	X					
Southern alligator lizard	*Elgaria mulilticoranata*	X	X	X	X		
Western fence lizard	*Sceloporus occidentalis*	X	X	X	X	X	
Western pond turtle	*Clemmys marmorata*	X					
Western racer	*Coluber mormon*	X	X				

Table D-28
(Continued)

Common Name	Scientific Name	Riparian	Oak Woodland	Grass-land	Farm Pond	Vernal Pool	Roads
Western rattlesnake	*Crotalus viridus*	X	X	X	X		X
Western sagebrush lizard	*Sceloporus graciosus gracilis*		X				
Western skink	*Eumeces skiltonianus*		X				
Western terrestrial garter snake	*Thamnophis elegans*	X	X		X		

Thomes-Newville Reservoir
Surveys for reptiles at the Thomes-Newville Reservoir were conducted from April 1981 through May 1982 at DWR's request to provide environmental information for water project planning. Reptile surveys were done by ground searching ponds and transects, seining, or night driving studies. Ground searches were done both day and night. Driving surveys were only done at night. Animals were identified using published identification keys. Pitfall trapping also was done in the Thomes-Newville Reservoir area. A camera was used to photograph specimens for species verification and to maintain a general record of the find.

This survey produced observations of 15 reptile species that occur within the habitats in the project area and surrounding areas (Table D-29). No estimate of population sizes was possible because of the small number of recaptures that occurred during the pitfall trapping.

Table D-29

Observed Reptiles in the Thomes-Newville Reservoir Area in 1982

Common Name	Scientific Name
Common garter snake	*Thamnophis sirtalis*
Common king snake	*Lampropeltis getulus*
Gopher snake	*Pituophis malanoleucus*
Sagebrush lizard	*Sceloperus graciosus*
Sharp-tailed snake	*Contia tenuis*
Southern alligator lizard	*Elgaria multicarinata*
Striped racer	*Masticophis lateralis*
Western aquatic garter snake	*Thamnophis couchi*
Western fence lizard	*Sceloperus occidentalis*
Western pond turtle	*Clemmys marmorata*
Western racer	*Coluber constrictor*
Western rattlesnake	*Crotalus viridis*
Western skink	*Eumeces skiltonianus*
Western terrestrial garter snake	*Thamnophis elegans*
Western whiptail	*Cnemidophorus tigris*

Pitfall traps tended to be selective for lizards and smaller snakes, such as the sharp-tailed snake. Larger snakes, because of their length, could easily avoid falling into the traps. This trapping method failed to provide any reptile species not found by at least one other collection method.

Western fence lizards were found in all habitat types (Table D-30). Gopher snakes and western rattlesnakes also were found in most habitat types. The sagebrush lizards were much more limited in their distribution.

Table D-30

Reptile Species Found in the Thomes-Newville Project Area in 1982

Common Name	Scientific Name	Grass-land	Chaparral	Oak Savannah	Pine-Oak Woodland	Riparian	Stream	Standing Water
Common garter snake	*Thamnophis sirtalis*	X				X	X	X
Common king snake	*Lampropeltis getulus*	X	X	X	X			
Gopher snake	*Pituophis malanoleucus*	X	X	X	X	X		
Sagebrush lizard	*Sceloperus graciosus*		X					
Sharp-tailed snake	*Contia tenuis*	X	X					
Southern alligator lizard	*Elgaria multicarinata*	X	X	X	X	X		
Striped racer	*Masticophis lateralis*	X	X					
Western aquatic garter snake	*Thamnophis couchi*					X	X	
Western fence lizard	*Sceloperus occidentalis*	X	X	X	X	X	X	X
Western pond turtle	*Clemmys marmorata*					X	X	X
Western racer	*Coluber constrictor*	X	X	X		X		
Western rattlesnake	*Crotalus viridis*	X	X	X	X	X		
Western skink	*Eumeces skiltonianus*	X	X	X				
Western terrestrial garter snake	*Thamnophis elegans*	X		X		X	X	X
Western whiptail	*Cnemidophorus tigris*		X	X	X			
Total number of species observed		**15**	**14**	**13**	**10**	**13**	**8**	**8**

Although no reptile species listed as rare or endangered was found in the Thomes-Newville Reservoir area, one Species of Special Concern to the State of California is found throughout the inundation area. The western pond turtle occurs in streams coursing through the reservoir site. The presence of this species constitutes a significant finding.

Red Bank Reservoir

Reptile surveys were conducted in the Red Bank Reservoir area 1998. Surveys were done by ground searching near ponds, transects, seining, or night driving studies. Ground searches were done both day and night. Driving surveys were done only at night. Seining was done during the day. General reptile surveys were conducted year-round throughout the Red Bank Reservoir areas, when the weather was appropriate for reptile activity. A 1986 survey of the Red Bank Reservoir area also was reviewed.

The objectives of the reptile surveys within the Red Bank Reservoir area were to search for one species, the western pond turtle, listed as a federal and sate Species of Special Concern. The western pond turtle, was found throughout the study area.

During the 1998 studies, 11 species of reptiles were found (Table D-31). The most significant finding of these studies was the discovery of western pond turtles, a California Species of Special Concern. They were found in Red Bank Creek and South Fork Cottonwood Creek. The most common species of reptiles observed were western terrestrial garter snakes.

Table D-31

Names and Abundance of Reptiles in the Red Bank Project Area

Common Name	Scientific Name	Catch per Hour	
		Cottonwood Creek	Red Bank Creek
Common garter snake	*Thamnophis sirtalis*	0.39	0.03
Common king snake	*Lampropeltis getulus*	0.01	0.01
Gopher snake	*Pituophis malanoleucus*	0.05	0.01
Southern alligator lizard	*Elgaria multicarinata*	0.02	0.01
Western fence lizard	*Sceloperus occidentalis*	0.14	0.08
Western pond turtle	*Clemmys marmorata*	0.17	0.09
Western racer	*Coluber mormon*	--	0.01
Western rattlesnake	*Crotalus viridis*	0.12	0.01
Western sagebrush lizard	*Sceloperus graciosus gracilis*	0.02	0.01
Western skink	*Eumeces skiltonianus*	0.01	0.03
Western terrestrial garter snake	*Thamnophis elegans*	0.15	0.13

Avian Surveys

The purpose of the avian survey effort was to identify the occurrence, density, and distribution of state and federally listed species of birds that may occur within the proposed project areas. These data provide information to help evaluate and compare the potential project effects on state and federally listed avian species and their habitats at the four proposed reservoir locations.

A compilation of state and federal listed species, California Species of Special Concern, and federal Species of Management Concern that could occur within the proposed reservoirs was developed from several sources, including: the Natural Diversity Database, California Wildlife Habitat Relationships

Program, literature review, landowner interviews, United States Fish and Wildlife Service (USFWS) lists, and consultation with species experts.

Three methodologies were used to determine presence, density, and distribution of State and federally listed bird species at the proposed reservoir locations, including monthly avian line-transects, annual bank swallow surveys, and annual owl surveys using pre-recorded calls. The avian studies were confined primarily to the area of the reservoir footprint. However, line transects extended up to 2.5 miles from the reservoir footprints along key drainages. Surveys were initiated at the existing Funks Reservoir to document which state or federally listed avian species would use a reservoir within low elevation grassland habitats.

Line transects were established in representative habitat within proposed reservoir locations as access allowed, using standard avian line transect methodology (Emlen 1971). Transect length and initiation dates are identified in Table D-32. Initial access for the transect surveys was obtained at different points in time, resulting in different numbers of transect repetitions for each season at the four proposed reservoir locations. Sites Reservoir data are most comprehensive; the 12.5-mile transect has been surveyed monthly since March 1997. CDFG conducted avian surveys between 1980 and 1983 within the Stony and Thomes Creek watersheds as part of the fish and wildlife studies for the proposed Thomes-Newville Reservoir.

Table D-32

Avian Transect Lengths and Initiation Date

Reservoir Location	Transect Length	Date Initiated
Sites Reservoir	12.5 miles	March 1997
Colusa Cell Reservoir	11.0 miles	October 1997
Newville Reservoir	19.5 miles	December 1998
Red Bank Reservoir	16.0 miles	April 1998
Funks Reservoir (existing)	2.5 miles	October 1997

Line transects were surveyed either by foot or from a vehicle at a rate of 2 to 3 miles per hour. All state and federally listed avian species, California Species of Special Concern, and federal Migratory Nongame Birds of Management Concern detected were recorded. The distance from the transect line at the point of detection was recorded using a Tasco Lasersite Rangefinder. Detections were recorded onto field data sheets in 100-yard increments. The maximum range of the rangefinder was 800 yards (either side of the transect line); this was used as the outer limit of the transect. State and federally listed species detected outside of the 800-yard limit were noted (presence), but not included in density estimates. Both a 10X40 binoculars and a 15X60 spotting scope were used for field identification.

Information recorded included species, number of individuals, and lateral distance from the transect line at the point of first sighting. Data analyses followed the methods of Balph et al. (1977). This method of line transect data analyses allows the field data to be used to determine differences in detectability between species and within the same species at different points in their life cycle, resulting in greater precision in density estimates.

Monthly transect results were consolidated into seasonal groups for density analyses. Seasons were defined based on the dates used by the California Wildlife Habitat Relationships Program for seasonal bird reports (Zeiner et. al. 1990). These seasonal breakdowns are based on documented migration and residency patterns of California species. Avian surveys were not conducted during periods of precipitation, high wind, or reduced visibility (fog or smoke).

Bank swallow surveys involved walking all permanent and ephemeral stream reaches with downcut channels during the bank swallow breeding season (May through July). All vertical banks were inspected for the presence of bank swallow burrows. All foraging swallow species were identified. All detections of burrows or foraging bank swallows were recorded.

Owl surveys were conducted at night along the previously identified line transect routes during May or June. Sampling was initiated at dusk. The methodology involved broadcasting pre-recorded calls using a tape recorder with an external speaker at half-mile intervals. Each species call (burrowing owl, shorteared owl, and long-eared owl) was broadcast for 30 seconds followed by 30 seconds of silence to detect return calls. Three repetitions of each call/listen cycle were conducted for each species at each one-half mile interval along the line transects. All owl detections were logged. Owl surveys were not conducted during periods of high wind or precipitation.

Review of existing databases indicated that nine state or federally listed avian species may occur within Tehama, Glenn, or Colusa Counties. Three of these species were identified during avian transect sampling at or near the proposed reservoir locations: the southern bald eagle, the bank swallow, and the greater sandhill crane (Table D-33).

Table D-33

State and Federal Listed and Special Concern Avian Species That May Occur at North-of-Delta Offstream Storage Reservoirs

Common Name	Status	Sites	Colusa	Thomes-Newville	Red Bank	Funks
Aleutian Canada Goose	FT					
American bittern	MNBMC					X
American white pelican	CSSC					X
Bank swallow	ST		X			
Barrow's goldeneye	CSSC					
Bell's sage sparrow	MNBMC					
Burrowing owl	CSSC, MNBMC	X	X	X		
California gull	CSSC	X				X
California horned lark	CSSC, MNBMC	X	X	X	X	
Common loon	CSSC, MNBMC					X
Cooper's hawk	CSSC	X	X	X	X	
Double-crested cormorant	CSSC		X			X
Ferruginous hawk	CSSC, MNBMC	X				X
Golden eagle	CSSC	X	X	X	X	X
Grasshopper sparrow	MNBMC		X			X
Greater sandhill crane	ST		X			

Table D-33
(Continued)

Common Name	Status	Sites	Colusa	Thomes-Newville	Red Bank	Funks
Hermit warbler	MNBMC					
Lark sparrow	MNBMC	X	X	X	X	
Lawrence's goldfinch	MNBMC		X		X	X
Least bittern	MNBMC					
Loggerhead shrike	CSSC, MNBMC	X	X	X	X	X
Long-billed curlew	CSSC, MNBMC	X	X	X		X
Long-eared owl	CSSC	X	X	X	X	
Merlin	CSSC	X		X	X	
Mountain plover	CSSC, MNBMC					
Northern goshawk	CSSC, MNBMC					
Northern harrier	CSSC	X	X	X	X	X
Northern spotted owl	FE, SE					
Osprey	CSSC				X	
Peregrine falcon	SE					
Prairie falcon	CSSC	X	X	X	X	X
Purple martin	CSSC					
Sharp-shinned hawk	CSSC	X	X		X	X
Short-eared owl	CSSC, MNBMC					X
Southern bald eagle	SE, FT	X	X	X	X	X
Swainson’s hawk	ST					
Tri-colored blackbird	CSSC, MNBMC	X	X	X		
Vaux's swift	CSSC, MNBMC					
Western snowy plover	CSSC, MNBMC					
Western yellow-billed cuckoo	SE, MNBMC					
White-faced ibis	CSSC, MNBMC					
White-tailed kite	MNBMC	X				X
Willow flycatcher	SE					
Yellow warbler	CSSC	X				
Yellow-breasted chat	CSSC					

CSSC = California Species of Special Concern
FE = Federal Endangered
FT = Federal Threatened
MNBMC = Migratory Nongame Birds of Management Concern (USFWS)
SE = State Endangered
ST = State Threatened

Sporadic wintering use by both adult and immature bald eagles has been documented at each of the four proposed reservoir locations. Wintering use was nearly an order of magnitude greater at Funks Reservoir than at any of the proposed reservoir locations. Fish and a large concentration of waterfowl are available as prey for bald eagles wintering at Funks Reservoir. Up to five bald eagles have been observed perched around the reservoir on one date. Extensive winter bald eagle surveys were conducted along Thomes Creek as part of the Thomes-Newville Reservoir studies in the 1980s. These studies confirmed extensive use of Thomes Creek by wintering bald eagles. No suitable nesting habitat is present in the vicinity of the Sites, Colusa, or Thomes-Newville Reservoirs. An adult and an immature bald eagle were observed together within the Red Bank Reservoir area during late April 1998. No indication of nesting, other than these two sightings during the breeding season, has been observed.

A single sighting of a bank swallow was made near the proposed Colusa Reservoir Cell during avian transect sampling. This sighting was made during late September 1998 approximately 2.5 miles east of the proposed Colusa Reservoir Cell. This sighting represents a transient or migrating bank swallow rather than a breeding season use. CDFG surveys conducted at the proposed Thomes-Newville Reservoir in the early 1980s identified two small bank swallow colonies along Thomes Creek, downstream from the project area. Both of these historic colony locations appear to be outside of the footprint of the proposed reservoir.

Five sandhill cranes were observed flying over the Colusa Reservoir site during November 1997. No actual habitat use was observed. This observation occurred on a date when the Sacramento Valley was fogged in, while the adjacent foothill areas were fog free. Under these conditions, sandhill cranes may set down and use foothill annual grasslands. No other sandhill crane observation at any of the other three reservoir locations was made during the sampling effort. No sandhill crane use was recorded during the three years of intensive study conducted at Thomes-Newville Reservoir during the early 1980s.

Nesting habitat for peregrine falcon, northern spotted owl, yellow-billed cuckoo, greater sandhill crane, and willow flycatcher is absent from the proposed reservoir sites. Marginal Swainson’s hawk nesting/foraging habitat is present at Sites, Colusa, and Newville Reservoir locations and absent at the Red Bank Reservoir area. Habitats within the proposed reservoirs offer very limited opportunity for wintering or migration use by Aleutian Canada goose, mountain plover, peregrine falcon, greater sandhill crane, and willow flycatcher.

Thirty-six avian species classified as either California Species of Special Concern or federal Migratory Nongame Birds of Management Concern may occur within Tehama, Glenn, or Colusa Counties. Twenty-five of these species have been observed at or near one or more of the proposed reservoir locations, including: American bittern, American white pelican, burrowing owl, California gull, California horned lark, common loon, Cooper’s hawk, double-crested cormorant, ferruginous hawk, golden eagle, grasshopper sparrow, lark sparrow, Lawrence’s goldfinch, loggerhead shrike, long-billed curlew, long-eared owl, merlin, northern harrier, osprey, prairie falcon, sharp-shinned hawk, short-eared owl, tri-colored blackbird, white-tailed kite, and yellow warbler (Table D-33).

Seasonal avian density estimates developed from line transect data for each of the four proposed reservoir locations are presented in Tables D-34 through D-37. Seasonal avian density estimates for the existing Funks Reservoir are shown in Table D-38.

Table D-34

Sites Reservoir Avian Transect Results
(Density in Birds/Square mile)

Species	Summer	Fall	Winter	Spring
Burrowing owl	0.24	0.05		
California horned lark	4.83	1.58	2.90	6.57
Cooper's hawk		0.03		0.06
Ferruginous hawk			0.12	
Golden eagle	0.23	0.20	0.26	0.32
Lark sparrow	NS	NS	0.47	1.46
Loggerhead shrike	0.93	1.60	1.17	0.47
Long-billed curlew			14.59	1.26
Northern harrier	0.05	0.50	1.53	0.58
Sharp-shinned hawk		0.40		0.03
Southern bald eagle			0.07	
Tri-colored blackbird				5.38
White-tailed kite	0.12			0.12
Miles of transect per season	37.50	88.0	75.0	150.50

NS = not sampled

Table D-35

Colusa Cell Reservoir Avian Transect Results
(Density in Birds/Square Mile)

Species	Summer	Fall	Winter	Spring
Bank swallow		0.14		
Burrowing owl		0.14		0.03
California horned lark	85.00	7.38	22.63	36.66
Cooper's hawk		0.14	0.27	
Double-crested cormorant				0.10
Golden eagle	0.22	0.32	0.24	0.30
Lark sparrow	NS	NS		0.80
Loggerhead shrike	0.89	2.15	1.84	2.82
Long-billed curlew				4.53
Northern harrier	1.00	0.67	0.87	0.50
Prairie falcon		0.14		
Sandhill crane		0.67		
Sharp-shinned hawk		0.14		

Table D-35
(Continued)

Species	Summer	Fall	Winter	Spring
Southern bald eagle		0.04	0.03	0.10
Tri-colored blackbird	41.50			20.32
Miles of transect per season	20.0	74.5	38.0	87.5

NS = not sampled

Table D-36

Thomes-Newville Reservoir Avian Transect Results
(Density in Birds/Square Mile)

Species	Summer	Fall	Winter	Spring
California horned lark	NS	NS	0.52	0.75
Cooper’s hawk	NS	NS	0.17	
Golden eagle	NS	NS	0.10	0.13
Lark sparrow	NS	NS	7.64	1.50
Loggerhead shrike	NS	NS	2.05	0.90
Merlin	NS	NS	0.04	
Northern harrier	NS	NS	0.15	0.06
Prairie falcon	NS	NS	0.05	0.12
Southern bald eagle	NS	NS	0.08	
Tri-colored blackbird	NS	NS	0.69	2.41
Miles of transect per season			58.5	58.5

NS = not sampled

Table D-37

Red Bank Reservoir Avian Transect Results
(Density in Birds/Square Mile)

Species	Summer	Fall	Winter	Spring
Cooper’s hawk		0.07	0.16	0.26
Golden eagle	0.09	0.25	0.30	0.32
Lark sparrow	NS	NS	0.18	4.79
Lawrence's goldfinch			0.36	0.78
Merlin				0.07
Northern harrier		0.08	1.07	0.26
Osprey				0.13

Table D-37
(Continued)

Species	Summer	Fall	Winter	Spring
Prairie falcon			0.00	0.13
Sharp-shinned hawk		0.19	0.40	0.06
Southern bald eagle		0.11	0.05	0.26
Miles of transect per season	25.5	53.0	55.0	68.0

NS = not sampled

Table D-38

Funks Reservoir Avian Transect Results (Existing Reservoir)
(Density in Birds/Square Mile)

Species	Summer	Fall	Winter	Spring
American bittern	0.84			
American white pelican		0.16	0.10	
California gull		0.32	1.84	0.43
Common loon				0.21
Cooper's hawk		0.48		
Double-crested cormorant	0.37	1.43	1.11	0.33
Golden eagle			0.13	0.05
Lark sparrow	NS	NS	8.18	
Loggerhead shrike		1.43	0.49	1.07
Long-billed curlew		4.20	17.73	
Northern harrier		0.53	3.89	0.75
Prairie falcon		0.09		
Sharp-shinned hawk			0.48	
Short-eared owl				0.43
Southern bald eagle			0.82	0.21
White-tailed kite			1.14	0.14
Miles of transect per season	6.0	21.5	18.0	20.5

NS = not sampled

Mammal Studies

A variety of field survey methods were used to sample the mammal populations at the four alternative sites. Preliminary research included general literature searches, consultation with agency and species experts, aerial photograph habitat interpretations, and landowner interviews. In addition, CDFG biologists reviewed the Natural Diversity Database, Wildlife Habitat Relationship System, the Federal Register of Threatened, Endangered, and Special Status Species, 1983 *Thomes/Newville Status Report,* and 1987 *Final Report on Reconnaissance Level Studies of the Fish and Wildlife Resources at the Dippingvat and Schoenfield Reservoir Sites* to gather additional species information for each project area. A list was then compiled that included the following potentially occurring Special Status Species of mammals. While the species listed in Table D-39 remain the focus of survey efforts, sampling has been designed to include the detection and assessment of all mammal species.

Table D-39

Mammal Species Surveyed at Proposed North of the Delta Offstream Storage Reservoirs

Common Name	Scientific Name	Status
American badger	*Taxidea taxus*	CSSC
Fringed myotis	*Myotis thysanodes*	FSCS
Long-eared myotis	*Myotis evotis*	FSCS
Long-legged myotis	*Myotis volans*	FSCS
Pacific fisher	*Martes pennanti pacificus*	FSCS, CSSC, SS
Pacific western big-eared bat	*Corynorhinus townsendii townsendii*	FSCS, CSSC, SS
Pale big-eared bat	*Corynorhinus townsendii pallescens*	FSCS, CSSC, SS
Pallid bat	*Antrozous pallidus*	CSSC, SS
Pine marten	*Martes americana*	SS
Ringtail	*Bassariscus astutus*	CFPS
San Joaquin pocket mouse	*Perognathus inornatus inornatus*	FSCS
Small-footed myotis	*Myotis ciliolabrum*	FSCS
Spotted bat	*Euderma maculatum*	FSCS, CSSC
Western mastiff bat	*Eumops perotis californicus*	FSCS, CSSC
Western red bat	*Lasiurus blossivillii*	SS
Yuma myotis	*Myotis yumanensis*	FSCS, CSSC

CFPS = California Fully Protected Species
CSSC = California Species of Special Concern
FSCS = Federal Special Concern Species
SS = Sensitive Species

After the development of the species list, field surveys were designed to assess the presence, distribution, and, where possible, relative abundance of the mammal species at the four alternative reservoir sites. Field investigation methods included small mammal live trapping, mist netting, acoustical surveys, roost and hibernacula searches, track plates, photography stations, spotlighting, general habitat measurements, walking transects, road transects, and incidental observations.

Small Mammal Trapping

H.B. Sherman live traps were used by DFG staff to inventory the small mammal (rodent) populations. The trap size used was 3 by 3.5 by 9 inches, the standard for conducting small mammal inventories. Traps were set for three consecutive nights and checked and closed at sunrise. All captures were identified, measured, marked, recorded on data sheets, and released back in the field. Traps were baited with a mixture of birdseed and crushed walnuts each afternoon, approximately one-half hour before sunset. The initial surveys specifically targeted habitat areas identified from aerial photograph habitat interpretations that appeared to have the greatest suitability for the target species. Those areas were ground checked and extensively surveyed with high densities of traps in an attempt to maximize capture success of Special Status Species, such as the San Joaquin pocket mouse.

During those efforts, trapping grids were implemented for larger sampling areas. Trapping locations, or grids, were randomly selected from each of the habitat types and designed so that the number of samples represented the amount and coverage area for each of the habitat types on the alternatives, a technique known as stratified sampling.

The trapping grids consisted of 200 traps within a 100 by 100-meter square. The grids were established by field crews using a compass and a 100-meter tape. Various colors of pin flags were used to mark the grids. One pin flag was placed every 10 meters on the grid, and 2 traps were set within 2 meters of each point (pin flag) on the grid.

Mist nets were the primary method of inventorying bat species. Nets were set over water sources (i.e., ponds, creeks, or water troughs), across draws or narrow canyons, in front of entrances of old buildings, in woodland or forest edges, and in small clearings within a woodland or forest. Various net sizes and configurations were used. Net configurations were primarily as simple as a single net but often involved several single nets spaced throughout an area. Other net configurations included “joining” several nets together and arranging them to form V, L, and T shapes. These configurations were used primarily in areas where there was a lot of known bat activity, but where previous capture efforts failed.

All captures were removed from the nets immediately upon capture and placed in a handling bag for later processing. Processing was conducted at the conclusion of netting efforts or when bat activity became slow. This reduced the potential for counting individuals of any particular species multiple times. Captures were all identified, measured, recorded on data sheets, recorded on the Anabat Detector, and released back into the field.

The Anabat Detector and software (Anabat) with a laptop computer or tape recorder was used to conduct acoustical surveys for free-flying bat species. The Anabat was used primarily to record free-flying bats at the nest sites during the initial efforts. As the studies progressed, other survey techniques were implemented. These techniques included recording while night driving and/or walking and at stationary points. Walking and driving surveys helped field crews identify potential trapping sites. When bats were detected, crews stopped for one minute and continued recording. If bat activity continued, an additional 5 minutes of recording was conducted. Those areas with a great amount of bat activity were mapped for future trapping efforts since long periods of activity probably indicate either a foraging area or a roost location.

Visual surveys were conducted during the daytime hours in rock outcroppings, out buildings, tree cavities, woodlands, and snags for evidence of bat presence. Visual inspections with the aid of a flashlight, if needed, in a rock crevice or tree cavity enabled field personnel to locate potential and existing roosts. The location of the site was recorded, and if the bat could be identified without disturbing the bat, the species was recorded. No bats were removed from the roost because it could cause them to abandon their roost.

Track plates were used to identify the presence of carnivores such as the marten and fisher. Track plates were set up in 3- to 4-foot-square areas. The site was prepared by raking a relatively flat surface and placing an aluminum plate on the ground. The bait included chicken parts or pieces or approximately one and one half ounces of canned mackerel.

Track plates were placed at intervals of approximately 1,000 meters. They were checked every morning by CDFG field staff. Any tracks were measured, identified, photographed, and recorded on data sheets. In addition, clear tape was used to lift the tracks from the plates and transfer them to data sheets.

Trailmaster Camera set-ups were used to survey for carnivores in a method similar to the track plates. Two types of Trailmaster sensors were used, infrared and motion sensors. When triggered, the sensors sent a signal to the camera, which then took a photograph. The area was baited with canned mackerel, commercial baits or scents, chicken, road-kill deer, or fish.

Each event (detection by the sensor) was recorded in the sensor's memory, which also differentiated which events were photographed. The camera setups were checked each morning by field personnel and recorded on data sheets.

Spotlight surveys were conducted by two- or three-person crews using handheld Q-beam spotlights (250,000 to 1,000,000 candle power) from a vehicle traveling between 10 and 15 miles per hour. When eye shine was detected, the vehicle was stopped, and CDFG personnel identified the species with the aid of binoculars or a spotting scope, when possible. Information such as location, habitat, species, time, distance traveled on the route, and weather was recorded on data sheets each night. All accessible roads in the study areas were included in spotlight surveys. Surveys began approximately one-half hour after sunset and concluded at approximately midnight.

Field personnel conducted walking transects throughout the different habitat types on the project areas. This effort was designed and implemented specifically to detect badger denning sites and rodent burrow areas. Field personnel performed walking transects between 10 and 50 meters (33 and 164 feet) apart, depending on terrain and ground cover. All potential denning sites and burrow areas were measured, mapped, counted, and recorded.

Road transects were used along with small mammal trapping to determine the prey base available to carnivores and raptors using the project areas. The main prey species sampled was the California ground squirrel (*Spermophilus beecheyi*). The technique involved driving the roads throughout the project areas at approximately 10 miles per hour and counting ground squirrels within 50 meters of the travel route.

Incidental observations were recorded by field personnel while conducting other, more formal, surveys. Observations from field personnel conducting surveys for other disciplines such as botany, birds, fish, and herps also were reported to CDFG and recorded. Reports from other field personnel were verified where possible.

Initial field investigations were designed and focused to detect the presence and distribution of Special Status Species in the proposed reservoir areas to provide decision-makers with some baseline information that might assist with assessing potential mitigation requirements. As the studies progressed, modifications were made to determine the presence and distribution of all mammal species in the alternative reservoir areas in an attempt to assess the cumulative potential impacts that would result from project construction.

General habitat measurements were made to assist with future efforts to conduct a Habitat Evaluation Procedure (HEP). Detailed vegetative inventories were conducted by DWR staff. CDFG staff focused primarily on identifying habitat features such as snags, logs, burrows, and basic vegetation measurements, such as plant heights and canopy cover, while conducting other surveys, such as trapping. This information was recorded and will be used in the future when the HEP Team is developed and begins the Habitat Suitability Index Model selection process.

As of August 13, 1999, six mammal Species of Special Concern were documented at the four project areas (Table D-40). The pallid bat (*Antrozous pallidus*) is the only species documented in all four of the project areas thus far. The American badger (*Taxidea taxus*) and Yuma myotis (*Myotis yumanensis*) were documented in three of the sites. The western red bat (*Lasiurus blossivillii*) and ringtail (*Bassariscus astutus*) were documented in two of the sites, while the San Joaquin pocket mouse (*Perognathus inormatus inornatus*) was documented in only one of the sites.

Table D-40

Sensitive Mammal Species by Project Area

Common Name	Scientific Name	Sites Reservoir	Colusa Reservoir	Thomes-Newville Reservoir	Red Bank Reservoir
American badger	*Taxidea taxus*	X	X	X	
Pallid bat	*Antrozous pallidus*	X	X	X	X
Ringtail	*Bassariscus astutus*	X		X	
San Joaquin pocket mouse	*Perognathus inornatus inornatus*			X	
Western red bat	*Lasiurus blossivillii*	X			X
Yuma myotis	*Myotis yumanensis*	X		X	X

Studies designed to evaluate the potential impacts of each of the alternatives on small mammals are not complete. Some areas have been surveyed lightly or not at all because of lack of vehicular access. Future surveys will require access to all areas throughout the year to allow a uniform effort at each of the alternative reservoir sites, which will be needed to make comparisons between the alternatives.

Special Status Species Survey

Valley Elderberry Longhorn Beetle Surveys

Elderberry bushes with stems greater than 1-inch in diameter at ground level are considered habitat for the valley elderberry longhorn beetle (VELB). Surveying of reservoir inundation areas identified mature elderberry bushes at each of the proposed reservoir locations. These bushes occur primarily adjacent to riparian habitat. However, several small stands of elderberry bushes were located in upland habitat within each of the proposed reservoir areas. A small number of beetle emergence holes were observed in elderberry stems at both the Sites and Thomes-Newville Reservoirs.

The VELB, *Desmocerus californicus dimorphus*, was listed by the USFWS as threatened, with Critical Habitat on August 10, 1980 (Federal Register 45:52803-52807). Although there were no known VELB sites within the proposed reservoirs, habitat was known to exist within the project areas and known VELB locations were recorded nearby. The purpose of this survey was to identify and record the presence of VELB and its habitat.

Surveys focused on identifying potential habitat for VELB, the number of elderberry stems found measuring one inch or more, and the presence of exit holes. All drainages and adjacent savannas were checked first with aerial photographs, and then by field surveying for all potential habitat.

Habitat for VELB occurs at each of the four proposed reservoir sites. VELB emergence holes were found within the proposed Sites and Thomes-Newville Reservoir areas. No emergence holes were found within the proposed Colusa and Red Bank Reservoir areas. No adult beetles were observed at any of the proposed reservoir sites. Within the Sites Reservoir area, 672 elderberry stems were counted. Emergence holes were found on 18 individual stems. Only one stand of elderberry (consisting of 38 stems) was found within the Colusa Cell. In the Thomes-Newville Reservoir area, 552 stems have been counted. Emergence holes have been found in 42 stems. A total of 1,001 elderberry stems were found within the proposed Red Bank Reservoir area and 210 elderberry stems were found at the Dippingvat Reservoir site. At the Schoenfield Reservoir site, 791 individual stems were counted. No emergence holes were found at either proposed reservoir area. No elderberry plants were found at either the Bluedoor or Lanyan Reservoir sites; however, potential elderberry habitat does exist at both.

Areas not surveyed prior to this report, such as areas with restricted access, conveyance facility locations, and road relocations, will have to be surveyed. Analyses also will be needed to predict how possible changes in water regimes within the channels and associated savannas downstream will affect elderberry survival and distribution.

Special Status Shrimp Habitat Surveys

Surveys designed to detect federally listed fairy or tadpole shrimp have not yet been conducted. Potential vernal pool fairy and tadpole shrimp habitat is present within annual grassland habitat at the Sites, Colusa Cell, and Thomes-Newville Reservoir sites but absent within the Red Bank Reservoir area.

This section describes the methods and results of the mapping of potential special status shrimp habitat at the proposed Sites, Colusa, Thomes-Newville, and Red Bank Reservoir areas.

Under contract with DWR, Jones & Stokes Associates ecologists performed surveys of potential special status shrimp habitat at the potential reservoir sites in 1998 and 1999. The 1999 surveys were conducted to verify potential special status shrimp habitat mapped in 1998 and to survey in areas where access was unavailable in the previous surveys because of flooded creeks, washed-out roads, and issues with property owners.

Special status shrimp include species in the following categories:

- Shrimp listed or proposed for listing as Threatened or Endangered Species under the federal Endangered Species Act (50 Code of Federal Regulations [CFR] 17.11 for listed animals and various Federal Register notices for proposed species).
- Other shrimp species meeting the definition of Rare, Threatened, or Endangered Species under the California Environmental Quality Act (CEQA) Guidelines (Section 15380).

The surveys focused on identifying potential habitat for the federally listed Threatened vernal pool fairy shrimp (*Branchinecta lynchi*); the federally listed Endangered Conservancy fairy shrimp (*Branchinecta conservatio*); the federally listed Endangered vernal pool tadpole shrimp (*Lepidurus packardi*); and the Rare, non-listed “Mid-Valley” fairy shrimp. The following three fairy shrimp species that are not special status species but are found in the same types of habitat, also have the potential to occur within the proposed project areas: *Branchinecta coloradensis, Branchinecta lindahli,* and *Linderiella occidentalis*.

The 1999 surveys were conducted between April 5 and May 21. Twenty-eight days (56 person days) were spent in the field. Aerial photographs and existing data from DWR and the 1998 survey results were used to select areas most likely to support special status shrimp habitat. Potential habitat was mapped conservatively in an effort to be as inclusive as possible. Potential habitat surveyed included vernal pools, alkali flats, clay flats, ephemeral stock ponds, pools, and salt lakes. Therefore, it is likely that the results of this study represent a high estimate of habitat extent. In certain instances, such as clay flats and nonvegetated artificial habitats that had dried for the season, precise boundaries were difficult to define and were estimated using best professional judgment. Future surveys conducted using the approved, more detailed USFWS protocol could result in the identification of a lesser amount of actual special status shrimp habitat.

Typical habitat for special status fairy and tadpole shrimp in California include vernal pools, ponded areas within vernal swales, rock outcrop ephemeral pools, playas, alkali flats, and salt lakes. Other kinds of depressions that hold water of a similar volume, depth, and area for a similar duration and seasonality, such as vernal pools and swales, also may be potential habitat. These other depressions, are typically artificial habitats and are unvegetated; nevertheless, they bear an equal potential for supporting special status shrimp.

Pool volume is important in determining potential shrimp habitat. Deeper pools with a large surface area can more easily maintain their dissolved oxygen levels. Deep pools will also pond long enough to allow the shrimp to complete their life cycle.

Common wetland plant species that typically occur with special status shrimp species generally need the same hydrologic conditions (i.e., ponding depth, ponded surface area, ponding duration). Therefore, the presence of these plant species within a potential habitat would imply a greater potential for a population of these shrimp to be present. Conversely, pools that are dominated by vernal pool plant species that tolerate only short inundation periods will have hydrology that cannot support shrimp species (i.e., ponding duration too short, pool area too shallow). Similarly, wetland habitats that support plant species that need water year round cannot support special status shrimp species because the shrimp's cysts must dry out before they can hatch.

Therefore, potential special status shrimp habitat is defined as seasonal wetlands and other temporarily ponded areas of sufficient size (depth and area) and seasonality to support specific vegetation. This vegetation indicates the potential for ponding for a sufficient duration to allow special status shrimp species to complete their life cycles and to maintain cool water temperatures conducive to special status shrimp species.

Unvegetated potential shrimp habitats (e.g., clay flats, road ruts, and alkali flats) were mapped to the perimeter (i.e., where the vegetation begins) or to highwater mark indicators, such as drift lines or dams.

All habitats mapped during the 1998 survey effort were revisited, in addition to areas previously inaccessible, for additional potential special status shrimp habitat. Habitats fulfilling these criteria were mapped on USGS 7.5-minute quadrangle maps. The shape and dimensions of the habitat sites were drawn and described in field notes and used to calculate habitat extent in acres.

A summary of potential special status shrimp habitat mapped in the 1998 and 1999 surveys is presented in Table D-41. Potential habitat was mapped conservatively, and the results represent a high estimate of habitat acreage. The highest quality, contiguous, potential special status shrimp habitat occurs at the Thomes-Newville Reservoir site. A greater extent of habitat occurs at the Sites Reservoir area; however, this habitat is degraded by cattle activity, erosion, and debris from cattle feeding areas. The potential special status shrimp habitat at the Colusa Reservoir site is similarly degraded by the activity of cattle, though not to the extent of the Sites Reservoir site. Implementation of the proposed Red Bank Reservoir would not result in impacts on special status shrimp or special status shrimp habitat.

Table D-41

Total Acreage of Potential Special Status Shrimp Habitat

Potential Reservoir Site	Total Extent of Potential Special Status Shrimp Habitat (Acres)		
	1998 Survey	1999 Survey	Difference
Sites	73	71	-2
Colusa Cell	12	12	0
Thomes-Newville	26	26	0
Red Bank	0.0	0.0	0.0

Sites Reservoir

Grasslands and vernal pools on heavy clay soils in basin terrain characterize the Sites Reservoir area, with low ridge lines near the valley margins. Clay slumps are common along the ridges, and clay flats occur in low-lying areas. The land is currently used for cattle and sheep grazing. During the 1999 surveys, 1.5 acres of potential special status shrimp habitat was determined to be incapable of supporting special status shrimp species based upon the dominant vegetation within those habitats. The revised total, potential, special status shrimp habitat is 71 acres.

Colusa Cell Reservoir

The terrain within the Colusa Cell Reservoir area is characterized by grassland and vernal pools on heavy clay soils in basin terrain, with low ridge lines near the valley margins. Clay slumps are common along the ridges, and clay flats occur in low-lying areas. Cattle grazing is the main agricultural practice in the area. During the 1998 surveys, 11.8 acres of potential special status shrimp habitat were mapped within the area. Potential habitat was predominantly vernal pools, clay flats, and ephemeral stock ponds. During 1999, surveys identified an additional 0.3 acre of potential special status shrimp habitat.

Thomes-Newville Reservoir

The Thomes-Newville Reservoir site is characterized by grassland and vernal pools on clay soils and Lodo shale in foothill-type terrain. Cattle grazing is the primary agricultural practice in this area. Potential habitat consisted predominantly of vernal pools and ephemeral stock ponds. During the 1999 surveys, an additional 0.3 acre of potential habitat was identified, making a total of 26 acres of potential special status shrimp habitat.

Red Bank Reservoir

The Red Bank Reservoir area consists of two main components: Schoenfield Reservoir on Red Bank Creek and Dippingvat Reservoir on South Fork Cottonwood Creek. Two smaller components include Lanyan Dam and Bluedoor Reservoir on North Fork Red Bank Creek. The terrain at this site is generally too sloped to support habitat suitable for special status shrimp species. DWR staff conducting the botanical, wetlands, wildlife, and geological studies all indicated that the soils are well drained and there was very little to no potential habitat in any of the component cells of this project area.

The Red Bank potential offstream reservoir site does not support suitable habitat for special status shrimp species and is considered outside of the range of special status shrimp species.

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APPENDIX E

CULTURAL RESOURCE SURVEYS

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APPENDIX E

Cultural Resource Surveys

The objectives of the cultural resource surveys at the Sites, Colusa Cell, and Red Bank Reservoir areas were to obtain information about the archaeological sites comparable to the data from the survey conducted at the Thomes-Newville Reservoir site in 1982, and to determine whether there are any cultural resource issues serious enough to consider removing a reservoir from further consideration. Many new sites were identified and documented during the surveys, representing a varied array of site types. In addition, almost all of the previously recorded sites were found again and documented to current standards. Archaeological evaluations of the proposed reservoirs yielded a wide range of variability in the numbers and types of sites, from 3 sites in one reservoir basin to more than 100 sites in another.

The reservoir assessments were based on record searches and field surveys. Database files, maps, and reports were reviewed at the Northeast, Northwest, and North Central Information Centers of the California Historical Resources Information System, an adjunct of the State Historic Preservation Office (SHPO). The goal was to determine the extent of coverage of prior surveys within the project footprints and to obtain the records of any previously recorded sites. The field surveys concentrated on those areas with the highest potential for significant archaeological sites, such as stream terraces and level woodland flats, though areas of lesser sensitivity, such as steep hill slopes and arid plains, also were sampled.

Sites Reservoir

Parts of the Sites area were surveyed in 1967 by a field class from the University of California, Los Angeles, and Chico State College, under an agreement with the National Park Service. A total of 15 prehistoric sites were recorded at that time. No further work has been done within the reservoir footprint until the present study, which resulted in the discovery of 26 additional archaeological sites. Of the 41 sites (15 sites from previous study and 26 sites from current study), at least 17 appear to be significant, in that they provisionally meet the criteria for eligibility to the National Register of Historic Places (NRHP). Six of the sites are not eligible for the NRHP and 16 have undetermined NRHP status. An accurate assessment could not be made of these sites based solely on the evidence visible on the surface. If further studies are warranted, a site testing program using techniques such as small-scale excavations, auger borings, and soil column sampling will be implemented to determine whether the sites have archaeological values that meet the criteria for eligibility to the NRHP.

Prehistoric settlement in the project area was constrained by the limited food and fuel resources and the scarcity of water; however, the area would have been important for seasonal hunting and gathering forays. The larger and more permanent villages were situated along the lower reaches of the bigger streams, in the Sacramento Valley, and on the knolls and natural levees along the Sacramento River.

Historic sites, features, and standing structures are significantly under-represented in the site totals. These resources were not recorded because they are associated with working ranches, occupied buildings, and the Town of Sites. A future survey of historic resources may yield an estimated 15 to 20 significant historic sites in addition to the Historic District of the Town of Sites. Moving the large cemetery associated with Sites and several smaller cemeteries would be costly and would present special problems; nevertheless, there is precedent, when these activities associated with a major public works project. No cultural resource problems are known that would remove this reservoir project from further consideration.

Colusa Cell Reservoir

The record search indicated that the footprint of the Colusa Cell Reservoir had never been surveyed for cultural resources and that there were no site records in the files of the state database. The field survey indicated an even greater scarcity of subsistence resources than existed in the Sites Reservoir area and an ephemeral water supply that was not suitable for extensive use or habitation during the prehistoric past.

A total of three sites was recorded, including two historic ranches and one site with a prehistoric and an historic component. The significance of the sites is undetermined. The assessment of eligibility to the National Register could not be made on the basis of surface indications. Additional studies would be necessary to complete the evaluation. The Colusa Cell has no cultural resource issues that would preclude reservoir construction.

Thomes-Newville Reservoir

A consultant for DWR completed a comprehensive survey of prehistoric sites within the Thomes-Newville Reservoir area in 1983. A total of 117 sites were recorded within the footprint of the proposed reservoir, representing a prehistoric settlement pattern that includes evidence of permanent or semi-permanent villages, seasonal camp sites, and special resource procurement and use sites. The presence of perennial streams and availability of fuel and subsistence resources accounts for the intensive use of the project area during prehistoric times. Approximately 60 sites meet the criteria for eligibility to the NRHP and would therefore qualify for some level of mitigation effort.

Historic features, sites, and standing structures are under-represented in the site totals. These resources are now given the same consideration as prehistoric resources; however, that was not the case in the early 1980s, when the survey was conducted. Additional survey work would be necessary to determine the number, type, and significance of the historic resources that are present.

As at the Sites Reservoir, moving the historic cemeteries within the footprint of the Thomes-Newville Reservoir would be costly and present special problems; however, there are no cultural resource issues serious enough to warrant removing this reservoir from consideration.

Red Bank Project

The record search for the Red Bank Reservoir indicated that the project area had not been surveyed for cultural resources and that no site records were present in the state database. The prior survey and excavations for the Red Bank Reservoir conducted in the early 1950s by the University of California, Berkeley, for the National Park Service was for a Sacramento River diversion project near Red Bluff that had the same name. The surveys completed in 1994 by California State University, Sacramento, for the Corps' Cottonwood Creek Project were downstream from the current proposed reservoir, with no overlap of the footprints.

A total of 31 sites were recorded within the footprint of three of the four sites comprising the Red Bank Reservoir; no sites were found at the fourth site. Twenty-eight sites are prehistoric, and three are historic. Nine sites appear to meet the criteria for eligibility to the NRHP, 16 sites are of undeterminable significance without further work, and 6 sites are not eligible for listing on the NRHP, and therefore are not significant.

The prehistoric sites in the Red Bank Reservoir area were generally small, and the artifact distribution was relatively sparse. The sites probably were associated with seasonal upland hunting, fishing, and gathering activities. The larger permanent settlements were situated farther downstream, on the banks of the perennial streams and along the Sacramento River.

No cultural resource issues that were serious enough to prevent construction of the reservoirs were identified as a result of the survey of the Red Bank Reservoir.

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APPENDIX F

PRELIMINARY MEASURES SCREENING – CALFED & NODOS INVESTIGATIONS

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APPENDIX F

Preliminary Measures Screening – CALFED and NODOS Investigations

This appendix summarizes previous storage investigations under the CALFED storage program and also evaluates those storage options for the NODOS Investigations.

F.1 CALFED SURFACE STORAGE PROGRAM

CALFED began the initial screening with a list of fifty-two potential reservoir sites (see Figure F-1). The initial screening was conducted to reduce the number of sites to a more manageable number for detailed evaluation during project-specific studies. CALFED eliminated sites providing less than 0.2 MAF of storage and those that conflicted with CALFED solution principles, objectives, or policies. Forty surface storage sites were removed from CALFED's list during the initial screening process detailed in the Initial Surface Water Storage Screening Report (August 2000). CALFED specifically looked for projects that could contribute significantly to CALFED's multiple purpose objectives. These included potential sites that could provide broad benefits for water supply, flood control, water quality, and the ecosystem. Those sites not retained for additional CALFED consideration may still be developed for others for other purposes.

The screening of the potential reservoir sites for further CALFED consideration consisted of two stages:

- **Initial Screening** – To identify and eliminate those reservoir sites that were clearly impracticable for the CALFED Bay-Delta Program. The initial screening was based on a minimum storage capacity and potential for conflict with CALFED's restoration programs, solution principles and policies. An interagency team drawn from the CALFED participating agencies cooperated in the initial screening. The initial screening was based on available information; more information was available for some sites than others. Since CALFED was seeking to eliminate those reservoir sites that are clearly impracticable for the Program, the availability of information was not important. For example, a site with limited available engineering information in a location clearly in conflict with the CALFED Ecosystem Restoration Program would be removed from CALFED consideration. Other sites, with little available information, were retained because no clear reason was found for removing them from consideration.
- **Project Specific Evaluations (future)** – Will focus subsequent evaluation on surface storage sites with the most potential of helping meet CALFED goals and objectives.

This screening resulted in selection of the following 12 surface reservoir sites for further CALFED consideration:

- Four north of the Delta offstream storage alternatives, including the Red Bank Project, Thomes-Newville Project, Colusa Project, and Sites Project.
- 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.
- Enlargement of Shasta Lake (Shasta Dam) and Millerton Lake (Friant Dam).

The previously listed reservoir sites are also identified on Figure F-2.

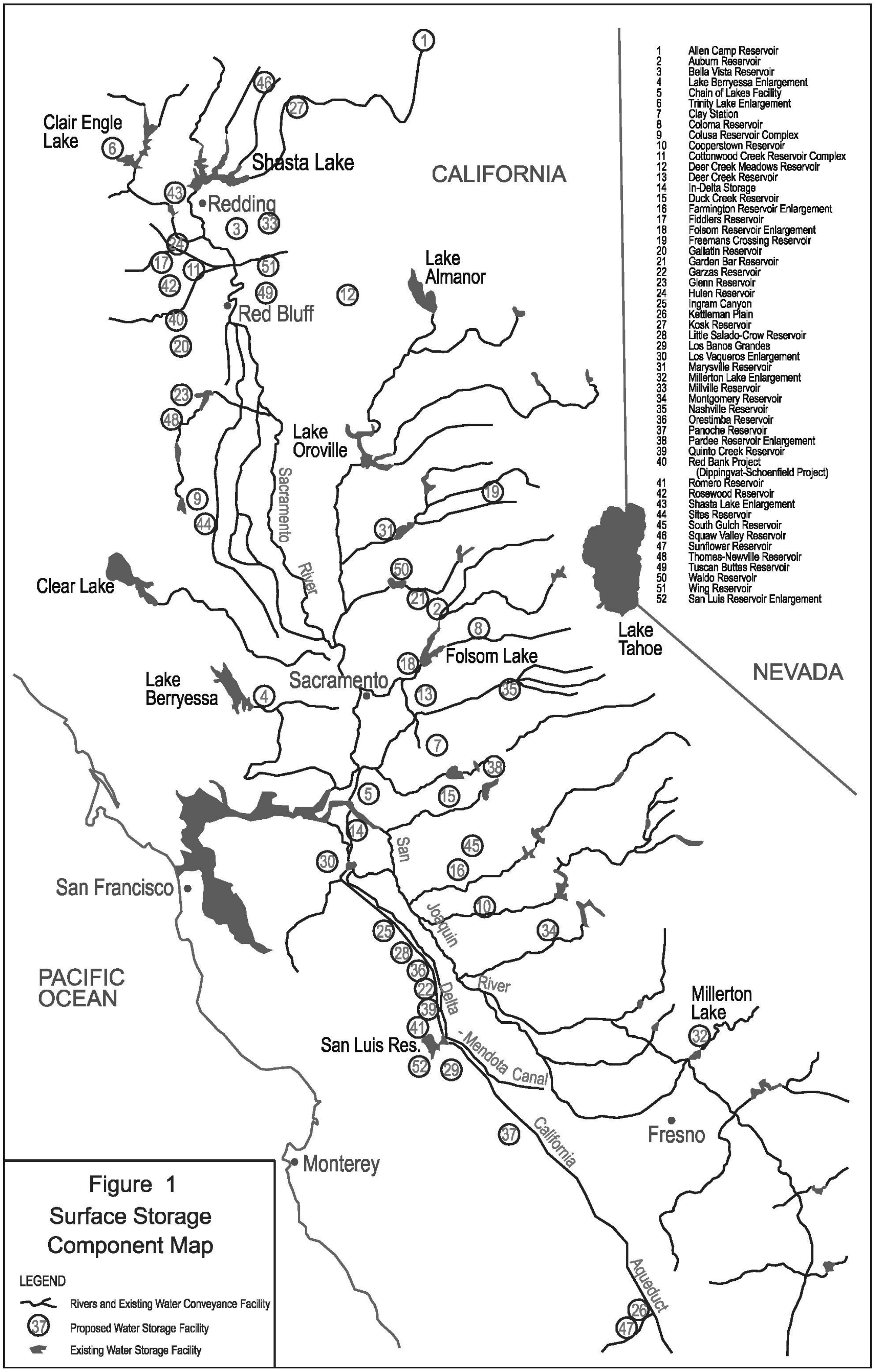

Figure F-1. Surface Storage Component Map

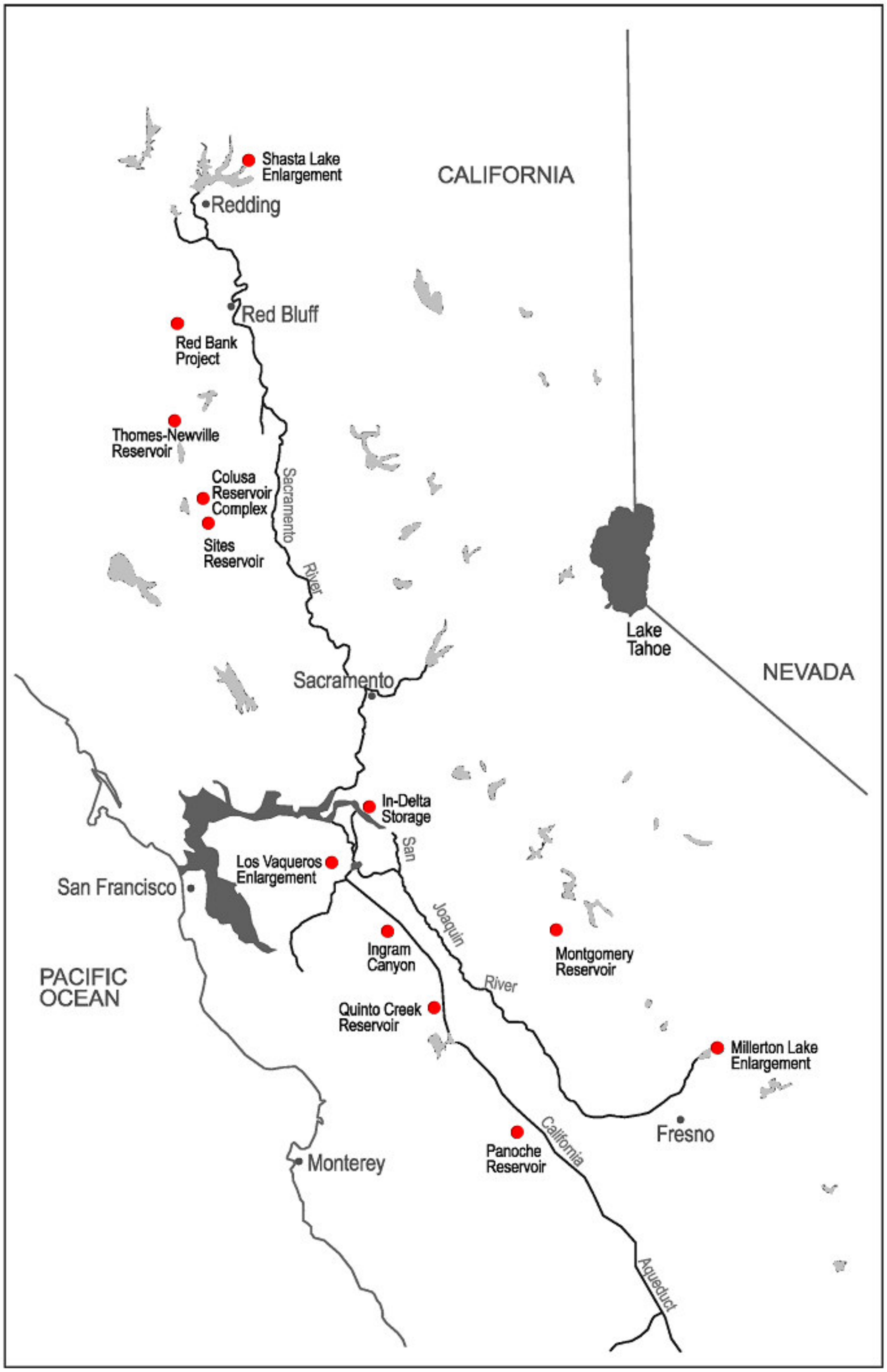

Figure F-2. Integrated Storage Investigations Potential Surface Water Storage Alternatives

Based on existing information, some potential storage facilities appeared to be more promising in contributing to CALFED goals and objectives and more implementable due to relative costs and stakeholder support. Subsequent evaluation has focused on surface storage sites with the most potential for helping meet CALFED goals and objectives during Stage 1, including the five surface storage projects identified by the CALFED ROD.

F.1.1 Integrated Storage Investigation

DWR began the investigating north-of-the-Delta offstream storage opportunities as a two-year reconnaissance-level study in late 1997 as part of the ISI Program. These investigations were funded to provide information for the completion of the programmatic EIS/EIR.

F.1.2 Coordination with CALFED's Mission Statement, Objectives, Solution Principles, and Policy

Early in the CALFED Program, CALFED developed a mission statement, a set of objectives, and a set of solution principles to guide a solution to problems in the Bay-Delta system. Potential new surface storage reservoirs must be consistent with these.

During the initial screening process, CALFED considered potential conflicts with each of the four objectives noted in Section 2.2.1. Only the ecosystem objective resulted in conflicts. To meet the ecosystem objective, the CALFED Ecosystem Restoration Program (ERP) proposed substantial actions to rehabilitate the natural processes in the Bay-Delta estuary and its watershed to support, with minimal ongoing human intervention, natural aquatic and associated terrestrial biotic communities, in ways that favor native members of those communities. Reservoir sites that significantly limit the success of the ERP are in direct conflict with the CALFED ecosystem objective. The "Essential Fish Habitat" covered in the Sustainable Fisheries Act of 1996 is one helpful measure of potential conflict. Those reservoir sites which conflict with CALFED objectives are considered to be infeasible based on logistics as defined in Clean Water Act Section 404(b)(1) Guidelines.

The six solution principles noted in Section 2.2.1 have guided CALFED Program development from the beginning. Reservoir sites that violate these solution principles should not be carried forward. Reservoir sites that violate one or more of the CALFED solution principles would also generally be infeasible based on cost or logistics as defined in the Clean Water Act Section 404(b)(1) Guidelines. A site considered unaffordable based on the CALFED solution principle would also be infeasible based on cost in the Clean Water Act Section 404(b)(1) Guidelines.

As a matter of policy, CALFED has focused on offstream reservoir sites for new surface storage, but will consider expansion of existing on-stream reservoirs. CALFED will not pursue storage at new on-stream reservoir sites due to environmental impacts and implementability issues. Offstream storage generally results in fewer environmental impacts than new on-stream storage. On-stream storage generally has much higher impacts on the aquatic environment than offstream storage. The offstream sites, filled primarily by diversion, are generally located on small or intermittent drainages where the impacts on the aquatic environment are much smaller than with on-stream reservoirs located on major rivers or tributaries. CALFED Agencies believe mitigation costs will be substantially less with the offstream reservoirs that will make the on-stream reservoirs infeasible based on cost in the Clean Water Act Section 404(b)(1) Guidelines. In addition, CALFED Agencies believe that most on-stream sites will have such high aquatic

Table F-1

Surface Water Storage Initial Alternatives
(Source: CALFED Initial Surface Water Storage Screening Report, August 2000)

No.	Component	Location			Type	Description	Gross Storage Capacity	Minimum Storage Capacity (<200 TAF)	CALFED Objectives, Principles, or Policy Conflicts	Location	Environ-mental Impacts
		County	River/Stream	Region							
1	Allen Camp Reservoir	Modoc County	Pit River	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities	196 TAF	✖			
2	Auburn Reservoir	Placer County	NF American River	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities	315 to 2,300 TAF		✖		
3	Bella Vista Reservoir	Shasta County	Little Cow Creek	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities in the northern Sacramento Valley	146 TAF	✖			
4	Lake Berryessa Enlargement	Napa County	Putah Creek	West Side Sacramento Valley	Off-Stream Storage	Storage for North Bay Aqueduct and/or new westside canal	Additional 4.4 to 11.7 TAF		✖		
5	Chain of Lakes Facility	Sacramento/San Joaquin Counties	Sacramento/San Joaquin Delta	In-Delta	Island Storage in Delta	A chain of contiguous island storage facilities from the north Delta to the export facilities	300 to 600 TAF		✖		
6	Trinity Lake Enlargement	Trinity County	Trinity River	West Side Sacramento Valley	Enlarged Existing On-Stream Storage	Develop in conjunction with pump/conveyance facility; transports Shasta storage to Trinity Lake	Additional 4,800 TAF		✖		
7	Clay Station	Sacramento County	Laguna Creek	San Joaquin Valley	Off-Stream Storage	Storage for American River flows	170 TAF	✖			
8	Coloma Reservoir	El Dorado County	SF American River	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities	710 TAF		✖		
9	**Colusa Reservoir Complex**	**Colusa/Glenn Counties**	**Funks Creek**	**West Side Sacramento Valley**	**Off-Stream Storage**	**Storage for new westside canal and Sacramento River flows**	**3,300 TAF**				✖
10	Cooperstown Reservoir	Stanislaus County	N/A	San Joaquin Valley	Off-Stream Storage	Storage for Stanislaus and Tuolumne River flows	609 TAF		✖		
11	Cottonwood Creek Reservoir Complex	Tehama/Shasta Counties	Cottonwood Creek	West Side Sacramento Valley	Combined On-Stream and Off-Stream Storage	Storage for new westside canal and Sacramento River flows. Includes Dutch Gulch and Tehama Reservoirs.	1,600 TAF		✖		
12	Deer Creek Meadows Reservoir	Tehama County	Deer Creek	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities	200 TAF		✖		
13	Deer Creek Reservoir	Sacramento County	Near Rancho Murietta	San Joaquin Valley	Off-Stream Storage	Storage for American River flows	600 TAF		✖		
14	In-Delta Storage	Sacramento/San Joaquin Counties	Sacramento/San Joaquin Delta	In-Delta	Island Storage in Central or Southern Delta	Island storage in the Delta flows	230 TAF				
15	Duck Creek Reservoir	San Joaquin County	Calaveras watershed	San Joaquin Valley	Off-Stream Storage	Storage for Mokelumne and Calaveras River flows	100 TAF	✖			
16	Farmington Reservoir Enlargement	San Joaquin County	Littejohns Creek	San Joaquin Valley	Off-Stream Storage	The existing reservoir would be improved for conservation storage of surplus Stanislaus River flows conveyed through the Upper Farmington Canal	100 TAF	✖			
17	Fiddlers Reservoir	Tehama/Shasta Counties	MF Cottonwood Creek	West Side Sacramento Valley	On-Stream Storage	Storage for new westside canal and Sacramento River flows	310 to 545 TAF		✖		
18	Folsom Reservoir Enlargement	El Dorado, Placer and Sacramento Counties	American River	East Side Sacramento Valley	Enlarged Existing On-Stream Storage	Increase regulating and yield opportunities	Additional 365 TAF		✖		
19	Freemans Crossing Reservoir	Yuba and Nevada Counties	Yuba River	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities	300 TAF		✖		
20	Gallatin Reservoir	Tehama County	Elder Creek	West Side Sacramento Valley	On-Stream Storage	Increase regulating capabilities and yield opportunities	183 TAF	✖			
21	Garden Bar Reservoir	Sutter County	Bear River	East Side Sacramento Valley	On-Stream Storage	Provide water supply opportunities in conjunction with Camp far West and Oroville Reservoirs	245 TAF		✖		
22	Garzas Reservoir	Stanislaus County	Garzas Creek	South-of-Delta Aqueduct Storage	Off-Stream Storage	Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal	139 to 1,754 TAF		✖		
23	Glenn Reservoir	Glenn/Tehama Counties	Stony Creek	West Side Sacramento Valley	Off-Stream Storage	Storage for Tehama-Colusa Canal or new westside canal	8,206 TAF		✖		
24	Hulen Reservoir	Shasta County	NF Cottonwood Creek	West Side Sacramento Valley	On-Stream Storage	Increase regulating capabilities and yield opportunities.			✖		
25	**Ingram Canyon**	**Stanislaus County**	**Ingram Creek**	**South-of-Delta Aqueduct Storage**	**Off-Stream Storage**	**Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal**	**333 to 1,201 TAF**			✖	
26	Kettleman Plain	Kings County	Kettleman Hill	South-of-Delta Aqueduct Storage	Off-Stream Storage	Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal	133 to 283 TAF		✖		
27	Kosk Reservoir	Shasta County	Pit River	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities	800 TAF		✖		

Table F-1
(Continued)

No.	Component	Location			Type	Description	Gross Storage Capacity	Minimum Storage Capacity (<200 TAF)	CALFED Objectives, Principles, or Policy Conflicts	Location	Environ-mental Impacts
		County	River/Stream	Region							
28	Little Salado-Crow Reservoir	Stanislaus County	Crow Creek	South-of-Delta Aqueduct Storage	Off-Stream Storage	Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal	132 to 250 TAF		✖		
29	Los Banos Grandes	Merced County	Los Banos Creek	South-of-Delta Aqueduct Storage	Off-Stream Storage	Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal	275 to 2,030 TAF		✖		
30	**Los Vaqueros Enlargement**	**Contra Costa County**	**Kellogg Creek**	**South-of-Delta Aqueduct Storage**	**Off-Stream Storage**	**Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal**	**Additional 965 TAF**				
31	Marysville Reservoir	Yuba County	Yuba River	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities from the Yuba River	916 TAF		✖		
32	**Millerton Lake Enlargement**	**Fresno County**	**San Joaquin River**		**On-Stream Storage**	**Increase flow regulating opportunities**	**720 TAF**				
33	Millville Reservoir	Shasta County	South Cow Creek	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities	206 TAF		✖		
34	**Montgomery Reservoir**	**Merced County**	**Dry Creek**	**San Joaquin Valley**	**Off-Stream Storage**	**Capture and store spills from Lake McClure**	**240 TAF**			✖	
35	Nashville Reservoir	El Dorado/Sacramento Counties	Cosumnes River	San Joaquin Valley	Combined Off-Stream and On Stream Storage	Storage for Cosumnes River flows	1,155 TAF		✖		
36	Orestimba Reservoir	Stanislaus County	Orestimba Creek	South-of-Delta Aqueduct Storage	Off-Stream Storage	Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal	380 to 1,140 TAF		✖		
37	**Panoche Reservoir**	**Fresno County**	**Silver Creek**	**South-of-Delta Aqueduct Storage**	**Off-Stream Storage**	**Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal**	**160 to 3,100 TAF**			✖	
38	Pardee Reservoir Enlargement	Calaveras/Amador Counties	Mokelumne River	San Joaquin Valley	On-Stream Storage	Increase regulating and yield opportunities	Additional 150 TAF	✖			
39	**Quinto Creek Reservoir**	**Merced/Stanislaus Counties**	**Quinto Creek**	**South-of-Delta Aqueduct Storage**	**Off-Stream Storage**	**Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal**	**332 to 381 TAF**			✖	
40	**Red Bank Project (Dippingvat-Schoenfield Project)**	**Tehama County**	**SF Cottonwood Creek**	**West Side Sacramento Valley**	**Off-Stream Storage - Schoenfield Reservoir On-Stream Storage - Dippingvat Reservoir**	**Provide flood control and water supply opportunities**	**Schoenfield - 250 TAF Dippingvat - 104 TAF**				✖
41	Romero Reservoir	Merced County	Romero Creek	South-of-Delta Aqueduct Storage	Off-Stream Storage	Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal	184 TAF	✖			
42	Rosewood Reservoir	Shasta/Tehama Counties	Salt Creek and Dry Creek	West Side Sacramento Valley	On-Stream Storage	Increase regulating capabilities and yield opportunities	155 TAF	✖			
43	**Shasta Lake Enlargement**	**Shasta County**	**Sacramento River**	**West Side Sacramento Valley**	**On-Stream Storage**	**Increase regulating capabilities and yield opportunities**	**Up to additional 9,750 TAF**				
44	**Sites Reservoir**	**Colusa/Glenn Counties**	**Funks Creek and Stone Corral Creek**	**West Side Sacramento Valley**	**Off-Stream Storage**	**Storage for Tehama-Colusa Canal or new westside canal**	**1,200 to 1,900 TAF**				
45	South Gulch Reservoir	San Joaquin County	South Gulch tributary to Calaveras River	San Joaquin Valley	Off-Stream Storage	Store flows from the Calaveras and Stanislaus Rivers	180 TAF	✖			
46	Squaw Valley Reservoir	Shasta County	Squaw Valley Creek	East Side Sacramento Valley	Combined Off-Stream and On-Stream Storage	Storage for Sacramento River flows	400 TAF		✖		
47	Sunflower Reservoir	Kings/Kern Counties	Avenal Creek	South-of-Delta Aqueduct Storage	Off-Stream Storage	Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal	360 to 600 TAF		✖		
48	**Thomes-Newville Reservoir**	**Glenn County**	**Thomes Creek and Stoney Creek**	**West Side Sacramento Valley**	**Off-Stream Storage**	**Storage for Tehama-Colusa Canal or new westside canal**	**1,840 to 3,080 TAF**				
49	Tuscan Buttes Reservoir	Tehama County	Paynes Creek and Inks Creek	East Side Sacramento Valley	Off-Stream Storage	Increase regulating and yield opportunities	3,675 to 5,500 TAF		✖		
50	Waldo Reservoir	Yuba County	Dry Creek	East Side Sacramento Valley	Off-Stream Storage	Storage for Yuba River Flows	60 to 300 TAF		✖		
51	Wing Reservoir	Shasta County	Inks Creek	East Side Sacramento Valley	On-Stream Storage	Increase regulating and yield opportunities	244 TAF		✖		
52	San Luis Reservoir Enlargement	Merced County	N/A	South-of-Delta Aqueduct Storage	Off-Stream Storage	Off-aqueduct storage for the California Aqueduct or the Delta-Mendota Canal	Additional 390 TAF		✖		

Bold indicates the 12 sites identified during the first screening process. ✖ Denotes an issue for that particular screening element (see column heading).

environmental impacts, that cannot be mitigated, that the sites would not be able to be developed. This would make the sites infeasible based on logistics as defined in the Clean Water Act Section 404(b)(1) Guidelines.

F.2 EVALUATION OF RESERVOIR SITES FOR THE NODOS INVESTIGATION

The previously identified 52 reservoir sites were revisited during the NODOS Investigation. The reservoir sites were evaluated for their ability to address the original CALFED objectives and their ability to address the NODOS Investigation planning objectives.

The NODOS Investigation objectives are used to guide formulation of alternatives to address the problems and needs. The primary objectives for the NODOS Investigation are:

- Increasing water supplies, water supply reliability, and Sacramento Valley water management flexibility for agricultural, M&I, and environmental purposes, including CALFED programs such as Delta water quality, EWA and ERP, to help meet California's current and future water demands, with a focus on offstream storage; and
- Increasing the survival of anadromous fish populations in the Sacramento River during critical fish migration periods as well as the health and survivability of other aquatic species.

To the extent possible, through the pursuit of the primary planning objectives, include as opportunities features to help accomplish the following secondary objectives:

- Providing ancillary hydropower generation benefits to the statewide power grid; and
- Developing additional recreational opportunities in the study area.

Table F-2 summarizes the evaluation of the 52 reservoir sites.

Consistent with the CALFED screening and the NODOS Investigation primary objectives, three offstream surface storage measures being considered for further studies by the NODOS Investigation are Sites, Newville, and Colusa Reservoirs. All measures are offstream storage facilities involving diversion of water out of a major stream and transporting the water through various conveyance systems to/from a surface storage reservoir. Therefore, future actions for feasible offstream storage projects within NODOS will include further assessments of diversion and conveyance facilities to carry water to and from the reservoirs.

Following is a brief description of each potential reservoir facility being retained:

- **Sites Reservoir** – Sites Reservoir would be located about 10 miles west of the town of Maxwell and formed by constructing dams on Stone Corral Creek and Funks Creek. Evaluation of a Site Project has focused on an up to 1.8 MAF reservoir, although a 1.2 million acre-feet reservoir has been considered. A 1.8 MAF Sites Reservoir would require construction of nine saddle dams along the southern edge of Hunters Creek watershed. Floodflows from the Colusa Basin Drain, the Sacramento River, and local tributaries are potential sources of water supply for the Sites project. These water sources have been studied with 14 optional conveyance systems from the Sacramento River; and two gravity flow conveyance alternatives that include tunnels for diverting floodflows from existing upper Stony Creek reservoirs.

- **Colusa Reservoir** – Colusa is a proposed 3.0 MAF storage project that 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 saddle dams along Logan ridge. Colusa Reservoir requires seven saddle dams. Water supply source and conveyance options are essentially the same as for Sites Reservoir, although capacities would likely be greater for the Colusa Project.

- **Newville Reservoir** – Newville would be located upstream of Black Butte Lake, 18 miles west of Orland. Constructing a dam on North Fork Stony Creek and a small saddle dam at Burrows Gap would form the proposed reservoir. The alternative reservoir sizes being evaluated are 1.9 and 3.0 MAF. Up to five additional saddle dams are 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 floodflows to be diverted to Newville Reservoir.

Following is a brief description of each the reservoir facility dismissed from further consideration:

- **Red Bank Project** – After review by the study team, the Red Bank Project offstream storage measure is hereby discontinued from further consideration under this investigation. The Red Bank Project alternative is being discontinued primarily because of significant fishery and environmental impacts. A California red-legged frog was found in the reservoir footprint. This alternative would block a portion of the Cottonwood Creek watershed in order to provide water supply to the reservoir. The Cottonwood Creek watershed is a known anadromous fishery for fall-run and late-fall-run chinook salmon. Additionally this creek is the largest un-dammed tributary to the Upper Sacramento River and is the Sacramento River's most important source of sediment. In addition, constructing this facility would require the removal and destruction of blue oaks, mixed oak and pine trees, as well as chaparral. Hydrologic conditions disfavor the Red Bank Project, without constructing a diversion dam across Cottonwood Creek to divert flow necessary to fill the Schoenfield site which would impede anadromous fish passage and spring-run salmon and steelhead. Additionally, initial investigations indicate the potential for excessive leakage of this project compared to other viable measures considered in this study. (As previously stated, the discontinuation of this measure at this time does not preclude it from future reconsideration under other circumstances, objectives and/or selection criteria.)

TABLE F-2
CALFED Surface Water Storage Alternatives Evaluation with NODOS Investigation Objectives

No.	Component	Region	Type	Gross Storage Capacity	CALFED Objectives: Minimum Storage Capacity (<200 TAF)	CALFED Objectives: CALFED Objectives, Principles, or Policy Conflicts	CALFED Objectives: Location	CALFED Objectives: Environ-mental Impacts	NODOS Investigation Primary Objectives: Objective #1	NODOS Investigation Primary Objectives: Objective #2	NODOS Investigation Secondary Objectives: Objective #3	NODOS Investigation Secondary Objectives: Objective #4	Status/Rationale
1	Allen Camp Reservoir	East Side Sacramento Valley	On-Stream Storage	196 TAF	✖				✖				**Deleted –** Although likely high potential for local project support, very low system contribution potential.
2	Auburn Reservoir	East Side Sacramento Valley	On-Stream Storage	315 to 2,300 TAF		✖			✖				**Deleted** – Project would have significant environmental impacts and low local support.
3	Bella Vista Reservoir	East Side Sacramento Valley	On-Stream Storage	146 TAF	✖				✖				**Deleted** – Project would not supply sufficient water supply and reliability for CALFED programs.
4	Lake Berryessa Enlargement	West Side Sacramento Valley	Off-Stream Storage	Additional 4.4 to 11.7 TAF		✖			✖				**Deleted** – Project would have significant environmental impacts. Project would result in a significant loss of habitat.
5	Chain of Lakes Facility	In-Delta	Island Storage in Delta	300 to 600 TAF		✖			✖				**Deleted** – Project would adversely affect the quality of Delta export water supplies.
6	Trinity Lake Enlargement	West Side Sacramento Valley	Enlarged Existing On-Stream Storage	Additional 4,800 TAF		✖			✖	✖			**Deleted** – Small potential to increase water supply in the Sacramento Valley, minimum flow releases to the Trinity River have been increasing due to severe decline in Trinity River salmon and Steelhead trout runs.
7	Clay Station	San Joaquin Valley	Off-Stream Storage	170 TAF	✖				✖				**Deleted** – Project would not supply sufficient water supply and reliability for CALFED programs.
8	Coloma Reservoir	East Side Sacramento Valley	On-Stream Storage	710 TAF		✖							**Deleted** – Project would violate California Water Code 10001.5 due to inundation of Gold Discovery Site State Park.
9	Colusa Reservoir Complex	West Side Sacramento Valley	Off-Stream Storage	3,300 TAF				✖					**Retained** – Although potentially feasible sites/projects exist that could increase water supply, significant overriding environmental and socioeconomic issues may restrict implementation at this time. Project warrants further investigation.
10	Cooperstown Reservoir	San Joaquin Valley	Off-Stream Storage	609 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
11	Cottonwood Creek Reservoir Complex	West Side Sacramento Valley	Combined On-Stream and Off-Stream Storage	1,600 TAF		✖			✖	✖			**Deleted** – Project would not support environmental purposes. Project would inundate 28 miles of stream and riparian habitat. Cottonwood Creek is essential to Sacramento River health and fishery production.
12	Deer Creek Meadows Reservoir	East Side Sacramento Valley	On-Stream Storage	200 TAF		✖			✖	✖			**Deleted** – Project would not support environmental purposes. Creek supports important population of spring-run Chinook salmon and is a priority watershed for early implementation of the ERP.
13	Deer Creek Reservoir	San Joaquin Valley	Off-Stream Storage	600 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River. Reservoir could jeopardize opportunity to provide cold water to the Lower American River.
14	In-Delta Storage	In-Delta	Island Storage in Central or Southern Delta	230 TAF					✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
15	Duck Creek Reservoir	San Joaquin Valley	Off-Stream Storage	100 TAF	✖				✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River. Project would not supply sufficient water supply and reliability for CALFED programs.
16	Farmington Reservoir Enlargement	San Joaquin Valley	Off-Stream Storage	100 TAF	✖				✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River. Project would not supply sufficient water supply and reliability for CALFED programs.
17	Fiddlers Reservoir	West Side Sacramento Valley	On-Stream Storage	310 to 545 TAF		✖			✖	✖			**Deleted** – Project would not support environmental purposes. Reservoir would block important sediment flow to the Sacramento River and would conflict with CALFED's ecosystem restoration objectives.
18	Folsom Reservoir Enlargement	East Side Sacramento Valley	Enlarged Existing On-Stream Storage	Additional 365 TAF		✖			✖				**Deleted** – Low potential for increasing water supply and reliability due to flood control operations.

TABLE F-2
(Continued)

No.	Component	Region	Type	Gross Storage Capacity	CALFED Objectives				NODOS Investigation Primary Objectives		NODOS Investigation Secondary Objectives		Status/Rationale
					Minimum Storage Capacity (<200 TAF)	CALFED Objectives, Principles, or Policy Conflicts	Location	Environ-mental Impacts	Objective #1	Objective #2	Objective #3	Objective #4	
19	Freemans Crossing Reservoir	East Side Sacramento Valley	On-Stream Storage	300 TAF		✖			✖				**Deleted** – Lack of water in the project area due to current diversions.
20	Gallatin Reservoir	West Side Sacramento Valley	On-Stream Storage	183 TAF	✖				✖				**Deleted** – Project would not supply sufficient water supply and reliability for CALFED programs.
21	Garden Bar Reservoir	East Side Sacramento Valley	On-Stream Storage	245 TAF		✖			✖	✖			**Deleted** – Project would not support environmental purposes. Project would negatively impact anadromous fish.
22	Garzas Reservoir	South-of-Delta Aqueduct Storage	Off-Stream Storage	139 to 1,754 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River. Project would not support environmental purposes.
23	Glenn Reservoir	West Side Sacramento Valley	Off-Stream Storage	8,206 TAF		✖			✖	✖			**Deleted** – Project would not support environmental purposes. Project would have significant impact on migration routes and spawning habitat.
24	Hulen Reservoir	West Side Sacramento Valley	On-Stream Storage	Up to 244 TAF		✖			✖	✖			**Deleted** – Project would not support environmental purposes. Reservoir would block important sediment flow to the Sacramento River and would conflict with CALFED's ecosystem restoration objectives.
25	Ingram Canyon	South-of-Delta Aqueduct Storage	Off-Stream Storage	333 to 1,201 TAF			✖		✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
26	Kettleman Plain	South-of-Delta Aqueduct Storage	Off-Stream Storage	133 to 283 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
27	Kosk Reservoir	East Side Sacramento Valley	On-Stream Storage	800 TAF		✖							**Deleted** – Reservoir was investigated as part of the SLWRI and was determined to have a very high unit cost per acre-foot of yield.
28	Little Salado-Crow Reservoir	South-of-Delta Aqueduct Storage	Off-Stream Storage	132 to 250 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
29	Los Banos Grandes	South-of-Delta Aqueduct Storage	Off-Stream Storage	275 to 2,030 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
30	Los Vaqueros Enlargement	South-of-Delta Aqueduct Storage	Off-Stream Storage	Additional 965 TAF					✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
31	Marysville Reservoir	East Side Sacramento Valley	On-Stream Storage	916 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
32	Millerton Lake Enlargement		On-Stream Storage	720 TAF					✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
33	Millville Reservoir	East Side Sacramento Valley	On-Stream Storage	206 TAF		✖			✖	✖			**Deleted** – Reservoir will likely be designated an Essential Fish Habitat. Would be in conflict with CALFED's restoration objectives.
34	Montgomery Reservoir	San Joaquin Valley	Off-Stream Storage	240 TAF			✖		✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
35	Nashville Reservoir	San Joaquin Valley	Combined Off-Stream and On Stream Storage	1,155 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
36	Orestimba Reservoir	South-of-Delta Aqueduct Storage	Off-Stream Storage	380 to 1,140 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.

TABLE F-2
(Continued)

No.	Component	Region	Type	Gross Storage Capacity	CALFED Objectives: Minimum Storage Capacity (<200 TAF)	CALFED Objectives: CALFED Objectives, Principles, or Policy Conflicts	CALFED Objectives: Location	CALFED Objectives: Environ-mental Impacts	NODOS Investigation Primary Objectives: Objective #1	NODOS Investigation Primary Objectives: Objective #2	NODOS Investigation Secondary Objectives: Objective #3	NODOS Investigation Secondary Objectives: Objective #4	Status/Rationale
37	Panoche Reservoir	South-of-Delta Aqueduct Storage	Off-Stream Storage	160 to 3,100 TAF			✖		✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
38	Pardee Reservoir Enlargement	San Joaquin Valley	On-Stream Storage	Additional 150 TAF	✖				✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River. Project would not supply sufficient water supply and reliability for CALFED programs.
39	Quinto Creek Reservoir	South-of-Delta Aqueduct Storage	Off-Stream Storage	332 to 381 TAF			✖		✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
40	Red Bank Project (Dippingvat-Schoenfield Project)	West Side Sacramento Valley	Off-Stream Storage - Schoenfield Reservoir On-Stream Storage - Dippingvat Reservoir	Schoenfield - 250 TAF Dippingvat - 104 TAF				✖		✖			**Deleted** – This project would block anadromous fishery utilization of portions of Cottonwood Creek watershed, and impede anadromous fish passage in Cottonwood Creek during spring diversions from South Fork Cottonwood Creek (Dippingvat Reservoir) into Red Bank Creek (Shoenfield Reservoir). Fishery impacts to anadromous species preclude this measure from being retained under NODOS primary objectives.
41	Romero Reservoir	South-of-Delta Aqueduct Storage	Off-Stream Storage	184 TAF	✖				✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River. Project would not supply sufficient water supply and reliability for CALFED programs.
42	Rosewood Reservoir	West Side Sacramento Valley	On-Stream Storage	155 TAF	✖				✖				**Deleted** – Project would not supply sufficient water supply and reliability for CALFED programs.
43	Shasta Lake Enlargement	West Side Sacramento Valley	On-Stream Storage	Up to additional 9,750 TAF					✖				**Deleted** – Consistent with primary planning objectives and directly contributes to secondary planning objectives. However, project does not focus on offstream storage.
44	Sites Reservoir	West Side Sacramento Valley	Off-Stream Storage	1,200 to 1,900 TAF									**Retained** – Consistent with primary planning objectives and directly contributes to secondary planning objectives.
45	South Gulch Reservoir	San Joaquin Valley	Off-Stream Storage	180 TAF	✖				✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River. Project would not supply sufficient water supply and reliability for CALFED programs.
46	Squaw Valley Reservoir	East Side Sacramento Valley	Combined Off-Stream and On-Stream Storage	400 TAF		✖			✖	✖		✖	**Deleted** – Project would reduce flows in the Upper Sacramento River. Project would inundate area of high recreational use.
47	Sunflower Reservoir	South-of-Delta Aqueduct Storage	Off-Stream Storage	360 to 600 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.
48	Thomes-Newville Reservoir	West Side Sacramento Valley	Off-Stream Storage	1,840 to 3,080 TAF									**Retained** – Consistent with primary planning objectives and directly contributes to secondary planning objectives.
49	Tuscan Buttes Reservoir	East Side Sacramento Valley	Off-Stream Storage	3,675 to 5,500 TAF		✖				✖			**Deleted** – Would cause significant fisheries impacts. Would require large diversion from the Sacramento River.
50	Waldo Reservoir	East Side Sacramento Valley	Off-Stream Storage	60 to 300 TAF		✖			✖			✖	**Deleted** – Would cause significant environmental and recreational impacts.
51	Wing Reservoir	East Side Sacramento Valley	On-Stream Storage	244 TAF		✖			✖				**Deleted** – Reservoir will likely be designated an Essential Fish Habitat. Would be in conflict with CALFED's restoration objectives.
52	San Luis Reservoir Enlargement	South-of-Delta Aqueduct Storage	Off-Stream Storage	Additional 390 TAF		✖			✖	✖			**Deleted** – Project does not supply water management flexibility in the Sacramento Valley, nor does it increase anadromous fish survival on the Sacramento River.

✖ Denotes an issue for that particular screening element (see column heading).

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APPENDIX G

POTENTIAL RESERVOIR SITES

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APPENDIX G

Potential Reservoir Sites

These potential reservoir sites for the NODOS Investigation were developed and reviewed during study team meetings, field inspections, and outreach for the NODOS Investigation for their ability to address the initial planning objectives. This Appendix generally describes the reservoir sites, and presents summary information related to their potential to create new water supplies, improve anadromous fish survival, hydropower generation and recreation effects, estimated costs, and environmental considerations. Rationale is provided for either retaining or eliminating potential reservoir sites from further development in the NODOS Investigation. Surface storage options that appear to contribute the least to the planning objectives will be dropped from further consideration in this appendix.

The four north-of-the-Delta offstream projects provide a range of potential water supply reliability benefits, but would serve similar project purposes. Since all of the projects are upstream of the Delta and adjacent to the Sacramento River, the kinds of benefits, such as supplemental yield for various uses and reduced diversions from the Sacramento River during the peak local delivery period will vary primarily in scale. Comparative project characteristics are shown on Table G-1. All of these projects have been investigated in the past. Current studies have updated and augmented these past studies as needed to allow comparative evaluation of alternatives.

Table G-1

Comparative Project Statistics for the Sites, Colusa, Thomes-Newville, and Red Bank Projects

Project Feature	Sites	Colusa	Small Thomes-Newville	Large Thomes-Newville	Red Bank	
					Dippingvat	Schoenfield
Storage (acre-feet)						
Gross	1,800,000	3,000,000	1,900,000	3,000,000	104,000	250,000
Dead	40,000	100,000	50,000	50,000		
Drainage Area (square miles)	85	115	63	63	132	39
Reservoir Surface Area (acres)	14,000	28,000	14,500	17,000	1,270	2,770
Dam Height/Volume (feet/1,000yd^3)						
Sites	290/3,800	290/3,800				
Golden Gate	310/10,600	310/10,600				
Prohibition		230/11,300				
Owens		260/11,700				
Hunters		260/24,700				
Logan		270/30,600				
Newville			325/16,000	400/33,000		
Burrows Gap (largest saddle)			75/600	150/2,000		
Schoenfield (RCC)						300/467
Dippingvat (RCC)					250/367	

Table G-1
(Continued)

Project Feature	Sites	Colusa	Small Thomes-Newville	Large Thomes-Newville	Red Bank	
					Dippingvat	Schoenfield
Lanyan (RCC)					75/19	
Bluedoor (RCC)					115/55	
Saddle Dams (Number/Height)	9/130	7/140	None	4/75		4/85
Reservoir Elevation (feet)						
Normal	520	520	905	980	1,205	1,017
Minimum	320	320	685	685	1,103	830
Average Annual Natural Reservoir Inflow (acre-feet)	15,000	20,000	20,000	20,000	96,400	16,000
Reservoir Evaporation						
Average Annual	40,000	80,000	50,000	60,000		
Critical Period Total	220,000	440,000	300,000	360,000		
Pumping						
Static Lift from T-C Canal (feet)	320	320	655	730		
Maximum	120	120	435	435		
Minimum	5 – 8	5 – 8	2	2 – 5		
Capacity (1,000 cfs)						

For Golden Gate Dam, statistics shown are for the downstream curved embankment alternative.

G.1 PHYSICAL ENVIRONMENT

All four of the proposed reservoir projects are located within the Coast Range foothills along the western edge of the northern Sacramento Valley. The United States Geological Survey watersheds and subbasins containing the proposed offstream reservoirs are delineated in Figure G-1. The acreage of the watersheds or subbasins associated with the reservoirs is shown in parentheses below. The drainage area of the watersheds upstream of the dams is shown in Table G-1.

Sites

The proposed Sites Reservoir is in north-central Colusa County and south-central Glenn County, approximately 10 miles due west of the community of Maxwell. The proposed reservoir inundation area includes most of Antelope Valley and the small community of Sites. As shown in Figure G-1, the reservoir is in the Funks Creek and Stone Corral Creek watersheds (59,700 acres), with the associated USGS subbasins. A mean full pool elevation of 520 feet would inundate 14,000 acres and could store a maximum of 1.8 MAF.

Colusa Cell

The proposed Colusa Project would also be located in north-central Colusa County and south-central Glenn County, approximately 12 miles southwest of the community of Willows and 10 miles west of

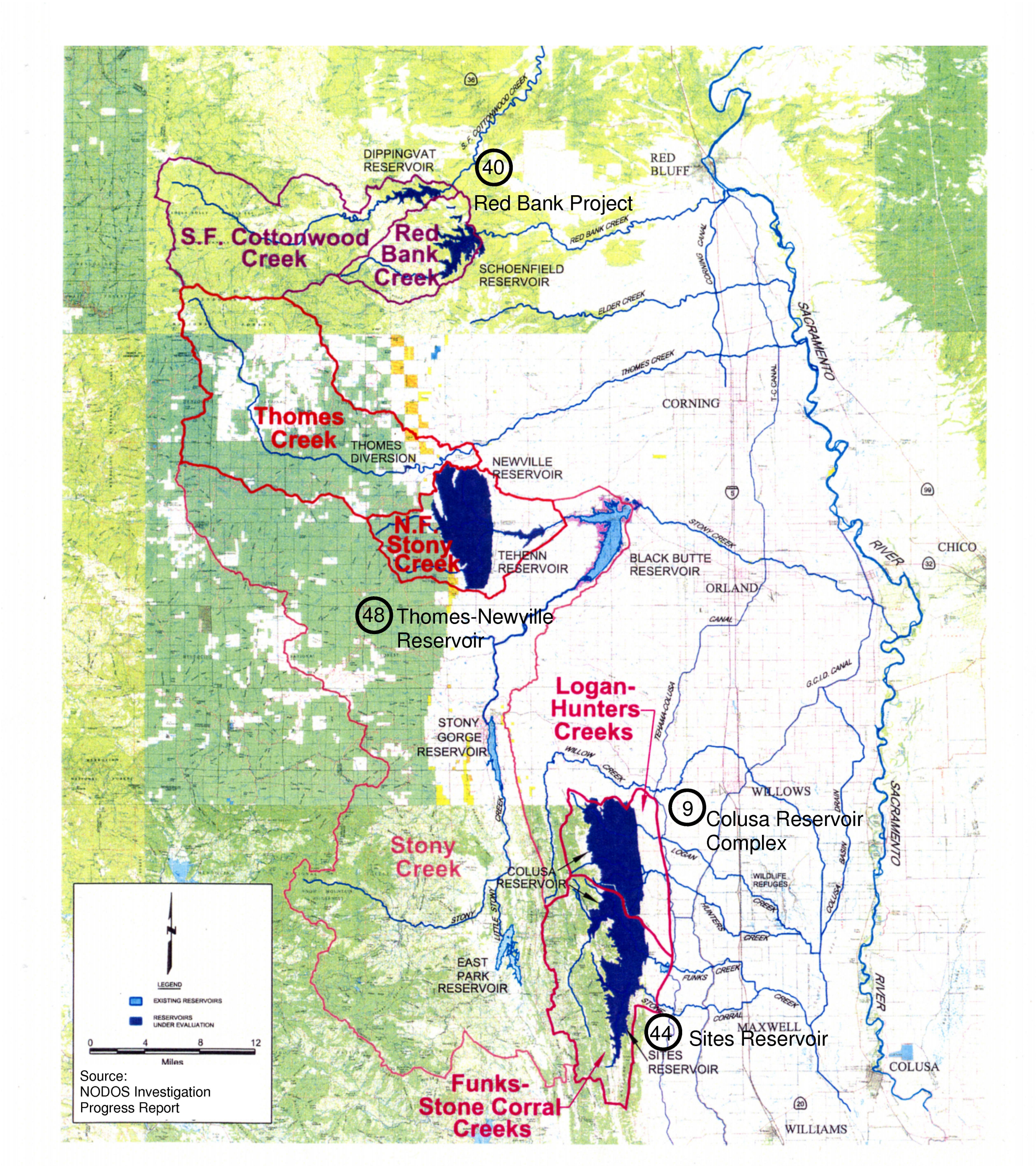

FIGURE G-1. Delineation of Watersheds for each Reservoir Location

Maxwell. The Colusa Cell would be due north of the proposed Sites Reservoir and could be constructed with Sites Reservoir facilities to form a single 28,000-acre reservoir (Colusa Reservoir). The inundation area of the Colusa Cell is within Logan Creek and Hunter Creek watersheds (35,000 acres), which are shown in Figure G-1, with the associated USGS subbasins. A mean full pool elevation of 520 feet would inundate about 14,000 acres within the Colusa Cell and could store an additional 1.2 MAF. The maximum storage of the Colusa Project would be 3.0 MAF.

Thomes-Newville

The Thomes-Newville Project would be situated within north-central Glenn County and south-central Tehama County. Newville Reservoir would be approximately 18 miles west of the City of Orland and 23 miles west-southwest of the City of Corning. As shown in Figure G-1, this proposed reservoir project would be within portions of the North Fork Stony Creek watershed (51,200 acres) and Thomes Creek watershed (123,500 acres), as well as the associated USGS subbasins. A small diversion along Thomes Creek would transfer water to Newville Reservoir in the North Fork Stony Creek watershed. Alternative reservoir sizes of 1.9 and 3.0 MAF are being evaluated, with associated normal water surface elevations of 905 and 980 feet and corresponding reservoir surface areas of 14,500 and 17,000 acres.

Red Bank

The proposed Red Bank Project is in northwest Tehama County, approximately 17 miles west of the City of Red Bluff. This project would include a diversion on South Fork Cottonwood Creek at Dippingvat Reservoir, two small reservoirs in the headwaters of North Fork Red Bank Creek (Blue Door and Lanyan Reservoirs), and a larger storage reservoir on Red Bank Creek (Schoenfield Reservoir). The South Fork Cottonwood Creek watershed is relatively large (81,900 acres), while the Red Bank Creek watershed is relatively small (27,300 acres). The reservoirs, watersheds, and subbasins are shown in Figure G-1. Dippingvat Reservoir would have a normal pool elevation of 1,205 feet and an inundation area of 1,800 acres. Schoenfield Reservoir, with a normal pool elevation of 1,017 feet, would inundate 2,770 acres and have a storage capacity of 0.25 MAF.

G.1.1 Topography

The physical topography of the watersheds draining the east side of the Coast Range toward the Sacramento Valley is diverse. The topography ranges from steep, rugged, mountainous terrain within the upper watersheds to rolling foothills in the project areas to relatively flat alluvial terrain as the watersheds enter the Sacramento Valley. Elevations range from less than 40 feet on the valley floor to over 8,000 feet along the Coast Range divide.

Sites

The Sites Project area is situated between the Sacramento Valley to the east and the mountainous portion of the Coast Range on the west. A relatively narrow band of steep rolling foothills, approximately 2 to 3 miles wide, separates the proposed reservoir area from the Sacramento Valley. Antelope Valley, the primary inundation area of the proposed Sites Reservoir, lies between this narrow band of foothills and the more mountainous Coast Range. This relatively narrow north-south tending valley is approximately 13 miles long and up to 2 miles wide. Elevation of the Antelope Valley floor ranges from 320 to 400 feet above mean sea level, while the foothills separating the valley from the Sacramento Valley reach a maximum elevation of 1,300 feet. Elevations along the west side of Antelope Valley increase rapidly with several peaks within 2 miles of the valley margin above 2,000 feet.

Colusa Cell

The Colusa Cell area is also between the Sacramento Valley to the east and the mountainous portion of the Coast Range on the west. In addition to the inundation area of Sites Reservoir, the proposed Colusa Reservoir would also inundate the valleys associated with both Hunter and Logan Creeks upstream of Logan Ridge. Topographic relief within the inundation area of the Colusa Cell is more varied than within Sites Reservoir and numerous islands would be created from hills greater than 520 feet elevation. The Colusa Cell inundation area would be approximately 10 miles long and 3 miles wide, with a maximum depth of 260 feet. The foothills separating the Colusa Cell from the Sacramento Valley are substantially lower in elevation than those found near Sites, with only a single peak in excess of 1,000 feet elevation. Development of this project would require construction of numerous saddle dams, as a number of areas along the eastern edge of the project are less than the normal pool elevation of 520 feet.

Thomes-Newville

Newville Reservoir would be located in a large circular valley surrounding the North Fork Stony Creek. Topographical relief within the inundation area of Newville Reservoir is that of gently rolling terrain ranging in elevation from 630 feet to 975 feet elevation. A single steep ridge (Rocky Ridge) separates the Newville Reservoir site from low, rolling foothill areas to the east. Rocky Ridge runs north and south with several peaks above 1,300 feet elevation. Steep, rugged mountains form the western boundary of the reservoir area, with elevations up to 3,000 feet within 2 miles of the reservoir inundation area. The currently preferred diversion on Thomes Creek would be made at a low dam in a steep, narrow, confined reach below Thomes Creek Canyon at approximately 1,035 feet above mean sea level.

Red Bank

The Red Bank Project area is highly dissected, rugged, mountainous terrain. The primary drainages (and associated valleys) run from west to east. Linear alluvial terraces are associated with the major drainages and stream gradients are much greater than those found in the other three proposed reservoirs. Topographical relief within the inundation area of the Red Bank Project varies from small areas of relatively flat alluvial terraces to gently rolling terrain to very steep hill slopes ranging in elevation from 780 to 1,200 feet.

G.1.2 Climate and Water Resources

The climate of the watersheds draining into the western Sacramento Valley is typical Mediterranean (detailed descriptions are provided in Appendix B). Winters are rainy and relatively mild with only occasional freezing temperatures at the lower elevations; summers are comparatively dry and hot. The rainy season normally begins in September and continues through March or April. Rains may continue for several days at a time, but are usually gentle. Summer rains are rare, as are thunderstorms and hailstorms. Thunderstorms occur about ten days per year in the Sacramento Valley, occasionally producing high intensity rainfall of short duration. Most precipitation is associated with migrant storms that move across the area during winter. Snow is the dominant form of precipitation above 5,000-foot elevation and persists on north- and east-facing slopes into the early summer.

Streams draining the proposed Sites Reservoir, Colusa Cell, and Newville Reservoir are ephemeral with little or no flow from July through October. However, these streams tend to respond rapidly to significant rainfall events. Flash flooding with substantial overland flow has been observed. Flow recorded at the stream gage on Stone Corral Creek near Sites is representative of the flow variability in these small ephemeral streams. Annual discharge volume varied from zero in 1972, 1976, and 1977 to 39,930 AF in 1963 and averages 6,500 AF. Monthly flow volumes in excess of 15,000 AF have been documented.

The immediate area of the alternative projects has very few groundwater resources. The area is underlain by the Great Valley Sequence rocks and locally by Quaternary terrace deposits. Groundwater is found in fractures in the Great Valley Sequence and in the sands and gravels in the terrace deposits. Springs occur where the terrace deposits terminate or where water-bearing fractures encounter the surface. A number of springs also occur in the Great Valley Sequence rocks where faults create subsurface dams that cause groundwater to reach the surface. Not all fractures or faults contain groundwater. Nor do all terrace deposits have groundwater.

G.1.3 Geology and Soils

The rocks underlying the proposed project sites are part of the Great Valley geomorphic province, which is mostly sandstone, mudstone, and conglomerate. The Great Valley geomorphic province is bounded to the west by the Coast Ranges province, to the north by the Klamath Mountains province, to the northeast by the Cascade Range province, and to the east by the Sierra Nevada province (Appendix C provides a detailed description of geology and soils).

G.1.4 Air Quality

Air Pollution Control Districts has been established for Colusa, Glenn and Tehama Counties. Each county monitors similar contaminants, including ozone and particulate matter. Detailed site-specific air quality information is not available. Colusa County is a non-attainment area for both particulates (PM10) and ozone under both State and federal criteria. Tehama County is considered a moderate non-attainment area for both ozone and particulates (PM10) under the California Clean Air Act. However, levels of both contaminates are within federal criteria. Glenn County air quality meets both State and federal air quality standards for ozone and PM10.

G.2 BIOLOGICAL RESOURCES

The following subsections summarize biological resources, such as vegetation, fish, and wildlife, found in the proposed project areas.

G.2.1 Vegetation

The watersheds of Sacramento Valley west-side streams contain a variety of vegetative communities (botanical surveys are summarized in Appendix D). These include white fir, Klamath mixed conifer, Douglas fir, ponderosa pine, closed-cone pine-cypress, montane hardwood conifer, montane hardwood, blue oak woodland, valley oak woodland, blue oak foothill pine, montane riparian, valley foothill riparian, montane chaparral, mixed chaparral, chamise-redshank chaparral, annual grassland, and cropland.

Vegetation within the four proposed project locations is varied due to the influence of local soils, geology, microclimate, hydrology, aspect, and elevation, as well as other physical and biological factors. All four project sites contain at least some annual grassland habitat. This upland plant community of herbaceous annual grasses and herbs is characteristically composed of many non-native species and a limited number of native species. Species composition is highly variable among stands and throughout the growing season. Vernal pools and swales within the annual grassland community support unique assemblages of native wetland plant species.

Chaparral communities occur at or near each of the proposed project locations in varying amounts. These stands frequently occur in a continuous canopy with little or no understory. Other shrub and tree species, including poison oak and manzanita, form a mosaic in some chaparral stands.

Riparian vegetation is associated with both intermittent and permanent streams. Common riparian overstory species include Fremont's cottonwood, willow, and Mexican elderberry.

Two types of oak woodland were identified within the four proposed project locations: valley oak woodland and blue oak woodland. Valley oak woodlands are found along the major tributaries and valley bottoms in the reservoir sites. This vegetative community may include other native tree and shrub species. Blue oak woodland occurs at or near each of the proposed project. Blue oak is the dominant or sole canopy species in these woodlands. An annual grassland understory is common and a shrub layer comprised of manzanita and wedgeleaf ceanothus can occur. Blue oak woodlands primarily occur on moderately rocky to well-drained slopes. Limited amounts of wetlands occur within the proposed project areas.

Foothill pine woodland is the most common vegetative community (61 percent) within the Red Bank Project area. This woodland is dominated by foothill pine and frequently contains a well-developed blue oak understory. The foothill pine community is most common on well-drained uplands.

Annual grasslands (89 percent of the surface area) dominate the proposed Sites Reservoir. Blue oak woodland occurs around the fringe of the reservoir area. Approximately 923 acres (7 percent of the surface area) of blue oak woodland are present within the project area. Relatively small amounts of chaparral, riparian, wetlands, cultivated grain, and non-vegetated areas comprise the remaining 4 percent of the inundation area. As elevation increases above the western edge of the reservoir boundary, the foothill pine community becomes dominant with large chamise chaparral stands present on shallow soils and southern exposures.

Ninety-nine percent of the Colusa Cell area is dominated by an annual grasslands community. The remaining one percent of the land area is divided between blue oak woodland, riparian, emergent wetlands, and non-vegetated areas. No chaparral, blue oak/gray pine woodland, or cultivated grain is present within the project area. As elevation increases above the western edge of the reservoir boundary, the blue oak savanna community becomes dominant.

The Newville Reservoir area is dominated (85 percent) by annual grasslands. Oak woodland comprises an additional 11 percent of the inundation area. A limited amount of chaparral, emergent wetland, and riparian habitat were also mapped within Newville Reservoir. No foothill pine or cultivated grain was mapped within the reservoir footprint.

Foothill pine woodland comprises 61 percent of the Red Bank Project area. Oak woodland habitat was identified and mapped in about 20 percent of the area. Annual grasslands are present on about 12 percent. Limited amounts of chaparral, riparian, and wetlands are also present.

G.2.2 Fish and Wildlife Resources

Following is aquatic and fishery, and wildlife resources found in the project areas.

Aquatic and Fishery Resources

The watersheds of the North Coast Range draining east toward the Sacramento Valley contain native and non-native species, warm-water and coldwater species, and anadromous and resident fish species. At least 24 species of fish are present in these watersheds. Several State or federally listed fish species occur in the region including steelhead, and various runs of Chinook salmon. Coldwater habitats are present in the upper watersheds of the major streams including Cottonwood Creek, Red Bank Creek, and Thomes Creek. Appendix E provides a summary of relevant biological survey results.

Fishery evaluations performed at Antelope, Stone Corral, and Funks Creeks within the footprint of Sites Reservoir indicated the presence of several native and non-native species. All of these streams are ephemeral within the reservoir area and do not provide cold-water habitat. Most are degraded with extensive downcutting and little riparian vegetation. However, a single adult spring-run Chinook salmon was observed in Antelope Creek within the inundation area. Habitat surveys indicate that the stream reaches above the reservoir do not provide suitable rearing habitat for anadromous species.

Fishery evaluations were performed on three ephemeral streams within the Colusa Cell footprint (Logan, Hunters, and Minton Creeks). Survey results indicate the presence of only one native species and several introduced warm water species. All of these streams are ephemeral upstream from the proposed dam sites and do not provide cold-water habitat. No State or federally listed fish species were identified within the reservoir area. Habitat surveys indicate that the stream reaches above the reservoir do not provide suitable rearing habitat for anadromous species.

Surveys from the 1980s of the ephemeral streams within the Newville Reservoir footprint resulted in capturing California roach, Sacramento pike minnow, Sacramento sucker, and green sunfish. Rainbow trout were present in the perennial headwater areas of Salt and Heifer Camp Creeks above the proposed reservoir inundation area. The lower Thomes Creek watershed contained a diverse fish assemblage that included runs of fall-run, late fall-run, and spring-run Chinook salmon and steelhead.

DFG conducted studies in lower Cottonwood Creek (below the north fork confluence) and in South Fork Cottonwood Creek in 1976. They found ten resident game species and 13 nongame species of fishes. The 1976 DFG survey also found runs of fall-run, late fall-run, and spring-run Chinook salmon in lower Cottonwood Creek and spring-run Chinook salmon and steelhead in South Fork Cottonwood Creek. A more recent survey on South Fork Cottonwood Creek and Red Bank Creek within the Red Bank Project area located four species of resident game fishes and four species of non-resident game fishes. Steelhead were identified within the Red Bank Creek watershed.

Wildlife

A wide variety of wildlife species utilize areas in and around the four proposed reservoir areas either seasonally or year-round. Surveys are ongoing of the proposed reservoir sites for the presence of State and federally listed species. However, substantially less information has been collected on non-listed species density and distribution.

Some general statements about relative wildlife species' diversities can be made based on the variety of habitat types and successional stages present within each of the proposed reservoir locations. The Colusa Cell is strongly dominated by annual grasslands with little habitat or structural diversity. This monotypic habitat would not support the same diversity of wildlife species that would be expected at the other proposed reservoir locations where a greater diversity of habitats is present. Sites Reservoir contains a greater diversity of habitat types than found within the Colusa Cell. Thomes-Newville and Red Bank Project areas support a greater diversity of habitat type than the Sites and Colusa Cell areas. This increased habitat diversity should provide habitat for a number of wildlife species not found within the Colusa Cell. Although the Red Bank Project area is the smallest of the four proposed reservoir locations, it contains the greatest diversity of habitats and several stages of habitats and should support the highest diversity of vertebrate wildlife.

State or federally listed wildlife species have been studied and documented at or near each proposed reservoir location. Wintering bald eagles (State endangered, federal threatened) occur in low numbers at each proposed reservoir. Both wintering sandhill cranes (State threatened) and a migrating bank swallow

(State threatened) have been detected at or near the proposed Colusa Cell. Extensive surveys of the proposed Sites and Colusa Cell project areas have failed to detect any California tiger salamanders, red-legged frogs, or giant garter snakes. Protocol for the field surveys requires that the study include areas around the proposed reservoirs where proposed facilities, roads, and utilities will be relocated. Surveys are not yet complete. One red-legged frog (federal threatened) has been reported within the Red Bank Project area. Numerous federal species of concern, California Species of Special Concern, federal Migratory Nongame Birds of Management Concern, or candidate species occur within each of the proposed reservoirs.

Several DFG harvest species occur within the proposed reservoirs. Upland game includes black-tailed deer, black bear, feral pig, gray squirrel, wild turkey, California and mountain quail, and mourning dove. Waterfowl use is limited within each of the proposed reservoirs and generally restricted to winter use of stock ponds and small lakes. Limited wood duck and mallard nesting also occurs within stock ponds and along the stream channels where adequate brooding water exists. Relatively high deer use of portions of the Thomes-Newville and Red Bank project areas during winter has been reported. Substantially less deer use has been observed within the Sites Reservoir area and no use has been noted within the Colusa Cell area. Observations indicate that feral pigs occur in low to moderate numbers within each of the proposed reservoirs, with the greatest use within the Red Bank Project area. Wild turkeys are relatively common in portions of the Red Bank Project area and Newville Reservoir area.

According to the Natural Diversity Database, several federally listed invertebrate species may occur within the four proposed reservoir sites. These species include valley elderberry longhorn beetle, vernal pool fairy shrimp, Conservancy fairy shrimp, and vernal pool tadpole shrimp (see Appendix E).

Summary of Evaluated Animal and Plant Species

Table G-2 summarizes the animal and plant species evaluated and the probability of species occurrence with the reservoir project areas.

Table G-2

Probability of Occurrence and Listing Status of Animal and Plant Species Evaluated

Species	Status[1]			Occurrence Probability within Reservoir Sites[2]				
Scientific Name (Common Name)	Federal	State	Other	Sites	Funks	Colusa	Thomes-Newville	Red Bank
Invertebrates								
Desmocerus californicus dimorphus (valley elderberry longhorn beetle)	FT	None	None	X	X	X	X	X
Lepidurus packardi (vernal pool tadpole shrimp)	FE	None	None	*	*	*	*	-
Branchinecta lynchi (vernal pool fairy shrimp)	FT	None	None	*	*	*	*	-
Branchinecta conservatio (Conservancy fairy shrimp)	FE	None	None	*	*	*	*	-
Anthicus antiochensis (Antioch Dunes anthicid beetle)	FSC	None	None	-	-	-	-	-

Table G-2
(Continued)

Species	Status[1]			Occurrence Probability within Reservoir Sites[2]				
Scientific Name (Common Name)	Federal	State	Other	Sites	Funks	Colusa	Thomes-Newville	Red Bank
Anthicus sacramento (Sacramento anthicid beetle)	FSC	None	None	-	-	-	-	-
Dubiraphia brunnescens- (brownish dubiraphian riffle beetle)	FSC	None	None	-	-	-	-	-
Ochthebius reticulatus (Wilbur Springs minute moss beetle)	FSC	None	None	-	-	-	-	-
Paracoenia calida (Wilbur Springs shore fly)	FSC	None	None	-	-	-	-	-
Hydroporus leechi (Leech's skyline diving beetle)	FSC	None	None	-	-	-	-	-
Amphibian								
Ambystoma californiense (California tiger salamander)	FC	DFG	None	-	-	-	-	-
Rana aurora ssp. draytonii (California red-legged frog)	FT	CSC, DFG	None	-	-	-	-	X
Rana boylii (Foothill yellow-legged frog)	FSC	CSC, DFG	None	-	-	-	*	X
Scaphiopus hammondii (western spadefoot toad)	None	DFG	None	*	-	*	X	*
Fish								
Lampetra tridentata (Pacific lamprey)	FSC	None	None	*	*	*	X	X
Mylopharodon conocephalus (Hardhead)	FS	CSC	None	X	X	X	X	X
Oncorhynchus mykiss (Steelhead)	FT	None	None	-	-	-	X	X
Oncorhynchus tshawytscha- (Late fall-run Chinook salmon)	FPT	CSC	None	-	-	-	-	-
Oncorhynchus tshawytscha (Spring-run Chinook salmon)	FPE, FS	ST	None	X	-	-	X	X
Pogonichthys macrolepidotus (Splitail)	FE	SE	None	-	*	-	-	-
Reptile								
Clemmys marmorata ssp. marmorata (Northwestern pond turtle)	FSC	CSC, DFG	None	X	X	X	X	X
Phrynosoma coronatum ssp. frontale (California horned lizard)	FSC	CSC, DFG	None	*	-	*	*	-
Thamnophis gigas (Giant garter snake)	FT	ST, DFG	None	-	*	-	-	-
Birds								
Accipiter cooperii (Cooper's hawk)	None	CSC	None	X	X	X	X	X
Accipiter gentilis (Northern goshawk)	None	CSC	SC	-	-	-	-	-
Accipiter striatus (Sharp-shinned hawk)	None	CSC	None	X	X	X	*	X

Table G-2
(Continued)

Species	Status[1]			Occurrence Probability within Reservoir Sites[2]				
Scientific Name (Common Name)	Federal	State	Other	Sites	Funks	Colusa	Thomes-Newville	Red Bank
Agelaius tricolor (Tri-colored blackbird)	None	CSC	SC	X	*	X	X	-
Ammodramus savannarum (Grasshopper sparrow)	None	CSC	CS	*	X	X	*	*
Amphispiza belli ssp. belli (Bell's sage sparrow)	None	CSC	SC	-	-	-	*	-
Aquila chrysaetos (Golden eagle)	PR	CSC, CFP	None	X	X	X	X	X
Asio flammeus (Short-eared owl)	None	CSC	None	*	*	X	*	*
Asio otus (Long -eared owl)	None	CSC	None	X	*	X	X	X
Athene cunicularia (Burrowing owl)	FSC	CSC	None	X	X	X	X	*
Botaurus lentiginosus (American bittern)	MNBMC	None	None	*	X	*	*	*
Branta canadensis ssp. leucopareia (Aleutian Canada goose)	FT	None	None	-	*	-	-	-
Bucephala islandica (Barrow's goldeneye)	None	CSC	None	-	*	-	-	*
Buteo regalis (Ferruginous hawk)	None	CSC	SC	X	X	*	*	-
Buteo swainsoni (Swainson's hawk)	None	ST	None	*	*	*	*	-
Carduelis lawrencei (Lawrence's goldfinch)	MNBMC	None	None	*	X	X	*	X
Chaetura vauxi (Vaux's swift)	MNBMC	CSC	None	*	*	*	*	*
Charadrius semipalmatus (Western snowy plover)	FT	CSC	None	-	-	-	-	-
Charadrius montanus (Mountain plover)	PLT	CSC	None	*	-	*	*	-
Chondestes grammacus (Lark sparrow)	MNBMC	None	None	X	X	X	X	X
Circus cyaneus (Northern harrier)	None	CSC	None	X	X	X	X	X
Coccyzus americanus ssp. occidentalis (Western yellow-billed cuckoo)	None	SE	None	-	-	-	-	-
Dendroica occidentalis (Hermit warbler)	MNBMC	None	None	*	*	*	*	*
Dendroica petechia (Yellow-warbler)	None	CSC	None	X	-	-	-	-
Elanus caeruleus (White-tailed kite)	None	None	None	X	X	*	*	*
Empidonax traillii (Willow flycatcher)	None	SE	None	-	-	-	-	-

Table G-2
(Continued)

Species	Status[1]			Occurrence Probability within Reservoir Sites[2]				
Scientific Name (Common Name)	Federal	State	Other	Sites	Funks	Colusa	Thomes-Newville	Red Bank
Eremophila alpestris ssp. actia (California horned lark)	None	None	SC	X	X	X	X	X
Falco columbarius (Merlin)	None	CSC	None	X	*	*	X	X
Falco mexicanus (Prarie falcon)	None	CSC	None	X	X	X	X	X
Falco peregrinus (Peregrine falcon)	FE	SE	None	*	*	*	*	*
Gavia immer (Common loon)	MNBMC	CSC	None	-	X	-	-	*
Mammals								
Antrozous pallidus (Pallid bat)	FS	CSC	None	X	NE	*	X	*
Bassariscus astutus (Ringtail)	None	CFP	None	X	NE	*	X	X
Corynorhinus townsendii ssp. pallescens (Pale big-eared bat)	FSC, FS	CSC	None	*	NE	*	*	*
Corynorhinus townsendii ssp. townsendii (Pacific western big-eared bat)	FS, FSC	CSC	None	*	NE	*	*	*
Euderma maculatum (Spotted bat)	FSC	CSC	None	-	NE	-	-	-
Eumops perotis californicus (Western mastiff bat)	FSC	CSC	None	-	NE	-	*	*
Lasiurus blossivillii (Western red bat)	FS	None	None	X	NE	*	*	X
Martes americana (Pine marten)	FS	None	None	*	NE	*	*	*
Martes pennanti ssp. pacificus (Pacific fisher)	FSC, FS	CSC	None	*	NE	*	*	*
Myotis ciliolabrum (Small-footed myotis)	FSC	None	None	*	NE	*	*	*
Myotis evotis (Long-eared myotis)	FSC	None	None	*	NE	*	*	*
Myotis thysanodes (Fringed myotis)	FSC	None	None	-	NE	-	*	*
Myotis volans (Long-legged myotis)	FSC	None	None	-	NE	-	*	*
Myotis yumanensis (Yuma myotis)	FSC	CSC	None	*	NE	*	*	X
Perognathus inornatus ssp. inornatus (San Joaquin pocket mouse)	FSC	CSC	None	*	NE	*	*	-
Taxidea taxus (American badger)	None	CSC	None	X	NE	X	*	*

Table G-2
(Continued)

Species	Status[1]			Occurrence Probability within Reservoir Sites[2]				
Scientific Name (Common Name)	Federal	State	Other	Sites	Funks	Colusa	Thomes-Newville	Red Bank
Plants								
Antirrhinum subcordatum (Dimorphic snapdragon)	None	None	1B	*	NE	*	X	X
Asclepias solanoana (Serpentine milkweed)	None	None	1B	-	NE	-	-	-
Astragalus rattanii var. jepsonianus (Jepson's milk-vetch)	None	None	1B	-	NE	-	X	X
Astragalus tener var. ferrisiae (Ferris's milk-vetch)	FSC	None	1B	*	NE	*	*	*
Atriplex cordulata (Heartscale)	FSC	None	1B	*	NE	*	*	*
Atriplex depressa (Brittlescale)	FSC	None	1B	*	NE	*	*	*
Atriplex joaquiniana (San Joaquin spearscale)	FSC	None	1B	*	NE	*	*	*
Atriplex persistens (Vernal pool saltbush)	None	None	1B	*	NE	*	*	-
Balsamorhiza macrolepis var. macrolepis (Big-scale balsamroot)	None	None	1B	*	NE	*	*	*
Brodiaea coronaria ssp. rosea (Indian Valley broadiaea)	FSC	SE	1B	*	NE	*	*	*
Chamaesyce hooveri (Hoovers spurge)	FT	None	1B	*	NE	*	*	-
Cordylanthus palmatus (Palmate-bracted bird's-beak)	FE	SE	1B	*	NE	*	*	-
Cryptantha crinita (Silky cryptantha)	None	None	1B	*	NE	*	*	*
Delphinium recurvatum (Recurved larkspur)	None	None	1B	*	NE	*	*	*
Eleocharis quadrangulata (Four-angled spikerush)	None	None	2	*	NE	*	*	-
Eriastrum brandegeae (Brandegee's eriastrum)	FSC	None	1B	-	NE	-	*	X
Eschscholzia rhombipetala (Diamond-petaled California poppy)	FSC	None	1A	*	NE	*	*	*
Fritillaria pluriflora (Adobe lilly)	FSC	None	1B	*	NE	*	X	X
Gratiola heterosepala (Bogg's Lake hedge-hyssop)	None	SE	1B	*	NE	*	*	*
Hesperevax acaulis var. acaulis (Dwarf evax)	None	None	1B	*	NE	*	*	*
Hesperolinon drymarioides (Drymaria-like western flax)	FSC	None	1B	-	NE	-	*	*
Hesperolinon tehamense (Tehama Co. western flax)	FSC	None	1B	-	NE	-	X	*

Table G-2
(Continued)

Species	Status[1]			Occurrence Probability within Reservoir Sites[2]				
Scientific Name (Common Name)	Federal	State	Other	Sites	Funks	Colusa	Thomes-Newville	Red Bank
Juncus leiospermus var. leiospermus (Red Bluff dwarf rush)	None	None	1B	*	NE	*	*	*
Layia septentrionalis (Colusa layia)	None	None	1B	*	NE	*	*	*
Legenere limosa (Legenere)	None	None	1B	*	NE	*	*	-
Lepidium latipes var. heckardii (Heckard's pepper-grass)	None	None	1B	*	NE	*	*	*
Lotus rubriflorus (Red-flowered lotus)	FSC	None	1B	*	NE	*	*	*
Lupinus milo-bakeri (Milo Baker's lupine)	FSC	ST	1B	*	NE	*	*	*
Lupinus sericatus (Cobb Mountain lupine)	None	None	1B	-	NE	-	*	*
Madia hallii (Hall's madia)	FSC	None	1B	-	NE	-	*	*
Madia stebbinsii (Stebbin's madia)	None	None	1B	-	NE	-	*	*
Microseris sylvatica (Woodland mocroseris)	None	None	3	*	NE	*	*	*
Myosurus minimus var. apus (Little mouse tail)	FSC	None	3	*	NE	*	*	-
Myosurus sessilis (Sessile mousetail)	None	None	3	*	NE	*	*	*
Neostaphia colusana (Colusa grass)	FT	SE	1B	*	NE	*	*	-
Orcuttia pilosa (Hairy Orcutt grass)	FT	SE	1B	*	NE	*	*	-
Orcuttia tenuis (Slender Orcutt grass)	PT	SE	1B	*	NE	*	*	-
Paronychia ahartii (Ahart's paronychia)	FSC	None	1B	*	NE	*	*	*
Sagittaria sanfordii (Sandford's arrowhead)	FSC	None	1B	*	NE	*	*	*
Silene campanulata var. campanulata (Red mountain catchfly)	FC	SE	1B	*	NE	*	*	*
Streptanthus morrisonii (Morrison's jewel flower)	FSC	None	1B	-	NE	-	*	-
Trichocoronis wrightii var. wrightii (Wright's trichocoronis)	None	None	2	*	NE	*	*	-
Tropidocarpum capparideum (Caper-fruited tropidocarpum)	FSC	None	1B	*	NE	*	*	*

Table G-2
(Continued)

Species	Status[1]			Occurrence Probability within Reservoir Sites[2]				
Scientific Name (Common Name)	Federal	State	Other	Sites	Funks	Colusa	Thomes-Newville	Red Bank
Tuctoria greenei (Green's tuctoria)	FE	CR	1B	*	NE	*	*	-
Viburnum ellipticum (Western viburnum)	None	None	3	-	NE	-	*	*

[1] **Status Key:**

1A	=	Presumed to be extinct in California (California Native Plant Society)
1B	=	Rare, Threatened or Endangered in California and elsewhere (California Native Plant Society)
2	=	Rare,Threatened or endangered in California but more common elsewhere
3	=	More information is needed
CFP	=	Fully protected under California Fish and Game
CR	=	State Listed as rare (Section1904, DFG code 1994)
CSC	=	California Species of Special Concern
DFG	=	California Department of Fish and Game Protected
FC	=	Federal Candidate Species
FE	=	Federally Endangered
FPE	=	Federally Proposed for listing as endangered
FPT	=	Federally Proposed as threatened
FS	=	Forest Service Sensitive Species
FSC	=	Federal Special Concern Species
FT	=	Federally Threatened
MNBMC	=	Migratory non-game bird of management concern (USFWS)
PL	=	Proposed for listing as threatened under ESA
PR	=	Protected under the Bald Eagle Act
PT	=	Federally Proposed, threatened
SB	=	Specified birds under California Fish and Game Code
SC	=	Other species of concern identified by CALFED
SE	=	State endangered
ST	=	State threatened

[2] Includes species that have been observed in survey efforts and the probability of species that may be present in the area, based on preliminary habitat evaluations, but have not been observed to date.

Occurrence Probability Key:

X	=	Observed in the reservoir footprint or within 1 mile of it
*	=	Not observed to date but potential habitat exists in the reservoir footprint or within 1 mile of it
-	=	Not observed and not likely to occur in the reservoir footprint or within 1 mile of it
NE	=	Not evaluated in inundation area studies, see site 1-mile perimeter column for potential occurrence at Funks Reservior.

G.3 SOCIOECONOMIC RESOURCES

The following subsections discuss socio-economic resources encountered in the study area.

G.3.1 Land Use

The watersheds draining the east slope of the Coast Range are subject to a variety of land use practices. Upper elevations are primarily commercial forest lands and managed for timber production, outdoor recreation, and grazing. Foothill areas are currently managed primarily for livestock grazing. Some foothill valleys support dryland grain or orchard production. Extensive mineral extraction activities have historically occurred throughout foothill and mountain areas. Sacramento Valley portions of the watersheds support a wide variety of agricultural uses including livestock grazing, irrigated grain and truck-crops, and orchards.

Land use within the proposed Sites Reservoir area is dedicated primarily to livestock production. Both year-round and winter/spring cattle grazing is the dominant land use, while a small amount of both horse and sheep grazing also occurs. Other agricultural land uses include minor amounts (200 to 300 acres) of dryland grain production. Some residential land use also occurs within the small community of Sites (population 20) and on 10 to 14 scattered ranch sites. A small commercial rock quarry is present near the proposed Sites Dam site. Limited commercial firewood harvesting has occurred within and adjacent to the inundation area.

Land use within the proposed Colusa Cell area is almost exclusively dedicated to livestock production. Both year-round and winter/spring cattle grazing is the dominant land use. No other agricultural land use practices have been identified. Only one occupied ranch homesite has been identified within the inundation area and no other residential or commercial developments are present.

Seasonal and year-round livestock grazing dominates land use within the Newville Reservoir area. However, limited horse and sheep grazing also occurs. At least 20 occupied ranch sites are found within the reservoir area. Limited firewood harvest has occurred in some areas.

Land use within the Red Bank Project area is similar to that at the other three proposed reservoirs. Both year-round and winter/spring cattle grazing is the dominant land use. Other agricultural land uses include a small walnut orchard and a few acres of irrigated pasture. Several landowners operate hunting clubs and at least one landowner operates a fee-for-fishing business.

G.3.2 Water Supply

Hydrology of Optional Water Supplies

Project formulation for the alternative offstream projects includes identification of water supply sources that will be diverted to storage. A list of optional water supply sources and conveyance has been developed and evaluation has been initiated to determine preferred sources for each project. The Red Bank Project has only one water supply source under consideration. The project formulation decisions have not yet been made and will require environmental, engineering, and economic evaluation of the water supply source options. The following discussion reflects the evaluation of the water supply sources to date.

Flows of various nearby streams were evaluated to determine the quantity of water that could be diverted to storage in the four alternative offstream reservoirs. In general, three steps were required in determining the hydrologic and water supply characteristics of the optional water supply sources. First, historical flows of the streams were reviewed to provide a preliminary assessment of the relative scale of available water in a given stream.

Second, the historical flows were subjected to local and downstream operational constraints to determine the divertible flow. Local operational constraints include instream flow requirements of the source stream, limitations related to the operations and water rights of existing local water supply projects, and existing or proposed diversion and conveyance facility capacities. Downstream operational constraints include lower Sacramento River flow requirements and requirements in the Sacramento–San Joaquin Delta.

Third, divertible flows of optional sources are combined to determine the water supply yield associated with alternative water supply projects by using a reservoir simulation model (CALSIM). In this step, water supplies are subject to the offstream reservoir capacity and the system-wide operational constraints of the Central Valley Project and State Water Project. System-wide operational constraints include pumping limitations in the Delta, availability of other systemwide water supplies, and customer demands.

Optional Water Supply Sources

Table G-3 shows the optional water supply sources considered for the alternative north of the Delta offstream storage projects. Sites, Colusa, and Thomes-Newville Projects each have a number of optional water supply sources. These sources may be packaged in various combinations to generate sufficient water supply for a specific project. The Red Bank Project is unique because there is only one major water supply source being considered for diversion and storage. The six optional sources are the same for Sites and Colusa. Thomes-Newville has three optional water supply sources. Local inflow sources are not shown, but each offstream project would receive some local inflow from the relatively smaller streams that flow directly to the offstream reservoirs.

Streamflow records were reviewed to determine the relative quantity of water that has historically flowed in various streams. Table G-4 shows November through March streamflow volumes at representative locations for the period 1945-1994. The November through March period was chosen to avoid any operational conflicts with existing facilities and water rights. Local irrigation operations often begin in April and conveyance facilities are being used for deliveries. Most of the data shown are directly from gage station streamflow records. A number of the data records needed to be extended or adapted using basic hydrologic correlations. Correlations for the entire period of record were required for Grindstone Creek, inflow to East Park Reservoir, and South Fork Cottonwood Creek.

Table G-3

Optional Water Supply Sources for North-of-the-Delta Offstream Projects

Sites/Colusa	Thomes-Newville	Red Bank
❖ Colusa Basin Drain ❖ Grindstone Creek ❖ Little Stony Creek ❖ Sacramento River ❖ Stony Creek ❖ Thomes Creek	❖ Sacramento River ❖ Stony Creek ❖ Thomes Creek	❖ South Fork Cottonwood Creek

Table G-4

November – March Streamflow Volumes, 1945-1994 of Optional Water Supply Source Streams

Source and Location	Minimum (MAF)	Maximum (MAF)	Average (MAF)
Sacramento River At Butte City	1.613	14.415	5.4607
Stony Creek Below Black Butte Dam	0.001	1.052	0.2345
Colusa Basin Drain At Highway 20	0.039	0.759	0.2089
Inflow To Stony Gorge Res.	0.004	0.509	0.1513
Thomes Creek At Paskenta	0.007	0.359	0.1509
Inflow To Proposed Grindstone Res.	0.009	0.301	0.0854
Inflow To East Park Res. W/ Rainbow Diversion	0.001	0.222	0.0762
South Fork Cottonwood Creek At Dippingvat	0.005	0.259	0.0754

MAF = million acre feet

The Sacramento River is by far the largest water supply source of the options considered. With an average historical five-month flow volume at Butte City of almost 5.5 MAF, the river's flow is over 23 times the size of the second largest option, Stony Creek. The three smallest optional water supply sources are Grindstone Creek, East Park Reservoir, and South Fork Cottonwood Creek, each with an average November through March runoff of less than 0.1 MAF. The sources are not independent options. All of the tributary streams contribute to the flow of the Sacramento River. Outflow from East Park Reservoir becomes inflow to Stony Gorge and then ultimately contributes to the flow below Black Butte.

Streamflow volumes are dependent upon diversion location. In general, volumes increase in the downstream direction. Optional diversion locations for the Sacramento River are at the existing Tehama-Colusa Canal diversion in Red Bluff, the existing Glenn-Colusa Irrigation District Canal diversion in Hamilton City, a new diversion at Chico Landing, and a new diversion opposite Moulton Weir. Diversion locations investigated for Stony Creek include Black Butte Lake, Stony Gorge Reservoir, and East Park Reservoir with additional water from the Rainbow Diversion, and at the GCID Canal crossing. The diversion location investigated for Colusa Basin Drain is due west of Moulton Weir, almost 10 miles north of Highway 20. Thomes Creek diversion locations include a number of options west of Paskenta and at the Tehama-Colusa Canal crossing. The Grindstone Creek diversion location is from a potential Grindstone Reservoir. The Grindstone Dam site is approximately 2-1/2 miles upstream from the confluence with Stony Creek. The diversion location for South Fork Cottonwood Creek is at the proposed Dippingvat Reservoir.

Divertible Flow of Water Supply Sources

Divertible flow is computed by imposing local and downstream restrictions on the streamflow volume, including applicable instream flow requirements of tributary streams and the Sacramento River. Divertible flow is also limited by diversion and conveyance capacity of new or existing facilities. A representative divertible flow is shown in Table G-5 for each of the water supply sources for comparison. The divertible flow value is used as input for the CALSIM operations model.

Table G-5

November-March Average Divertible Flow

Stream and Location	Conveyance Capacity (cfs)	Divertible Flow (MAF)
Sacramento River At Butte City	5,000	0.5873
Stony Creek Below Black Butte Dam	1,700	0.2345
Colusa Basin Drain	3,000	0.1365
Stony Gorge Reservoir	1,500	0.0702
Thomes Creek	2,100	0.1089
Grindstone Reservoir	750	0.0679
East Park Reservoir W/ 300 Cfs Rainbow Diversion	1,200	0.0301
South Fork Cottonwood Creek At Dippingvat	800	0.0529

cfs = cubic feet per second
MAF = million acre feet

Stony Creek Hydrology and Water Supply

Subsequent to the initial evaluations of optional water supply sources, members of the Technical Advisory Group requested that DWR refine its treatment of options from the upper watershed of Stony Creek. Based on input from TAG members and local project operators, some adjustments were made to the assumptions related to these optional sources. These adjustments did generate corresponding changes in available streamflow volume and the water supply characteristics of these sources. Following is a more comprehensive description of the Stony Creek options.

Stony Creek is a potential source of water supply for an offstream storage reservoir along the western edge of the Sacramento Valley. More specifically, water from Stony Creek could be conveyed to Sites, Colusa, or Thomes-Newville project alternatives for storage. Stony Creek diversion and conveyance options that take advantage of existing reservoirs or conveyance facilities were evaluated for this study.

The major surface water projects in the Stony Creek basin include the Orland Project and Black Butte Dam and Lake. The Orland Project is one of the oldest reclamation projects in the country and includes two main dams and reservoirs, East Park and Stony Gorge. The project is locally operated by the Orland Unit Water Users' Association and provides irrigation water for up to 20,000 acres near Orland, as well as residential, commercial and industrial water supply to about 2,500 residents. East Park Dam and Reservoir are located on Little Stony Creek, about 33 miles southwest of Orland. The capacity of East Park Reservoir is about 51,000 AF. In addition to the inflow from Little Stony Creek, East Park receives water from Rainbow Diversion Dam on the mainstem. The Rainbow Feeder Canal is about 7 miles long with a design capacity of 300 cfs. Stony Gorge Dam and Reservoir are located about 18 miles downstream of East Park at the confluence of Little Stony and Stony Creeks. The capacity of Stony Gorge Reservoir is about 50,000 AF.

The U.S. Army Corps of Engineers developed Black Butte Dam and Lake, approximately 22 miles downstream of Stony Gorge and 9 miles west of Orland, primarily for flood control in the early 1960s. Black Butte is operated in coordination with a number of other agencies including the OUWUA and Reclamation for water supply. In addition, the City of Santa Clara generates hydroelectric power. The lake's capacity is about 143,000 AF.

Stony Creek Water Supply Source Options

A number of options have been considered for diverting Stony Creek winter flows to offstream storage including:

- Diversion from Black Butte Reservoir to Newville Reservoir;
- Diversion from lower Stony Creek into existing Tehama-Colusa and GCID canals for conveyance to Sites or Colusa Reservoirs;
- Diversion from East Park Reservoir to Sites or Colusa Reservoirs;
- Diversion from Stony Gorge Reservoir to Sites or Colusa Reservoirs; and
- Diversion from proposed Grindstone Reservoir to Stony Gorge Reservoir and rediversion to Sites or Colusa Reservoirs.

The Grindstone Reservoir water supply source option was evaluated at a cursory level. Ranges of reservoir and diversion capacities were considered. The cursory analysis of Grindstone Reservoir indicated a number of undesirable characteristics related to this option, including susceptibility to large landslides, relatively large embankment quantities for the dam and saddles, relatively high sediment load in the creek, and close proximity to a fault. While these characteristics would not make the Grindstone Reservoir option technically infeasible, a number of other options appear to be more feasible at this stage of evaluation. Therefore, Grindstone Reservoir as an optional source has been set aside.

The following analysis has focused on the reservoir diversions to Sites or Colusa Reservoirs. Simplified operation simulations using the historic hydrology and current reservoir operations have been used to estimate potential water supply diversions from East Park and Stony Gorge Reservoirs. Potential water supply diversions are simply the amount of water that can be diverted from a source with given conveyance capacities, instream flow, and other operational requirements. Unimpaired inflow to Stony Gorge Reservoir was determined based on historic outflow and changes in storage in East Park and Stony Gorge. Inflow to East Park and Rainbow were estimated as a percentage of the unimpaired Stony Gorge inflow. The area of the watersheds above Stony Gorge, East Park, and Rainbow diversions was determined. Area/precipitation factors of 45 and 31 percent were used for Rainbow and East Park respectively. This means that 45 percent of the unimpaired inflow to Stony Gorge flows past the Rainbow location and 31 percent flows into East Park.

A review of available data and discussions with local project operators provided helpful information. For example, a review of monthly reservoir storage indicates that a significant shift in Orland Project reservoir operations occurred subsequent to construction of Black Butte Reservoir in 1963. After Black Butte Reservoir was built, water in storage at the end of the irrigation season in the Orland Project reservoirs increased to an average of about 16,000 AF. Local project operators helped refine current project operating criteria, including estimates of instream water releases below the dams.

Criteria were established to determine the potential water supply diversions from Orland Project reservoirs including:

- Instream flow requirements for the creeks below East Park, Stony Gorge, and Black Butte were set at 10, 20, and 30 cfs, respectively. These are based on operator's estimates of current operating practices;
- Diversion was limited to the November through April period to avoid potential impacts to existing projects. This diversion period is one month longer than for other options, but will not conflict with the rights of existing water users;
- Diversion was limited such that end of the month reservoir storage during the diversion period was equal to or greater than historic levels in all three reservoirs; and
- A minimum diversion storage level of 20,000 AF in East Park and Stony Gorge was established to provide adequate tunnel submersion.

A range of conveyance capacities to the offstream storage alternatives was evaluated to determine optimal sizing of diversion and conveyance facilities. For Stony Gorge, conveyance of 500, 1,000, 1,500, and 2,000 cfs were considered; for East Park, conveyance of 800, 1,000, and 1,200 cfs; the Rainbow Feeder Canal to East Park was sized at 300, 500, 750, and 1,000 cfs.

Potential water supply diversions were analyzed for the above range of facilities for the 1964 through 1994 period. This period was chosen based on the previously mentioned effect of Black Butte operations and the data requirements of CALSIM. The potential water supply diversion data was then extended to the standard CALSIM period, 1922 through 1994, by correlation with the Sacramento River Index. Annual potential water supply diversions from Stony Creek sources are shown in Table G-6 for the 1922-1994 period.

Water Supply Contribution

Water supply contribution (Table G-7 is the amount of water actually diverted in an operation simulation to an offstream reservoir from a specific source and is an output from CALSIM. Water supply contribution to an offstream reservoir is dependent on potential water supply diversions and a number of other hydrologic and operational variables that are input to the CALSIM model. These variables include capacity of the offstream reservoir, water supply diversions from other sources, instream flow requirements, Delta conditions, demands, and Delta diversion facilities.

Table G-6

Stony Creek Reservoir Options Average Potential Water Supply Diversions (MAF)

Diversion And Conveyance (Cfs)	Existing or Rainbow (300)	Rainbow (500)	Rainbow (750)	Rainbow (1,000)
Stony Gorge (500)	0.060			
Stony Gorge (1,000)	0.090			
Stony Gorge (1,500)	0.107			
Stony Gorge (2,000)	0.117			
East Park (800)	0.060	0.066	0.068	0.069
East Park (1,000)	0.062	0.070	0.074	0.076
East Park (1,200)	0.063	0.071	0.077	0.080

cfs = cubic feet per second
MAF = million acre feet

Table G-7

Water Supply Contribution (MAF) from Sources to 1.8 MAF Sites Reservoir (Typical Operational Studies)

Conveyance Package	Stony Creek	Sacramento River	Colusa Basin Drain	Total
2,000 CFS Tunnel from Stony Gorge	0.117			0.117
2,100 CFS T-C Canal		0.143		0.302
1,800 CFS GCID Canal		0.159		
2,100 CFS T-C Canal		0.127		
1,800 CFS GCID Canal	0.058	0.141		0.325
2,000 CFS Tunnel from SG				
2,100 CFS T-C Canal		0.085		
1,800 CFS GCID Canal		0.168	0.063	0.317
3,000 CFS canal from CBD				

cfs = cubic feet per second
MAF = million acre feet

Yield is difficult to assign to a specific source for a project with multiple sources of water. The portion of total water supply contribution from a specific source is an indicator of the yield from a specific source (using specific sources and conveyances for a project). Yield of a given offstream reservoir project can be determined by computing the difference between deliveries with and without the project and is discussed in the section describing CALSIM results.

Factors Related to the Upper Stony Creek Options

Factors other than potential water supply diversions, water supply contribution, and yield may be considered in evaluating the upper Stony Creek reservoir diversion options. Using Stony Creek as a water supply source may offer a number of unique advantages compared to other sources. Since the East Park and Stony Gorge diversions are from existing reservoirs, fishery impacts and their associated mitigation costs may be significantly less. While Stony Creek would not provide enough water for an offstream reservoir by itself, maximizing diversion from Stony Creek sources would provide opportunities to limit diversions from the Sacramento River. Since potential Stony Creek diversions are at greater elevation than Colusa or Sites Reservoirs, no pumping is required and additional hydroelectric power may be generated. All of the other source options must be pumped up 120 to 320 feet from Funks Reservoir.

Finally, conveyance from these reservoirs to Sites or Colusa would be independent of existing conveyance systems. All of the other source options are dependent upon the Tehama-Colusa Canal, at a minimum, to get water into Sites or Colusa. The independence described above means that water could continue to be conveyed to offstream storage after deliveries begin in the Tehama-Colusa and GCID service areas.

Project Operation Studies

Two important characteristics of a surface water project are the size of its increased water supply and the cost of the project. The new or additional yield that a proposed project could generate is predicted by conducting operation studies. This is an accounting process over a historic period using recorded or estimated streamflows. This accounting includes all water hypothetically supplied to, stored in, lost to seepage and evaporation, and released from the reservoir. Operation studies are performed using a computer-based hydrologic simulation model. CALSIM allows an operation simulation of a project under investigation simultaneously with other major reservoir systems such as the Central Valley Project and the State Water Project over a historic period. The current operation simulation uses the 1922 through 1994 hydrologic sequence.

For a project operation study, water is released on a schedule representing project water demands at some point in the future (in this investigation the year 2020). The difference between the total system water supply with and without the project under investigation is considered to be the water supply attributable to the proposed project. The model is run using average monthly flows; whereas the availability of water supplies from various streams is developed using average daily flow data. Although the model is running on monthly steps, the result is refined enough to determine water supply yield estimates that are acceptable for making comparisons between competing alternatives.

For this phase of the offstream storage investigation, 42 CALSIM operation studies were run. These studies include 3 base studies, 31 for the Sites Project, 4 for the Colusa Project, and 4 for the Thomes-Newville Project. These studies include various optional sources of water and conveyance facilities for filling the reservoirs to allow identification of a preferred source and conveyance alternative for each project. The 1993 operation studies for the Red Bank Project were considered adequate for this phase of evaluation.

For the Sites and Colusa Projects, seven possible diversion locations were considered as sources of water to fill the reservoir: the Sacramento River at Red Bluff Diversion Dam; the Sacramento River at the

GCID pumps; the Sacramento River at Chico Landing; the Sacramento River at mile 158.5 (opposite Moulton Weir); the Colusa Basin Drain; Stony Gorge Reservoir; East Park Reservoir; Thomes Creek at the Tehama-Colusa Canal crossing; and lower Stony Creek at the Glenn-Colusa Canal crossing.

For the Thomes-Newville Project, five possible diversion locations were considered: Thomes Creek about 5 miles upstream from Paskenta; Stony Creek at Black Butte Lake; the Sacramento River at the Red Bluff Diversion Dam; the Sacramento River at the GCID pumps; and Thomes Creek at the Tehama-Colusa Canal crossing.

The general formulation of the CALSIM operation studies:

- Runs on a monthly basis for years 1922 through 1994;
- Uses estimated 2020 level of development;
- Uses a surrogate demand for project water supply. A surrogate demand is representative of currently unassigned project beneficiaries of the offstream project yield. After project beneficiaries have been identified, an actual projected demand schedule will replace the surrogate in subsequent operation study runs;
- Models flows of both the Sacramento and San Joaquin River systems, with coordinated operation of CVP and SWP reservoirs; and
- Generates data to estimate water supply, power use and power generation, fishery maintenance flows, recreation use, and Delta flow requirements.

The computation of project yield is one of the most useful outputs from an operation study. Yields are computed by comparing total system-wide deliveries for a proposed project to the deliveries under a base study. Table G-8 summarizes the yields or increase in system deliveries for specific project formulations completed to date. Average and drought yields have been determined for each study. An average yield is the average annual increase in system deliveries from 1922 through 1994. Similarly, drought yield is the average annual increase in system deliveries during the 1928 through 1934 drought period.

Table G-8

Increase In System Deliveries With Offstream Storage Project (MAF)

Study #	T-C Canal	GCID Canal	New Canal	Chico Landing	Colusa Drain	East Park	Stony Gorge	Thomes Creek	Stony Creek	Assumptions	Avg Drought Yield (28-34)	Avg Yield (22-94)
Base Studies:												
2												
6										Banks P.P.=10,300 cfs	0.079	0.184
7										Proposed Trinity flows	-0.134	-0.040
1.8 MAF Sites Project:												
3	2.100	1.800									0.290	0.268
3b	2.100										0.159	0.242
4	2.100	1.800			3.000						0.310	0.277
5	2.100	1.800					1.000				0.290	0.268
8	2.100	1.800					2.000				0.296	0.282
8a							2.000				0.036	0.098
9	2.100	1.800				0.800					0.292	0.275

Table G-8
(Continued)

Study #	T-C Canal	GCID Canal	New Canal	Chico Landing	Colusa Drain	East Park	Stony Gorge	Thomes Creek	Stony Creek	Assumptions	Avg Drought Yield (28-34)	Avg Yield (22-94)
9a	2.100	1.800				1.000					0.293	0.277
10	2.100	1.800				1.200					0.295	0.278
11	2.100	1.800								Banks P.P.=10,300 cfs	0.282	0.349
12	2.100	1.800					1.000			Banks P.P.=10,300 cfs	0.299	0.354
13	2.100	1.800				0.800				Banks P.P.=10,300 cfs	0.295	0.351
14	2.100	1.800			3.000					Banks P.P.=10,300 cfs	0.315	0.370
15	2.500	2.500									0.294	0.282
16	2.500	2.500			3.000						0.336	0.284
17			5.000		3.000						0.365	0.284
24	2.100	2.900									0.294	0.279
25	2.100	2.900			3.000						0.336	0.286
38		5.000			3.000						0.331	0.286
39		2.900		2.100	3.000						0.349	0.285
40	2.100		2.900		3.000						0.342	0.284
41	3.200	1.800			3.000						0.339	0.287
42	5.000				3.000						0.338	0.288
43				5.000	3.000						0.360	0.284
44	2.100	1.800					1.500				0.293	0.269
Sacramento River Flow Requirement:												
18	2.100	1.800			3.000					Diversion Min=7,000 cfs	0.314	0.266
19	2.100	1.800								3000 Diversion Min=10,000 cfs	0.277	0.254
20	2.100	1.800			3.000					Diversion Min=13,000 cfs	0.227	0.251
21	2.100	1.800			3.000					Trigger=40,000 cfs	0.192	0.228
22	2.100	1.800			3.000					Trigger=60,000 cfs	0.160	0.200
23	2.100	1.800			3.000					Proposed Trinity	0.335	0.274
3.0 MAF Colusa Project:												
30	2.100	1.800			3.000					Diversion Min=10,000 cfs	0.277	0.313
31	2.100	1.800			3.000					Trigger=60,000 cfs	0.159	0.236
32	2.100	1.800			3.000					Proposed Trinity flows	0.398	0.328
33	2.100	1.800			3.000					Banks P.P. =10,300 cfs	0.412	0.428
1.9 MAF Thomes-Newville Project:												
34								5.000	3.000		0.146	0.213
35	2.200							5.000	3.000		0.319	0.275

Table G-8
(Continued)

Study #	T-C Canal	GCID Canal	New Canal	Chico Landing	Colusa Drain	East Park	Stony Gorge	Thomes Creek	Stony Creek	Assumptions	Avg Drought Yield (28-34)	Avg Yield (22-94)
3.0 MAF Thomes-Newville Project:												
36								5.000	3.000		0.146	0.248
37	2.200							5.000	3.000		0.377	0.315

avg = average
cfs = cubic feet per second
MAF = million acre feet

Three base studies were used in this set of modeling studies. In addition to the general formulation of the studies described above, Base Study 2 assumes the existing Banks Pumping Plant capacity restrictions per the Corps' 1981 Criteria, existing Trinity River instream flow requirements, and existing Sacramento River operating guidelines for flows. Base Studies 6 and 7 model the effect of increased Banks Pumping Plant capacity and proposed instream flow requirements for the Trinity River, respectively.

The proposed instream flow requirements for the Trinity River would reduce the average system yield by about 0.040 MAF. The remaining studies that model these proposed flow requirements are compared against this lesser system yield indicated in Study 7. Other sensitivity analyses performed in this study set are related to potential flow requirements for the Sacramento River. The sensitivity analyses conducted for Sacramento River Diversion include trigger flows of 40,000 and 60,000 cfs and minimum downstream flows of 7,000, 10,000, and 13,000 cfs. A trigger flow is a minimum required flow that must be met once in a water year before diversion can be made to an offstream project. Once the trigger is achieved, only current restrictions related to Sacramento River flow would limit diversion. A minimum downstream flow is a continuing requirement that must be met at all times for diversion to offstream storage to be allowed.

The average project yields for NODOS range from 0.098 to 0.428 MAF. The 0.098 MAF yield is associated with a 2,000 cfs conveyance from Stony Gorge Reservoir for the 1.8 MAF Sites Project. This study formulation is not an actual alternative, but indicates the maximum amount of yield associated with the Stony Gorge source since no other sources would fill up storage space in the reservoir. The 0.428 MAF yield is associated with the 3.0 MAF Colusa Project with increased capacity at Banks Pumping Plant.

In addition to project yield, the operation studies also enable an assessment of impacts to Sacramento River flow and storage in existing reservoirs. By comparing "with project" flows and "without project" flows in specific reaches of the river, an estimate of streamflow changes related to project operation can be made. A comparison of storage in Shasta Lake and Lake Oroville with and without an offstream project indicates the potential change in storage levels in these existing reservoirs associated with project operation.

In general, the timing of flows in the Sacramento River is shifted a few months later in a given year. The shift in flows is mainly related to the exchange, where water that would have been released from Shasta Lake and delivered locally in the Tehama-Colusa and GCID service areas would instead be served by an offstream project. Water that is held in Shasta would then be released for other uses according to a demand schedule that generally requires water later in the year.

This flow information will be evaluated more thoroughly in the next phase of the investigation. In addition to providing a general overview of flow impacts for the Sacramento River, the potential impacts of the flow changes in the river related to operation of an offstream reservoir project will be assessed.

The operation of an offstream project would also impact storage levels in existing reservoirs. Again, changes in the end-of-month storage in Shasta Lake are likely related to the exchange described above. Another factor that appears to affect both Shasta and Oroville is related to the additional storage that would be created by an offstream project and adjustments needed to operate that additional storage with the existing projects. More evaluation of end-of-month storage impacts is anticipated during the next phase of the investigation.

G.3.3 Cultural Resources

Surveys of cultural resources (see Appendix F) within the Sites project area recorded a total of 41 historic and prehistoric sites. Seventeen sites appear to be significant because they provisionally meet the criteria for eligibility to the National Register of Historic Places. Prehistoric settlement in the project area was constrained by the limited food and fuel resources and the scarcity of water. However, the area would have been important for seasonal hunting and gathering forays. The larger and more permanent villages were situated along the lower reaches of the bigger streams and on the knolls and natural levees along the Sacramento River.

Historic sites, features, and standing structures are significantly underrepresented in the site totals. These resources were not recorded because they are associated with working ranches, occupied buildings, and the town site of Sites. A future survey of historic resources may yield other historic sites in addition to the Historic District of the Town of Sites. Moving the cemetery associated with Sites and several smaller cemeteries would present special consideration.

Results of the record search indicated that there were no site records in the files of the State database for the Colusa Cell. A field survey found greater scarcity of subsistence resources than in the Sites Reservoir area and the ephemeral nature of the water supply were not suitable for extensive use or habitation during the prehistoric past.

Three sites were recorded within the Colusa Cell, two historic ranches and one site with a prehistoric and an historic component. The significance of the sites is undetermined. The assessment of eligibility to the National Register could not be made on the basis of surface indications. Additional studies would be necessary to complete the evaluation.

A comprehensive survey of prehistoric sites within Thomes-Newville project area was completed in 1983. A total of 117 sites was recorded within the footprint of the proposed reservoir, representing a more complete prehistoric settlement pattern that includes evidence of permanent or semi-permanent villages, seasonal campsites, and special resource procurement and use sites. The presence of perennial streams and availability of fuel and subsistence resources accounts for the more intensive use of the project area during prehistoric times. As with the Sites project, moving the historic cemeteries within the footprint of the Thomes-Newville project would be necessary.

Results of the record search for the Red Bank project indicated that the project area had not been surveyed for cultural resources and no site records were present in the State database. The surveys completed in 1994 for the Corps' Cottonwood Creek project were downstream of the project described here, with no overlap of the footprints.

A total of 31 sites were recorded within the Red Bank project. Twenty-eight sites are prehistoric and three are historic. The prehistoric sites in the Red Bank project area were generally small and the artifact distribution relatively sparse. The sites were probably associated with seasonal upland hunting, fishing, and gathering activities. The larger permanent settlements were situated further downstream on the banks of the perennial streams and along the Sacramento River.

G.3.4 Transportation

The proposed Sites Reservoir is approximately 11 miles west of U.S. Interstate 5. East-to-west access through the project area is via the Maxwell/Sites Road. This Colusa County road receives relatively heavy volumes of traffic, especially on weekends, because it provides access to East Park Reservoir and the southwest portion of the Mendocino National Forest as well as the communities of Stonyford and Lodoga. Other Colusa County roads include Peterson Road, which extends approximately 4 miles north from the community of Sites, and Huffmeister Road, which extends south and west from the community of Sites to the community of Leesville. The closest airport is approximately 17 miles away at the City of Willows.

The Colusa Cell is approximately 7 miles west of Interstate 5. Access to the reservoir area is via Glenn County roads 60 and 69. These gravel/paved roads receive relatively little traffic. No public access currently exists within the reservoir footprint. Ranch roads within the reservoir inundation area are very limited and access is severely restricted during winter and spring due to a high number of unimproved stream crossings. The closest airport is approximately 12 miles away at the City of Willows.

The Thomes-Newville Project area is accessed via Newville Road west from Orland or Corning Road west from Corning. The project area is approximately 18 miles west of Interstate 5. Round Valley Road connects to both Newville and Corning Roads in the northern end of the proposed reservoir. Round Valley Road continues west from the reservoir and provides access to the central portions of the Mendocino National Forest. The southern part of the proposed reservoir area can be accessed via Elk Creek Road and State Highway 162. The closest airport is approximately 18 miles away at the City of Orland.

The Red Bank Project is approximately 18 miles west-southwest from Interstate 5 at Red Bluff. Access to the project area is provided by a variety of Tehama County roads that travel west from Red Bluff including Red Bank Road, Reeds Creek Road, Pettyjohn Road, Johnson Road, and Balis-Bell Road. Red Bank Road provides public access through the Schoenfield Reservoir area. Balis-Bell Road follows Clover Creek and provides public access into Blue Door Reservoir. No public access currently exists into the Lanyan or Dippingvat Reservoir areas. However, several private ranch roads provide some access into both of these proposed reservoirs. The closest airport is approximately 18 miles away at the City of Red Bluff.

G.3.5 Recreation

Recreational activities within watersheds of the streams flowing through the project areas include hiking, hunting, fishing, camping, boating, mountain biking, and off-road vehicle use. Most of these activities occur primarily on public lands on the Mendocino National Forest and associated private timberlands. Little public access into the foothill private grazing lands occurs. However, public recreation areas are present within the foothill portion of the Stony Creek watershed at Black Butte Lake and Stony Gorge and East Park Reservoirs. Waterfowl and upland game bird hunting are the primary recreational use activities within the Sacramento Valley portions of these watersheds.

Recreation use and opportunity are currently very limited within the proposed project areas. Almost all lands are privately owned and posted against trespass, thus preventing general public access. Recreational activities that do occur are primarily by landowner families, their friends, and employees. This level of recreation use probably amounts to only a few hundred recreation-hours per year per reservoir site. Upland game birds (dove, quail, and pheasant), black-tailed deer and feral pigs are the most commonly hunted species within the proposed reservoir areas. Commercial hunting operations for feral pig, blacktailed deer, and wild turkey occur within the Red Bank Project area, and may operate on individual landholdings within the other reservoirs as well. Fishing is an infrequent activity because of the intermittent nature of the streams in Sites, Colusa Cell, and Newville Reservoir areas. Numerous stock ponds within the project areas are large enough to support bass, catfish, and sunfish. Angling pressure for these ponds appears to be generally low. At least one fee-for-fishing recreational operation is currently in business on a small lake within the Red Bank Project area.