Volume 2 – Appendices

DAVIS-WOODLAND WATER SUPPLY PROJECT

Draft Environmental Impact Report

State Clearinghouse No. 2006042175

Lead Agency:
City of Davis, Public Works Department
In Association with:
UC Davis and City of Woodland

April 2007

Volume 2 – Appendices

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April 2007

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TABLE OF CONTENTS

Davis-Woodland Water Supply Project
Draft Environmental Impact Report

		Page
	Acronyms, Glossary, and Conversion Factors	**x**
	Executive Summary	**ES-1**
	Introduction	ES-1
	CEQA Process	ES-2
	Description of Proposed Project	ES-3
	Summary of Environmental Impacts	ES-5
	Significant Unavoidable Effects	ES-43
	Alternatives to the Proposed Project and Project Options	ES-45
	Environmentally Superior Alternative	ES-55
1.	**Introduction**	**1-1**
	1.1 Purpose of the Environmental Impact Report	1-1
	1.2 Introduction	1-1
	1.3 Compliance with the Requirements of CEQA	1-2
	1.4 CEQA EIR Preparation Process	1-3
	1.5 EIR Organization	1-5
2.	**Description of Proposed Project**	**2-1**
	2.1 Project Overview	2-1
	2.2 Project Objectives and Water Supply Needs	2-8
	2.3 Description of Project Components	2-18
	2.4 Description of Water Transfer Source Options	2-35
	2.5 Project Construction	2-51
	2.6 Project Operations and Maintenance	2-59
	2.7 Project Implementation Schedule	2-60
	2.8 Anticipated Regulatory Requirements and Permits for the Project	2-60
3.	**Environmental Analysis**	**3.1-1**
	3.1 Introduction	3.1-1
	3.2 Surface Water Hydrology and Water Quality	3.2-1
	3.3 Groundwater	3.3-1
	3.4 Drainage and Floodplains	3.4-1
	3.5 Land Use and Agriculture	3.5-1
	3.6 Biological Resources	3.6-1
	3.7 Geology, Soils, and Seismicity	3.7-1
	3.8 Air Quality	3.8-1
	3.9 Noise	3.9-1

		Page
	3.10 Hazards and Hazardous Materials	3.10-1
	3.11 Public Health and Safety	3.11-1
	3.12 Transportation and Traffic	3.12-1
	3.13 Public Services and Utility Service Systems	3.13-1
	3.14 Cultural Resources	3.14-1
	3.15 Recreation	3.15-1
	3.16 Aesthetic Resources	3.16-1
4.	**Growth Inducing Effects**	**4-1**
	4.1 Introduction	4-1
	4.2 Growth and Development Trends	4-2
	4.3 Environmental Effects of Growth	4-18
5.	**Alternatives to the Proposed Project**	**5-1**
	5.1 Introduction	5-1
	5.2 Alternatives Analysis	5-2
	5.3 Comparison of Environmental Impacts of Water Supply Alternatives	5-30
	5.4 Comparison of Environmentally Superior Alternative	5-52
6.	**Other CEQA Issues**	**6-1**
	6.1 Cumulative Effects	6-1
	6.2 Significant Unavoidable Impacts	6-35
	6.3 Significant Irreversible Environmental Changes Which Would Result from the Proposed Project Should It Be Implemented	6-37
7.	**References**	**7-1**
8.	**EIR Authors, Consultants, and Persons Consulted**	**8-1**

Appendices

A.	Notice of Preparation and Comments	A-1
B.	Modeling Results and Water Demand	B-1
C1.	Special Status Species Potentially Occurring Within the Project Area and Water Sellers' Districts	C1-1
C2.	Survey Protocols	C2-1
D.	Air Quality Analysis	D-1

Page

List of Figures

ES-1	Potential Locations of Project Facilities	ES-4
2-1	Regional Location	2-4
2-2	Potential Locations of Project Facilities	2-5
2-3	Location of Potential Water Sellers	2-6
2-4	Proposed Place of Use	2-7
2-5	Project Partners' Existing Water Demand	2-14
2-6	Annual Water Sources Period: 1922-1994	2-17
2-7	Proposed Project Average Monthly Water Sources in 2040	2-17
2-8	Proposed Project Duration of Water Rights Supply Diversion	2-18
2-9	Pipeline Options 1 and 2	2-21
2-10	Pipeline Options 2 and 3	2-23
2-11	Intake Plan and Profile Views	2-25
2-12	Diversion/Intake -- Option 1	2-26
2-13	Diversion/Intake -- Option 2	2-28
2-14	Diversion/Intake -- Option 3	2-29
2-15	Water Treatment Plant Locations	2-31
2-16	Conceptual Water Treatment Plant Layout	2-32
2-17	Anderson-Cottonwood Irrigation District	2-38
2-18	Browns Valley Irrigation District	2-40
2-19	Conaway Ranch Preservation Group	2-42
2-20	Natomas Central Mutual Water Company	2-44
2-2	Reclamation District 108	2-47
2-22	River Garden Farms	2-49
2-23	Development Schedule	2-62
3.2-1	Sacramento River Basin Facilities	3.2-4
3.2-2	Sacramento-San Joaquin Delta Water Management Facilities	3.2-5
3.2-3	Frequency of Flooding Within the Yolo Bypass	3.2-7
3.2-4	Existing Mean Monthly Sacramento River Flow at the Proposed Point of Diversion	3.2-8
3.2-5	Flow Exceedance Curve at the Proposed Point of Diversion	3.2-9
3.2-6	Sacramento River Annual Flow at Proposed Point of Diversion	3.2-10
3.2-7	Mean Monthly Delta Inflow at Freeport	3.2-11
3.2-8	Mean Monthly Delta Outflow	3.2-12
3.2-9	Delta Inflow Exceedance Curve	3.2-12
3.2-10	Delta Outflow Exceedance Curve	3.2-13
3.2-11	Change in the Sacramento River Flow with Project	3.2-37
3.2-12	Change in Location of X-2 with Project	3.2-45
3.2-13	Change in Sacramento River Water Temperature with Project	3.2-46
3.3-1	Groundwater Basins	3.3-2
3.3-2	Existing Wells	3.3-9
3.4-1	FEMA Flood Zones	3.4-5
3.5-1	Existing City of Davis Land Use	3.5-3
3.5-2	Existing City of Woodland Land Use	3.5-4
3.5-3	Existing UC Davis Land Use	3.5-6
3.5-4	Important Farmlands	3.5-9
3.6-1	Life History of Chinook Salmon in the Sacramento River	3.6-18
3.9-1	Effects of Noise on People	3.9-2

Page

3.9-2	Noise Measurement Locations	3.9-6
3.9-3	24-Hour Noise Measurement Eastside Sacramento River Near Option 1 Diversion	3.9-8
3.9-4	24-Hour Noise Measurement Eastside Sacramento River Across from Existing Diversion Facility	3.9-8
3.9-5	24-Hour Noise Measurement Westside Sacramento River 600-Feet from Diversion Option 3	3.9-9
3.9-6	24-Hour Noise Measurement Eastside Sacramento River 600-Feet from Diversion Option 3	3.9-9
3.11-1	Effectiveness of Various Treatment Technologies for Contaminant Removal	3.11-11
3.15-1	Recreation and Public Access	3.15-2
3.16-1	Option 1 Intake Site Photographs	3.16-3
3.16-2	Option 2 Intake Site Photographs	3.16-5
3.16-3	Option 3 Intake Site Photographs	3.16-6
3.16-4	WTP Option Site Photographs	3.16-7
4-1	Existing City of Davis Land Use	4-5
4-2	Existing City of Woodland Land Use	4-6
4-3	Existing UC Davis Land Use	4-7
4-4	Future City of Davis Land Use	4-8
4-5	Future City of Woodland Land Use	4-9
4-6	Future UC Davis Land Use	4-10
5-1	Tehama-Colusa Canal Alternative	5-5
5-2	Alternative 1: Annual Water Sources, Period: 1922-1994	5-18
5-3	Alternative 1 - Monthly Water Sources	5-20
5-4	Alternative 1 - Duration of Water Rights Supply Diversion	5-20
5-5	Alternative 2: Annual Water Sources, Period: 1922-1994	5-21
5-6	Alternative 2 - Monthly Water Sources	5-22
5-7	Alternative 2 - Duration of Water Rights Supply Diversion	5-22
5-8	Alternative 3 Annual Water Sources, Period: 1922-1994	5-25
5-9	Alternative 3 - Monthly Water Sources	5-26
5-10	Alternative 3 - Duration of Water Rights Supply Diversion	5-26
5-11	Alternative 4: Annual Water Sources, Period: 1922-1994	5-27
5-12	Alternative 4 - Monthly Water Sources	5-28
5-13	Alternative 4 - Duration of Water Rights Supply Diversion	5-28
5-14	Alternative 5: Annual Water Sources, Period: 1922-1994	
5-15	Alternative 5 - Monthly Water Sources	5-32
5-16	Alternative 5 - Duration of Water Rights Supply Diversion	5-32
5-17	Salt Load Change of Project Alternatives	5-37
6-1	Projects Potentially Contributing to Cumulative Impacts	6-7
6-2	Cumulative Exceedance Curves for Sacramento River; Comparison of Future Conditions with- and without-Project	6-16
6-3	Exeedance Curves for X-2 Position: Comparison of with-Project to without-Project Cumulative Conditions	6-26
6-4	Sacramento River at Red Bluff Temperature Exceedance Curves: Comparison of with-Project to without-Project Cumulative Conditions	6-27

Page

List of Tables

ES-1	Summary of Diversion/Intake Impacts and Mitigation Measures	ES-6
ES-2	Significant Unavoidable Effects of Project Implementation	ES-43
ES-3	Summary Comparison of Facility Siting and Water Transfer Option Impacts	ES-45
ES-4	Summary Comparison of Water Supply Alternative Impacts	ES-53
2-1	Major Features of the Project Partners' Municipal Groundwater Systems	2-3
2-2	Studies Completed as Part of Project Planning	2-8
2-3	Summary of Existing Drinking Water Quality	2-10
2-4	Project Partners' Water Demand in 2005	2-14
2-5	Project Partners' Future Water Demand	2-15
2-6	Existing Mean Monthly Diversions from the RD 2035 Intake	2-20
2-7	WTP Chemical Use and Storage	2-33
2-8	Description of Transmission Pipeline Segments	2-34
2-9	Potential Sources of Water Supply Acquired Through Transfer	2-36
2-10	Schedule of ACID Base-Supply Water Diversions	2-37
2-11	Summary of Conaway Preservation Group Sacramento River Water Rights	2-41
2-12	Schedule of Conaway Conservancy Group Base-Supply Water Diversions	2-43
2-13	Summary of Natomas Water Rights	2-45
2-14	Natomas Base-Supply Water Diversions	2-45
2-15	Summary of RD 108 Sacramento River Water Rights	2-46
2-16	Schedule of RD 108 Base-Supply Water Diversions	2-48
2-17	Summary of River Garden Farms Water Rights	2-50
2-18	Schedule of RGF Base-Supply Water Diversions	2-50
2-19	Diversion/Intake Structure and Pump Station Construction Activities and Sequencing	2-51
2-20	Water Treatment Plant Construction Activities and Sequencing	2-55
2-21	List of Expected Construction Equipment	2-58
2-22	Chemicals Anticipated To Be Used at the WTP	2-59
2-23	Anticipated Regulatory Requirements and Permits for Project Implementation	2-60
3.2-1	Major Federal and State Reservoirs in the Sacramento River Basin	3.2-2
3.2-2	Sacramento River Untreated Water Quality at City of West Sacramento	3.2-16
3.2-3	Water Quality for Selected Stations in the Delta	3.2-19
3.2-4	Surface Water-Related Objectives of the Project Partners	3.2-27
3.2-5	CALSIM II Output used for Impact Analysis	3.2-33
3.2-6	Impact Summary of Project Siting Options - Surface Water Hydrology and Water Quality	3.2-34
3.2-7	Maximum Changes in Sacramento River Flow that would Result from Upstream Water Transfers (CFS)	3.2-37
3.2-8	Changes in Delta Flow and Export	3.2-38
3.2-9	Changes in CVP and SWP Reservoir Carryover Storage	3.2-41
3.2-10	Changes in WWTP Effluent Electrical Conductivity	3.2-43

Page

3.2-11	Changes in Average Monthly Salinity Concentrations (EC)	3.2-43
3.3-1	Land Subsidence in Yolo County, 1999-2030 (Inches)	3.3-4
3.3-2	Water Quality of Intermediate Depth Aquifer	3.3-11
3.3-3	Water Quality of the Deep Aquifer	3.3-13
3.3-4	Local Groundwater Hydrology and Water Quality Objectives of the Project Partners	3.3-15
3.3-5	Impact Summary of Project Siting Options -- Groundwater	3.3-21
3.3-6	Summary of Estimated Drawdown within Water Sellers' Service Areas (FBGS)	3.3-28
3.4-1	100-Year Flood Elevations in the Areas of Proposed Project Intakes, Sacramento River	3.4-2
3.4-2	Flood Stage and Record Flood Elevations in the Sacramento River Near the Proposed Project Area	3.4-2
3.4-3	Sacramento River Floodway Management Plan (FMP) Guidelines	3.4-8
3.4-4	Yolo County General Plan, Safety and Conservation Elements Policies Relevant to Drainage and Floodplain	3.4-10
3.4-5	Impact Summary of Project Siting Options -- Drainage and Floodplains	3.4-11
3.4-6	Reclamation Discricts To Be Consulted During Intake Facility and Untreated Water Pipeline Engineering	3.4-17
3.5-1	Existing Project Partner Land Use (Acres)	3.5-1
3.5-2	Farmland Definitions	3.5-10
3.5-3	Land Use and Agricultural Policies of Yolo County	3.5-11
3.5-4	Land Use and Agricultural Policies of the City of Woodland	3.5-12
3.5-5	Land Use and Agricultural Policies of the City of Davis	3.5-14
3.5-6	Land Use and Agricultural Policies of UC Davis	3.5-14
3.5-7	Land Use and Planning Designation of Potential Water Sellers	3.5-16
3.5-8	Impact Summary of Project Siting Options: Land Use and Agriculture	3.5-18
3.5-9	Summary of Impact to Agricultural Lands	3.5-23
3.5-10	Farmland Affected by Installation of Water Conveyance Pipeline Options	3.5-24
3.6-1	Acreage and Crop Types Found in the Vicinity of Project Sites	3.6-4
3.6-2	Habitats Located within Potential Water Seller Service Areas	3.6-5
3.6-3	Potential for a Species to Occur within the Proposed Project Area	3.6-6
3.6-4	Special-Status Plant Species with High Potential to Occur within the Proposed Project Area and Vicinity	3.6-7
3.6-5	Special-Status Wildlife Species with Potential to Occur within the Proposed Project Area	3.6-11
3.6-6	Summary of Electrofishing Results at East Canal	3.6-24
3.6-7	Summary of Electrofishing Results at Colusa Basin Drain	3.6-24
3.6-8	Summary of 1996 Electrofishing and Netting Results on the Sacramento River at Colusa	3.6-25
3.6-9	Summary of 1998 Boat Electrofishing and Netting on the Sacramento River at Colusa	3.6-25
3.6-10	Description of Sacramento River Essential Fish Habitat	3.6-30
3.6-11	Fish Management Plan Concerns in Project Area	3.6-30
3.6-12	Relevant Yolo County General Plan Conservation Policies	3.6-35

		Page
3.6-13	Relevant City of Woodland General Plan Conservation Policies	3.6-36
3.6-14	Relevant City of Davis General Plan Conservation Policies	3.6-37
3.6-15	Biological Resources Policies of UC Davis	3.6-38
3.6-16	Impact Summary of Project Siting Options - Biological Resources	3.6-43
3.6-17	Presence of Salmonid Fish Species in Vicinity of Diversion/Intake Siting Options	3.6-47
3.6-18	Affected Vegetation and Habitat in the Proposed Project Area	3.6-55
3.6-19	Affected Potential Habitat for Special-Status Plants in the Proposed Project Area	3.6-57
3.6-20	Affected Potential Habitat for Special-Status Crustaceans and Amphibians in the Proposed Project Area	3.6-58
3.6-21	Affected Potential Giant Garter Snake and Western Pond Turtle Habitat in the Proposed Project Area	3.6-60
3.6-22	Affected Potential Swainson's Hawk Habitat in the Proposed Project Area	3.6-62
3.7-1	Soil Associations in Project Area	3.7-2
3.7-2	Active and Potentially Active Faults within 70 Miles of the Project Area	3.7-3
3.7-3	Seismic and Geologic Hazards Objectives of the Project Partners	3.7-8
3.7-4	Summary of Project Option Impacts - Geology, Soils, and Seismicity	3.7-10
3.8-1	Air Quality Data Summary (2001-2005)	3.8-3
3.8-2	State and National Criteria Air Pollutant Standards, Effects, and Sources	3.8-5
3.8-3	Yolo County Attainment Status	3.8-6
3.8-4	Attainment Status for Other Sacramento Valley Counties	3.8-7
3.8-5	Qualitative Indicators for Determining Air Quality Impacts	3.8-11
3.8-6	Impact Summary of Project Siting Options - Air Quality	3.8-14
3.8-7	Construction Emissions Estimates	3.8-16
3.8-8	Operations Emissions Estimates	3.8-17
3.9-1	Existing Noise Environment	3.9-7
3.9-2	Noise Objectives of the Yolo County General Plan	3.9-11
3.9-3	Noise Objectives/Standards of the City of Woodland	3.9-12
3.9-4	Noise Performance Standards New Projects Affected by or Including Non-Transportation Sources	3.9-13
3.9-5	Maximum Allowable Noise Exposure Transportation Noise Sources	3.9-13
3.9-6	Noise Objectives of the City of Davis General Plan	3.9-14
3.9-7	City of Davis Standards for Exterior Noise Exposure	3.9-15
3.9-8	City of Davis Standards for Interior Noise Levels	3.9-16
3.9-9	Noise Limits of the City of Davis Noise Ordinance	3.9-17
3.9-10	City of Davis Allowable Noise Levels and Time Restrictions	3.9-18
3.9-11	Threshold of Substantial Increase for Transportation Noise Exposure	3.9-19
3.9-12	Impact Summary of Proposed Project Options - Noise	3.9-21
3.9-13	Typical Construction Noise Levels	3.9-22
3.9-14	Typical Noise Levels from Construction Equipment	3.9-22

Page

3.10-1	List of Recorded Spill and Leak Sites in the Project Area	3.10-1
3.10-2	List of Recorded Leaking Underground Storage Tanks in the Project Area	3.10-2
3.10-3	List of Cortese Sites found in the Project Area	3.10-2
3.10-4	List of Other Contaminated Sites found in the Project Area	3.10-3
3.10-5	Yolo County Hazardous Materials and Safety Policies	3.10-6
3.10-6	City of Woodland Hazardous Materials Policies	3.10-7
3.10-7	City of Davis Hazards Goals and Policies	3.10-8
3.10-8	Impact Summary: Hazards and Hazardous Materials	3.10-10
3.10-9	Anticipated Hazardous Materials Use at the WTP	3.10-12
3.10-10	LUST Site Located within One-Quarter Mile of Schools that may be Disturbed during Project Construction	
3.11-1	Water Quality Concentrations for Constituents of Concern for City of Davis, University of California Davis, City of Woodland, and Treated Sacramento River Water	3.11-2
3.11-2	Water Quality Considerations	3.11-5
3.11-3	Impact Summary of Project Siting Options – Public Health	3.11-15
3.12-1	Roadways in the Project Area	3.12-2
3.12-2	Existing Traffic Volumes on Area Roadways	3.12-2
3.12-3	Transportation Objectives of the Project Partners	3.12-4
3.12-4	Summary of Impacts – Transportation and Traffic	3.12-9
3.13-1	Public Services Policies of the Project Partners and Yolo County	3.13-4
3.13-2	Impact Summary of Project Siting Options – Public Services, Utilities and Service Systems	3.13-9
3.14-1	Historic and Prehistoric Preservation Objectives of the Project Partners	3.14-7
3.14-2	Impact Summary of Project Siting Options – Cultural Resources	3.14-10
3.15-1	Recreation Objectives of the Project Partners	3.15-4
3.15-2	Impact Summary of Project Siting Options – Recreation	3.15-6
3.15-3	Distance from Intake Options to Existing Boat Launches	3.15-9
3.16-1	Scenic Resource Management Objectives of the Project Partners	3.16-10
3.16-2	Impact Summary of Project Siting Options – Aesthetic Resources	3.16-11
4-1	Project Partners Future Population Estimate	4-3
4-2	Current and Future Land Use of the Project Partners	4-4
4-3	Relevant City of Davis General Plan Growth Management Goals and Policies	4-12
4-4	Relevant City of Woodland General Plan Growth Policies	4-14
4-5	Relevant UC Davis Resource Objectives	4-16
4-6	Project Partners' Long-Term Growth Potential	4-18
4-7	Significant Unavoidable Impacts of Planned Population Growth and Development	4-18
5-1	Water Demand Reduction Percentages Needed to Offset all Future Water Demand Increases (Taf/yr)	5-10
5-2	Summary Comparison of Facility Siting and Water Transfer Option Impacts	5-12

		Page
5-3	Summary of Water Supply Alternatives	5-15
5-4	Potential Best Management Practices to Achieve Additional 10 Percent Water Conservation	5-23
5-5	Future Water Demands Adjusted for Water Conservation (Taf/yr)	5-24
5-6	Comparison of Significant and Unavoidable Impacts of Diversion/Intake Facility Options	5-30
5-7	Summary Comparison of Water Supply Alternative Impacts	5-33
5-8	Comparison of Salt Loads Associated with Water Supply Alternatives	5-36
5-9	Comparison of EC Concentrations in Treated Wastewater Effluent	5-38
6-1	Projects which may Contribute to Cumulative Effects	6-2
6-2	Local Plans	6-9
6-3	Summary of Potential Cumulative Impacts	6-14
6-4	Cumulative Changes in Delta Hydrologic Conditions	6-18
6-5	Cumulative Changes in CVP/SWP Reservoir Storage	6-22
6-6	Cumulative Changes in Delta Salinity (EC), Comparison of Existing Conditions to with-Project Cumulative Conditions	6-25
6-7	Potential Cumulative Effect on Groundwater Pumping Levels by Pending Water Transfer Projects (TAF)	6-28

Appendix A
Notice of Preparation

APPENDIX A
Notice of Preparation and Comments

Appendix A presents the Notice of Preparation (NOP), which was prepared and submitted to the State Clearinghouse in April, 2006. Also presented are written and summarized oral comments that were received for the NOP during the period of comment.

Notice of Completion, April, 2006

Notice of Completion & Environmental Document Transmittal

Appendix C

For U.S. Mail: State Clearinghouse, P.O. Box 3044, Sacramento, CA 95812-3044
For Hand Delivery/Street Address: 1400 Tenth Street, Sacramento, CA 95814

SCH # 2006042175

RECEIVED
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STATE CLEARING HOUSE

Project Title:
Davis-Woodland Water Supply Project

Lead Agency: City of Davis
Contact Person: Jacques DeBra
Street Address: 1717 Fifth Street
Phone: 530-757-5679
City: Davis
Zip: 95616
County: Yolo

Project Location:
County: Yolo County
City/Nearest Community: Davis and Woodland
Cross Streets: Old River Road, County Road 102
Zip code: 95616, 95695
Assessor's Parcel No. Multiple Parcels
Section: Numerous
Twp: 8 - 11
Range: 1 - 3
Base: MD
Within 2 miles: State Hwy#: Interstate-5, SR-113
Waterways: Sacramento River
Airports: ______
Railways: Yolo Short Line
Schools: UC Davis

Document Type:

CEQA:
- ☒ NOP
- ☐ Early Cons
- ☐ Neg Dec
- ☐ Mit Neg Dec
- ☐ Draft EIR
- ☐ Supplement to EIR
- ☐ Subsequent EIR
- ☐ Other: ______

NEPA:
- ☐ NOI
- ☐ EA
- ☐ Draft EIS
- ☐ FONSI

Other:
- ☐ Joint Document
- ☐ Final Document
- ☐ Other: ______

Local Action Type:
- ☐ General Plan Update
- ☐ General Plan Amendment
- ☐ General Plan Element
- ☐ Community Plan
- ☐ Specific Plan
- ☐ Master Plan
- ☐ Planned Unit Development
- ☐ Site Plan
- ☐ Rezone
- ☐ Prezone
- ☐ Use Permit
- ☐ Land Division (Subdivision, etc.)
- ☐ Annexation
- ☐ Redevelopment
- ☐ Coastal Permit
- ☒ Other: Decision to Construct

Development Type:
- ☐ Residential: *Units* ______ *Acres* ______
- ☐ Office: *Sq.ft.* ______ *Acres* ______ *Employees* ______
- ☐ Commercial: *Sq.ft.* ______ *Acres* ______ *Employees* ______
- ☐ Industrial: *Sq.ft.* ______ *Acres* ______ *Employees* ______
- ☐ Educational ______
- ☐ Recreational ______
- ☒ Water Facilities: *Type* Diversion, Conveyance, Treatment *MGD* 60
- ☐ Transportation: *Type* ______
- ☐ Mining: *Mineral* ______
- ☐ Power: *Type* ______ *MW* ______
- ☐ Waste Treatment: *Type* ______ *MGD* ______
- ☐ Hazardous Waste: *Type* ______
- ☐ Other: ______

Total Acres: (approx.) ______

Project Issues That May Have A Significant Or Potentially Significant Impact:
- ☒ Aesthetic/Visual
- ☒ Agricultural Land
- ☒ Air Quality
- ☒ Archeological/Historical
- ☒ Biological Resources
- ☐ Coastal Zone
- ☐ Drainage/Absorption
- ☐ Economic/Jobs
- ☐ Fiscal
- ☒ Flood Plain/Flooding
- ☐ Forest Land/Fire Hazard
- ☒ Geologic/Seismic
- ☐ Minerals
- ☒ Noise
- ☒ Population/Housing Balance
- ☒ Public Services/Facilities
- ☐ Recreation/Parks
- ☐ Schools/Universities
- ☐ Septic Systems
- ☐ Sewer Capacity
- ☒ Soil Erosion/Compaction/Grading
- ☐ Solid Waste
- ☐ Toxic/Hazardous
- ☒ Traffic/Circulation
- ☒ Vegetation
- ☒ Water Quality
- ☒ Water Supply/Groundwater
- ☒ Wetland/Riparian
- ☒ Growth Inducement
- ☒ Land Use
- ☒ Cumulative Effects
- ☐ Other: ______

Present Land Use/Zoning/General Plan Designation: Multiple land use designations.

Project Description: *(please use a separate page if necessary)*

NOTE: Clearinghouse will assign identification numbers for all new projects. If a SCH number already exists for a project (e.g. Notice of Preparation or previous draft document) please fill in.

The objective of the Project is to provide a reliable water supply of adequate quality for drinking and cost-effective wastewater treatment in Davis, Woodland, and UC Davis through 2040 without removing a source of irrigation supply that will cause fallowing of agricultural land. The Project Partners propose to acquire a new surface water supply from the Sacramento River and to construct and operate water intake/diversion, conveyance, and treatment facilities so that the Project Partners can use treated surface water in their respective service areas.

NOTE: Clearinghouse will assign identification numbers for all new projects. If a SCH number already exists for a project (e.g. Notice of Preparation or previous draft document) please fill in.

Reviewing Agencies Checklist *Appendix C*

continued

Lead Agencies may recommend State Clearinghouse distribution by marking agencies below.

	Air Resources Board		Office of Emergency Services
	Boating & Waterways, Department of	X	Office of Historic Preservation
	California Highway Patrol		Parks & Recreation
X	Caltrans District # 3		Pesticide Regulation, Department of
	Caltrans Division of Aeronautics		Public Utilities Commission
	Caltrans Planning	X	Reclamation Board
	Coachella Valley Mountains Conservancy	X	Regional WQCB # 5
	Coastal Commission	X	Resources Agency
	Colorado River Board Commission		S.F. Bay Conservation & Development
	Conservation, Department of		San Gabriel & Lower Los Angeles Rivers & Mountains Conservancy
	Corrections, Department of		San Joaquin River Conservancy
	Delta Protection Commission		Santa Monica Mountains Conservancy
	Education, Department of Office of Public School Construction		State Lands Commission
	Energy Commission		SWRCB: Clean Water Grants
X	Fish & Game Region #		SWRCB: Water Quality
	Food & Agriculture, Department of	X	SWRCB: Water Rights
	Forestry & Fire Protection		Tahoe Regional Planning Agency
	General Services, Department of		Toxic Substances Control, Department of
X	Health Services, Department of	X	Water Resources, Department of
	Housing & Community Development		
	Integrated Waste Management Board	X	Other: U.S. Fish and Wildlife Service U.S. National Marine Fisheries Service
X	Native American Heritage Commission	X	Other: U.S. Army Corps of Engineers

Local Public Review Period (to be filled in by lead agency)

Starting Date April 28, 2006 Ending Date June 12, 2006

Lead Agency (Complete if applicable):

Consulting Firm: Environmental Science Associates

Address: 8950 Cal Center Drive, Bldg 3, Suite 300

City/State/Zip: Sacramento, CA 95826

Contact: Richard Hunn / Clint Meyer

Phone: (916) 564-4500

Applicant: Jacque DeBra/City of Davis

Address: 1717 Fifth Street

City/State/Zip: Davis, CA 95616

Phone: (530) 757-5679

Signature of Lead Agency Representative: ________ Date: April 28, 2006

Authority cited: Sections 21083 and 21087, Public Resources Code. Reference: Section 21161, Public Resources Code.

Notice of Preparation, April, 2006

DAVIS-WOODLAND WATER SUPPLY PROJECT ENVIRONMENTAL IMPACT REPORT

Notice of Preparation

Prepared for:
City of Davis
University of California-Davis
City of Woodland

April 2006

DAVIS-WOODLAND WATER SUPPLY PROJECT ENVIRONMENTAL IMPACT REPORT

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City of Davis
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TABLE OF CONTENTS

Notice of Preparation: Davis-Woodland Water Supply Project EIR

Page

1.0 Introduction	**1**
1.1 Opportunities for Public Participation	3
2.0 Description of Proposed Project	**5**
2.1 Project Objectives	6
2.2 Description of Project Features	10
2.3 Project Alternatives	15
3.0 Environmental Checklist	**19**
Determination	19
Environmental Factors Potentially Affected	20
Description of Impact Methodology	20
Aesthetics	21
Agricultural Resources	22
Air Quality	23
Biological Resources	24
Cultural Resources	26
Geology, Soils, and Seismicity	27
Hazards and Hazardous Materials	29
Hydrology and Water Quality	31
Land Use, Planning, and Policies	33
Mineral Resources	35
Noise	35
Population and Housing	37
Public Services	38
Recreation	39
Transportation and Traffic	39
Utilities and Service Systems	41
Mandatory Findings of Significance	43

List of Figures

1	Project Facility Options	2
2	Intake Plan and Profile Views	11

NOTICE OF PREPARATION

Davis-Woodland Water Supply Project Environmental Impact Report

1.0 Introduction

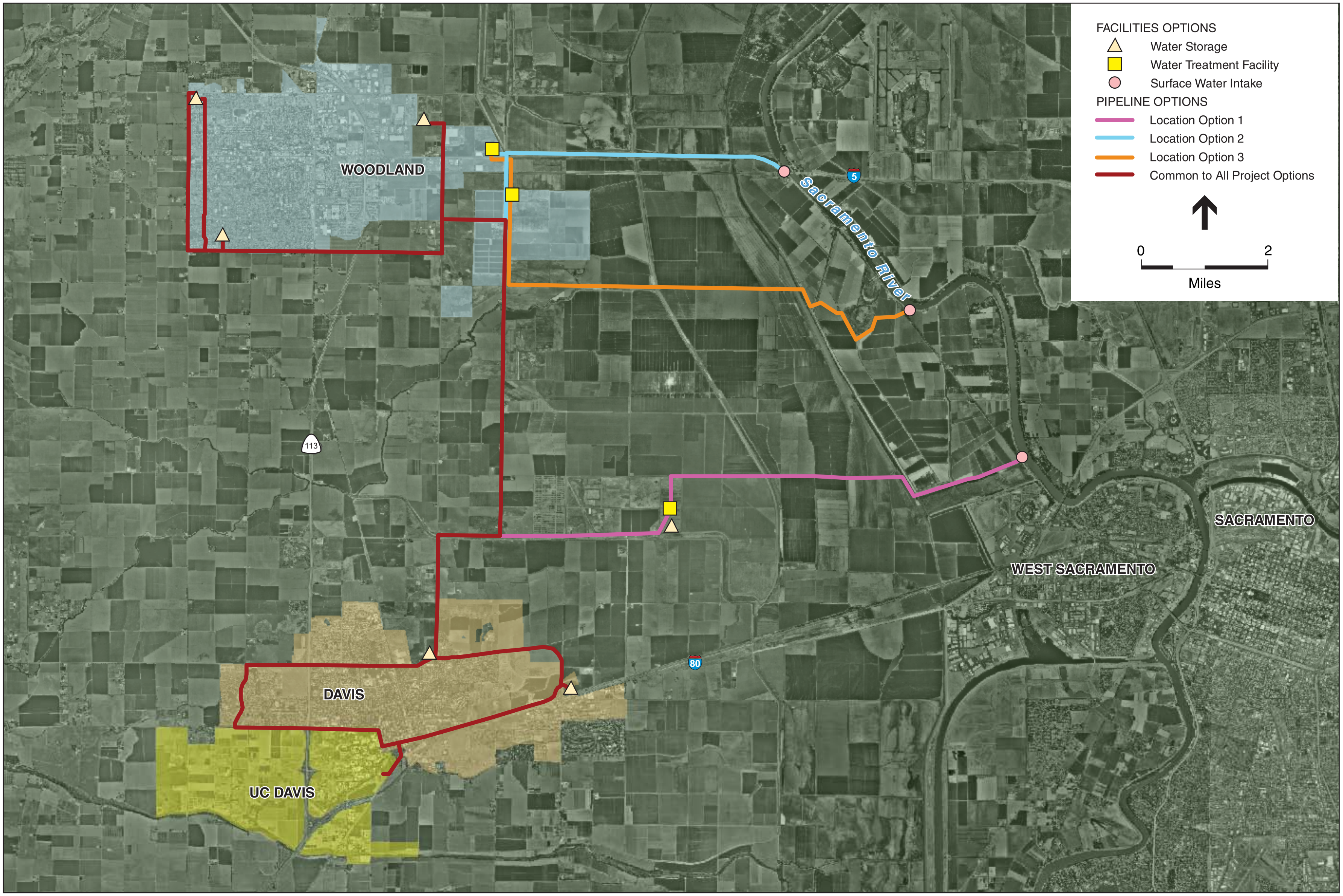
The City of Davis (Davis), the University of California, Davis (UC Davis), and the City of Woodland (Woodland) (collectively referred to in this Notice of Preparation as the Project Partners) are jointly proposing to develop a surface water supply for use within each of the Project Partners' jurisdictions in conjunction with existing groundwater supplies. The Project Partners propose to divert surface water from the Sacramento River and convey it for treatment and subsequent use in Davis and Woodland and on the UC Davis campus. Figure 1 shows the locations of potential water diversion and pipeline routes being considered by the Project Partners.

Based on the studies completed to date, the Davis-Woodland Water Supply Project (Project) could ultimately divert up to 52,000 acre-feet per year of surface water by the year 2040 to meet most of the municipal and industrial demands of the Project Partners. The Project would divert water under new water rights that would be based on the Project Partners' pending water-right applications and through water transfers from holders of existing senior water rights.

Local groundwater is presently used to meet the Project Partners' water needs within their service areas and would continue to be used during drier periods as a component of the Partners' water system to help meet daily peak water demands.

Several engineering feasibility studies have evaluated various water diversion/intake sites along the Sacramento River, water treatment plant locations, and pipeline conveyance routes. Of the sites, locations, and routes that have been considered, the Project Partners have selected three diversion/intake and pipeline options and three water treatment plant locations for detailed consideration in the California Environmental Quality Act (CEQA) process.

A preferred diversion site, pipeline route, and water treatment plant location have not been identified at this time. The Project Partners intend to analyze each of the water diversion/intake and pipeline options and water treatment plant locations (discussed below) selected for CEQA review equally and, based on that analysis and other relevant factors, to select a preferred Project configuration.



SOURCE: USGS, 1993; West Yost & Associates, 2005; and ESA, 2006

Davis/Woodland Water Supply Project Notice of Preparation . 205413

Figure 1
Diversion and Conveyance Options

Davis will be the lead agency for the purposes of complying with the applicable CEQA requirements. The City of Woodland and UC Davis will be CEQA responsible agencies. The Yolo County Flood Control and Water Conservation District (YCFC&WCD) will be an interested party during the CEQA process.

This NOP is divided into the following sections:

- Section 1.1 describes opportunities for public participation
- Section 2.0 describes the Project.
    - Section 2.1 sets forth Project objectives, the need for the Project, and the history of the Project's development.
    - Section 2.2 describes the Project's features, including each of the optional configurations of the Project's components (three different variations on the locations of the water diversion/intake facility, pipeline route and water treatment plant site) that will be evaluated in the Environmental Impact Report (EIR).
    - Section 2.3 sets forth the alternatives to the Project that will be analyzed in the EIR.
- Section 3.0 includes an Initial Study, which describes the environmental issues that will be addressed in the EIR. For each environmental issue, the Initial Study identifies the criteria used to evaluate potential significance of the impact and the preliminary findings regarding the Project's potential environmental impacts.

The configuration of the Project will be refined during the EIR process. Agencies and interested members of the public are invited to provide input on the scope of the environmental analysis, options for configuration of the Project, and alternatives to the Project to be evaluated.

1.1 Opportunities for Public Participation

The public is invited to submit oral and/or written comments on the scope of issues to be included in the EIR. The comment period extends through June 12, 2006.

Interested persons and organizations are invited to call or write Jacques DeBra at the City of Davis, Department of Public Works, 530-757-5679, jdebra@ci.davis.ca.us, to ask to be included on the mailing list for public meetings and to receive other correspondence concerning the Project.

Scoping Meetings

Scoping meetings are scheduled for May 18 and May 22, 2006, at the locations shown below:

Woodland Public Library
Leake Room
250 First Street
Woodland, California 95695
May 18, 2006, 6:00 p.m.

City of Davis Natural Resources Commission
City of Davis Community Chambers
23 Russell Boulevard
Davis, California 95616
May 22, 2006, 6:30 p.m.

Interested agencies and the public will have opportunities to submit their oral or written comments at these meetings.

Written Comments

Please submit any comments by the end of the public comment period, May 31, 2006. Written comments on the scope, content, and format of the environmental document should be emailed using the link from the following websites: www.daviswoodlandwatersupply.com or www.cityofdavis.org. Written comments may be also mailed to the following address:

Mr. Jacques DeBra
City of Davis
Department of Public Works
23 Russell Blvd.
Davis, CA 95616

2.0 Description of Proposed Project

The Project Partners propose to acquire a new surface water supply from the Sacramento River and to construct and operate water intake/diversion, conveyance, and treatment facilities so that the Project Partners can use treated surface water in their respective service areas. The total amount of water rights and entitlements that would be acquired and the capacities of the key Project facilities are proposed to meet the needs of the Project Partners through 2040; other Project facilities would be developed in stages corresponding to planned population growth and development that is anticipated will take place in accordance with local land use plans.

Project surface water supplies would be acquired by the Project Partners through new water rights and water rights transfers from senior water rights holders. The Project Partners have applied to the State Water Resources Control Board (SWRCB) for new water-right permits to unappropriated water from the Sacramento River. Water available for appropriation does not include water needed to protect aquatic species or to supply other legal water users who have senior rights. Water appropriated pursuant to new water-right permits would comply with the SWRCB's Standard Water Right Permit Term 91. Term 91 imposes diversion limitations on certain junior water rights holders (which would include the Project Partners' new water-right permits) in the Sacramento Valley, by prohibiting water diversions when in-basin entitlements require the release of supplemental Project water by the Central Valley Project (CVP) or the State Water Project (SWP).

When Term 91 is in effect, Project surface water would be supplied by Sacramento River senior water right holders willing to transfer their existing surface water entitlements used for irrigating agricultural crops to the Project Partners. Water for transfer would be created when the potential transferor would:

- Implement a groundwater substitution program by pumping groundwater in lieu of using its surface water supplies during some summer months, thereby freeing up surface water for transfer to the Project Partners during these months.
- Release water from storage for transfer to the Project Partners.
- Implement conservation measures and transfer the conserved water to the Project Partners.

The Project Partners expect to negotiate water transfer agreements with one or more of the following potential senior water rights holders who have authorized the Lead Agency to include discussions of potential transfers under their water rights in the EIR:

- Anderson-Cottonwood Irrigation District
- Browns Valley Irrigation District
- Natomas Central Mutual Water Company
- Reclamation District 108
- River Garden Farms
- Swanston Properties

Additional potential transferors could be identified and the impacts of those transfers would be analyzed in the EIR.

The Project Partners would not purchase from these sellers any water that would be made available by fallowing agricultural lands. It is expected that the purchase agreement for this supplemental water supply would be for a long-term period (extending from 30 to 50 years) and would include a right for renewal to ensure a long-term supply for the Project Partners. In addition to acquiring surface water supplies, the Project involves the continued use of intermediate and deep-aquifer groundwater sources currently serving the Project Partners' service areas when necessary to meet summer daily peaking demands, and possibly in other drier water-year conditions when water demands could not be met with Project surface water supplies. For purposes of this analysis, intermediate-depth wells are those less than 700 feet below the ground surface.

As aging intermediate-aquifer wells are taken out of service, replacement deep-aquifer wells will be installed, and new deep-aquifer wells also may be needed to meet future peak daily demands. Each Project Partner would independently manage its own groundwater wells and supplies. As intermediate-aquifer wells are taken off-line, the Project Partners would close and abandon wells in place, consistent with applicable ordinances. It is expected that deep-aquifer wells will eventually replace all wells that currently pump water from only the intermediate-depth groundwater aquifer.

2.1 Project Objectives

The objective of the Project is to provide a reliable water supply of adequate quality for drinking and cost-effective wastewater treatment in Davis, Woodland, and UC Davis through 2040 without removing a source of irrigation supply that would cause fallowing of agricultural land.

This objective has been developed over the more than ten-year period during which the Project Partners have assessed their water supply and its quality and reliability and analyzed their available options. Over time, a number of factors have led the Project Parties to refine their aims and develop the Project objective. These include the following:

- The primary factor that has changed over the last couple of years is the new regulatory requirement that Woodland and Davis will, in the near future, have to greatly reduce the salt loading in their treated wastewater effluent prior to discharge or reuse. A primary Project objective for these two agencies is to greatly reduce the total dissolved solids (TDS) of their water supply as a means of meeting future wastewater discharge requirements in an economically feasible manner.
- The Project Partners also anticipate that more stringent drinking water standards will be applied in the near future. Some wells have already been taken out of production due to water quality concerns. Older wells in developed areas cannot be retrofitted with wellhead treatment facilities to ensure sufficient quality because these facilities require more space than is available at many existing well sites.

- The Project Partners also wish to increase the reliability of their water supply. Each of the Project Partners currently relies exclusively on groundwater to meet its water supply needs. If the Project Partners were to all pump their groundwater exclusively from the deep aquifer, which has higher quality than the intermediate aquifer, the technical studies indicate that the yield available from this source may be limited. It is not clear that all future demand can be met by pumping from the deep aquifer; attempting this may overtax the aquifer and lead to well failures and other threats to a stable, reliable supply. Because the customers served by the Project Partners use water for municipal, industrial and educational uses, they must be assured of reliable supply capable of providing minimum fire flows and potable water without interruptions.
- In recognition of Yolo County's agricultural heritage, the Project Partners do not want the Project to take irrigation supplies that would result in the fallowing of agricultural lands or the reduction of the irrigator's agricultural production. The Project Partners have therefore determined that they will not enter into a water transfer agreement with a seller that intends to obtain the water supply by fallowing land that is currently used for agricultural purposes.

Need for the Project

The need for the Proposed Project is supported by a number of studies conducted for each of the Project Partners, which have concluded that the following facts apply to varying degrees to each Project Partner:

- The intermediate aquifer groundwater supply, while a safe source of drinking water, has elevated concentrations of constituents such as boron and water hardness (total dissolved solids) that affect taste, aesthetics, suitability for irrigation, and the useful life expectancy of plumbing features. As a result, some municipal wells have been decommissioned or are considered unreliable.
- The existing intermediate aquifer groundwater supply also contains elevated concentrations of dissolved minerals, which, while safe for human ingestion, may result in exceeding anticipated future Waste Discharge Requirements (WDRs) applicable to the Project Partners' wastewater treatment systems unless special or experimental treatment processes are installed. The Project Partners also anticipate that more stringent water quality standards will be established by the governing regulatory agencies, and these standards may reduce the quantity of groundwater supply presently available for public consumption.
- Each Project Partner anticipates that continued population growth and development within its respective service area will require additional water supplies to meet future increases in demand, and there is uncertainty whether the existing groundwater supply alone would be sufficient to meet these increased demands.
- Continuing groundwater withdrawals from the deep aquifer at present or increased future rates may cause or contribute to surface subsidence in Yolo County. Adverse effects associated with ground-level subsidence include reductions in groundwater aquifer storage capacity, modified surface drainage patterns, and reduced flood protection.

The need for the Project has evolved over a number of years as Davis, Woodland and UC Davis have been investigating options to improve the quality and reliability of their drinking water supplies. Work completed by Davis/UC Davis and Woodland includes the following studies:

Future Water Supply Needs Study (1996)

This study concluded that Davis should further evaluate (1) the adequacy of deep wells to provide additional and better quality water supply than the water produced from the intermediate aquifer and (2) the feasibility of using surface water as a supplementary supply. This study included the evaluation of eight alternative means of obtaining adequate water supply; these alternatives can be divided into three broad categories: continued complete reliance on groundwater, complete conversion to a surface water supply, and conjunctive use of groundwater and surface water. A number of sources of supply were evaluated, as were many alternatives to improve supply quality and reliability.

City of Davis/UC Davis Joint Water Supply Feasibility Study (2002)

Davis and UC Davis, working together on two deep aquifer studies, investigated the potential yield and the risks associated with more reliance on the deep aquifer as a primary source of supply (water produced from the deep aquifer is generally higher quality [i.e., lower salinity] than that from the intermediate aquifer). This work, conducted over a multi-year period, concluded that (1) water quality from the deep aquifer, while better than the intermediate aquifer, would not meet all anticipated future drinking water and wastewater quality objectives and standards and (2) complete reliance upon the deep aquifer to supply the future demands of Davis and UC Davis would carry significant potential risks of subsidence impacts, well interference and drawdown effects and quality degradation over time. It was further concluded that a surface supply was the highest quality source available and should be seriously considered as a primary water source to be supplemented with groundwater from the deep aquifer to meet peak-day demands.

A Water Supply Feasibility Study evaluated the feasibility and cost of a number of water supply alternatives, including surface and groundwater that could serve the two agencies in the future. This work concluded that acquisition of a supplemental surface water supply was essential for long-term improvements in water quality (including both drinking water and wastewater objectives) and reliability needed for Davis and UC Davis.

City of Woodland Surface Water Supply Master Plan (1999)

The 1999 Water Supply Master Plan evaluated a number of alternatives for meeting Woodland’s future water demand and concluded that use of Sacramento River water could help meet future demands and improve the quality of Woodland’s water supply.

City of Woodland Surface Water Supply Project Draft Report (2004)

The Surface Water Supply Feasibility Study, completed in 2004, evaluated four alternatives for supplementing Woodland’s water supply by making use of Sacramento River water rights: (1) direct use of Sacramento River water by agriculture surrounding Woodland, freeing up more groundwater for use by Woodland; (2) direct use of Sacramento River water by Woodland when the surface water was available, and use of groundwater when surface water was unavailable; (3) diversion of surface water into a reservoir near Woodland to allow Woodland’s direct use of surface water all year around; and (4) a combination of use by Woodland and surrounding agriculture. When this report was prepared, Woodland selected diversion into a reservoir for year-round use as its preferred alternative.

Davis/UC Davis/Woodland Joint Water Supply Project Study (2004)

In summer 2004, Woodland joined with Davis and UC Davis to conduct a study of water supply projects that could be configured to serve the needs of all three agencies. The study analyzed three alternative means of meeting future water demands, including use of surface water to meet average-day and most of the maximum-day demands and use of groundwater to meet remaining peak demands.

Alternatives evaluated in some detail included (1) diversion and treatment of surface water at the West Sacramento Bryte Bend Water Treatment Plant, with delivery to Davis and UC Davis (Woodland would not be served with this alternative); (2) diversion at a new intake facility on the Sacramento River near the Sacramento Weir, treatment at a new plant near the Davis Wastewater Treatment Plant, and delivery of treated water to all three agencies; and (3) diversion at the Reclamation District (RD) 2035 Sacramento River Pumping Station, treatment at a new plant near the Woodland Regional Park site, and delivery of treated water to all three agencies. West Sacramento has concluded that there is insufficient space at its Bryte Bend Water Treatment Plant site to accommodate an expansion of the plant to meet Davis, Woodland and UC Davis' needs, so that alternative is not viable.

Based on the results of all of these studies, the Project Partners have concluded that there is a need for them to obtain rights to appropriate water from the Sacramento River to meet the anticipated future water demand within their respective service areas.

Planned Future Water Demand

Annual and monthly water demands for 2005 for each of the Project Partners are listed in Table 1. The combined total water demand for the Project Partners is estimated to reach about 58,000 acre-feet per year by 2040 (West Yost, 2004). The year 2040 was chosen as the long-term planning horizon because it would encompass the 35-year life cycle expectancy of most Project components subject to replacement or retrofit.

TABLE 1
PROJECT PARTNERS' WATER DEMAND IN 2005

Project Partners	Annual	Monthly Water Use (Acre-Feet)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Davis	15,175	689	607	770	1,080	1,410	1,777	2,035	1,998	1,722	1,425	944	715
UC Davis	3,200	164	197	244	217	251	327	411	364	322	281	230	192
Woodland	15,225	737	652	877	1,039	1,409	1,770	2,048	1,916	1,667	1,385	908	819

SOURCE: City of Davis, 2004, UC Davis, 2004, City of Woodland, 2004

2.2 Description of Project Features

The Project Partners will select a preferred Project that will include the following five components, which are described in more detail in the discussions provided below:

- Diversion and intake facility
- Conveyance pipeline
- Water treatment plant
- New groundwater wells
- Local distribution facilities

As discussed in more detail below, the Project Partners have identified multiple locations for the diversion and intake facility, conveyance pipeline, and water treatment plant. (See Figure 1, identifying options for locating the diversion/intake facilities, conveyance pipeline, and water treatment plant.) At this time, the Project Partners have not identified a preferred location for any of these three Project components. Each of the available locations for these Project components will be analyzed in the EIR, and the preferred Project will be selected from among these options, based on the environmental analysis and other relevant factors.

Diversion and Intake Facility

The Project will include diversion and intake facilities to divert surface water supplies from the Sacramento River. As shown by the pink circles on Figure 1, the Project Partners have identified three possible location options for the diversion/intake facilities. Each of these three possible locations for the diversion/intake facilities will be considered in the EIR.

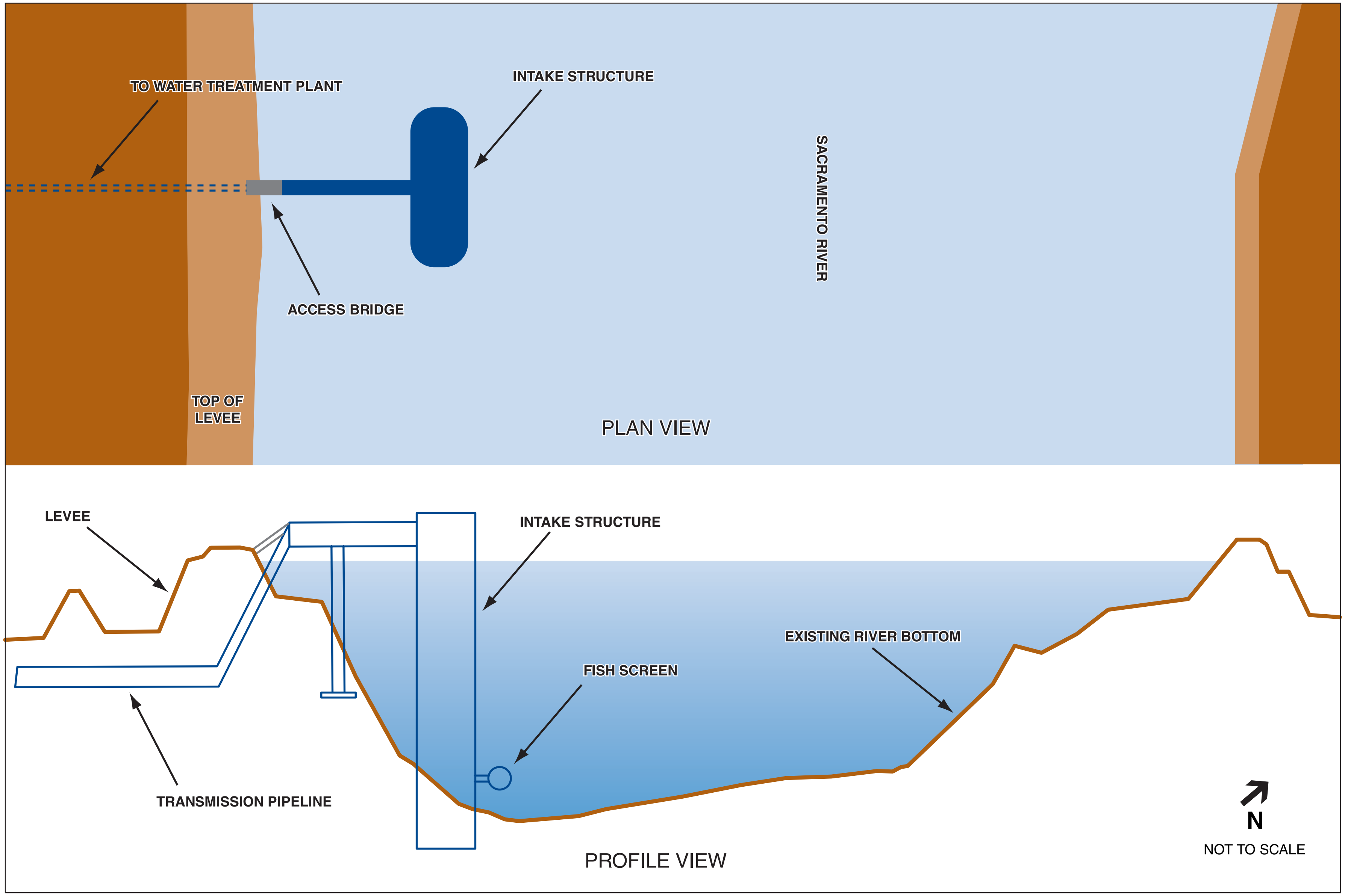
Diversion/Intake Option 1 consists of diversion at River Mile 70.5, where a new 400-cubic-foot-per-second (cfs) capacity water intake structure would be constructed to serve the needs of both RD 2035 and the Project Partners. This new facility would replace RD 2035's present 400 cfs capacity unscreened intake facility.

Diversion/Intake Option 2 consists of diversion at River Mile 67.75 through a new 92 cfs capacity intake structure constructed to serve the needs of the Project Partners.

Diversion/Intake Option 3 consists of diversion at River Mile 63.5. As with Diversion/Intake Option 2, this diversion would be accomplished via a new 92 cfs capacity intake structure designed to serve only the Project Partners.

Regardless of which of the three location options is ultimately selected, the configuration of the Diversion/Intake facility will be similar. Figure 2 illustrates the plan and profile view of a typical in-river diversion and intake facility. The top of the structure would extend above the 100-year flood elevation of the Sacramento River and would have an access bridge to connect the structure to the adjacent shore.

The in-river diversion structure would be equipped with either flat-plate or cylindrical-tee stainless-steel state-of-the-art fish screens. The structure would be designed to minimize eddies.



SOURCE: USGS, 1993; West Yost & Associates, 2005; and ESA, 2006

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Figure 2
Intake Plan and Profile Views

Pumps and electrical equipment would be installed on the operating floor to provide clearance between the bottom of the access bridge and the 100-year flood stage. The operating floor would be enclosed in a building to provide security and protect the equipment.

The screens would be oriented so that the screen face would be parallel to the river flow, and so that upstream and downstream transitions would minimize the formation of eddies. Depending on regulatory agency preference, either a flat-screen or tee-screen would be installed.

A uniform approach velocity of less than 0.33-foot per second would be provided across the face of the screen. The entire fish screen would be capable of completing one automatic cleaning cycle every five minutes. The Project Partners plan to coordinate with the National Marine Fisheries Service/National Oceanic Atmospheric Administration–Fisheries, U.S. Fish and Wildlife Service, and California Department of Fish and Game to develop site-specific requirements for the intake screens.

Conveyance Pipeline

The Project will include conveyance pipelines to connect the Diversion/Intake Facility with the Water Treatment Plant. As shown by the blue, orange, and pink lines on Figure 1, each of the Diversion/Intake and the Water Treatment Plant Options being considered by the Project Partners would involve a different Conveyance Pipeline Alignment. These include:

- Conveyance Pipeline Alignment 1 - from Diversion/Intake Option 1 (diversion at River Mile 70.5 in joint RD 2035/Project Partner facilities) to Water Treatment Plant Option 1 (a new plant near the Woodland Regional Park site, described below). Untreated water diverted from the Sacramento River would be conveyed to the water treatment facilities through either a 4.5-mile-long, 60-inch-diameter buried pipeline or dual 4.5-mile-long, 42-inch-diameter pipelines.
- Conveyance Pipeline Alignment 2 - from Diversion/Intake Option 2 (diversion at River Mile 67.75 in new Project Partner facilities) to Water Treatment Plant Option 2 (a new plant near the Woodland Regional Park site, described below). Untreated water would be conveyed to a new WTP located southeast of Woodland through a buried 7.5-mile-long, 60-inch-diameter buried pipeline or dual 7.5-mile-long, 42-inch-diameter pipelines.
- Conveyance Pipeline Alignment 3 - from Diversion/Intake Option 3 (diversion at River Mile 63.5 in new Project Partner facilities) to Water Treatment Plant Option 3 (a new plant near the Davis Wastewater Treatment Plant, described below). A buried 6.5-mile-long, 60-inch-diameter buried pipeline or dual 6.5-mile long, 42-inch-diameter pipelines would convey water supplies from the intake to a new water treatment plant near Davis' wastewater treatment plant.

The Project Partners will need to select the corresponding Diversion/Intake Option and Water Treatment Plant Option to determine which Conveyance Pipeline Alignment Option will be needed. Regardless of which location is selected for the pipeline, though, the conveyance pipeline would be installed within public rights-of-way, where available. The pipeline would have appurtenant facilities such as blowoff vents, air and vacuum/air release valves, intertie stations, and access portals.

Air and vacuum valves would admit air into the pipe to prevent the formation of a vacuum that might result from valve operations, rapid draining (such as a line break), or column separation. Access portals would provide access into the pipelines for inspection, maintenance, and repair. Access points would consist of a flanged outlet oriented vertically; removal of the flange would be required for access. Typically, portals would be adjacent to or combined with other appurtenances and would be placed about 2,000 feet apart.

Water Treatment Plant (WTP)

The Project will include a water treatment plant (WTP) to treat the surface water diverted from the Sacramento River so that it can be used to meet the Project Partners' water needs. As part of the Project, a new WTP, about 15 acres in size, would be constructed at a location that can be used to serve the treated water to each of the Project Partners. The WTP may be constructed in two stages to correspond with the actual water demands that are anticipated to develop in the Project Partners' service areas.

It is anticipated that the first-stage treatment facilities would be sized to serve the Project Partners' water demands from 2015 through the year 2025, while the second stage would be sized to serve the Project Partners' water demands from about the year 2025 through the year 2040.

As shown by the yellow squares on Figure 1, the Project Partners have identified three alternative locations for the Water Treatment Plant, each of which will be analyzed in the EIR. These are:

- Water Treatment Plant Option 1 – the new Water Treatment Plant would be located near County Road 22 and Hanson Way.
- Water Treatment Plant Option 2 – the new Water Treatment Plant would be located at the east end of County Road 24
- Water Treatment Plant Option 3 – the new Water Treatment Plant would be located near the existing Davis Wastewater Treatment Plant east of the intersection of County Road 105 and County Road 28H.

Regardless of which location the Project Partners select, the new WTP would use conventional or advanced filtration technologies that have been successfully used to treat municipal and industrial water supplies for other urban water users. Regulating agencies have accepted these processes because they have reliably produced safe, aesthetically acceptable water supplies that meet the drinking water quality objectives specified in Title 22 of the California Code of Regulations. These regulations specify drinking water quality standards for bacteriological quality (pathogens), disinfection by-products, lead, copper, radioactivity, and maximum contaminant levels for specific inorganic and organic chemicals. In addition, a 0.2-milligram-per-liter disinfectant residual must be maintained in the system.

The following components comprise a typical surface water treatment facility:

- Chemical addition and rapid mixing
- Coagulation/flocculation and clarification
- Filtration

- Disinfection

Advanced filtration technologies may eliminate one or more of these components.

Local Water Distribution Facilities

Local water distribution facilities required for the implementation of this Project include new distribution pipelines within the Cities of Davis and Woodland, a connecting pipeline between Davis and UC Davis, and a series of pump stations, water storage facilities, vaults, and other appurtenant facilities to operate and maintain the water supply systems. The anticipated local distribution facilities are shown on Figure 1 with red lines and light orange triangles. Local water distribution facilities would be similar under each of the Diversion/Intake or WTP options.

New Groundwater Wells

New groundwater wells will be needed to meet current water demands in Davis, Woodland, and UC Davis, especially as existing intermediate-depth wells are taken out of service. New wells may also be needed to meet future peak daily demands.

Each Project Partner would independently manage its own groundwater wells and supplies. As wells become obsolete or unusable, the Project Partners would close and abandon wells, consistent with applicable ordinances. New wells are expected to extend into the deeper aquifer, eventually replacing wells that currently pump water from only the intermediate-depth groundwater aquifer.

Water Transfer

The Project Partners have applied for permits to divert surface water from the Sacramento River. Diversions under these permits will be subject to Standard Water Right Permit Term 91, which prohibits diversions when water is being released from storage in CVP or SWP reservoirs to meet in basin entitlements. To have a surface water supply during such conditions (which typically occur in the summer months), the Project Partners would enter into water supply transfer agreements with one or more senior water rights holders. The following senior water rights holders have authorized Davis to include discussion of potential transfers under their water rights in the EIR:

- Anderson-Cottonwood Irrigation District
- Browns Valley Irrigation District
- Natomas Central Mutual Water Company
- RD 108
- River Garden Farms
- Swanston Properties

Additional potential water transfer opportunities and parties may be identified and analyzed in the EIR.

The Project Partners expect to negotiate a water transfer agreement with one or more of these potential transferors after certification of the EIR. Water for transfer would be created when the potential transferor would:

- Implement a groundwater substitution program by pumping groundwater in lieu of using its surface water supplies during some months, thereby freeing up surface water for transfer to the Project Partners during these months.
- Release water from storage for transfer to the Project Partners.
- Implement conservation measures and transfer the conserved water to the Project Partners.

It is expected that the purchase agreement for this supplemental water supply would be for a long-term period (extending from 30 to 50 years) and would include a right for renewal to ensure a long-term supply for the Project Partners.

2.3 Project Alternatives

As required by CEQA, the EIR will analyze a reasonable range of feasible alternatives. Alternatives may be eliminated from detailed discussion if they are found not to be feasible, they fail to meet the Project Partners' objectives, or they are not environmentally superior to the Project. A discussion will be provided to explain why the alternative was eliminated from detailed consideration.

No Project Alternative

As required by CEQA, the EIR will include an analysis of the No Project Alternative. If the No Project Alternative were implemented, the Project Partners would not acquire a new surface water supply from the Sacramento River or construct or operate new surface water diversion/intake and conveyance facilities. Instead, the Project Partners would continue to rely solely on groundwater supplies to meet their future demand.

Under the No Project Alternative, the Project Partners would have to expand their water supply systems to meet additional demand. Continued reliance on the intermediate depth aquifer would likely require demineralization to reduce the TDS level. The brine produced in the treatment process would have to be disposed of, and the Project Partners would have to construct facilities to accomplish this. Individual wellhead treatment systems probably will be required to ensure compliance with anticipated future drinking water and wastewater discharge standards. Many of the intermediate-depth wells cannot accommodate on-site wellhead treatment improvements. Obtaining sites within the urban area to construct new replacement wells and install wellhead treatment units for demineralization would likely require the condemnation of private residences or other private property.

Also, the wells in the intermediate-depth aquifer will all need to be replaced over time because of the age of the facilities. For the reasons set forth above, new wells would likely be drilled in the deep aquifer.

Davis, Woodland, and UC Davis also would likely need to install additional wastewater treatment systems to be able to comply with anticipated future regulations affecting their treated wastewater effluent discharges.

Thus, the No Project Alternative assumes that additional groundwater wells would be drilled and operated, as needed, to meet local water demand and to replace older wells that cannot meet water quality or water volume requirements according to future population growth and development patterns. Each Project Partner would continue to operate its well system independently, according to its individual needs.

Water Supply Alternatives

The EIR will discuss several potential means of obtaining additional water supply of adequate quality to meet the Project Partners' needs.

Water Supply Alternative 1

With implementation of this alternative, the Project Partners would seek a reduced amount of surface water that would be sufficient to supply the Project Partners' anticipated needs through 2030 but would not provide for water needs past that date. This alternative would be limited in size to meet a total demand of about 51,000 af/yr.

The appropriation of this water would be consistent with State Water Resources Control Board's (SWRCB) Standard Water Right Permit Term 91. Term 91 specifies diversion limitations on certain junior water rights in the Sacramento Valley, prohibiting diversion under these rights when in-basin entitlements require the release of supplemental Project water by the Central Valley Project (CVP) or the State Water Project (SWP).

Water transferred to the Project Partners from senior water right holders willing to provide water from their supplies through groundwater substitution or water conservation programs.[1] This water would be used by the Project Partners during those periods of the year when they could not divert water under their own water rights (i.e., when Standard Water Right Term 91 is in effect).

The Project Partners would continue to use groundwater to meet summer daily peaking demands and possibly other drier water-year conditions that could not be met with surface water supplies.

1 Under groundwater substitution programs, surface water currently used to irrigate agricultural crops in the senior water right holders' service areas would be transferred to the Project Partners, and the senior water right holders would pump groundwater in their service areas to replace the transferred water. Under water conservation programs, the senior water right holders would implement water conservation measures in their service areas that would reduce their diversions and consumptive uses of surface water, and the water freed up from such conservation would be transferred to the Project Partners.

Water Supply Alternative 2

Under this alternative, the Project Partners would seek a reduced amount of surface water which would be sufficient to supply the Project Partners' anticipated needs under the population and land uses planned for in Davis' and Woodland's adopted General Plans and UC Davis' adopted Long-Range Development Plan. Because the buildout horizons under the current adopted plans for Davis, UC Davis, and Woodland are 2010, 2015, and 2025, respectively, this alternative would supply the Project Partners' water needs as forecast through those dates but would not provide for water needs arising thereafter. Term 91 limitations would still apply to this diversion, and the Project Partners likely would still need to enter into transfer agreements with existing Sacramento River water rights holders to obtain surface water supplies for the summer months. The Project Partners would still be able to supplement their surface water supplies with groundwater. This alternative would be limited in size to meet a total demand of about 43,000 af/yr.

Water Supply Alternative 3

With implementation of this alternative, the Project Partners would supply all future water needs through aggressive water conservation programs designed to keep water demand at its existing levels. The Project Partners already rely on water conservation measures (as outlined in their respective water management plans) to reduce future water demand. This alternative assumes that much more aggressive water conservation programs, far exceeding the best management practices currently being employed by the Project Partners, would be implemented and would be sufficient to meet the Project Partners' anticipated future water demands.

Under this alternative, the Project Partners would continue to rely primarily or exclusively on groundwater to meet their water supply needs. Each Project Partner would continue to operate its well system independently, according to its individual needs. Older wells that cannot meet water quality or water volume requirements would still need to be replaced, and new wells likely would be drilled in the deeper aquifer. The Project Partners likely would need to install additional wastewater treatment systems to be able to comply with anticipated future regulations of their treated wastewater effluent discharges. Moreover, increased water use efficiency will increase wastewater strength, including total dissolved solids (TDS), and eliminating excessive TDS and other constituents may require advanced wastewater treatment technologies such as reverse osmosis or micro-filtration.

More aggressive levels of conservation would therefore hamper the ability of the Project Partners to achieve their waste discharge standards without also integrating facilities to demineralize the wastewater effluent. The Project Partners would likely have to construct new wastewater treatment plants incorporating these technologies; construction of these facilities would entail its own set of environmental impacts. The Project Partners also likely would need to install individual wellhead treatment systems to ensure compliance with anticipated future drinking water standards.

Water Supply Alternative 4

With implementation of this alternative, the Project Partners would stop using their existing groundwater supplies and would rely exclusively on surface water to meet all their future water supply needs. This alternative would require increased diversion and pipeline capacities that would only be used on an intermittent basis during peak demand periods. Term 91 would still apply to the appropriation of Sacramento River water, so the new area of origin appropriation could not be used to meet water demand in most summer months. Consequently, this alternative would require transfers under existing senior water rights to meet peak demand periods.

Water Supply Alternative 5

Under this alternative, the Project Partners would continue to rely on groundwater but would obtain surface water supplies to meet anticipated future demand through new water-right permits and by purchasing water from senior water rights holders on the Sacramento River.

Alternative Diversion/Intake Facility, Conveyance Pipeline and Water Treatment Plant Locations

As indicated above in the Project description, the preferred Project is obtaining surface water supply capable of being used in conjunction with groundwater to meet the estimated 2040 demand of the Project Partners. This preferred Project has several components, including (1) a Diversion/Intake Facility, (2) a Conveyance Pipeline, and (3) a Water Treatment Plant. The Project Partners are considering three possible locations for each of these Project components.

Alternatives Eliminated from Further Consideration

In accordance with CEQA, the No Project alternative may be different from a “No Development” alternative. For this Project, the No Project alternative assumes that increased future demand for water will be met by the Project Partners’ continued reliance on groundwater supplies. In contrast, a No Development alternative would eliminate the increase in future water demand by assuming that the Project Partners can “freeze” their populations and land uses at their currently existing (baseline) levels. This alternative would not permit growth even at the levels anticipated and planned for in each of the Project Partners’ respective adopted plans. This alternative also would not allow Davis and Woodland to meet their obligation to accept their share of anticipated future regional housing needs. For these and other reasons, the “No Development” alternative is considered to be legally, socially, economically, and otherwise infeasible, and it has been eliminated from further consideration in the EIR.

3.0 Environmental Checklist

Determination

On the basis of this initial study:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☒ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, no further environmental documentation is required.

Richard Hunn

Signature

April 28, 2006

Date

Richard Hunn

Printed Name

Jacques DeBra/City of Davis

For

Environmental Factors Potentially Affected

The proposed project could potentially affect the environmental factor(s) checked below. The following pages present a more detailed checklist and discussion of each environmental factor.

- ☒ Aesthetics
- ☒ Agriculture Resources
- ☒ Air Quality
- ☒ Biological Resources
- ☒ Cultural Resources
- ☒ Geology, Soils and Seismicity
- ☒ Hazards and Hazardous Materials
- ☒ Hydrology and Water Quality
- ☒ Land Use and Land Use Planning
- ☐ Mineral Resources
- ☒ Noise
- ☒ Population and Housing
- ☒ Public Services
- ☒ Recreation
- ☒ Transportation and Traffic
- ☒ Utilities and Service Systems
- ☒ Mandatory Findings of Significance

Description of Impact Methodology

This Initial Study was prepared to support the Notice of Preparation for the Davis-Woodland Water Supply Project (Project) Environmental Impact Report (EIR). This Initial Study presents responses for the checklist items under each of the resource topics addressed. All responses take into account the whole of the action involved, including direct and indirect effects of project implementation, and construction and operation of project facilities.

In instances where Davis has determined that a particular physical impact may occur, the checklist responses provide an initial indication of whether the impact is potentially significant, less than significant with mitigation, or less than significant. Because the City has already elected to prepare an EIR, this initial study does not include a detailed discussion for those impacts identified as potentially significant, less than significant with mitigation, or less than significant. Rather, the responses indicate that further discussion in support of the findings will be provided in the EIR. In instances, where the City anticipates the need for mitigation for a potentially significant impact, this finding is noted with further elaboration to be provided in the EIR.

For each issue area addressed in the initial study, the City has identified appropriate significance criteria or thresholds used to evaluate each topic.

Aesthetics

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
1. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☒	☐
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☒	☐	☐	☐
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☒	☐	☐

Discussion

a) The Project is not located within a local or state-designated scenic vista and would not result in substantial adverse impacts to a scenic vista. The impact is considered less than significant and will be analyzed in the EIR.

b) The Project is not located in close proximity to a state-designated scenic highway. For this reason, the Project would not damage any scenic resources within a state highway and no impact is expected.

c) The Project could include a new intake facility, or reconstruct an existing intake facility, on the Sacramento River which would be visible in the immediate vicinity, including areas on the east side of the river. At the Alternative 1 intake site, the Reclamation District 2035 intake would be replaced with a new intake structure. In addition to the permanent installation of a diversion facility, temporary changes to the visual character of construction areas will result when construction equipment, materials, and crews are introduced. Pipeline installation will also temporarily alter local visual resources until pipeline construction is complete and the disturbed areas are restored or stabilized. These impacts are considered potentially significant and will be analyzed in the EIR.

d) New security lighting would be utilized as part of the Project. At the Alternative 1 diversion site, the lighting intensity would be comparable to lighting at existing facilities. However, at new diversion sites, the Project would add an additional source of nighttime lighting. Mitigation requirements are available to minimize the impacts resulting from light and glare to levels considered less than significant. Evaluation of this potential impact will be included in the EIR.

Agricultural Resources

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
2. AGRICULTURE RESOURCES-Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☒	☐	☐
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☒	☐	☐
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland of Statewide Importance, to non-agricultural use?	☐	☒	☐	☐

Discussion

a) Much of the land within the Project area has been designated as important farmlands by the Department of Conservation. Project facilities could displace agricultural production on lands because of installation of the untreated water and distribution pipelines, water treatment facilities, and other auxiliary facilities (e.g., pump stations). The Project may also reduce demand on local groundwater supplies enabling existing groundwater to be available for irrigated agricultural purposes. Impacts to agricultural lands would be expected to be less than significant with mitigation (e.g., compensation for losses in production). Analysis of impacts to important farmlands will be provided in the EIR.

b) The Project area contains numerous properties currently managed under a Williamson Act contract. To the extent feasible, contract lands would be avoided or conflicts with agricultural use minimized. Analysis of impacts to contract lands and potential mitigation will be presented in the EIR. This impact would be expected to be less than significant with mitigation.

c) The Project would not substantially change development patterns which, due to their location or nature would result in the conversion of farmland to non-agricultural use. This impact would be expected to be less than significant with mitigation and will be analyzed in the EIR.

Air Quality

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
3. AIR QUALITY - Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☒	☐	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☒	☐	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

Discussion

a) The Project area is located in the south-central portion of the Sacramento Valley Air Basin (SVAB). The SVAB is designated non-attainment for ozone and respirable particulate matter (PM_{10}). The Project would take place in an area for which ozone and PM10 plans have been developed. Construction emissions will be managed in accordance with the requirements of the Yolo-Solano Air Quality Management District. Impacts on air quality are considered to be less than significant and will be analyzed in the EIR.

b) Construction-related activities resulting from the Project would result in the generation of criteria air pollutants, including NO_x, ROG, and PM_{10}, from construction equipment, truck exhaust, soil disturbance, and wind erosion. The Project Partners may be required to implement appropriate measures to reduce these effects to a less-than-significant level. Estimated construction emissions will be discussed in the EIR.

c) Operation of the Project would result in a minimal increase in criteria air pollutants. Calculations in support of this conclusion will be provided in the EIR. This impact is expected to be less than significant with mitigation and will be analyzed in the EIR

d) Pipelines to convey and distribute untreated water are expected to be constructed near residential land uses. With the implementation of the measures prescribed in question (b), construction of the Project would not significantly affect local sensitive receptors and the impact is considered less than significant and will be analyzed in the EIR.

e) Implementation of the Project would not create a source of objectionable odors. Consequently, no impact is expected.

Biological Resources

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
4. BIOLOGICAL RESOURCES— Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☒	☐	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☒	☐	☐
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☒	☐	☐

Discussion

a) Requirements imposed by agencies with regulatory jurisdiction will require that the Project is designed, constructed, and operated in a way that will minimize significant adverse impacts, either directly or through habitat modifications, to endangered, rare, or threatened species, as listed in 14 CCR 670.2 or 670.5 or in 50 CFR 17.11 or 17.12. The EIR will include an evaluation of potentially occurring species, including the following:

- Fish Species. Because the Project would involve work within the Sacramento River, the most important special-status species to consider are the endangered winter-run

Chinook salmon and the threatened delta smelt, and spring-run Chinook salmon and Central Valley steelhead trout.

- Valley Elderberry Longhorn Beetle (VELB). The Project area has not been surveyed for suitable habitat for the federally threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB). As part of the EIR, investigation of all Project facilities will be surveyed to determine the presence elderberry shrubs and the likelihood of VELB. In instances where shrubs are identified, appropriate mitigation consistent with current protocols would be identified.
- Giant Garter Snake. Potentially suitable giant garter snake habitat may occur within irrigation ditches and natural drainage ways that may be crossed by the Project. Surveys will be conducted in support of the EIR to determine potential effects to giant garter snake and appropriate mitigation applied where necessary.
- Swainson's Hawk. Suitable nesting habitat for Swainson's hawk (*Buteo swainsoni*) is found adjacent to the Sacramento River within the valley riparian habitat. Additionally, the construction of the water treatment plant (WTP) and pipelines may affect foraging habitat. Formal surveys will be conducted for the EIR to determine potential effects to Swainson's hawk and appropriate mitigation measures will be applied where necessary.

Based on the habitats found in the Project area, the following special-status species will also be addressed in the EIR:

- Bank swallow – *Riparia riparia*
- Tricolored blackbird - *Agelaius tricolor*
- White-tailed kite – *Elanus leucurus*
- Western burrowing owl – *Athene cunicularia*
- Aleutian cackling goose – *Branta hutchinsii leucopareia*

The construction of the Project may affect potential habitat for these species. In addition, other nesting birds (such as migratory birds protected by the Migratory Bird Treaty Act) may also be affected by the Project. To compensate for potential impacts, mitigation measures will be prescribed to minimize impacts.

Several special-status plant species may inhabit areas that would be affected by the alternative facility locations. These species will be identified and discussed in the EIR.

b) Construction of Project facilities will occur in riparian areas and possibly occur in other sensitive plant communities, such as wetlands. Existing plans will be reviewed to determine potential conflict with policies of state and federal agencies. This impact is expected to be less than significant with mitigation and will be analyzed in the EIR.

c) The Project would place fill in the Sacramento River in conjunction with the installation of the diversion facilities. In addition, irrigation channels and drainage may be modified as part of installing the conveyance pipeline from the proposed diversion facilities. Effects to wetlands and waters of the U.S. will be addressed in the EIR. This impact is expected to be less than significant with mitigation and will be analyzed in the EIR.

d) The Project is not expected to substantially interfere with the movement or migration of species found in the area. Local movement may be obstructed during construction. Measures to minimize potential impacts will be identified in the EIR. This impact is expected to be less than significant and will be analyzed in the EIR.

e) Local and regional policies will be addressed to determine potential conflicts with construction and operation of Project facilities. This impact is expected to be less than significant with mitigation and will be analyzed in the EIR.

f) The Project will be assessed to determine its potential to conflict with the Yolo County Habitat Conservation Plan (HCP) and Natural Conservation Community Plan (NCCP). This impact is expected to be less than significant with mitigation and will be analyzed in the EIR.

Cultural Resources

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
5. CULTURAL RESOURCES— Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
b) Cause a substantial adverse change in the significance of a unique archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐

Discussion

a) A records search of all pertinent survey and site data will be conducted to determine if historic structures and/or resources are present within the Project area. This impact is expected to be less than significant with mitigation. A further evaluation in support of this conclusion will be provided in the EIR.

b) A formal records search of pertinent survey and site data will be conducted as part of the EIR to determine if archaeological resources are present within the Project area. This impact is expected to be less than significant with mitigation.

c) The Project is not likely to destroy, either directly or indirectly, a unique paleontological resource or site or geological feature. The implementation of mitigation prescribed in the EIR is expected to reduce potential impacts to a less-than-significant level.

d) In the event that human remains are discovered, work within the immediate vicinity of the find will be stopped and the Yolo County Sheriff-Coroner will be notified immediately. Work will only resume after the investigation and in accordance with any requirements and procedures imposed by the Yolo County Sheriff-Coroner. If determined to be Native American origin, coordination with the California Native American Heritage Commission will be undertaken. Mitigation requirements contained in the EIR will ensure a less-than-significant impact.

Geology, Soils, and Seismicity

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
6. GEOLOGY, SOILS, AND SEISMICITY— Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? (Refer to Division of Mines and Geology Special Publication 42.)	☐	☐	☒	☐
ii) Strong seismic ground shaking?	☐	☐	☒	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☒	☐
iv) Landslides?	☐	☒	☐	☐
b) Result in substantial soil erosion or the loss of topsoil?	☐	☒	☐	☐
c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☒	☐
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☒	☐
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒

Discussion

a) i) A review of Special Publication 42 for areas in the vicinity of the Project indicates that the site is not within an Alquist-Priolo Earthquake Fault Zone (CGS Special Publication 42, 1999). For this reason, impacts resulting from rupture of a known earthquake fault are considered less than significant and will be analyzed in the EIR.

ii) Due to the substantial distances of active fault sources from the Project, the risk of strong ground shaking is considered relatively low, when compared to other areas in California. Design of the Project in conformance with the 2001 California Building Code (CBC) Seismic Design Parameters for Seismic Zone 3 should be sufficient to prevent significant damage from ground shaking during seismic events resulting from movement on any of the local faults and/or fault systems. For these reasons, impacts resulting from seismic ground shaking are considered less than significant and will be analyzed in the EIR.

iii) The soils encountered in the Project area generally consist of inter-bedded sandy silts, silts, silty clays and clays; however, no formal subsurface exploration has been conducted to confirm this conclusion. Groundwater elevations in the immediate vicinity of the river are highly influenced by the water surface elevation of the Sacramento River. Accordingly, the potential for liquefaction, lateral spreading, differential settlement during the maximum credible earthquake is considered minimal. Design of the Project in conformance with the 2001 CBC Seismic Design Parameters for Seismic Zone 3 should be sufficient to prevent significant damage from seismically induced ground failure. This impact is expected to be less than significant and will be analyzed in the EIR.

iv) The Project area is generally level, with the exception of the levee along the western perimeter of the Sacramento River. The placement of new facilities on levees and on the land-side of the levee could destabilize the levee embankment. The levee alterations would be designed in accordance with the requirements of the State Reclamation Board, local levee maintenance district, and recommendations of the Project engineer. This impact is expected to be less than significant with mitigation and will be analyzed in the EIR.

b) During Project construction, grading and other soil-disturbing activities may introduce the potential for accelerated soil erosion. The Project would be required to prepare a Storm Water Pollution Prevention Plan (SWPPP) in accordance with Section 402 of the Clean Water Act. As a result, any potential impacts will be reduced to a less-than-significant level through the implementation of appropriate mitigation and will be analyzed in the EIR.

c) The Project will be constructed according to industry standards to protect proposed structures against hazards associated with unstable soil conditions, landslides, lateral spreading, subsidence, liquefaction, or collapse. With compliance with UBC criteria for Seismic Risk Zone 3, CBC amendments, and other applicable design standards, risks associated with these geologic hazards would be minimized to a less-than-significant level and will be analyzed in the EIR.

d) If unstable soil conditions are encountered, standard engineering practices will be incorporated into the Project to protect structures from the effects associated with expansive soils. As a result, the impact is considered to be less than significant and will be analyzed in the EIR.

e) No additional new onsite wastewater treatment systems to support the Project are necessary. Consequently, no impact is expected.

Hazards and Hazardous Materials

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
7. HAZARDS AND HAZARDOUS MATERIALS Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☒	☐	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☒	☐
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☒	☐	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☒	☐	☐

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
7. HAZARDS AND HAZARDOUS MATERIALS Would the project:				
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☒	☐

Discussion

a) The construction of the Project and the increased routine transport, use, or disposal of hazardous materials would not create a significant hazard to the public or the environment. Operation of the WTP facility would include the routine transport of minor quantities of chemicals used in water treatment. These chemicals would be transported in accordance with county and state requirements. As a result, impacts are considered to be less than significant and will be analyzed in the EIR.

b) Actions associated with the Project have the potential to accidentally release hazardous materials into the environment. However, the implementation of best management practices will be followed according to protocols recommended in the Project Partners' or other applicable Hazardous Materials Management Plan (HMMP). In addition, the integration of standard transportation, handling, and disposal protocols make it further unlikely that an accidental release will occur during construction. For this reason, the Project would not create an additional significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. As a result, the impact is considered less than significant with mitigation prescribed in the HMMP.

c) The proposed alternative WTP sites would not be located within one-quarter mile of a school. In considering the nature of the proposed facilities and minimal quantities and types of hazardous substances used during construction, there would be negligible impacts to local schools. As previously indicated in response to Items 7a and 7b, when the WTP is operational, hazardous materials will be transported, stored, and handled in a manner consistent with applicable regulations and guidelines. As a result, the impact is considered less than significant.

d) A formal agency database search will be conducted to confirm the locations and types of hazardous material sites historically reported within the Project area. Nonetheless, during excavation, it is possible that contaminated soil and/or groundwater could be encountered, which may pose a health threat to construction workers, the public, and the environment. Implementation of mitigation that will be prescribed in the EIR would reduce the impact to a less-than-significant level.

e), f) The construction and operation of the proposed diversion, fish screens, WTP, and distribution pipelines would have no effect on preexisting safety hazards relative to any nearby public airport operations. For this reason, no impact would occur from the implementation of the Project.

g) The Project Partners will be required to obtain encroachment permits for any crossing of County rights-of-way. Compliance with the encroachment permit and the mitigation prescribed in the EIR will ensure that the Project does not interfere with adopted emergency response plans or emergency evacuation plans. As a result, the impact is considered less than significant with mitigation and will be analyzed in the EIR.

h) The Project is located in a rural area where the risk of wildland fire is considered to be low to moderate. Construction equipment shall be equipped with arresters in good working order. The Project is therefore not expected to expose people or structures to a significant risk of loss, injury, or death involving wildland fires. As a result, a less-than-significant impact is anticipated.

Hydrology and Water Quality

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
8. HYDROLOGY AND WATER QUALITY— Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☒	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☒	☐	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion of siltation on- or off-site?	☐	☒	☐	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site?	☐	☒	☐	☐
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☒	☐	☐

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
f) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other authoritative flood hazard delineation map?	☐	☐	☐	☒
g) Place within a 100-year flood hazard area structures that would impede or redirect flood flows?	☐	☒	☐	☐
h) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☒	☐	☐
i) Expose people or structures to a significant risk of loss, injury or death involving inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒

Discussion

a) Construction activities within the Sacramento River and other waterways could increase turbidity, introduce oils and grease, and affect downstream salinity and water quality constituents in the Sacramento-San Joaquin Delta. Applicable water quality standards are delineated in the Water Quality Control Plan for the Sacramento and San Joaquin River Basins and the Water Quality Control Plan for the San Francisco Bay/Sacramento and San Joaquin Delta Estuary.

In anticipation of potential water quality impacts, the Project Partners will implement a mitigation program during construction to minimize adverse impacts to water quality. Details of this program will be provided in the EIR. This impact is expected to be less than significant with mitigation.

b) Dewatering operations may occur as part of constructing the Project and may result in localized and temporary lowering of the water table. However, these operations would use standard methods as required by the RWQCB's General Dewatering Permit. Consequently, potential impacts to groundwater quantity and quality associated with Project construction are considered to be less than significant and will be analyzed in the EIR.

The Project would reduce reliance on the regional groundwater basin as a municipal water supply source and therefore is expected to lessen the impacts of ongoing groundwater pumping. The EIR will evaluate this change in water supplies to characterize potential changes in groundwater use resulting from the Project's implementation. Potential impacts on groundwater resulting from groundwater substitution water transfers will be identified and characterized. This impact is expected to be less than significant with mitigation.

c) Best management practices will be employed to control and minimize erosion potential, reestablish construction areas, and protect water quality. This impact is expected to be less than significant with mitigation and will be analyzed in the EIR.

d) Drainage patterns will be temporarily disrupted during Project construction. However, the Project will not increase the rate or amount of surface runoff in a manner that would result in on- or offsite flooding. As a result, runoff-related impacts are considered to be less-than-significant with mitigation and will be analyzed in the EIR.

e) The WTP would create new impervious surfaces. A drainage plan would minimize new sources of runoff in conjunction with associated non-point sources of pollution. Therefore, the Project is not expected to exceed the capacity of existing or planned storm water drainage systems, and impacts are considered to be less than significant with mitigation and will be analyzed in the EIR.

f) The Project would not include the construction or placement of housing within floodplains. Consequently, no impact is expected.

g) The Project would place a new diversion facility within a 100-year flood zone of the Sacramento River, thereby carrying the potential to redirect or impede flood flows. An engineering hydraulic analysis will determine the extent of this potential interference with river flows and identify measures to minimize potential effects. With the implementation of engineering design features, this potential impact would be mitigated to a less-than-significant level and will be analyzed in the EIR.

h) To ensure that the integrity of affected levees is not compromised, the Project will use appropriate standard engineering practices for stabilizing and compacting soils both during construction and following the installation of the proposed diversion and raw water pipeline. Construction plans, specifications, and inspections will be coordinated with the State Reclamation Board, U.S. Army Corps of Engineers, and local reclamation districts. Following completion of the Project, residual impacts would be less than significant with mitigation and will be analyzed in the EIR.

i) Since the Project is not located near the ocean or any large water bodies, risks associated with seiche or tsunami are considered low. In addition, the Project site is essentially level, with minimal hazards from mudflows. Therefore, no impact is anticipated.

Land Use, Planning, and Policies

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
9. LAND USE AND LAND USE PLANNING— Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☒	☐
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☒	☐	☐

Discussion

a) The Project would not construct any physical features that would divide an established community or neighborhoods. For this reason, no impact is expected.

b) The Project would not alter current land uses, with the exception of the new WTP site. The Project would not conflict with applicable land use policies adopted for the purpose of avoiding or mitigating an environmental effect. For these reasons, impacts are anticipated to be less than significant and will be analyzed in the EIR.

c) The Project is located within the boundaries of the Yolo County Habitat Conservation Plan (HCP) study area. Although not adopted, the EIR will address the Project's potential consistency with likely provisions of the HCP as currently envisioned. This impact is expected to be less than significant with mitigation and will be analyzed in the EIR.

Mineral Resources

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less than Significant with Mitigation Incorporation	Less-than-Significant Impact	No Impact
10. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒

Discussion

a), b) The Project will be constructed on a site that has not been identified as a significant source of mineral resources. According to the Yolo County General Plan Background Report, mineral resources areas classified as MRZ-2 by the State Geologist are concentrated along Cache Creek, to the west of the Project area. Therefore, no impact is expected.

Noise

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less than Significant with Mitigation Incorporation	Less-than-Significant Impact	No Impact
11. NOISE—Would the project:				
a) Result in exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☒	☐	☐
b) Result in exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☒	☐	☐
c) Result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☒	☐	☐
d) Result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☒	☐	☐	☐
e) For a project located within an airport land use plan area, or, where such a plan has not been adopted, in an area within two miles of a public airport or public use airport, would the project expose people residing or working in the area to excessive noise levels?	☐	☐	☐	☒

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
f) For a project located in the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

Discussion

a) The Project would generate temporary noise associated with the construction and installation of Project features. Operation of the Project would be limited to pumps and electrical and water treatment equipment.

The Project area is primarily located in rural sections of the Yolo County, except for portions of the Project (e.g., the WTP, distribution pipelines) located in Davis and Woodland and on the UC Davis campus. Agricultural production is the primary land use over most of the Project area. Sensitive receptors in the rural areas of the Project are generally limited to scattered rural residences and residential areas near the edges of each respective jurisdiction.

In certain instances, the nearest residences may be within 100 feet of Project construction and, therefore, are likely to be affected by temporary construction noise. Long-term changes to the ambient noise environment would be expected to occur within the vicinity of pump stations and the WTP. These impacts would generally be mitigated by incorporating noise-attenuating technologies and noise barriers to ensure that noise emanating from the facilities at maximum operation will not exceed applicable standards and to ensure a less-than-significant impact level. However, further analysis will be presented in the EIR to support this conclusion.

b) Construction of the Project will incorporate the use of pile-driving to install the foundation of the new diversion/fish screen facilities. Pile-driving will be a source of ground-borne vibration. Given that this activity would occur for a limited duration, the impact of exposure would be minimal. However, noise-attenuating mitigation may be needed to reduce this impact to a less-than-significant level and will be analyzed in the EIR.

c) As described in (a), the Project would introduce new noise sources that would increase the ambient noise environment. The EIR will estimate changes to ambient noise levels that may result from project operations. It is expected that the use of noise-reduction measures in the final design of new pump station and the WTP will reduce operational noise impacts to a less-than-significant level.

d) Project construction activities would cause temporary increases in ambient noise levels in the Project vicinity. Given that noise-reduction mitigation will be included within the EIR and given the temporary nature of construction-related noise, these increases would be minimized. In locations near sensitive receptors, construction-related noise may temporarily exceed acceptable levels. This would result in a potentially significant impact.

e), f) No new residential housing would be constructed part of the Project. For this reason, the Project would not expose people residing or working in the Project area to excessive noise levels associated with air traffic. As a result, no impact is expected.

Population and Housing

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
12. POPULATION AND HOUSING— Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☒	☐	☐	☐
b) Displace substantial numbers of existing housing units, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

Discussion

a) The Project would not directly induce population growth or require the extension of new infrastructure or development.

The Project would provide a new source of potable water to Davis and Woodland and the UC Davis campus that could be used alone or blended with existing groundwater supplies to serve the three service areas. Alternatives to the Project could provide a volume of water sufficient to serve future populations and meet future demand. Therefore, certain alternatives to the Project could contribute to an increase in regional or local populations by removing an obstacle to future growth and is considered potentially significant. The EIR will analyze the Project’s potential to induce growth above the levels approved in the Project Partners’ approved plans to the extent that these impacts are reasonably foreseeable. While the Project Partners are unable to predict which locations will develop at what time in the future, they can forecast anticipated patterns of land use development that will be facilitated by the Project, and the EIR will analyze environmental impacts associated with this development, such as conversion of agricultural lands, changes in visual character/aesthetics, hydrology impacts associated with urbanization, air quality impacts, and regional traffic impacts. .

b) The Project would not require the demolition of existing housing, thereby necessitating the construction of housing elsewhere. As a result, no impacts are anticipated.

c) As stated in (b) above, the Project is not expected to displace people from their homes. Therefore, no impacts are anticipated.

Public Services

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
13. PUBLIC SERVICES— Would the project:				
a) Result in substantial adverse physical impacts associated with the provision of, or the need for, new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the following public services:				
i) Fire protection?	☐	☐	☒	☐
ii) Police protection?	☐	☐	☒	☐
iii) Schools?	☐	☐	☒	☐
iv) Parks?	☐	☐	☒	☐
v) Other public facilities?	☐	☐	☒	☐

Discussion

a) The Project would not result in the need to provide new governmental facilities. In addition, the Project would not generate any additional demands for additional public services that would require new or altered facilities, including police and fire protection. As previously indicated, the Project would remove an obstacle to future population growth which could create additional demand for public services.

However, because each respective jurisdiction's General Plan provides a policy framework for providing schools, parks, or other public services, future land development projects would address their effects on these services and mitigate potential impact when appropriate. The indirect effects attributable to the Project are less than significant and will be analyzed in the EIR.

Recreation

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
14. RECREATION—Would the project:				
a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facilities would occur or be accelerated?	☐	☐	☒	☐
b) Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?	☐	☐	☐	☒

Discussion

a) The Project is not expected to contribute to any increased use of recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated. For this reason, impacts are expected to be less than significant. However, given the recreational use along the Sacramento River, this issue will be analyzed further in the EIR to address this conclusion.

b) The Project does not include or require the construction of new recreational facilities. Further, as discussed in (a), the Project is not expected to increase demand for recreational facilities such that construction or expansion of those facilities is necessary. In addition, the Project is not expected to affect the recreational values along the Sacramento River. Appropriate navigational signage will be provided to alert recreational boaters of the in-river intake facilities. As a result, no impact is expected.

Transportation and Traffic

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
15. TRANSPORTATION AND TRAFFIC— Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume-to-capacity ratio on roads, or congestion at intersections)?	☐	☒	☐	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐

Issues (and Supporting Information Sources):	Potentially Significant Impact	Less than Significant with Mitigation Incorporation	Less-than-Significant Impact	No Impact
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐		☒
e) Result in inadequate emergency access?	☐	☒	☐	☐
f) Result in inadequate parking capacity?	☐	☒	☐	☐
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., conflict with policies promoting bus turnouts, bicycle racks, etc.)?	☐	☐	☐	☒

Discussion

a) Construction activities would temporarily generate increased traffic because of construction-related worker trips and truck movements to and from construction sites. As a consequence, appropriate traffic routing measures will be implemented to reduce traffic delays and minimize impacts to local roadways. However, because the Project would be located in a rural agricultural area with minimal traffic loads, these effects are not expected to be substantial. Operation of the Project would generate minimal new traffic with respect to new worker trips and/or deliveries to and from the WTP.

Construction and installation of pipelines in the urban areas may temporarily interfere with local traffic movement and cause congestion in certain areas. Traffic management planning would effectively minimize the potential for increased vehicle congestion and interruption of traffic flow in the urbanized areas. As a result, traffic impacts would be reduced to a less-than-significant level through the application of construction-traffic management measures and will be analyzed in the EIR.

b) The Project will include traffic routing measures to ensure that increases in traffic do not exceed, either individually or cumulatively, level of service standards. Impacts to those standards are, therefore, considered less than significant and will be analyzed in the EIR.

c) The Project would not cause any change in air traffic patterns. No impact is expected.

d) Construction of the Project is not expected to require any relocation or any change to roadway design features. Further, appropriate traffic routing and signage measures will be implemented to avoid and/or minimize such conflicts and ensure no impact.

e) Construction and pipeline installation could result in temporary lane closures. Construction at these locations would, therefore, have the potential to create temporarily inadequate emergency access. However, as previously indicated, traffic routing measures will be implemented to minimize any such impacts. Impacts are, therefore, considered to be less than significant with mitigation and will be analyzed in the EIR.

f) Project-related construction activities would require temporary parking for workers and equipment. However, these parking areas would be sited to minimize impacts to existing parking facilities. This impact is expected to be less than significant with mitigation and will be analyzed in the EIR.

g) The Project does not include alternative forms of transportation, nor is it expected to create conditions that conflict with adopted policies supporting alternative transportation. Therefore, no impact is expected.

Utilities and Service Systems

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
16. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Conflict with wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☒	☐	☐	☐
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☒	☐
d) Require new or expanded water supply resources or entitlements?	☐	☒	☐	☐
e) Result in a determination by the wastewater treatment provider that would serve the project that it has inadequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☐	☒
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☒

Discussion

a) The Project would not increase the demand for wastewater treatment; nor does it include the construction of any new wastewater treatment facilities. For this reason, the Project will not exceed wastewater treatment requirements of the Central Valley Regional Water

Quality Control Board. The Project is expected to improve the treated effluent quality at the Davis, Woodland, and UC Davis wastewater treatment plants by improving source water quality. Therefore, no adverse impact is anticipated.

b) The Project would involve the construction of new water treatment facilities and distribution pipelines, the effects of which will be analyzed in the EIR. Effects associated with the WTP's construction and local distribution pipelines may cause potentially significant on biological resources, drainage, cultural resources, traffic congestion, noise and loss of agricultural lands and will be analyzed in the EIR.

c) The Project would require new onsite drainage infrastructure for the WTP; however, these facilities would not be connected to a larger drainage infrastructure network. As a result, no expanded stormwater conveyance facilities, the construction of which could cause significant adverse environmental effects, would be required. This impact is less than significant.

d) The Project is an alternative water supply project designed to provide a reliable water supply to the Project Partners. It would not require new or expanded water supplies beyond those planned with this Project.

This Project does rely on obtaining a new water right for the diversion and use of surface water from the Sacramento River. The effect of diverting and using this supply will be addressed in the EIR.

Effects associated with the diversion and conveyance or the water supply to the Project Partners' service areas may cause potentially significant impact on biological resources, drainage, cultural resources, traffic congestion, noise and loss of agricultural lands and will be analyzed in the EIR.

e) The Project would not generate any significant additional demands for wastewater treatment, and therefore, no impact is expected.

f) Once constructed, operation of the Project will produce solid waste beyond that produced under existing conditions, but this issue will be covered in more detail in the EIR. No impact is expected

g) The Project will comply with all relevant federal, state, and local statutes and regulations related to solid waste. Therefore, no impacts are anticipated.

Mandatory Findings of Significance

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less than Significant with Mitigation Incorporation*	*Less-than-Significant Impact*	*No Impact*
17. MANDATORY FINDINGS OF SIGNIFICANCE—Would the project:				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☒	☐	☐
d) Does the project have the potential to achieve short-term environmental goals to the disadvantage of long-term environmental goals?	☐	☒	☐	☐

Discussion

a) The Project has the potential to affect the hydrology and water quality of the Sacramento River and substantially reduce habitat for fish and wildlife species. These changes may contribute to reducing the number of Chinook salmon, delta smelt, giant garter snake, or other species below self-sustaining levels. The Project is not expected to eliminate important examples of California history or prehistory.

These effects would be minimized by the design of the Project and by the mitigation requirements described in the EIR. The particular impacts, as well as the Project design elements and mitigation requirements that would reduce the effects to below a level of significance, will be described in the EIR.

b) The Project has the potential to contribute to cumulative effects on air quality resulting from the emissions from construction equipment and to the hydrology and water quality of the Sacramento River and Delta. With the integration of Project design features and operational restrictions, in conjunction with the implementation of the prescribed mitigation, potential cumulative impacts would be mitigated to a less-than-significant level and will be analyzed in the EIR

c) The Project would not directly or indirectly cause substantial adverse effects on human beings. Air quality and noise would be the only issues through which the Project could have a substantial effect on human beings. However, potential effects of the Project on air quality and noise generated by construction equipment would be mitigated to a less-than-significant level and would, therefore, avoid causing substantial adverse effects on human beings.

d) The development of a surface water supply for the Project Partners has the potential to conflict with environmental goals for the management and protection of fish species in the Sacramento River, habitat and special-status species in Yolo County, and long-term protection of important farmlands. These issues will be addressed in the EIR.

Written and Summarized Oral Comments on the April, 2006 Notice of Preparation

Summary of Oral Comments Received on the Davis-Woodland Water Supply Project EIR Notice of Preparation

Woodland Meeting May 18, 2006

Joe Green-Heffern

- Need to consider future plans for levee management and possible conflicts when selecting diversion location based on levee stability.
- Levee modification due to the project should consider any future modifications that may be required to affected levees and work to incorporate those improvements.

Rolf Frankenbach/Yolo Resident

- Will there be energy savings from project when compared to groundwater pumping and wastewater treatment requirements?
- Will allocation/mix of water sources affect wastewater treatment processes?
- Who will own and operate the project?
- Will water be purchased?

Davis Meeting May 22, 2006

Chris Sheraton/California Farm Bureau

- EIR needs to analyze potential loss of agricultural production resulting from transferring water from agricultural to municipal use.

Gary Shad/Dunnigan Resident

- An extension of the Tehama/Colusa Canal (T/C/ Canal) to serve both agricultural and municipal uses should be considered.

Vijay Kumar/ Davis Resident

- Approach being used is “piece-mealing”; EIR should discuss place of use and area of origin; a Program EIR should be prepared and followed by a Project EIR.
- Surface water supply should be considered an unreliable water source.
- An extension of the T/C Canal should be considered as an alternative.
- EIR should address operation impacts, including a technical discussion of how water will be managed (blended from multiple sources) and achieve water quality objectives. Includes examping any socio-economic impacts resulting from providing different water qualities to different areas served by the project.

- Questions why West Sacramento is involved given their limited treatment capacity.
- Questions the viability of operating two separate water systems in each community.
- Substantial investment in wastewater treatment is still needed, regardless of water quality.
- Partners need to look for better quality and more reliable water supply.
- Preparation time for the EIR is too short.

Leah Orloff/Contra Costa Water District

- Impacts of project on downstream drinking water quality, including timing of diversions, must be addressed.
- Impacts can be considered significant even if no violation of standards occurs.CCWD wants to work with Davis.
- CCWD intends to offer additional comments after review of studies.

Matt Vanderslice/Davis Resident

- Aggressive Conservation Alternative needs robust analysis.
- Suggests reviewing
    - DWR 2005 Water Plan Update (Bulletin 160)
    - PCL, 2004 Investment Strategy for Calif. Water
    - Pacific Institute, California Water 2030: An Efficient Future
- Increased water use efficiency may affect wastewater treatment by resulting in less water to treat.
- Will there be a reduction in groundwater use; Project needs to ensure that groundwater use will not increase.
- Current state of the Delta needs to be addressed, including decline in Delta quality and pelagic organism decline.
- Climate change needs to be addressed in relation to changes in future water supply reliability.
- Energy impacts of pumping needs to be addressed, along with air quality impacts and savings associated with water conservation, Calif. Energy Commission studies should be used as basis of analysis.
- Impacts of diversions and fish screens needs to be addressed. Loss at new screens should be assessed.
- The NEPA process should be described including which alternatives will be assessed.
- Limits of using the CALSIM model should be included in the document.

Natural Resource Commissioner's Comments

- EIR should consider overall Delta management and the CALFED process.
- T/C Canal alternative may have intake, drinking water quality, and fish benefits.
- Water conservation should be reflected in all alternatives for all partners.
- What other ways can hydrology be analyzed considering limits of CALSIM model?

- How can climate change be addressed – EIR should include analysis of greenhouse gas and energy impacts.
- EIR should examine socio-economic impacts of supply varying water quality to different part of the project service areas.

Comments on Davis/Woodland Water Supply Project

City staff should be complimented for evaluating various options to find a solution for drinking water quality as well as improving wastewater effluent that eventually may reduce wastewater treatment and disposal costs. Drinking water in Davis, Woodland and UCD needs improvement from a water quality perspective. If a project is not implemented in the next 10 years, it is unlikely to happen in the future due to regulatory constraints and very high capital costs.

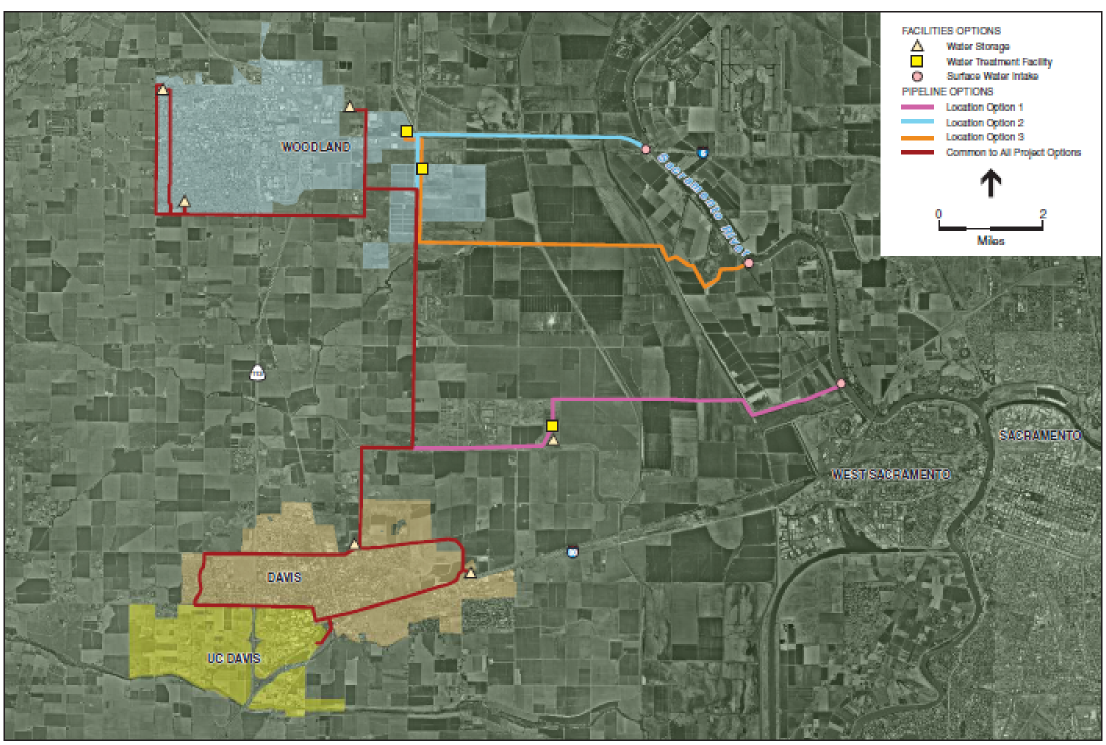
Since Woodland and UC Davis are involved, it provides a framework for successful implementation since it is being viewed as a Regional Project by the Regulatory Agencies.

The proposed project consists of diverting surface water from the Sacramento River and providing treatment at a new water treatment that will be built either near Woodland or Davis. New transmission lines are needed to supply water from the new water treatment plant to Davis, Woodland and UC Davis. Existing distribution system within the above areas would be used to supply treated surface water to residents.

As stated in the Notice of Preparation for the EIR, there are 4 major alternatives that are being considered as shown below:

Alt. 5—Divert Sacramento River water from existing City of West Sacramento intake (near Ikea) and treat at a new plant to be located northeast of City of Davis.

Alt 5A—Divert Sacramento River water from a new intake located about 1 mile upstream of the City of West Sacramento intake and treat at a new plant to be located northeast of City of Davis.



Alt 5B—Divert Sacramento River water from RD 2035 intake (located just north of I-5 Bridge southwest of SAC airport) and treat at a new plant to be located at the eastern end of City of Woodland.

Alt 5C--Divert Sacramento River water from a new intake located about 5 miles downstream of RD 2035 intake and treat at a new plant to be located at the eastern end of City of Woodland.

From an implementation perspective, each of the above alternatives has its own advantages and disadvantages. The common elements amongst all alternatives are

1. **Unavailability of Surface Water:** Although project proponents have filed a Water Rights application (based on area of origin) with the State Board in early 1990s, nothing happened in last 13 years. There is limited availability of extra water in the Sacramento River due to several other Regional projects such as Freeport and City of Sacramento/Placer County Water Supply project. Also, environmental needs (mainly fish flows) used up any remaining surface water. It is important to maintain City's application's priority with the State Board.

2. **Uncertainly of Availability:** Even if water rights application is approved, it is subject to Term 91 conditions. This means, surface water is not available from May through October in dry years—assume once in 5 to 8 years). Supplemental water needs to be purchased and similar uncertainty exists. Note that the water demand is highest from May through October due to outdoor water use. Conjunctive water use is needed and there is limited success in groundwater storage and recovery.

3. **Excessive Cost of Intake Facility:** National Oceanic Atmospheric Administration (Federal agency responsible for Fisheries) is requiring elaborate fish screens on all new intakes or upgrades to existing intakes. In addition, fish screens are very expensive to operate and maintain. RD 2035 intake upgrade is also subject to the same requirement. Actual implementation of intake upgrade is uncertain due to funding constraints and project timing (there are three other intake projects ahead of RD 2035 and limited funding in the near future). Current capacity of RD 2035 intake is 400 cfs and they need only 300 cfs. The proposal is to use the remaining 100 cfs. Since it was constructed for agricultural purposes, it will be an uphill battle to obtain regulatory concurrence to use agriculture diversion for municipal use (requires amendment of Warren Act).

4. **Overall Program Cost:** Although preliminary estimates have been made, it should be noted that cost estimates at this level could be off by as much as 50%. O & M costs appear to be low. However, to evaluate various alternatives, it is a good basis.

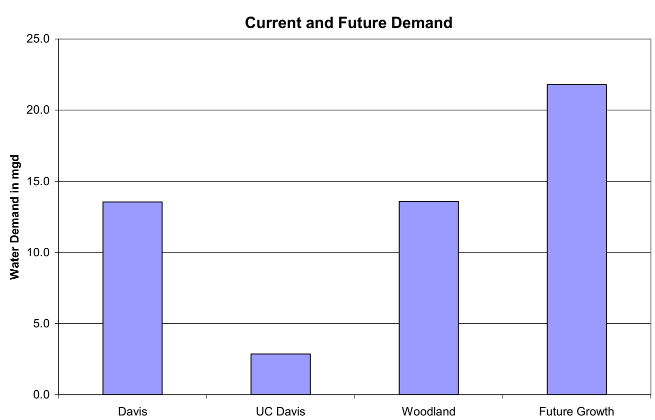
5. **Policy Decision:** In the overall framework, all surface water alternatives provide almost similar benefits for the given cost. Therefore, Davis, Woodland and UCD have to reaffirm their policy decision on

    a. surface water only
    b. groundwater with treatment
    c. a combination of surface and groundwater

Obviously, groundwater with treatment is the lowest cost and surface water only has the highest cost.

Major issues with Current Project

1. **Water Availability**—limited, uncertain, insufficient quantity
2. **Water Quality**—Due to water quality near Sacramento, increased treatment cost
3. **Piece-Mealing of Environmental Documentation**—Current environmental documentation is evaluating impacts of 4 alternatives. There is no program EIR. Additional environmental documentation is needed for water rights, change of place of water use, water transfer, conjunctive use, operations and maintenance. Therefore, opponents would challenge CEQA process. Opposition could come from City of Sacramento, Placer County, CUWA, MWD, CCWD and even West Sacramento. These senior water rights holders will oppose any new "**straw**" into the River and they need additional water for their growth too.
4. **Affordability**--- Assuming the overall costs is in the range of $300 to $400 Million for surface water project by the time it is implemented, the additional cost per household may be $110 to $145 per month. Monthly water bill could be in the range of $150 to $200 per month. There may be a reduction in wastewater service fee.
5. **Growth Inducing**—Proposed project plans to divert <u>73 percent more</u> water than current demand. Since intake and transmission lines need to be built in the beginning of the project, it is difficult to obtain support from current rate payers to pay for facilities needed for future growth. This situation forces Cities approve (since they need money) developments that they may not need or like.



Since new information is available, it may be prudent to review (or take a snap shot) project's uncertainty, risks, costs and benefits. There are too many assumptions that may not be realistic. A tentative schedule for overall implementation must be identified (currently there is none). Overall cost update is needed using current information. Community needs to be involved to determine whether an increase of 400% to 500% will be accepted by Davis, UCD and Woodland residents.

CONTRA COSTA
WATER DISTRICT

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June 12, 2006

Mr. Jacques DeBra
City of Davis
Public Works Department
1717 5th Street
Davis, CA 95616

Subject: Notice of Preparation of Davis-Woodland Water Supply Project EIR

Dear Mr. DeBra:

Contra Costa Water District (CCWD) appreciates this opportunity to comment on the proposed Davis-Woodland Water Supply Project (Project), which involves a new surface water supply from the Sacramento River. CCWD diverts water from the Sacramento-San Joaquin Delta to serve approximately 500,000 people in northern, eastern and central Contra Costa County; a description of CCWD's facilities and operations is attached. CCWD is concerned about the effect of new upstream diversions on our water quality and water supply.

Water Quality Impacts

Increased diversions from the Sacramento River can degrade Delta water quality by allowing more seawater intrusion into the Delta. Both the Notice of Preparation for the Project and Water Rights Application No. 30358 specify that Project diversions will be limited by State Water Resources Control Board Standard Permit Term 91, which should help to reduce significant degradation. Nonetheless, the following reasons for concern remain:

- When the Delta is in surplus conditions and Term 91 is not in effect, diversions made under conditions of relatively low net Delta outflow can degrade Delta water quality. Significant degradation can occur even in the absence of standards violations. Chapter 3 of the State CEQA guidelines (14 California Code of Regulations 15000 *et seq*) includes a checklist for hydrology and water quality environmental impacts with both of the following questions:

  [Would the project] Violate any water quality standards or waste discharge requirements?

  [Would the project] Otherwise substantially degrade water quality?

Only the first of these checklist items is included in the Notice of Preparation for the Project; the second item must be addressed as well. CCWD's operations are based upon water quality and are particularly vulnerable to increases in Delta salinity, even when those increases do not violate State Water Resources Control Board Decision 1641 standards.

- When Term 91 is in effect, the Project may continue to divert supplemental Sacramento River water under an agreement with senior water rights holders, in which they substitute groundwater for their surface water supply and transfer their surface water to the Project agencies. If the water rights holders are currently diverting less than the maximum allowed, and if the Project agencies divert more supplemental water than the water rights holders would have diverted, there may be Delta water quality impacts.

Water Supply Impacts

The Project also has the potential to injure CCWD's senior Los Vaqueros water right by increasing the amount of surplus water diverted from the Delta, either by diverting surplus water to which CCWD has a senior right or by causing X2 to shift in such a way that CCWD can no longer exercise its Los Vaqueros water right. The Project has the potential to injure the US Bureau of Reclamation's water rights under which CCWD diverts its Central Valley Project water if the use of supplemental water increases diversions over the base case, as described in the second bullet point above.

CCWD requests that any potential adverse impacts to our water quality or water supply be analyzed and disclosed in the Projects Environmental Impact Report, and that proposed mitigation measures be included as required.

Modeling

CCWD commends you on the proposed modeling approach outlined in the March 23, 2006 letter from MWH to the State Water Resources Control Board. We request that you add the following results metrics to the list in that letter: Delta surplus flow; base case diversions by the holders of the rights for Project supplemental water; and electroconductivity in Victoria Canal at the site of CCWD's proposed Alternative Intake Project (DSM2 channel 229, distance 1328). In addition, you may want to include water quality on the San Joaquin River at Empire Tract at the City of Stockton's proposed intake site.

The Project Environmental Impact Report should include tables of monthly average water quality impacts at CCWD's existing and proposed intakes, with discussion of the maximum and minimum daily values. In addition, we request that CALSIM model output and daily DSM2 model output DSS files be made available to interested parties in electronic form. CCWD will use information from these files as inputs to our operations model, to evaluate the Project's impacts on our ability to supply high quality drinking water to our customers in all seasons and year types.

We Look Forward to Working With You

CCWD is encouraged to see that one of the Project objectives is to reduce the salt load in the treated wastewater discharge to the Delta. We recognize that the Cities of Davis and Woodland and U.C. Davis need to ensure the reliability of their water supply and to plan for future growth. We look forward to working with you to ensure that the Project moves forward to meet your interests while not harming our interests. If you have any questions, please call me at (925) 688-8083, or call Lucinda Shih at (925) 688-8168.

Sincerely,

Leah Orloff
Senior Water Resources Specialist

LSO/LHS:wec

Attachment: Contra Costa Water District's Operations and Facilities

CCWD Operations and Facilities

The Contra Costa Water District (CCWD) serves water to approximately 500,000 people throughout north, central and eastern Contra Costa County. Formed in 1936 to provide water for irrigation and industry, CCWD is now one of the largest urban water districts in California and a leader in drinking-water treatment technology and source water protection. CCWD's customers also include 10 major industries, and 12 smaller industries and businesses. The mission of the Contra Costa Water District is to strategically provide a reliable supply of high quality water at the lowest cost possible, in an environmentally responsible manner.

CCWD operates untreated water distribution facilities, water treatment plants, and treated water distribution facilities. CCWD provides treated water to Clayton, Clyde, Concord, Pacheco, Port Costa and parts of Martinez, Pleasant Hill and Walnut Creek. CCWD operates two water treatment facilities, the 75 Million Gallons per Day (MGD) Bollman Water Treatment Plant and the 40 MGD Randall-Bold Water Treatment Plant. The Bollman plant serves CCWD's treated water customers in Central County, and under an agreement, provides treated water to the Golden State Water Company in Bay Point. The Randall-Bold plant in Oakley, which came on line in July 1992, currently provides treated water to the Diablo Water District (DWD) and the Cities of Brentwood and Antioch. The Randall-Bold Water Treatment Plant is a direct/deep-bed filtration plant and utilizes both pre- and post-ozonation to provide a high quality drinking water to the customers in its service area. Additionally, the Multi-Purpose Pipeline, constructed in 2003, allows the District to serve new treated water customers in Central County from the Randall-Bold plant. CCWD sells untreated water to the cities of Antioch, Martinez, and Pittsburg, and the Golden State Water Company in Bay Point, as well as industrial and irrigation customers. Antioch, Martinez, Pittsburg and Golden State Water Company all have their own treatment plants and retail treated water distribution systems.

The 48-mile Contra Costa Canal and the Los Vaqueros Project (completed in 1998) make up CCWD's principal water supply and delivery system. CCWD diverts unregulated flows and regulated flows from storage releases from Shasta, Folsom, and Clair Engle reservoirs into the Sacramento River as a contractor of the United States Bureau of Reclamation's (Reclamation) Central Valley Project (CVP). Under Water Service Contract I75r-3401A-LTR1 (executed May 10, 2005) with Reclamation, CCWD can divert and re-divert up to 195,000 acre-feet annually (AFA) of water from its Rock Slough and Old River intakes. Currently, CCWD uses between 125,000 and 140,000 AFA. CCWD can also divert up to 26,780 AFA of water from its Mallard Slough intake under its own water rights (Water Rights License No.3167 and Permit No.19856). Some CCWD customers have additional sources of water. The City of Antioch has a water right permit to divert water from the lower San Joaquin River. Pittsburg, Brentwood, and DWD all have wells that can provide a portion of their needs.

CCWD has obtained water from the Delta since 1940. Delta water is subject to large variations in salinity and mineral concentrations. The Delta is also vulnerable to many anthropogenic and natural sources of water quality degradation. Degradation in water quality is objectionable to many CCWD customers, costly to all residential and industrial users, and a health risk for some individuals. Federal drinking water regulations impose stringent limits on disinfection by-products in treated water, making it difficult to achieve the required pathogen inactivation while minimizing disinfection by-product formation. Bromide and Total Organic Carbon (TOC) are the significant constituents in Delta water that affect CCWD's requirement to meet disinfection by-product standards. Currently, CCWD's primary means of ensuring that disinfection by-product standards are met in the treated water are to ensure that bromide and TOC levels in the source water from the Delta are maintained below certain levels. Chlorides are monitored as an indicator of bromide levels, while TOC is monitored directly. CCWD adjusts operations daily to meet water quality goals in water delivered by CCWD to its customers. Bromide and TOC are not the only constituents of concern. Pathogens, nutrients, and other constituents contribute to the challenges of meeting regulations for treated water using Delta water as the source.

Contra Costa Water District is committed to supplying its customers with the highest quality water practicable and providing all reasonable protection of the supply from any known or potential source of contamination. CCWD Resolution No. 88-45 states in part that:

> "CCWD is committed to reducing the concentration of sodium and chloride in the District's water, thereby reducing household and landscape irrigation concerns and industrial and manufacturing costs caused by the fluctuating sodium and chloride level of CCWD's Delta source."

CCWD's Board of Directors has adopted water quality objectives for water distributed within its service area. The acceptable concentration level for chloride is established at 65 milligrams per liter (mg/l).

In 1988, the voter-constituents of CCWD approved the issuance of bonds to finance a $450 million water quality and emergency water supply project known as the Los Vaqueros Project. The primary purposes of the Los Vaqueros Project are to improve the quality of water supplied to CCWD customers and minimize seasonal quality changes, and to improve the reliability of the emergency water supply available to CCWD. The Los Vaqueros Project consists of a reservoir with 100,000 acre-feet of storage, a new point of diversion at Old River, south of the Highway 4 crossing, which operates in conjunction with the current Rock Slough diversion point, plus associated water conveyance and delivery facilities, pumping plants, and other facilities. Construction of the reservoir began in September 1994 and was completed in January 1998. Diversion from the Old River intake for delivery to CCWD's service area began in the summer of 1997. The first filling of Los Vaqueros Reservoir to 100,000 acre-feet was completed on January 28, 1999.

Under State Water Resources Control Board Decision 1629 (June 2, 1994), CCWD holds water rights to divert and store water for beneficial uses, defined in Water Rights Permits No. 20749 and 20750 that provide for filling Los Vaqueros Reservoir from the new intake at Old River and diversion and storage of the water of Kellogg Creek. These rights are in addition to the contractual rights to divert and store water furnished through the CVP. Up to 95,850 AFA may be diverted for storage between November 1 of each year to June 30 of the succeeding year under Water Rights Permit No. 20749.

A key to successful performance of the Los Vaqueros Project is the District's ability to fill the reservoir from Old River with high quality water at times when it is available, typically late winter through early summer, and to use that water for blending when salinity at the District's Delta intakes exceeds the 65 mg/L chloride goal, generally late summer through early winter. Any increase in Delta salinity caused by new Bay-Delta projects will increase the demand on blending water from the reservoir and affect the availability of high quality water for refilling. The District and its 500,000 customers will be impacted through higher pumping costs to replace the extra blending water that is released and through the health effects, increased corrosion, and additional treatment costs of delivering higher salinity water. This also reduces the water supply available to CCWD in the reservoir in case of an emergency, thereby eroding the $450 million investment CCWD's customers have made in the Los Vaqueros Project.

Appendix B

Modeling Results and Water Demand

APPENDIX B
Modeling Results and Water Demand

Appendix B presents detailed results of the CALSIM II, DSM II, and temperature models that are discussed within this EIR. Also contained within Appendix B are detailed estimations of water demand for each of the Project Partners, for the Proposed Project and all Alternatives.

Surface Water Supply and Water Quality Model Results

Water Right Diversion Modeling Technical Appendix to the Draft Environmental Impact Report

Davis-Woodland Water Supply Project

March 2007

TABLE OF CONTENTS

TABLE OF CONTENTS i

LIST OF TABLES iv

LIST OF FIGURES v

LIST OF ACRONYMS AND ABBREVIATIONS vii

LIST OF PREPARERS ix

CHAPTER 1. INTRODUCTION 1-1

BACKGROUND 1-1
Term 91 Condition *1-2*
ORGANIZATION OF THE APPENDIX 1-2

CHAPTER 2. MODELING SCENARIOS 2-1

MODELING BASES 2-1
EXISTING CONDITIONS 2-2
Water Demands *2-3*
Project Partners 2-3
CVP-SWP System 2-3
Local Water Supplies 2-3
Other Projects/Programs *2-3*
Central Valley Project Improvement Act 2-3
Environmental Water Account 2-4
WITH-PROJECT CONDITIONS 2-5
Water demands *2-5*
Project Partners 2-5
CVP-SWP System 2-5
Local Water Supplies *2-5*
SWRCB Term 91 Conditions 2-6
Local Surface Water Facilities *2-7*
Other Projects/Programs *2-7*
CUMULATIVE CONDITIONS WITHOUT PROJECT 2-7
Water Demands *2-7*
Project Partners 2-7
CVP-SWP System 2-7
Local Water Supplies *2-7*
Other Potential Future Projects/Programs *2-7*
Freeport Regional Water Project 2-7
South Delta Improvement Program 2-8
Delta-Mendota Canal/California Aqueduct Intertie 2-8
CVP-SWP Integration 2-8
Long-Term Environmental Water Account 2-8
CUMULATIVE CONDITIONS WITH PROJECT 2-9
Water Demands *2-9*
Local Water Supplies *2-9*

Local Surface Water Facilities........2-9
Other Potential Future Projects/Programs........2-9

CHAPTER 3. MODELING METHODOLOGY........3-1

HYDROLOGIC MODELING........3-1
CALSIM Software........3-1
CALSIM Application........3-2
Consistency with Previous Analysis........3-2
Modeling Base for DWWSP........3-3
Multi-Step Analysis........3-3
Model Modification for the DWWSP........3-4
Modeling Contra Costa Water District Delta Diversion........3-7
Model Limitations........3-7
Metrics for Measuring Impacts........3-7
HYDRODYNAMIC AND WATER QUALITY MODELING........3-8
Methodology........3-8
CALSIM II Flow-Salinity Modeling........3-9
X2........3-9
Artificial Neural Network........3-10
DSM2........3-10
Planning Tide at Martinez Boundary........3-12
Salinity Boundary Conditions........3-12
Delta Channel Flow........3-13
Flow Control Structures........3-13
Delta Island Consumptive Use........3-16
Water Quality Conversions........3-16
Model limitations........3-17
Metrics for Measuring Impacts........3-17
Drinking Water........3-17
Ecosystem........3-17
Agriculture........3-19
Water Levels........3-19
WATER TEMPERATURE MODELING........3-20
INTERPRETATION AND APPLICATION OF MODELING RESULTS........3-20

CHAPTER 4. HYDROLOGIC MODELING RESULTS........4-1

SUMMARY RESULTS........4-1
DWWSP........4-1
Delta Flows........4-1
River Flows........4-2
Reservoir Carryover Storage........4-2
CVP-SWP Deliveries........4-2
COMPARISON BETWEEN EXISTING CONDITIONS AND WITH-PROJECT CONDITION........4-7
COMPARISON BETWEEN CUMULATIVE CONDITIONS WITHOUT PROJECT AND CUMULATIVE CONDITIONS WITH PROJECT........4-14

CHAPTER 5. HYDRODYNAMIC AND WATER QUALITY MODELING RESULTS........5-1

COMPARISON BETWEEN EXISTING CONDITIONS AND WITH-PROJECT CONDITION........5-3
Boundary Conditions........5-3
Delta Channel Flow........5-6
Delta Channel Stage........5-6
Delta Water Quality........5-6
X2 Location........5-10
COMPARISON BETWEEN CUMULATIVE CONDITIONS WITHOUT PROJECT AND CUMULATIVE CONDITIONS WITH PROJECT........5-18
Boundary Conditions........5-18
Delta Channel Flow........5-21
Delta Channel Stage........5-21

Delta Water Quality *5-21*
X2 Location *5-25*

CHAPTER 6. TEMPERATURE MODELING RESULTS 6-1

SUMMARY RESULTS 6-1

CHAPTER 7. SUMMARY 7-1

WITH-PROJECT CONDITIONS COMPARED TO EXISTING CONDITIONS 7-1
Delta Diversion *7-1*
River Flows *7-1*
Delta Conditions *7-1*
CVP-SWP Reservoir Operations and Deliveries *7-2*
Water Levels in the South Delta *7-2*
Delta Water Quality *7-2*
Reservoir and River Temperatures *7-2*
CUMULATIVE CONDITIONS WITH PROJECT COMPARED TO CUMULATIVE CONDITIONS WITHOUT PROJECT 7-2
Delta Diversion *7-3*
River Flows *7-3*
Delta Conditions *7-3*
CVP-SWP Reservoir Operations and Deliveries *7-3*
Water Levels in the South Delta *7-3*
Delta Water Quality *7-4*
Reservoir and River Temperatures *7-4*

CHAPTER 8. REFERENCES 8-1

LIST OF TABLES

Table 2-1. Major CALSIM II Modeling Assumptions 2-2
Table 2-2. Project Partner's Water Demand under Existing Conditions (in AF) 2-3
Table 2-3. Project Water Demands under With-Project Conditions Scenario (in AF) 2-5
Table 3-1. CALSIM II Modeling Outputs for Hydrological Impacts Assessment 3-8
Table 3-2. DSM2 Input Requirements and Assumptions 3-12
Table 3-3. Delta Cross Channel Simulated Operation 3-14
Table 3-4. Temporary Barrier Simulated Operation 3-15
Table 3-5. Relationship between Salinity Parameters 3-17
Table 3-6. Metrics for Assessing Hydrodynamic and Water Quality Impacts 3-18
Table 3-7. Water Quality at Delta Drinking Water Intakes, 1982 - 1995 3-19
Table 4-1. Summary Results, With-Project Conditions Compared to Existing Conditions 4-3
Table 4-2. Summary Results, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 4-4
Table 4-3. Project Partners' Water Right Diversion (1,000 AF/yr) under With-Project Conditions 4-8
Table 4-4. Annual River and Delta Flows by Water Year Type, With-Project Conditions Compared to Existing Conditions 4-10
Table 4-5. Average Monthly River and Delta Flows, With-Project Conditions Compared to Existing Conditions 4-11
Table 4-6. Carryover Storage by Water Year Type, With-Project Conditions Compared to Existing Conditions 4-13
Table 4-7. Annual Delta Exports and Diversions by Water Year Type, With-Project Conditions Compared to Existing Conditions 4-13
Table 4-8. Annual CVP and SWP Deliveries by Water Year Type, With-Project Conditions Compared to Existing Conditions 4-14
Table 4-9. Project Partners' Water Right Diversion (1,000 AF/yr) under Cumulative Conditions with Project 4-15
Table 4-10. Annual River and Delta Flows by Water Year Type, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 4-17
Table 4-11. Average Monthly River and Delta Flows, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 4-19
Table 4-12. Carryover Storage by Water Year Type, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 4-21
Table 4-13. Annual Delta Exports and Diversions by Water Year Type, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 4-21
Table 4-14. Annual CVP and SWP Deliveries by Water Year Type, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 4-22
Table 5-1. Boundary Flow Conditions, With-Project Conditions Compared to Existing Conditions 5-3
Table 5-2. Average Daily Minimum Stage, With-Project Conditions Compared to Existing Conditions 5-8
Table 5-3. Average Monthly EC, With-Project Conditions Compared to Existing Conditions 5-9
Table 5-4. Change in Average Monthly EC, With-Project Conditions Compared to Existing Conditions 5-10
Table 5-5. EC at Old River at CCWD's Los Vaqueros Intake, With-Project Conditions Compared to Existing Conditions 5-11
Table 5-6. EC at Old River at Rock Slough, With-Project Conditions Compared to Existing Conditions 5-12
Table 5-7. EC at West Canal at mouth of Clifton Court Forebay, With-Project Conditions Compared to Existing Conditions 5-13
Table 5-8. EC at Delta Mendota Canal at Tracy Pumping Plant, With-Project Conditions Compared to Existing Conditions 5-14
Table 5-9. Change in X2 Location, With-Project Conditions Compared to Existing Conditions 5-17
Table 5-10. Boundary Flow Conditions, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-18
Table 5-11. Average Daily Minimum Stage, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-23
Table 5-12. Average Monthly EC, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-24
Table 5-13. Change in Average Monthly EC, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-25

Table 5-14. EC at Old River at CCWD's Los Vaqueros Intake, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-26
Table 5-15. EC at Old River at Rock Slough, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-27
Table 5-16. EC at West Canal at mouth of Clifton Court Forebay, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-28
Table 5-17. EC at Delta Mendota Canal at Tracy Pumping Plant, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-29
Table 5-18. Change in X2 Location, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-32
Table 6-1. Magnitude and Frequency of Change in Water Temperature, With-Project Conditions Compared to Existing Conditions 6-2
Table 6-2. Magnitude and Frequency of Change in Water Temperature, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 6-3

LIST OF FIGURES

Figure 2-1. Historical Imposition of Term 91 2-6
Figure 3-1. Modeling Framework for DWWSP EIR Analysis 3-1
Figure 3-2. Illustration of CALSIM II Schematic 3-5
Figure 3-3. Illustration of CALSIM II Schematic for the DWWSP 3-6
Figure 3-4. Illustration of DSM2 Schematic 3-11
Figure 4-1. Average Annual Delta Flows, With-Project Conditions Compared to Existing Conditions 4-5
Figure 4-2. Average Annual Delta Flows, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 4-5
Figure 4-3. Reservoir Carryover Storage, With-Project Conditions Compared to Existing Conditions 4-6
Figure 4-4. Reservoir Carryover Storage, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 4-6
Figure 4-5. DWWSP Annual Water-Right Diversions, With-Project Condition 4-9
Figure 4-6. Exceedence of DWWSP Annual Diversion, With-Project Condition 4-9
Figure 4-7. Average Monthly DWWSP Water Delivery, With-Project Condition 4-9
Figure 4-8. DWWSP Annual Water-Right Diversions, Cumulative Condition with Project 4-16
Figure 4-9. Exceedence of DWWSP Annual Diversion, Cumulative Condition with Project 4-16
Figure 4-10. Average Monthly DWWSP Water Delivery, Cumulative Condition with Project 4-16
Figure 5-1. Major Delta Islands, Waterways, Water Quality Control Stations, and Potential Future Projects 5-2
Figure 5-2. Sacramento River Delta Inflow, With-Project Conditions Compared to Existing Conditions 5-4
Figure 5-3. San Joaquin River Delta Inflow, With-Project Conditions Compared to Existing Conditions 5-4
Figure 5-4. CVP-SWP Exports, With-Project Conditions Compared to Existing Conditions 5-5
Figure 5-5. Net Delta Outflow, With-Project Conditions Compared to Existing Conditions 5-5
Figure 5-6. Average Annual Flows at Selected Locations in the Delta, With-Project Conditions Compared to Existing Conditions 5-7
Figure 5-7. EC at Selected Locations, With-Project Conditions Compared to Existing Conditions 5-8
Figure 5-8. X2 Location, With-Project Conditions Compared to Existing Conditions 5-15
Figure 5-9. X2 Location in Periods (January, June-August) of Restricted Filling of Los Vaqueros Reservoir, With-Project Conditions Compared to Existing Conditions 5-15
Figure 5-10. X2 Location in Periods (February-May) of Restricted Filling of Los Vaqueros Reservoir, With-Project Conditions Compared to Existing Conditions 5-16
Figure 5-11. Sacramento River Delta Inflow, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-19
Figure 5-12. San Joaquin River Delta Inflow, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-19
Figure 5-13. CVP-SWP Exports, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-20
Figure 5-14. Net Delta Outflow, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-20

Figure 5-15. Average Annual Flow at Selected Locations in the Delta, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-22
Figure 5-16. EC at Selected Locations, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-23
Figure 5-17. X2 Location, Cumulative Conditions with Project Compared to Cumulative Conditions without Project .. 5-30
Figure 5-18. X2 Location in Periods (January, June-August) of Restricted Filling of Los Vaqueros Reservoir, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-30
Figure 5-19. X2 Location in Periods (February-May) of Restricted Filling of Los Vaqueros Reservoir, Cumulative Conditions with Project Compared to Cumulative Conditions without Project 5-31
Figure 6-1. Temperature Exceedence for American River at Sunrise Bridge, Existing Conditions and With-Project Conditions 6-4
Figure 6-2. Temperature Exceedence for Feather River below Thermalito Afterbay, Existing Conditions and With-Project Conditions 6-4
Figure 6-3. Temperature Exceedence for Sacramento River at Bend Bridge, Existing Conditions and With-Project Conditions 6-5
Figure 6-4. Temperature Exceedence for Sacramento River at Keswick Dam, Existing Conditions and With-Project Conditions 6-5
Figure 6-5. Temperature Exceedence for Sacramento River at Red Bluff, Existing Conditions and With-Project Conditions 6-6
Figure 6-6. Temperature Exceedence for Trinity River at Lewiston Dam, Existing Conditions and With-Project Conditions 6-6
Figure 6-7. Temperature Exceedence for American River at Sunrise Bridge, Cumulative Conditions without Project and Cumulative Conditions with Project 6-7
Figure 6-8. Temperature Exceedence for Feather River below Thermalito Afterbay, Existing Cumulative Conditions without Project and Cumulative Conditions with Project 6-7
Figure 6-9. Temperature Exceedence for Sacramento River at Bend Bridge, Cumulative Conditions without Project and Cumulative Conditions with Project 6-8
Figure 6-10. Temperature Exceedence for Sacramento River at Keswick Dam, Cumulative Conditions without Project and Cumulative Conditions with Project 6-8
Figure 6-11. Temperature Exceedence for Sacramento River at Red Blluff, Cumulative Conditions without Project and Cumulative Conditions with Project 6-9
Figure 6-12. Temperature Exceedence for Trinity River at Lewiston Dam, Cumulative Conditions without Project and Cumulative Conditions with Project 6-9

LIST OF ACRONYMS AND ABBREVIATIONS

ACID	Anderson-Cottonwood Irrigation District
AF	acre-feet
AF/year	acre-feet per year
ANN	artificial neural network
avg	average
(b)(2)	Central Valley Project Improvement Act Section 3406(b)(2)
BA	Biological Assessment
BO	Biological Opinion
CA	California Aqueduct
CALSIM II	California Simulation Model II
CCC PP No.1	Contra Costa Canal Pumping Plant Number 1
CCWD	Contra Costa Water District
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
cfs	cubic feet per second
Corps	United States Army Corps of Engineers
CVOO	Central Valley Operations Office
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
D-xxxx	State Water Resources Control Board Decision xxxx
Davis	City of Davis
DCU	Delta Consumptive Use
Delta	Sacramento River-San Joaquin River Delta
DICU	Delta Island Consumptive Use
DMC/CA Intertie	Delta Mendota Canal / California Aqueduct Intertie
DMC	Delta Mendota Canal
DSA	Depletion Study Area
DSM2	Delta Simulation Model, Version 2
DWR	California Department of Water Resources
DWWSP	Davis-Woodland Water Supply Project
EC	electrical conductivity
E/I	export to inflow ratio
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EIS/EIR	Environmental Impact Statement / Environmental Impact Report
ESA	Endangered Species Act
EWA	Environmental Water Account
^{o}F	degrees Fahrenheit

FERC	Federal Energy Regulatory Commission
FRWP	Freeport Regional Water Project
ISI	Integrated Storage Investigations
JPOD	Joint Point of Diversion
km	kilometer
LOD	Level of Development
µS/cm	microSiemens per centimeter
M&I	municipal and industrial
MAF	million acre-feet
msl	mean sea level
mg/L	milligrams per liter
MWQI	Municipal Water Quality Investigations
NCP	Navigation Control Point
NDOI	Net Delta Outflow Index
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service of National Oceanic and Atmospheric Administration
NOD	north of Delta
NOP	Notice of Preparation
OCAP	Operations Criteria and Plan
PEIS	Programmatic Environmental Impact Statement
PL	Public Law
PP	pumping plant
ppt	parts per thousand
RD	Reclamation District
Reclamation	United States Department of the Interior, Bureau of Reclamation
ROD	Record of Decision
SDIP	South Delta Improvement Program
SOD	south of Delta
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TDS	total dissolved solids
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VAMP	Vernalis Adaptive Management Program
Woodland	City of Woodland
X2	The location of 2 parts per thousand salinity contour (isohaline), one meter off the bottom of the estuary, as measured in kilometers upstream from the Golden Gate Bridge

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CHAPTER 1. INTRODUCTION

This Water Right Diversion Modeling Technical Appendix to the Draft Environmental Impact Report (Modeling Technical Appendix) presents the application and results of hydrologic, hydrodynamic, water quality, and temperature modeling for the Environmental Impact Report (EIR) prepared for the Davis-Woodland Water Supply Project (DWWSP). The purpose of the modeling analysis is to identify potential impacts of the DWWSP water-right diversions (described below) on channel flow, reservoir storage, surface water deliveries, water quality, and water temperature relative to baseline conditions (i.e. without the proposed DWWSP). The modeling analysis was undertaken using the California Department of Water Resources (DWR) and United States Department of the Interior, Bureau of Reclamation (Reclamation) joint planning model – California Simulation Model II (CALSIM II), DWR's Delta Simulation Model, Version 2 (DSM2), and Reclamation's reservoir and river temperature models.

BACKGROUND

The DWWSP would be a joint undertaking of the City of Davis (Davis), the University of California, Davis and the City of Woodland (Woodland). These entities are collectively referred to in this appendix as the "Project Partners." The purpose of the DWWSP would be to develop a water supply facility plan that would include intake facilities, a water treatment plant, and associated transmission pipelines for diverting surface water from the Sacramento River for municipal and industrial uses in the Davis and Woodland areas. The surface water supply could reduce the Project Partners' reliance on existing groundwater supplies.

Three alternative points of diversion on the Sacramento River are considered in the EIR for the DWWSP: (1) new diversion facilities at the site of the existing Reclamation District (RD) 2035 diversion just upstream from the Interstate 5 Bridge, and (2) new diversion facilities at two alternative sites on the Sacramento River between the RD 2035 facilities and West Sacramento facilities.

Two types of water rights would be used to authorize the DWWSP's diversions from the Sacramento River: (1) water rights perfected under permits issued on the Project Partners' Water Right Applications 30358A and 30358B (referred to in this appendix as "Project Water Rights"), and (2) supplemental water supplies obtained through water transfers from holders of existing senior water rights in the Sacramento Valley (referred to in this appendix as "Supplemental Water Supplies").

This appendix addresses the DWWSP diversions from the Sacramento River that would be associated with the Project Partners' Project Water Rights. The modeling approach for evaluating these diversions is discussed in Chapter 2 and Chapter 3. This appendix does not address the analysis of Supplemental Water Supplies associated with the DWWSP; this analysis will be summarized in a separate appendix.

Term 91 Condition

The Project Partners are applying for new water-right permits that would authorize diversions of water from the Sacramento River for the DWWSP. It is anticipated that these new water-right permits will contain the State Water Resources Control Board (SWRCB) Standard Permit Term 91.[1] Term 91 prohibits a permittee from diverting water from the Sacramento River when the Central Valley Project (CVP) and State Water Project (SWP) need to release water from storage to meet in-basin entitlements.

ORGANIZATION OF THE APPENDIX

Chapter 1 describes the introduction and background. Chapter 2 discusses the modeling scenarios analyzed. Chapter 3 describes the computer simulation models used for the EIR analysis. Chapter 4 presents results from the hydrologic modeling. Chapter 5 presents results from the hydrodynamic and water quality modeling. Chapter 6 presents results from the temperature modeling. Chapter 7 provides a discussion and summary of modeling results. Chapter 8 contains a list of references.

[1] Term 91 reads as follows: "No diversion is authorized by this permit when satisfaction of inbasin entitlements requires release of supplemental Project water by the Central Valley Project or the State Water Project."

a. Inbasin entitlements are defined as all rights to divert water from streams tributary to the Sacramento-San Joaquin Delta or the Delta for use within the respective basins of origin or the Legal Delta, unavoidable natural requirements for riparian habitat and conveyance losses, and flows required by the State Water Resources Control Board (SWRCB) for maintenance of water quality and fish and wildlife. Export diversions and Project carriage water are specifically excluded from the definition of inbasin entitlements.

b. Supplemental Project water is defined as water imported to the basin by the projects, and water released from Project storage, which is in excess of export diversions, Project carriage water, and Project inbasin deliveries.

The SWRCB shall notify the permittee of curtailment of diversion under this term after it finds that supplemental Project water has been released or will be released. The SWRCB will advise the permittee of the probability of imminent curtailment of diversion as far in advance as practicable based on anticipated requirements for supplemental Project water provided by the Project operators.

CHAPTER 2. MODELING SCENARIOS

This chapter describes the modeling scenarios and associated major modeling assumptions used to complete the hydrologic, hydrodynamic, water quality, and temperature modeling in support of the DWWSP EIR analysis.

Four modeling scenarios were defined and analyzed to support the hydrology section of the EIR: (1) Existing Conditions, (2) With-Project Conditions, (3) Cumulative Conditions without Project, and (4) Cumulative Conditions with Project. Potential hydrological impacts of the proposed DWWSP water-right diversions are determined from the following two comparisons:

- Comparison of the With-Project Conditions to the Existing Conditions
- Comparison of the Cumulative Conditions with Project to the Cumulative Conditions without Project

The three potential locations of the proposed DWWSP water-right diversion, identified in the *Notice of Preparation: Davis-Woodland Water Supply Project Environmental Impact Report* (NOP) (ESA, 2006), are identical, from a hydrological modeling perspective, in their specification and model implementation.

MODELING BASES

On June 30, 2004, Reclamation's Central Valley Operations Office (CVOO) issued the Long-Term CVP and SWP Operations Criteria and Plan (OCAP) Biological Assessment (BA) to update the proposed CVP operation in view of changes in regulations, increases in system demand, and anticipated new programs/projects coming on-line in the future for Endangered Species Act (ESA) compliance. The National Oceanic Atmospheric Administration, National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS) issued their Biological Opinions (BO) for this OCAP in October 2004 and February 2005 (revision), respectively. The 2004 OCAP and OCAP BA are supported by a set of CALSIM II studies. These OCAP BA studies were released by Reclamation on February 2, 2004, with revisions released on June 30, 2004.

Reclamation re-initiated ESA Section 7 consultation for OCAP with NMFS and USFWS in June and July 2006, respectively. Currently, Reclamation is in the process of developing a BA (scheduled for release in 2007) that will be used for the re-consultation.

Since the model used for the OCAP re-consultation is not available, the hydrological modeling base for DWWSP EIR analysis is the 2004 OCAP Study 3 for the Existing Condition and With-Project Conditions; the hydrological modeling base for the Cumulative Conditions without Project and Cumulative Conditions with Project is 2004 OCAP study 5.

Table 2-1 summarizes the modeling scenarios with associated major assumptions and minor modifications for the DWWSP hydrological modeling analysis. Refer the 2004 OCAP BA for more detailed CALSIM II modeling assumptions.

Table 2-1. Major CALSIM II Modeling Assumptions

Items	Modeling Scenarios			
	Existing Conditions	With-Project Conditions	Cumulative Conditions Without Project	Cumulative Conditions With Project
Modeling Base – OCAP Studies (June, 2004)	Study 3	Study 3	Study 5	Study 5
Level of Development of CVP/SWP systems	2001	2001	2020	2020
Level of Development of Project Partners[1]	2005	2040	2040	2040
Ongoing/Potential Projects from OCAP Studies				
Trinity River Flows	Trinity ROD Flows[2]	Trinity ROD Flows[2]	Trinity ROD Flows	Trinity ROD Flows
CVPIA 3406 (b)(2)	Included	Included	Included	Included
Freeport Regional Water Project	-	-	Included	Included
CVP/SWP Intertie	-	-	Included	Included
Short-Term EWA	Included	Included	-	-
Long-Term EWA[3]	-	-	Included	Included
South Delta Improvements Project	-	-	Included	Included
CVP/SWP Operational Integration	-	-	Included	Included
Project Partners' Water-Right Diversion				
Total Maximum Annual Diversion (AF)	-	56,717[4]	-	56,717[4]
Term 91 Conditions	-	Applicable	-	Applicable
Other Assumptions				
Wastewater Discharge[5]	No return flow	No return flow	No return flow	No return flow
Climate Change[6]	Not Included	Not Included	Not Included	Not Included

[1] The 2004 OCAP studies use years 2001 and 2020 to represent the existing and future level of developments (LOD). For the DWWSP EIR analysis, 2005 and 2040 are assumed to represent the existing and future LODs for Project Partners.
[2] The 2004 OCAP Study 3 did not include the Trinity Record of Decision (ROD) flow schedule. However, the ROD flow schedule was included after it was upheld by a Ninth Circuit Court ruling (July 2004).
[3] In 2004 OCAP studies, the short-term Environmental Water Account (EWA) is used as a surrogate for the long-term EWA.
[4] For modeling analysis purposes, a scenario with diversions of Sacramento River water to meet Project Partners' demands based on total annual diversion of 56,717 AF is used to assess potential impacts.
[5] Because the wastewater discharge will probably be rediverted for agricultural uses, it is assumed that no wastewater will return to the Sacramento River or the Delta.
[6] The effects of climate change on the hydrology is not considered in 2004 OCAP CALSIM II studies.

EXISTING CONDITIONS

The Existing Conditions under the California Environmental Quality Act (CEQA) for determining project impacts are the water flow, water quality, and environmental conditions that existed at the time the NOP was published for the DWWSP (April, 2006).

Water Demands

Project Partners

Year 2005 is assumed as the Level of Development (LOD) for the Project Partners for the Existing Conditions. The annual amount of the total demand is about 33,600 AF per year. The annual and monthly water demands for Existing Conditions for each of the Project Partners are summarized in **Table 2-2**.

Table 2-2. Project Partner's Water Demand under Existing Conditions (in AF)

Project Partners	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Davis	1,425	944	715	689	607	770	1,080	1,410	1,777	2,035	1,998	1,722	15,172
Woodland	1,385	908	819	737	652	877	1,039	1,409	1,770	2,048	1,916	1,667	15,227
UC Davis	281	230	192	164	197	244	217	251	327	411	364	322	3,200
Total	3,091	2,082	1,726	1,590	1,456	1,891	2,336	3,070	3,874	4,494	4,278	3,711	33,599

CVP-SWP System

CALSIM II used a hydrology which was in part the result of an analysis of agricultural and urban land use. CALSIM II currently uses two types of LOD, 2001 and 2020 LODs, to represent the existing conditions and future conditions, respectively. For the CVP and SWP, CALSIM II simulates their operations based on their service contract amounts and applicable operation criteria.

DWR developed the 1995 and 2020 LODs through preparation of California Water Plan 1998 Update (DWR, 1998). The demands were calculated using an aggregation of land use surveys. For CALSIM II modeling purposes, DWR defined the 2001 LOD by using linear interpolation of the previously developed 1995 and 2020 data. Existing Conditions for areas external to the DWWSP were modeled using hydrologic inputs for the 2001 LOD.

The recent California Water Plan Update 2005 did not result in any updated LODs, the associated efforts were deferred. Therefore, the currently available 2001 and 2020 LODs are the best available information for local demand projection under the existing and future conditions.

Local Water Supplies

Under the Existing Conditions, the source of water supply for the Project Partners is groundwater.

Other Projects/Programs

Central Valley Project Improvement Act

The Central Valley Project Improvement Act (CVPIA) was included in the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law (PL) 102-575) as Title XXXIV. The CVPIA amended previous authorizations of the CVP by designating fish and wildlife protection, restoration, and mitigation as project purposes equal in priority with irrigation and domestic water supply uses, and giving fish and wildlife enhancement equal priority with power generation.

Major areas of change stipulated in the CVPIA include 800,000 AF of water dedicated to fish and wildlife annually (also known as (b)(2) water); tiered water pricing applicable to new and renewed contracts; water transfers provision, including sale of water to users outside the CVP service area; special efforts to restore anadromous fish population; restoration fund financed by water and power users for habitat restoration and enhancement and water and land acquisitions; no new water contracts until fish and wildlife goals are achieved; no contract renewals until completion of a Programmatic Environmental Impact Statement (PEIS); terms of new contracts reduced from 40 to 25 years with renewal at the discretion of the Secretary of the Interior; installation of the temperature control device at Shasta Dam; implementation of fish passage measures at Red Bluff Diversion Dam; firm water supplies for Central Valley wildlife refuges; and development of a plan to increase CVP yield.

The Final PEIS for CVPIA implementation was completed in October 1999, and Reclamation subsequently issued a Record of Decision (ROD) in January 2001 for implementing the recommended plan.

(b)(2) Water

Implementation of the CVPIA (b)(2) provision has been a contentious process, marked by conflicts between Federal and State parties, and substantial litigation. The primary dispute has been whether (b)(2) water translates into an automatic reduction in exports under water supply contracts. In May 2003, Reclamation released a final decision on implementation of Section 3406 (b)(2). The decision incorporates parts of an earlier decision (U.S. Department of the Interior 1999 Final Decision), modifies other decisions, and adds new components. The intent of these changes was to simplify and clarify the accounting process for (b)(2) water uses and to integrate (b)(2) water dedication and management with CVP operations for other CVP purposes.

Trinity River Restoration Plan

Reclamation completed a Final Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for Trinity River Mainstem Fishery Restoration in 1999. U.S. Department of the Interior issued a ROD in December 2000 for implementation of the alternative recommended in the Final Environmental Impact Statement (EIS), including Trinity River instream flow requirements of 368,900 AF per year in "Critically Dry" years to 815,200 AF per year in "Extremely Wet" years, to restore and maintain the anadromous fishery in the Trinity River. This ROD was the culmination of a nearly 20-year process of detailed scientific efforts. The Trinity ROD implements a component of the CVPIA (Section 3406(b)(23)) intended to meet Federal trust responsibilities for protecting the fishery resources of the Hoopa Valley Tribe, and to meet the fishery restoration goals of PL 98-541 (October 24, 1984).

The ROD was immediately challenged in Federal court. In March 2001, the district court issued a preliminary injunction limiting flow releases to 368,600 AF per year but otherwise allowing for the implementation of the ROD's restoration plan. In March 2002, the district court granted the Hoopa Valley Tribe's motion to modify the preliminary injunction to allow for increased releases, authorizing the release of 468,600 AF for the 2002 water year. Subsequently, the district court ordered the Department of the Interior to prepare a supplemental Environmental Impact Statement to address additional alternatives and implement all non-flow related actions under the ROD's restoration plan. This order was appealed in the Ninth Circuit Court of Appeals. In 2003, the district court granted an extension for Reclamation to prepare the supplemental Environmental Impact Statement, and granted the motion by Hoopa Valley Tribe to modify the injunction to allow for additional releases of up to 50,000 AF for the 2003 water year. In April 2003, this Ninth Circuit Court granted Hoopa Valley's motion to stay the injunction, permitting the release of 647,000 AF for the 2004 year, the flow level appropriate for a Normal water year. On July 13, 2004, the Ninth Circuit Court upheld the ROD flows for the Trinity River.

Environmental Water Account

Environmental Water Account (EWA) is a component of CALFED's Water Management Strategy included in the *CALFED Programmatic Program Record of Decision* (August 28, 2000) to provide environmental managers assets, including water and money, to provide greater flexibility in helping with fishery protection, restoration, and recovery needs in the CVP/SWP system. USFWS, NMFS, DWR, Reclamation, and California Department of Fish and Game (CDFG) (collectively, EWA agencies) executed the *Environmental*

Water Account Operating Principles Agreement contemporaneously with the CALFED ROD. One of the criteria for EWA operation is that there shall be no reduction in contract deliveries or increases in cost; in other words, EWA operation shall not affect normal CVP and SWP operations.

Since 2001, CALFED agencies (consisting of 9 State agencies and 12 Federal agencies) have acquired, transferred, and borrowed water and arranged for its conveyance for the EWA; the resulting physical assets acquired from alternative sources of project water supply, called the "EWA assets," will be used to augment streamflows, Sacramento River-San Joaquin River Delta (Delta) outflows, to modify exports to provide fishery benefits and to replace the regular project water supply interrupted by the changes to project operations. The replacement water will compensate for reductions in deliveries relative to existing facilities, project operations and the regulatory baseline as defined in the CALFED ROD that result from EWA actions. The EWA assets are managed by federal and state fishery agencies (USFWS, NMFS, and DFG) in coordination with operators of CVP and SWP, and stakeholders through the CALFED Operations Group.

The *Environmental Water Account Operating Principles Agreement* stipulates a four-year implementation of EWA Program through September 30, 2004. In 2004, this agreement was extended after the EWA agencies completed an EIS/EIR for implementing short-term EWA Program through 2007.

WITH-PROJECT CONDITIONS

The With-Project Conditions are based upon a scenario with annual diversions of 56,717 acre-feet (AF) which is referred to in this appendix as the "56 TAF/yr scenario". This scenario represents the maximum potential water-right diversions for the DWWSP and would result in the greatest potential impact on the hydrological system. This 56 TAF/yr scenario was based on a preliminary demand estimate when the modeling analysis started. The subsequent demand of Project Partners' was updated and now is less than 56,717 AF. Refer to the DWWSP draft EIR for more detailed information.

Water demands

Project Partners

The annual amount of the total demand for the With-Project Conditions is assumed to be 56,717 AF. The monthly water demands for the With-Project Conditions scenario are listed in **Table 2-3**.

Table 2-3. Project Water Demands under With-Project Conditions Scenario (in AF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
5,108	3,517	2,808	2,695	2,535	3,345	4,040	5,312	6,509	7,354	7,272	6,221	56,717

CVP-SWP System

The demands for the CVP-SWP system are the same as for the Existing Conditions.

Local Water Supplies

The Project Partners are applying for new water-right permits to divert water from the Sacramento River. The three alternative points of the new diversion on the Sacramento River that are considered in the EIR are: (1) new diversion facilities at the site of the existing RD 2035 diversion just upstream of the Interstate 5 Bridge; and (2) new diversion facilities at two sites on the Sacramento River between the RD 2035 and West Sacramento facilities. It is anticipated that these new water-right permits will contain the SWRCB's Standard Permit Term 91. Term 91 prohibits a permittee from diverting water from the Sacramento River when the CVP and SWP need to release water from storage to meet in-basin entitlements.

Under the With-Project Conditions scenario, the demands of Project Partners are met by the water-right water and any potential water transfer (as supplemental water).

SWRCB Term 91 Conditions

Term 91 prohibits the permittee from diverting water when satisfaction of in-basin entitlements requires release of supplemental project water by the CVP or SWP. Supplemental project water (SW) is defined as water imported to the basin by the CVP or SWP, and water released from CVP or SWP storage that is in excess of export diversions (EX), carriage water (CW), and CVP/SWP in-basin deliveries. The method for calculating when supplemental water exists was developed in Order 81-15 (SWRCB, 1981) and D-1594 (SWRCB, 1983):

$$SW = SR - (EX + CW)$$

"SR" is the net storage release from Shasta, Oroville, and Folsom Reservoirs plus imports to the Sacramento Valley from the Trinity River CVP complex, less exports from the Folsom South Canal. "EX" is the CVP and SWP export diversions at Clifton Court Forebay, Tracy Pumping Plant, North Bay Aqueduct, and Contra Costa Canal Intake. "CW" is the CVP/SWP carriage water (i.e., the additional outflow requirement to achieve water quality standards in the Delta due to project exports). The carriage water term is zero when flow rather than salinity objectives control Delta operations. Reclamation's CVOO publishes daily accounts of supplemental water (http:// www.usbr.gov/mp/cvo).

Figure 2-1 shows the periods for which Term 91 has been imposed. Between 1984 and 2002, Term 91 was typically imposed for a two to three month period with a default ending date of August 31. Historically, the start of Term 91 has ranged from mid-May to late July, and on occasions has extended past the default August 31 end date. In 1992, Term 91 was extended to mid-November. In 2002, Term 91 was reimposed in October and November. In the future, Term 91 may be extended more often into the fall due to new water demands associated with rice straw decomposition and other fall diversions.

Source: CVOO website, http:// www.usbr.gov/mp/cvo.

Figure 2-1. Historical Imposition of Term 91

Local Surface Water Facilities

For modeling purpose, the 56 TAF/yr scenario was chosen as a representative modeling scenario for evaluating the potential impacts of DWWSP. In this scenario, the capacity of the new water intake/treatment facilities is assumed to be sufficient for maximum monthly diversion of 7,354 AF. For CALSIM II modeling purposes, the three potential locations of the new diversion facilities for the DWWSP are identical in their specification and model implementation.

Other Projects/Programs

Under the With-Project Conditions, the other projects/programs are the same as under Existing Conditions.

CUMULATIVE CONDITIONS WITHOUT PROJECT

CEQA requires a cumulative analysis to include future actions and projects that can be reasonably predicted to occur within the terms of the proposed project. The cumulative analysis evaluates the combined effects of the proposed project with other water supply programs/actions. The time frame for the DWWSP Cumulative Condition analysis is 2040. Regions external to the DWWSP were modeled using the available CALSIM II 2020 LOD land use and export demands.

Water Demands

Project Partners

A demand level of 56,717 AF per year for the Project Partners is assumed for the Cumulative Conditions without Project scenario. This is the same demand as for the With-Project Conditions scenario.

CVP-SWP System

The 2020 LOD demand is used for the CVP-SWP system.

Local Water Supplies

The source of water supply for the Project Partners is groundwater.

Other Potential Future Projects/Programs

Future actions and projects under the Cumulative Conditions include the Freeport Regional Water Project (FRWP), the South Delta Improvement Program (SDIP), the Delta-Mendota Canal/California Aqueduct Intertie (DMC/CA Intertie), integrated CVP-SWP operations, and the Long-Term EWA. The SDIP and CVP-SWP Integration were included in Reclamation's 2004 OCAP BA as part of the early consultation process. The FRWP and DMC/CA Intertie were included as part of the 2004 OCAP BA formal consultation.

Freeport Regional Water Project

The FRWP is being developed by the Freeport Regional Water Authority, a joint powers agency formed by Sacramento County Water Agency and East Bay Municipal Utility District. The basic purpose of the FRWP is to increase water service reliability for customers, reduce rationing during droughts, and facilitate conjunctive use of surface water and groundwater supplies in central Sacramento County. This project would consist of a diversion (a capacity of 185 million gallons per day) on the Sacramento River near the town of Freeport. The FRWP Final EIR has been certified; Reclamation issued the ROD for the Final EIS on January 4, 2005.

South Delta Improvement Program

The SDIP is one of the actions identified in the CALFED ROD. SDIP will address export water needs while maintaining water levels for agricultural diversions and improving migratory conditions for fall-run Chinook salmon in the San Joaquin River. The SDIP actions are divided into two stages:

- Stage 1 includes constructing and operating four permanent gates across Old River at its divergence from San Joaquin River, Old River near Tracy, Middle River, and Grant Line Canal; and dredging in Middle River, Old River, and West Canal in the south Delta.

- Stage 2 will increase the permitted pumping capacity of the SWP's Banks Pumping Plant from 6,680 cubic feet per second (cfs) to 8,500 cfs.

The SDIP is currently being undertaken by Reclamation and DWR. On June 6, 2006, DWR and Reclamation requested to initiate formal ESA and California Endangered Species Act consultation on the Stage 1 of SDIP. The SDIP Final EIS/EIR was released on December 1, 2005.

Delta-Mendota Canal/California Aqueduct Intertie

The DMC/CA Intertie would connect the Delta-Mendota Canal (DMC) and the California Aqueduct (CA) via a new two-way flow pipeline and pumping plant. The DMC/CA Intertie would be located in an unincorporated area of the San Joaquin Valley in Alameda County, west of the city of Tracy. The DMC/CA Intertie would be owned by Reclamation and operated by the San Luis and Delta Mendota Water Authority. The DMC/CA Intertie would be used to accomplish a range of benefits, including meeting current water supply demands, maintaining and repairing CVP Delta export and conveyance facilities, and providing CVP and SWP operational flexibility. Reclamation is preparing an EIS for the DMC/CA Intertie. A Draft EIS is expected to be available in May 2007.

CVP-SWP Integration

DWR and Reclamation have considered and attempted to increase the level of CVP/SWP operational coordination and integration. Under this proposal, one project would utilize the other project's resources to improve water supply reliability and reduce operational costs. Under the proposed integration, DWR would assume primary responsibility for delivering water to the federal wildlife refuges located south of the Delta. CVP storage facilities would be available to the SWP. The integration agreement also supports implementation of the SDIP and continued implementation of the EWA.

Long-Term Environmental Water Account

Future implementation of EWA Program could be affected by many ongoing projects and proposed operational changes within and beyond CALFED ROD. These include the following actions:

- Using EWA to provide additional coverage to supplement CVPIA Section 3406(b)(2) actions ((b)(2) actions) under certain conditions;

- The implementation of proposed increase in pumping limitations of the Harvey O. Banks Delta Pumping Plant from 6,680 cfs to 8,500 cfs considered by Reclamation and DWR in the SDIP;

- The implementation of the proposed further integrated operation of CVP and SWP (also known as the Napa Proposition);

- The implementation of the DMC Recirculation to meet flow and water quality standards in the lower San Joaquin River and in the South Delta.

- The re-consultation of the long-term OCAP for the CVP and SWP for compliance with the Federal Endangered Species Act of 1973, as amended.

Currently, there is no continued authorization or secured funding sources for the implementation of a Long-Term EWA Program beyond 2007. The EWA agencies are currently developing a Long-Term EWA Program through 2030. As part of the CALFED 10-Year Action Plan (CALFED, 2006), the development of the Long-Term EWA and its associated EIS/EIR will focus on alternative strategies for obtaining assets through 2030. The asset acquisition and management tools described in the Short-Term EWA Program will be expanded to include source shifting and purchase of stored reservoir water from additional reservoirs, groundwater substitution and banking in additional counties, crop idling in additional counties, as well as idling different crops. The draft EIS/EIR is scheduled for release in 2007.

Since the Long-Term EWA was not available, the Short-Term EWA was used as a surrogate for the Long-Term EWA in 2004 OCAP CALSIM II studies.

CUMULATIVE CONDITIONS WITH PROJECT

Water Demands

The same demand level of 56,717 AF per year is assumed for the Cumulative Conditions with Project scenario.

Local Water Supplies

Same as the With-Project Conditions.

Local Surface Water Facilities

For modeling purpose, the 56 TAF/yr scenario was chosen as a representative modeling scenario for evaluating any potential impacts of the proposed project.

Other Potential Future Projects/Programs

Same as the Cumulative Conditions without Project.

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CHAPTER 3. MODELING METHODOLOGY

This chapter describes the modeling methodology, including the use of CALSIM II, DSM2, and temperature modeling for the DWWSP EIR analysis.

The CALSIM II simulation constructs the main core of the modeling framework. CALSIM II is used by DWR and Reclamation to support a wide range of programs that include CALFED's Integrated Storage Investigations (ISI), the Federal Energy Regulatory Commission (FERC) relicensing of Oroville facilities, and the 2004 OCAP BA studies. CALSIM II also has been used to support the FRWP EIS/EIR, the EWA EIS/EIR, City of Stockton Delta Water Supply Project EIR, and the Sacramento Valley Water Management Program Short-Term Program EIS/EIR. CALSIM II is generally regarded as the best available planning tool for analysis of the CVP-SWP system and regions tributary to the Delta. The model underwent peer review in 2003 as part of the CALFED Science Program.

After the CALSIM II simulation, outputs from the CALSIM II can: (1) provide flow boundary conditions for Delta hydrodynamic and water quality simulations, and (2) provide stream flows and reservoir storage information for temperature modeling simulations. **Figure 3-1** shows the modeling framework for the DWWSP EIR analysis.

Figure 3-1. Modeling Framework for DWWSP EIR Analysis

HYDROLOGIC MODELING

The purpose of the hydrologic modeling was as follows:

- Identify impacts of the proposed DWWSP on the surface water systems
- Provide flow boundary conditions for detailed hydrodynamic and water quality modeling of the Delta
- Provide flow boundary conditions for reservoir and river temperature modeling
- Quantify the water supply reliability of the DWWSP
- Quantify surface water delivery impacts to other water users

CALSIM Software

CALSIM is a generalized water resources tool developed by DWR's Bay-Delta Office. The model is data driven and can be applied to most reservoir-river basin systems. The model represents the physical system (reservoirs, streams, canals, pumping stations, etc.) by a network of nodes and arcs. The model user describes the system connectivity and various operational constraints using a modeling language known as Water Resources Simulation Language. CALSIM subsequently simulates system operations using optimization techniques to route water through the network. A linear programming solver determines an optimal set of decisions each time-step for a set of user-defined priorities (weights) and system constraints. The model is described by DWR (2000) and Draper et al. (2004).

CALSIM Application

CALSIM II is the application of the CALSIM software to model the CVP and the SWP systems. This application was jointly developed by DWR and Reclamation for planning studies relating to CVP-SWP operations. The primary purpose of CALSIM II is to evaluate the water supply reliability of the CVP and SWP at current and future levels of development (e.g. 2001 and 2020), with and without various assumed future facilities, and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta, and SWP exports to the San Francisco Bay Area, Central Coast, and Southern California. CALSIM II provides a set of operations that meet all applicable regulatory and operational constraints in the Central Valley and the Delta.

CALSIM II typically simulates system operations for a 73-year period (water year 1922 – 1994) using a monthly time-step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed LOD (e.g., 2001 or 2020). The historical flow record October 1921 to September 1994, adjusted for the influence of land use changes and upstream flow regulation, is used to represent the possible range of water supply conditions. It is assumed that past hydrological conditions are good indicators of future hydrologic conditions.

CALSIM II uses a mix of land-use-based and contract-based demands. Agricultural demands in the Sacramento Valley and Delta are land-use-based and vary with winter and spring precipitation. Agricultural demands in the San Joaquin Valley are contract-based. CVP south-of-Delta annual demands are constant, and set equal to the maximum contract amounts. SWP south-of-Delta demands are based on the Table A amounts in the SWP contracts.

CALSIM II represents a complex and extensive set of regulatory standards and operations criteria. Descriptions of both are contained in Chapter 8 of the 2004 OCAP BA (Reclamation, 2004), and in the Benchmark Studies Assumptions Document (DWR and Reclamation, 2002).

Consistency with Previous Analysis

DWR and Reclamation have released “benchmark studies” for CALSIM II. These studies provide a common platform and set of assumptions for water resources planning. The last set of benchmark studies released by the agencies was September 30, 2002. They consist of two CALSIM II studies corresponding to 2001 and 2020 LODs. These studies are available from DWR’s Web site (http://baydeltaoffice .water.ca.gov/modeling).

The 2004 OCAP and OCAP BA are supported by a set of CALSIM II studies. These OCAP BA studies were released by Reclamation on February 2, 2004, with revisions released on June 30, 2004. The studies are available from Reclamation’s CVOO Web site (http://www.usbr.gov/mp/cvo/ocap .html). Numerous amendments and improvements to the 2002 benchmark studies have been incorporated into the 2004 OCAP BA studies.

The 2004 OCAP BA studies consist of five CALSIM II simulations, three at the current (2001) LOD and two at a future (2020) LOD. The studies are as follows:

- Study 1: OCAP_2001D10A_1997_B2D1641_012104
- Study 2: OCAP_2001D10A_Today_B2_011904
- Study 3: OCAP_2001D10A_TodayEWA_012104

- Study 4: OCAP_2020D09D_FutureSDIP_011904
- Study 5: OCAP_2020D09D_FutureEWA_012104

The future projects/programs included in 2004 OCAP BA studies are considered reasonably likely to be implemented. These include the SDIP, DMC/CA Intertie, CVP-SWP Integration (the “Napa Proposition”), and the FRWP. The 2020 studies also implement 2000 Trinity ROD flow targets. Two additional studies were later released that included projects/programs under formal consultation only:

- Study 4a: OCAP_2020D09D_Futureb24a_031804
- Study 5a: OCAP_2020D09D_FutureEWA5a_032304

The SDIP and the CVP-SWP Integration are not included in these two studies.

DWR, Reclamation and their consultants are developing a set of “Common Assumptions” studies as part of the CALFED ISI Program. These studies provide a common baseline for analyzing the storage projects defined in the 2000 CALFED ROD. CALSIM II model revisions made for the Common Assumptions would not likely be considered as the modeling basis for the DWWSP because: (1) the DWWSP is not a CALFED project, and (2) the date for public acceptance of the updated version of CALSIM II is not certain.

Modeling Base for DWWSP

The DWWSP EIR modeling analysis was developed based on two CALSIM II studies for 2004 OCAP BA:

- Existing Conditions and With-Project Conditions: based on 2004 OCAP Study 3
- Cumulative Conditions without Project and Cumulative Conditions with Project: based on 2004 OCAP Study 5

Formal consultation on the 2004 OCAP BA, including the Trinity River ROD flows, FRWP, and DMC/CA Intertie, are considered in the Cumulative Conditions analysis for the DWWSP. The SDIP will require a separate formal consultation following completion of the SDIP EIS/EIR. However, it is included in the Cumulative Conditions analysis as well.

Multi-Step Analysis

Modeling the CVPIA (b)(2) and EWA requires knowledge of project operations under different regulatory baseline conditions. Simulation of (b)(2) requires knowledge of operations under Water Rights Decision 1485 (D-1485) (SWRCB, 1978) and Decision 1641 (D-1641) (SWRCB, 2000). Similarly, simulation of EWA requires knowledge of deliveries and storage conditions under (b)(2) and the Joint Point of Diversion (JPOD).

A 73-year simulation of project operations under a single regulatory regime is referred to as a CALSIM II single-step study. Modeling EWA requires simulating five regulatory regimes (D-1485, D-1641, (b)(2), JPOD, EWA). The resulting five-step study is conducted in 12-month blocks in which each regulatory regime is simulated for 12 months starting from the same initial conditions. Carryover storage conditions from the EWA step provide initial water year conditions for each subsequent year step.

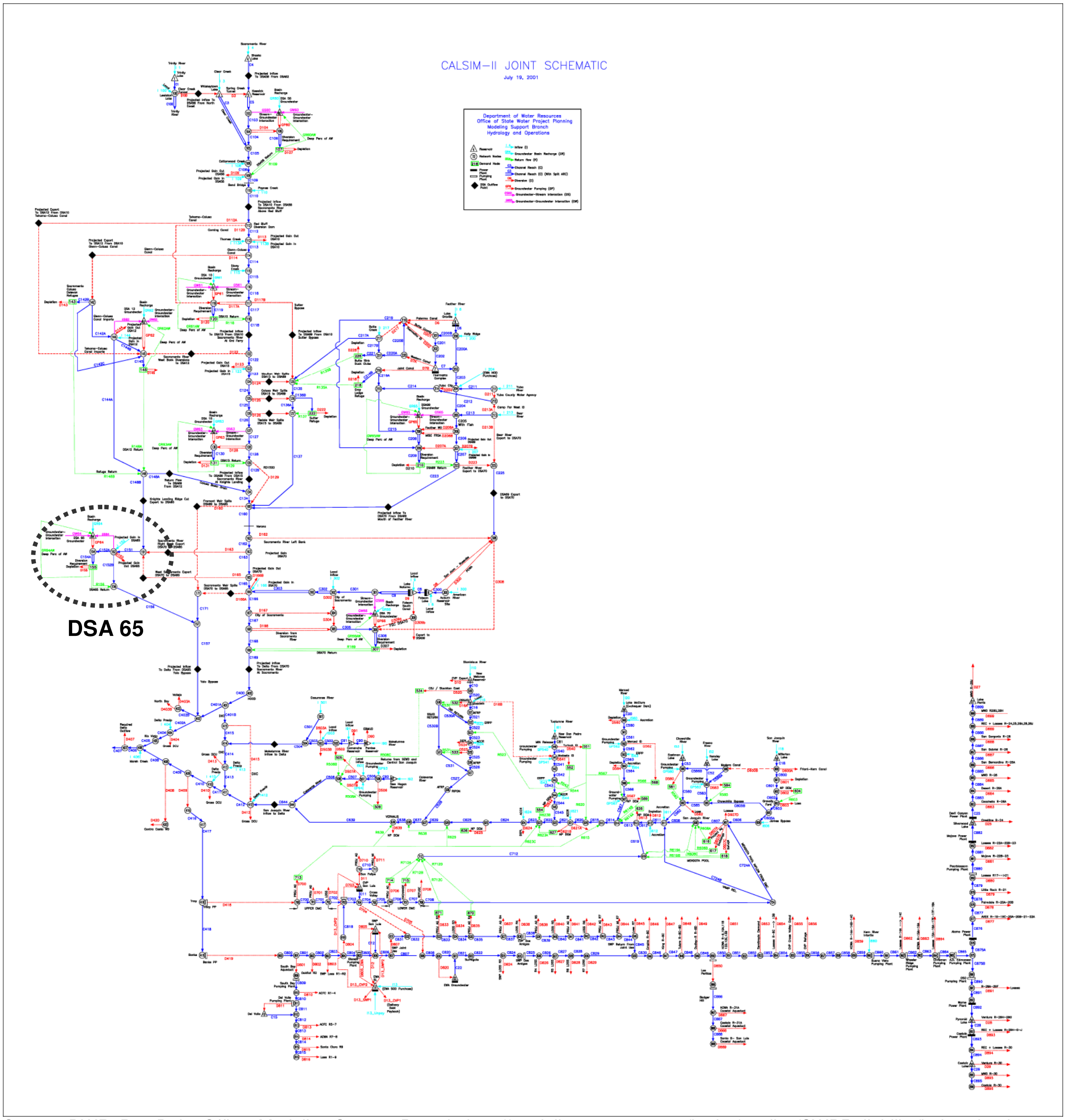
The EWA, described in the CALFED ROD, was originally a four-year program that has been implemented since 2000, and has been extended to 2007. Implementing of a Long-Term EWA as part of the operation of the CVP and SWP is envisioned. A plan of operations for the Long-Term EWA has not been finalized. Future implementation will be subject to National Environmental Policy Act (NEPA) and CEQA. EWA is an additional layer of operations that provides increased stream flows through reservoir releases, and curtailment of project export pumping in the Delta at sensitive times of the year. Since the long-term EWA is still uncertain, the Short-Term EWA is used as surrogate under the 2004 OCAP Study 5.

Model Modification for the DWWSP

In the current CALSIM II schematic (see **Figure 3-2**), the Project Partners' demand was lumped with other water users in Depletion Study Area (DSA)[2] 65. To facilitate the modeling exercise for the DWWSP, the CALSIM II schematic was modified and additional code and logic were added to CALSIM II to explicitly represent the DWWSP diversions. The original and revised network schematics are shown in **Figure 3-3**. Model modifications include:

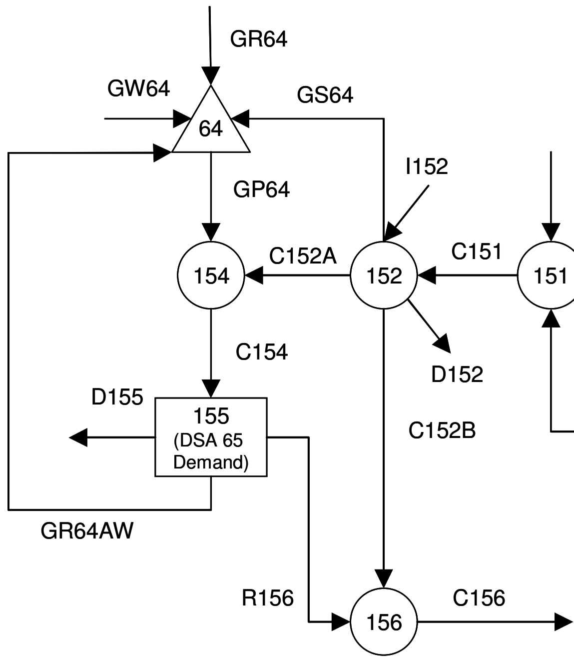
- System-wide
  - **Trinity ROD target flows (368,600 – 815,000 AF per year)** - The 2004 OCAP consultation was conducted in conjunction with the ongoing court proceeding to resolve the Trinity River flow issues. The 2004 OCAP modeling simulation was completed in February 2004, and the associated BA was completed in June 2004. Due to the pending court decision, 2004 OCAP Study 3 for existing conditions includes an instream flow requirement for 368,600 AF per year as ordered by the district court. Recognizing the significant differences in instream flow requirements between 2004 OCAP Study 3 assumption and the 2000 ROD flows, the current hydrologic modeling for the DWWSP EIR updates the modeling assumption to reflect the July 2004 Ninth Circuit Court order. The implementation of the ROD flows in the Trinity River would result in reduced water availability for the CVP, and potentially affect SWP operations indirectly through the implementation of the Coordinated Operations Agreement. However, most impacts were reflected in reduction in CVP exports from the Delta.
  - **Contract amount modification for Anderson-Cottonwood Irrigation District (ACID)** – ACID is a CVP settlement contractor and was considered as a potential supplier of supplemental water. The 2004 OCAP CALSIM II studies assumed that ACID's contract amount was 175,000 AF per year. However, in the new contract between Reclamation and ACID, dated in July 2005, the contract amount is 128,000 AF per year; therefore, the water service amount was modified in CALSIM II accordingly.
- Local
  - **Modeling Project Partners' demands** – The project description stated that the purpose of DWWSP is to introduce surface water to replace the existing and planned future groundwater use. Therefore, based on the project description, the Project Partners' demands were assumed to be included in the current CALSIM II DSA 65 demands for EIR modeling purposes. The total demand of the Project Partners for Existing Conditions, With-Project Conditions, Cumulative Conditions without Project, and Cumulative Conditions with Project could be treated as an individual demand which could be separated from the total demand of other water users in DSA 65.
  - **Project Partners' water-right diversion** – A new surface water diversion delivering water from the Sacramento River to the Project Partners was added for the modeling of the With-Project Condition and the Cumulative Conditions with Project. It was assumed that the diversion would be limited by SWRCB standard permit Term 91. Code was added to CALSIM II to dynamically calculate the period when Term 91 would be in effect.

[2] The DSAs were developed to facilitate the calculation of a water balance. These DSAs are large, and hydrologic characteristics may vary significantly within a DSA's boundaries.

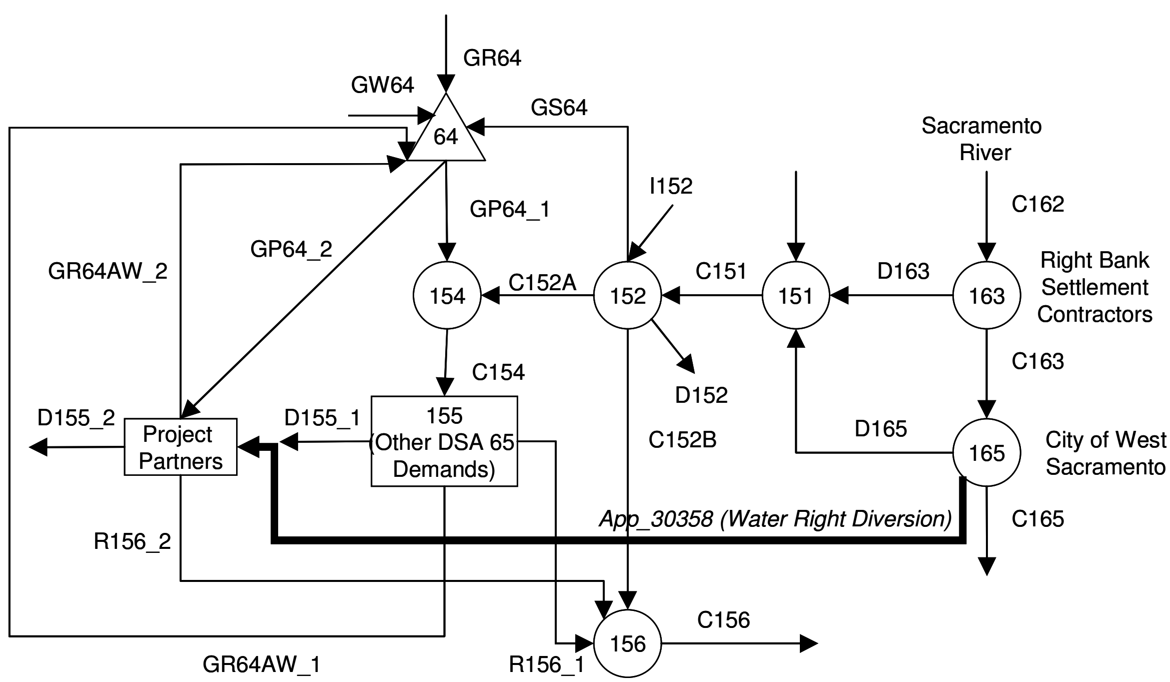


Source: DWR, Bay-Delta Office, Modeling Support Branch, http://modeling.water.ca.gov/hydro/studies/SWPReliability/index2.html.

Figure 3-2. Illustration of CALSIM II Schematic



(a) Original Schematic



(b) Revised Schematic

Figure 3-3. Illustration of CALSIM II Schematic for the DWWSP

Modeling Contra Costa Water District Delta Diversion

Contra Costa Water District (CCWD) diverts water from the Delta for its water supply. CCWD's raw water system consists of three Delta pumping plants (Mallard Slough, Rock Slough and Old River), and a 100,000 AF blending reservoir (Los Vaqueros). The pumping plants at Rock Slough and on the Old River are the primary sources. The third intake at Mallard Slough is used only when water quality conditions in the western Delta permit, usually following a prolonged period of surplus Delta outflow. Use of the Rock Slough and Old River intakes is based on demand, water quality, capacity, pumping costs, and environmental considerations (Campbell et al., 2002). Water diverted at Rock Slough Pumping Plant is used directly. Water diverted at the Old River Pumping Plant is either used directly or stored in Los Vaqueros Reservoir for later use. CCWD's current operational priority is to fill Los Vaqueros Reservoir with high quality water whenever possible.

CALSIM II represents CCWD Delta diversions as a pre-processed time series that is given a high priority (weight). The input time series was developed by CCWD based on CCWD's own internal planning models. CALSIM II represents only a single point of diversion, and does not dynamically model impacts to CCWD diversions due to changes in water quality, operation of Los Vaqueros Reservoir, or imposed deficiencies on CVP water service contracts. To support subsequent water quality analyses, CCWD's diversions have been disaggregated into two components: diversions at the Rock Slough Pumping Plant and diversions at the Old River Pumping Plant. Modeling diversions at the Mallard Slough Pumping Plant was not considered necessary.

Model Limitations

CALSIM II uses a monthly time step and simplified system representations due to the difficulty of incorporating complex operating criteria for long-term planning purposes. The simplified system representation may not recognize detailed local and specific system operational rules. The system operations and model calculations are based on generalized monthly operational rules. However, the actual operational decisions may be developed based on weekly, daily, or even hourly time steps. Therefore, operational adjustments on time steps less than one month, such as flood control operations, are assumed to be included in monthly averaged stream flows, storages, and releases. Model inputs and results are considered as monthly averages.

CALSIM II uses perfect foresight and does not consider the flow traveling time associated with reservoir releases for downstream flow requirements (due to the use of monthly step). Therefore, the actual amount of water that is needed to be released from reservoirs may not be completely accurately simulated in CALSIM II. For example, in real practice, reservoir releases must be made hours or days in advance of a downstream flow requirement. If it rains before the released water reaches the required location, stream flows increase and more water than necessary may have been released to meet the flow requirement.

Metrics for Measuring Impacts

Table 3-1 lists the various performance metrics that were used to assess the hydrologic impacts of the DWWSP. Metrics were determined for the long-term average (water year 1922 – 1994) and dry periods (average of October 1928 – September 1934, October 1975 – September 1977, and October 1986 – September 1992).

Table 3-1. CALSIM II Modeling Outputs for Hydrological Impacts Assessment

Items	Major Outputs	
River Flows	• Trinity River Flow below Lewiston Reservoir • Sacramento River flow below Keswick Dam • Sacramento River flow below Navigation Control Point (at Wilkins Slough) • Sacramento River flow below the confluence with American River	• Sacramento River flow below Freeport • Feather River Flow below Thermalito Afterbay Outlet • Feather River Flow at mouth • American River Flow below Nimbus Dam • American River Flow at H Street • San Joaquin River near Vernalis
Delta Flows	• Exports at Tracy Pumping Plant • Exports at Banks Pumping Plant	• Total Delta inflow • Net Delta outflow • QWEST
CVP/SWP Deliveries	• CVP North-of-Delta o Agricultural service contractors o M&I service contractors • CVP South-of-Delta o Agricultural service contractors o M&I service contractors	• SWP o Table A o Article 21
Reservoir Carryover Storage	• CVP o Trinity Lake o Shasta Lake o Whiskeytown Lake o Folsom Lake o CVP San Luis Reservoir	• SWP o Lake Oroville o SWP San Luis Reservoir
Project Partners' Diversion	• Water Right Diversion	• Supplemental Water Needed

HYDRODYNAMIC AND WATER QUALITY MODELING

Methodology

Water quality in the Delta is a function of many factors, including tidal exchange, agricultural diversions and return flows, operation of flow control structures (Delta Cross Channel, temporary barriers in the south Delta, and Suisun Marsh Salinity Control Gate), Delta inflows (Sacramento River, Yolo Bypass, San Joaquin River, and eastside streams), and export pumping at CVP and SWP facilities. Delta outflow is the key determinant of salinity. Daily outflow, averaged over a tidal cycle, can range from negative 6,000 cfs to over 500,000 cfs during extreme flood events like the event that occurred in January 1997. Average monthly outflows can vary between 3,000 cfs and 20,000 cfs. Correspondingly salinity at most water quality stations can vary by a factor of ten.

Various mathematical models have been developed over the last 20 years to estimate hydrodynamic and water quality conditions in the Delta under different hydrologic conditions. DSM2 developed by DWR's Delta Modeling Section of the Bay-Delta Office is the recognized standard for analyzing the potential impacts of water projects. It is being used currently by DWR for the SDIP and by DWR, Reclamation and their consultants for the CALFED ISI. DSM2 has also been used to support the CALFED Programmatic EIS/EIR, FRWP EIS/EIR, Short-Term EWA EIS/EIR, and the Sacramento Valley Water Management Program Short-Term Program EIS/EIR. The DSM2 model is publicly available from DWR.

The proposed DWWSP diversion from the Sacramento River has the potential to impact water quality in the Delta by inducing greater salinity intrusion from the Western Delta. Water quality impacts of the DWWSP were assessed using an integrated CALSIM II-DSM2 approach. CALSIM II was used to simulate monthly statewide reservoir operations, river flows and CVP-SWP deliveries for a 73-year period based on the 1922-1994 hydrology. CALSIM II output provided flow (and salinity for the San Joaquin River) boundary conditions for DSM2. DSM2 was used to calculate corresponding changes in water quality in the Delta compared to baseline conditions for a 16-year period (water year 1976-1991). This 16-year period includes the 1976-1977 two-year drought and the 1987-1991 five-year drought.

For the DWWSP, water quality impacts were analyzed using electrical conductivity (EC) as the primary salinity parameter. Other measurements of salinity such as chloride, bromide, and total dissolved solids (TDS) were estimated using regression equations determined from field data.

CALSIM II Flow-Salinity Modeling

The Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (SWRCB, 1995) and D-1641 specify water quality standards that the CVP and SWP have joint obligations to meet. Salinity standards for the Delta are stated in terms of EC (for protection of agricultural, and fish and wildlife beneficial uses), and chloride (for protection of municipal and industrial (M&I) uses). Upstream CVP and SWP reservoir operations are often controlled by Delta salinity standards. However, salinity in the Delta cannot be modeled accurately by the simple mass balance routing and coarse time-step used in CALSIM II. Instead, CALSIM II uses two algorithms to translate water quality standards into flow equivalents.

X2

The location of X2, the 2 parts per thousand (ppt) in practical salinity unit isohaline at one meter above the bottom of the Sacramento River Channel, is used as a surrogate measure of ecosystem health in the Delta. Under D-1641, the CVP and SWP are responsible for maintaining the X2 location as specified in the 1995 Water Quality Control Plan. Compliance is achieved through either meeting a surface EC of 2,640 microSiemens per centimeter (μS/cm) at the compliance location, or meeting a Delta outflow equivalent.

Kimmerer and Monismith (1992) developed a linear regression equation relating the mean monthly location of X2 to the monthly averaged Delta outflow in that month and the location of X2 in the previous month. The equation is as follows:

$$X2^{t} = 122.2 + 0.3278\, X2^{t-1} - 17.65 \log_{10} NDOI$$

where:

$X2^{t}$ = Monthly-averaged distance of the 2,640 μS/cm surface isohaline from the Golden Gate Bridge, in kilometers and along the main shipping channel;

$X2^{t-1}$ = Monthly-averaged distance in the previous month;

NDOI = Monthly-averaged Net Delta Outflow Index in cfs in the month in which X2 is computed.

This equation is used in CALSIM II to ensure compliance with the X2 requirement by maintaining the equivalent Net Delta Outflow. CALSIM II's estimate of the X2 position was used as a metric of ecosystem impacts of the DWWSP and alternatives.

Artificial Neural Network

The Kimmerer-Monismith equation relates Delta salinity to Delta outflow. The use of Delta outflow captures the effects of seawater intrusion and provides a good estimate of the salinity variation in the western Delta. However, salinity in the interior Delta also is influenced by the relative magnitudes of flows through the channel network and export pumping. Agricultural drainage and M&I wastewater discharges also can affect local salinity conditions. To capture these effects, DWR developed an artificial neural network (ANN) algorithm capable of mimicking DSM2. The algorithm uses four input parameters (Delta inflow from the Sacramento Valley, Delta inflow from the San Joaquin River, total Delta exports, and Delta Cross Channel gate operations), to estimate EC at key locations in the Delta. The ANN is calibrated using DSM2 output. Appendix D of the Benchmark Studies Assumptions (DWR and Reclamation, 2002) provides details of the link between ANN and CALSIM II. Discussion of ANN performance is discussed by DWR (1999, 2002a).

The current CALSIM-ANN integration allows the simulation of flow-salinity relationships at four locations: (1) Emmaton, (2) Jersey Point, (3) Contra Costa Canal Pumping Plant No. 1 (CCC PP No. 1), and (4) Collinsville. The Emmaton, Jersey Point and Collinsville salinity standards are modeled directly at their respective locations in the Delta. The CCC PP No. 1 chloride standard is translated into an equivalent salinity standard for the Old River at Rock Slough due to difficulties in DSM2 in accurately modeling water quality in Rock Slough. The current transformation of the standard is as follows:

$$\text{Old River at Rock Slough EC} = (\text{CCC PP No. 1 chloride} + 23.6)/0.268$$

The transformation is for EC in µS/cm and chloride in milligrams per liter (mg/L). A regressive correlation has been found between the Old River at Rock Slough and Jersey Point locations that better simulates salinity at the entrance to the slough:

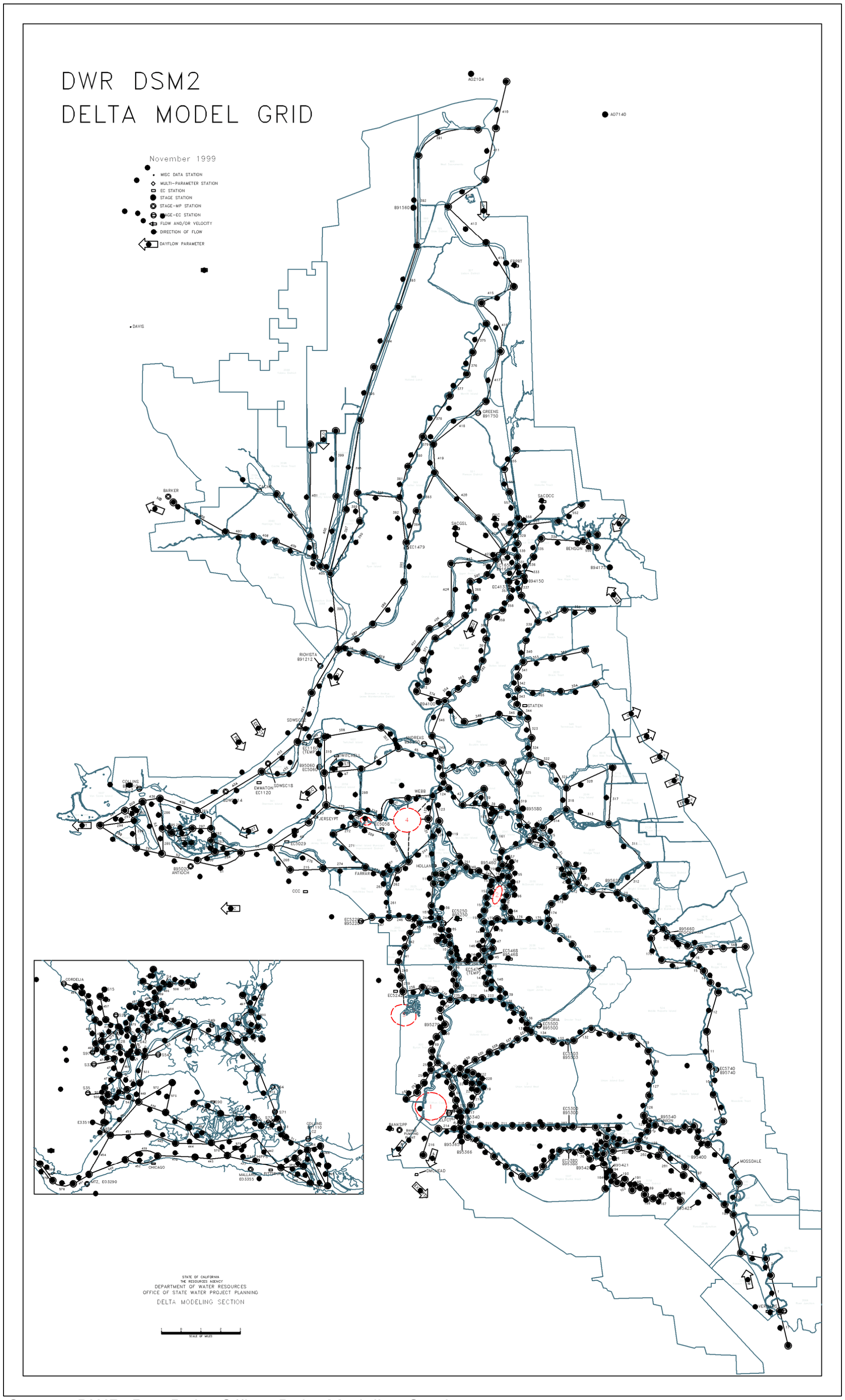
$$ORRS^{t} = 0.188 * JP^{t} + 0.140 * JP^{t-1} + 142.2$$

t refers to the current time-step and t-1 refers to the previous time-step. ORRS and JP are the salinity for the Old River at Rock Slough and Jersey Point, respectively. This equation is used to transform the Rock Slough salinity standard to an equivalent standard at Jersey Point. This new, equivalent Rock Slough standard is used with the Jersey Point ANN to determine the flow–salinity relationship.

DSM2

DSM2 is a branched one-dimensional, physically based numerical model of the Delta developed by DWR in the late 1990s. DSM2-Hydro, the hydrodynamics module, is derived from the United States Geological Survey's (USGS) Four Point model. DSM2-Qual, the water quality module, is derived from the USGS Branched Lagrangian Transport Model. Details of the model, including source codes and model performance, are available from the DWR, Bay-Delta Office, Modeling Support Branch Web site (http://modeling.water.ca.gov /delta/models/dsm2/index.html). Documentation of model development is discussed in the annual reports to the SWRCB, *Methodology for flow and salinity estimates in the Sacramento-San Joaquin Delta and Suisun Marsh*, by the Delta Modeling Section of DWR.

The DSM2 schematic is shown in **Figure 3-4**. Key DSM2 inputs include tidal stage, boundary inflow and salinity concentration, and operation of flow control structures. **Table 3-2** summarizes basic input requirements and assumptions.



Source: DWR, Bay-Delta Office, Delta Modeling Section,
http://modeling.water.ca.gov/delta/models/dsm2/documentation.shtml.

Figure 3-4. Illustration of DSM2 Schematic

Table 3-2. DSM2 Input Requirements and Assumptions

Parameters	Assumptions
Period of simulation	October 1975 – September 1991
Boundary flows	CALSIM II output
Boundary stage	15-minute adjusted astronomical tide
Agricultural diversion & return flows	Delta Island Consumptive Use model, 2001/2020 LOD
Salinity	
Martinez EC	Computed from modified G-model, adjusted astronomical tide and Net Delta Outflow from CALSIM II
Sacramento River	Constant value = 150 µS/cm
Yolo Bypass	Constant value = 175 µS/cm
Mokelumne River	Constant value = 125 µS/cm
Cosumnes River	Constant value = 125 µS/cm
Calaveras River	Constant value = 125 µS/cm
San Joaquin River	CALSIM II EC estimate using modified Kratzer equation
Agricultural drainage	Varying monthly values that are constant year to year
Facility operations	
Delta Cross Channel	CALSIM II output
South Delta barriers	Temporary barriers/SDIP operation of permanent barriers

Planning Tide at Martinez Boundary

Tidal forcing is imposed at the downstream boundary at Martinez as a time series of stage (for the hydrodynamic module) and salinity (for the water quality module). DWR has traditionally used a "19-year mean tide" (or "repeating tide") in all DSM2 planning studies, in which the tide is represented by a single repeating 25-hour cycle. An "adjusted astronomical tide" was later developed that accounts for the spring-neap variation of the lunar tide cycle (DWR, 2001a, 2001b). Recent comparisons of DSM2 mean tide and modified astronomical tide simulations show similar water quality results except at times of seawater intrusion. At times of low Delta outflow, monthly-averaged salinity from modified astronomical tide simulation is consistently lower than, but closer to observed data.

For the DWWSP EIR analyses, all DSM2 simulations use the same adjusted astronomical tide. This is consistent with planning studies being conducted by DWR as part of the SDIP, and on-going analysis for the CALFED ISI.

Salinity Boundary Conditions

Martinez

Salinity at the Martinez downstream boundary reflects intrusion of salt water into San Pablo Bay from the ocean. It is determined using an empirical model known as the modified G-model (DWR, 2001b). The model calculates a 15-minute time series of salinity values based on the adjusted astronomical tide and the Net Delta Outflow. Since these aggregate flows are available from CALSIM II, salinity at Martinez can be pre-processed and input to DSM2 as time series data. Each simulation has a different EC boundary condition at Martinez reflecting the different inflows and exports from the Delta that occur in a particular scenario.

Sacramento River/Yolo Bypass/ Eastside Streams

The inflow salinities for the Sacramento River, Yolo Bypass, and eastside streams (Mokelumne River, Cosumnes River, and Calaveras River) were assumed to be constant at 150, 175, and 125 µS/cm, respectively.

San Joaquin River at Vernalis

CALSIM II calculates EC for the San Joaquin River at Vernalis using a modified Kratzer equation. The resulting EC values were used to define the inflow salinity for DSM2. Potentially each simulation has a different EC boundary condition at Vernalis reflecting the different upstream operations on the San Joaquin River and its tributaries. However, differences in salinity between scenarios were small.

M&I and Agricultural Return Flows

The salinity of agricultural return flows was based on an analysis of Municipal Water Quality Investigations (MWQI) data (DWR, 1995). Monthly, regional representative EC values of drainage were determined for three regions in the Delta (north, west, and southeast regions). The EC values vary by month, but are constant from year-to-year and are independent of the LOD. EC values were highest for the west region due to its proximity to the ocean. The monthly EC values follow a seasonal trend with the highest concentrations occurring in winter and spring during the rainfall-runoff season (approximately 820 µS/cm to 1890 µS/cm). Lowest drainage concentrations occur in July and August (approximately 340 µS/cm to 920 µS/cm). The simulated effects of agricultural drainage are greatest during the low-flow winter months. However, salinity impacts are not significant because they remain unchanged between the proposed DWWSP and the "without-project" condition.

Delta Channel Flow

Sacramento River water flows into the central Delta via the Delta Cross Channel and Georgiana Slough. The Delta Cross Channel, constructed in 1951 as part of the CVP, connects the Sacramento River to the Mokelumne River via Snodgrass Slough. Its purpose is to increase flow in the lower San Joaquin River and to reduce salinity intrusion and the movement of saline water from Suisun Bay towards CCWD's Rock Slough intake and the Tracy Pumping Plant. Two radial gates regulate flow through the Delta Cross Channel. When the gates are open, flow through the Delta Cross Channel is determined by the upstream stage in the Sacramento River. Similarly, flow through Georgiana Slough is a function of upstream Sacramento River stage. Sacramento River water is also transported southward through Threemile Slough, which connects the Sacramento River just downstream of Rio Vista to the San Joaquin River.

The mouth of the Old River, located upstream of the mouth of the Mokelumne River, is the major conduit for water flowing from the Sacramento River, through Georgiana Slough and the Delta Cross Channel, via the Mokelumne River, to the south Delta. Additional water for the CVP-SWP export pumps moves through the mouth of the Middle River, Columbia Cut, Turner Cut, False River, Fisherman's Cut and Dutch Slough. Net flows at the mouth of the Old River and Middle River are influenced by CVP-SWP exports and south Delta irrigation diversions (approximately 40% of total net Delta diversions). Previous DSM2 simulations indicate that about 45% of south Delta exports flows through the mouth of the Old River or through the False River. About 40% of the south Delta exports flows through the mouth of the Middle River, and about 10% of the flow is through Turner Cut. This division of flow is insensitive to the magnitude of exports (Jones and Stokes, 2004, Section D-5).

Flow Control Structures

A number of flow control structures are currently operated seasonally in the Delta. These structures can have a major impact on water quality by changing the pattern of flow through the Delta.

Clifton Court Forebay

In all DSM2 simulations the Clifton Court Forebay gates were operated tidally using "priority 3". Under priority 3, the gates are closed one hour before and two hours after the lower low tide. They are also closed from two hours after the high low tide to one hour before the high tide. Discharge is proportional to the square root of the head difference across the gates. The maximum flow was capped at 15,000 cfs. The discharge coefficient was set equal to 2,400, which results in a flow of 15,000 cfs for a 1.0 foot head difference.

Delta Cross Channel

The Delta Cross Channel has a major impact on salinity in the central and south Delta. CALSIM II calculates the number of days the Delta Cross Channel is open in each month. The 1995 Water Quality Control Plan (SWRCB, 1995) specifies that the gates be closed for 10 days in November, 15 days in December, and 20 days in January, from February 1 to May 20, and for 14 days between May 21 and June 15. In addition, the gates must be closed to avoid scouring whenever the Sacramento River flow at the Delta Cross Channel is greater than 25,000 cfs. For DSM2 simulations, all partial month closings of the Delta Cross Channel were assumed to occur at the end of the month. This is consistent with planning simulations performed by the DWR Delta Modeling Section. The same Delta Cross Channel operations were used in all DSM2 simulations. The number of days per month that the gates were assumed to be open is given in **Table 3-3**.

Table 3-3. Delta Cross Channel Simulated Operation

	Gate Opening in Days/Month															
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1990	1991
Jan	-	11	11	0	11	0	11	0	0	0	11	11	11	0	11	11
Feb	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	-	26	26	26	26	26	26	26	0	26	26	26	26	26	26	26
Jul	-	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
Aug	-	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
Sep	-	30	30	30	30	30	30	30	0	30	30	30	30	30	30	30
Oct	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	-
Nov	20	20	20	20	20	20	0	0	0	0	20	20	20	20	20	-
Dec	16	16	16	16	16	16	0	0	0	16	16	16	16	16	16	-

South Delta Barriers

The South Delta Temporary Barriers Project consists of four rock barriers that are temporarily installed across south Delta channels. The objectives of the project are as follows:

- Increase water levels, circulation patterns, and water quality in the southern Delta area for local agricultural diversions
- Improve operational flexibility of the SWP to help reduce fishery impacts and improve fishery conditions

Details of the temporary barriers can be found on DWR's Web site (http://sdelta.water.ca.gov). Installations of permanent barriers (to be operated seasonally) are being studied as part of the SDIP. Of the four temporary barriers, the Head of Old River barrier serves as a fish barrier and has been in place most years between September 15 and November 30 since 1963. The remaining three barriers serve as agricultural barriers and are installed between April 15 and September 30. Installation and removal dates of the barriers are based on the United States Army Corps of Engineers' (Corps) Section 404 Permit, the CDFG 1601 Permit, and various Temporary Entry Permits required from landowners and local reclamation districts.

Experience from operating the temporary barriers will allow DWR to improve permanent barrier designs and develop operations criteria for the permanent barriers. The permanent barrier operation will be defined as part of the SDIP Final EIS/EIR. **Table 3-4** gives the assumed temporary barrier operation for modeling existing conditions.

Table 3-4. Temporary Barrier Simulated Operation

Barriers	DSM2 Channel No.	Closure	Complete Removal
Head of Old River (Spring)	54	April 15	May 15
Head of Old River (Fall)	54	September 15	November 30
Middle River	134	April 15	November 30
Old River near Tracy	99	April 15	November 30
Grant Line Canal	206	May 15	November 30

The assumed operation of the temporary barriers for model simulations is:

- Temporary head of Old River Fish Barrier:
  - installed from April 16 to May 15 when San Joaquin River flows fall below 5,000 cfs,
  - installed from September 16 to November 30 when San Joaquin River flows fall below 5,000 cfs,
  - removed when San Joaquin River flows exceed 8,500 cfs,
  - installed in spring (April 16 to May 15) at: 10 feet mean sea level (msl) if the Vernalis Adaptive Management Program (VAMP) flow less than or equal to 7,500 cfs (dry, below normal, normal years) or 11 feet msl if VAMP flow greater than 7,5000 cfs (wet years),
  - installed in fall (September 16 to November 30) with a 32-foot notch at 0.0 foot msl.
- Temporary agricultural barriers (at Middle River, Old River at DMC, and Grant Line Canal):
  - may be installed from April 16 to November 30,
  - not installed when San Joaquin River flows exceed 18,200 cfs,
  - not installed from April 16 to May 15 if head of Old River barrier is not installed,
  - not installed until the San Joaquin River flow drops below 12,000 cfs if head of Old River barrier is not installed,
  - have a 20-foot notch cut at 0 feet msl during the fall (September 16 to November 30),
  - change fall notch configuration (Old River at DMC only) when San Joaquin River flow is above 5,500 cfs, and
  - removed if the head of Old River barrier is removed as a result of Vernalis flows exceeding 8,500 cfs, unless the barriers are needed to maintain 0.0-foot msl minimum water levels at three key locations.

For the DWWSP cumulative-condition analysis, the permanent barriers were assumed to be in place.

Suisun Marsh Salinity Control Gate

The Suisun Marsh Salinity Control Gate limits flow in Montezuma Slough from Suisun Marsh during flood tide, and allows drainage from the marsh during ebb tide. The gates are not operated in the summer months

(June-September) and are not operated at all in some wet years. Actual gate operations are triggered by salinity levels in Suisun Marsh. However, in DSM2 months of gate operations are an input to the model. Suisun Marsh diversion and drainage flows have relatively little effect on salinity upstream of Chipps Island.

Delta Island Consumptive Use

CALSIM II represents agricultural demands in the Delta as a mass balance between gross Delta Consumptive Use (DCU) and precipitation. DCU is estimated using DWR's Consumptive Use model and land use estimates for the Delta. The DCU is adjusted to account for storage within the islands. The DCU and precipitation are subsequently disaggregated into four locations on the CALSIM II network.

DSM2 uses the Delta Island Consumptive Use (DICU) model to develop agricultural diversions and return flows to each of 142 Delta sub-areas on a monthly time-step. An associated routine allocates the diversions and return flows to approximately 250 diversion nodes and 200 drainage nodes in DSM2. The DICU model considers precipitation, seepage, evapotranspiration, irrigation, soil moisture, leach water, runoff, crop type, and acreage. The net DICU is computed as diversions plus seepage less drainage. Positive values indicate a net depletion of water from the Delta channels; negative values indicate a net return flow from the Delta islands into the channels. DICU follows the seasonal pattern of irrigation diversions during the summer and drainage return flows from winter runoff.

The DSM2 net channel accretions and depletions match the aggregated values used in CALSIM II so that the Net Delta Outflow is consistent between the two models.

Water Quality Conversions

DSM2 uses EC as a substitute for salinity. However, other water quality constituents were needed to assess potential impacts of the proposed DWWSP. For example, CCWD diversions and operations are primarily driven by chloride concentrations. Also, change in bromide concentration in source water can affect trihalomethane formation from chlorination of the water. Finally, there are concerns about total salt load at the Banks Pumping Plant.

Site or regionally specific relationships between Delta water quality constituents have been developed by analyzing historical grab samples. Guivetchi (1986) reports relationships between EC, TDS, and chloride from a Delta-wide evaluation of grab samples from the D-1485 monitoring program conducted by DWR. Relationships were broken down by water year type. The TDS relationships are considered reasonably accurate; however, more accurate relationships have since been determined between EC and chloride. DWR's Delta Modeling Section is currently updating Guivetchi's analysis (DWR, 2002b) using additional data from DWR's Operation and Maintenance, the MWQI, and the now defunct Water Information Monitoring System. This updated analysis has not been completed.

DWR has derived relationships between EC, bromide, and chloride at Delta export locations for use in the In-Delta Storage Investigations (Suits, 2001). Suits gives a regression equation for EC at the Old River at Rock Slough as a function of chloride at CCC PP No. 1, and a regression equation relating EC to chloride at the Los Vaqueros intake. The relationship between EC and chloride in the vicinity of the Clifton Court Forebay and DMC intake is more complex. In general, the relationship depends on whether the source water is derived from the San Joaquin River or the Sacramento River. The regression equation established by Suits is conservative, giving high values of chloride for a given EC. The relationship between chloride and bromide is fairly uniform with little site-specific variation (Suits, 2001). Therefore, a single regression equation can be used for different export locations. An analysis of MWQI data was conducted as part of the FRWP EIS/EIR. Regression equations were established as part of this analysis to estimate TDS as a function of EC at the Clifton Court Forebay. Regression equations used to convert EC to chloride, bromide, and TDS are given in **Table 3-5**.

Table 3-5. Relationship between Salinity Parameters

Location	Slope	Intercept
From EC (µS/cm) to Chloride (mg/L)		
Old River at Rock Slough[1] to Contra Costa Canal (CCWD PP No.1)	0.268	-24.0
Los Vaqueros Intake[1]	0.273	-43.9
Clifton Court Forebay[1]	0.273	-43.9
DMC Intake[1]	0.273	-43.9
From EC (µS/cm) to Bromide(mg/L)		
Old River at Rock Slough[1] to Contra Costa Canal (CCWD PP No.1)	0.000961	-0.114
Los Vaqueros Intake[1]	0.000980	-0.185
Clifton Court Forebay[1]	0.000980	-0.185
DMC Intake[1]	0.000980	-0.185
From EC (µS/cm) to TDS (mg/L)		
Clifton Court Forebay[2]	0.513	23

[1] Source: Suits, 2001.
[2] Source: FRWP EIS/EIR, March 2004.

Model limitations

The main limitation of DSM2 is that it is a one-dimensional numerical model. Stages, flows, velocity, mass transport, and water quality in Delta channels are actually three-dimensional processes. Therefore, the use of DSM2 to simulate these complex processes requires adequate assumptions and approximations.

Metrics for Measuring Impacts

Table 3-6 summarizes the metrics used to assess water quality impacts of the DWWSP.

Drinking Water

An increase in Delta salinity could adversely affect conjunctive use and groundwater management, water reclamation, and reuse, and increase salinity damage from corrosion. **Table 3-7**, extracted from the FRWP EIS/EIR, shows the range of historical variation for various drinking water quality parameters at Rock Slough and Banks Pumping Plant.

M&I Delta water use is protected by the 1995 Water Quality Control Plan (SWRCB, 1995), which established a maximum salinity standard of 250 mg/L chloride concentration. This standard applies to the Contra Costa Canal, West Canal, DMC, Barker Slough, and Cache Slough. For the Contra Costa Canal, a maximum standard of 150 mg/L applies for between 155 and 240 days depending on the water year type. The SWP has salinity goals of 220 mg/L TDS on a long-term average and 440 mg/L TDS as a maximum monthly average. CCWD has established a delivered water quality goal of 65 mg/L chloride.

Ecosystem

The location of X2 is used as a surrogate measure of ecosystem health in the Delta. Kimmerer and Monismith (1992) provide a detailed discussion of the significance of X2. The location of X2 during February to June indirectly affects the reproduction and survival of several estuarine fish species. Analysis of historical data shows that abundance of these species is greater when X2 is located in west Suisan Bay during the spring months.

Table 3-6. Metrics for Assessing Hydrodynamic and Water Quality Impacts

Source	Parameter	Location	Comments
CALSIM II			
	X2[1]	Delta	
	EC[2]	San Joaquin River at Vernalis	D-1641 compliance location, agricultural water quality objective
DSM2			
	Stage	Old River Barrier at Tracy Road Bridge	
		Old River at Head Barrier	
		Middle River Barrier	
		Grant Line Canal Barrier	
	EC	Barker Slough at North Bay Aqueduct	D-1641 compliance location, M&I water quality objective
		Sacramento River at Emmaton	D-1641 compliance location, agricultural water quality objective
		Sacramento River at Collinsville	D-1641 compliance location, fish & wildlife water quality objective
		Sacramento River at Port Chicago	D-1641 compliance location, agricultural water quality objective
		Sacramento at Chipps Island	
		Old River near Middle River	D-1641 compliance location, agricultural water quality objective
		Old River at Tracy Road bridge	D-1641 compliance location, agricultural water quality objective
		Old River at Los Vaqueros Reservoir intake	
		Old River at Rock Slough	
		Rock Slough at Contra Costa Canal	D-1641 compliance location, M&I water quality objective
		Victoria Canal	CCWD proposed Alternative Intake
		Clifton Court Forebay intake	D-1641 compliance location, ag. and M&I water quality objective
		Tracy Pumping Plant intake	D-1641 compliance location, ag. and M&I water quality objective
		San Joaquin River at Brandt Bridge	D-1641 compliance location, agricultural water quality objective
		San Joaquin River at Empire Tract	City of Stockton proposed intake site
		San Joaquin River at Prisoners Point	D-1641 compliance location fish & wildlife water quality objective
		San Joaquin River at San Andreas Landing	D-1641 compliance location, agricultural water quality objective
		San Joaquin River at Jersey Point	D-1641 compliance location, agricultural water quality objective
		Martinez/Benicia	DSM2 boundary condition[3]

[1] Calculated using monthly Net Delta Outflow Index and the Kimmerer-Monismith equation.
[2] Calculated using the modified Kratzer equation.
[3] Calculated using the Net Delta Outflow Index and the modified G-model.

Table 3-7. Water Quality at Delta Drinking Water Intakes, 1982 - 1995

	Rock Slough				Banks Pumping Plant			
Parameter	EC	TDS	Cl	Br	EC	TDS	Cl	Br
Unit	µS/cm	mg/L	mg/L	mg/L	µS/cm	mg/L	mg/L	mg/L
Sample Period	07/83 – 10/94	07/86 – 10/94	07/83 – 10/94	01/90 – 10/94	03/82 – 01/95	07/86 – 01/95	03/82 – 01/95	01/90 – 01/95
No. of Samples	170	42	170	90	258	81	258	121
Maximum	1250	544	303	0.92	877	475	186	0.65
Median	547	302	105	0.47	492	287	79	0.32
Average	552	302	109	0.45	508	293	87	0.32
Minimum	156	86	12	0.04	143	102	14	0.05
SD	280	124	78	0.25	181	84	48	0.16

Source: Data collected by DWR's MWQI.
Notes: Cl – chloride, Br – bromide, TDS – total dissolved solids
SD – standard deviation

Net Delta Outflow is an indicator of freshwater flow through the Delta. Net Delta Outflow directly affects salinity in the downstream estuarine environment and the abundance of fish and macroinvertebrates. The export to inflow ratio (E/I), defined by the 1995 Water Quality Control Plan (SWRCB, 1995) as the ratio of CVP-SWP Delta exports to Delta inflows, provides a measure of migration and transport for resident and anadromous fish in the Delta, and the risk of fish loss through entrainment at the export pumps.

QWEST is an index of the net San Joaquin River flow at Jersey Point. The flow rate and diversion are indicative of the water balance in the central and southern Delta. Net reverse flow past Jersey Point indicates that higher salinity water is being drawn into the interior Delta as a result of high depletions and exports compared to Delta inflows and cross-Delta flows. QWEST is used as an indicator of changes in habitat conditions and Chinook salmon survival.

Agriculture

The 1995 Water Quality Control Plan (SWRCB, 1995) specifies eight salinity compliance locations in the Delta to protect agriculture water use. Agricultural water quality objectives vary considerably depending on the location in the Delta, the season, and the water year type. Objectives range from 0.45 µS/cm for Emmaton, Jersey Point and the interior Delta for wet years during the spring, to 2.78 µS/cm at Emmaton in critical dry years. Water quality at San Andreas Landing, Mokelumne River at Terminus, Prisoners Point, and Brandt Bridge are the primary metrics for agricultural impacts. It is not expected that the DWWSP would impact the salinity at Vernalis.

Water Levels

Water levels in the south Delta are a concern to agriculture water users. When water levels are low, sufficient pump draft cannot be maintained and diverters can experience an interruption to irrigation. Water level impacts in the south Delta are measured by changes in stage upstream of the agricultural barriers on the Old River, Middle River, and the Grant Line Canal.

According to DWR's *Response Plan for Water Level Concerns in the South Delta under D-1641* prepared for SWRCB (DWR, 2003), south Delta water levels would be adequate for southern Delta diversions if they were 0.0 feet msl or greater at Old River near the Tracy Road Bridge and Grant Line Canal near Tracy Road Bridge, and 0.3 feet above msl or greater at Middle River near the Undine Road Bridge. Changes in stage of greater than 0.1 feet are considered potentially significant.

WATER TEMPERATURE MODELING

The objective of the water temperature modeling was to help quantify fishery impacts of the DWWSP compared to without-project conditions. Temperature modeling has been conducted for the Trinity, Sacramento, Feather, and American river systems using Reclamation's one-dimensional reservoir and river temperature models. These models are described by Reclamation (1997), and by Rowell (1979, 1990). Reservoir models are available for Trinity, Whiskeytown, Shasta, Oroville, and Folsom reservoirs. These models also calculate temperatures for the downstream regulating reservoirs (Lewiston, Keswick, Thermalito, and Natoma) using an algorithm similar to the river model equations. The reservoir models include simulation of existing temperature control devices at Shasta, Oroville, and Folsom.

The river temperature models provide temperature output at specific sites (3 locations on the Trinity River from Lewiston Dam to the North Fork, 12 locations on the Sacramento River from Keswick Dam to Freeport, 12 locations on the Feather River from Oroville Dam to the river mouth, and 9 locations on the American River from Nimbus Dam to the mouth).

The Reclamation-modified reservoir temperature models are based on the Corps' Hydrologic Engineering Center program prepared for the Sacramento District of the Corps (program 723-X2-L2810). The program simulates the end-of-month vertical temperature profile and average monthly release temperature based on monthly inflow, outflow, and meteorology. Reservoirs are divided into horizontal layers of uniform thickness. Each layer is assumed to be isothermal. The program considers the energy exchange between the reservoir and the atmosphere, vertical mixing between layers due to diffusion, mixing of reservoir inflow, and selective withdrawal from each layer.

The river temperature model uses steady-state equilibrium temperature equations with mass balance calculations of temperatures for tributary inflows. Model inputs include reservoir releases, stream flows, and climatic data. Monthly output from CALSIM II provides input to the temperature models for the 73-year hydrologic period (water years 1922-1994). Monthly mean climatic data are based on U.S. Weather Bureau data.

Reclamation's temperature models have been used in many previous water resources studies and in support of environmental documentation. They were used as part of the 2004 OCAP BA. The temperature models were also used in association with the FRWP EIS/EIR, the EWA EIS/EIR, and the Sacramento Valley Water Management Program Short-Term Program EIS/EIR. Temperature models used for evaluating the DWWSP are identical to those used by Reclamation for the 2004 OCAP BA.

The main limitation of the temperature models is the monthly time-step. Simulation of mean monthly flows and temperatures cannot capture daily variations that occur due to climatic conditions. However, the temperature models are considered sufficient to provide a general comparison and effect assessment.

INTERPRETATION AND APPLICATION OF MODELING RESULTS

Modeling results could be used in either a comparative or an absolute mode. The comparative mode consists of comparing two model runs; one that contains a proposed action and one that does not. Differences in certain factors, such as deliveries or reservoir storage levels, are analyzed to determine the effect of the proposed action. In the absolute mode, results of a single model run, such as the amount of delivery or reservoir levels, are considered directly. Model results are generally believed to be more reliable in a comparative study than an absolute study. This is because all of the assumptions are the same for both the with-project and without-project model runs, except the action itself, and the focus of the analysis is the differences in the results.

CHAPTER 4. HYDROLOGIC MODELING RESULTS

This section presents the results of the hydrologic modeling analysis. Emphasis is placed on comparative rather than absolute results. The results for the With-Project Conditions are compared to the results for Existing Conditions. The results for the Cumulative Conditions with Project are compared to the results for Cumulative Conditions without Project.

SUMMARY RESULTS

Tables 4-1 and **Table 4-2** provide summary results for long-term (water year 1922 – 1994) and dry periods (October 1928 – September 1934, October 1975 – September 1977, and October 1986 – September 1992) for average annual flows and storage. Model outputs from CALSIM II are grouped into five categories: DWWSP operations, Delta channel flows (including diversions and exports), river flows, reservoir carryover storage, and CVP-SWP deliveries. **Figures 4-1** and **Figure 4-2** show changes in average annual simulated flows in the Delta. **Figures 4-3** and **Figure 4-4** show the corresponding changes in carryover storage in key CVP and SWP reservoirs.

DWWSP

For the Existing Conditions analysis, the diversion of the Project Partners' water-right water from the Sacramento River as part of the proposed DWWSP occurs only when Term 91 conditions are not in effect. Model results show that, under the With-Project Conditions scenario, the Project Partners would divert approximately 36.6 thousand acre-feet (TAF) of water-right water per year from the Sacramento River. The average annual diversion during dry periods would be 28.3 TAF.

For the Cumulative Conditions analysis, the diversion of the Project Partners' water-right water from the Sacramento River as part of the proposed DWWSP also is subject to Term 91 conditions. Model results show that, under the Cumulative Conditions scenario, the Project Partners would extract approximately 36.7 TAF per year from the Sacramento River. The average annual diversion during dry periods is 28.8 TAF per year.

Delta Flows

General indicators of ecosystem health within the Delta include Net Delta Outflow, the location of X2, the E/I ratio, and net flow in the San Joaquin River at Jersey Point (QWEST). Model results show that changes in long-term annual Net Delta Outflow under the DWWSP are small. Average annual Net Delta Outflow under the With-Project Conditions decreases by 27 TAF per year. This is about 0.2 percent of the outflow under Existing Conditions. Model results show that the DWWSP under the Cumulative Conditions with Project would decrease Net Delta Outflow by 21 TAF per year. This is about 0.2 percent of the outflow under Cumulative Conditions without Project.

Changes in the X2 location are discussed in Chapter 5. Model results show that the DWWSP has no significant impact on the E/I ratio.

For the Existing Conditions analysis, QWEST decreases under the DWWSP by 1 cfs or about 0.05 percent of the average annual net flow in the lower San Joaquin River. For the Cumulative Conditions analysis QWEST increases under the DWWSP by 8 cfs, or 0.66 percent of the average annual net flow in the lower San Joaquin River.

River Flows

The DWWSP would have direct impacts on Sacramento River flows, and indirect effects on other rivers could occur since changes in Delta conditions can trigger changes in CVP/SWP reservoir operations and CVP/SWP exports in the south Delta. Model results show that changes in average annual flows for the Trinity, Sacramento, Feather, and American rivers, both long-term average and during dry years, are negligible. Changes in the monthly patterns of flows are also negligible.

Reservoir Carryover Storage

The amount of carryover storage affects the CVP-SWP long-term average annual deliveries and dry year deliveries. It is indicative of operators' and contractors' tolerances of risk. A reduction in water supply available to the CVP-SWP will partly translate into reduced deliveries and partly translate into reduced carryover storage.

CALSIM II modeling shows small changes in CVP and SWP carryover storage under the DWWSP. For the Existing Condition and Cumulative Condition analyses, the long-term average changes in the total CVP carryover storage (Trinity, Shasta, Folsom, CVP San Luis) are 4 TAF and 2 TAF, respectively. The long-term average changes in SWP total carryover storage (Oroville, SWP San Luis) for these two analyses are -19 TAF and -3 TAF. These changes are small compared to the total average carryover storage of about 4.6 million acre-feet (MAF) for the CVP and 2.4 MAF for the SWP for Existing Condition analysis. The total average carryover storage is about 4.7 MAF for the CVP and 2.3 MAF for the SWP for Cumulative Condition analysis. Also, changes in carryover storage are considered to be partly an artifact of CALSIM II modeling, rather than reflecting an actual change in CVP/SWP operations because of DWWSP operations.

CVP-SWP Deliveries

Under Existing Conditions analysis, changes on CVP long-term average annual deliveries are about 1 TAF per year with the DWWSP. Changes on the SWP long-term average annual deliveries are about -9 TAF per year (including 2 TAF per year increase in Article 21 deliveries). Under Cumulative Conditions analysis, changes in CVP long-term average annual deliveries are about -2 TAF per year. Changes on SWP long-term average annual deliveries are about -9 TAF per year (including 1 TAF per year increase in Article 21 deliveries).

Table 4-1. Summary Results, With-Project Conditions Compared to Existing Conditions

Items	Existing Conditions		With-Project Conditions		Difference: With-Project Conditions Minus Existing Conditions	
	Long-Term	Dry Periods	Long-Term	Dry Periods	Long-Term	Dry Periods
DWWSP (1,000 AF/year) [1]						
Water Right diversion	0	0	36.6	28.3	36.6	28.3
Delta (1,000 AF/year) [1]						
Export at Banks Pumping Plant	3,258	1,976	3,254	1,964	-5	-12
Export at Tracy Pumping Plant	2,308	1,565	2,307	1,562	-1	-3
Total exports	5,567	3,541	5,561	3,526	-6	-15
Contra Costa Water District diversion	124	114	124	114	0	0
North Bay Aqueduct/City of Vallejo	55	37	55	37	0	0
Georgiana Slough	2,722	1,749	2,718	1,746	-4	-3
Delta Cross Channel	1,281	1,167	1,279	1,165	-2	-2
Total Delta inflow	20,822	10,066	20,789	10,046	-33	-20
Net Delta outflow	14,156	5,233	14,129	5,228	-27	-5
QWEST	1,089	-197	1,088	-187	0	10
Surplus Delta outflow	8,551	1,055	8,523	1,053	-29	-2
River Flows (cfs) [1]						
Trinity River below Lewiston	925	601	925	601	0	0
Sacramento River below Keswick	8,357	6,080	8,357	6,081	0	1
Sacramento River below NCP	8,928	6,052	8,930	6,054	2	2
Sacramento River below DWWSP	18,558	10,079	18,512	10,049	-46	-29
Sacramento River below Freeport	22,101	11,915	22,057	11,887	-44	-28
Feather River below Thermalito	4,161	2,158	4,162	2,162	0	4
Feather River at mouth	7,448	3,392	7,449	3,400	1	8
American River below Nimbus	3,456	1,718	3,456	1,718	0	1
American River at H Street	3,325	1,584	3,326	1,585	1	1
Calaveras River below Bellota Weir	193	70	193	70	0	0
San Joaquin River at Vernalis	3,695	1,571	3,695	1,571	0	0
Reservoir Carryover Storage (1,000 AF) [1]						
Trinity Lake	1,296	670	1,297	671	1	1
Whiskeytown Lake	232	223	232	223	0	0
Lake Shasta	2,572	1,486	2,575	1,483	3	-3
Folsom Lake	529	372	529	371	0	-1
CVP total NOD storage	4,629	2,751	4,633	2,748	4	-3
CVP San Luis Reservoir	232	228	232	227	0	-1
Lake Oroville	2,058	1,319	2,040	1,293	-18	-26
SWP San Luis Reservoir	334	270	333	278	-1	7
New Hogan Reservoir	113	51	113	51	0	0
New Melones Reservoir	1,379	818	1,380	818	1	0
CVP-SWP Deliveries (1,000 AF/year) [2]						
CVP NOD agricultural deliveries	236	60	236	60	0	-1
CVP NOD M&I deliverie	30	27	30	27	0	0
CVP SOD agricultural deliveries	1,095	302	1,096	300	1	-3
CVP SOD M&I deliveries	123	89	124	89	0	0
SWP Table A deliveries	2,821	1,549	2,810	1,520	-11	-29
SWP Article 21 deliveries	161	103	162	107	2	4

[1] Dry periods are water-year based (Oct 1928 - Sep 1934, Oct 1975 - Sep 1977, and Oct 1986 - Sep 1992).

[2] Dry periods for CVP and SWP deliveries are contract-year based (CVP: Mar 1929 - Feb 1935, Mar 1976 - Feb 1978, and Mar 1987 - Feb 1993, SWP: Jan 1929 - Dec 1934, Jan 1976 - Dec 1977, Jan 1987 - Dec 1992).

Table 4-2. Summary Results, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Items	Cumulative Conditions without Project		Cumulative Conditions with Project		Difference: Cumulative Conditions with Project Minus Cumulative Conditions without Project	
	Long-Term	Dry Periods	Long-Term	Dry Periods	Long-Term	Dry periods
DWWSP (1,000 AF/year) [1]						
Water Right diversion	0	0	36.7	28.8	36.7	28.8
Delta (1,000 AF/year) [1]						
Export at Banks Pumping Plant	3,433	2,050	3,425	2,044	-7	-6
Export at Tracy Pumping Plant	2,326	1,561	2,322	1,559	-4	-2
Total exports	5,759	3,611	5,747	3,604	-12	-7
Contra Costa Water District diversion	158	140	158	140	0	0
North Bay Aqueduct/City of Vallejo	69	47	69	47	0	0
Georgiana Slough	2,725	1,756	2,721	1,753	-4	-3
Delta Cross Channel	1,273	1,160	1,271	1,160	-2	0
Total Delta inflow	20,833	10,130	20,800	10,110	-33	-20
Net Delta outflow	13,961	5,224	13,939	5,212	-21	-12
QWEST	883	-266	888	-261	6	4
Surplus Delta outflow	8,322	1,030	8,299	1,014	-23	-16
River Flows (cfs) [1]						
Trinity River below Lewiston	922	601	922	601	0	0
Sacramento River below Keswick	8,363	6,075	8,363	6,082	1	7
Sacramento River below NCP	8,940	6,092	8,941	6,098	1	6
Sacramento River below DWWSP	18,608	10,137	18,559	10,104	-48	-33
Sacramento River below Freeport	22,128	11,990	22,083	11,962	-45	-28
Feather River below Thermalito	4,161	2,160	4,161	2,161	0	1
Feather River at mouth	7,452	3,398	7,452	3,400	0	1
American River below Nimbus	3,207	1,548	3,207	1,551	0	3
American River at H Street	3,011	1,368	3,012	1,371	1	4
Calaveras River below Bellota Weir	193	70	193	70	0	0
San Joaquin River at Vernalis	3,695	1,561	3,695	1,561	0	0
Reservoir Carryover Storage (1,000 AF) [1]						
Trinity Lake	1,282	661	1,285	660	3	0
Whiskeytown Lake	232	223	232	223	0	0
Lake Shasta	2,526	1,439	2,523	1,438	-3	0
Folsom Lake	497	343	498	345	1	1
CVP total NOD storage	4,538	2,666	4,538	2,667	0	1
CVP San Luis Reservoir	243	224	244	228	1	3
Lake Oroville	2,040	1,404	2,033	1,397	-7	-7
SWP San Luis Reservoir	290	234	294	250	4	16
New Hogan Reservoir	113	51	113	51	0	0
New Melones Reservoir	1,379	816	1,380	816	0	1
CVP-SWP Deliveries (1,000 AF/year) [2]						
CVP NOD agricultural deliveries	242	58	242	58	0	0
CVP NOD M&I deliverie	38	42	38	42	0	0
CVP SOD agricultural deliveries	1,118	283	1,116	284	-2	1
CVP SOD M&I deliveries	124	90	124	90	0	0
SWP Table A deliveries	3,026	1,696	3,016	1,665	-10	-31
SWP Article 21 deliveries	135	78	137	84	1	6

[1] Dry periods are water-year based (Oct 1928 - Sep 1934, Oct 1975 - Sep 1977, and Oct 1986 - Sep 1992).
[2] Dry periods for CVP and SWP deliveries are contract-year based (CVP: Mar 1929 - Feb 1935, Mar 1976 - Feb 1978, and Mar 1987 - Feb 1993, SWP: Jan 1929 - Dec 1934, Jan 1976 - Dec 1977, Jan 1987 - Dec 1992).

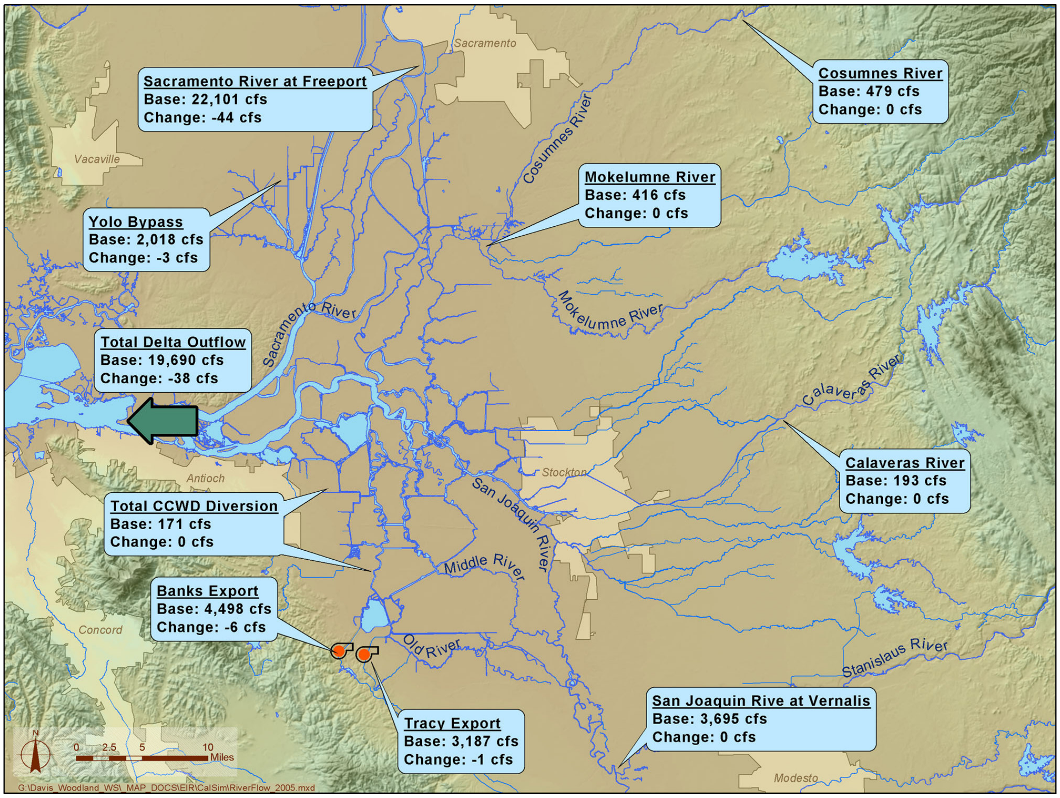


Figure 4-1. Average Annual Delta Flows, With-Project Conditions Compared to Existing Conditions

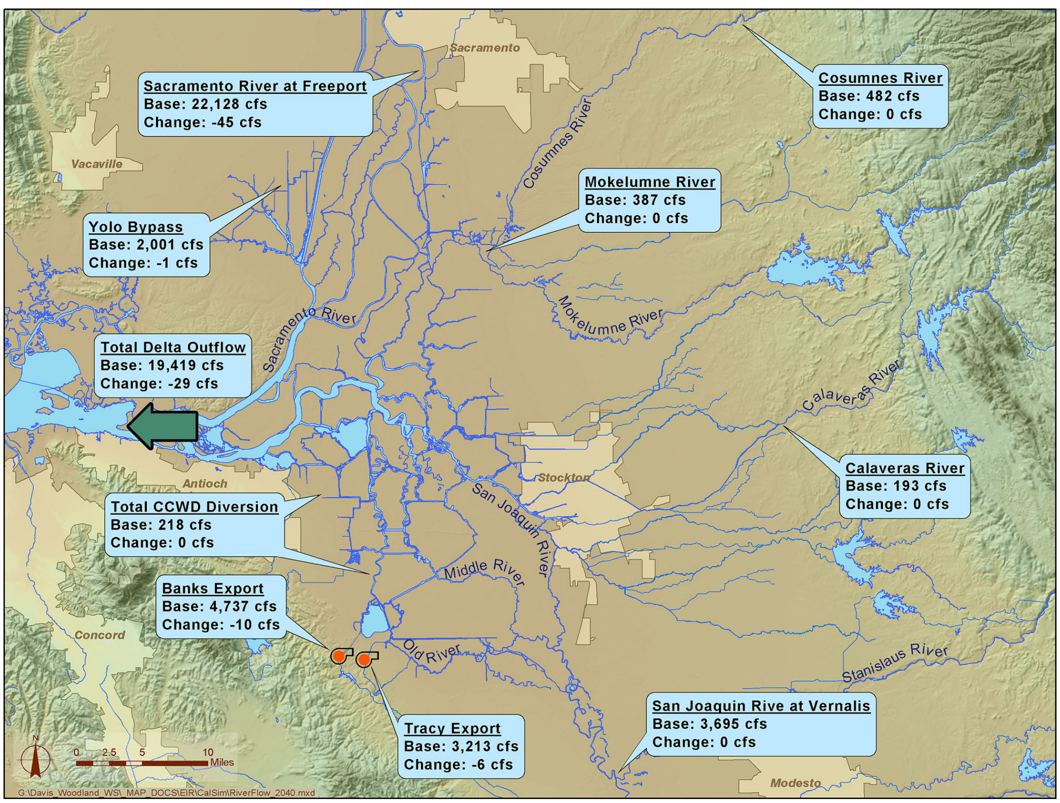


Figure 4-2. Average Annual Delta Flows, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

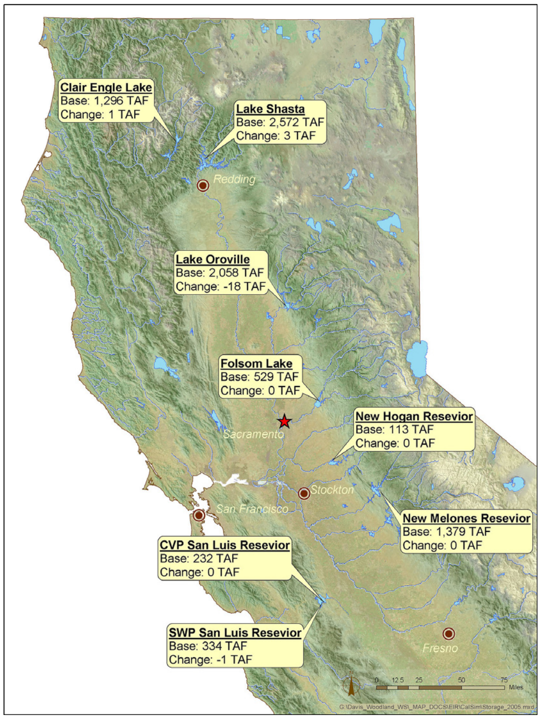


Figure 4-3. Reservoir Carryover Storage, With-Project Conditions Compared to Existing Conditions

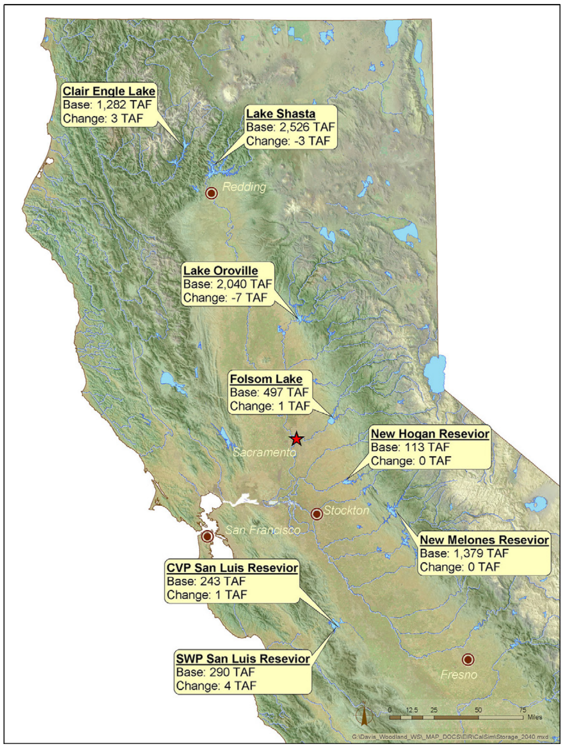


Figure 4-4. Reservoir Carryover Storage, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

COMPARISON BETWEEN EXISTING CONDITIONS AND WITH-PROJECT CONDITION

The DWWSP is assumed to operate in all months of the year and Term 91 conditions apply to diversions of the Project Partners' water-right water. The modeling results are summarized using average annual values under long-term and by water-year type. The water-year types are based on the Sacramento Valley Index water-year types: Wet, Above Normal, Below Normal, Dry, and Critical.

Table 4-3 shows the monthly DWWSP diversions for the 73-year period of simulation with associated periods when Term 91 is or is not in effect. The long-term average annual diversion of water-right water is 36.6 TAF per year. Generally Term 91 is in effect from June through August, during which the demands are at highest level. The modeling results indicate that there would be a need for supplemental water (a long-term average of 20.1 TAF per year) to help meet the Project Partners' demands. **Figures 4-5**, **4-6**, and **4-7** show the simulated DWWSP diversions in the form of an annual time series, annual exceedence, and average monthly plots. Annual DWWSP water-right diversions vary between 16.7 and 56.7 TAF per year.

Tables 4-4 and **4-5** present average monthly and average annual river and Delta flows. **Table 4-6** presents average reservoir carryover storage by water year type. **Table 4-7** presents average annual Delta exports and diversions by water year type. **Table 4-8** presents average annual CVP and SWP deliveries to their water contractors by water year type. CVP deliveries are separated by location (north of Delta and south of Delta) and contract type (agricultural and M&I). SWP deliveries are separated into Table A and Article 21 deliveries to the long-term SWP contractors. CVP deliveries to water right holders (Settlement Contractors in the Sacramento Valley and Exchange Contractors in the San Joaquin Valley) and wildlife refuges are not shown. Similarly, SWP deliveries to water right holders in the Feather River service area are not shown. These CVP and SWP deliveries are a function of inflow hydrology and contract conditions rather than CVP-SWP operations. As such, they would not be affected by the proposed DWWSP project.

Table 4-3. Project Partners' Water Right Diversion (1,000 AF/yr) under With-Project Conditions

Water Year	Year Type*	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1922	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1923	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1924	C	5.1	3.5	2.8	2.7	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
1925	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1926	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1927	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1928	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1929	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	0.0	29.4
1930	D	5.1	0.0	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	32.1
1931	C	5.1	3.5	2.8	2.7	2.5	3.3	0.0	0.0	0.0	0.0	0.0	0.0	20.0
1932	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1933	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1934	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	0.0	24.0
1935	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1936	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1937	BN	5.1	0.0	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	32.1
1938	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1939	D	5.1	3.5	2.8	2.7	2.5	3.3	0.0	0.0	0.0	0.0	0.0	6.2	26.2
1940	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1941	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1942	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1943	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1944	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1945	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1946	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1947	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1948	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1949	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1950	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1951	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1952	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	6.2	56.7
1953	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1954	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1955	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1956	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1957	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1958	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1959	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1960	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1961	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1962	BN	0.0	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	30.5
1963	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1964	D	5.1	3.5	2.8	2.7	2.5	3.3	0.0	5.3	0.0	0.0	0.0	6.2	31.5
1965	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1966	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1967	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	0.0	50.5
1968	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1969	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1970	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1971	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1972	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1973	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1974	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	6.2	56.7
1975	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1976	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1977	C	5.1	3.5	2.8	2.7	0.0	3.3	0.0	0.0	0.0	0.0	0.0	6.2	23.7
1978	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1979	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1980	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1981	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1982	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1983	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	0.0	0.0	43.2
1984	W	5.1	0.0	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	7.3	6.2	39.3
1985	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1986	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1987	D	5.1	3.5	2.8	2.7	2.5	3.3	0.0	0.0	0.0	0.0	0.0	6.2	26.2
1988	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	0.0	29.4
1989	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1990	C	5.1	3.5	2.8	2.7	2.5	3.3	0.0	5.3	0.0	0.0	0.0	6.2	31.5
1991	C	5.1	0.0	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	32.1
1992	C	5.1	0.0	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	0.0	20.5
1993	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1994	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
Average		5.0	3.3	2.8	2.7	2.5	3.3	3.7	4.2	2.1	0.4	1.0	5.5	36.6
Maximum		5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	6.2	56.7
Minimum		0.0	0.0	2.8	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Average	W	5.1	3.3	2.8	2.7	2.5	3.3	4.0	5.3	5.6	1.4	3.5	5.6	45.3
Average	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	4.8	2.6	0.0	0.0	6.2	37.7
Average	BN	4.7	3.3	2.8	2.7	2.5	3.3	4.0	4.9	0.9	0.0	0.0	6.2	35.5
Average	D	5.1	3.3	2.8	2.7	2.5	3.3	3.3	3.3	0.0	0.0	0.0	6.2	32.6
Average	C	5.1	2.9	2.8	2.7	2.3	3.1	2.7	2.2	0.0	0.0	0.0	3.1	26.9

Note: 1. Water year types are based on Sacramento Valley Index: Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critical (C).
2. Shaded period area represents that Term 91condition is in effect.

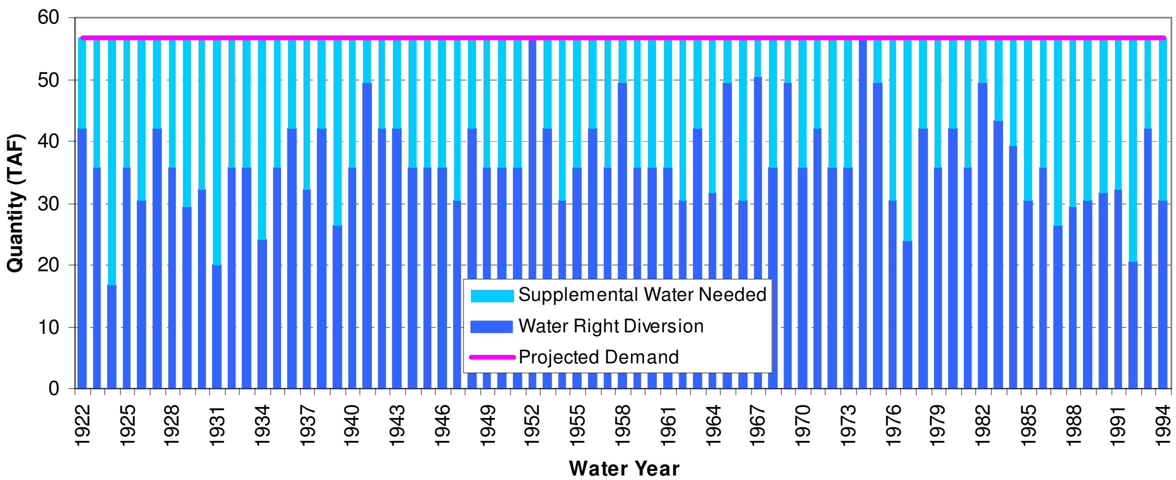


Figure 4-5. DWWSP Annual Water-Right Diversions, With-Project Condition

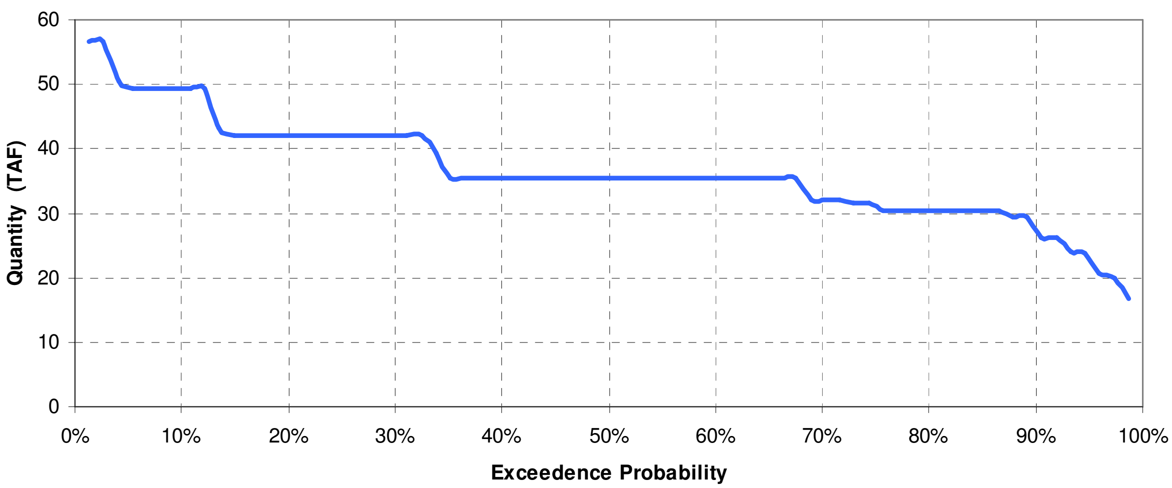


Figure 4-6. Exceedence of DWWSP Annual Diversion, With-Project Condition

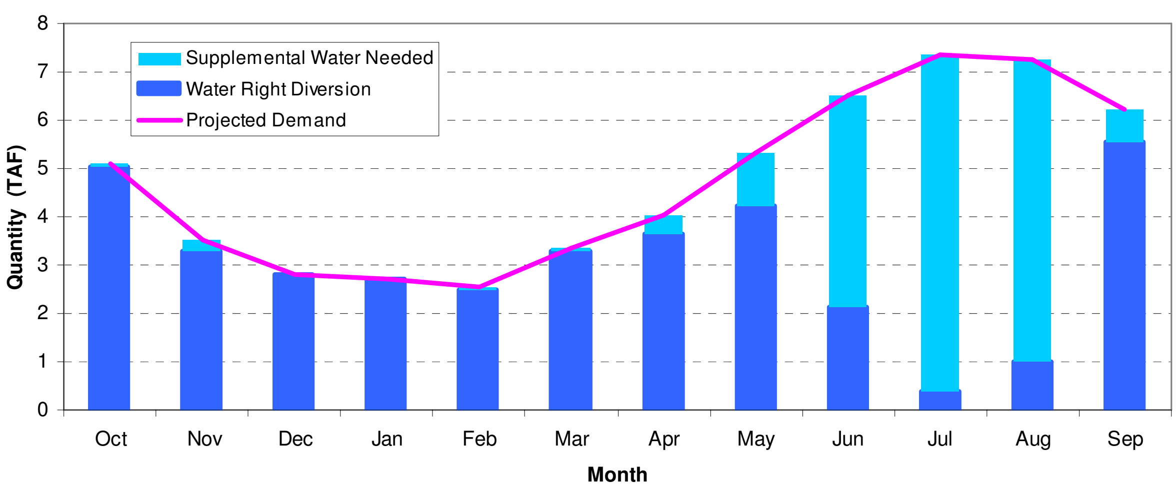


Figure 4-7. Average Monthly DWWSP Water Delivery, With-Project Condition

Table 4-4. Annual River and Delta Flows by Water Year Type, With-Project Conditions Compared to Existing Conditions

Location	Items	Flow					
		Average	Wet	Above Normal	Below Normal	Dry	Critical
Rivers (cfs)							
Trinity River below Lewiston	Existing Conditions	925	1,373	948	814	696	556
	Changes	0	1	0	0	0	0
Sacramento River below Keswick	Existing Conditions	8,357	11,436	8,584	7,230	6,723	6,273
	Changes	0	5	-5	-5	-2	4
Sacramento River below Navigation Control Point	Existing Conditions	8,928	12,038	10,112	8,120	7,106	5,873
	Changes	2	8	-2	-8	2	6
Sacramento River below DWWSP Diversion	Existing Conditions	18,558	28,709	22,135	15,482	12,480	9,504
	Changes	-46	-53	-54	-64	-38	-14
Sacramento River below Freeport	Existing Conditions	22,101	33,592	26,460	19,085	15,152	11,144
	Changes	-44	-49	-54	-65	-35	-13
Feather River below Thermalito	Existing Conditions	4,161	6,573	4,604	3,528	2,759	2,181
	Changes	0	-3	-9	-7	7	13
Feather River at Mouth	Existing Conditions	7,448	12,467	9,032	6,067	4,344	3,096
	Changes	1	-3	-9	-7	8	17
American River below Nimbus	Existing Conditions	3,456	5,468	4,132	3,026	2,207	1,540
	Changes	0	1	-5	-1	3	0
American River at H Street	Existing Conditions	3,325	5,343	4,001	2,890	2,075	1,407
	Changes	1	2	-5	-1	4	1
Calaveras River at Mouth	Existing Conditions	193	370	205	161	74	67
	Changes	0	0	0	0	0	0
San Joaquin River at Vernalis	Existing Conditions	3,695	6,426	4,027	3,157	2,052	1,456
	Changes	0	0	1	-1	0	0
Delta (1,000 AF)							
Georgiana Slough	Existing Conditions	2,722	3,823	3,139	2,433	2,057	1,674
	Changes	-4	-5	-5	-6	-3	-1
Delta Cross Channel	Existing Conditions	1,281	1,255	1,315	1,375	1,314	1,147
	Changes	-2	-3	-2	-2	-1	-1
Total Delta Inflow	Existing Conditions	20,822	34,618	23,960	16,804	12,843	9,391
	Changes	-33	-37	-50	-46	-24	-10
Net Delta Outflow	Existing Conditions	14,156	27,143	16,714	9,643	6,554	4,703
	Changes	-27	-35	-48	-38	-15	-1
QWEST	Existing Conditions	1,089	3,995	1,269	-129	-770	-247
	Changes	0	-5	-4	-2	4	6
Surplus Delta Outflow	Existing Conditions	8,551	20,286	10,018	4,240	1,864	742
	Changes	-29	-38	-47	-39	-21	4

Note: Changes are defined as With-Project Conditions minus Existing Conditions.

Table 4-5. Average Monthly River and Delta Flows, With-Project Conditions Compared to Existing Conditions

Location		Flow											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rivers (cfs)													
Trinity River below Lewiston	Existing Conditions	373	371	570	604	554	551	575	3,700	2,013	887	450	450
	Changes	0	1	0	0	0	0	2	0	0	0	0	0
Sacramento River below Keswick	Existing Conditions	5,586	5,294	6,757	7,961	9,956	8,254	7,241	8,229	10,467	12,817	10,771	6,950
	Changes	24	12	-3	-14	-10	-4	4	5	-14	16	-15	-2
Sacramento River below Navigation Control Point	Existing Conditions	6,293	7,727	11,287	13,126	15,318	14,029	9,295	6,695	5,693	6,510	5,480	5,687
	Changes	22	14	-4	-11	2	2	4	5	-14	17	-16	0
Sacramento River below DWWSP Diversion	Existing Conditions	9,939	12,040	20,837	28,946	34,665	30,268	20,553	15,208	13,146	14,331	12,059	10,702
	Changes	-44	-40	-27	-61	-98	-41	-38	-55	-34	-6	-46	-60
Sacramento River below Freeport	Existing Conditions	12,148	15,367	24,693	32,682	39,175	33,788	24,398	19,299	17,411	18,389	14,778	13,086
	Changes	-42	-35	-14	-59	-119	-36	-20	-58	-29	-26	-31	-56
Feather River below Thermalito	Existing Conditions	2,558	2,191	3,742	4,874	6,003	6,152	3,224	3,610	4,384	6,542	4,736	1,920
	Changes	18	0	3	-18	-59	11	19	9	16	-19	-10	34
Feather River at Mouth	Existing Conditions	3,376	3,349	5,958	10,891	12,767	12,796	9,156	7,414	6,910	7,495	5,550	3,719
	Changes	18	0	3	-9	-58	12	19	9	16	-16	-13	33
American River below Nimbus	Existing Conditions	1,943	2,800	3,392	4,081	5,059	3,723	3,564	3,782	4,165	4,074	2,661	2,228
	Changes	1	4	19	-6	-30	-2	15	-4	5	-20	14	4
American River at H Street	Existing Conditions	1,826	2,720	3,329	4,030	5,010	3,674	3,458	3,614	3,931	3,823	2,431	2,057
	Changes	1	5	19	-5	-29	-1	17	-3	6	-20	14	3
Calaveras River at Mouth	Existing Conditions	61	101	260	341	506	439	171	74	84	86	83	106
	Changes	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Vernalis	Existing Conditions	2,964	1,895	2,755	4,093	5,805	5,855	5,905	5,394	4,095	2,200	1,595	1,784
	Changes	-2	-2	3	0	0	0	0	0	0	0	0	0
Delta (1,000 AF)													
Georgiana Slough	Existing Conditions	150	171	253	318	338	327	242	209	187	201	172	153
	Changes	0	0	0	0	-1	0	0	0	0	0	0	0
Delta Cross Channel	Existing Conditions	191	117	83	44	0	0	0	0	169	258	223	195
	Changes	0	0	0	0	0	0	0	0	0	0	0	-1
Total Delta Inflow	Existing Conditions	947	1,068	1,859	2,733	3,123	2,917	1,989	1,612	1,333	1,292	1,033	916
	Changes	-3	-2	-2	-4	-8	-3	-1	-3	-2	-2	-2	-3
Net Delta Outflow	Existing Conditions	363	568	1,308	2,238	2,670	2,392	1,635	1,276	717	443	279	268
	Changes	-1	-1	-1	-4	-9	-3	-1	-4	-2	0	0	-1
QWEST	Existing Conditions	-22	-50	26	187	310	288	363	341	112	-145	-183	-137
	Changes	0	0	0	0	-2	-1	0	-1	0	1	1	0
Surplus Delta Outflow	Existing Conditions	111	267	1,018	1,888	1,930	1,534	875	595	198	39	8	89
	Changes	0	-1	-3	-3	-9	-4	-2	-4	-2	0	0	-2

Note: Changes are defined as With-Project Conditions minus Existing Conditions.

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Table 4-6. Carryover Storage by Water Year Type, With-Project Conditions Compared to Existing Conditions

Reservoir	Items	Carryover Storage (1,000 AF) Average	Wet	Above Normal	Below Normal	Dry	Critical
CVP NOD Storage							
Trinity Lake	Existing Conditions	1,296	1,832	1,532	1,187	1,031	641
	Changes	1	0	0	5	0	1
Whiskeytown Lake	Existing Conditions	232	235	235	235	232	221
	Changes	0	0	0	0	0	0
Lake Shasta	Existing Conditions	2,572	3,305	3,060	2,630	2,234	1,266
	Changes	3	0	1	18	0	-4
Folsom Lake	Existing Conditions	529	643	592	574	469	304
	Changes	0	0	2	-2	0	-1
Total	Existing Conditions	4,629	6,015	5,419	4,626	3,966	2,433
	Changes	4	0	3	21	0	-4
CVP SOD Storage							
New Melones Reservoir	Existing Conditions	1,379	1,882	1,494	1,338	1,142	767
	Changes	1	0	0	2	1	0
CVP San Luis Reservoir	Existing Conditions	232	271	259	243	175	205
	Changes	0	2	-3	1	-4	3
US Army Corps of Engineers							
New Hogan Reservoir	Existing Conditions	113	155	139	115	87	50
	Changes	0	0	0	0	0	0
SWP Storage							
Lake Oroville	Existing Conditions	2,058	2,873	2,328	1,927	1,570	1,208
	Changes	-18	-2	-6	-32	-28	-25
SWP San Luis Reservoir	Existing Conditions	334	603	319	165	206	245
	Changes	-1	-3	-3	-14	14	-2
San Luis Reservoir							
Total San Luis	Existing Conditions	566	874	577	408	381	450
	Changes	-1	-1	-5	-13	10	1

Note: Changes are defined as With-Project Conditions minus Existing Conditions.

Table 4-7. Annual Delta Exports and Diversions by Water Year Type, With-Project Conditions Compared to Existing Conditions

Location	Items	Annual Quantity (1,000 AF) Average	Wet	Above Normal	Below Normal	Dry	Critical
Exports at Banks PP	Existing Conditions	3,258	3,998	3,724	3,523	2,843	1,821
	Changes	-5	-1	-1	-12	-2	-10
Exports at Tracy PP	Existing Conditions	2,308	2,610	2,574	2,445	2,200	1,544
	Changes	-1	-1	-2	5	-7	1
Total Export	Existing Conditions	5,567	6,609	6,298	5,968	5,043	3,365
	Changes	-6	-2	-3	-7	-9	-9
Contra Costa Water District	Existing Conditions	124	125	130	132	124	108
Diversion	Changes	0	0	0	0	0	0
North Bay Aqueduct/City of	Existing Conditions	55	64	61	60	50	37
Vallejo	Changes	0	0	0	0	0	0

Note: Changes are defined as With-Project Conditions minus Existing Conditions.

Table 4-8. Annual CVP and SWP Deliveries by Water Year Type, With-Project Conditions Compared to Existing Conditions

Contract Type	Items	Annual Delivery (1,000 AF)					
		Average	Wet	Above Normal	Below Normal	Dry	Critical
CVP							
NOD Agricultural	Existing Conditions	236	320	323	267	183	33
	Changes	0	0	0	2	0	-1
NOD M&I	Existing Conditions	30	31	31	31	30	25
	Changes	0	0	0	0	0	0
SOD Agricultural	Existing Conditions	1,095	1,565	1,406	1,144	871	165
	Changes	1	-1	2	10	-1	-3
SOD M&I	Existing Conditions	123	142	138	128	114	77
	Changes	0	0	0	1	0	0
SWP							
Table A	Existing Conditions	2,821	3,247	3,363	3,303	2,678	1,015
	Changes	-11	1	4	-4	-36	-15
Article 21	Existing Conditions	161	295	156	114	94	60
	Changes	2	-2	-1	3	1	9

Note: Changes are defined as With-Project Conditions minus Existing Conditions.

COMPARISON BETWEEN CUMULATIVE CONDITIONS WITHOUT PROJECT AND CUMULATIVE CONDITIONS WITH PROJECT

The Cumulative Conditions analysis evaluates the combined effects of the proposed DWWSP with other water supply programs/actions. These include the Long-Term EWA, SDIP, the DMC/CA Intertie, the FRWP, and the CVP-SWP Integration.

The DWWSP is assumed to operate in all months of the year and to be subject to Term 91 conditions on diversions under the Project Partners' water rights. The modeling results are summarized using average annual values under long-term and water year type. The water year is based on the Sacramento Valley Index water year type: Wet, Above Normal, Below Normal, Dry, and Critical.

Table 4-9 shows the monthly DWWSP diversions for the 73-year period of simulation with associated periods that Term 91 is or is not in effect. The long-term average annual diversion is 36.7 TAF per year. Generally, the Term 91 is in effect from June through August, during which the demands are at highest level. From the modeling results, there would be a need to have supplemental water (long-term average is about 20 TAF per year) available to help meet the Project Partners' demands. **Figures 4-8**, **4-9**, and **4-10** show the simulated DWWSP diversions in the form of an annual time series, annual exceedence, and average monthly plots. Annual DWWSP diversions vary between 16.7 and 56.7 TAF per year.

Tables 4-10 and **4-11** present average monthly and average annual river and Delta flows. **Table 4-12** presents average reservoir carryover storage by water year type. **Table 4-13** presents average annual Delta exports and diversions by water year type. **Table 4-14** presents average annual CVP and SWP deliveries to their water contractors by water year type. CVP deliveries are separated by location (north of Delta and south of Delta) and contract type (agricultural and M&I). SWP deliveries are separated into Table A and Article 21 deliveries to the long-term SWP contractors.

Table 4-9. Project Partners' Water Right Diversion (1,000 AF/yr) under Cumulative Conditions with Project

Water Year	Year Type*	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1922	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1923	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1924	C	5.1	3.5	2.8	2.7	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
1925	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1926	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1927	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1928	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1929	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	0.0	29.4
1930	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1931	C	5.1	3.5	2.8	2.7	2.5	3.3	0.0	0.0	0.0	0.0	0.0	0.0	20.0
1932	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1933	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1934	C	5.1	3.5	2.8	2.7	2.5	3.3	0.0	0.0	0.0	0.0	0.0	0.0	20.0
1935	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1936	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1937	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1938	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1939	D	5.1	3.5	2.8	2.7	2.5	3.3	0.0	0.0	0.0	0.0	0.0	6.2	26.2
1940	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1941	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1942	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1943	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1944	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1945	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1946	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1947	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1948	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1949	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1950	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1951	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1952	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	6.2	56.7
1953	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1954	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1955	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1956	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1957	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1958	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1959	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1960	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1961	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1962	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1963	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1964	D	5.1	3.5	2.8	2.7	2.5	3.3	0.0	5.3	0.0	0.0	0.0	6.2	31.5
1965	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1966	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1967	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	6.2	56.7
1968	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1969	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1970	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1971	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1972	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1973	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1974	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	6.2	56.7
1975	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1976	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1977	C	5.1	3.5	2.8	2.7	2.5	3.3	0.0	0.0	0.0	0.0	0.0	6.2	26.2
1978	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1979	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1980	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1981	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1982	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	7.3	6.2	49.4
1983	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	0.0	50.5
1984	W	5.1	0.0	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	7.3	6.2	39.3
1985	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1986	W	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1987	D	5.1	3.5	2.8	2.7	2.5	3.3	0.0	0.0	0.0	0.0	0.0	6.2	26.2
1988	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	0.0	29.4
1989	D	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
1990	C	5.1	3.5	2.8	2.7	2.5	3.3	0.0	5.3	0.0	0.0	0.0	6.2	31.5
1991	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	0.0	0.0	0.0	6.2	35.6
1992	C	5.1	0.0	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	0.0	20.5
1993	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	0.0	0.0	6.2	42.1
1994	C	5.1	3.5	2.8	2.7	2.5	3.3	4.0	0.0	0.0	0.0	0.0	6.2	30.3
Average		5.1	3.4	2.8	2.7	2.5	3.3	3.6	4.1	2.1	0.4	0.9	5.6	36.7
Maximum		5.1	3.5	2.8	2.7	2.5	3.3	4.0	5.3	6.5	7.4	7.3	6.2	56.7
Minimum		5.1	0.0	2.8	2.7	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Average	W	5.1	3.3	2.8	2.7	2.5	3.3	4.0	5.3	5.6	1.4	3.1	5.9	45.2
Average	AN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	4.8	2.6	0.0	0.0	6.2	37.7
Average	BN	5.1	3.5	2.8	2.7	2.5	3.3	4.0	4.9	0.9	0.0	0.0	6.2	36.1
Average	D	5.1	3.5	2.8	2.7	2.5	3.3	3.3	3.0	0.0	0.0	0.0	6.2	32.5
Average	C	5.1	3.2	2.8	2.7	2.5	3.1	2.4	2.2	0.0	0.0	0.0	3.1	27.1

Note: 1. Water year types are based on Sacramento Valley Index: Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critical (C).
2. Shaded period area represents that Term 91 condition is in effect.

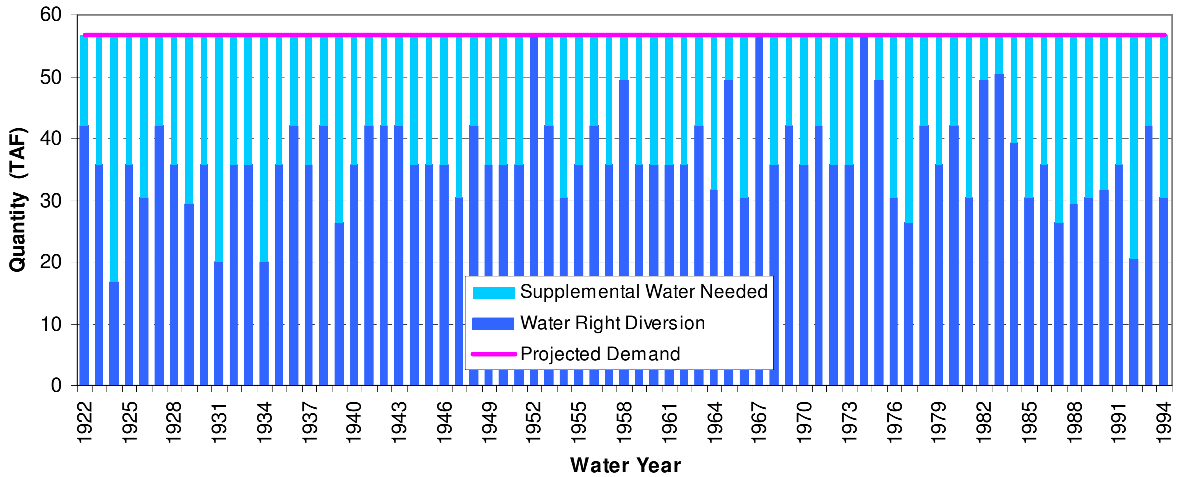

Figure 4-8. DWWSP Annual Water-Right Diversions, Cumulative Condition with Project

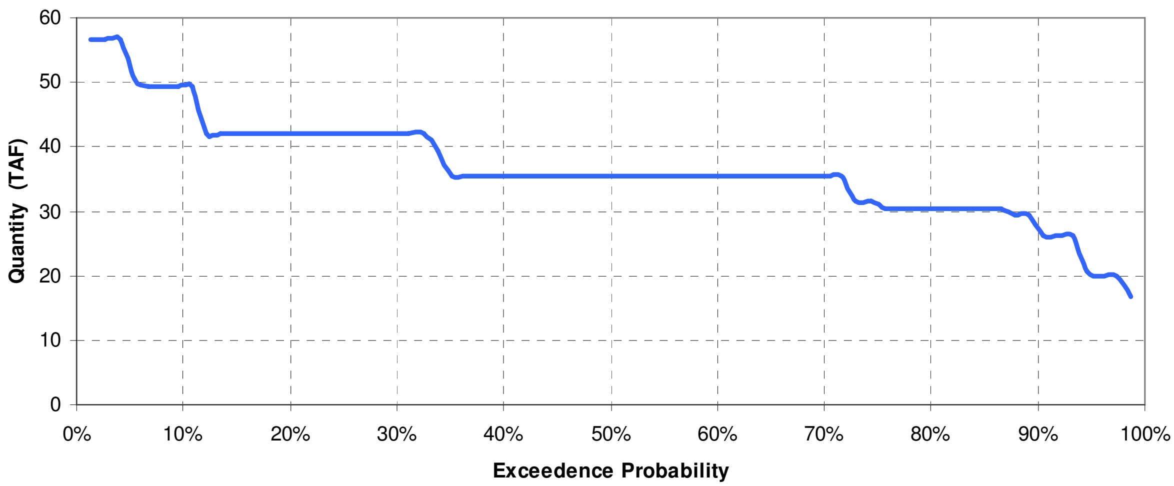

Figure 4-9. Exceedence of DWWSP Annual Diversion, Cumulative Condition with Project

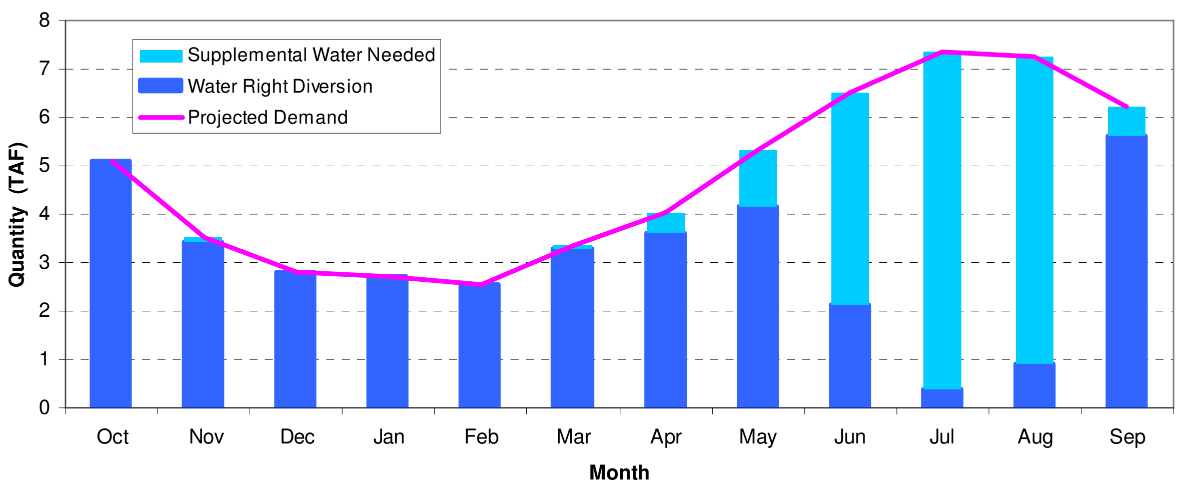

Figure 4-10. Average Monthly DWWSP Water Delivery, Cumulative Condition with Project

Table 4-10. Annual River and Delta Flows by Water Year Type, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Location	Items	Flow					
		Average	Wet	Above Normal	Below Normal	Dry	Critical
Rivers (cfs)							
Trinity River below Lewiston	Cumulative Conditions without Project	922	1,365	948	812	696	556
	Changes	0	-2	0	1	0	0
Sacramento River below Keswick	Cumulative Conditions without Project	8,363	11,411	8,616	7,263	6,736	6,268
	Changes	1	-1	0	-5	5	6
Sacramento River below Navigation Control Point	Cumulative Conditions without Project	8,940	11,990	10,096	8,151	7,170	5,919
	Changes	1	0	-4	-4	6	4
Sacramento River below DWWSP Diversion	Cumulative Conditions without Project	18,629	28,790	22,151	15,540	12,576	9,587
	Changes	-48	-58	-53	-39	-53	-31
Sacramento River below Freeport	Cumulative Conditions without Project	22,128	33,598	26,416	19,089	15,234	11,221
	Changes	-45	-54	-46	-34	-52	-31
Feather River below Thermalito	Cumulative Conditions without Project	4,161	6,653	4,565	3,508	2,716	2,151
	Changes	0	-1	-2	14	-12	2
Feather River at Mouth	Cumulative Conditions without Project	7,452	12,523	8,983	6,046	4,335	3,101
	Changes	0	0	-2	13	-12	2
American River below Nimbus	Cumulative Conditions without Project	3,207	5,164	3,842	2,762	1,999	1,384
	Changes	0	-5	4	5	1	-1
American River at H Street	Cumulative Conditions without Project	3,011	4,954	3,644	2,564	1,809	1,209
	Changes	1	-3	4	5	1	0
Calaveras River at Mouth	Cumulative Conditions without Project	193	370	205	161	74	67
	Changes	0	0	0	0	0	0
San Joaquin River at Vernalis	Cumulative Conditions without Project	3,695	6,459	4,011	3,154	2,033	1,445
	Changes	0	0	0	-1	0	0
Delta (1,000 AF)							
Georgiana Slough	Cumulative Conditions without Project	2,725	3,824	3,135	2,433	2,065	1,681
	Changes	-4	-5	-4	-3	-5	-3
Delta Cross Channel	Cumulative Conditions without Project	1,273	1,219	1,314	1,379	1,324	1,140
	Changes	-2	-2	-2	-1	-1	-2
Total Delta Inflow	Cumulative Conditions without Project	20,833	34,607	23,892	16,806	12,897	9,457
	Changes	-33	-44	-35	-23	-35	-22
Net Delta Outflow	Cumulative Conditions without Project	13,961	26,771	16,389	9,448	6,508	4,719
	Changes	-21	-38	-26	-9	-14	-11
QWEST	Cumulative Conditions without Project	883	3,628	1,007	-324	-861	-294
	Changes	6	-1	2	10	14	5
Surplus Delta Outflow	Cumulative Conditions without Project	8,322	19,870	9,631	4,033	1,777	752
	Changes	-23	-42	-20	-10	-21	-10

Note: Changes are defined as Cumulative Conditions with Project minus Cumulative Conditions without Project.

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Table 4-11. Average Monthly River and Delta Flows, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Location		Flow											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rivers (cfs)													
Trinity River below Lewiston	Cumulative Conditions without Project	368	368	559	608	557	534	574	3,700	2,013	887	450	450
	Changes	3	1	-5	-7	0	5	2	0	0	0	0	0
Sacramento River below Keswick	Cumulative Conditions without Project	5,448	5,186	6,599	7,822	9,936	8,287	7,141	8,265	10,582	13,111	11,058	6,914
	Changes	19	-3	-43	-11	34	-13	8	-13	-30	13	19	28
Sacramento River below Navigation Control Point	Cumulative Conditions without Project	6,211	7,775	11,267	13,076	15,338	14,092	9,365	6,703	5,711	6,619	5,579	5,543
	Changes	18	1	-23	-10	15	-7	1	-14	-29	14	18	26
Sacramento River below DWWSP Diversion	Cumulative Conditions without Project	9,802	12,059	20,799	28,992	34,782	30,676	20,697	15,286	13,335	14,771	11,910	10,439
	Changes	-53	-57	-108	-61	-36	-70	-73	-65	-48	21	18	-48
Sacramento River below Freeport	Cumulative Conditions without Project	12,067	15,419	24,860	32,837	39,333	34,278	24,576	19,162	17,351	18,754	14,431	12,472
	Changes	-50	-50	-105	-58	-30	-63	-62	-62	-46	28	0	-40
Feather River below Thermalito	Cumulative Conditions without Project	2,405	2,144	3,704	4,921	5,972	6,218	3,185	3,588	4,652	6,829	4,529	1,784
	Changes	8	3	-25	-16	-27	-11	-21	16	17	10	21	22
Feather River at Mouth	Cumulative Conditions without Project	3,324	3,339	5,948	10,877	12,750	13,057	9,109	7,436	7,034	7,783	5,229	3,540
	Changes	8	3	-25	-15	-25	-10	-21	16	18	13	16	23
American River below Nimbus	Cumulative Conditions without Project	1,811	2,544	3,280	3,889	4,819	3,610	3,313	3,499	3,771	3,856	2,324	1,771
	Changes	3	7	-11	-4	0	0	8	2	1	7	-19	8
American River at H Street	Cumulative Conditions without Project	1,653	2,429	3,183	3,793	4,708	3,486	3,100	3,240	3,469	3,511	2,021	1,543
	Changes	3	7	-11	-4	1	1	10	3	2	7	-18	8
Calaveras River at Mouth	Cumulative Conditions without Project	61	101	260	341	506	439	171	74	84	86	83	106
	Changes	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Vernalis	Cumulative Conditions without Project	2,825	1,893	2,753	4,096	5,815	5,856	5,924	5,497	4,106	2,202	1,614	1,766
	Changes	1	0	0	0	0	0	0	0	0	0	-1	0
Delta (1,000 AF)													
Georgiana Slough	Cumulative Conditions without Project	150	171	254	320	339	331	244	208	187	204	169	148
	Changes	0	0	-1	0	0	-1	0	-1	0	0	0	0
Delta Cross Channel	Cumulative Conditions without Project	191	118	84	44	0	0	0	0	169	257	220	189
	Changes	0	0	0	0	0	0	0	0	0	0	0	0
Total Delta Inflow	Cumulative Conditions without Project	934	1,072	1,871	2,736	3,132	2,951	1,996	1,609	1,329	1,313	1,012	878
	Changes	-3	-3	-8	-4	-2	-4	-3	-4	-3	2	0	-2
Net Delta Outflow	Cumulative Conditions without Project	329	554	1,262	2,207	2,654	2,389	1,631	1,273	697	443	283	239
	Changes	-1	-1	-6	-4	-1	-3	-1	-4	-1	0	0	-1
QWEST	Cumulative Conditions without Project	-51	-67	-28	157	290	257	355	345	94	-166	-164	-140
	Changes	1	1	0	0	1	1	2	0	1	-1	0	0
Surplus Delta Outflow	Cumulative Conditions without Project	80	243	962	1,851	1,911	1,528	873	593	177	38	4	61
	Changes	-1	-2	-6	-3	-1	-3	-1	-4	-1	0	0	-1

Note: Changes are defined as Cumulative Conditions with Project minus Cumulative Conditions without Project.

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Table 4-12. Carryover Storage by Water Year Type, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Reservoir	Items	Carryover Storage (1,000 AF)					
		Average	Wet	Above Normal	Below Normal	Dry	Critical
CVP NOD Storage							
Trinity Lake	Cumulative Conditions without Project	1,282	1,828	1,522	1,159	1,015	628
	Changes	3	2	4	14	-5	-1
Whiskeytown Lake	Cumulative Conditions without Project	232	235	235	235	232	221
	Changes	0	0	0	0	0	0
Lake Shasta	Cumulative Conditions without Project	2,526	3,265	3,018	2,588	2,176	1,219
	Changes	-3	-1	-6	-13	2	-1
Folsom Lake	Cumulative Conditions without Project	497	626	564	531	416	285
	Changes	1	2	-1	-2	2	1
Total	Cumulative Conditions without Project	4,538	5,954	5,339	4,514	3,839	2,353
	Changes	0	4	-3	-1	0	-1
CVP SOD Storage							
New Melones Reservoir	Cumulative Conditions without Project	1,379	1,884	1,494	1,339	1,142	765
	Changes	0	0	0	0	0	1
CVP San Luis Reservoir	Cumulative Conditions without Project	243	342	182	234	194	196
	Changes	1	-1	1	12	-6	3
US Army Corps of Engineers							
New Hogan Reservoir	Cumulative Conditions without Project	113	155	139	115	87	50
	Changes	0	0	0	0	0	0
SWP Storage							
Lake Oroville	Cumulative Conditions without Project	2,040	2,792	2,304	1,906	1,608	1,238
	Changes	-7	-5	-3	-10	-9	-6
SWP San Luis Reservoir	Cumulative Conditions without Project	290	525	243	143	211	194
	Changes	4	-1	-4	1	6	19
San Luis Reservoir							
Total San Luis	Cumulative Conditions without Project	533	867	425	377	405	389
	Changes	5	-2	-3	13	-1	22

Note: Changes are defined as Cumulative Conditions with Project minus Cumulative Conditions without Project.

Table 4-13. Annual Delta Exports and Diversions by Water Year Type, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Location	Items	Annual Quantity (1,000 AF)					
		Average	Wet	Above Normal	Below Normal	Dry	Critical
Exports at Banks PP	Cumulative Conditions without Project	3,433	4,281	3,933	3,665	2,969	1,879
	Changes	-7	-5	-8	-10	-6	-11
Exports at Tracy PP	Cumulative Conditions without Project	2,326	2,669	2,602	2,481	2,160	1,537
	Changes	-4	-1	-1	-4	-15	1
Total Export	Cumulative Conditions without Project	5,759	6,950	6,536	6,146	5,130	3,416
	Changes	-12	-6	-8	-14	-21	-10
Contra Costa Water District Diversion	Cumulative Conditions without Project	158	161	167	167	158	134
	Changes	0	0	0	0	0	0
North Bay Aqueduct/City of Vallejo	Cumulative Conditions without Project	69	81	77	76	61	46
	Changes	0	0	0	0	0	-1

Note: Changes are defined as Cumulative Conditions with Project minus Cumulative Conditions without Project.

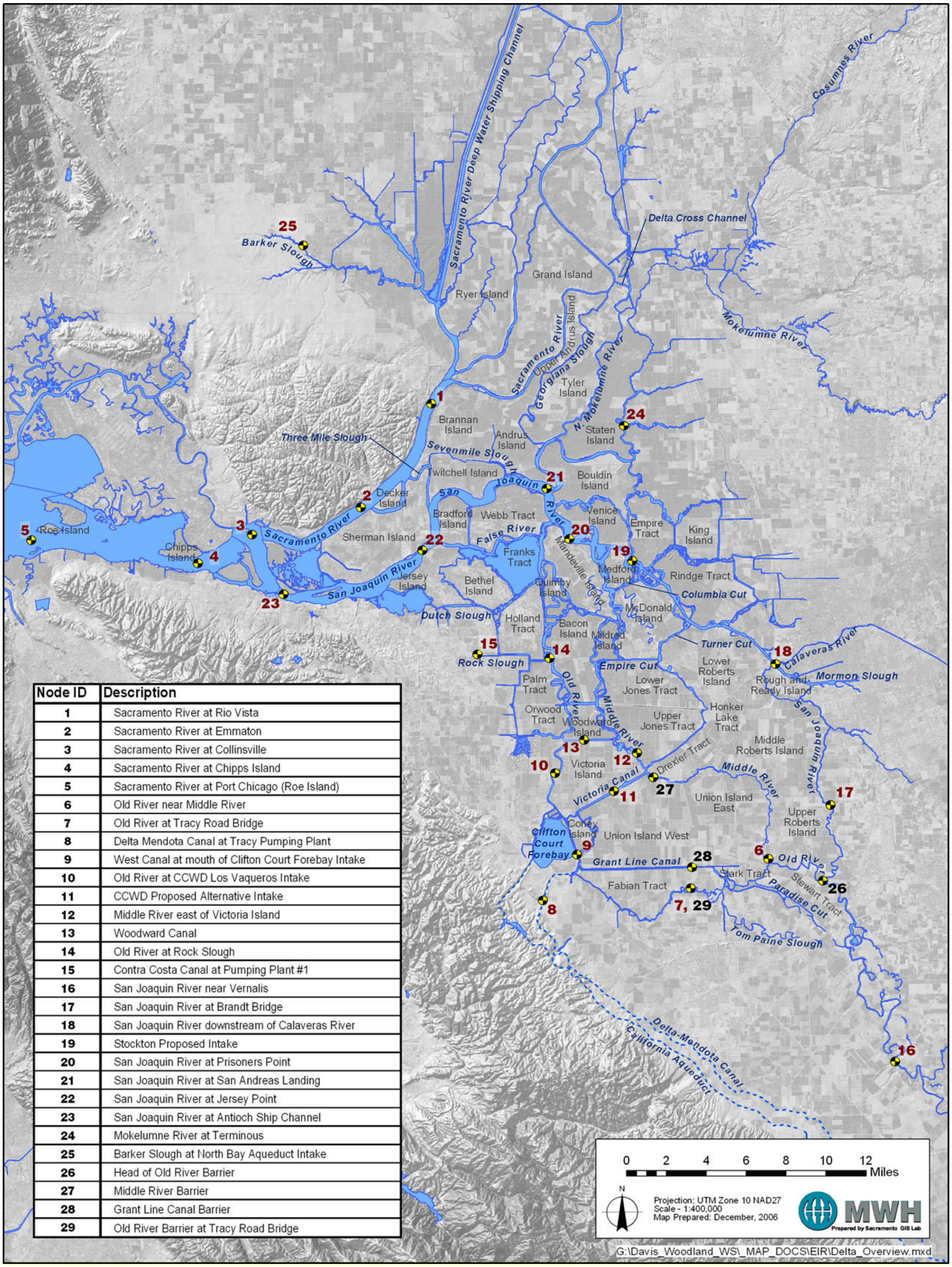
Table 4-14. Annual CVP and SWP Deliveries by Water Year Type, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Contract Type	Items	Annual Delivery (1,000 AF)					
		Average	Wet	Above Normal	Below Normal	Dry	Critical
CVP							
NOD Agricultural	Cumulative Conditions without Project	242	341	344	269	167	29
	Changes	0	0	0	-1	0	0
NOD M&I	Cumulative Conditions without Project	38	34	36	38	41	38
	Changes	0	0	0	0	0	0
SOD Agricultural	Cumulative Conditions without Project	1,118	1,645	1,544	1,159	784	145
	Changes	-2	0	-1	-19	5	2
SOD M&I	Cumulative Conditions without Project	124	142	141	130	111	77
	Changes	0	0	0	-1	0	0
SWP							
Table A	Cumulative Conditions without Project	3,026	3,564	3,751	3,494	2,680	1,142
	Changes	-10	2	-3	4	-22	-36
Article 21	Cumulative Conditions without Project	135	255	128	103	69	46
	Changes	1	-3	5	1	2	6

Note: Changes are defined as Cumulative Conditions with Project minus Cumulative Conditions without Project.

CHAPTER 5. HYDRODYNAMIC AND WATER QUALITY MODELING RESULTS

This chapter presents a summary of the hydrodynamic and water quality modeling analysis. Emphasis is placed on comparative rather than absolute results. DSM2 outputs regarding Delta channel flow, stage, and EC under the DWWSP are discussed. Results are typically presented as average monthly values for the 16-year period (water year 1976 – 1991) of simulation, or as monthly time series data. The results for the With-Project Conditions are compared to the results for Existing Conditions. The results for the Cumulative Conditions with Project are compared to the results for Cumulative Conditions without Project. **Figure 5-1** identifies the key Delta channels and sites referred to in the presentation of results.



Node ID	Description
1	Sacramento River at Rio Vista
2	Sacramento River at Emmaton
3	Sacramento River at Collinsville
4	Sacramento River at Chipps Island
5	Sacramento River at Port Chicago (Roe Island)
6	Old River near Middle River
7	Old River at Tracy Road Bridge
8	Delta Mendota Canal at Tracy Pumping Plant
9	West Canal at mouth of Clifton Court Forebay Intake
10	Old River at CCWD Los Vaqueros Intake
11	CCWD Proposed Alternative Intake
12	Middle River east of Victoria Island
13	Woodward Canal
14	Old River at Rock Slough
15	Contra Costa Canal at Pumping Plant #1
16	San Joaquin River near Vernalis
17	San Joaquin River at Brandt Bridge
18	San Joaquin River downstream of Calaveras River
19	Stockton Proposed Intake
20	San Joaquin River at Prisoners Point
21	San Joaquin River at San Andreas Landing
22	San Joaquin River at Jersey Point
23	San Joaquin River at Antioch Ship Channel
24	Mokelumne River at Terminous
25	Barker Slough at North Bay Aqueduct Intake
26	Head of Old River Barrier
27	Middle River Barrier
28	Grant Line Canal Barrier
29	Old River Barrier at Tracy Road Bridge

Figure 5-1. Major Delta Islands, Waterways, Water Quality Control Stations, and Potential Future Projects

COMPARISON BETWEEN EXISTING CONDITIONS AND WITH-PROJECT CONDITION

This section presents simulation results for the With-Project Conditions compared to Existing Conditions. Since the Project Partners' water-right diversions would divert water from the Sacramento River, there is a potential that DWWSP would have impacts on the Delta inflow.

Boundary Conditions

The hydrodynamic and water quality conditions within the Delta are driven by the flow and salinity boundary conditions. For the DSM2 modeling, boundary conditions are determined based on CALSIM II outputs, as discussed in **Chapter 4**. **Figures 5-2, 5-3** and **5-4** present comparisons of the major boundary flows (Sacramento River inflow, San Joaquin River inflow, and CVP and SWP exports). These figures show occasional large changes in monthly inflow, export, or outflow. These changes are triggered by a CALSIM II 'step function' (an abrupt change in flow when a specified threshold is crossed). Typically an increase in flow in one month is offset by a lower flow in the following month.

Martinez is specified as a stage rather than as a flow boundary condition. The salinity boundary condition at Martinez is calculated from the Net Delta Outflow using a modified G-model. **Figure 5-5** compares Net Delta Outflow under the With-Project Conditions to Existing Conditions. **Table 5-1** presents a comparison of flow boundary conditions as average monthly values for the 16-year period of simulation.

Table 5-1. Boundary Flow Conditions, With-Project Conditions Compared to Existing Conditions

Location	Average Monthly Flow (cfs)												Total
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	(TAF/year)
Sacramento River inflow													
Existing Conditions	12,148	15,367	24,693	32,682	39,175	33,788	24,398	19,299	17,411	18,389	14,778	13,086	15,953
Changes	-42	-35	-14	-59	-119	-36	-20	-58	-29	-26	-31	-56	-31
San Joaquin River inflow													
Existing Conditions	3,025	1,996	3,015	4,434	6,311	6,293	6,076	5,468	4,178	2,285	1,678	1,891	2,806
Changes	-2	-2	3	0	0	0	0	0	0	0	0	0	0
CVP-SWP Exports (Tracy PP and Banks PP)													
Existing Conditions	8,239	7,611	8,675	9,453	9,080	8,341	4,640	2,942	5,839	9,086	9,231	9,079	5,567
Changes	-23	-15	-4	-12	15	10	2	9	-1	-30	-21	-24	-6
Net Delta Outflow													
Existing Conditions	5,905	9,551	21,275	36,396	47,731	38,900	27,470	20,757	12,043	7,198	4,538	4,511	14,156
Changes	-18	-21	-20	-58	-155	-54	-17	-65	-26	4	-6	-25	-27

Note: Changes are defined as the With-Project Conditions minus Existing Conditions.

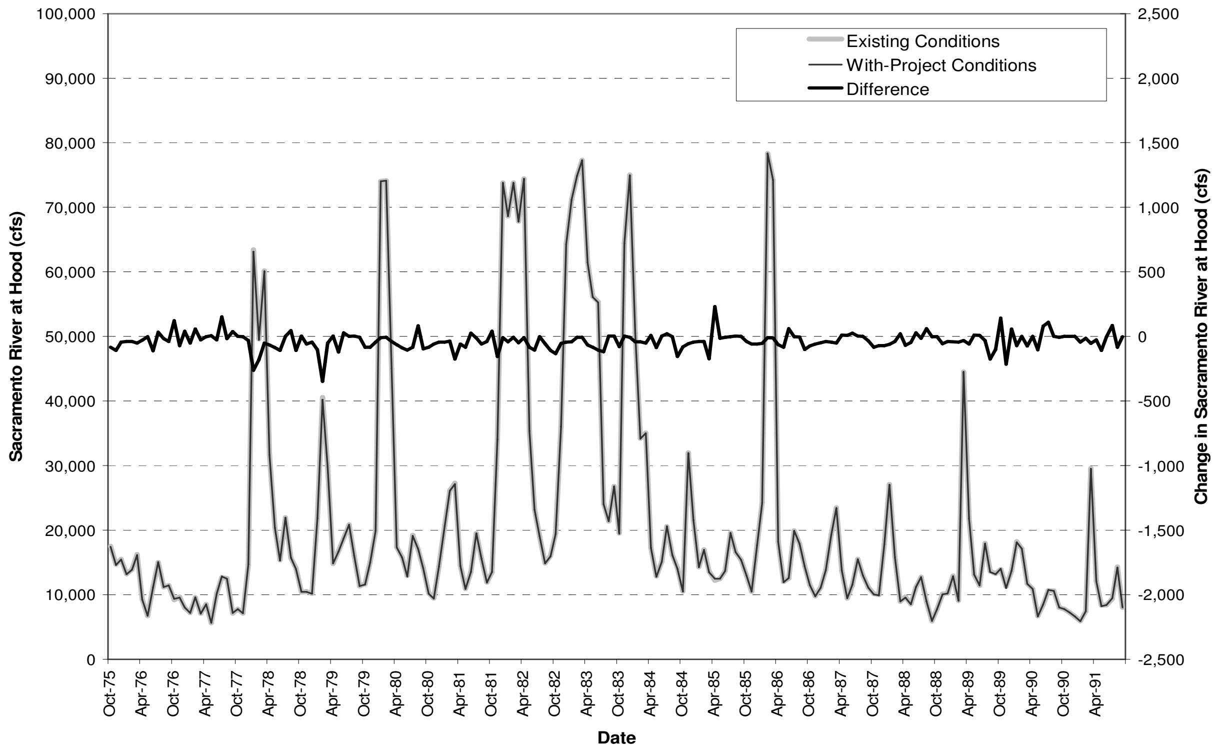


Figure 5-2. Sacramento River Delta Inflow, With-Project Conditions Compared to Existing Conditions

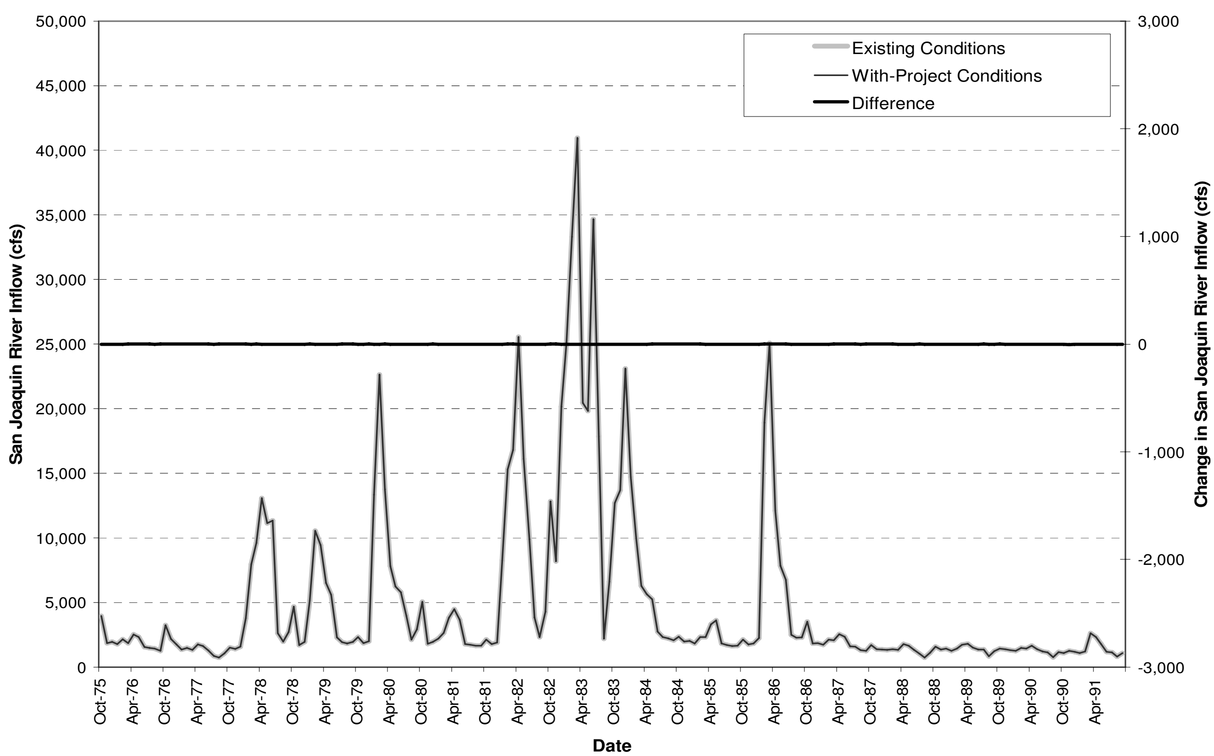


Figure 5-3. San Joaquin River Delta Inflow, With-Project Conditions Compared to Existing Conditions

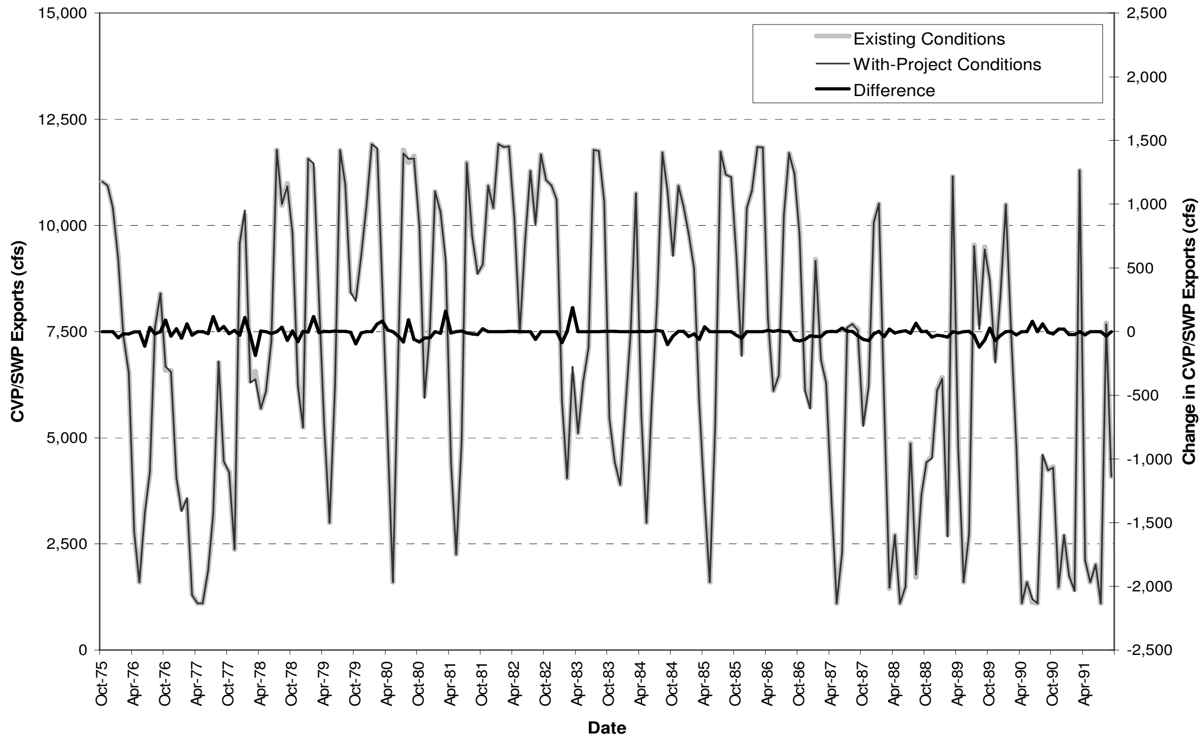


Figure 5-4. CVP-SWP Exports, With-Project Conditions Compared to Existing Conditions

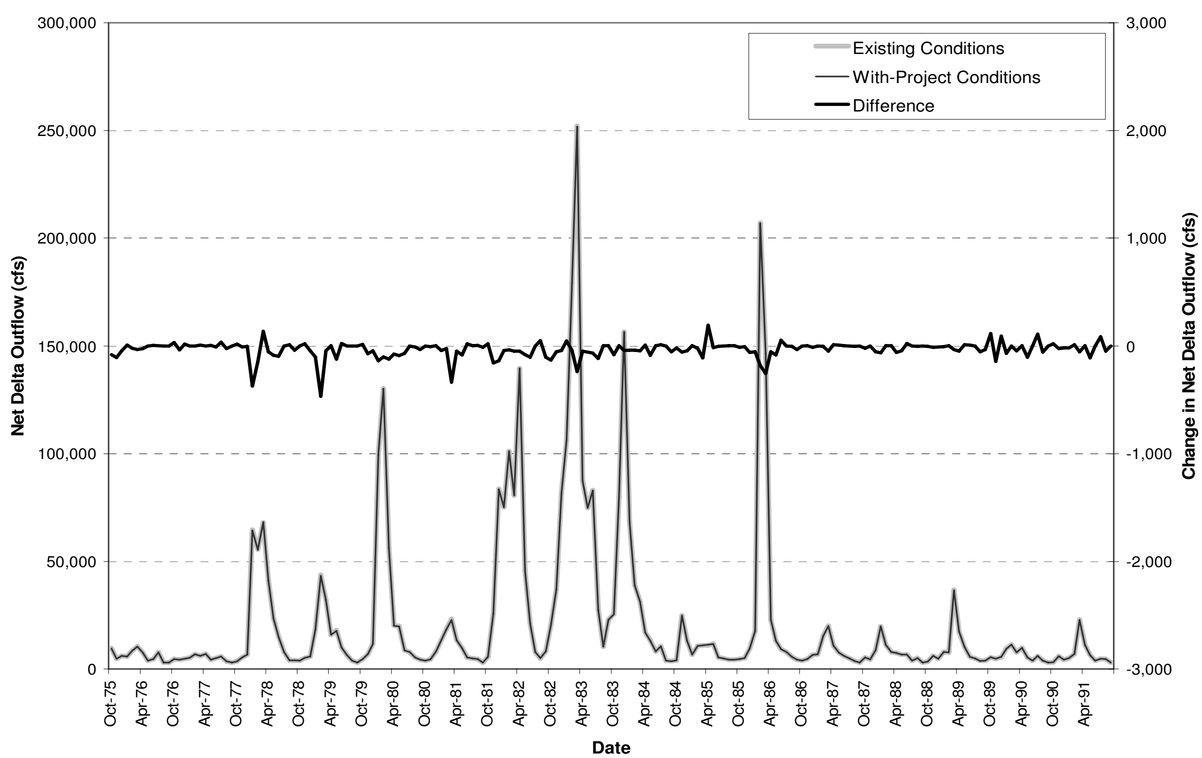


Figure 5-5. Net Delta Outflow, With-Project Conditions Compared to Existing Conditions

Delta Channel Flow

Figure 5-6 shows the Existing Conditions and changes under the DWWSP in flow in key Delta channels. The DWWSP average water-right diversion, over the 16-year period of simulation, is 48 cfs. DSM2 results show that there are no major changes in Delta channel flow caused by the DWWSP water-right diversion.

Delta Channel Stage

Table 5-2 shows the Existing Conditions and changes under the DWWSP in water level upstream and downstream of the four temporary barriers in the south Delta. The results show that the DWWSP would have negligible impacts on stage in the south Delta.

Delta Water Quality

Changes in salinity at Martinez impact salinity throughout the Delta through tidal exchange. The salinity boundary condition at Martinez is a function of Net Delta Outflow. **Figure 5-7** shows a comparison of the EC boundary condition at Martinez together with salinity at selected locations in the western and south Delta. This figure also shows Net Delta Outflow. Changes in EC at Martinez would propagate through the Delta during periods of low Delta outflow, and that there is little lag between changes in salinity at Martinez and changes in salinity in the south Delta.

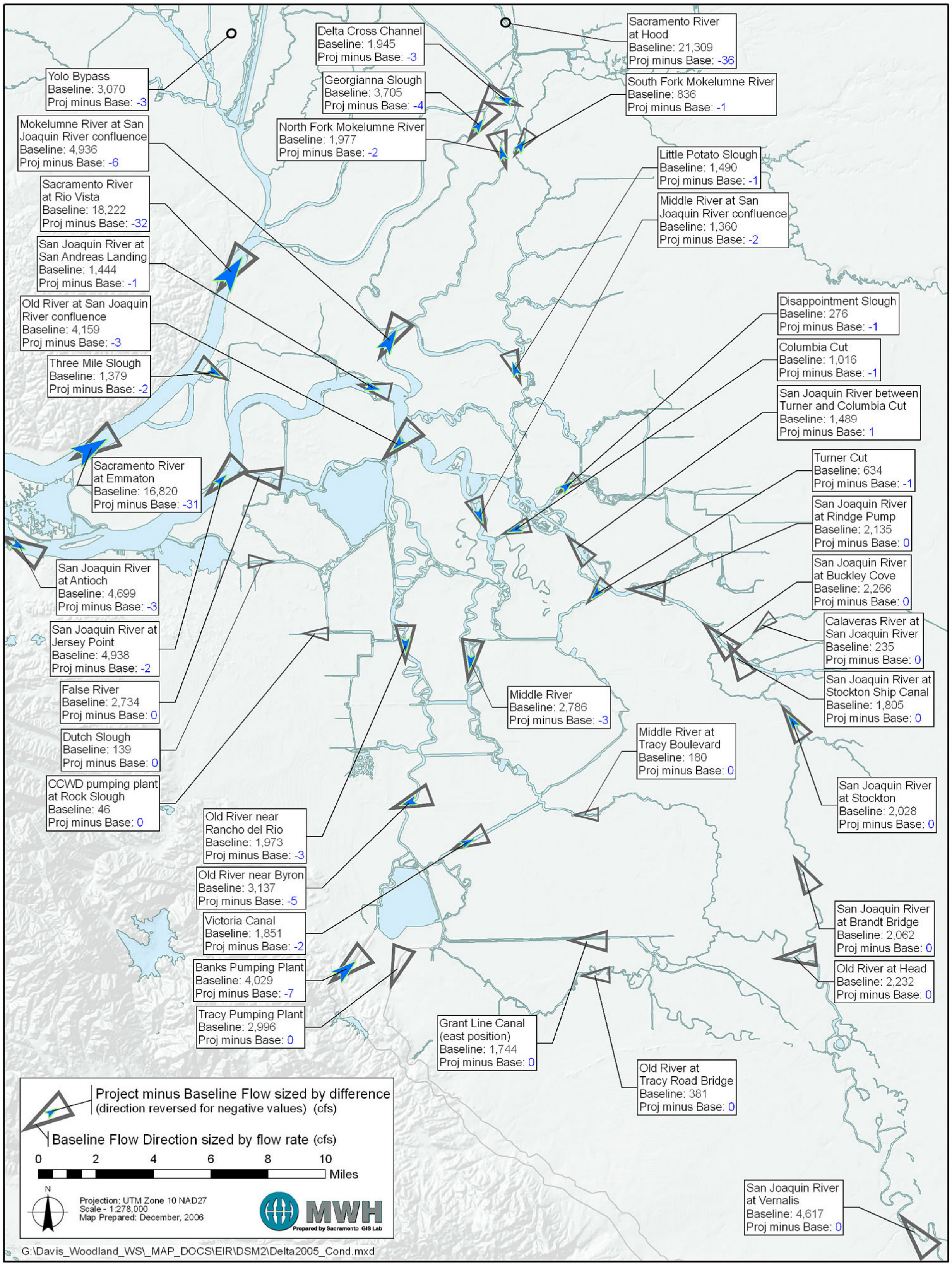


Figure 5-6. Average Annual Flows at Selected Locations in the Delta, With-Project Conditions Compared to Existing Conditions

Table 5-2. Average Daily Minimum Stage, With-Project Conditions Compared to Existing Conditions

Location	Stage (feet)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
Middle River Barrier upstream													
Existing Conditions	1.20	1.05	-0.62	-0.44	-0.11	-0.17	-0.02	0.40	1.16	0.95	1.10	1.18	0.47
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle River Barrier downstream													
Existing Conditions	-0.87	-0.92	-0.62	-0.44	-0.12	-0.17	-0.55	-0.74	-0.84	-0.84	-0.80	-0.74	-0.64
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Old River at Head Barrier upstream													
Existing Conditions	3.00	2.14	1.83	2.62	3.94	3.96	4.10	3.69	3.06	2.04	1.42	1.87	2.80
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Old River at Head Barrier downstream													
Existing Conditions	2.36	1.89	1.83	2.62	3.94	3.96	2.96	2.76	3.06	2.04	1.42	1.70	2.54
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant Line Canal Barrier upstream													
Existing Conditions	1.64	1.38	-0.11	0.16	0.73	0.70	0.30	0.76	1.88	1.37	1.28	1.42	0.96
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant Line Canal Barrier downstream													
Existing Conditions	-0.89	-0.96	-0.17	0.09	0.63	0.60	0.21	-0.26	-0.63	-0.88	-0.97	-0.87	-0.34
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Old River Barrier at Tracy Road bridge upstream													
Existing Conditions	1.56	1.31	-0.61	-0.42	-0.03	-0.09	-0.07	0.56	1.62	1.21	1.24	1.39	0.64
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Old River Barrier at Tracy Road bridge downstream													
Existing Conditions	-1.07	-1.11	-0.61	-0.42	-0.03	-0.09	-0.50	-0.74	-0.94	-1.05	-1.03	-0.96	-0.71
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: 1. Changes are defined as the With-Project Conditions minus Existing Conditions.
2. Stage is in feet relative to NGVD 1929.
3. Monthly average daily minimum stage = Total (Minimum daily stage in a month)/number of days in a month.
4. Grant Line Canal barrier represents the barrier at the east side.

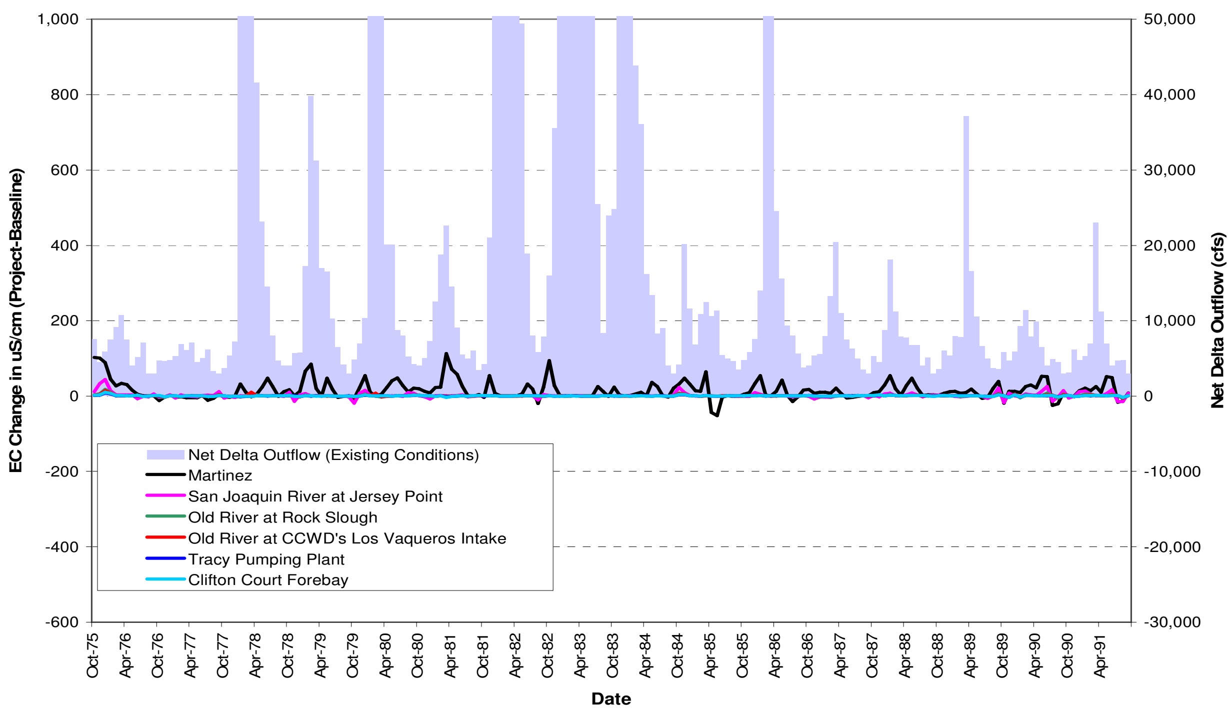


Figure 5-7. EC at Selected Locations, With-Project Conditions Compared to Existing Conditions

Table 5-3 presents the Existing Conditions and changes in EC under the DWWSP at selected locations in the Delta. EC values are expressed as average monthly values in μS/cm for the 16-year period of simulation. **Table 5-4** presents the percentage change in EC. Usually the greatest salinity impact occurs in the late fall and early winter when Net Delta Outflow is low. Changes in average monthly EC are typically less then one percent.

Table 5-3. Average Monthly EC, With-Project Conditions Compared to Existing Conditions

Location	Average Monthly EC (µS/cm)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
Sacramento River at Emmaton													
Existing Conditions	2,230	1,723	1,246	761	502	308	337	518	898	972	1,375	2,165	1,086
Changes	3	10	6	4	1	1	1	4	5	-5	0	10	3
Sacramento River at Collinsville													
Existing Conditions	6,995	5,812	4,739	2,896	1,943	1,113	1,314	1,966	3,224	3,943	5,273	6,909	3,844
Changes	8	18	19	11	4	5	3	12	12	-7	-1	19	9
Sacramento River at Port Chicago (Roe Island)													
Existing Conditions	15,203	13,321	11,947	8,672	6,460	4,599	5,456	7,286	9,869	11,983	14,182	15,675	10,388
Changes	16	21	23	21	10	16	8	21	19	-2	-2	15	14
Sacramento River at Chipps Island													
Existing Conditions	10,254	8,764	7,529	4,909	3,448	2,124	2,522	3,599	5,445	6,740	8,548	10,315	6,183
Changes	12	20	23	16	7	9	5	17	15	-6	-2	20	11
Old River near Middle River													
Existing Conditions	604	649	566	498	526	563	445	438	545	640	763	940	598
Changes	0	0	0	0	0	0	0	0	0	0	0	0	0
Old River at Tracy Road Bridge													
Existing Conditions	648	655	579	534	542	577	479	457	535	610	661	753	586
Changes	1	0	0	0	0	0	0	0	0	1	0	0	0
Old River at CCWD's Los Vaqueros intake													
Existing Conditions	643	554	523	475	442	354	306	361	336	353	423	580	446
Changes	1	0	2	1	1	1	0	0	1	0	-1	1	1
Old River at Rock Slough													
Existing Conditions	717	603	565	488	422	307	266	307	305	365	469	672	457
Changes	1	0	2	1	0	0	0	0	1	0	-1	1	1
CCWD Proposed Alternative Intake													
Existing Conditions	467	430	402	411	398	371	332	387	364	320	322	401	384
Changes	1	1	1	1	1	1	0	0	0	1	0	0	1
West Canal at mouth of Clifton Court Forebay intake													
Existing Conditions	574	511	491	458	430	418	351	382	359	347	395	516	436
Changes	1	0	1	1	0	0	0	0	1	0	0	1	0
Delta Mendota Canal at Tracy Pumping Plant													
Existing Conditions	583	530	507	474	454	455	372	399	379	381	438	572	462
Changes	1	0	1	0	0	0	0	0	0	0	0	1	0
Mokelumne River at Terminus													
Existing Conditions	161	165	172	210	220	203	185	172	165	162	158	158	177
Changes	0	0	0	0	0	0	0	0	0	0	0	0	0
Barker Slough at North Bay Aqueduct intake													
Existing Conditions	189	193	208	234	295	364	378	305	233	204	194	191	249
Changes	0	0	0	0	0	0	-2	-1	0	0	0	0	0
Rock Slough at Contra Costa Canal at Pumping Plant No. 1													
Existing Conditions	737	683	650	698	753	654	478	418	354	406	493	634	580
Changes	2	0	1	2	0	0	0	0	1	1	-1	0	0
San Joaquin near Vernalis													
Existing Conditions	588	647	558	489	524	556	430	434	542	643	782	954	596
Changes	0	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Brandt Bridge													
Existing Conditions	601	647	570	499	523	563	450	441	544	640	761	939	598
Changes	0	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at mouth of Calaveras River													
Existing Conditions	606	614	556	484	471	506	469	428	494	565	623	793	551
Changes	0	0	0	0	0	0	0	0	0	0	0	0	0
Stockton Proposed intake													
Existing Conditions	383	346	332	334	319	291	306	360	276	254	271	346	318
Changes	1	1	1	1	0	0	0	0	1	0	0	1	0
San Joaquin River at Prisoner's Point													
Existing Conditions	472	407	403	371	334	265	262	320	264	277	333	457	347
Changes	0	0	1	1	0	0	0	0	1	0	0	1	0
San Joaquin River at San Andreas Landing													
Existing Conditions	441	402	389	331	293	215	204	233	231	257	314	451	314
Changes	0	1	1	1	0	0	0	0	1	0	0	1	0
San Joaquin River at Jersey Point													
Existing Conditions	1,887	1,514	1,337	892	596	354	295	362	595	939	1,415	2,083	1,022
Changes	0	2	5	2	1	1	1	2	3	-2	-1	4	1
Martinez/Benicia boundary condition													
Existing Conditions	20,115	17,966	16,343	12,954	10,135	8,142	9,582	12,043	15,085	17,732	19,908	20,882	15,074
Changes	17	19	20	22	15	20	11	23	20	2	-1	10	15

Table 5-4. Change in Average Monthly EC, With-Project Conditions Compared to Existing Conditions

Location	Change in Average Monthly EC (in %)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
Sacramento River at Emmaton	0.1	0.6	0.5	0.5	0.2	0.3	0.2	0.7	0.5	-0.5	0.0	0.5	0.3
Sacramento River at Collinsville	0.1	0.3	0.4	0.4	0.2	0.5	0.2	0.6	0.4	-0.2	0.0	0.3	0.2
Sacramento River at Port Chicago (Roe Island)	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.0	0.0	0.1	0.1
Sacramento River at Chipps Island	0.1	0.2	0.3	0.3	0.2	0.4	0.2	0.5	0.3	-0.1	0.0	0.2	0.2
Old River near Middle River	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Old River at Tracy Road Bridge	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Old River at CCWD's Los Vaqueros intake	0.2	0.1	0.3	0.2	0.2	0.3	0.1	0.1	0.2	0.1	-0.2	0.2	0.1
Old River at Rock Slough	0.1	0.1	0.3	0.2	0.1	0.1	0.2	0.1	0.3	0.0	-0.2	0.2	0.1
CCWD Proposed Alternative intake	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.2	-0.1	0.1	0.1
West Canal at mouth of Clifton Court Forebay	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-0.1	0.1	0.1
Delta Mendota Canal at Tracy Pumping Plant	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-0.1	0.1	0.1
Mokelumne River at Terminus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barker Slough at North Bay Aqueduct Intake	0.1	0.0	0.0	0.0	-0.1	0.0	-0.5	-0.3	0.0	0.1	0.1	0.1	-0.1
Rock Slough at Contra Costa Canal	0.2	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.2	0.1	-0.2	0.0	0.1
San Joaquin near Vernalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
San Joaquin River at Brandt Bridge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
San Joaquin River at mouth of Calaveras River	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stockton Proposed intake	0.2	0.2	0.3	0.2	0.1	0.1	0.2	0.0	0.3	0.2	0.0	0.2	0.2
San Joaquin River at Prisoners Point	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.3	0.0	-0.1	0.2	0.1
San Joaquin River at San Andreas Landing	0.1	0.2	0.3	0.2	0.1	0.1	0.1	0.2	0.3	-0.2	-0.1	0.3	0.1
San Joaquin River at Jersey Point	0.0	0.1	0.4	0.3	0.2	0.1	0.2	0.5	0.5	-0.2	-0.1	0.2	0.1
Martinez/Benicia boundary condition	0.1	0.1	0.1	0.2	0.1	0.3	0.1	0.2	0.1	0.0	0.0	0.0	0.1

Tables 5-5 to **5-8** show the monthly EC's and changes in EC for the Old River at Rock Slough, the Old River at Los Vaqueros Reservoir intake, the West Canal at the mouth of the Clifton Court Forebay, and at Tracy Pumping Plant. In general, the changes are negligible.

X2 Location

The DWWSP may affect the location of X2 either directly by affecting the Sacramento River flow, reducing Net Delta Outflow, or indirectly by triggering changes in upstream CVP-SWP reservoir operations or Delta exports as a result of DWWSP diversion. Average monthly DWWSP diversion ranges from 7 cfs to 93 cfs, depending on Term 91 conditions. This would be small compared to the 11,400 cfs flow required to maintain X2 at Chipps Island (located at kilometer [km] 74.0). **Figure 5-8** and **Table 5-9** show the change in X2 location under the With-Project Conditions compared to Existing Conditions. In general, average monthly changes in the X2 location would be on the order of 0.1 km or less; however, the maximum increase in X2 location would be approximately 0.8 km, and would mainly be caused by changes in CVP-SWP operations.

CCWD diversions to fill Los Vaqueros Reservoir are constrained by the Delta Smelt BO (USFWS 1993). From February through May, the BO precondition for filling the reservoir is that the X2 location is west of Chipps Island. In January and June through August, the X2 must be located west of Collinsville. **Figure 5-9** and **Figure 5-10** show the location of Chipps Island and Collinsville, the X2 location and the change in X2 location for the two sets of months when filling is potentially restricted. Only in one month during the period of simulation would the change in X2 location impact filling of Los Vaqueros.

Table 5-5. EC at Old River at CCWD's Los Vaqueros Intake, With-Project Conditions Compared to Existing Conditions

(a) Existing Condition, Monthly EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	272	276	551	678	759	491	386	456	545	488	386	734	502
1977	858	661	751	760	713	639	586	559	591	501	459	686	647
1978	885	779	662	574	455	449	285	319	264	225	319	555	481
1979	619	593	590	440	304	287	296	360	252	259	438	685	427
1980	779	566	441	318	367	349	266	328	276	236	298	438	388
1981	523	561	611	403	315	258	270	377	308	470	606	667	447
1982	746	484	232	341	272	306	172	222	232	219	264	335	319
1983	261	227	310	164	124	160	186	176	134	193	192	225	196
1984	244	186	137	166	250	236	252	361	280	239	291	583	269
1985	730	635	267	263	397	351	328	426	307	458	659	752	464
1986	688	572	536	372	391	271	295	283	272	246	309	456	391
1987	579	615	640	533	584	361	296	407	388	369	520	728	502
1988	793	595	665	532	310	336	349	431	422	372	462	533	483
1989	774	736	578	613	534	315	225	320	297	383	581	739	508
1990	706	569	721	755	578	379	371	398	444	511	455	574	539
1991	827	803	671	688	719	480	333	359	370	473	529	593	570
Median	718	582	584	486	394	343	295	361	302	370	447	588	473
Average	643	554	523	475	442	354	306	361	336	353	423	580	446
Min	244	186	137	164	124	160	172	176	134	193	192	225	196
Max	885	803	751	760	759	639	586	559	591	511	659	752	647

(b) Change in Monthly EC, With-Project Conditions minus Existing Conditions (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	3	4	14	9	1	1	1	1	1	-1	0	1	3
1977	-1	-3	2	0	-1	1	1	0	0	-1	-1	3	0
1978	0	-1	-1	-1	0	10	2	1	0	0	0	0	1
1979	2	0	-2	2	0	0	0	0	0	0	0	0	0
1980	-2	0	4	1	7	-2	-1	0	1	0	1	3	1
1981	2	1	0	-1	1	-1	-1	0	0	-1	0	1	0
1982	1	0	0	0	0	0	0	0	0	0	0	-1	0
1983	0	0	0	0	0	0	-1	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	6	5	1	0	-1	1	0	0	0	0	0	0	1
1986	0	2	1	2	0	0	0	0	0	0	0	0	0
1987	2	0	-1	0	-1	1	1	1	0	1	1	0	0
1988	1	3	0	3	2	1	1	2	2	1	0	0	1
1989	0	1	1	1	0	0	0	0	0	-1	-1	5	0
1990	0	-4	5	-4	2	2	1	1	3	2	-4	3	1
1991	1	-1	0	2	3	2	1	1	3	2	-5	1	1
Median	1	0	0	0	0	0	0	0	0	0	0	0	0
Average	1	0	2	1	1	1	0	0	1	0	-1	1	1
Min	-2	-4	-2	-4	-1	-2	-1	0	0	-1	-5	-1	0
Max	6	5	14	9	7	10	2	2	3	2	1	5	3

Table 5-6. EC at Old River at Rock Slough, With-Project Conditions Compared to Existing Conditions

(a) Existing Condition, Monthly EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	234	281	630	757	813	465	334	398	584	500	424	892	526
1977	974	755	888	850	731	554	490	486	611	520	521	851	686
1978	1,034	850	735	505	327	326	334	279	229	204	345	629	483
1979	704	675	640	424	275	252	254	305	205	258	496	805	441
1980	876	605	462	284	376	278	247	326	228	210	316	484	391
1981	585	646	660	397	283	203	210	313	264	542	685	772	463
1982	825	479	197	264	227	244	194	218	203	186	262	326	302
1983	231	197	263	205	137	169	199	192	140	177	175	181	189
1984	260	217	150	194	215	195	205	309	226	209	309	678	264
1985	828	664	231	252	402	301	261	348	263	527	761	870	476
1986	746	608	571	345	289	338	257	240	226	223	325	507	390
1987	643	700	701	564	581	278	222	315	312	386	603	860	514
1988	871	645	742	532	259	258	289	354	350	382	525	619	486
1989	897	794	631	647	517	268	192	233	236	425	677	866	532
1990	773	626	834	829	567	334	313	318	445	552	490	696	565
1991	989	910	701	762	757	443	261	277	355	538	594	719	609
Median	799	646	635	465	352	278	256	311	250	384	493	707	479
Average	717	603	565	488	422	307	266	307	305	365	469	672	457
Min	231	197	150	194	137	169	192	192	140	177	175	181	189
Max	1,034	910	888	850	813	554	490	486	611	552	761	892	686

(b) Change in Monthly EC, With-Project Conditions minus Existing Conditions (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	3	6	18	10	1	1	1	1	0	-1	0	2	4
1977	-2	-3	2	-1	-1	0	0	0	0	0	-1	4	0
1978	0	-2	-1	-2	0	5	3	0	0	0	0	0	0
1979	2	-1	-2	3	0	0	0	0	0	0	0	0	0
1980	-3	0	5	1	0	-3	0	0	0	0	2	3	1
1981	2	1	-1	-1	1	0	0	0	1	-1	0	1	0
1982	0	0	0	0	0	0	0	0	0	0	-1	-1	0
1983	0	0	0	-1	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	7	6	1	0	-1	1	0	0	0	0	0	0	1
1986	0	1	1	2	0	0	0	0	0	0	0	0	0
1987	1	-1	-2	-1	-2	0	0	0	0	0	0	0	0
1988	1	2	1	4	1	0	1	2	2	0	0	0	1
1989	1	2	1	0	-1	0	0	0	0	-2	-1	6	1
1990	-1	-3	5	-4	3	1	1	1	7	1	-5	5	1
1991	1	-2	2	4	4	1	1	1	5	1	-7	2	1
Median	0	0	1	0	0	0	0	0	0	0	0	0	0
Average	1	0	2	1	0	0	0	0	1	0	-1	1	1
Min	-3	-3	-2	-4	-2	-3	0	0	0	-2	-7	-1	0
Max	7	6	18	10	4	5	3	2	7	1	2	6	4

Table 5-7. EC at West Canal at mouth of Clifton Court Forebay, With-Project Conditions Compared to Existing Conditions

(a) Existing Condition, Monthly EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	300	272	481	601	699	521	397	433	514	483	366	597	472
1977	768	591	652	697	710	674	649	613	597	570	421	548	624
1978	747	751	603	581	397	378	247	246	257	237	294	488	435
1979	550	521	553	436	293	293	294	337	289	256	387	579	399
1980	697	537	424	266	144	245	260	288	302	254	281	398	341
1981	472	483	563	407	341	318	301	364	349	410	539	575	427
1982	679	484	272	343	246	278	172	187	245	240	261	339	312
1983	257	237	158	135	119	147	165	170	134	184	202	257	180
1984	243	178	127	139	234	275	273	355	325	261	273	501	265
1985	644	606	305	275	387	398	356	400	356	401	573	651	446
1986	638	540	509	393	281	182	244	282	296	261	294	412	361
1987	522	541	592	510	583	455	336	347	397	355	451	609	475
1988	730	574	594	525	356	348	372	393	424	368	405	452	462
1989	638	703	545	572	527	356	227	287	332	345	498	629	472
1990	651	523	617	684	588	417	371	394	424	449	432	471	502
1991	674	758	703	656	688	512	364	371	383	397	469	493	539
Median	641	539	549	473	372	352	298	351	341	350	396	497	441
Average	576	519	481	451	412	362	314	342	351	342	384	500	420
Min	243	178	127	135	119	147	165	170	134	184	202	257	180
Max	768	758	703	697	710	674	649	613	597	570	573	651	624

(b) Change in Monthly EC, With-Project Conditions minus Existing Conditions (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	2	3	11	9	2	1	1	1	1	0	0	1	3
1977	0	-3	1	0	-1	-1	0	0	0	0	-1	2	0
1978	1	0	0	-3	-1	0	0	0	0	0	0	0	0
1979	1	1	-2	1	0	0	0	0	0	0	0	0	0
1980	-1	0	3	1	1	1	0	0	0	1	1	2	1
1981	2	1	0	-1	1	-3	-1	0	0	0	0	1	0
1982	1	0	0	0	0	0	0	0	0	1	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	4	4	1	0	-1	1	0	0	0	0	0	0	1
1986	0	2	1	2	0	0	0	0	0	1	0	0	1
1987	2	0	0	0	-1	1	1	1	1	2	1	0	1
1988	1	5	1	3	3	3	2	2	2	2	1	0	2
1989	0	1	1	1	0	0	0	0	0	-1	-2	3	0
1990	1	-4	5	-4	1	2	2	1	1	2	-3	0	0
1991	1	0	0	1	2	2	1	1	1	2	-4	-1	0
Median	1	0	0	0	0	0	0	0	0	0	0	0	0
Average	1	1	1	1	0	0	0	0	0	0	0	0	1
Min	-1	-4	-2	-4	-1	-3	-1	0	0	-1	-4	-1	0
Max	4	5	11	9	3	3	2	2	2	2	1	3	3

Table 5-8. EC at Delta Mendota Canal at Tracy Pumping Plant, With-Project Conditions Compared to Existing Conditions

(a) Existing Condition, Monthly EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	339	321	522	622	714	607	493	519	544	525	470	683	530
1977	715	581	609	712	825	901	693	610	585	484	436	635	649
1978	784	734	625	508	306	355	228	237	247	291	356	543	435
1979	513	533	568	402	255	295	309	358	331	301	433	637	411
1980	696	544	471	201	160	223	284	332	335	304	339	460	362
1981	448	506	574	463	437	402	366	436	367	445	558	637	470
1982	697	521	410	338	203	261	163	199	276	307	337	419	344
1983	214	260	139	217	151	204	188	178	144	194	287	355	211
1984	211	180	158	149	238	329	332	402	378	322	353	580	303
1985	662	610	390	392	498	536	448	460	371	436	588	694	507
1986	660	597	571	474	268	193	234	297	336	343	363	497	403
1987	528	556	596	556	638	572	423	491	454	421	529	681	537
1988	747	578	627	573	461	835	495	514	467	387	434	529	554
1989	711	693	564	603	663	473	323	411	379	385	548	704	538
1990	666	542	641	693	633	562	531	501	463	500	486	558	565
1991	731	731	646	689	819	540	447	444	392	454	491	542	577
Median	664	550	569	491	449	438	349	423	374	386	435	569	489
Average	583	530	507	474	454	455	372	399	379	381	438	572	462
Min	211	180	139	149	151	193	163	178	144	194	287	355	211
Max	784	734	646	712	825	901	693	610	585	525	588	704	649

(b) Change in Monthly EC, With-Project Conditions minus Existing Conditions (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	2	3	8	6	1	1	1	0	2	0	0	1	2
1977	1	-2	0	0	-1	0	0	0	0	-1	-1	1	0
1978	1	-1	0	-2	-1	-1	0	0	0	0	0	0	0
1979	1	0	-1	1	0	0	0	0	0	0	0	0	0
1980	-1	0	2	0	1	0	0	0	0	0	1	2	0
1981	1	0	0	0	0	-2	-1	0	0	0	0	1	0
1982	1	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	1	0	1	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	4	4	0	0	0	2	0	0	0	0	0	0	1
1986	0	2	1	1	0	0	1	0	0	0	0	0	0
1987	2	0	0	0	0	1	1	1	0	1	1	2	1
1988	1	3	0	2	2	0	1	1	2	2	0	0	1
1989	0	1	1	0	2	0	0	0	0	-1	-1	3	0
1990	1	-3	3	-3	1	1	1	0	1	2	-2	0	0
1991	1	-1	0	1	1	1	1	0	2	2	-4	0	0
Median	1	0	0	0	0	0	0	0	0	0	0	0	0
Average	1	0	1	0	0	0	0	0	0	0	0	1	0
Min	-1	-3	-1	-3	-1	-2	-1	0	0	-1	-4	0	0
Max	4	4	8	6	2	2	1	1	2	2	1	3	2

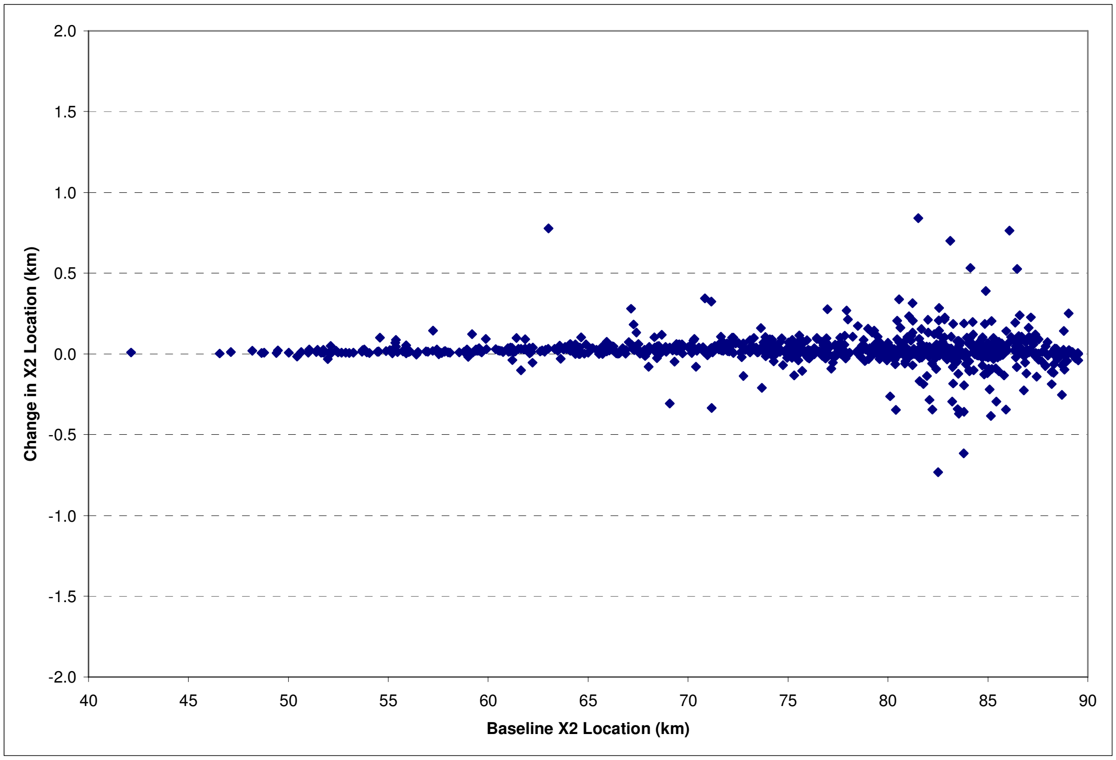


Figure 5-8. X2 Location, With-Project Conditions Compared to Existing Conditions

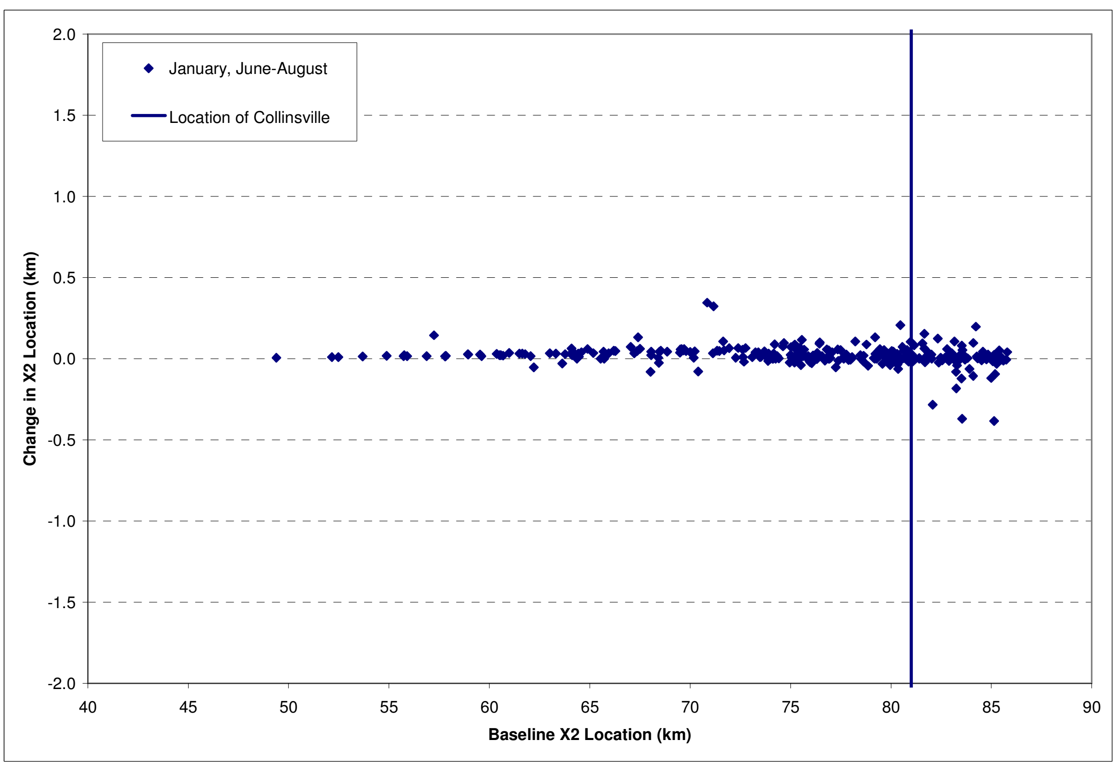


Figure 5-9. X2 Location in Periods (January, June-August) of Restricted Filling of Los Vaqueros Reservoir, With-Project Conditions Compared to Existing Conditions

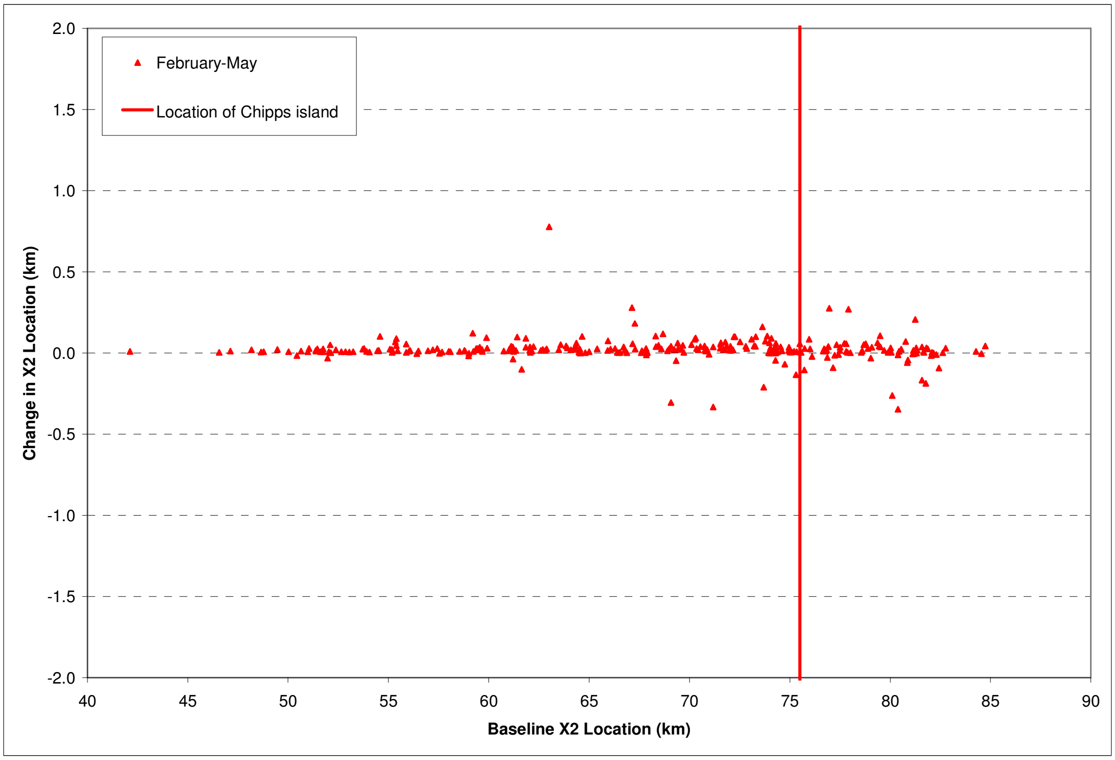


Figure 5-10. X2 Location in Periods (February-May) of Restricted Filling of Los Vaqueros Reservoir, With-Project Conditions Compared to Existing Conditions

Table 5-9. Change in X2 Location, With-Project Conditions Compared to Existing Conditions

Water Year	Year Type	Difference in X2 Location (km), With-Project Conditions minus Existing Conditions											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	AN	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1923	BN	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1924	C	0.0	-0.1	-0.1	-0.2	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
1925	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1926	D	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.1	-0.2	-0.1
1927	W	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1928	AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1
1929	C	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1930	D	-0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0
1931	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.2	-0.4	0.8	0.3
1932	D	-0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1933	C	0.0	0.0	0.0	-0.3	-0.3	-0.1	0.0	0.1	0.0	0.0	0.0	0.0
1934	C	0.0	0.0	0.0	0.1	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
1935	BN	0.0	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	0.3	0.1	0.0	-0.2
1936	BN	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	-0.3	-0.1
1937	BN	0.0	0.0	0.0	-0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
1938	W	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
1939	D	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1940	AN	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1941	W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1942	W	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1943	W	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1944	D	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
1945	BN	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0
1946	BN	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
1947	D	0.1	-0.3	0.0	0.0	0.3	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0
1948	BN	0.5	0.1	-0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.7	0.1
1949	D	0.5	-0.6	0.0	0.2	0.1	0.2	0.1	0.0	0.0	0.0	-0.4	-0.1
1950	BN	0.2	-0.1	0.0	0.1	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0
1951	AN	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1952	W	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1953	W	0.1	0.8	0.1	0.1	0.8	-0.3	-0.3	-0.1	0.0	0.0	0.0	0.3
1954	AN	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.2
1955	D	-0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0
1956	W	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1957	AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
1958	W	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
1959	BN	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
1960	D	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.2	0.1	0.0
1961	D	-0.1	0.0	0.1	0.0	0.2	0.1	0.0	0.0	0.0	0.1	-0.3	-0.1
1962	BN	0.4	-0.1	-0.3	-0.1	0.3	0.1	0.1	0.0	0.1	0.2	0.1	0.1
1963	W	-0.1	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1	0.1	0.0	0.1
1964	D	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1
1965	W	-0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
1966	BN	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
1967	W	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1
1968	BN	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
1969	W	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1970	W	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
1972	BN	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.1
1973	AN	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
1974	W	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1975	W	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
1976	C	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	C	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978	AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1979	BN	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
1980	AN	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1981	D	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0
1982	W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1
1983	W	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
1985	D	0.1	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	0.0
1986	W	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
1987	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	C	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
1989	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
1990	C	-0.1	0.2	-0.1	0.0	0.0	0.1	0.0	0.2	0.1	-0.1	0.1	0.0
1991	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.0
1992	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1
1993	AN	0.1	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1
1994	C	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum		0.5	0.8	0.1	0.3	0.8	0.2	0.1	0.3	0.3	0.2	0.8	0.3
Minimum		-0.3	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.1	-0.1	-0.4	-0.7	-0.3

Note: Water year types are based on Sacramento Valley Index: Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critical (C).

COMPARISON BETWEEN CUMULATIVE CONDITIONS WITHOUT PROJECT AND CUMULATIVE CONDITIONS WITH PROJECT

This section presents simulation results for the Cumulative Conditions with Project compared to Cumulative Conditions without Project. Since the Project Partners' water-right diversion diverts water from the Sacramento River, there is a potential that DWWSP would have impacts on the Delta inflow.

Boundary Conditions

The hydrodynamic and water quality conditions within the Delta are driven by the flow and salinity boundary conditions. For the DSM2 modeling, boundary conditions are determined based on CALSIM II outputs, as discussed in **Chapter 4**. **Figures 5-11, 5-12** and **5-13** present comparisons of the major boundary flows (Sacramento River inflow, San Joaquin River inflow, and CVP and SWP exports). The figures show occasional large changes in monthly inflow, export, or outflow. These changes are triggered by a CALSIM II 'step function' (an abrupt change in flow when a specified threshold is crossed). Typically an increase in flow in one month is offset by a lower flow in the following month.

Martinez is specified as a stage rather than as a flow boundary condition. The salinity boundary condition at Martinez is calculated from the Net Delta Outflow using a modified G-model. **Figure 5-14** compares Net Delta Outflow under the Cumulative Conditions with Project to Cumulative Conditions without Project. **Table 5-10** presents a comparison of flow boundary conditions as average monthly values for the 16-year period of simulation.

Table 5-10. Boundary Flow Conditions, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Location	Average Monthly Flow (cfs)												Total
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	(TAF/year)
Sacramento River inflow													
Cumulative Conditions without Project	12,067	15,419	24,860	32,837	39,333	34,278	24,576	19,162	17,351	18,754	14,431	12,472	15,973
Changes	-50	-50	-105	-58	-30	-63	-62	-62	-46	28	0	-40	-32
San Joaquin River inflow													
Cumulative Conditions without Project	2,885	1,994	3,013	4,438	6,321	6,294	6,095	5,570	4,190	2,288	1,698	1,872	2,806
Changes	1	0	0	0	0	0	0	0	0	0	-1	0	0
CVP-SWP Exports (Tracy PP and Banks PP)													
Cumulative Conditions without Project	8,526	7,892	9,584	9,984	9,486	8,908	4,809	2,934	6,129	9,433	8,782	8,929	5,759
Changes	-22	-31	-19	-14	-22	-25	-39	-1	-28	20	-1	-16	-12
Net Delta Outflow													
Cumulative Conditions without Project	5,348	9,310	20,532	35,892	47,448	38,846	27,409	20,705	11,714	7,197	4,603	4,021	13,961
Changes	-24	-19	-104	-58	-10	-48	-13	-58	-17	8	7	-14	-21

Note: Changes are defined as the Cumulative Conditions with Project minus Cumulative Conditions without Project.

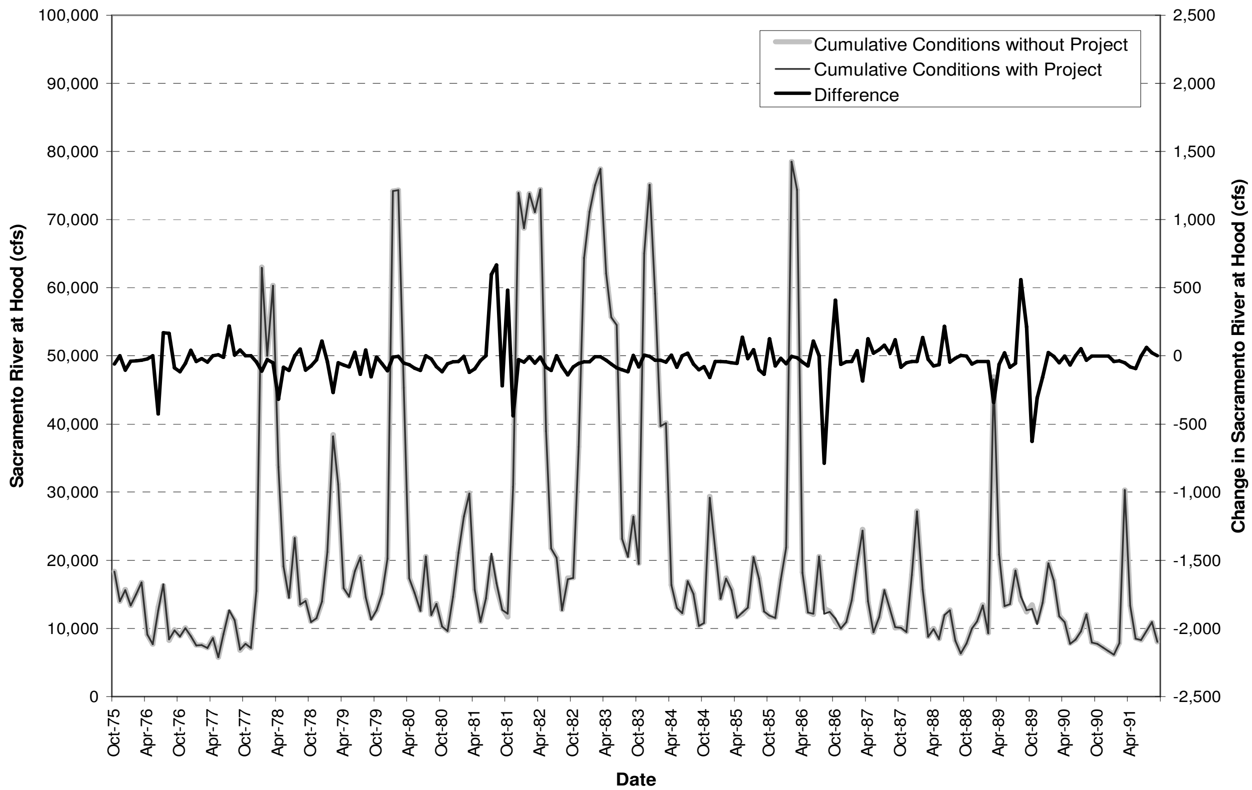


Figure 5-11. Sacramento River Delta Inflow, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

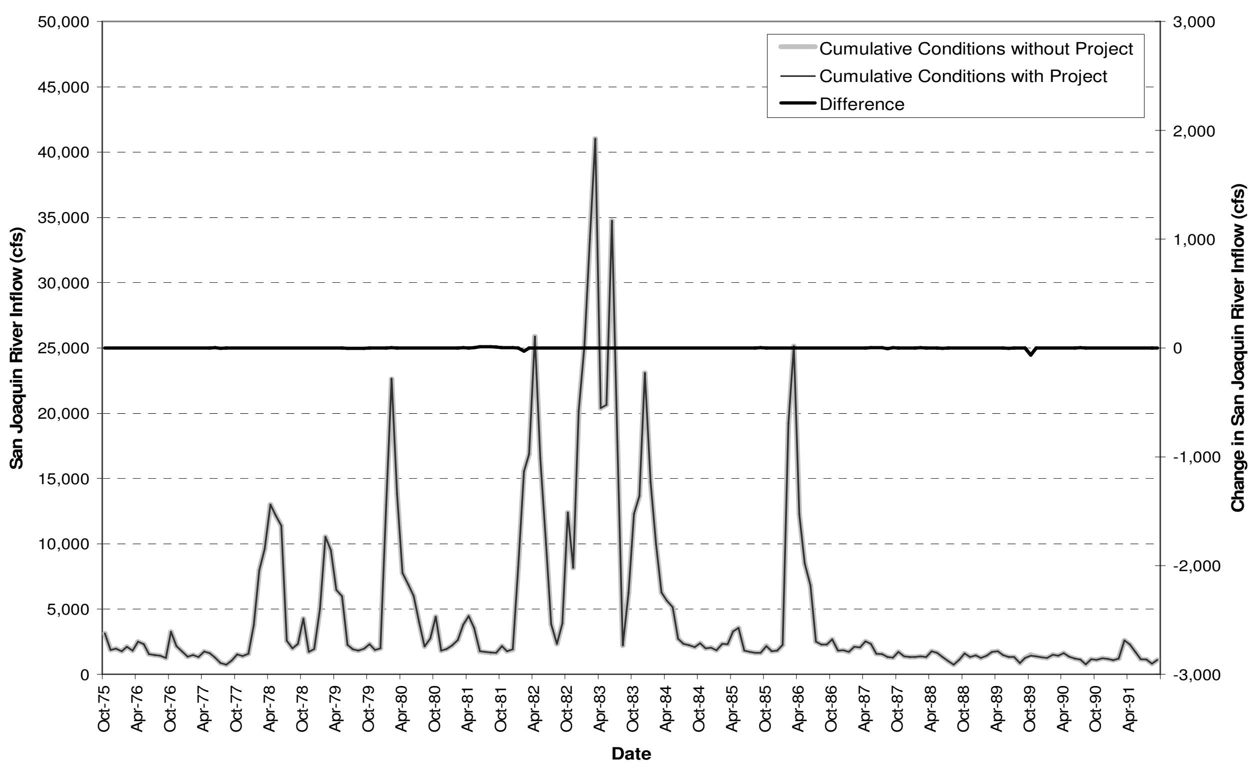


Figure 5-12. San Joaquin River Delta Inflow, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

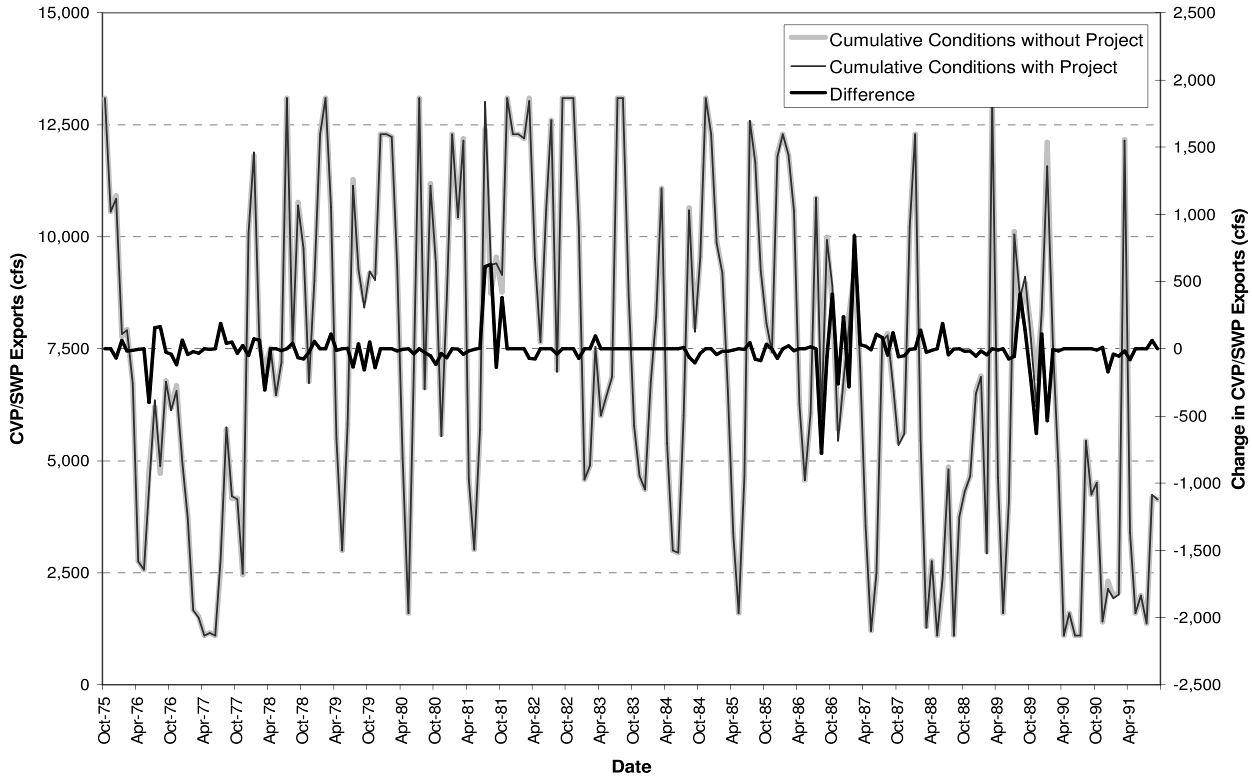


Figure 5-13. CVP-SWP Exports, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

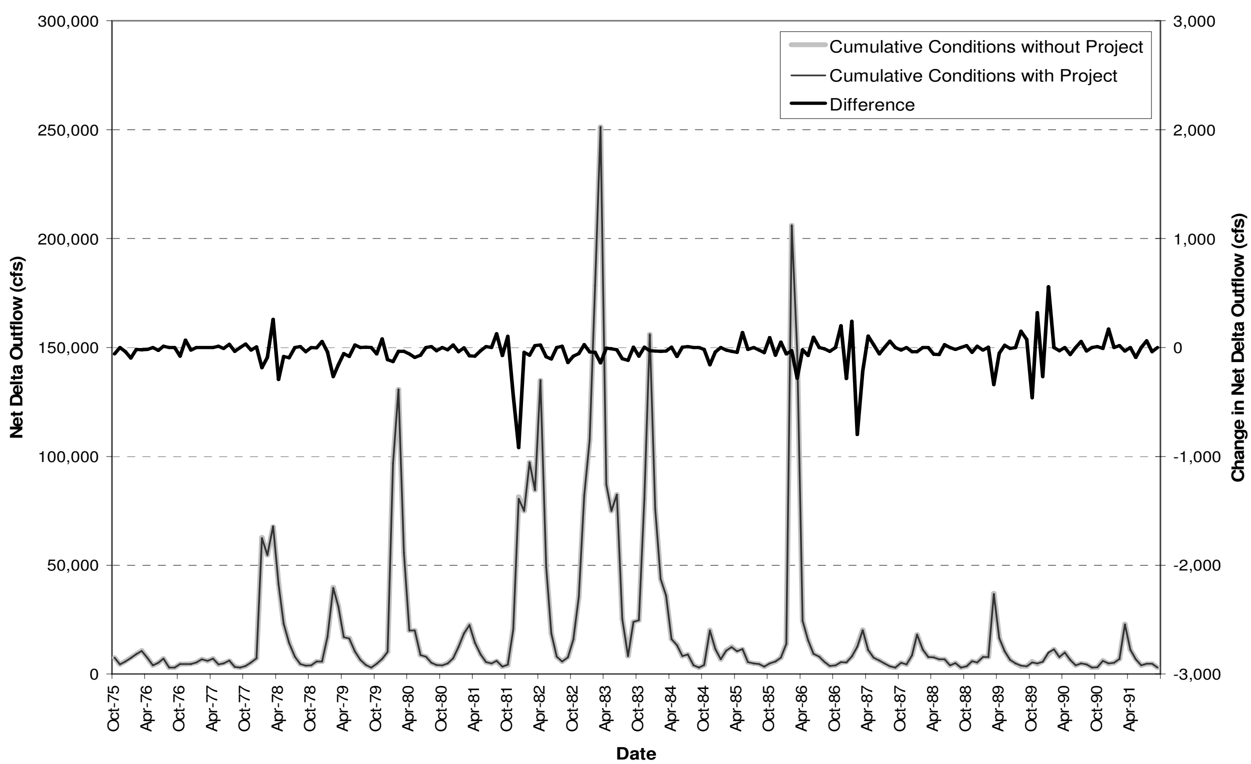


Figure 5-14. Net Delta Outflow, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Delta Channel Flow

Figure 5-15 shows the Cumulative Conditions without Project and changes under the DWWSP in flow in key Delta channels. The DWWSP water-right diversion, averaged over the 16-year period of simulation, is 48 cfs. DSM2 results show that there would be no major changes in Delta channel flow caused by the DWWSP water-right diversion.

Delta Channel Stage

Table 5-11 shows the Cumulative Conditions without Project and change under the DWWSP in water level upstream and downstream of the four temporary barriers in the south Delta. The results show that the DWWSP would have negligible impact on stage in the south Delta.

Delta Water Quality

Changes in salinity at Martinez impact salinity throughout the Delta through tidal exchange. The salinity boundary condition at Martinez is a function of Net Delta Outflow. **Figure 5-16** shows a comparison of the EC boundary condition at Martinez together with salinity at selected locations in the western and south Delta. The figure also shows Net Delta Outflow. It is apparent that changes in EC at Martinez propagate through the Delta during periods of low Delta outflow, and that there is little lag between changes in salinity at Martinez and changes in salinity in the south Delta.

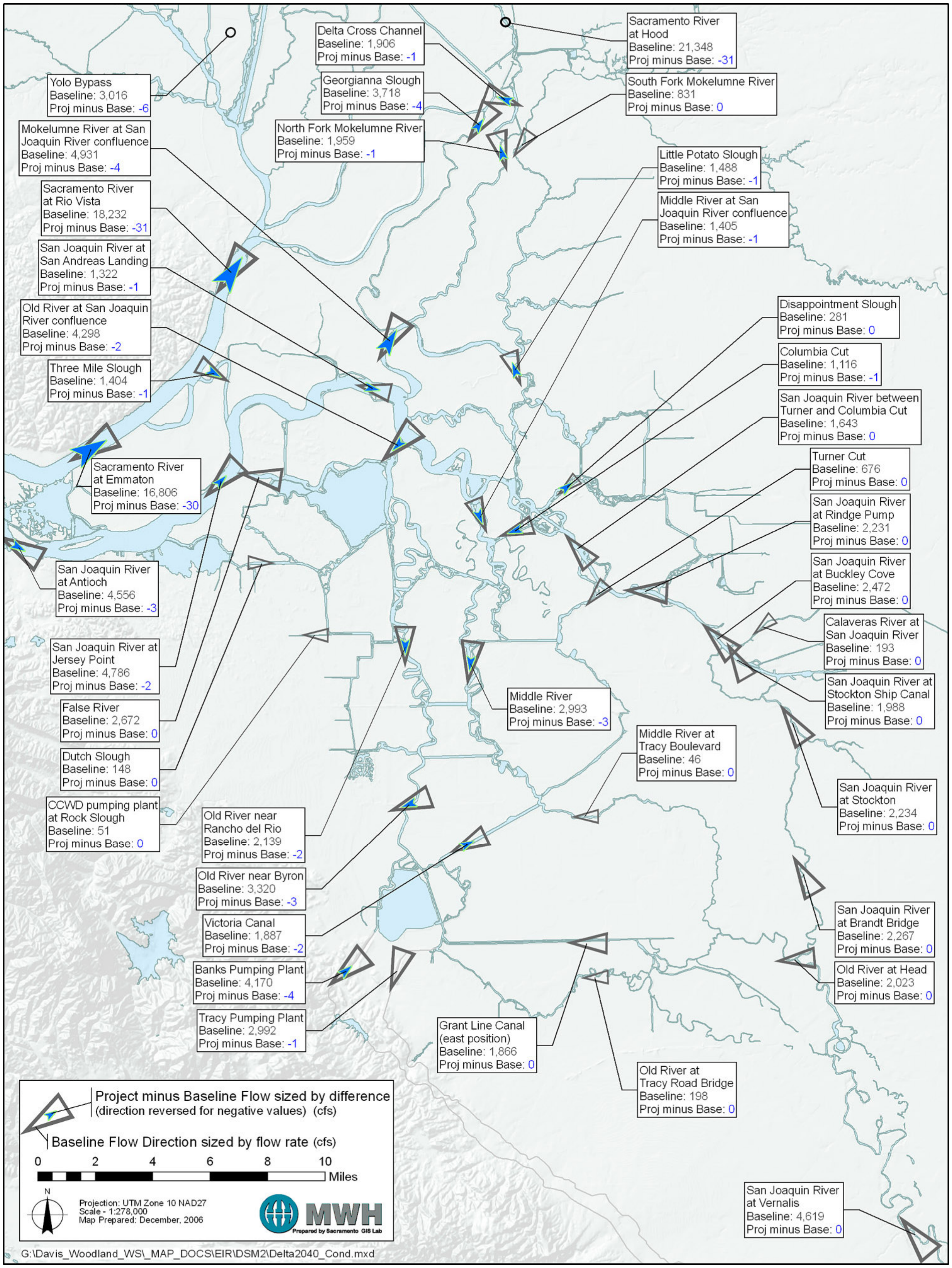


Figure 5-15. Average Annual Flow at Selected Locations in the Delta, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Table 5-11. Average Daily Minimum Stage, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Location	Stage (feet)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
Middle River Barrier upstream													
Cumulative Conditions without Project	1.34	-0.84	-0.70	-0.51	-0.20	-0.25	1.49	1.27	1.79	0.98	1.32	1.62	0.61
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle River Barrier downstream													
Cumulative Conditions without Project	-0.86	-0.84	-0.71	-0.51	-0.21	-0.27	-0.68	-0.81	-0.97	-0.93	-0.86	-0.82	-0.71
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Old River at Head Barrier upstream													
Cumulative Conditions without Project	3.63	2.60	1.82	2.62	3.99	3.99	4.62	4.74	3.13	1.96	1.45	1.79	3.03
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Old River at Head Barrier downstream													
Cumulative Conditions without Project	0.35	-0.06	1.80	2.60	3.95	3.95	2.54	1.58	3.11	1.95	1.45	1.77	2.08
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant Line Canal Barrier upstream													
Cumulative Conditions without Project	-0.32	-0.60	-0.14	0.15	0.74	0.68	0.38	0.05	1.54	0.77	0.91	1.10	0.44
Changes	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00
Grant Line Canal Barrier downstream													
Cumulative Conditions without Project	-0.32	-0.60	-0.14	0.15	0.74	0.68	0.38	0.05	1.54	0.77	0.91	1.10	0.44
Changes	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00
Old River Barrier at Tracy Road bridge upstream													
Cumulative Conditions without Project	0.42	-0.85	-0.63	-0.42	-0.03	-0.09	0.76	0.61	1.60	0.86	1.13	1.34	0.39
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00
Old River Barrier at Tracy Road bridge downstream													
Cumulative Conditions without Project	-1.04	-0.86	-0.65	-0.43	-0.06	-0.13	-0.66	-0.81	-1.04	-1.14	-1.09	-1.07	-0.75
Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: 1. Changes are defined as the Cumulative Conditions with Project minus Cumulative Conditions without Project.
2. Stage is in feet relative to NGVD 1929.
3. Monthly average daily minimum stage = Total (Minimum daily stage in a month)/number of days in a month.
4. Grant Line Canal barrier represents the barrier at the west side.

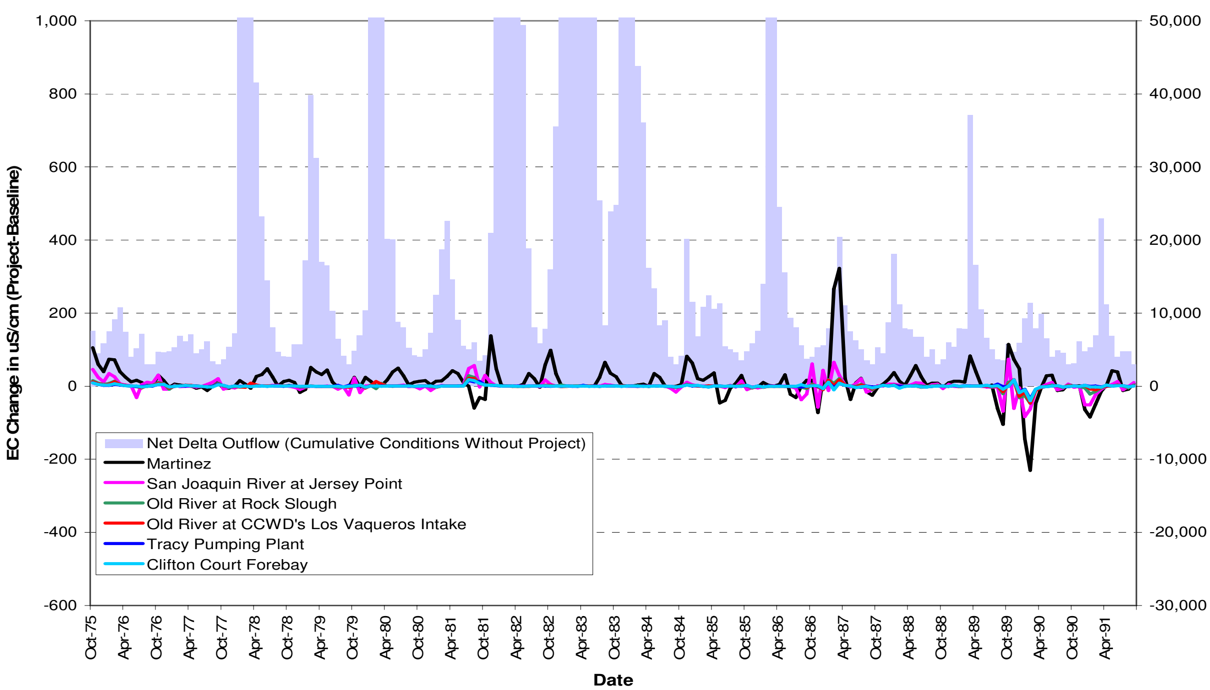


Figure 5-16. EC at Selected Locations, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Table 5-12 presents the baselines and changes in EC under the DWWSP at selected locations in the Delta. EC values are expressed as average monthly values in µS/cm for the 16-year period of simulation. **Table 5-13** presents the percentage changes in EC. Usually the greatest salinity impact occurs in the late fall and early winter when Net Delta Outflow is low. Changes in average monthly EC are typically less then one percent.

Table 5-12. Average Monthly EC, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Location	Average Monthly EC (µS/cm)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
Sacramento River at Emmaton													
Cumulative Conditions without Project	2,335	1,705	1,211	739	492	300	332	492	879	1,003	1,481	2,283	1,104
Changes	9	7	-1	-2	0	1	1	2	6	-6	-9	2	1
Sacramento River at Collinsville													
Cumulative Conditions without Project	7,303	5,867	4,780	2,906	1,899	1,069	1,290	1,918	3,193	4,014	5,409	7,077	3,894
Changes	26	10	6	-7	3	4	4	7	11	-8	-18	2	3
Sacramento River at Port Chicago (Roe Island)													
Cumulative Conditions without Project	15,650	13,664	12,151	8,910	6,464	4,512	5,389	7,224	9,830	12,089	14,279	15,762	10,494
Changes	30	21	11	-7	10	20	13	14	14	0	-11	2	10
Sacramento River at Chipps Island													
Cumulative Conditions without Project	10,655	8,932	7,656	5,011	3,412	2,058	2,482	3,544	5,408	6,835	8,674	10,465	6,261
Changes	31	15	9	-9	7	9	8	10	13	-5	-17	1	6
Old River near Middle River													
Cumulative Conditions without Project	491	539	566	514	527	565	382	408	534	598	533	560	518
Changes	0	2	0	-3	0	0	0	0	0	0	1	0	0
Old River at Tracy Road Bridge													
Cumulative Conditions without Project	626	583	575	535	542	578	434	409	437	466	482	543	518
Changes	1	2	0	0	0	0	1	0	0	0	1	0	0
Old River at CCWD's Los Vaqueros intake													
Cumulative Conditions without Project	663	577	537	507	430	334	299	351	338	363	431	563	449
Changes	2	2	-2	0	-2	1	1	0	0	1	1	0	0
Old River at Rock Slough													
Cumulative Conditions without Project	736	622	583	524	408	292	256	296	306	381	474	652	461
Changes	3	2	-3	-2	-3	1	0	0	0	2	1	-1	0
CCWD Proposed Alternative Intake													
Cumulative Conditions without Project	482	462	408	420	388	357	328	394	368	320	334	394	388
Changes	0	2	-1	0	-3	0	0	0	0	0	0	0	0
West Canal at mouth of Clifton Court Forebay intake													
Cumulative Conditions without Project	596	539	497	477	423	401	340	361	367	357	407	508	439
Changes	1	2	-1	0	-3	0	1	0	0	1	1	0	0
Delta Mendota Canal at Tracy Pumping Plant													
Cumulative Conditions without Project	601	543	515	491	448	447	357	364	396	415	466	589	469
Changes	1	2	-1	0	-2	0	1	0	0	1	1	1	0
Mokelumne River at Terminus													
Cumulative Conditions without Project	160	165	171	209	220	201	184	172	164	161	158	158	177
Changes	0	0	0	0	0	0	0	0	0	0	0	0	0
Barker Slough at North Bay Aqueduct intake													
Cumulative Conditions without Project	185	190	208	240	313	376	371	281	215	193	187	186	245
Changes	0	0	0	0	0	-1	0	0	1	0	0	0	0
Rock Slough at Contra Costa Canal at Pumping Plant No. 1													
Cumulative Conditions without Project	761	721	638	745	774	666	482	413	351	411	505	609	590
Changes	1	3	-2	-1	-6	0	0	0	0	1	1	0	0
San Joaquin near Vernalis													
Cumulative Conditions without Project	601	647	558	491	525	557	433	431	541	645	778	963	597
Changes	0	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Brandt Bridge													
Cumulative Conditions without Project	614	647	570	503	524	565	451	437	542	641	758	949	600
Changes	0	0	0	-1	0	0	0	0	0	0	0	0	0
San Joaquin River at mouth of Calaveras River													
Cumulative Conditions without Project	605	609	535	455	449	480	462	422	486	550	625	789	539
Changes	0	0	0	1	1	0	0	0	0	-1	-1	-1	0
Stockton Proposed intake													
Cumulative Conditions without Project	406	380	339	341	307	277	302	371	282	259	278	338	323
Changes	0	2	-1	-1	-2	0	0	0	0	1	1	0	0
San Joaquin River at Prisoner's Point													
Cumulative Conditions without Project	476	415	412	385	317	253	259	329	268	286	334	445	348
Changes	2	1	-2	-1	-2	0	0	0	0	1	0	0	0
San Joaquin River at San Andreas Landing													
Cumulative Conditions without Project	446	404	403	339	283	212	202	234	231	268	318	452	316
Changes	2	0	-1	-2	-1	0	0	0	0	0	0	0	0
San Joaquin River at Jersey Point													
Cumulative Conditions without Project	1,980	1,549	1,450	932	575	349	290	360	609	1,007	1,336	2,032	1,039
Changes	14	-6	-2	-7	0	1	1	1	0	3	1	-4	0
Martinez/Benicia boundary condition													
Cumulative Conditions without Project	20,520	18,402	16,572	13,237	10,180	8,041	9,492	11,968	15,059	17,835	19,983	20,920	15,184
Changes	24	23	12	-3	11	30	17	17	15	4	-5	2	12

Table 5-13. Change in Average Monthly EC, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Location	Change in Average Monthly EC (in %)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
Sacramento River at Emmaton	0.4	0.4	-0.1	-0.2	0.0	0.2	0.3	0.4	0.7	-0.6	-0.6	0.1	0.1
Sacramento River at Collinsville	0.4	0.2	0.1	-0.2	0.2	0.4	0.3	0.4	0.3	-0.2	-0.3	0.0	0.1
Sacramento River at Port Chicago (Roe Island)	0.2	0.2	0.1	-0.1	0.2	0.5	0.2	0.2	0.1	0.0	-0.1	0.0	0.1
Sacramento River at Chipps Island	0.3	0.2	0.1	-0.2	0.2	0.5	0.3	0.3	0.2	-0.1	-0.2	0.0	0.1
Old River near Middle River	0.0	0.3	0.0	-0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0
Old River at Tracy Road Bridge	0.2	0.3	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.1
Old River at CCWD's Los Vaqueros intake	0.3	0.4	-0.4	-0.1	-0.5	0.4	0.2	0.1	0.0	0.3	0.2	-0.1	0.1
Old River at Rock Slough	0.4	0.3	-0.5	-0.3	-0.7	0.5	0.1	0.1	0.1	0.4	0.1	-0.1	0.0
CCWD Proposed Alternative intake	0.0	0.3	-0.1	0.1	-0.7	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0
West Canal at mouth of Clifton Court Forebay	0.2	0.4	-0.2	0.0	-0.7	0.0	0.2	0.0	0.0	0.2	0.2	0.0	0.0
Delta Mendota Canal at Tracy Pumping Plant	0.2	0.4	-0.2	0.0	-0.4	-0.1	0.2	0.0	0.0	0.2	0.1	0.1	0.1
Mokelumne River at Terminus	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barker Slough at North Bay Aqueduct Intake	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.1	0.1	0.3	0.2	0.1	0.1	0.0
Rock Slough at Contra Costa Canal	0.2	0.5	-0.3	-0.2	-0.8	0.0	-0.1	0.1	0.1	0.3	0.2	0.0	0.0
San Joaquin near Vernalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
San Joaquin River at Brandt Bridge	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
San Joaquin River at mouth of Calaveras River	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.1	0.0
Stockton Proposed intake	0.0	0.4	-0.2	-0.2	-0.6	0.0	0.1	0.0	0.0	0.2	0.3	0.0	0.0
San Joaquin River at Prisoners Point	0.3	0.3	-0.4	-0.4	-0.6	0.2	0.1	0.0	0.0	0.3	0.1	-0.1	0.0
San Joaquin River at San Andreas Landing	0.4	0.1	-0.3	-0.6	-0.2	0.2	0.1	0.1	0.2	0.2	-0.1	0.0	0.0
San Joaquin River at Jersey Point	0.7	-0.4	-0.1	-0.7	0.1	0.3	0.2	0.3	0.0	0.3	0.1	-0.2	0.0
Martinez/Benicia boundary condition	0.1	0.1	0.1	0.0	0.1	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.1

Tables 5-14 to **5-17** show the monthly EC and change in EC for the Old River at Rock Slough, the Old River at Los Vaqueros Reservoir intake, the West Canal at the mouth of the Clifton Court Forebay, and at Tracy Pumping Plant. The tables show that while the median change in EC woud be small, much larger changes in EC occur in specific months. The large changes in Delta salinity are in response to changes in Delta inflow, outflow, and exports that are boundary conditions determined from CALSIM II. As discussed earlier, these changes in boundary flows are triggered by step functions in CALSIM II, rather than by the DWWSP.

X2 Location

The DWWSP may affect the location of X2 either directly affecting the Sacramento River flow, reducing Net Delta Outflow, or indirectly by triggering changes in upstream CVP-SWP reservoir operations or Delta exports as a result of DWWSP water-right diversions. Average monthly DWWSP water-right diversions range from 7 cfs to 93 cfs considering the Term 91 conditions. This is small compared to the 11,400 cfs flow required to maintain X2 at Chipps Island (located at kilometer [km] 74.0). **Figure 5-17** and **Table 5-18** show the change in X2 location under the Cumulative Conditions with Project compared to Cumulative Conditions without Project. In general, average monthly changes in the X2 location are on the order of 0.1 km or less; however, the maximum increase in X2 location is approximately 1.1 km, and is mainly caused by changes in CVP-SWP operations.

CCWD diversion to fill Los Vaqueros Reservoir is constrained by the Delta Smelt BO (USFWS 1993). From February through May, the BO precondition for filling the reservoir is that the X2 location is west of Chipps Island. In January and June through August, the X2 must be located west of Collinsville. **Figure 5-18 and Figure 5-19** show the location of Chipps Island and Collinsville, the X2 location and the change in X2 location for the two sets of months when filling is potentially restricted. The model results show that there is no change during the period of simulation in X2 location regarding the filling of Los Vaqueros.

Table 5-14. EC at Old River at CCWD's Los Vaqueros Intake, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

(a) Cumulative Conditions without Project n, Monthly EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	490	447	742	732	554	405	356	442	576	510	427	725	534
1977	813	616	704	740	722	654	569	537	598	529	459	711	638
1978	910	779	663	548	395	397	356	332	257	226	302	470	470
1979	604	574	590	555	300	256	258	296	251	252	406	634	415
1980	766	560	510	362	393	305	248	295	264	238	293	403	386
1981	534	552	586	499	381	252	254	358	305	532	589	517	447
1982	716	701	258	325	250	266	167	216	223	213	256	301	324
1983	247	215	297	172	125	162	193	172	133	187	193	244	195
1984	263	187	138	202	244	228	247	351	327	269	301	581	278
1985	775	771	301	301	429	351	314	407	317	494	694	747	492
1986	739	559	589	531	420	215	306	330	277	245	289	394	408
1987	607	610	602	567	523	359	286	400	389	377	551	766	503
1988	803	605	669	573	327	351	350	428	416	374	479	566	495
1989	778	720	575	590	527	309	223	320	286	373	616	801	510
1990	723	542	706	759	621	379	362	389	426	510	528	583	544
1991	834	799	666	650	666	461	297	337	370	483	516	557	553
Median	731	590	590	551	407	330	291	344	311	373	443	574	481
Average	663	577	537	507	430	334	299	351	338	363	431	563	449
Min	247	187	138	172	125	162	167	172	133	187	193	244	195
Max	910	799	742	759	722	654	569	537	598	532	694	801	638

(b) Change in Monthly EC, Cumulative Conditions with Project minus Cumulative Conditions without Project (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	12	7	4	5	12	5	2	1	-1	-4	1	1	4
1977	7	6	-5	0	1	3	2	1	0	-2	-1	6	1
1978	2	-2	0	-2	-3	9	3	1	0	0	0	0	1
1979	1	0	-1	-2	0	-1	0	0	0	-1	-2	-3	-1
1980	1	2	-5	1	12	5	0	0	1	1	0	0	2
1981	1	1	0	-3	1	0	0	0	1	22	20	7	4
1982	4	3	2	0	0	1	0	0	0	0	0	2	1
1983	2	0	-1	0	0	0	1	0	0	0	0	1	0
1984	0	0	0	0	0	0	0	0	0	0	-1	-3	0
1985	-1	4	2	1	0	0	1	0	-1	1	0	2	1
1986	1	-4	0	-3	-1	0	0	0	0	-1	0	-3	-1
1987	3	0	-9	17	1	17	3	1	-2	3	0	-7	2
1988	-1	2	1	3	-1	0	1	1	-3	-1	0	2	0
1989	0	0	2	-1	0	1	0	0	1	-1	1	-15	-1
1990	4	17	-27	-16	-46	-12	-4	-1	1	1	-3	1	-7
1991	0	-1	2	-8	-10	-4	1	0	2	1	-3	1	-1
Median	1	0	0	0	0	0	0	0	0	0	0	1	0
Average	2	2	-2	0	-2	1	1	0	0	1	1	0	0
Min	-1	-4	-27	-16	-46	-12	-4	-1	-3	-4	-3	-15	-7
Max	12	17	4	17	12	17	3	1	2	22	20	7	4

Table 5-15. EC at Old River at Rock Slough, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

(a) Cumulative Conditions without Project, Monthly EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	511	489	860	777	566	384	310	392	635	543	473	881	568
1977	912	687	821	830	732	554	475	476	620	544	517	889	671
1978	1,048	838	733	486	295	300	296	270	223	213	314	532	462
1979	682	634	664	571	278	230	222	264	208	254	455	752	434
1980	859	589	565	332	359	230	212	262	222	221	294	445	382
1981	592	609	640	526	355	205	206	304	275	627	647	590	465
1982	803	742	219	255	210	221	184	211	195	186	241	293	313
1983	229	189	257	207	139	170	205	188	139	173	180	203	190
1984	282	227	151	217	207	189	205	306	251	219	317	682	271
1985	880	832	270	301	441	305	252	341	270	576	800	872	512
1986	796	568	654	535	313	290	281	268	230	227	284	433	407
1987	671	660	660	598	526	297	220	310	315	398	644	911	517
1988	872	642	747	587	276	265	288	348	345	393	551	643	496
1989	881	763	622	623	521	271	192	232	227	418	726	947	535
1990	776	578	810	850	607	333	302	305	396	564	579	693	566
1991	984	897	662	685	699	434	243	262	347	543	567	663	582
Median	799	638	657	553	357	280	233	287	260	396	495	672	480
Average	736	622	583	524	408	292	256	296	306	381	474	652	461
Min	229	189	151	207	139	170	184	188	139	173	180	203	190
Max	1,048	897	860	850	732	554	475	476	635	627	800	947	671

(b) Change in Monthly EC, Cumulative Conditions with Project minus Cumulative Conditions without Project (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	15	8	5	8	14	4	1	1	-1	-4	2	2	5
1977	10	6	-8	1	1	2	1	0	-1	-1	0	8	2
1978	1	-4	-1	-2	-2	3	1	0	0	0	0	0	0
1979	2	0	-2	-2	0	0	0	0	0	-2	-3	-4	-1
1980	2	1	-5	2	-7	8	0	0	0	1	0	0	0
1981	1	1	-1	-3	1	0	0	0	1	28	24	7	5
1982	4	4	1	0	0	0	0	0	0	0	0	3	1
1983	2	0	3	0	0	0	0	0	0	0	0	1	1
1984	0	0	0	0	0	0	0	0	0	0	-2	-4	0
1985	-1	5	2	1	-1	0	0	0	-1	1	-1	3	1
1986	1	-4	-1	-3	0	-1	0	0	0	-1	-3	-7	-2
1987	6	-3	-9	18	8	21	3	0	-1	5	-1	-9	3
1988	0	2	1	3	0	0	1	2	0	0	0	2	1
1989	0	0	2	-1	0	1	0	0	0	-2	1	-20	-2
1990	11	16	-31	-26	-47	-11	-3	0	3	0	-4	2	-7
1991	0	-1	-5	-21	-14	-5	0	0	3	0	-4	3	-4
Median	1	1	-1	0	0	0	0	0	0	0	0	2	0
Average	3	2	-3	-2	-3	1	0	0	0	2	1	-1	0
Min	-1	-4	-31	-26	-47	-11	-3	0	-1	-4	-4	-20	-7
Max	15	16	5	18	14	21	3	2	3	28	24	8	5

Table 5-16. EC at West Canal at mouth of Clifton Court Forebay, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

(a) Cumulative Conditions without Project, Monthly EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	455	418	643	675	576	506	441	468	560	511	467	629	529
1977	731	559	614	696	815	831	670	568	596	510	418	622	636
1978	809	728	611	521	312	333	222	217	237	230	291	425	411
1979	533	520	549	480	268	278	284	314	293	249	367	549	390
1980	678	524	475	239	129	228	270	316	302	251	288	373	339
1981	481	504	548	482	421	326	311	389	331	467	533	462	438
1982	640	648	331	319	202	247	157	186	253	231	265	317	316
1983	223	239	130	142	116	154	173	166	130	185	200	288	179
1984	214	171	122	142	236	298	297	375	388	301	291	505	278
1985	684	697	351	354	461	455	400	439	364	440	607	657	492
1986	681	547	559	531	229	172	226	279	315	262	290	368	372
1987	548	567	569	569	573	531	377	437	455	394	504	671	516
1988	744	577	612	562	428	689	468	460	478	385	445	533	532
1989	715	679	555	574	631	343	267	360	336	343	538	694	503
1990	668	512	630	682	636	538	516	428	453	492	514	542	551
1991	734	741	648	659	736	480	359	376	389	462	497	500	548
Median	673	553	557	526	425	338	304	376	350	364	431	519	465
Average	596	539	497	477	423	401	340	361	367	357	407	508	439
Min	214	171	122	142	116	154	157	166	130	185	200	288	179
Max	809	741	648	696	815	831	670	568	596	511	607	694	636

(b) Change in Monthly EC, Cumulative Conditions with Project minus Cumulative Conditions without Project (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	9	5	3	3	7	4	1	1	1	-3	0	1	3
1977	5	5	-2	0	1	2	1	1	0	-2	-2	4	1
1978	2	-2	1	-1	1	-1	0	0	0	0	0	0	0
1979	1	0	-1	-1	0	0	0	0	0	-1	-2	-1	0
1980	0	3	-4	0	0	0	0	0	0	0	0	0	0
1981	1	1	0	-2	1	1	1	0	1	18	16	7	4
1982	3	2	2	0	1	0	0	0	0	0	0	1	1
1983	0	0	0	0	0	0	0	0	0	0	0	1	0
1984	0	0	0	0	0	0	0	0	0	0	-1	-2	0
1985	-1	3	1	2	0	-2	1	0	0	1	0	1	1
1986	2	-3	0	-3	0	0	0	0	0	-1	4	-1	0
1987	1	1	-7	11	-10	8	2	1	-4	-1	-1	-4	0
1988	-1	2	1	2	-6	-1	1	1	-2	-2	0	1	0
1989	0	0	2	-1	1	1	1	0	2	0	1	-8	0
1990	0	17	-18	-10	-40	-9	-2	-1	1	1	-2	-1	-5
1991	1	0	2	-2	-2	-3	3	0	1	1	-2	1	0
Median	1	1	0	0	0	0	0	0	0	0	0	0	0
Average	1	2	-1	0	-3	0	1	0	0	1	1	0	0
Min	-1	-3	-18	-10	-40	-9	-2	-1	-4	-3	-2	-8	-5
Max	9	17	3	11	7	8	3	1	2	18	16	7	4

Table 5-17. EC at Delta Mendota Canal at Tracy Pumping Plant, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

(a) Cumulative Conditions without Project, Monthly EC (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	465	418	629	671	607	551	459	470	587	559	511	715	553
1977	737	559	609	699	859	924	682	571	603	518	461	669	658
1978	808	730	624	491	306	352	221	214	233	325	368	526	433
1979	542	520	558	448	250	286	295	319	368	342	440	628	416
1980	686	528	499	213	155	223	277	318	327	321	352	473	364
1981	487	503	556	510	476	388	338	392	387	507	569	579	474
1982	648	654	423	329	196	257	164	196	262	326	354	431	353
1983	216	255	136	242	153	206	187	174	144	193	317	367	216
1984	215	182	158	149	236	328	321	378	433	368	388	593	312
1985	690	704	410	407	513	493	422	442	414	484	619	734	528
1986	688	549	592	560	259	192	230	279	329	380	369	494	410
1987	556	567	571	588	596	559	403	436	485	471	569	743	545
1988	749	577	625	597	467	844	488	460	502	441	459	576	565
1989	715	681	562	587	650	465	314	361	378	417	596	767	541
1990	677	512	631	689	663	566	526	429	467	504	558	594	568
1991	733	743	651	673	782	522	378	379	409	477	524	536	567
Median	682	554	567	535	472	426	330	378	398	429	460	586	501
Average	601	543	515	491	448	447	357	364	396	415	466	589	469
Min	215	182	136	149	153	192	164	174	144	193	317	367	216
Max	808	743	651	699	859	924	682	571	603	559	619	767	658

(b) Change in Monthly EC, Cumulative Conditions with Project minus Cumulative Conditions without Project (µS/cm)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
1976	9	5	3	2	5	3	1	1	-2	-1	1	1	2
1977	5	5	-2	0	0	1	1	1	0	-2	-1	4	1
1978	2	-2	0	-1	0	-1	0	0	0	0	0	0	0
1979	1	0	0	-1	0	0	0	0	0	2	-2	2	0
1980	0	2	-3	0	0	0	0	0	0	0	0	0	0
1981	1	0	0	-1	0	1	1	0	1	16	12	12	4
1982	3	2	2	1	1	0	0	0	0	0	0	1	1
1983	0	0	0	0	0	-1	2	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	-1	-3	0
1985	-1	3	1	1	0	-2	0	0	0	1	0	0	0
1986	2	-3	0	-2	0	-1	1	0	0	0	-2	-1	0
1987	1	1	-6	9	-4	7	2	1	-3	-3	0	-2	0
1988	-1	2	1	2	-1	-1	1	1	-1	-2	0	1	0
1989	0	0	1	-1	1	0	0	0	2	0	5	-1	1
1990	0	17	-16	-8	-35	-9	-2	-1	1	1	-2	-1	-5
1991	1	0	2	-1	0	-2	2	0	1	1	-1	1	0
Median	1	1	0	0	0	0	1	0	0	0	0	0	0
Average	1	2	-1	0	-2	0	1	0	0	1	1	1	0
Min	-1	-3	-16	-8	-35	-9	-2	-1	-3	-3	-2	-3	-5
Max	9	17	3	9	5	7	2	1	2	16	12	12	4

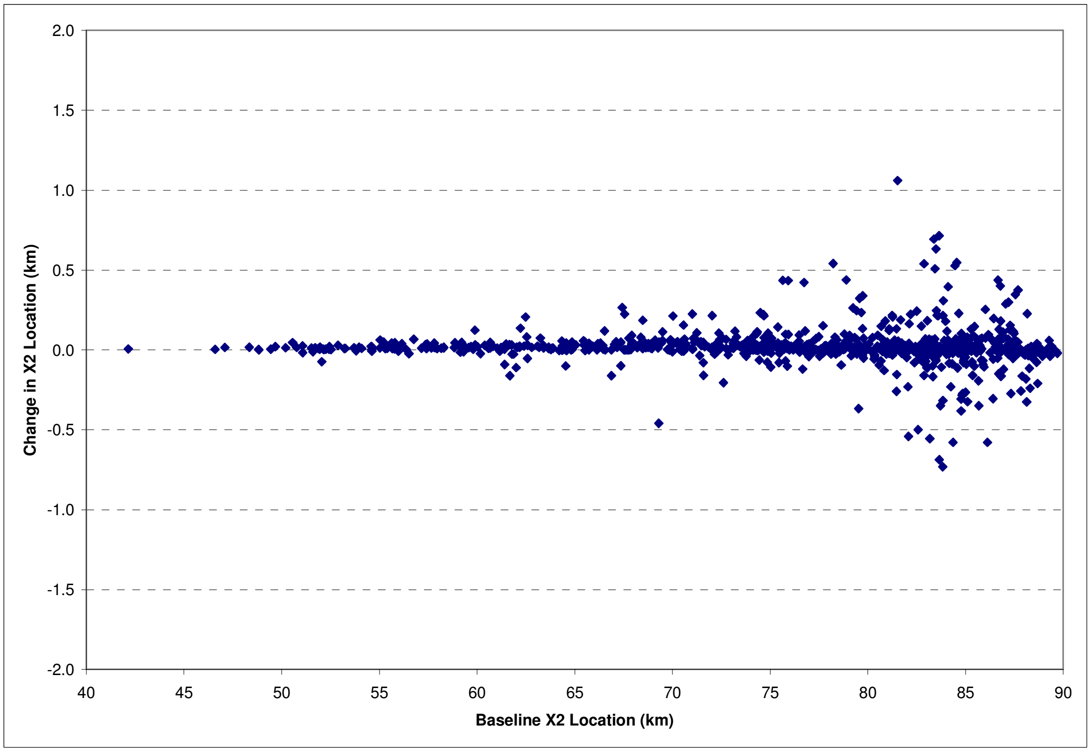


Figure 5-17. X2 Location, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

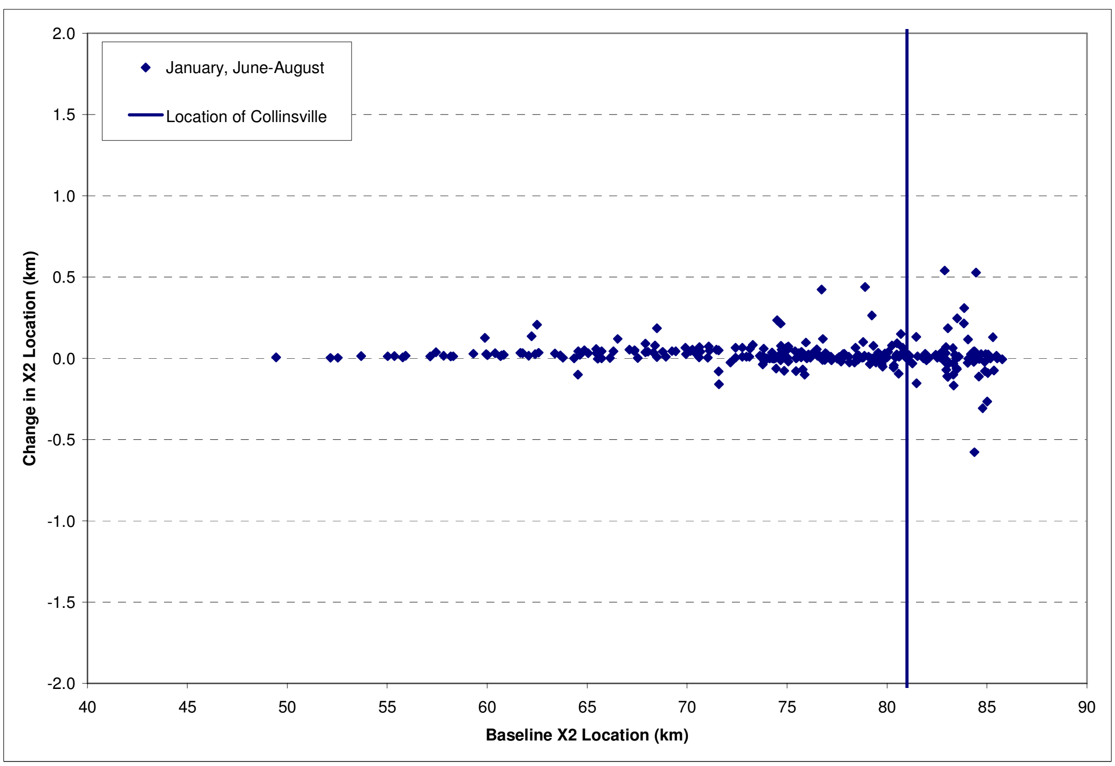


Figure 5-18. X2 Location in Periods (January, June-August) of Restricted Filling of Los Vaqueros Reservoir, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

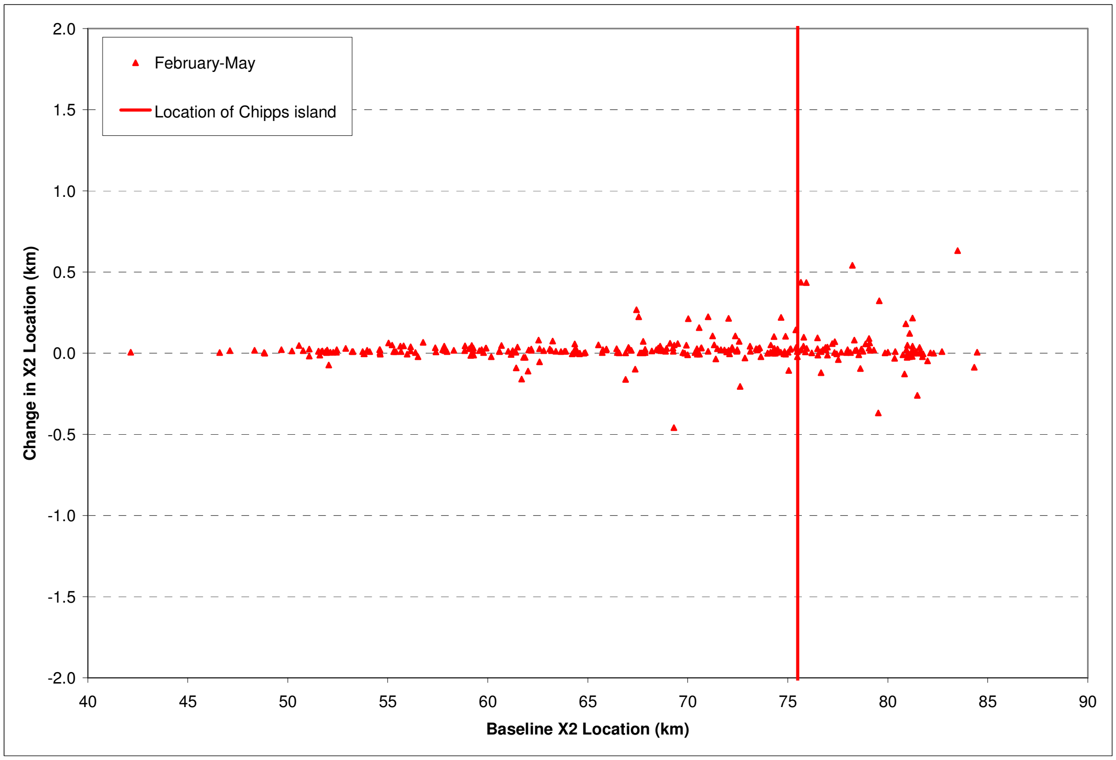


Figure 5-19. X2 Location in Periods (February-May) of Restricted Filling of Los Vaqueros Reservoir, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Table 5-18. Change in X2 Location, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Water Year	Year Type	Difference in X2 Location (km), Cumulative Conditions with Project minus Cumulative Conditions without Project											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1923	BN	-0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
1924	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1925	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1926	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
1927	W	0.0	0.0	0.3	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1928	AN	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1929	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1930	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1931	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.1	0.0
1932	D	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0
1933	C	0.0	-0.1	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1934	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1935	BN	0.0	0.0	0.0	0.0	0.0	-0.5	-0.2	0.0	0.0	0.0	0.0	0.4
1936	BN	-0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	-0.5	-0.2
1937	BN	-0.1	0.5	-0.3	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1938	W	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6
1939	D	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.2	0.1
1940	AN	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1941	W	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
1942	W	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1943	W	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1944	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.1	0.0
1945	BN	0.4	-0.1	0.1	0.0	-0.2	0.3	0.1	0.1	0.0	0.0	1.1	0.3
1946	BN	-0.3	-0.5	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.1
1947	D	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.3	-0.1
1948	BN	0.4	-0.2	-0.1	0.2	0.1	0.1	0.0	0.0	-0.1	0.0	-0.7	0.3
1949	D	0.2	-0.3	0.1	-0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.7	0.2
1950	BN	-0.2	0.4	0.1	-0.1	0.0	0.0	0.0	-0.2	-0.1	0.0	0.0	0.1
1951	AN	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1952	W	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1953	W	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.4
1954	AN	-0.1	0.2	-0.6	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.7	0.3
1955	D	-0.3	0.2	0.4	0.4	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0
1956	W	-0.2	0.2	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
1957	AN	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1958	W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1959	BN	0.1	0.0	-0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1960	D	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.0
1961	D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.6	-0.2
1962	BN	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
1963	W	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
1964	D	-0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	-0.1	0.0	-0.7	-0.2
1965	W	0.3	-0.2	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0
1966	BN	0.0	0.1	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
1967	W	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1968	BN	0.2	0.0	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.2
1969	W	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1970	W	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	W	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1972	BN	0.1	-0.3	0.0	0.0	0.1	0.1	0.0	0.1	-0.1	0.0	-0.1	0.0
1973	AN	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974	W	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1975	W	0.2	0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1976	C	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	C	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
1978	AN	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1979	BN	0.0	0.0	-0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0
1980	AN	0.1	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
1981	D	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.2	0.1
1982	W	-0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1983	W	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
1984	W	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	D	0.0	0.1	0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.1
1986	W	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.1
1987	D	0.0	-0.3	0.3	-0.1	0.4	0.2	0.0	0.0	0.1	0.0	-0.1	0.0
1988	C	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
1989	D	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.3	-0.3
1990	C	0.5	-0.3	0.2	-0.4	-0.1	0.0	0.0	0.1	0.0	-0.1	0.0	0.0
1991	C	0.0	0.0	-0.3	-0.1	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.0
1992	C	0.0	0.0	0.5	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1993	AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.1
1994	C	0.0	0.0	0.2	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Average		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum		0.5	0.5	0.5	0.6	0.4	0.3	0.2	0.2	0.2	0.5	1.1	0.4
Minimum		-0.3	-0.5	-0.6	-0.4	-0.2	-0.5	-0.2	-0.2	-0.1	-0.2	-0.7	-0.6

Note: Water year types are based on Sacramento Valley Index: Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critical (C).

CHAPTER 6. TEMPERATURE MODELING RESULTS

This chapter presents results from the temperature modeling. Emphasis is placed on comparative rather than absolute results. River temperatures for the With-Project Conditions are compared to Existing Conditions. River temperatures for the Cumulative Conditions with Project are compared to Cumulative Conditions without Project.

SUMMARY RESULTS

Table 6-1 and **Table 6-2** present temperature results for the Trinity River at Lewiston Dam, the Sacramento River at Keswick Dam, Bend Bridge, and Red Bluff Diversion Dam, the Feather River below Thermalito, and the American River at Sunrise Bridge. For each location, results show the frequency and magnitude of the temperature changes under the DWWSP compared to the "no project" conditions. **Figures 6-1** through **6-12** present temperature exceedence curves for the locations mentioned above.

Changes in reservoir and river water temperature are caused primarily by changes in CVP and SWP operations. Temperature changes for the DWWSP compared to "no project" conditions are generally less than 0.1 degrees Fahrenheit (^{o}F). In a few specific months, temperature changes could be significantly greater. These temperature differences typically result from differences in the timing of storage transfers from north of the Delta to San Luis Reservoir. Differences in reservoir operations in specific months are triggered by reaching threshold values or by step functions used in CALSIM II, and are modeling artifacts, rather than impacts caused by the DWWSP.

Table 6-1. Magnitude and Frequency of Change in Water Temperature, With-Project Conditions Compared to Existing Conditions

Change in Monthly Water Temperature (ºF)	Water Year Type				
	Wet	Above Normal	Below Normal	Dry	Critical
Total Number of Months	**252**	**117**	**168**	**192**	**135**
American River at Sunrise Bridge					
≤ - 0.6	0	1	0	2	0
> - 0.6 and ≤ - 0.4	0	1	0	0	0
> - 0.4 and ≤ - 0.2	0	2	4	6	7
> - 0.2 and < 0.0	8	4	14	13	16
≈ 0.0	233	100	127	151	84
> 0.0 and ≤ +0.2	10	9	18	16	26
> +0.2 and ≤ +0.4	0	0	2	3	2
> +0.4 and ≤ +0.6	1	0	3	1	0
> +0.6	0	0	0	2	0
Average Change	0.00	-0.01	0.02	-0.01	0.01
Feather River below Thermalito Afterbay					
≤ - 0.6	1	0	2	1	0
> - 0.6 and ≤ - 0.4	1	0	0	1	1
> - 0.4 and ≤ - 0.2	1	1	2	2	1
> - 0.2 and < 0.0	14	9	15	15	13
≈ 0.0	220	101	131	150	95
> 0.0 and ≤ +0.2	14	6	14	19	22
> +0.2 and ≤ +0.4	0	0	1	2	0
> +0.4 and ≤ +0.6	1	0	2	1	2
> +0.6	0	0	1	1	1
Average Change	0.00	-0.01	0.00	0.01	0.02
Sacramento River at Bend Bridge					
≤ - 0.6	0	0	1	0	0
> - 0.6 and ≤ - 0.4	1	0	7	1	4
> - 0.4 and ≤ - 0.2	3	2	8	3	3
> - 0.2 and < 0.0	5	6	11	12	12
≈ 0.0	232	100	123	161	79
> 0.0 and ≤ +0.2	10	9	15	14	33
> +0.2 and ≤ +0.4	1	0	1	1	3
> +0.4 and ≤ +0.6	0	0	2	0	1
> +0.6	0	0	1	0	0
Average Change	0.00	0.00	-0.02	0.00	0.01
Sacramento River at Keswick Dam					
≤ - 0.6	0	0	7	1	1
> - 0.6 and ≤ - 0.4	2	0	3	1	3
> - 0.4 and ≤ - 0.2	0	4	7	4	5
> - 0.2 and < 0.0	8	6	8	10	12
≈ 0.0	226	100	122	154	79
> 0.0 and ≤ +0.2	15	6	17	19	28
> +0.2 and ≤ +0.4	1	1	3	2	3
> +0.4 and ≤ +0.6	0	0	1	1	2
> +0.6	0	0	7	1	1
Average Change	0.00	0.00	-0.03	0.00	0.02
Sacramento River at Red Buff Diversion Dam					
≤ - 0.6	0	0	0	0	0
> - 0.6 and ≤ - 0.4	1	0	7	1	4
> - 0.4 and ≤ - 0.2	3	0	10	1	1
> - 0.2 and < 0.0	9	6	8	14	6
≈ 0.0	225	105	127	162	95
> 0.0 and ≤ +0.2	13	5	13	13	26
> +0.2 and ≤ +0.4	1	1	2	1	2
> +0.4 and ≤ +0.6	0	0	1	0	1
> +0.6	0	0	0	0	0
Average Change	0.00	0.00	-0.02	0.00	0.01
Trinity River at Lewiston Dam					
≤ - 0.6	3	0	1	4	2
> - 0.6 and ≤ - 0.4	0	0	0	0	0
> - 0.4 and ≤ - 0.2	1	1	11	2	7
> - 0.2 and < 0.0	6	4	14	12	8
≈ 0.0	234	102	132	156	94
> 0.0 and ≤ +0.2	8	8	6	15	22
> +0.2 and ≤ +0.4	0	1	1	1	2
> +0.4 and ≤ +0.6	0	0	1	1	0
> +0.6	3	0	1	4	2
Average Change	-0.01	0.01	0.00	-0.01	-0.01

Note: Changes are defined as With-Project Conditions minus Existing Conditions.

Table 6-2. Magnitude and Frequency of Change in Water Temperature, Cumulative Conditions with Project Compared to Cumulative Conditions without Project

Change in Monthly Water Temperature (ºF)	Water Year Type				
	Wet	Above Normal	Below Normal	Dry	Critical
Total Number of Months	**252**	**117**	**168**	**192**	**135**
American River at Sunrise Bridge					
≤ - 0.6	12	4	15	13	24
> - 0.6 and ≤ - 0.4	13	1	2	8	6
> - 0.4 and ≤ - 0.2	6	5	7	15	17
> - 0.2 and < 0.0	13	14	9	28	19
≈ 0.0	155	70	92	51	22
> 0.0 and ≤ +0.2	30	17	20	36	15
> +0.2 and ≤ +0.4	11	3	9	15	8
> +0.4 and ≤ +0.6	6	2	5	10	13
> +0.6	12	4	15	13	24
Average Change	-0.02	-0.03	0.00	0.07	-0.05
Feather River below Thermalito Afterbay					
≤ - 0.6	0	0	3	2	0
> - 0.6 and ≤ - 0.4	3	0	5	0	0
> - 0.4 and ≤ - 0.2	4	1	6	10	3
> - 0.2 and < 0.0	18	15	12	6	12
≈ 0.0	215	97	121	147	104
> 0.0 and ≤ +0.2	11	4	16	21	14
> +0.2 and ≤ +0.4	1	0	4	6	2
> +0.4 and ≤ +0.6	0	0	0	0	0
> +0.6	0	0	3	2	0
Average Change	-0.01	-0.01	-0.01	0.00	0.00
Sacramento River at Bend Bridge					
≤ - 0.6	0	0	0	2	2
> - 0.6 and ≤ - 0.4	2	0	0	3	1
> - 0.4 and ≤ - 0.2	2	2	0	10	5
> - 0.2 and < 0.0	8	3	11	18	12
≈ 0.0	228	102	130	141	93
> 0.0 and ≤ +0.2	9	8	21	14	20
> +0.2 and ≤ +0.4	1	2	5	3	2
> +0.4 and ≤ +0.6	2	0	1	0	0
> +0.6	0	0	0	2	2
Average Change	0.00	0.01	0.02	-0.02	-0.01
Sacramento River at Keswick Dam					
≤ - 0.6	1	0	0	4	3
> - 0.6 and ≤ - 0.4	0	0	1	2	1
> - 0.4 and ≤ - 0.2	1	2	0	5	8
> - 0.2 and < 0.0	12	6	13	19	11
≈ 0.0	226	95	132	142	90
> 0.0 and ≤ +0.2	8	12	12	15	17
> +0.2 and ≤ +0.4	1	2	7	3	3
> +0.4 and ≤ +0.6	0	0	2	2	2
> +0.6	1	0	0	4	3
Average Change	0.01	0.01	0.02	-0.02	-0.02
Sacramento River at Red Buff Diversion Dam					
≤ - 0.6	0	0	0	3	2
> - 0.6 and ≤ - 0.4	2	0	0	2	1
> - 0.4 and ≤ - 0.2	2	1	0	7	7
> - 0.2 and < 0.0	12	7	12	18	13
≈ 0.0	227	101	129	140	89
> 0.0 and ≤ +0.2	6	6	22	19	21
> +0.2 and ≤ +0.4	1	1	4	2	2
> +0.4 and ≤ +0.6	2	1	1	0	0
> +0.6	0	0	0	3	2
Average Change	0.00	0.01	0.02	-0.01	-0.01
Trinity River at Lewiston Dam					
≤ - 0.6	3	0	9	7	3
> - 0.6 and ≤ - 0.4	2	0	6	2	3
> - 0.4 and ≤ - 0.2	5	4	3	3	1
> - 0.2 and < 0.0	6	11	7	14	9
≈ 0.0	217	89	128	148	97
> 0.0 and ≤ +0.2	18	9	11	12	14
> +0.2 and ≤ +0.4	0	2	0	2	3
> +0.4 and ≤ +0.6	1	0	1	1	2
> +0.6	3	0	9	7	3
Average Change	-0.03	0.01	-0.02	0.00	0.00

Note: Changes are defined as Cumulative Conditions with Project minus Cumulative Conditions without Project.

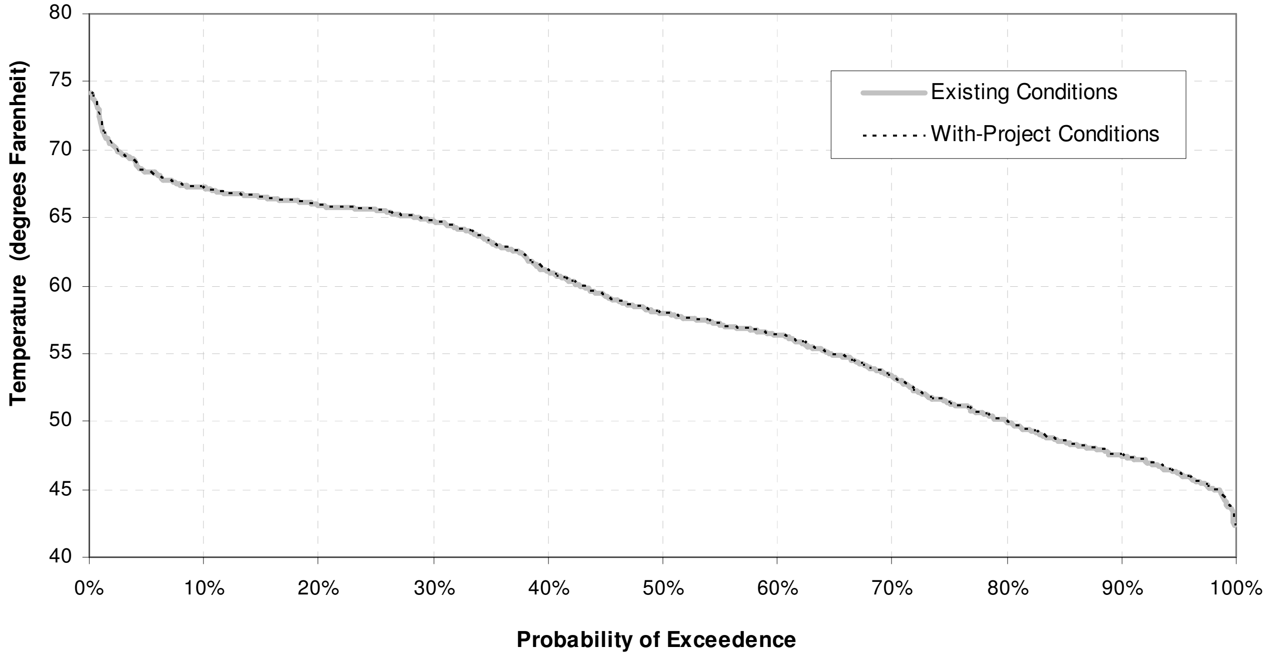


Figure 6-1. Temperature Exceedence for American River at Sunrise Bridge, Existing Conditions and With-Project Conditions

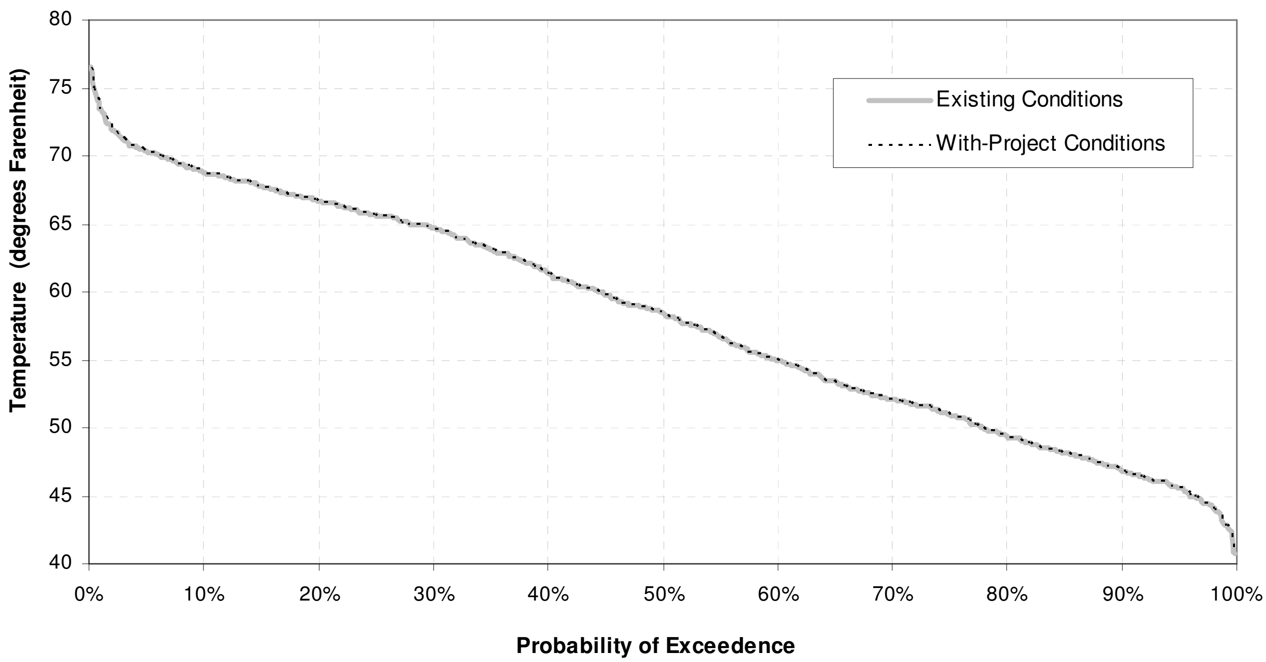


Figure 6-2. Temperature Exceedence for Feather River below Thermalito Afterbay, Existing Conditions and With-Project Conditions

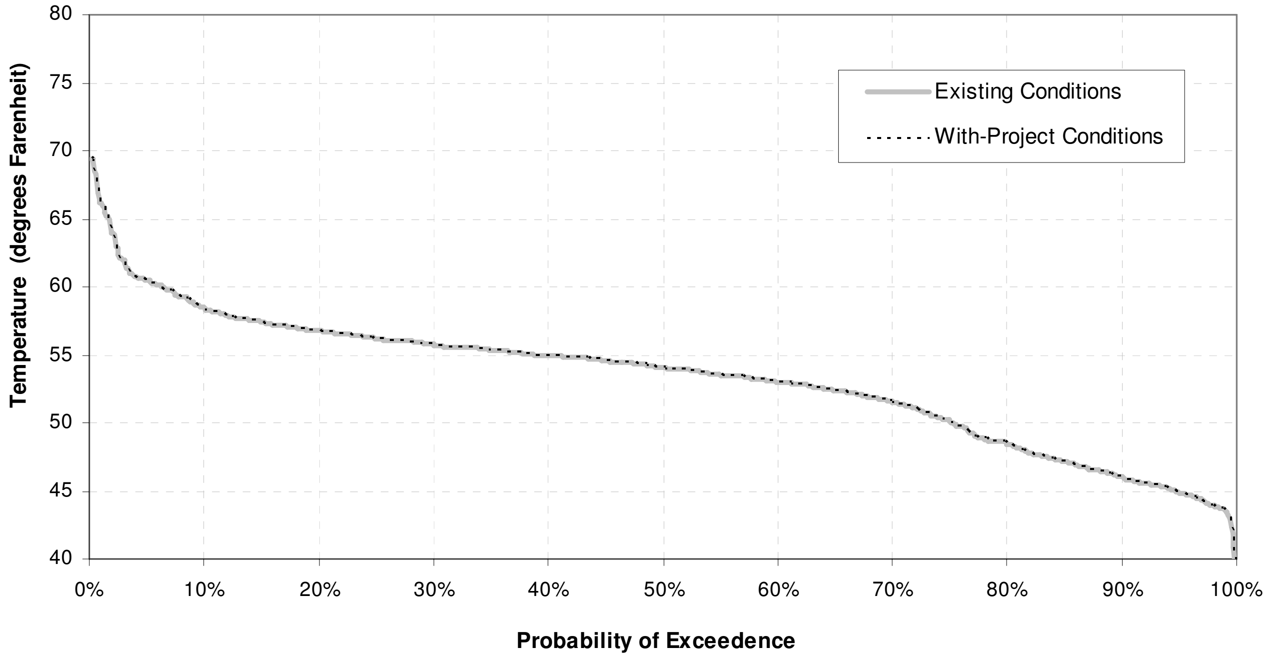


Figure 6-3. Temperature Exceedence for Sacramento River at Bend Bridge, Existing Conditions and With-Project Conditions

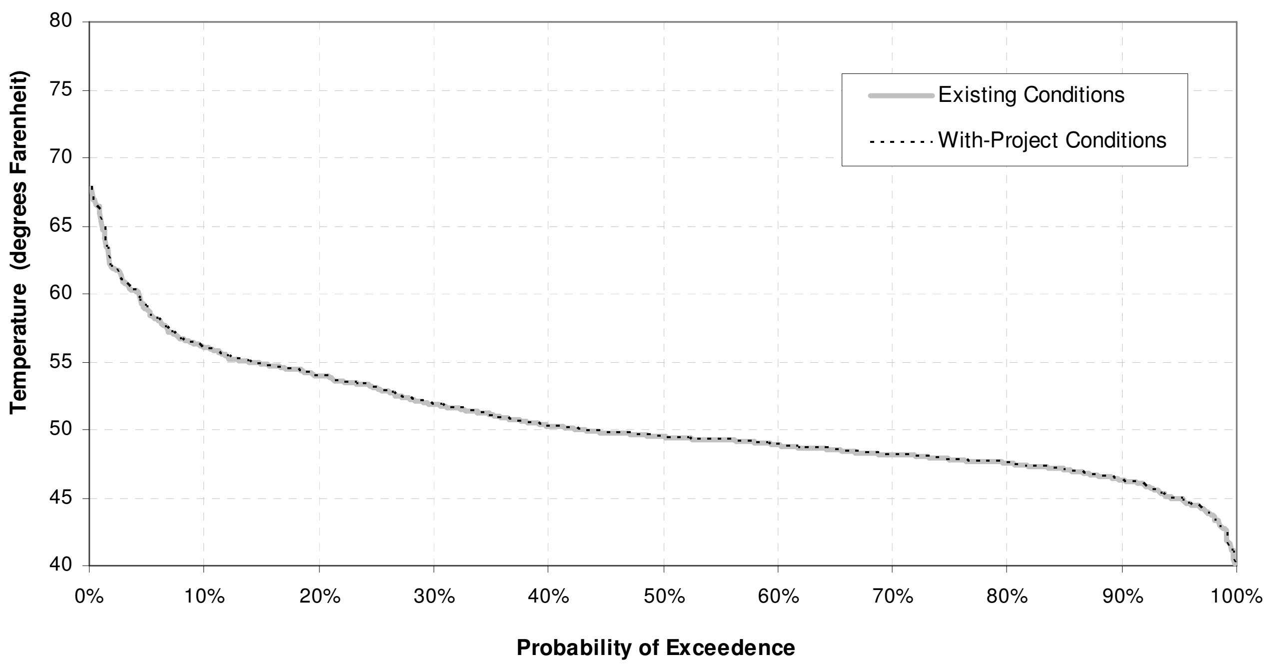


Figure 6-4. Temperature Exceedence for Sacramento River at Keswick Dam, Existing Conditions and With-Project Conditions

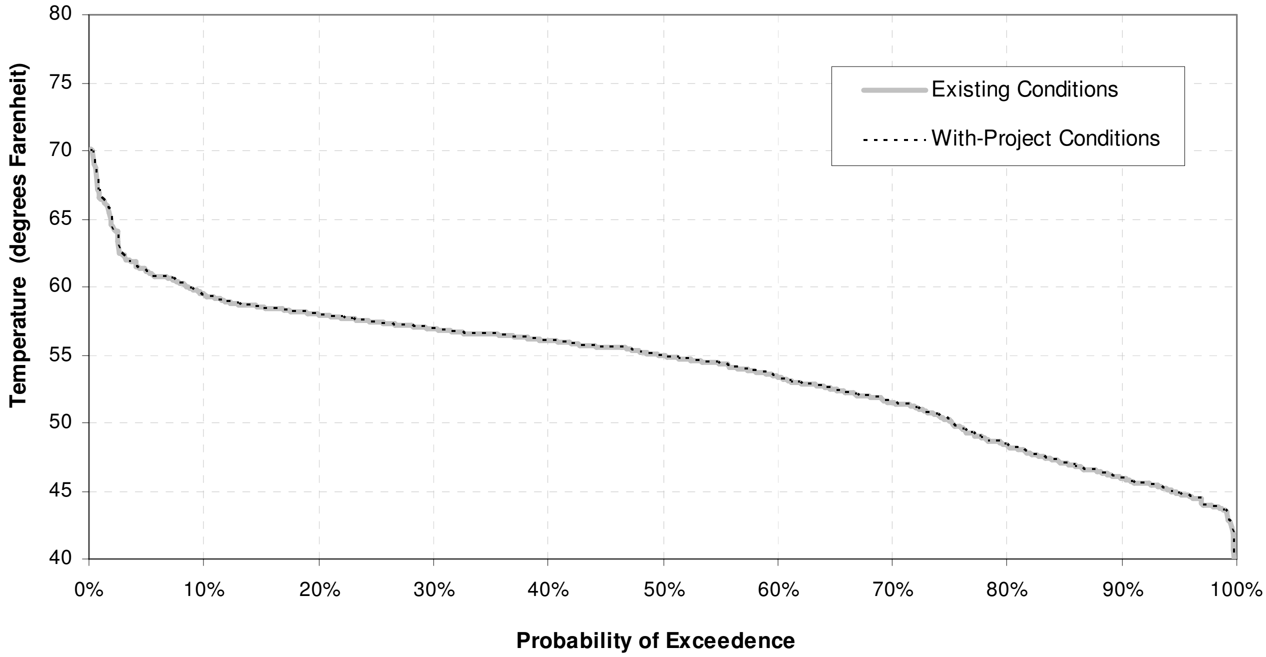


Figure 6-5. Temperature Exceedence for Sacramento River at Red Bluff, Existing Conditions and With-Project Conditions

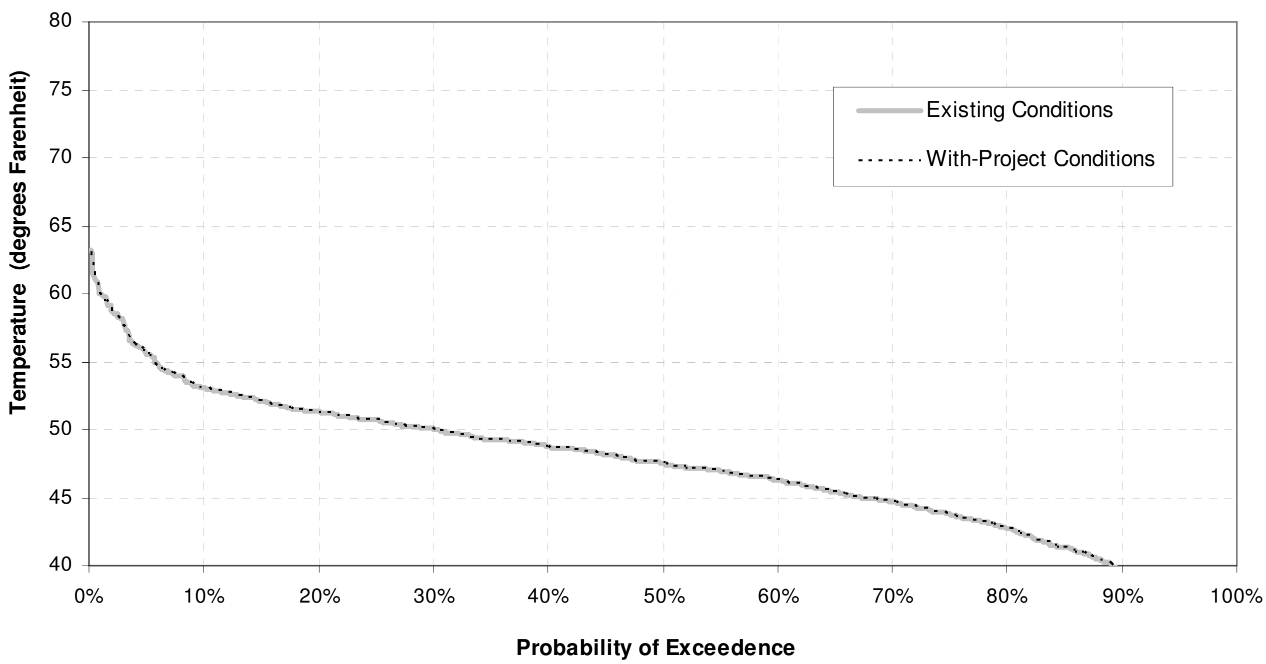


Figure 6-6. Temperature Exceedence for Trinity River at Lewiston Dam, Existing Conditions and With-Project Conditions

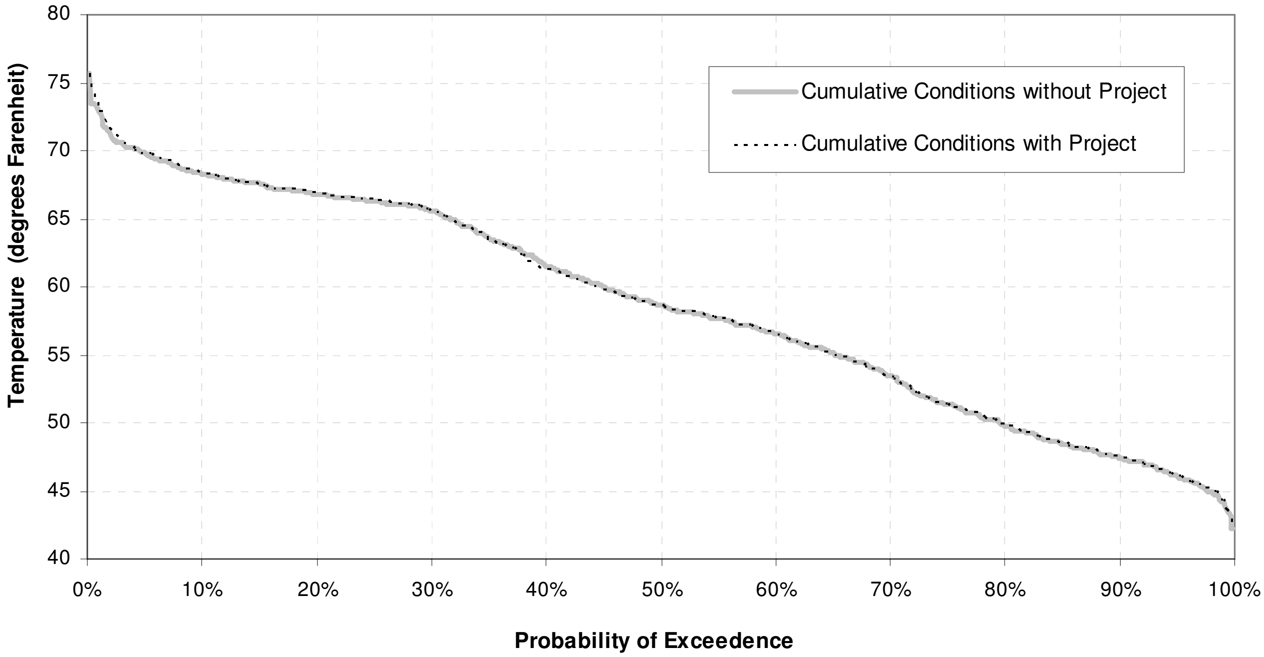


Figure 6-7. Temperature Exceedence for American River at Sunrise Bridge, Cumulative Conditions without Project and Cumulative Conditions with Project

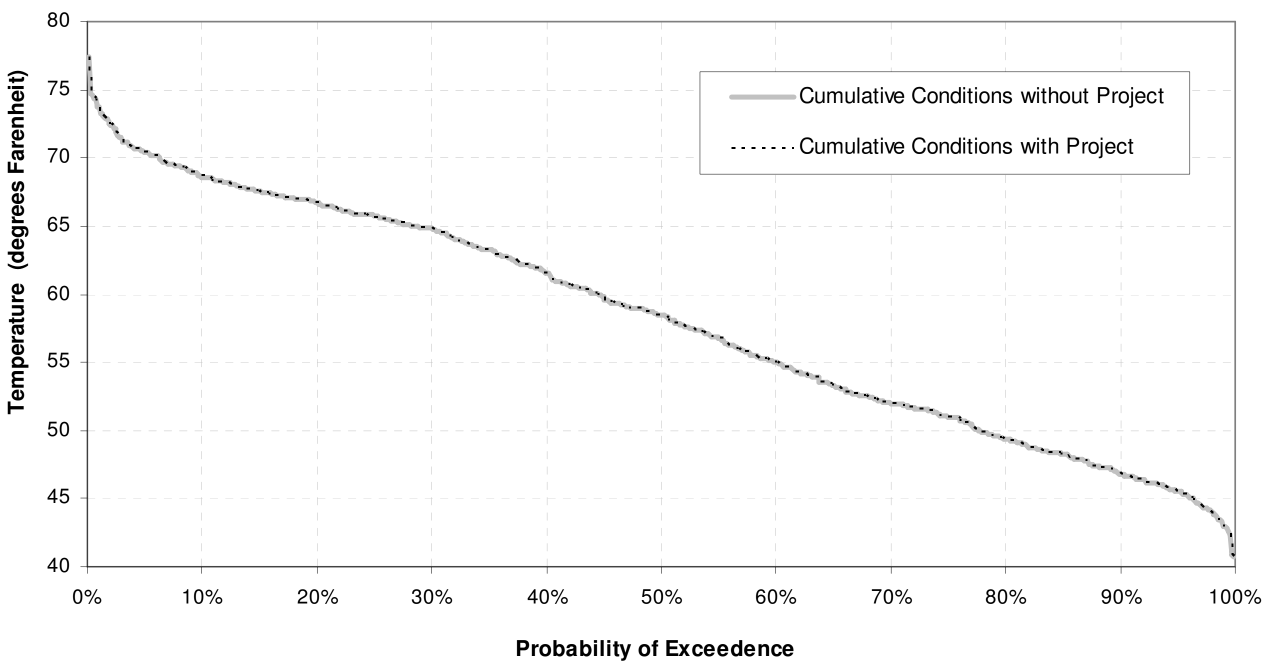


Figure 6-8. Temperature Exceedence for Feather River below Thermalito Afterbay, Existing Cumulative Conditions without Project and Cumulative Conditions with Project

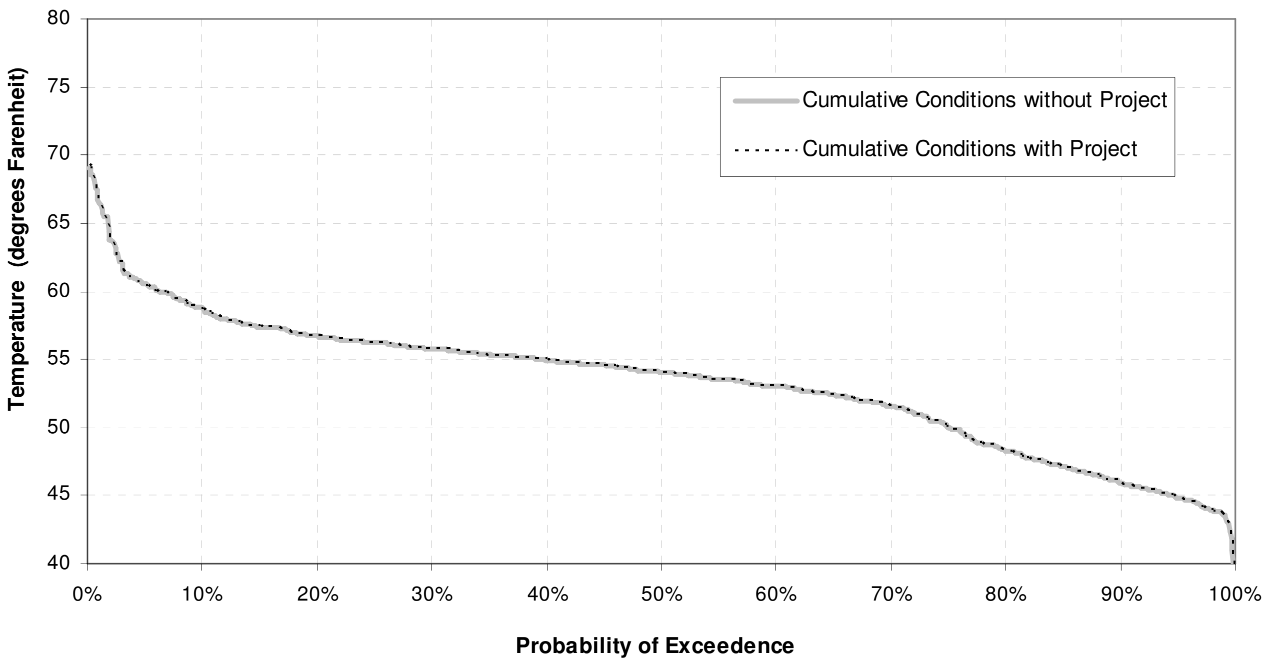


Figure 6-9. Temperature Exceedence for Sacramento River at Bend Bridge, Cumulative Conditions without Project and Cumulative Conditions with Project

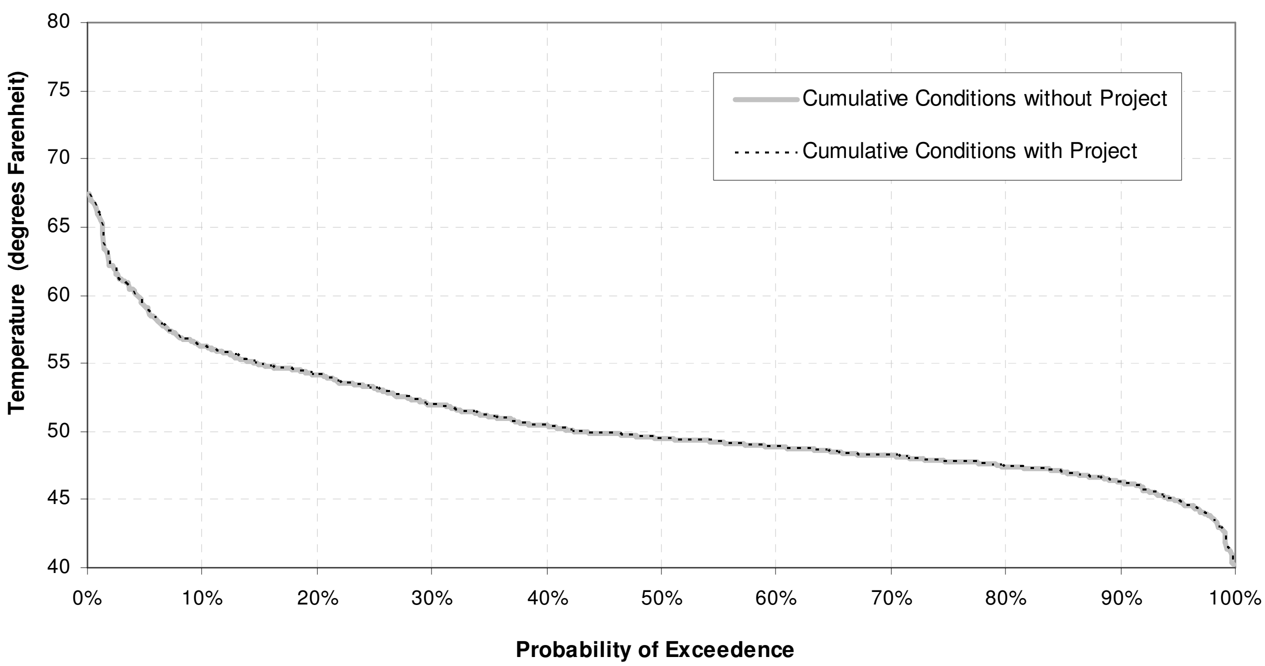


Figure 6-10. Temperature Exceedence for Sacramento River at Keswick Dam, Cumulative Conditions without Project and Cumulative Conditions with Project

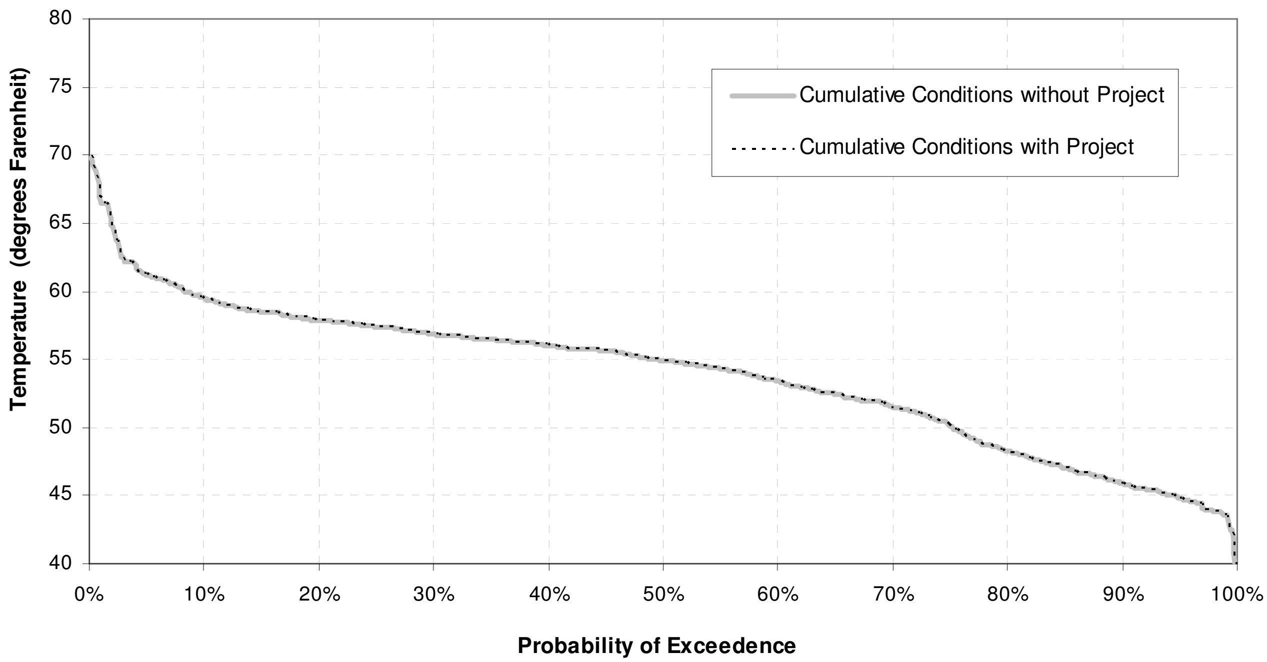


Figure 6-11. Temperature Exceedence for Sacramento River at Red Blluff, Cumulative Conditions without Project and Cumulative Conditions with Project

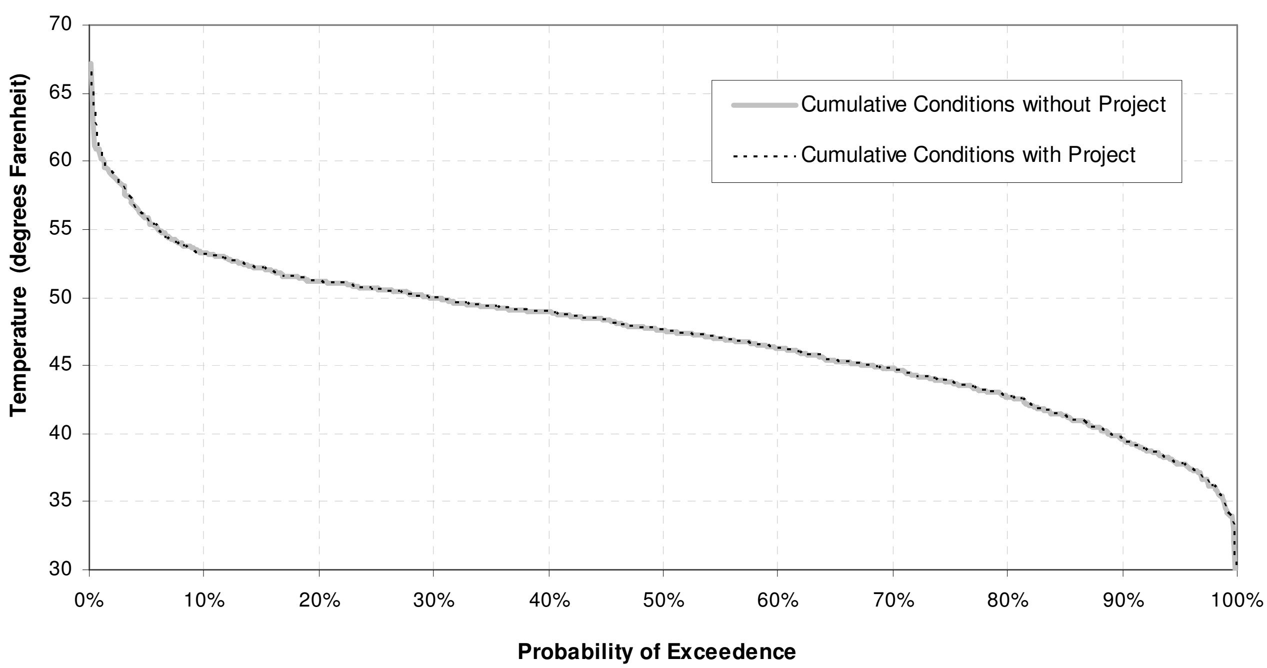


Figure 6-12. Temperature Exceedence for Trinity River at Lewiston Dam, Cumulative Conditions without Project and Cumulative Conditions with Project

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CHAPTER 7. SUMMARY

This chapter summarizes the results of the hydrologic, hydrodynamic and water quality, and temperature modeling for DWWSP EIR modeling analysis.

Four modeling scenarios were analyzed: (1) Existing Conditions, (2) With-Project Conditions, (3) Cumulative Conditions without Project, and (4) Cumulative Conditions with Project. Potential impacts of the DWWSP were determined from the two comparisons: (1) comparison of the With-Project Conditions to the Existing Conditions, and (2) comparison of the Cumulative Conditions with Project to the Cumulative Conditions without Project.

WITH-PROJECT CONDITIONS COMPARED TO EXISTING CONDITIONS

Determination of whether impacts of the proposed DWWSP would be significant requires the definition of a baseline condition from which impacts are measured. The baseline under CEQA for comparative analysis and assessing impacts is the environmental setting for the project at the time the DWWSP NOP was issued (April, 2006).

Under the Existing Conditions, the Project Partners would use groundwater only to meet their demands; under the With-Project Conditions, the Project Partners would use surface water only to meet their demands.

Delta Diversion

Under the With-Project Conditions with a projected demand of 56.7 TAF per year for the Project Partners, model results show that the long-term water-right diversion is approximately 36.6 TAF per year. Therefore, about 20.1 TAF per year of supplemental water would be needed to help meet the demands.

River Flows

The DWWSP would have direct impacts on Sacramento River flow, but the effects would be negligible. Indirect effects may occur because changes in Delta conditions could trigger changes in CVP-SWP reservoir operations. However, modeling results show that changes in average annual flow for the Trinity, Sacramento, Feather, and American rivers, both long-term and during dry periods, are negligible.

Delta Conditions

General indicators of ecosystem health within the Delta include the Net Delta Outflow, the location of X2, E/I ratio, and net flow in the San Joaquin River at Jersey Point (QWEST). Model results show that changes in the Net Delta Outflow under the DWWSP would be small. Average outflow under the DWWSP decreases by approximately 27 TAF per year, which is less than 0.2 percent of the outflow under Existing Conditions. The average monthly change in X2 location during the February to June period is 0.02 km. No significant change occurs in the E/I ratio. QWEST flows under the DWWSP decrease by 0.4 TAF per year.

Filling Los Vaqueros is constrained by the Delta smelt BO (USFWS, 1993) based on the location of X2. From CALSIM II results, the average monthly increase in X2 location under the DWWSP varies from 0.0 to 0.04 km. Only one month during the 73-year period of simulation is the shift eastwards of the X2 location sufficient to restrict filling Los Vaqueros Reservoir.

CVP-SWP Reservoir Operations and Deliveries

The amount of carryover storage affects the balance between CVP-SWP long-term average annual deliveries and dry year deliveries. It is indicative of operators' and contractors' tolerances of risk. A reduction in water supply available to the CVP-SWP will partly translate into reduced deliveries and partly translate into reduced carryover storage.

Model results show a long-term average total CVP carryover storage (Trinity, Shasta, Folsom, CVP San Luis) increase of 5 TAF, and a long-term average total SWP carryover storage (Oroville, SWP San Luis) decrease of 19 TAF. These changes are small compared to the total carryover storage under the Existing Conditions of 4.6 MAF for the CVP and 2.4 MAF for the SWP. Changes in carryover storage are considered to be partly an artifact of CALSIM II rather than reflecting a potential change in CVP-SWP operations. Model results show that impacts to long-term CVP-SWP deliveries are relatively minor. The change in long-term average CVP deliveries is 1 TAF and the change in average SWP deliveries is about -9 TAF per year.

Water Levels in the South Delta

Reductions in water levels in the south Delta can adversely impact agricultural diversions. An analysis using DSM2 shows that water level impacts are minor. The monthly average of the daily maximum decrease in stage upstream and downstream of the temporary barriers is usually less than 0.01 feet.

Delta Water Quality

DSM2 modeling shows that generally the largest water quality impacts would occur in the late summer, fall, and early winter. In general, the EC changes are minor. The increase in average monthly EC under the DWWSP for the Old River at Rock Slough, and the Old River at the Los Vaqueros Reservoir intake is about 0.3 percent or less. Increases in average monthly EC for Clifton Court Forebay and Tracy Pumping Plant are about 0.2 percent or less.

Reservoir and River Temperatures

Changes in reservoir and river water temperature would be caused primarily by changes in CVP-SWP operations. Model temperature results show that long-term changes for the DWWSP compared to the Existing Conditions are typically less than 0.1°F. In a few specific months, temperature changes could be significantly greater, close to 1.0°F. These temperature differences typically result from differences in the timing of storage transfers from north of the Delta to San Luis Reservoir. Differences in reservoir operations in specific months can be triggered by reaching threshold values or by step functions used in the model, and are considered as modeling artifacts, rather than being caused by the DWWSP.

CUMULATIVE CONDITIONS WITH PROJECT COMPARED TO CUMULATIVE CONDITIONS WITHOUT PROJECT

The Cumulative Conditions analysis considers incremental effects of the DWWSP when combined with other projects that are reasonably foreseeable. Other projects assumed to exist under Cumulative Conditions analysis include the FRWP, DMC/CA Intertie, SDIP, CVP-SWP Integration, and Long-Term EWA.

Under the Cumulative Conditions without Project, the Project Partners would use groundwater only to meet their demands; under the Cumulative Conditions with Project, the Project partners would use surface water only to meet their demands.

Delta Diversion

Under the Cumulative Conditions with Project with a demand of 56.7 TAF per year for the Project Partners, model results show that the long-term water-right diversion is approximately 36.7 TAF per year considering the Term 91 conditions. Therefore, it is about 20 TAF per year of supplemental water would be needed to help meet the demands.

River Flows

The DWWSP would have direct impact on Sacramento River flow, but the effect would be negligible. Indirect effects may occur because changes in Delta conditions can trigger changes in CVP-SWP reservoir operations. However, modeling results show that changes in average annual flow for the Trinity, Sacramento, Feather, and American rivers, both long-term and during dry periods, are negligible.

Delta Conditions

General indicators of ecosystem health within the Delta include the Net Delta Outflow, the location of X2, E/I ratio, and net flow in the San Joaquin River at Jersey Point (QWEST). Model results show that changes in the Net Delta Outflow under the DWWSP would be small. Average outflow under the DWWSP decreases by approximately 21 TAF per year, which is less than 0.2 percent of the outflow under Cumulative Conditions without Project. The average monthly change in X2 location during the February to June period is 0.02 km. No significant change occurs in the E/I ratio. QWEST flows under the DWWSP increase by 6 TAF per year.

Filling Los Vaqueros is constrained by the delta smelt BO (USFWS, 1993) based on the location of X2. From CALSIM II results, the average monthly increase in X2 location under the DWWSP varies from 0.0 to 0.04 km. At no time during the 73-year period of simulation is the shift eastwards of the X2 location sufficient to restrict filling Los Vaqueros Reservoir.

CVP-SWP Reservoir Operations and Deliveries

The amount of carryover storage affects the balance between CVP-SWP long-term average annual deliveries and dry year deliveries. It is indicative of operators' and contractors' tolerances of risk. A reduction in water supply available to the CVP-SWP will partly translate into reduced deliveries and partly translate into reduced carryover storage.

Model results show no change on total CVP carryover storage (Trinity, Shasta, Folsom, CVP San Luis), and that the total SWP carryover storage (Oroville, SWP San Luis) decreases by -3 TAF. These changes are small compared to the total carryover storage under the Cumulative Conditions without Project of 4.7 MAF for the CVP and 2.3 MAF for the SWP. Changes in carryover storage are considered to be largely artifacts of CALSIM II rather than reflecting a potential change in CVP-SWP operations. Model results show that impacts to long-term CVP-SWP deliveries are relatively minor. Change in long-term average CVP deliveries is -2 TAF and changes in SWP deliveries are about -9 TAF per year.

Water Levels in the South Delta

Reductions in water levels in the south Delta can adversely impact agricultural diversions. An analysis using DSM2 shows that water level impacts would be minor. The monthly average of the daily maximum decrease in stage upstream and downstream of the temporary barriers is usually less than 0.01 feet.

Delta Water Quality

DSM2 modeling shows that generally the largest water quality impacts would occur in the late summer, fall, and early winter. In general, the EC changes are minor. The increase in average monthly EC under the DWWSP for the Old River at Rock Slough, and the Old River at the Los Vaqueros Reservoir intake is about 0.4 percent or less. Increases in average monthly EC for Clifton Court Forebay and Tracy Pumping Plant are about 0.4 percent or less.

Reservoir and River Temperatures

Changes in reservoir and river water temperature are caused primarily by changes in CVP-SWP operations. Model temperature results show that long-term changes under Cumulative Conditions with Project compared to the Cumulative Conditions without Project are typically less than 0.1°F. In a few specific months, temperature changes could be significantly greater, close to 1.0°F. These temperature differences typically result from differences in the timing of storage transfer from north of the Delta to San Luis Reservoir. Differences in reservoir operations in specific months can be triggered by reaching threshold values or by step functions used in the model, and are modeling artifacts, rather than caused by the DWWSP.

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MEMORANDUM

To:	**Alan Lilly, Bartkiewicz, Kronick & Shanahan**
From:	**Ming-Yen Tu, MWH**
Review:	**Andy Draper, Yung-Hsin Sun, MWH**
Date:	**March 26, 2007**
Subject:	**Addendum to the Modeling Appendix of the Draft Environmental Impact Report for the Davis-Woodland Water Supply Project**

The purpose of this addendum is to summarize how water demands are represented in CALSIM II and how supplies and demands are related to the assumed Level of Development (LOD). This addendum also summarizes limitations of modeling application to support the development of the draft Environmental Impact Report (DEIR) for the Davis-Woodland Water Supply Project (DWWSP).

Modeling for the DWWSP DEIR is based on CALSIM II planning studies developed to support the Long-Term Central Valley Project (CVP) and State Water project (SWP) Operations Criteria and Plan (OCAP) Biological Assessment, dated June 2004. Detailed of the modeling assumptions and applications were provided in the main document of Modeling Appendix to the DWWSP DEIR.

CALSIM II HYDROLOGY AND DEMANDS

CALSIM II typically simulates system operations for a 73-year period using a monthly time-step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant, representing a fixed LOD used for the entire 73-year simulation period.

The hydrology represented in CALSIM II includes projected inflows to major CVP/SWP reservoirs and inflows from unregulated streams. These inflows are calculated based on historical gage data and, where applicable, upstream reservoir operation models. Inflows from undeveloped upstream watersheds are independent of the LOD. Inflows from developed watersheds vary based on assumed land uses in the watersheds.

The historical flow record of October 1921 through September 1994, adjusted for the effects of land use changes and upstream flow regulation, is used to represent the possible range of hydrologic conditions. CALSIM II currently uses two LODs, corresponding to years 2001 and 2020, to represent the existing condition and future condition, respectively. The following provides a summary of assumed hydrology and demand conditions.

In the Sacramento Valley, most of the municipal and industrial (M&I) uses are located in the Sacramento-Placer region; the rest of the Sacramento Valley has mostly agricultural uses. These water uses are aggregated regionally into seven Depletion Study Areas (DSAs) for water balance calculation.

In CALSIM II, M&I demands in the Sacramento-Placer region are based on the model assumptions of the Environmental Impact Report (EIR) for the Sacramento Water Forum Proposal (1999). Agricultural demands of each DSA are land-use-based and subject to the total contract entitlements. That is, if the total agricultural demand in one DSA is greater than total contract entitlements (including settlement contracts), the maximum amount of water delivered to the total agricultural use is the total of contract entitlements for that DSA.

Agricultural demands in CALSIM II for the San Joaquin Valley are contract-based. CVP south-of-Delta annual demands are constant, and set equal to the maximum contract amounts. Thus, these demands are independent of the LOD.

In CALSIM II, SWP south-of-Delta agricultural demands vary with hydrologic conditions, but in drier years are equal to the SWP contractors' full Table A amounts. The SWP south-of-Delta M&I demands, with the exception of Metropolitan Water District of Southern California (MWDSC), are close to and equal to their full Table A amounts for 2001 and 2020 LODs, respectively. Assumed demands for MWDSC vary with hydrologic conditions, up to the full Table A amount for 2001 and 2020 LODs. MWDSC's demands vary between 2001 and 2020 LODs; other SWP south-of-Delta demands are very similar between 2001 and 2020 LODs.

LEVEL OF DEVELOPMENT

The Department of Water Resources (DWR) developed the 1995 and 2020 LODs as part of the California Water Plan 1998 Update (Bulletin 160-98). The demands are based on historical land use surveys in the Sacramento Valley and an agricultural production model for the Central Valley. Currently, CALSIM II can be run using two LODs: 2001 and 2020. For CALSIM II modeling purposes, DWR defined the 2001 LOD by using linear interpolation of the previously developed 1995 and 2020 data.

2001 vs. 2020 LODs

In CALSIM II, the Sacramento Valley average annual available water supply under 2020 LOD is approximately 1 percent greater than that under the 2001 LOD. The change in available water supply from 2001 to 2020 LODs after upstream impairment (minor changes in upstream uses) is minimal.

Sacramento Valley demands in CALSIM II are further split into project demands (CVP and SWP contractors) and non-project demands. Excluding the Water Forum Proposal based diversions for the Sacramento-Placer region, the annual project demands under 2020 LOD are approximately 3 percent greater than the 2001 LOD project demands. Similarly, the annual non-project demands under 2020 LOD are approximately 3 percent greater than the 2001 LOD non-project demands.

2020 vs. 2040 LODs

The recent 2005 California Water Plan Update (Bulletin 160-05) did not quantify future LODs. The attempt to quantify a 2030 LOD has not been completed. Therefore, the currently available 2020 LOD is the best available information for demand projection and water supply under the future conditions. The following provides an assessment of projected 2040 conditions using available 2001 and 2020 LODs.

- The projected water supply beyond 2020 is not available. Assuming that the projected trend between 2001 and 2020 LODs in available water supply continues (i.e., approximately 1-percent change in 20 years per the general trend of change between 2001 and 2020 LODs), the resulting difference between 2020 and 2040 LODs also would be approximately 1 percent, which would be minimal.

- Land use projections beyond 2020 are currently not available. Assuming that the projected trend between 2001 and 2020 LODs in agricultural demands continues (i.e., approximately 3-percent change in 20 years per the general trend of change between 2001 and 2020 LODs), the resulting difference between 2020 and 2040 LODs also would be approximately 3 percent.

The planning horizon for DWWSP is through 2040. CALSIM II was used to support the environmental impact assessments in the DWWSP DEIR. The 2020 LOD, which is the best available information, was used to represent the future conditions, and it was considered adequate to analyze potential DWWSP impacts through 2040 because:

- The projected changes between 2020 and 2040 LODs are insignificant, and
- DWWSP's effects on hydrology in the CVP/SWP system would be relatively insensitive to these small projected changes in LODs.

MODELING LIMITATIONS

For DWWSP, the hydrologic analysis was based on CALSIM II planning studies developed for the 2004 OCAP; Sacramento-San Joaquin Delta (Delta) water quality analysis was based on hydrodynamic and water quality simulation using DWR's Delta Simulation model, DSM2; the river temperature analysis was based on monthly reservoir and river temperature models developed by the Department of the Interior, Bureau of Reclamation (Reclamation). CALSIM II modeling results were used in the DSM2 and temperature models. It is well accepted to apply this set of tools to CVP/SWP system-wide analyses and thus, they were used for analyzing regional environmental impacts associated with the DWWSP. These impacts include changes in reservoir storage, river and channel flows, water deliveries, Delta exports, Delta salinity, and river temperatures.

CALSIM II is a planning model designed to evaluate long-term water resources management practices for the CVP/SWP system based on applicable laws, regulations, agreements, and other operational rules and guidelines. CALSIM II is considered the best available planning tool for analysis of the CVP/SWP system and tributaries to the Delta and has been used for environmental analyses for a wide range of projects and programs. Due to the complexity of the CVP/SWP system, CALSIM II was developed in a simplified manner as a planning tool for use in a comparative analysis, where inferences are drawn from the changes in results from two model simulations. In other words, CALSIM II was not intended for use in predictive applications where inferences are drawn from absolute numbers of single simulation (with or without certain confidence intervals). When applied in comparative analysis, potential errors and/or uncertainties of CALSIM II stemming from the simplification and assumptions in one model simulation are also present in another; therefore, the effects from these potential errors and/or uncertainties on inferences normally are reduced.

Due to its significant role in California water resources planning, CALSIM II is under continued improvement and review by DWR and Reclamation through various project evaluations and consultations. A general external review of the methodology, software, and applications of CALSIM II was conducted in 2003 (Close et al., 2003). Recently, an external review of the San Joaquin River Valley CALSIM II model was also conducted (Ford et al., 2006). The main limitations of CALSIM II identified in these external reviews are as follows:

- **Monthly time steps.** CALSIM II uses monthly time steps. Therefore, CALSIM II does not consider daily variations that occur in the rivers under actual flow and climate conditions.
- **Representation for water users in the Sacramento Valley.** The agricultural and M&I demands are modeled in a simplified way in the current CALSIM II. Water demands are land-use based and are lumped into one demand for each DSA. In addition, the coverage area of each DSA is much broader than the service area of individual water purveyor. Additional model resolution for CVP/SWP contractors and non-CVP/SWP water users may be needed to improve the representation in CALSIM II.

- **Groundwater representation.**
  - **Sacramento Valley.** Groundwater is explicitly modeled in CALSIM II. Although groundwater is dynamically simulated in the Sacramento Valley, there is no pumping limitation from aquifers. In addition, the historical groundwater pumping is used to estimate local groundwater sources in the model; however, the information on the historical pumping is very limited, causing these pumping rates to be very uncertain.
  - **San Joaquin Valley.** CALSIM II does not include explicit groundwater representation in the San Joaquin Valley. A surrogate of minimum and maximum groundwater pumping and non-dynamic assumptions for stream-groundwater interactions is used in CALSIM II. Access to pumping data and incorporating dynamic groundwater interaction into the San Joaquin Valley will improve the CALSIM II representation.

Reclamation, DWR, and the external reviews have identified the need for a comprehensive error and uncertainty analysis for various aspects of the CALSIM II. The effects of error in estimating parameters such as agricultural efficiencies, water quality parameters, and return flows can be evaluated using sensitivity and uncertainty. DWR has issued the CALSIM II Model Sensitivity Analysis Study (DWR, 2005) and Reclamation is currently developing a similar sensitivity and uncertainty analysis for the San Joaquin River Basin. This information will improve understanding of the model results.

Despite the above-identified limitations, CALSIM II is an adequate modeling tool for the DWWSP DEIR. The impact assessments in the DWWSP DEIR for compliance with the California Environmental Quality Act were based on incremental changes between a pair of scenarios, a protocol consistent with intended applications of CALSIM II.

As previously mentioned, CALSIM II modeling results (flows and reservoir storages) were used in other models, including DSM2 and reservoir and river temperature models, as boundary conditions for assessing impacts of DWWSP in other resources areas. Therefore, these models are subject to the limitations in CALSIM II. In other words, the DSM2 and temperature modeling results should be used for comparative purposes only. This is how these results were used for the analyses for the DWWSP DEIR.

REFERENCES

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Ford, D., L. Grober, T. Harmon, J. R. Lund, and D. C. McKinney. 2006. *Review Panel Report, San Joaquin River Valley CalSim II Model Review*. CALFED Science Program – California Water and Environment Modeling Forum. January 12.

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Estimated Water Demand for the Project Partners

Proposed Davis-Woodland Water Supply Project
Calendar Year 2040 Projected Monthly Water Consumption, AF/month
(Assumes water supply project is sized to meet projected 2040 demands)
Sacramento River Water Treatment Plant Capacity = 51.8 mgd (23 Davis, 27 Woodland, 1.8 UC Davis)

City of Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,031	0	0	1,031
February	916	0	0	916
March	1,168	0	0	1,168
April	1,626	0	0	1,626
May	2,130	0	0	2,130
June	2,118	0	562	2,679
July	2,188	0	880	3,069
August	2,188	0	835	3,023
September	2,118	0	493	2,611
October	2,153	0	0	2,153
November	1,420	0	0	1,420
December	1,076	0	0	1,076
Annual	20,131	0	2,769	22,900

City of Woodland

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,308	0	0	1,308
February	1,192	0	0	1,192
March	1,645	0	0	1,645
April	1,938	0	0	1,938
May	2,569	0	68	2,636
June	2,486	0	630	3,116
July	2,569	0	814	3,383
August	2,569	0	882	3,451
September	2,486	0	417	2,903
October	2,340	0	0	2,340
November	1,593	0	0	1,593
December	1,312	0	0	1,312
Annual	24,006	0	2,811	26,817

UC Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	170	170	36	376
February	153	153	72	379
March	170	170	99	439
April	164	164	98	427
May	170	170	227	567
June	164	164	264	593
July	170	170	298	638
August	170	170	291	630
September	164	164	237	566
October	170	170	170	510
November	164	164	119	448
December	170	158	0	328
Annual	2,000	1,988	1,912	5,900

All Project Partners

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	2,508	170	36	2,714
February	2,261	153	72	2,486
March	2,983	170	99	3,252
April	3,728	164	98	3,990
May	4,868	170	295	5,333
June	4,768	164	1,456	6,388
July	4,927	170	1,993	7,090
August	4,927	170	2,007	7,104
September	4,768	164	1,147	6,079
October	4,662	170	170	5,002
November	3,178	164	119	3,461
December	2,558	158	0	2,716
Annual	46,137	1,988	7,492	55,617

"No Project" Water Supply Alternative 4 to Proposed Davis-Woodland Water Supply Project
Calendar Year 2040 Projected Monthly Water Consumption, AF/month
(Assumes all projected 2040 demands are met by groundwater)

City of Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	0	0	1,031	1,031
February	0	0	916	916
March	0	0	1,168	1,168
April	0	0	1,626	1,626
May	0	0	2,130	2,130
June	0	0	2,679	2,679
July	0	0	3,069	3,069
August	0	0	3,023	3,023
September	0	0	2,611	2,611
October	0	0	2,153	2,153
November	0	0	1,420	1,420
December	0	0	1,076	1,076
Annual	0	0	22,900	22,900

City of Woodland

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	0	0	1,308	1,308
February	0	0	1,192	1,192
March	0	0	1,645	1,645
April	0	0	1,938	1,938
May	0	0	2,636	2,636
June	0	0	3,116	3,116
July	0	0	3,383	3,383
August	0	0	3,451	3,451
September	0	0	2,903	2,903
October	0	0	2,340	2,340
November	0	0	1,593	1,593
December	0	0	1,312	1,312
Annual	0	0	26,817	26,817

UC Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	0	170	206	376
February	0	153	225	379
March	0	170	269	439
April	0	164	262	427
May	0	170	397	567
June	0	164	429	593
July	0	170	468	638
August	0	170	461	630
September	0	164	401	566
October	0	170	340	510
November	0	164	283	448
December	0	158	170	328
Annual	0	1,988	3,912	5,900

All Project Partners

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	0	170	2,544	2,714
February	0	153	2,333	2,486
March	0	170	3,082	3,252
April	0	164	3,826	3,990
May	0	170	5,163	5,333
June	0	164	6,224	6,388
July	0	170	6,920	7,090
August	0	170	6,934	7,104
September	0	164	5,915	6,079
October	0	170	4,832	5,002
November	0	164	3,297	3,461
December	0	158	2,558	2,716
Annual	0	1,988	53,629	55,617

Water Supply Alternative 1 to Proposed Davis-Woodland Water Supply Project
Calendar Year 2030 Projected Water Consumption, AF/month
(Assumes water supply project is sized to meet projected 2030 demands)
Sacramento River Water Treatment Plant Capacity = 45.8 mgd (21 Davis, 23 Woodland, 1.8 UC Davis)

City of Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	927	0	0	927
February	824	0	0	824
March	1,051	0	0	1,051
April	1,463	0	0	1,463
May	1,916	0	0	1,916
June	1,934	0	477	2,410
July	1,998	0	762	2,760
August	1,998	0	721	2,719
September	1,934	0	415	2,348
October	1,936	0	0	1,936
November	1,277	0	0	1,277
December	968	0	0	968
Annual	18,225	0	2,375	20,600

City of Woodland

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,078	0	0	1,078
February	982	0	0	982
March	1,356	0	0	1,356
April	1,597	0	0	1,597
May	2,173	0	0	2,173
June	2,118	0	450	2,568
July	2,188	0	600	2,788
August	2,188	0	656	2,844
September	2,118	0	275	2,393
October	1,928	0	0	1,928
November	1,313	0	0	1,313
December	1,081	0	0	1,081
Annual	20,120	0	1,980	22,100

UC Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	170	145	0	315
February	153	153	10	317
March	170	170	28	367
April	164	164	28	357
May	170	170	135	475
June	164	164	168	497
July	170	170	195	534
August	170	170	188	528
September	164	164	145	474
October	170	170	87	427
November	164	164	46	375
December	170	105	0	275
Annual	2,000	1,910	1,030	4,940

All Project Partners

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	2,174	145	0	2,319
February	1,959	153	10	2,123
March	2,576	170	28	2,774
April	3,224	164	28	3,417
May	4,258	170	135	4,563
June	4,216	164	1,095	5,475
July	4,356	170	1,557	6,083
August	4,356	170	1,565	6,091
September	4,216	164	835	5,215
October	4,035	170	87	4,292
November	2,755	164	46	2,965
December	2,219	105	0	2,324
Annual	40,345	1,910	5,385	47,640

Water Supply Alternative 2 to Proposed Davis-Woodland Water Supply Project
Cal. Year 2010-Davis, 2016 UC Davis, & 2025-Woodland Proj. Water Consumption, AF/month
(Assumes water supply project is sized to meet demands per adopted general or long range development plans)
Sacramento River Water Treatment Plant Capacity = 39.8 mgd (17 Davis, 21 Woodland, 1.8 UC Davis)

City of Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	729	0	0	729
February	648	0	0	648
March	826	0	0	826
April	1,150	0	0	1,150
May	1,507	0	0	1,507
June	1,565	0	330	1,895
July	1,617	0	553	2,171
August	1,617	0	521	2,138
September	1,565	0	282	1,847
October	1,523	0	0	1,523
November	1,004	0	0	1,004
December	761	0	0	761
Annual	14,514	0	1,686	16,200

City of Woodland

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,004	0	0	1,004
February	915	0	0	915
March	1,264	0	0	1,264
April	1,489	0	0	1,489
May	1,998	0	27	2,025
June	1,934	0	460	2,393
July	1,998	0	601	2,599
August	1,998	0	653	2,651
September	1,934	0	297	2,230
October	1,797	0	0	1,797
November	1,224	0	0	1,224
December	1,008	0	0	1,008
Annual	18,563	0	2,037	20,600

UC Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	170	59	0	229
February	153	77	0	230
March	170	97	0	267
April	164	95	0	260
May	170	170	5	345
June	164	164	32	361
July	170	170	49	388
August	170	170	44	384
September	164	164	15	344
October	170	140	0	310
November	164	108	0	272
December	170	30	0	200
Annual	2,000	1,445	145	3,590

All Project Partners

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,903	59	0	1,962
February	1,717	77	0	1,794
March	2,260	97	0	2,357
April	2,803	95	0	2,898
May	3,674	170	33	3,877
June	3,663	164	822	4,650
July	3,785	170	1,203	5,158
August	3,785	170	1,218	5,173
September	3,663	164	594	4,421
October	3,490	140	0	3,630
November	2,393	108	0	2,501
December	1,939	30	0	1,969
Annual	35,077	1,445	3,869	40,390

Water Supply Alternative 3 to Proposed Davis-Woodland Water Supply Project
Calendar Year 2040 Projected Monthly Water Consumption, AF/month
(Assumes water supply project is sized to meet projected 2040 demands with an additional
10% reduction in water use by each project partner)
Sacramento River Water Treatment Plant Capacity = 47.8 mgd (21 Davis, 25 Woodland, 1.8 UC Davis)

City of Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	927	0	0	927
February	824	0	0	824
March	1,051	0	0	1,051
April	1,463	0	0	1,463
May	1,917	0	0	1,917
June	1,934	0	478	2,411
July	1,998	0	764	2,762
August	1,998	0	723	2,721
September	1,934	0	416	2,350
October	1,937	0	0	1,937
November	1,278	0	0	1,278
December	969	0	0	969
Annual	18,230	0	2,380	20,610

City of Woodland

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,177	0	0	1,177
February	1,073	0	0	1,073
March	1,481	0	0	1,481
April	1,744	0	0	1,744
May	2,373	0	0	2,373
June	2,302	0	502	2,804
July	2,379	0	666	3,045
August	2,379	0	727	3,106
September	2,302	0	311	2,613
October	2,106	0	0	2,106
November	1,434	0	0	1,434
December	1,181	0	0	1,181
Annual	21,929	0	2,207	24,135

UC Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	170	169	0	338
February	153	156	31	341
March	170	173	52	395
April	164	167	52	384
May	170	173	168	510
June	164	167	202	534
July	170	173	232	574
August	170	173	225	567
September	164	167	178	509
October	170	173	116	459
November	164	167	71	403
December	170	125	0	295
Annual	2,000	1,981	1,329	5,310

All Project Partners

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	2,274	169	0	2,443
February	2,050	156	31	2,238
March	2,702	173	52	2,927
April	3,372	167	52	3,591
May	4,459	173	168	4,800
June	4,400	167	1,183	5,749
July	4,546	173	1,662	6,381
August	4,546	173	1,675	6,394
September	4,400	167	905	5,471
October	4,213	173	116	4,502
November	2,876	167	71	3,115
December	2,319	125	0	2,445
Annual	42,158	1,981	5,915	50,055

Water Supply Alternative 4 to Proposed Davis-Woodland Water Supply Project
Calendar Year 2040 Projected Monthly Water Consumption, AF/month
(Assumes water supply project is sized to meet all projected 2040 demands with surface water)
Sacramento River Water Treatment Plant Capacity = 106 mgd (41 Davis, 53 Woodland, 12 UC Davis)

City of Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,031	0	0	1,031
February	916	0	0	916
March	1,168	0	0	1,168
April	1,626	0	0	1,626
May	2,130	0	0	2,130
June	2,679	0	0	2,679
July	3,069	0	0	3,069
August	3,023	0	0	3,023
September	2,611	0	0	2,611
October	2,153	0	0	2,153
November	1,420	0	0	1,420
December	1,076	0	0	1,076
Annual	22,900	0	0	22,900

City of Woodland

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,308	0	0	1,308
February	1,192	0	0	1,192
March	1,645	0	0	1,645
April	1,938	0	0	1,938
May	2,636	0	0	2,636
June	3,116	0	0	3,116
July	3,383	0	0	3,383
August	3,451	0	0	3,451
September	2,903	0	0	2,903
October	2,340	0	0	2,340
November	1,593	0	0	1,593
December	1,312	0	0	1,312
Annual	26,817	0	0	26,817

UC Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	206	170	0	376
February	225	153	0	379
March	269	170	0	439
April	262	164	0	427
May	397	170	0	567
June	429	164	0	593
July	468	170	0	638
August	461	170	0	630
September	401	164	0	566
October	340	170	0	510
November	283	164	0	448
December	170	158	0	328
Annual	3,912	1,988	0	5,900

All Project Partners

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	2,544	170	0	2,714
February	2,333	153	0	2,486
March	3,082	170	0	3,252
April	3,826	164	0	3,990
May	5,163	170	0	5,333
June	6,224	164	0	6,388
July	6,920	170	0	7,090
August	6,934	170	0	7,104
September	5,915	164	0	6,079
October	4,832	170	0	5,002
November	3,297	164	0	3,461
December	2,558	158	0	2,716
Annual	53,629	1,988	0	55,617

Water Supply Alternative 5 to Proposed Davis-Woodland Water Supply Project
Calendar Year 2040 Projected Monthly Water Consumption, AF/month
(Assumes water supply project is sized such that annual groundwater use
by project partners remains approximately at 2005 levels)
Sacramento River Water Treatment Plant Capacity = 18.8 mgd (7 Davis, 10 Woodland, 1.8 UC Davis)

City of Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	666	0	365	1,031
February	602	0	314	916
March	666	0	502	1,168
April	645	0	981	1,626
May	666	0	1,464	2,130
June	645	0	2,035	2,679
July	666	0	2,403	3,069
August	666	0	2,357	3,023
September	645	0	1,966	2,611
October	666	0	1,487	2,153
November	645	0	775	1,420
December	666	0	410	1,076
Annual	7,842	0	15,058	22,900

City of Woodland

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	951	0	356	1,308
February	859	0	332	1,192
March	951	0	694	1,645
April	921	0	1,017	1,938
May	951	0	1,685	2,636
June	921	0	2,195	3,116
July	951	0	2,431	3,383
August	951	0	2,500	3,451
September	921	0	1,983	2,903
October	951	0	1,388	2,340
November	921	0	673	1,593
December	951	0	361	1,312
Annual	11,202	0	15,615	26,817

UC Davis

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	47	170	159	376
February	65	153	160	379
March	83	170	186	439
April	81	164	181	427
May	157	170	240	567
June	164	164	264	593
July	169	170	299	638
August	170	170	291	630
September	162	164	240	566
October	124	170	216	510
November	94	164	190	448
December	31	158	139	328
Annual	1,346	1,988	2,565	5,900

All Project Partners

	Surface Water			
	Sacramento River	Solano Project	Ground Water	Total
January	1,664	170	880	2,714
February	1,526	153	807	2,486
March	1,700	170	1,382	3,252
April	1,647	164	2,179	3,990
May	1,774	170	3,389	5,333
June	1,730	164	4,494	6,388
July	1,787	170	5,133	7,090
August	1,787	170	5,147	7,104
September	1,727	164	4,188	6,079
October	1,741	170	3,091	5,002
November	1,659	164	1,638	3,461
December	1,648	158	910	2,716
Annual	20,390	1,988	33,238	55,617

Appendix C1

Special Status Species Potentially Occurring Within the Project Area and Water Sellers' Districts

APPENDIX C1

Special-Status Species Potentially Occurring Within the Project Area and Water Sellers' Districts

Table C-1 of this appendix lists scientific names, common names, status, preferred habitat types, and potential to occur within the Project area for all relevant special-status animal and plant species. Table C-2 lists special status species that are likely to occur within the districts of potential water sellers.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Invertebrate			
Branchinecta conservatio Conservancy fairy shrimp	FE/--/--	Lifecycle restricted to large, deep, cool-water vernal pools with moderately turbid water.	**Medium Potential:** Known to occur in vernal pools south of the City of Davis near the Glide Tule Elk Reserve. Habitat for this species is likely to occur within the Project area.
Branchinecta lynchi vernal pool fairy shrimp	FT/--/--	Lifecycle restricted to vernal pools and sandstone rock outcrop pools.	**Medium Potential:** Known to occur in vernal pools in several locations in Yolo County, including south of the City of Davis along the Northern Railroad line; on D.Q. University west of City of Davis; and potential habitat exists at Grasslands Park, McClellan AFB communications site, near Moody Slough north of Winters and along Dunnigan Hills in northern Yolo County. Habitat for this species is likely to occur within the Project area.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Desmocerus californicus dimorphus valley elderberry longhorn beetle	FT/--/--	Breeds and forages exclusively on elderberry shrubs (Sambucus mexicana) typically associated with riparian forests, riparian woodlands, elderberry savannas, and other Central Valley habitats. Occurs only in the Central Valley of California.	**Medium Potential:** Known to occur in riparian and floodplain habitats along Cache Creek, Putah Creek, and the Sacramento River. Habitat for this species is likely to occur within the Project area.
Lepidurus packardi vernal pool tadpole shrimp	FE/--/--	Lifecycle restricted to vernal pools.	**Medium Potential:** Known to occur in vernal pools in south of the City of Davis along the Northern Railroad line; at Grasslands Park and McClellan AFB telecommunications site; near Moody Slough north of Winters; and potential habitat exists and along Dunnigan Hills in northern Yolo County and on D.Q. University west of City of Davis. Habitat for this species is likely to occur within the Project area.
Amphibian			
Ambystoma californiense California tiger salamander	FE, FT/CSC/--	Annual grassland and grassy understory of valley-foothill hardwood habitats in central and northern California. Needs underground refuges and vernal pools or other seasonal water sources.	**Medium Potential:** Known to occur in vernal pools at the northern end of Dunnigan Hills in northern Yolo County. Habitat for this species is likely to occur within the Project area.
Rana aurora draytonii California red-legged frog	FT/CSC/--	Breeds in slow moving streams, ponds, and marshes with emergent vegetation; forages in nearby uplands within about 200 feet.	**Low Potential.** This species is considered extirpated from the Central Valley floor.
Spea (=Scaphiopus) hammondii Western spadefoot	FSC/CSC/--	Occurs seasonally in grasslands, prairies, chaparral, and woodlands, in and around wet sites. Breeds in shallow, temporary pools formed by winter rains. Takes refuge in burrows.	**Medium Potential:** Known historically from Buckeye Creek at the northern boundary of Yolo County. Occurs in vernal pool habitats. Habitat for this species is likely to occur within the Project area.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Reptile			
Emys (=Clemmys) marmorata northwestern pond turtle	--/CSC/--	Ponds, marshes, rivers, streams, and irrigation ditches with aquatic vegetation. Requires basking sites and suitable upland habitat for egg-laying. Nest sites most often characterized as having gentle slopes (<15%) with little vegetation or sandy banks.	**Medium Potential:** May occur in perennial streams, creeks, irrigation ditches, and stock ponds throughout Yolo County. Habitat for this species is likely to occur within the Project area.
Thamnophis gigas giant garter snake	FT/ST/--	Generally inhabits marshes, sloughs, ponds, slow-moving streams, ditches, and rice fields that have water from early spring till mid-fall. Emergent vegetation (cattails and bulrushes), open areas for sunning and high ground for hibernation and cover.	**High Potential:** Known to occur within Sycamore Slough, Willow Slough, Yolo Basin, and irrigation ditches and canals associated with rice fields in eastern Yolo County. Habitat for this species is likely to occur within the Project area.
Bird			
Accipiter cooperii Cooper's hawk	--/CSC/--	Nests in riparian areas and oak woodlands, forages at woodland edges.	**Medium Potential:** Known to nest within the City of Davis and likely to occur in riparian and wooded areas in Yolo County. Habitat for this species is likely to occur within the Project area.
Agelaius tricolor tricolored blackbird	--/CSC/--	Largely endemic to California, most numerous in the Central Valley and nearby vicinity. Typically requires open water, protected nesting substrate, and foraging grounds within vicinity of the nesting colony. Nests in dense thickets of cattails, tules, willows.	**High Potential:** Nesting colonies known to occur in Yolo County. Habitat for this species is likely to occur within the Project area.
Asio flammeus short-eared owl	--/CSC/--	Nests and forages in densely vegetated grasslands and emergent wetlands with abundant prey from October through April.	**Medium Potential:** Known to winter and potentially nest in grassland and agricultural fields in Yolo County. Habitat for this species is likely to occur within the Project area.
Athene cunicularia burrowing owl	--/CSC/--	Forages in open plains, grasslands, and prairies; typically nests in abandoned small mammal burrows.	**High Potential:** Several occurrence of nesting pairs have been documented in grasslands and agricultral landscapes throughout Yolo County. Habitat for this species is likely to occur within the Project area.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Buteo swainsoni Swainson's hawk	--/ST/--	Forages in open plains, grasslands, and prairies; typically nests in trees or large shrubs.	**High Potential:** Several occurrence of nesting pairs have been documented in riparian woodlands and isolated oaks near annual grasslands or low-growing agricultral crops (especially alfalfa) throughout Yolo County. Habitat for this species is likely to occur within the Project area.
Charadrius alexandrinus nivosus western snowy plover	FT/CSC/--	Flat sandy beaches, salt flats and sandy areas with minimal vegetation, nests in sandy depressions. May also nest on gravelly substrate. Has been known to nest near sewage ponds as well.	**High Potential:** Nesting known to occur in Yolo Bypass area; last documented occurrence was in 1998. Habitat for this species is likely to occur within the Project area.
Charadrius montanus mountain plover	FSC/CSC/--	In California, winters in open short grasslands and plowed agricultural fields in the Central Valley and in foothill valleys west of San Joaquin Valley, and in Imperial Valley. Winters below 1000 m (3200 ft).	**Medium Potential:** Does not breed in Yolo County, but has been documented annually wintering north of Woodland since at least 1970. Habitat for this species is likely to occur within the Project area.
Circus cyaneus northern harrier	--/CSC/--	Nests in wet meadows and tall grasslands, forages in grasslands and marshes.	**High Potential:** Common nester in grasslands, agricultural fields, and wet meadows in Yolo County. Habitat for this species is likely to occur within the Project area.
Coccyzus americanus occidentalis western yellow-billed cuckoo	FC/SE/--	Nests in densely foliaged deciduous trees and shrubs especially willow, in broad riparian forest.	**Medium Potential:** Known to occur in Yolo County. Habitat for this species is likely to occur within the Project area.
Dendroica petechia brewsteri yellow warbler	--/CSC/--	Nests in dense riparian cover.	**Medium Potential:** Does not breed in Yolo County, but is a rare spring and common fall migrant in lowland riparian woodlands throughout Yolo County. Habitat for this species is likely to occur within the Project area.
Elanus leucurus white-tailed kite	--/CFP/--	Forages in open plains, grasslands, and prairies; typically nests in trees.	**Medium Potential:** Known to nest in suburban areas of Davis and Woodland as well as in typical riparian, grassaland, and agricultural landscapes. fields in Yolo County. Forages in open habitats. Habitat for this species is likely to occur within the Project area.
Haliaeetus leucocephalus bald eagle	FPD, FT/SE/--	Nests in large trees with open branches along lake and river margins, usually within one mile of water.	**Low Potential -** One occurrence in Yolo County.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name **Common Name**	**Federal Status/** **State Status/** **CNPS Status**	**Habitat**	**Potential to Occur**
Lanius ludovicianus loggerhead shrike	FSC/CSC/--	Nests in dense shrub or tree foliage, forages in scrub, open woodlands, grasslands, and croplands.	**Medium Potential:** Uncommon resident throughout lowlands of Yolo County, but has been observed foraging along agricultural lands and open fields, particulary along barbed-wire fences. Habitat for this species is likely to occur within the Project area.
Plegadis chihi white-faced ibis	FSC/CSC/--	Forages in salt, freshwater, and coastal marshes; nests in shrubs or reedbeds associated with marsh habitats.	**Medium Potential:** Known to occur in the Yolo Bypass in variable numbers. Habitat for this species is likely to occur within the Project area.
Progne subis purple martin	--/CSC/--	Inhabits woodlands, low elevation coniferous forest of Douglas fir, ponderosa pine, and monterey pine. Nests in old woodpecker cavities mostly, also in human-made structures. Nest often located in tall, isolated tree/snag.	**Low Potential** - One occurrence in West Davis.
Riparia riparia bank swallow	--/ST/--	Banks of rivers, creeks, lakes, and seashores; nests in excavated dirt tunnels near the top of steep banks.	**Medium Potential:** Several occurrences documented of nesting along Cache Creek and the Sacramento River in Yolo County. Habitat for this species is likely to occur within the Project area.
Mammal			
Taxidea taxus American badger	--/CSC/--	Occurs in a wide variety of open forest, shrub, and grassland habitats that have friable soils for digging.	**Medium Potential:** Occurs in open grasslands with friable soils in Yolo County. Habitat for this species is likely to occur within the Project area.
Fish			
Archoplites interruptus Sacramento perch	FSC/CSC/--	Sloughs, slow-moving rivers, and lakes of the Central Valley. Emergent vegetation necessary for nurseries.	**Medium Potential:** May occur in the Sacramento River. Habitat for this species is likely to occur within the Project area.
Hypomesus transpacificus Delta smelt	FT/ST/--	Open surface waters in the Sacramento/San Joaquin Delta. Seasonally in Suisun Bay, Carquinex Strair and San Pablo Bay. Found in Delta estuaries with dense aquatic vegetation and low occurrence of predators. May be affected by downstream sedimentation.	**Medium Potential** - May occur in Sacramento River in Yolo County during high flows. Has occasionally been collected in the Sacramento River near the potential Project diversion/intake sites, but primarily occurs farther downstream.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Oncorhynchus mykiss Steelhead - Central Valley ESU	FT/--/--	This ESU enters the Sacramento and San Joaquin Rivers and their tributaries from July to May; spawning from December to April. Young move to rearing areas in and through the Sacramento and San Joaquin Rivers, Delta, and San Pablo and San Francisco Bays.	**Medium Potential:** Known to occur in Putah Creek, Yolo Bypass, and the Sacramento River. Habitat for this species is likely to occur within the Project area.
Oncorhynchus tshawytscha Chinook Salmon - Central Valley Fall / Late Fall-Run ESU	--/CSC/--	This ESU enters the Sacramento and San Joaquin rivers and their tributaries from July to April; spawning October to February. Young move to rearing areas in and through the Sacramento and San Joaquin Rivers, Delta, and San Pablo and San Francisco Bays.	**Medium Potential:** Known to occur in Putah Creek, Yolo Bypass, and the Sacramento River. Habitat for this species is likely to occur within the Project area.
Oncorhynchus tshawytscha Chinook Salmon Winter Run	FE/SE/--	This ESU enters the Sacramento River December to May; spawning peaks May and June. Upstream movement occurs more quickly than in spring run population. Young move to rearing areas in and through the Sacramento River, Delta, and San Pablo and San Francisco Bays.	**Medium Potential:** Known to occur in the Sacramento River. Habitat for this species is likely to occur within the Project area.
Oncorhynchus tshawytscha Spring-Run Chinook Salmon	FT/ST/--	This ESU enters the Sacramento and San Joaquin Rivers and tributaries March to July; spawning from late August to early October. Young move to rearing areas in and through the Sacramento and San Joaquin Rivers, Delta, and San Pablo and San Francisco Bays.	**Medium Potential:** Known to occur in the Sacramento River. Habitat for this species is likely to occur within the Project area.
Pogonichthys macrolepidotus Sacramento splittail	--/ST/--	Currently known only from the Delta, Suisun Bay and associated marshes. Prefers slow moving river sections and dead end sloughs. Requires flooded vegetation for spawning and juvenile foraging habitat. Spawning occurs over flooded vegetation.	**Medium Potential:** Known to occur in Yolo Bypass and the Sacramento River. Habitat for this species is likely to occur within the Project area.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Acipenseridae sp. *Green sturgeon*	FT/--/--	May spawn both upstream and downstream of the Project area. Larvae may attach to rip rap, but are not likely to attach to the sandy-silty river bottom found in the Project area. It is probable that green sturgeon larvae or juveniles will be in the water column throughout the year. Spawning happens in freshwater, preferred spawning is in lowing reaches of large rivers with swift currents and large cobble. Larvae and juveniles may rear for up to 2 years in 2 water before migrating to an estuarine or marine environment.	**Medium Potential:** Known to occur in the Sacramento River. Habitat for this species is likely to occur within the Project area.
Plant			
Astragalus tener var. *ferrisiae* Ferris's milk-vetch	--/--/1B.1	Annual herb occurring in vernally mesic meadow and seeps, and sub alkaline flats in valley and foothill grasslands. Blooms Apr-May.	**Medium Potential:** Habitat present in vernally flooded subalkaline grasslands within and adjacent to the Project area.
Astragalus tener var. *tener* Alkali milk-vetch	--/--/1B.2	Generally found in playas, valley and foothill grasslands with adobe clay soils, and vernal pools. Generally found in alkaline soils. Blooms Mar-Jun.	**High Potential:** Known to occur in vernally flooded subalkaline grasslands within and adjacent to the Project area.
*Atriplex cordulata*Heartscale	--/--/1B.2	Chenopod scrub, alkali seasonal wetlands, and grassland. Often found in the sandy soils of alkaline flats and scalds in the Central Valley. Blooms Apr-Oct.	**Medium Potential:** Habitat present in vernally flooded subalkaline grasslands adjacent to the Project area.
Atriplex depressa Brittlescale	--/--/1B.2	Generally found in chenopod scrub, alkali seasonal wetlands and grassland, meadows and playas. Blooms May-Oct.	**High Potential:** Known to occur in vernally flooded subalkaline grasslands within and adjacent to the Project area.
Atriplex joaquiniana San Joaquin spearscale	--/--/1B.2	Generally found in chenopod scrub, alkali seasonal wetlands and grassland, meadows and playas. Blooms Apr-Oct.	**High Potential:** Known to occur in vernally flooded subalkaline grasslands within and adjacent to the Project area.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Cordylanthus palmatus Palmate-bracted bird's-beak	FE/SE/1B.1	Prefers marshes and swamps, lake margins, vernal pools and wet places. Blooms May-Oct.	**High Potential:** Known to occur in seasonally flooded areas with subalkaline soils within and adjacent to the Project area.
Cryptantha crymophila Subalpine cryptantha	--/--/1B.3	On dry talus of volcanic formation in subalpine coniferous forest. Elevation range from 2600-3200m.	**Unlikely.** Elevation range for this species is well above the Project area.
Delphinium recurvatum Recurved larkspur	--/--/1B.2	Perennial herb occurring in chenopod scrub, cismontane woodland, and in alkaline substrate in valley and foothill grassland. Blooms Mar-May.	**Unlikely.** The only occurrence near the project site was last seen in 1940 and may have been misidentified.
Downingia pusilla Dwarf downingia	--/--/2.2	Prefers lake margins, vernal pools and wet places sometimes playas and grasslands. Blooms Mar-May.	**Unlikely.** Habitat not present in the Project area.
Erodium macrophyllum Round-leaved filaree	--/--/2.1	Generally found in Valley and foothill grasslands, particularly on clay soils. Blooms Mar-May.	**Unlikely.** The only occurrence near the project area was last seen in 1955 and species does not appear to be tolerant of agricultural-related disturbance.
Fritillaria pluriflora Adobe-lily	--/--/1B.2	Bulbiferous herb occurring in chaparral, cismontane woodland, and valley and foothill grassland, often on adobe or serpentine substrate. Blooms Feb-Apr. Elevation range from 55-820 meters.	**Unlikely.** The only occurrence near the project area was last seen in 1910 and the reported elevation range for this species is well-above those found in the Project area.
Hibiscus lasiocarpus Rose-mallow	--/--/2.2	Prefers freshwater marshes and swamps. Blooms Jun-Sept.	**Medium Potential:** May occur along drainages within and adjacent to the Project area.
Juglans hindsii Northern California black walnut	--/--/1B.1	Occurs in riparian forest and woodland. Blooms Apr.-May.	**Unlikely.** There are only three extant native stands of this species reported in CNDDB; much of what is called Northern California black walnut/Hinds' walnut are naturalized hybrids with black walnut (*J.nigra*). The occurrence in the vicinity of the Project area has been extirpated since 1949.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Lepidium latipes var. *heckardii* Heckard's pepper-grass	--/--/1B.2	Generally found in valley and foothill grasslands. Prefers wet places including vernal pools. Blooms Mar-May.	**High Potential:** Known to occur in vernally flooded subalkaline grasslands within and adjacent to the Project area.
*Lessingia hololeuca*Woolly-headed lessingia	--/--/3	Annual herb occurring in broadleafed upland forest, coastal scrub, lower montane coniferous forest, and in serpentinite valley and foothill grasslands. Blooms Jun-Oct.	**Unlikely.** Serpentine grasslands not present in the Project area.
Navarretia leucocephala ssp. *bakeri* Baker's navarretia	--/--/1B.1	Annual herb occurring in cismontane woodland, lower montane coniferous forest, meadows and seeps, Valley and foothill grassland, and vernal pools. Blooms May-Jul. 15-1740 meters elevation.	**Unlikely.** Habitat not present in the Project area.
Neostapfia colusana Colusa grass	FT/SE/1B.1	Found in the bottoms of large, deep vernal pools. Blooms May-Aug.	**Unlikely.** Habitat not present in the Project area.
Sagittaria sanfordii Sanford's arrowhead	--/--/1B.2	Found in assorted freshwater habitats including marshes, swamps, and seasonal drainages. Blooms May-Oct.	**Medium.** Habitat present in drainages within the Project area.
Tuctoria mucronata Crampton's tuctoria or Solano grass	FE/SE/1B.1	Annual herb occurring in mesic valley and foothill grassland and in vernal pools. Blooms Apr-Aug.	**Unlikely.** This species is well-known to only occur at Jepson Prairie and a vernal pool complex in south Davis.
Wolffia brasiliensis Brazilian watermeal	--/--/2.3	Aquatic herb occurring in marshes and swamps. Blooms Apr.- Dec.	**Medium.** Habitat present in slow-moving drainages and wetlands in the Project area.
Sensitive Habitats			
Elderberry savanna	--/--/--	Elderberry savanna occurs along riparian corridors within the Central Valley and the range of this habitat has become restricted due to habitat loss.	**Medium**. Elderberry shrubs are mapped in the vicinity of the Project area.
Great valley cottonwood riparian forest	--/--/--	Cottonwood riparian forests are important wildlife habitats within the Central Valley and loss of these habitats has become a conservation concern	**Medium**. Cottonwood forests may occur along the Sacramento River within the Project area.

TABLE C-1
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

Scientific Name Common Name	Federal Status/ State Status/ CNPS Status	Habitat	Potential to Occur
Valley oak woodland	--/--/--	Valley oak (*Quercus lobata*) woodlands have become increasingly rare in the California landscape and their conservation has become a growing concern state-wide for resource managers.	**High**, Valley oak woodlands are known to occur in the Project area.

FEDERAL: (U.S. Fish and Wildlife Service)
California Native Plant Society classifications:
FE = Federally listed as Endangered (in danger of extinction).
List 1A = Plants presumed extinct in California.
FT = Federally listed as Threatened (likely to become Endangered within foreseeable future).
List 1B = Plants rare, Threatened, or Endangered in California and elsewhere.
PE = Proposed for listing as Endangered.
List 2 = Plants rare, Threatened or Endangered in California but more common elsewhere.
PT = Proposed for listing as Threatened.
List 3 = Plants about which more information is needed.
FC = Candidate to become a *proposed* species.
List 4 = Plants of limited distribution.
FSC = Federal Species of Concern.

D[FSC] = Delisted; considered a Federal Species of Concern.

STATE: (California Department of Fish and Game)

CE = State listed as Endangered.

CT = State listed as Threatened.

CR = State listed as Rare.

CSC = California species of special concern.

CP = Fully protected by the State of California under Section 3511 and 4700 of the CDFG Code.

TABLE C-2
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN WATER SELLERS' DISTRICTS

District	Common Name	Scientific Name	Description
Anderson-Cottonwood Irrigation District (ACID)	tricolored blackbird	Agelaius tricolor	bird
	bald eagle	Haliaeetus leucocephalus	bird
	osprey	Pandion haliaetus	bird
	bank swallow	Riparia riparia	bird
	spring-run chinook salmon	Oncorhynchus tshawytscha spring-run	fish
	chinook salmon winter run	Oncorhynchus tshawytscha winter run	fish
	vernal pool fairy shrimp	Branchinecta lynchi	invertebrate
	valley elderberry longhorn beetle	Desmocerus californicus dimorphus	invertebrate
	vernal pool tadpole shrimp	Lepidurus packardi	invertebrate
	California linderiella	Linderiella occidentalis	invertebrate
	pointed broom sedge	Carex scoparia	plant
	fox sedge	Carex vulpinoidea	plant
	silky cryptantha	Cryptantha crinita	plant
	Red Bluff dwarf rush	Juncus leiospermus var. leiospermus	plant
Browns Valley Irrigation District (BVID)	tricolored blackbird	Agelaius tricolor	bird
	bald eagle	Haliaeetus leucocephalus	bird
	spring-run chinook salmon	Oncorhynchus tshawytscha spring-run	fish
	valley elderberry longhorn beetle	Desmocerus californicus dimorphus	invertebrate
	Brandegee's clarkia	Clarkia biloba ssp. brandegeeae	plant
	dwarf downingia	Downingia pusilla	plant
	northwestern pond turtle	Emys (=Clemmys) marmorata marmorata	reptile
Natomas Central Metropolitan Water District	tricolored blackbird	Agelaius tricolor	bird
	great egret	Ardea alba	bird
	burrowing owl	Athene cunicularia	bird
	Swainson's hawk	Buteo swainsoni	bird

TABLE C-2
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN WATER SELLERS' DISTRICTS

District	Common Name	Scientific Name	Description
	snowy egret	Egretta thula	bird
	black-crowned night heron	Nycticorax nycticorax	bird
	vernal pool fairy shrimp	Branchinecta lynchi	invertebrate
	California linderiella	Linderiella occidentalis	invertebrate
	rose-mallow	Hibiscus lasiocarpus	plant
	giant garter snake	Thamnophis gigas	reptile
Reclamation District 108	tricolored blackbird	Agelaius tricolor	bird
	Swainson's hawk	Buteo swainsoni	bird
	mountain plover	Charadrius montanus	bird
	bank swallow	Riparia riparia	bird
	Ferris's milk-vetch	Astragalus tener var. ferrisiae	plant
	palmate-bracted bird's-beak	Cordylanthus palmatus	plant
	round-leaved filaree	Erodium macrophyllum	plant
	Colusa layia	Layia septentrionalis	plant
	Baker's navarretia	Navarretia leucocephala ssp. bakeri	plant
	Wright's trichocoronis	Trichocoronis wrightii var. wrightii	plant
	giant garter snake	Thamnophis gigas	reptile
River Garden Farms	tricolored blackbird	Agelaius tricolor	bird
	Swainson's hawk	Buteo swainsoni	bird
	bank swallow	Riparia riparia	bird
	Sacramento splittail	Pogonichthys macrolepidotus	fish
Swanston Properties	None	None	none
Conaway Ranch	Buteo swainsoni	Swainson's hawk	bird
	Agelaius tricolor	tricolored blackbird	bird
	Charadrius alexandrinus nivosus	western snowy plover	bird
	Astragalus tener var. tener	alkali milk-vetch	plant

TABLE C-2
SPECIAL STATUS SPECIES POTENTIALLY OCCURRING WITHIN WATER SELLERS' DISTRICTS

District	Common Name	Scientific Name	Description
	Lepidium latipes var. heckardii	Heckard's pepper-grass	plant
	Cordylanthus palmatus	palmate-bracted bird's-beak	plant
	Atriplex joaquiniana	San Joaquin spearscale	plant
	Thamnophis gigas	giant garter snake	reptile

Appendix C2
Survey Protocols

CNPS Botanical Survey Guidelines

CALIFORNIA NATIVE PLANT SOCIETY
December 9, 1983
Revised June 2, 2001

The following recommendations are intended to help those who prepare and review environmental documents determine when a botanical survey is needed, who should be considered qualified to conduct such surveys, how surveys should be conducted, and what information should be contained in the survey report. The California Native Plant Society recommends that lead agencies not accept the results of surveys unless they are conducted and reported according to these guidelines.

1. Botanical surveys are conducted in order to determine the environmental effects of proposed projects on all botanical resources, including special status plants (rare, threatened, and endangered plants) and plant (vegetation) communities. Special status plants are not limited to those that have been listed by state and federal agencies but include any plants that, based on all available data, can be shown to be rare, threatened, or endangered under the following definitions:

    > A species, subspecies, or variety of plant is “endangered” when the prospects of its survival and reproduction are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, over-exploitation, predation, competition, or disease. A plant is "threatened" when it is likely to become endangered in the foreseeable future in the absence of protection measures. A plant is "rare" when, although not presently threatened with extinction, the species, subspecies, or variety is found in such small numbers throughout its range that it may be endangered if its environment worsens.[1]

    Rare plant (vegetation) communities are those communities that are of highly limited distribution. These communities may or may not contain special status plants. The most current version of the California Natural Diversity Database's *List of California Terrestrial Natural Communities*[2] should be used as a guide to the names and status of communities.

    Consistent with the California Native Plant Society’s goal of preserving plant biodiversity on a regional and local scale, and with California Environmental Quality Act environmental impact assessment criteria[3], surveys should also assess impacts to locally significant plants. Both plants and plant communities can be considered significant if their local occurrence is on the outer limits of known distribution, a range extension, a rediscovery, or rare or uncommon in a local context (such as within a county or region). Lead agencies should address impacts to these locally unique botanical resources regardless of their status elsewhere in the state.

2. Botanical surveys must be conducted to determine if, or to the extent that, special status or locally significant plants and plant communities will be affected by a proposed project when any natural vegetation occurs on the site and the project has the potential for direct or indirect effects on vegetation.

3. Those conducting botanical surveys must possess the following qualifications:
    a. Experience conducting floristic field surveys;
    b. Knowledge of plant taxonomy and plant community ecology and classification;
    c. Familiarity with the plants of the area, including special status and locally significant plants;

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[1] California Environmental Quality Act Guidelines, §15065 and §15380.
[2] List of California Terrestrial Natural Communities. California Department of Fish and Game Natural Diversity Database. Sacramento, CA.
[3] California Environmental Quality Act Guidelines, Appendix G (Initial Study Environmental Checklist).

d. Familiarity with the appropriate state and federal statutes related to plants and plant collecting; and,
e. Experience with analyzing impacts of a project on native plants and communities.

4. Botanical surveys should be conducted in a manner that will locate any special status or locally significant plants or plant communities that may be present. Specifically, botanical surveys should be:

   a. Conducted in the field at the proper times of year when special status and locally significant plants are both evident and identifiable. When special status plants are known to occur in the type(s) of habitat present in the project area, nearby accessible occurrences of the plants (reference sites) should be observed to determine that the plants are identifiable at the time of survey.

   b. Floristic in nature. A floristic survey requires that every plant observed be identified to species, subspecies, or variety as applicable. In order to properly characterize the site, a complete list of plants observed on the site shall be included in every botanical survey report. In addition, a sufficient number of visits spaced throughout the growing season is necessary to prepare an accurate inventory of all plants that exist on the site. The number of visits and the timing between visits must be determined by geographic location, the plant communities present, and the weather patterns of the year(s) in which the surveys are conducted.

   c. Conducted in a manner that is consistent with conservation ethics and accepted plant collection and documentation techniques[4,5]. Collections (voucher specimens) of special status and locally significant plants should be made, unless such actions would jeopardize the continued existence of the population. A single sheet should be collected and deposited at a recognized public herbarium for future reference. All collections shall be made in accordance with applicable state and federal permit requirements. Photography may be used to document plant identification only when the population cannot withstand collection of voucher specimens.

   d. Conducted using systematic field techniques in all habitats of the site to ensure a thorough coverage of potential impact areas. All habitats within the project site must be surveyed thoroughly in order to properly inventory and document the plants present. The level of effort required per given area and habitat is dependent upon the vegetation and its overall diversity and structural complexity.

   e. Well documented. When a special status plant (or rare plant community) is located, a California Native Species (or Community) Field Survey Form or equivalent written form, accompanied by a copy of the appropriate portion of a 7.5-minute topographic map with the occurrence mapped, shall be completed, included within the survey report, and separately submitted to the California Natural Diversity Database. Population boundaries should be mapped as accurately as possible. The number of individuals in each population should be counted or estimated, as appropriate.

5. Complete reports of botanical surveys shall be included with all environmental assessment documents, including Negative Declarations and Mitigated Negative Declarations, Timber Harvesting Plans, Environmental Impact Reports, and Environmental Impact Statements. Survey reports shall contain the following information:

   a. <u>Project location and description</u>**,** including:

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[4] Collecting Guidelines and Documentation Techniques. California Native Plant Society Policy (adopted March 4, 1995).
[5] Ferren, W.R., Jr., D.L. Magney, and T.A. Sholars. 1995. The Future of California Floristics and Systematics: Collecting Guidelines and Documentation Techniques. *Madroño* 42(2):197-210.

1) A detailed map of the location and footprint of the proposed project.
2) A detailed description of the proposed project, including one-time activities and ongoing activities that may affect botanical resources.
3) A description of the general biological setting of the project area.

b. Methods, including:
1) Survey methods for each of the habitats present, and rationale for the methods used.
2) Description of reference site(s) visited and phenological development of the target special status plants, with an assessment of any conditions differing from the project site that may affect their identification.
3) Dates of surveys and rationale for timing and intervals; names of personnel conducting the surveys; and total hours spent in the field for each surveyor on each date.
4) Location of deposited voucher specimens and herbaria visited.

c. Results, including:
1) A description and map of the vegetation communities on the project site. The current standard for vegetation classification, *A Manual of California Vegetation*[6], should be used as a basis for the habitat descriptions and the vegetation map. If another vegetation classification system is used, the report must reference the system and provide the reason for its use.
2) A description of the phenology of each of the plant communities at the time of each survey date.
3) A list of all plants observed on the project site using accepted scientific nomenclature, along with any special status designation. The reference(s) used for scientific nomenclature shall be cited.
4) Written description and detailed map(s) showing the location of each special status or locally significant plant found, the size of each population, and method used to estimate or census the population.
5) Copies of all California Native Species Field Survey Forms or Natural Community Field Survey Forms and accompanying maps.

d. Discussion**,** including:
1) Any factors that may have affected the results of the surveys (*e.g.*, drought, human disturbance, recent fire).
2) Discussion of any special local or range-wide significance of any plant population or community on the site.
3) An assessment of potential impacts. This shall include a map showing the distribution of special status and locally significant plants and communities on the site in relation to the proposed activities. Direct, indirect, and cumulative impacts to the plants and communities shall be discussed.
4) Recommended measures to avoid and/or minimize direct, indirect, and cumulative impacts.

e. References cited and persons contacted.

f. Qualifications of field personnel including any special experience with the habitats and special status plants present on the site.

[6] Sawyer, J.O. and T. Keeler-Wolf. 1995. *A Manual of California Vegetation.* California Native Plant Society. Sacramento, CA. 471 pp.

April 19, 1996

Interim Survey Guidelines to Permittees for Recovery Permits under Section 10(a)(1)(A) of the Endangered Species Act for the Listed Vernal Pool Branchiopods

The endangered Conservancy fairy shrimp (*Branchinecta conservatio*), longhorn fairy shrimp (*Branchinecta longiantenna*), vernal pool tadpole shrimp (*Lepidurus packardi*), and the threatened vernal pool fairy shrimp (*Branchinecta lynchi*) were listed on September 19, 1994, under the Endangered Species Act of 1973, as amended (Act) (59 Federal Register 48136). These species are endemic to vernal pools in the Central Valley, coast ranges, and a limited number of sites in the Transverse Range and Riverside County, California. The endangered Riverside fairy shrimp (*Streptocephalus woottoni*) was listed under the Act on August 3, 1993 (58 Federal Register 41391). This species inhabits Riverside, Orange and San Diego Counties, California, and northern Baja California, Mexico. These five species, hereafter referred to as vernal pool branchiopods, are fully protected under the Act. The San Diego fairy shrimp (*Branchinecta sandiegonensis*) is a proposed endangered species. Surveys for all these species should follow the methodologies described in these Interim Survey Guidelines (Guidelines). It is expected that the Guidelines will be revised in the future as additional information becomes available.

These Guidelines are issued as guidance to section 10(a)(1)(A) permittees. Because taking (killing, injuring, harming or harassing) endangered species is strictly prohibited under the Act, a section 10(a)(1)(A) recovery permit must be obtained prior to initiating any surveys or studies that might result in the take of endangered or threatened branchiopods. Failure to obtain this permit may result in violation(s) of section 9 of the Endangered Species Act. Additionally, violation(s) of a section 10(a)(1)(A) permit may result in its non-renewal, suspension or revocation.

For the purposes of these Guidelines, vernal pools and swales are defined as follows:

> Vernal pools and swales are ephemeral wetlands that form in areas of California with Mediterranean climates that have shallow depressions underlain by a substrate of hardpan, clay, or basalt near the surface that restricts the percolation of water. They may be characterized by a barrier to overland flow that causes water to collect and pond. Vernal pools/swales may occur singly, but more typically occur in vernal pool/swale complexes, due to the local hydrology, geology, and topography. Initially, the dry soil in vernal pools/swales becomes wet and starts to saturate during the fall and early winter rains. The second stage in a typical vernal pool cycle is characterized by peak rainfall and inundation of the vernal pools/swales. Vernal pools may remain inundated until spring or early summer, sometimes filling and emptying numerous times during the wet season. The vernal pools gradually dry down during the spring, quite often forming the unique "bathtub ring" of flowers from endemic vernal pool plants blooming profusely at the pool margins. This drying down stage is typified by the production of seeds in the endemic plants and the dispersal of animals from the vernal pools. These pools eventually dry down totally, with the onset of drought conditions. During this final stage, early season and shallow-rooted plants turn brown, and the soil dries and may crack. With average rainfall patterns, vernal pools are typically characterized by a predominantly annual plant community dominated by wetland species.

Note: At this time, vernal pool-associated activities not directed toward the listed species, such as botanical surveys and wetland delineations, are not considered to require a permit. However, persons conducting such activities should minimize any potential impact on the vernal pool branchiopods or plants by reducing the amount of walking through vernal pools to the lowest extent practical. Persons conducting projects that require permits (e.g., branchiopod or amphibian surveys) should also minimize walking through the pools.

I. Survey Approval

Unless otherwise authorized by the U.S. Fish and Wildlife Service (Service) in writing, these Guidelines shall be utilized for all surveys conducted for the listed vernal pool branchiopods. Any deviations from the methods prescribed by these Guidelines must be approved by the Service before surveys are conducted. The permittee shall provide the appropriate Service Field Office (see XI, Service Contact section) with all of the following information in writing for each project site at least 10 working days prior to the anticipated start date of survey work:

a. The precise location of the project site clearly delineated on either an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=2,000 ft.). The map should contain the project name, type of project by category [the categories are: development, mitigation banking, or other (specify)], the estimated area (acreage) of the project site and an estimated number or area (acreage) of pool/swales on the site, quad name, and county name;

b. Names of all vernal pool biologists and associated personnel with reference to their section 10(a)(1)(A) permit number; and

c. A written request to commence wet season or dry season sampling for each project to be surveyed for the listed vernal pool branchiopods.

II. Sampling Survey Completion

a. Once initiated, surveys conducted pursuant to these Guidelines may be suspended prior to completion if:

1. the presence of one or more of the five listed branchiopods on the subject site is determined through identification at any point within the wet season survey cycle; or

2. it is agreed that one or more of the listed vernal pool branchiopods are present on the subject site.

b. Permission to dry season survey for the listed vernal pool branchiopods requires the completion of both the full wet season survey and the dry season survey, including the complete analysis of all dry soil samples (see V).

c. A complete survey consists of sampling for either:

1. two full wet season surveys done within a 5-year period; or

2. two consecutive seasons of one full wet season survey and one dry season

survey (or one dry season survey and one full wet season survey).

d. Each vernal pool/swale in a vernal pool/swale complex shall be surveyed as per these Guidelines. However, in the case of a large vernal pool/swale complex, the Service may authorize a representative portion or portions of the vernal pool/swale complex to be surveyed as per these Guidelines.

III. Notification of Presence

Should the permittee determine that any of the five listed vernal pool branchiopods are present at a site, the appropriate Service Field Office (see XI, Service Contact section) shall be notified within 10 working days by letter or telephone.

IV. Wet Season Surveys

Wet season survey sampling shall not be conducted at any project site unless the permittee receives prior permission from the Service (see I (c)).

a. Survey Initiation, Frequency, and Termination

1. Surveyors should visit sites after initial storm events to determine when pools/swales have been inundated. A pool/swale is considered to be inundated when it holds greater than 3 cm of standing water 24 hours after a rain event.

2. Pools/swales shall be adequately sampled once every two weeks, beginning no later than two weeks after their initial inundation and continuing until they are no longer inundated, or until they have experienced 120 days of continuous inundation. .

3. In cases where the pools/swales dry and then refill in the same wet season, sampling shall be reinitiated within eight days of refilling every time they meet the 3 cm of standing water criteria and shall continue until they have experienced 120 days of continuous inundation, or until they are no longer inundated.

4. If a vernal pool/swale has already experienced 120 days of continuous inundation, but then dries down and subsequently refills in the same wet season, surveys must be re-initiated in accordance with IV(a)(3) above, each time the vernal pool/swale refills and meets the 3 cm of standing water criteria.

5. Once initiated, surveys conducted pursuant to these Guidelines may be suspended prior to completion if the presence of one or more of the five listed branchiopods on the subject site is determined through identification at any point within the wet season survey cycle

b. Survey Sampling At each wet season visit, representative portions of the pool/swale bottom, edges, and vertical water column shall be adequately sampled using a seine, dip net or aquarium net appropriate for the size of the pool or swale. Net mesh size shall not be larger than (1/8) inch. Seines shall be examined and emptied of material at least once every five linear meters.

c. Voucher Specimens

1. Voucher specimens shall be collected only once for each individual vernal pool/swale and shall be accessioned to either the California Academy of Sciences (CAS) or the Natural History Museum of Los Angeles County (LACM) (see VIII).

2. Voucher specimens of all listed vernal pool branchiopods captured shall be collected and all other specimens shall be returned in good condition to the vernal pool/swale where they were found as quickly as possible.

3. No more than 20 specimens of each species of listed vernal pool branchiopods from each pool/swale, or less than 10% of the subpopulation present in the pool/swale, whichever is the lesser amount, shall be retained and preserved as voucher specimens.

4. Only sexually mature, adult branchiopods shall be used for purposes of voucher specimens for species identification. The Service will not accept species identifications made using immature specimens.

5. The sample of 20 voucher specimens shall include no less than three specimens of either sex.

V. Dry Season Surveys

Dry season soil sampling shall not be conducted at any project site unless the permittee receives prior written permission from the Service (see I (c)).

a. Soil Collection

Soil shall be collected when it is dry to avoid damaging or destroying cysts which are more fragile when wet. A hand trowel or similar instrument shall be used to collect approximately one liter volume sample per pool/swale of the top 1-3 cm of pool sediment. Whenever possible, soil samples shall be collected in chunks. The trowel shall be used to pry up intact chunks of sediment, rather than loosening the soil by raking and shoveling which can damage cysts.

In southern California there are a number of federally listed plant species (Orcuttia californica, Pogogyne abramsii, and Pogogyne nudiscula) that often co-occur with the fairy shrimp. Removal of soil could damage populations of these plants by inadvertently removing seed. Dry sampling should be minimized or avoided within those vernal pools/swales that are known to, or may, contain these species. The permittee shall contact the Carlsbad Field Office (see XI, Service Contact section) regarding the distribution of these listed plants species prior to conducting dry sampling in Los Angeles, Orange, Riverside and other southern California counties.

b. Soil Sample Volume

Each soil sample from the 10 soil sample locations shall be labeled, stored, and analyzed individually.

1. A total of 10 soil samples of approximately 100 ml each shall be taken from each pool/swale, for a total soil sample volume of approximately one liter per pool/swale.

2. In the case of a very large playa, dry lake, or vernal pool, the Service may authorize the removal of more than one liter of soil.

3. If a pool has a diameter of less than three meters, the total soil sample taken shall not exceed ½ liter in volume per pool, and the 10 soil samples shall be approximately 50 ml each in volume.

c. Soil Sample Locations

A total of 10 soil samples shall be collected from the following locations within each pool/swale sampled:

1. Starting with one soil sample taken from the edge of the pool/swale, at least four soil samples shall be taken from equidistant points along the longest transect of the pool/swale.

2. Starting with one soil sample taken from the edge of the pool/swale, at least four soil samples shall be taken from equidistant points along the widest transect of the pool/swale.

3. If neither the longest or the widest transect encompasses the deepest part (or parts) of the pool/swale, then at least two soil samples shall be taken from the deepest part (or parts) of the pool/swale..

d. Soil Storage

1. The soil samples from each soil sample location shall be stored in separate bags, labeled with the specific location within the pool/swale from where each soil sample was taken. A sketch of the pool/swale showing the specific location of each soil sample shall be included in the 90-day report.

2. Soil samples containing any residual moisture initially shall be adequately ventilated and allowed to air dry thoroughly before storage of the sample. The bags containing the soil samples shall be kept out of direct sunlight in order to avoid excessively heating the sample.

3. All soil samples shall be retained and stored as directed in V(d)(1) and V(d)

(2) above until the Service is able to provide direction in species-level identification of the cysts of all the aforementioned branchiopod species.

e. Soil Sieving

1. The soil samples shall not be ground, crushed, or otherwise manipulated in order to expedite the sieving process. A relatively short period of pre-soaking the soil sample may be helpful/necessary in order to facilitate the sieving process. Small aliquots (approximately 50 ml in volume) of soil shall be gently washed with water through a graded series of U.S. standard eight inch soil sieves ending in mesh sizes 300 micron (um), and 150 micron (um).

2. Sieves must be thoroughly rinsed and visually inspected for any cysts adhered to the sieves prior to the start of sieving. This process must be repeated for each individual soil sample location. Sieves shall also be rinsed and thoroughly inspected upon completion of sieving soil samples.

f. Soil Examination

1. Washed and sieved soil fractions from the 300 um and 150 um sieves shall be examined under a dissecting microscope for tadpole shrimp and fairy shrimp cysts. The process shall be repeated until all individual soil samples have been examined. All sieved material shall be processed and dried as quickly as possible, preferably within one hour from the initial wetting.

Note: Do not return soil to survey sampling site.

2. All fairy shrimp and tadpole shrimp cysts shall be removed from the soil, separated by cyst type into labeled vials, allowed to air-dry, and then stored dry.

g. Cyst Density

Cyst density information for each soil sample location shall be calculated by dividing the total number of cysts recovered by the total amount of soil from the individual aliquots from that soil sample location. Total cyst density information for each soil sample location shall be reported for each species in terms of: none; 1-25 cysts/100 ml soil; 26-50 cysts/100 ml soil; 51-100 cysts/100 ml soil; 101-199 cysts/100 ml soil; or more than 200 cysts/100 ml soil.

h. Cyst Identification

Each fairy shrimp and tadpole shrimp cyst type shall be identified to genus by a qualified biologist. The Service may require an independent review by a crustacean biologist(s) of any vernal pool branchiopod or cyst identification.

There are two options when a branchiopod cyst identification is made to genus:

1. the survey, pursuant to these Guidelines, may be suspended if it

is agreed one or more of the listed species are present on the project site; or

2. one subsequent complete wet season sampling survey shall be conducted to complete survey requirements.

VI. Cyst Voucher Specimens

A representative sample of each cyst type from each pool/swale shall be accessioned to either CAS or LACM (see VIII).

VII. 90-Day Reports

a. U.S. Fish & Wildlife Service

The permittee shall provide the appropriate Service Field Office (listed in the Service Contact section) with all of the following information in writing, using the appropriate Vernal Pool Data Sheet where applicable as the reporting form, no more than 90 calendar days after completing the last field visit of the season at each project site:

1. The location of the project site clearly delineated on an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=2,000 ft.). The location of the listed vernal pool branchiopods is to be included on the 7.5 minute maps in as precise a manner as possible (e.g., lat/long or location within a section).

2. Five color photographic 35mm slides and/or 3" x 5" photographs of each project site taken during sampling in the wet season; this is to include two slides and/or photographs taken from standing position that portray the general landscape of the site [i.e., two photos from an opposing axis of the site (e.g., north and south compass headings)]; and three slides and/or photographs of representative vernal pools, swales, and other areas within the site sampled for the five listed vernal pool branchiopod species. The following information shall be legibly written on each slide/photograph with permanent ink: precise location of the project site, direction from which photograph was taken, date of photograph, initials of photographer, and initials of the scientific names of any of the five listed vernal pool branchiopod species that were found at the depicted site. Note: Slides and/or photographs only need to be submitted once per project site.

3. The estimated number of individuals of any of the listed vernal pool branchiopods observed in each pool/swale shall be reported in terms of an order of magnitude (e.g., 10's, 100's, 1000's). (*Refer to the Vernal Pool Data Sheet*)

4. The number of individuals of any of the listed vernal pool

branchiopods or cysts preserved from each pool/swale and the name of the institution in which they are accessioned.
(*Refer to the Vernal Pool Data Sheet*)

5. A qualitative description of the vernal pool/swale community. A general list of amphibian species and non-listed vernal pool crustacean species (by common and/or scientific name) encountered at the project site is desirable. For purposes of this permit a full survey for these species is not required. However, if more detailed information is collected, it shall be included in the Vernal Pool Data Sheet. .
(*Refer to the Vernal Pool Data Sheet*)

6. Data collected during each field visit, including: date, air temperature, water temperature, weather conditions (e.g., sunny, overcast), maximum depth of each pool/swale, and size (area in square meters) of each pool/swale.
(*Refer to the Vernal Pool Data Sheet*).

7. (Optional) water chemistry data collected during each field visit, including: alkalinity (total: ppm or mg/l), conductivity (uMHO), dissolved oxygen (ppm or mg/l), dissolved NH4 (ppm or mg/l), pH, salinity (ppt), total dissolved solids (TDS, ppm), and turbidity.
(Refer to the Vernal Pool Data Sheet)

b. California Department of Fish & Game

1. Permittees should consult with the California Department of Fish and Game (916/653-4875) to determine their responsibilities under the California Endangered Species Act and the California Fish and Game Code.

2. The permittee shall supply the California Department of Fish and Game (Natural Diversity Data Base, Staff Zoologist, California Department of Fish and Game, 1416 9th Street, Sacramento, California 95814; telephone 916/322-2494) with completed California Native Species Field Survey Forms, no more than 90 calendar days after completing the last field visit of the season at each project site.

VIII. Accessioning Voucher Specimens

a. All vernal pool branchiopod voucher specimens (including individuals collected and cysts) shall be accessioned into either the California Academy of Sciences (CAS) or the Natural History Museum of Los Angeles County (LACM). All specimens shall be preserved according to the accession standards of the repository which will accession and maintain the specimens. The October 1995 CAS and September 1995 LACM standards are attached to these Interim Survey Guidelines.

b. All vernal pool branchiopod voucher specimens (including individuals collected and cysts), along with a copy of the Vernal Pool Data Sheet containing all of the items listed in VII (a), shall be permanently deposited in the CAS or LACM within 90 calendar days of the completion of the field survey and the Service shall be supplied with the CAS or LACM catalog numbers given to the specimens.

c. The permittee shall supply the CAS or LACM with a photocopy of their section 10(a)(1)(A) permit to validate that the specimens supplied to them were taken pursuant to a permit. The Service will likely consider refusal by the CAS or LACM to accession any listed branchiopod specimens to be a violation by the permittee of their section 10(a)(1)(A) permit (e.g., if due to improper preservation/storage).

California Academy of Sciences (CAS)
Department of Invertebrate Zoology and Geology, Golden Gate Park,
San Francisco, California 94118; telephone (415) 750-7082

Natural History Museum of Los Angeles County (LACM)
Crustacea Section, Invertebrate Zoology, 900 Exposition Boulevard,
Los Angeles, California 90007; telephone (213) 744-3450

IX. Additional information, limitations, and caveats with respect to these Guidelines are as follows:

a. From time to time, specific circumstances may justify or necessitate revision of these Guidelines, on a case-by-case basis. At the discretion of the Service, such a variance may be allowable under these Guidelines if:

1. the permittee explains to the Service in writing why the variance to the Guidelines is needed and justified; and

2. the Service concurs, in writing, with the variance requested by the permittee.

b. The Service reserves the right to reject vernal pool branchiopod surveys conducted under these protocols as inadequate if:

1. survey methods used are inconsistent with these Guidelines, unless prior written permission (see I, Survey Approval) has been obtained; or

2. other information indicates that the survey is inadequate as determined by the Service.

X. Permit Infractions

The Service may consider any of these actions to be a violation by the permittee of their section 10(a)(1)(A) permit:

a. falsification of any reporting or information;

b. failure to follow the stated Guidelines sampling methodologies;

c. failure to obtain prior permission to commence wet season surveys or failure to obtain written permission to commence dry season surveys (see section I (c));

d. failure to notify the Service within 10 days of a determination of presence of one or more of the listed vernal pool branchiopods on a survey site;

e. failure to accession voucher specimens or improperly accessioned voucher specimens;

f. failure to file completed 90-day reports with the Service within 90 calendar days after completing the last field visit of the season at each project site; or

g. failure to file completed Natural Diversity Data Base forms with the California Department of Fish and Game within 90 calendar days after completing the last field visit of the season at each project site.

Violation(s) of a section 10(a)(1)(A) permit may result in its non-renewal, suspension or revocation.

XI. Service Contact

For the Central Valley hydrographic basin and the coast ranges north of the Santa Cruz County line, the Sacramento Field Office (2800 Cottage Way Room E-1803, Sacramento, California 95825; telephone 916/979-2728) should be contacted regarding vernal pool branchiopod issues.

For areas from Santa Cruz County south to Ventura County, contact the Ventura Field Office (2493 Portola Road - Suite B, Ventura, California 93003; telephone 805/644-1766).

For areas from Los Angeles County south to the U.S.- Mexico border, contact the Carlsbad Field Office (2730 Loker Avenue West, Carlsbad, California 92008; telephone 619/431-9440).

Outdated information has been corrected or deleted.
Programmatic consultation is suspended in San Joaquin Valley except where there are approved HCPs (habitat conservation plans).

U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825

In Reply Refer To:
1-1-96-F-1

February 28, 1996

Mr. Art Champ
Regulatory Branch
Department of the Army
U.S. Army Engineer District, Sacramento
Corps of Engineers
Sacramento, CA 95814-2922

Subject: Programmatic Formal Endangered Species Act Consultation on Issuance of 404 Permits for Projects with Relatively Small Effects on Listed Vernal Pool Crustaceans Within the Jurisdiction of the Sacramento Field Office, California

Dear Mr. Champ:

This document serves as a programmatic formal consultation document pursuant to section 7 of the Endangered Species Act of 1973, as amended (Act), on issuance of Clean Water Act section 404 permits for projects with limited environmental impacts on vernal pools within the jurisdiction of the Sacramento Field Office (SFO) of the U.S. Fish and Wildlife Service (Service). The issues addressed in this document are the effects of these projects on the endangered Conservancy fairy shrimp (*Branchinecta conservatio*), longhorn fairy shrimp (*Branchinecta longiantenna*), vernal pool tadpole shrimp (*Lepidurus packardi*), and/or the threatened vernal pool fairy shrimp (*Branchinecta lynchi*). These animals (species) were listed on September 19, 1994 (59 **FR** 48136). This consultation document has been prepared pursuant to 50 CFR 402 of our interagency regulations governing section 7 of the Act.

The purpose of this programmatic consultation document is to expedite consultations on proposed projects with relatively small impacts on listed species. Future projects that meet the conditions specified below, or that the SFO determines will have similar impacts, may be appended to this consultation document. Contributions from the State resources agencies, U.S. Army Corps of Engineers (Corps), and U.S. Environmental Protection Agency have aided the development of this consultation document. Continued assistance of these entities in implementing its provisions will facilitate the purpose of streamlining the consultation process.

This consultation document is based on information provided in biological assessments and biological data reports submitted to the SFO by the Corps. Information obtained during site visits and meetings between members of my staff, Corps personnel, applicants, and other Federal and State entities has also has been used. These meetings resulted in the development of appropriate mitigation measures that are outlined in the Description of the Proposed Action section below.

This document supersedes the Service's prior programmatic consultation document on vernal pool crustaceans dated April 4, 1995. The Service will reevaluate the effectiveness of this programmatic consultation at least every six (6) months to ensure that continued implementation will not result in unacceptable effects on the ecosystem upon which the listed species depend. This opinion may be modified during reevaluation to alleviate excessive effects on listed species or problems with the programmatic process.

BIOLOGICAL OPINION

Description of the Proposed Action

This consultation collectively covers projects with small effects on listed vernal pool crustaceans in the Sacramento Basin of California. For the purposes of this consultation, all applicants will have either surveyed habitat of these species (habitat) and confirmed the presence of listed species, or chosen to assume that all potential habitat contains listed species.

Habitat is considered to include any areas that seasonally pond water in which one or more of the listed vernal pool species could exist. Such areas include, but may not be restricted to, vernal pools and swales. Vernal pools and swales are ephemeral wetlands that typically form in shallow depressions underlain by a substrate near the surface that restricts the percolation of water. They are characterized by a barrier to overland flow that causes water to collect and pond. These depressions fill with rainwater and runoff from adjacent areas during the winter and may remain inundated until spring or early summer, sometimes filling and emptying more than once during the wet season. Vernal pools and swales are frequently clustered into assemblages known as vernal pool complexes. Individual pools within a vernal pool complex are mutually interdependent in supporting listed vernal pool species; when a species is extirpated from an individual pool, other pools in the complex may serve as recolonization sources. Upland habitat and swales around and within a vernal pool complex are essential to the hydrological and biological integrity of the complex.

All projects implemented under this programmatic consultation will meet the following conditions or will be determined by the Service to have impacts similar in nature:

1. Less than one acre of habitat will be affected, including habitat filled or otherwise destroyed (directly affected) and habitat indirectly affected by the proposed action.

Habitat indirectly affected includes all habitat supported by destroyed upland areas and swales, and all habitat otherwise damaged by loss of watershed, human intrusion, introduced species, and pollution caused by the project (see Effects of the Proposed Action below). Where the reach of these effects cannot be determined definitively, all habitat within 250 feet of proposed development may be considered to be indirectly affected. If any habitat within a vernal pool complex is destroyed, then all remaining habitat within the complex may potentially be indirectly affected. If any part of a vernal pool is destroyed, then the entire pool is directly affected.

2. Projects proposed in areas with known populations of the Conservancy fairy shrimp or longhorn fairy shrimp (in Butte, Tehama, Solano, Glenn, Merced, San Luis Obispo, and Contra Costa Counties) will not proceed until the Corps has initiated consultation and the Service has reviewed the proposed projects to ensure that impacts to these species are adequately mitigated.

3. Projects with listed or proposed plant species will undergo individual review, but, upon determination by the Service, may be included as part of this consultation.

Projects that are not consistent with these conditions may be appended to this biological opinion only as the Service deems appropriate. For example, a project that affects 5 acres of habitat, but has effects similar in scope and nature to those analyzed in this biological opinion, may be appended in the future. If the project is implemented in a manner consistent with the process described within this biological opinion, take resulting from implementation of the proposed project may be permitted.

The impacts of projects that will be authorized under this biological opinion on vernal pool species will be minimized as follows:

A. **Preservation component.** For every acre of habitat directly or indirectly affected, at least two vernal pool credits will be dedicated within a Service-approved ecosystem preservation bank, or, based on Service evaluation of site-specific conservation values, three acres of vernal pool habitat may be preserved on the project site or on another non-bank site as approved by the Service (Table 1).

B. **Creation component.** For every acre of habitat directly affected, at least one vernal pool creation credit will be dedicated within a Service-approved habitat mitigation bank, or, based on Service evaluation of site-specific conservation values, two acres of vernal pool habitat will be created and monitored on the project site or on another non-bank site as approved by the Service (Table 1).

Table 1. Mitigation ratios for credits dedicated in Service-approved mitigation banks or for acres of habitat outside of mitigation banks.

	bank	non-bank
preservation	2:1	3:1
creation	1:1	2:1

Mitigation ratios for non-bank mitigation may be adjusted to approach those for banks if the Service considers the conservation value of the non-bank mitigation area to approach that of Service-approved mitigation banks.

For non-natural habitat (habitat created *de novo* by human activity), habitat that is significantly altered and without restoration potential, and habitat indirectly affected by agricultural practices, mitigation may be adjusted. Certain agricultural practices have no adverse effect on vernal pool habitat and therefore may be entirely exempt from mitigation. In particular, low intensity grazing may approximately reproduce the natural conditions to which vernal pool crustaceans are adapted (i.e., prehistoric grazing by native herbivores). Consequently, such levels of grazing incur neither the creation nor the preservation component of mitigation.

C. Vernal pool habitat and associated upland habitat used as on-site mitigation will be protected from adverse impacts and managed in perpetuity or until the Corps, the applicant, and the Service agree on a process to exchange such areas for credits within a Service-approved mitigation banking system.

D. If habitat is avoided (preserved) on site, then a Service-approved biologist (monitor) will inspect any construction-related activities at the proposed project site to ensure that no unnecessary take of listed species or destruction of their habitat occurs. The biologist will have the authority to stop all activities that may result in such take or destruction until appropriate corrective measures have been completed. The biologist also will be required to report immediately any unauthorized impacts to the Service and the California Department of Fish and Game.

E. Adequate fencing will be placed and maintained around any avoided (preserved) vernal pool habitat to prevent impacts from vehicles.

F. All on-site construction personnel will receive instruction regarding the presence of listed species and the importance of avoiding impacts to these species and their habitat.

G. The applicant will ensure that activities that are inconsistent with the maintenance of the suitability of remaining habitat and associated on-site watershed are prohibited. This includes, but is not limited to (i) alteration of existing topography or any other alteration or uses for any purposes, including the exploration for or development of mineral extraction; (ii) placement of any new structures on these parcels; (iii) dumping, burning, and/or burying of rubbish, garbage, or any other wastes or fill materials; (iv) building of any new roads or trails; (v) killing, removal, alteration, or replacement of any existing native vegetation; (vi) placement of storm water drains; (vii) fire protection activities not required to protect existing structures at the project site; and (viii) use of pesticides or other toxic chemicals.

To ensure that incremental losses of habitat authorized by this biological opinion do not significantly hinder conservation of the ecosystem upon which listed vernal pool crustaceans depend, the following measures will be taken:

H. Before implementation of each proposed project, the Service will be supplied with a 7.5 minute U. S. Geological Survey topographic map that clearly delineates the project area and habitat contained within this area.

I. The Service will implement a tracking system to ensure that the total amount of listed crustacean habitat affected by projects permitted under this consultation is not so great that it jeopardizes the listed crustacean species in any county within the jurisdiction of the SFO. The Service is conducting a county-by-county survey to determine the extent of existing habitat of listed vernal pool crustaceans. Pending completion of that survey, the Service will ensure that no more than fifty [50] acres of listed crustacean habitat are filled per county, from the date of issuance of this consultation prior to completion of reinitiated formal consultation.

Limiting this programmatic consultation to projects involving relatively minor impacts will minimize effects on the listed vernal pool crustaceans and their habitat. Through the tracking of project impacts over time, effects will be further minimized at local and regional levels.

The emphasis in this programmatic biological opinion on mitigating in ecosystem mitigation banks is justified for projects that meet the conditions listed above, because generally the isolated pools and small complexes to be affected are expected to be less ecologically stable than pools that are part of the larger complexes in mitigation banks. Chance extinctions are more likely to occur in isolated pools and small complexes than in larger complexes. Such stochastic extinctions can result in lower species diversity if they are not balanced by recolonization. In addition, waterfowl are thought to be an important dispersal vehicle for cysts, especially over great distances (e.g., between vernal pool complexes). Large preserve areas are likely to be more attractive to larger numbers of these species.

The use of a habitat banking system has several additional advantages. By combining the mitigation of many applicants, an economy of scale is achieved (i.e., project mitigations have overlapping buffer zones and shared costs of monitoring; larger preserve areas that can maintain the integrity of the ecosystem, are created).

Creation and preservation areas will be established within each county. Thus, it will be assured that mitigation will occur in the same general areas as the destruction, and that local planning efforts will have foundations for conservation planing efforts appropriate for the level of destruction that occurs during the short-term.

The option of on-site mitigation also is included in this biological opinion because of the potential importance of maintaining some remnant of the historic distribution of vernal pool clusters outside of large vernal pool mitigation banks. If these intervening "islands" of habitat are large enough and adequately protected, they may serve as "stepping stones," enabling listed species to disperse and recolonize between the major vernal pool complexes that will be preserved in banks. Such stepping stones may be especially important if wind plays a role in the dispersal of the cysts of listed crustacean species, because wind is probably only effective as a dispersal agent over short distances. An array of on-site reserves, if they are large enough to sustain populations, also may serve to maintain the full range of intraspecific genetic diversity better than reliance solely on a relatively few large reserves. A larger number of reserves also may provide better insurance against local natural disasters, disease, and predation (Simberloff and Abele 1976 and 1982; Quinn and Robinson 1987; Quinn and Hastings 1987).

The comprehensive review of the baseline (the number and location of acres destroyed within each county) that will be conducted at the end of each six-month period will limit the extent of impacts that occur as a result of the implementation of this opinion. During these reviews it may be determined that habitat destruction can continue with the same or otherwise necessary mitigation processes in place, or that further destruction in specific areas will jeopardize listed species. The Service will work closely with recovery efforts to ensure that created and preserved areas are distributed across the landscape in such a manner as to allow them to function effectively.

The following process will be used when implementing proposed projects under this biological opinion:

1. After reviewing the permit request, the Corps will forward to the Sacramento Field Office all biological and other pertinent information along with a letter requesting that the proposed project be appended to this biological opinion;

2. The Service will review the proposed project to determine appropriate mitigation.

3. The Service will deliver to the Corps a letter specifying measures that will adequately mitigate for the impacts of the proposed project (note that this could entail the approval of the applicant's proposed mitigation). Also, the Service will designate a staff biologist to serve as the contact regarding the proposed project.

4. The Corps will forward the above letter to the applicant, approving the applicant's mitigation plan, or presenting the mitigation requirements and instructing the applicant to contact the Service's staff biologist for assistance in fulfilling the applicant's mitigation responsibilities.

5. After the mitigation responsibilities are fulfilled, the Service will forward a letter to the Corps describing habitat monitoring requirements (if any) and stating that the proposed project is in compliance with requirements of the Act.

Species Accounts

Descriptions of the Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool tadpole shrimp, and the vernal pool fairy shrimp are found in 59 **FR** 48136, the publication of the final rule to list these species under the Act. These crustaceans are restricted to vernal pools, swales, and other seasonal pools in California. Eng *et al*. (1990) and Simovich *et al*. (1992) provide further details on the life history and ecology of the Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool tadpole shrimp, and the vernal pool fairy shrimp.

Fairy shrimp have delicate elongate bodies, large stalked compound eyes, no carapace, and 11 pairs of swimming legs. They swim or glide gracefully upside down by means of complex beating movements of the legs that pass in a wavelike, anterior-to-posterior direction. Nearly all fairy shrimp feed on algae, bacteria, protozoa, rotifers, and bits of detritus. The females carry the eggs in an oval or elongate ventral brood sac. The eggs are either dropped to the pool bottom or remain in the brood sac until the female dies and sinks. The "resting" or "summer" eggs are known as "cysts." They are capable of withstanding heat, cold, and prolonged desiccation. When the pools refill in the same or subsequent seasons, some, but not all, of the cysts may hatch. The cyst bank in the soil may comprise the cysts from several years of breeding. The cysts hatch when the vernal pools fill with rainwater. The early stages of the fairy shrimp develop rapidly into adults. These non-dormant populations often disappear early in the season long before the vernal pools dry up.

The Conservancy fairy shrimp inhabits vernal pools with highly turbid water. The species is known from six disjunct populations: Vina Plains, north of Chico, Tehama County; south of Chico, Butte County; Jepson Prairie, Solano County; Sacramento National Wildlife Refuge, Glenn County; near Haystack Mountain northeast of Merced in Merced County; and the Lockewood Valley of northern Ventura County.

The longhorn fairy shrimp inhabits clear to turbid grass-bottomed vernal pools in grasslands and clear-water pools in sandstone depressions. This species is known only from four disjunct populations along the eastern margin of the central coast range from Concord, Contra Costa County south to Soda Lake in San Luis Obispo County: the Kellogg Creek watershed, the Altamont Pass area, the western and northern boundaries of Soda Lake on the Carrizo Plain, and Kesterson National Wildlife Refuge in the San Joaquin Valley.

The vernal pool fairy shrimp inhabits vernal pools with clear to tea-colored water, most commonly in grass or mud bottomed swales, or basalt flow depression pools in unplowed grasslands. The vernal pool fairy shrimp has been collected from early December to early May. There are 32 known populations of the vernal pool fairy shrimp, extending from Stillwater Plain in Shasta County through most of the length of the Central Valley to Pixley in Tulare County, and along the central coast range from northern Solano County to Pinnacles National Monument in San Benito County. Four additional, disjunct populations exist: one near Soda Lake in San Luis Obispo County, one in the mountain grasslands of northern Santa Barbara County, one on the Santa Rosa Plateau in Riverside County, and one near Rancho California in Riverside County.

The vernal pool tadpole shrimp has dorsal compound eyes, a large shield-like carapace that covers most of the body, and a pair of long cercopods at the end of the last abdominal segment. Tadpole shrimp climb or scramble over objects, as well as plow along or in bottom sediments. Their diet consists of organic detritus and living organisms, such as fairy shrimp and other invertebrates. The vernal pool tadpole shrimp is known from 18 populations in the Central Valley, ranging from east of Redding in Shasta County south to the San Luis National Wildlife Refuge in Merced County, and from a single vernal pool complex located on the San Francisco Bay National Wildlife Refuge in the City of Fremont, Alameda County. This animal inhabits vernal pools containing clear to highly turbid water, ranging in size from 54 square feet in the former Mather Air Force Base area of Sacramento County, to the 89-acre Olcott Lake at Jepson Prairie. The life history of the vernal pool tadpole shrimp is linked to the phenology of the vernal pool habitat. After winter rainwater fills the pools, the populations are reestablished from diapaused cysts which lie dormant in the dry pool sediments. Sexually mature adults have been observed in vernal pools three to four weeks after the pools had been filled. Some of the cysts hatch immediately and the rest enter diapause and remain in the soil to hatch during later rainy seasons.

The listed species of fairy shrimp and tadpole shrimp are imperiled by habitat loss caused by a variety of human-caused activities, primarily urban development, water supply/flood control projects, and conversion of land to agricultural use. Only a small proportion of the habitat of these species is protected from these threats. State and local laws and regulations have not been passed to protect these species, and other regulatory mechanisms necessary for the conservation of the habitat of these species have proven ineffective.

Environmental Baseline

Holland (1978) estimated that between 60 and 85 percent of the habitat that once supported vernal pools, the endemic habitat of the vernal pool fairy shrimp, had been destroyed by 1973. In the ensuing twenty-one years, a substantial amount of remaining habitat has been converted for human uses. The rate of loss of vernal pool habitat in the state has been estimated at two to three percent per year (Holland and Jain 1988). Rapid urbanization of the Central Valley of California currently poses the most severe threat to the continued existence of the listed vernal pool crustaceans. The Sacramento District of the U. S. Army Corps of Engineers has several thousand vernal pools under its jurisdiction (Coe 1988), which includes most of the known populations of these listed species. It is estimated that within 20 years 60 to 70 per cent of these will be destroyed by human activities (Coe 1988).

The habitat of the listed vernal pool crustaceans is highly fragmented throughout their ranges due to conversion of natural habitat for urban and agricultural uses. This fragmentation results in small isolated fairy shrimp populations. Ecological theory predicts that such populations will be highly susceptible to extinction due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1986; Goodman 1987*a*,*b*). Should an extinction event occur in a population that has been fragmented, the opportunities for recolonization are thought to be greatly reduced due to physical (geographical) isolation from other (source) populations.

In accordance with measure I on page five of this biological opinion, the Service has been tracking losses of habitat permitted under this consultation in each county under the jurisdiction of the SFO and within the ranges of the listed crustaceans covered by this consultation. A summary of the results is displayed in Table 2 below.

Table 2. Amount of habitat of listed vernal pool crustaceans that has been permitted for fill under this programmatic consultation since its issuance on April 4, 1995, until February 14, 1996.

County	Acres of Habitat Destroyed
Shasta	0
Tehama	0
Plumas	0
Butte	0.02
Glenn	0
Colusa	0
Sutter	0
Placer	3.378
Yolo	0
Sacramento	3.9
Solano	0.55
San Joaquin	0
Contra Costa	0
Stanislaus	0

Tuolumne	0
Mariposa	0
Merced	0
Madera	0
Fresno	0
Kings	0
Tulare	0
Kern	0
San Luis Obispo	0
TOTAL	7.848

Effects of the Proposed Action

Direct effects

Individuals of listed crustaceans and their cysts may be directly injured or killed by activities leading to the destruction (i.e., the filling of habitat) of the pools in which they exist. The proposed action may directly affect all listed vernal pool crustaceans associated with up to 50 acres of habitat in each of the following counties: Shasta, Tehama, Plumas, Butte, Glenn, Colusa, Sutter, Placer, Yolo, Sacramento, Solano, San Joaquin, Contra Costa, Stanislaus, Tuolumne, Mariposa, Merced, Madera, Fresno, Kings, Tulare, Kern, and San Luis Obispo. Therefore, all listed species associated with up to a total of 1150 acres of habitat may be affected (23 counties times 50 acres per county).

Indirect effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Individuals and their cysts may be injured or killed by several indirect effects:

Changes in hydrology: In addition to the direct impacts associated with filling, development can have impacts on the hydrology of remaining habitat (e.g., pools/swales) and surrounding areas. Projects involving storm water drains, deep ripping, or the coverage of land surfaces with concrete, asphalt, or irrigated recreation parks, etc., can affect the amount and quality of water available to the perched water tables characteristic of vernal pool areas. Changes to the perched water table can lead to alterations in the rate, extent, and duration of inundation (water regime) of remaining habitat. The biota of vernal pools and swales can change when the hydrologic regime is altered (Bauder 1986, 1987). Survival of aquatic organisms like fairy shrimp is directly linked to the water regime of their habitat (Zedler 1987). Therefore, development near vernal pool areas may, at times, result in the failure of local sub-populations of vernal pool organisms, including fairy shrimp and tadpole shrimp.

Roads: Grading for roads may affect the water regime of vernal pool habitat, particularly when grading involves cutting into the substrata in or near habitat areas. Exposure of sub-surface layers of soil at road cuts may hasten the loss of water from adjacent habitat by mass flow through networks of cracks, lenses of coarser material, animal burrows, old root channels, or other macroscopic channels. Any decrease in the duration of inundation of habitat can affect the reproductive success of species present, including the listed vernal pool crustacea. Erosion associated with road building can contaminate vernal habitat through the transport and deposition of sediments into these areas. In addition, roads or other changes in drainage patterns could result in an increase in surface runoff and conversion of vernal pool habitat.

Roads in or near the watersheds of habitat areas can lead to additional impacts through the introduction of chemically laden runoff (i.e., petroleum products) from the road surfaces. Chemical contamination of habitat can kill listed species by poisoning. Roads in close proximity to habitat areas may encourage additional impacts through other human activities.

Human intrusion: Development frequently results in human intrusion into surrounding areas. Human intrusion is a mechanism by which trash or hazardous waste can be introduced into remaining habitat areas (Bauder 1986, 1987). Disposal of waste materials can eliminate habitat, disrupt pool hydrology, or release substances into pools that are toxic or that adversely affect water chemistry. In addition, off-road vehicle use and other recreational activities associated with humans can lead to wheel ruts, soil compaction, increased siltation, destruction of native vegetation, and an alteration of pool hydrology.

Pesticides/Herbicides: Development often results in the introduction of pesticides or herbicides into the environment. These chemical compounds are thought to have adverse effects on all of the listed vernal pool crustacea and/or their cysts. Individuals may be killed directly or suffer reduced fitness through physiological stress or a reduction in their food base due to the presence of these chemicals.

Introduced predators: Development may produce conditions that are favorable for exotic predators such as bullfrogs, and mosquito fish. The stomachs of bullfrogs captured in vernal pools near Chico, California were found to contain large numbers of vernal pool tadpole shrimp (Hayes, pers. com., 1993 in 59 **FR** 48136). Mosquito fish can be equally devastating as predators when introduced into vernal pool habitat. Thus, listed species and their cysts may be adversely affected by the introduction of exotic predators.

Cumulative Effects

Cumulative effects are those impacts of future State, local, and private actions affecting endangered and threatened species that are reasonably certain to occur in the action areas. Future

Federal actions will be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed project.

Because the Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool tadpole shrimp, and vernal pool fairy shrimp are endemic to vernal pools in the Central Valley, coast ranges, and a limited number of sites in the transverse range and Santa Rosa plateau of California, the Service anticipates that a wide range of activities will be determined to affect these species. Such activities include, but are not limited to, urban, water, flood control, highway, and utility projects, chemical contaminants, as well as conversion of vernal pools to agricultural use. Many of these activities will be reviewed under section 7 of the Act as a result of the Federal nexus provided by section 404 of the Federal Water Pollution Control Act, as amended (Clean Water Act). The Service is currently unaware of any State, local, or private actions which, when considered in conjunction with the known environmental baseline for these species, would be likely to preclude the survival and recovery of the Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool tadpole shrimp, and vernal pool fairy shrimp.

Conclusion

After reviewing the current status of the endangered longhorn fairy shrimp, Conservancy fairy shrimp, vernal pool tadpole shrimp, and the threatened vernal pool fairy shrimp; the environmental baseline for the area within the jurisdiction of the SFO; the effects of the proposed projects; and the cumulative effects; it is the Service's biological opinion that the proposed projects, as described in this consultation document, are not likely to jeopardize the continued existence of these species. Critical habitat has not been proposed for these species; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act prohibits take (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harass is defined as an intentional or negligent act that creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Incidental take is any take of listed animal species which result from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered a prohibited taking provided that such taking is in compliance with this incidental take statement.

The measures described below are nondiscretionary, and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

The Service anticipates the following forms of incidental take:

1. An unknown number of adult and juvenile Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool tadpole shrimp, and vernal pool fairy shrimp per pool affected will be killed as a result of proposed projects that will destroy or modify habitat.

2. An unknown number of cysts of the Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool tadpole shrimp, and vernal pool fairy shrimp will be lost per pool affected due to changes in hydrology of habitat that will occur as a result of proposed development projects.

The proposed action may result in incidental take of all listed vernal pool crustaceans associated with up to 50 acres of habitat in each of the following counties: Shasta, Tehama, Plumas, Butte, Glenn, Colusa, Sutter, Placer, Yolo, Sacramento, Solano, San Joaquin, Contra Costa, Stanislaus, Tuolumne, Mariposa, Merced, Madera, Fresno, Kings, Tulare, Kern, and San Luis Obispo.

Effect of the Take

In the accompanying biological opinion, the Service has determined that this level of anticipated take is not likely to result in extinction or a reduction of opportunity for recovery of Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool tadpole shrimp, or vernal pool fairy shrimp.

Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize incidental take of Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool tadpole shrimp, and vernal pool fairy shrimp:

1. The impact of habitat loss to vernal pool species shall be minimized;

2. Loss of listed vernal pool crustacean habitat shall be confined to the proposed project site, and habitat and associated upland remaining on site shall be protected from adverse impacts; and,

3. The baseline condition for vernal pool species shall be adequately tracked to ensure that no more than 50 acres of habitat per county are authorized for fill under this biological opinion.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the following terms and conditions, which implement the reasonable and prudent measures described above, must be complied with.

1. To implement reasonable and prudent measure (1), mitigation measures A through C as described on pages three and four of this biological opinion shall be accomplished. These measures are hereby incorporated into these terms and conditions as requirements of the proposed projects.

2. To implement reasonable and prudent measure (2), mitigation measures D through G as described on page four of this biological opinion shall be accomplished. These measures are hereby incorporated into these terms and conditions as requirements of the proposed projects.

3. To implement reasonable and prudent measure (3), mitigation measures H and I as described on page five of this biological opinion shall be accomplished. These measures are hereby incorporated into these terms and conditions as requirements of the proposed projects.

Reporting Requirements

Any unauthorized deviation from the Description of the Proposed Action will be reported, within one working day of discovery, to the Assistant Field Supervisor at (916) 414-6600. Written notification must be made within three calendar days and include the date, time, and precise location of the event indicated on a U.S. Geological Survey 7.5 minute topographic map, and any other pertinent information. Additionally, color photographs should be taken of the specific site and provided with the notification.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The term "conservation recommendations" has been defined as suggestions from the Service regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information.

The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's 7(a)(1) responsibilities for these species.

1. The Corps should work with the Service to establish functioning preserve and creation banking systems in each county to further the conservation of listed crustacean species. Such banking systems could incorporate other Corps-required mitigation (i.e., seasonal wetlands, riparian habitats, etc.);

2. As recovery plans for listed crustacean species are developed, the Corps should assist the Service in their implementation;

3. The Corps should work with the Service to ensure that its wetland delineation techniques fully assess the impacts of proposed projects on listed crustacean species; and,

4. The uppermost layer of soil in seasonally ponded habitat may contain cysts of listed crustaceans as well as seeds of vernal pool plants. Therefore, before these wetlands are filled, the top layer of soil should be made available to any vernal pool creation bank that requests it, with Service approval, for inoculating newly created pools. Soil stockpiled for this purpose or for on-site creation should be shielded from rain with a water-proof cover to ensure that it remains completely dry.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the project described in this biological opinion. As provided for in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law), and if (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take should cease pending reinitiation.

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Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the California Tiger Salamander
October 2003

The Santa Barbara County population of the California tiger salamander (Ambystoma californiense) was federally listed as endangered on September 21, 2000 (65 FR 57242). The Sonoma County Distinct Population Segment (DPS) of the California tiger salamander was listed as endangered on July 22, 2002 (67 FR 47727). The Central California DPS of the California tiger salamander was proposed for listing as threatened on May 23, 2003 (68 FR 28648). The Santa Barbara and Sonoma County DPSs were proposed for reclassification from endangered to threatened, on May 23, 2003 (68 FR 28648). The California Department of Fish and Game (Department) considers the California tiger salamander throughout its entire range to be a species of special concern.
(Special Animals List July 2003 http://www.dfg.ca.gov/whdab/html/lists.html)

The Service and Department have received numerous requests for guidance in planning for the protection of the California tiger salamander (CTS) at the sites of proposed and existing land use activities. This document provides interim guidance for two procedures to accurately assess the likelihood of CTS presence in the vicinity of a project site, including: (1) an assessment of CTS locality records and potential CTS habitat in and around the project area; and (2) focused field surveys of breeding pools and their associated uplands to determine whether CTS are likely to be present.

Because CTS use aquatic and upland habitats during their life cycle, they may be present in either or both habitats on a given property. For sites with suitable breeding habitat, two consecutive seasons of negative larval surveys and a negative upland drift fence study in the intervening fall/winter are recommended to support a negative finding. For sites with no suitable aquatic breeding habitat, but where suitable upland habitat exists, two consecutive seasons of negative upland drift fence studies are recommended to support a negative finding.

If the following Guidance is followed completely, the results of these site assessments and field surveys will be considered valid by the Service and Department. Results of the site assessments and field surveys should be reported to the appropriate Service's Field Office, if appropriate the Service's Regional Office in Portland, Oregon pursuant to the terms and conditions of the permittee's section 10(a)(1)(A) recovery permit, and to the Department and other agencies or offices as required. Details regarding the recommended content and/or format of reports are provided throughout the remainder of this document.

Surveyors must obtain permission of the landowner before implementing any surveys or research on the CTS. **In locations where the CTS is federally listed surveyors should obtain a Recovery Permit for this species pursuant to section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended, prior to implementing the guidance.** For surveys that may ultimately be used in support of a negative finding, it is recommended that surveyors consult with Service biologists on their study design before beginning work. If surveyors are working in areas with other federally listed species that are likely to be captured incidentally during CTS surveys, surveyors should also possess a valid 10(a)(1)(A) permit for these species (e.g., California red-legged frog, vernal pool tadpole shrimp, etc.). For all locations, the surveyor should hold an active Scientific Collecting Permit from the Department that specifically names CTS surveys as an authorized activity. Authorization Number 9, without explicit permission for handling CTS, is not adequate for CTS surveys.

Site Assessment for the California tiger salamander

Available information about CTS and their habitats in the vicinity of the project should be used to determine the likelihood that CTS may occur there and if field surveys are appropriate. The project proponent should compile and submit to the Service and the Department the following information:

Element 1. Is the project site within the range of the CTS?

The surveyor should review the attached maps or referenced weblink to determine if the project site is within the range of the CTS. For Sonoma County, refer to the attached county map (Sonoma County pdf). For Santa Barbara County, refer to http://www.fws.gov/ventura/es/protocols/ctsfieldsurvey_protocols.pdf. For Monterey, San Benito, and San Luis Obispo counties, contact the Ventura Fish and Wildlife Office at the address provided below. For all other areas, refer to the attached map of California (all of California pdf).

Element 2. What are the known localities of CTS within the project site and within 3.1 miles (5.0 kilometers) (km) of the project boundaries?

This is to place the project site in a regional perspective. The surveyor should consult the California Natural Diversity Data Base (CNDDB) maintained by the Department to determine known localities of the CTS. The Sacramento or Ventura Fish and Wildlife Offices should be contacted for localities within their respective jurisdictions. Other information sources on local occurrences of CTS should be consulted. These sources may include, but are not limited to, biological consultants, local residents, amateur herpetologists, resources managers and biologists from municipal, state, and Federal agencies, environmental groups, and herpetologists at museums and universities. The surveyor should note in their report all known CTS localities within the project site and within 3.1 miles of the project boundaries; if there are no localities within 3.1 miles, the nearest locality should be noted.

Element 3. What are the habitats within the project site and within 1.24 miles (2 km) of the project boundaries?

This distance is based on the observed mobility of the species. Describe the upland and aquatic habitats within the project site and within 1.24 miles of the project boundaries. Characteristics of the site that should be recorded include acreage, elevation, topography, plant communities, presence and types of water bodies, fossorial mammal species and their burrows, current land use, a description of adjacent lands, and an assessment of potential barriers to CTS movement. Use of aerial photographs is necessary to characterize potential breeding habitats that are not part of the project site under consideration. The aquatic habitats should be mapped and characterized (e.g., natural vernal pools, stockponds, drainage ditches, creeks, types of vegetation, surface area, depth, approximate drying date). Suitable upland habitat, including locations of underground refugia, for CTS should be mapped as well, with a focus on areas where small mammal burrows are located or are most dense.

Reporting and interpretation of the site assessment
Site assessments should include, but are not limited to, the following information: (1) photographs of the project site(s); (2) survey dates and times; names of evaluator(s); (3) a description of the site assessment methods used; (4) a list of CTS localities, as requested above; and (5) a map of the site(s) showing habitat as requested above. Maps should be of similar nature to a U.S. Geological Survey (USGS) 7.5-minute (1:24,000) topographic maps -or- Geographic Information System (GIS) data depicting the site(s) and the area within 5 kilometers (3.2 miles) of its boundaries. The report should be provided to the appropriate Service field office and Department regional office prior to initiating field surveys.

After completing items 1-3 of the site assessment (as above), send a report to the appropriate Service field office and Department regional office. Based on the information provided from the site assessment, the Service and Department will provide recommendations as to the appropriateness of field surveys. Surveys should not be initiated until recommended by the Service and Department.

Interim Presence/Negative Finding Survey Guidance for the California Tiger Salamander

Biological field surveys should be conducted for all sites with potential CTS habitat. Due to its unique life history, the CTS can be difficult to detect depending on weather and time of year. Aquatic sampling for larvae during spring months can be the most effective way to determine if CTS are present in a given area. However, especially if environmental conditions are unfavorable, CTS may not breed successfully in a given year. After metamorphosis CTS spend most of each year on land, emerging from refugia only occasionally, usually on rainy nights. CTS have been observed on land 1.24 miles from any potential breeding pool.

At sites that contain both upland habitat and potential breeding habitat (i.e., pools that contain standing water continuously for at least 10 weeks, extending into April), aquatic sampling during two breeding seasons and a drift fence study in the intervening winter should be conducted to support a negative finding. At sites that contain appropriate upland habitat only, but where there is a known or potential breeding site accessible within 1.24 miles, a two-year drift fence study should be conducted.

In years with little rainfall, upland emergence may be reduced and CTS may not breed. Field surveys conducted in years with at least 70% of average rainfall between September 1 and April 1, at the nearest National Oceanic and Atmospheric Administration climate station are most reliable. Data from survey seasons not meeting this criterion will also be considered; surveyors should provide strong justification that their data are reliable including but not limited to local climate (e.g., daily rainfall totals, pond filling date, pond drying date) and biological survey data (e.g., other species captured during each sampling interval).

Aquatic larval sampling

1. Aquatic larval surveys of potential breeding pools should be repeated three times each season. Surveys should be conducted once each in March, April, and May, with at least 10 days between surveys. **If pools are likely to dry prior to the completion of three surveys, the sampling schedule should be shifted accordingly.**

2. Captured CTS should remain in nets for the minimum amount of time necessary, but no longer than 5 minutes. During this time, larvae should not be kept out of water for more than 30 seconds. Photographs should document a representative sample of captured CTS.

3. Disruption to the pond's bottom should be minimized. Shallow areas where young larvae may occur should be traversed in the most direct and least disturbing manner possible.

4. Sampling should cease once presence has been determined to minimize disturbance of pool flora and fauna. If CTS are detected at a pond, subsequent visits to that pond are not necessary.

5. Ponds should be initially sampled using D-shaped or similar, long-handled dipnets with 1/8th inch (3.2mm) or finer mesh. If CTS larvae are not captured in the first 50 dipnet sweeps, covering representative portions of the pond, seines should be used.

6. If dipnetting has been unsuccessful, seines should be used to sample 100% of the surface area of ponds smaller than 1 acre and at least 30% of the surface area of larger pools, including a representative sample from different water depths and vegetated and non-vegetated areas. One eighth inch (3.2 mm) or finer mesh minnow seines with weights along the bottom and floats along the top edge should be used, with dowling or PVC pipe attached to the end of the seine so the bottom edge can be dragged along the bottom of the pool. Whenever possible, the seine should be pulled from one edge of the pond to the other.

7. Use of minnow traps will be considered on a case-by-case basis. Minnow trapping for CTS larvae should only be conducted in habitats that are too deep to adequately survey with dipnets and seines, or in which dense vegetation impedes normal dipnetting/seining activities. **In these cases the surveyor should submit to the Service a written minnow trap sampling design based on the requirements detailed below.** No minnow trapping should be conducted in ponds known to support state or federally threatened or endangered animals (e.g., California red-legged frogs (Rana aurora draytonii)). In areas where California red-legged frogs may occur, minnow trapping should be preceded by negative surveys following the Service guidelines for this species. To conduct minnow trap sampling in pools known to contain California red-legged frogs, surveyors must possess a valid Recovery Permit for this species pursuant to section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended.

   Minnow trapping should be conducted in the following manner:

   a. Minnow traps should be monitored for three three-day intervals between March 1 and May 15 (for a total of nine days of trapping per site). Trapping intervals should be separated by at least ten days. Minnow trap surveys should immediately cease if CTS presence is determined.

   b. Minnow trapping should be avoided during warm periods when air temperatures reach 80 degrees Fahrenheit or when water temperatures reach 70 degrees Fahrenheit or warmer, to prevent the possibility of mortality due to reduced oxygen availability.

   c. Minnow traps should be deployed overnight and checked frequently enough to ensure that larvae are not killed or injured. Traps should be checked at least once per day.

   d. A minimum of four traps should be placed in each pond. For larger ponds, traps should be distributed along the shoreline with no more than 75 ft (23 m) between traps. Each trap should be clearly marked with the name, telephone number, and State and Federal permit number of the surveyor. Traps should be anchored to stakes set near the shoreline. Steel braided fishing line or heavy cord works well for this purpose; galvanized wire and stainless steel wire should not be used because these wires may kink and break. If livestock are present, we recommend that the surveyor devise a method to anchor the trap in a manner to prevent entanglement of livestock. Brightly colored flagging should be affixed to each anchor point. For extra security, a float attached to each trap can aid in detection. If a minnow trap is lost, every effort should be made to recover it to avoid the possibility of leaving behind a trap that can kill a variety of species over time.

   e. Traps should be deployed to the deepest parts of ponds and in shoreline areas with aquatic vegetation growth.

9. Data regarding the type and quality of each pool sampled should be recorded. At a minimum, these data should include the date and time, location, type of water body (e.g., vernal pool, seasonal wetland, artificial impoundment, etc.), dimension and depth of pond, water temperature, turbidity, presence of aquatic vegetation (submergent and emergent), and dominant invertebrates and all vertebrates observed. Photographs of pools and adjacent upland areas are helpful and copies should be included in the final report.

10. Surveyors should follow guidance below for disinfecting equipment and clothing after surveying a pond and before entering a new pond, unless the two ponds are hydrologically connected to one another. These recommendations are adapted from the Declining Amphibian Population Task Force's Code which can be found in their entirety at: http://www.open.ac.uk/daptf/.

a. All dirt and debris, including mud, snails, plant material (including fruits and seeds), and algae, should be removed from nets, traps, boots, vehicle tires and all other surfaces that have come into contact with water. Cleaned items should be rinsed with clean water before leaving each study site.

b. Boots, nets, traps, etc., should then be scrubbed with either a 70 % ethanol solution, a bleach solution (0.5 to 1.0 cup of bleach to 1.0 gallon of water), QUAT 128 (quaternary ammonium, use 1:60 dilution), or a 6% sodium hypochlorite 3 solution and rinsed clean with water between study sites. Cleaning equipment in the immediate vicinity of a pond or wetland should be avoided. Care should be taken so that all traces of the disinfectant are removed before entering the next aquatic habitat.

c. When working at sites with known or suspected disease problems, disposable gloves should be worn and changed between handling each animal.

d. Used cleaning materials (liquids, etc.) should be disposed of safely, and if necessary, taken back to the lab for proper disposal. Used disposable gloves should be retained for safe disposal in sealed bags.

Upland Habitat Survey Methods

A drift fence study conducted during fall and winter is the primary method used to study CTS in upland habitats. To support a negative finding, an upland drift fence study should be included. Although less intrusive methods (see below) may also be used to determine presence of the CTS, these methods are less reliable and thus cannot be used to support a negative finding.

Because CTS have been observed to make breeding migrations of at least 0.6 miles (1 km), the project proponent or the Service may assume presence of CTS if a known breeding pond lies within 1 km and no significant barriers exist. Examples of significant physical barriers include high-density residential or urban development and Interstate Highways, while features such as golf courses, disked fields, and most paved roads are not considered barriers.

For sites with at least one accessible potential breeding pool, we recommend that a one-year drift fence study be conducted during the winter between two consecutive seasons of aquatic larval surveys (if presence of CTS was not established during the first season of aquatic sampling). We recommend that a two year drift fence study be conducted if: 1) a site has suitable upland habitat and a potential breeding pool lies within 1.2 miles (2 km); 2) on-site ponds cannot be adequately sampled using aquatic methods (e.g., deep impoundments with known presence of California red-legged frogs); or 3) if non-native predators or poor water quality may preclude detection of CTS during larval sampling (i.e., due to mortality of the larvae).

1. We recommend that a proposal to conduct a drift fence study be submitted in writing to the Service and the Department. The results of studies not approved by the Service and Department may not be accepted in support of a negative finding. The proposal should include an aerial photograph of the study site indicating all potential on- and off-site breeding locations identified in the site assessment and an overlay with the proposed drift fence study design clearly delineated. We recommend that drift fence study designs incorporate the following:

   a. **For sites with at least one suitable breeding pond** (i.e., ponds that contain standing water for at least 10 continuous weeks in most years), the ponds should be surrounded by drift fences installed 10 - 50 ft from the high water line. Sections of drift fence should be spaced regularly around the pond, focusing on areas where salamanders are most likely to be captured. We recommend that each section of fence be at least 30 ft (9.2 m) long, and that the total distance between fence sections be no greater than the total length of installed fence (i.e., >50% of the circumference fenced). There should be no more than 33 ft (10 m) between pitfall traps, and drift fences should be constructed such that during periods when traps are closed, openings at least every 66 ft (20 m) allow animal passage.

b. **For all sites**, we also recommend upland drift fences. Unless a strong rationale can be presented, drift fence equaling at least 90% of the site perimeter should be installed. The exact placement of fences should be selected to maximize the probability of capturing CTS (e.g., in grassland areas with high densities of mammal burrows; along site boundaries closest to identified potential breeding pools; with pitfalls situated away from areas where flooding is likely). Pitfalls should be spaced less than 33 ft apart. To the extent possible drift fences and pitfalls should be placed to minimize the number of flooded buckets. Each section of fence should be a minimum of 30 ft (9.2 m) long, unless topography, property lines, or other circumstances dictate. Upland drift fences should be constructed such that during periods when traps are closed, openings at least every 66 ft (20 m) allow animal passage.

2. Arrays should be approved and constructed by 15 October. Beginning on or before October 15, pitfall buckets should be opened before sunset if there was any rain during the day or if at 2 PM rain is forecast for the remainder of the day or subsequent night with 70% or greater probability (based on the nearest National Weather Service forecast - available at http://www.wrh.noaa.gov/Sacramento/). Traps should be open each night and checked each morning until no rain has fallen within the preceding 24 hours. Nights of high relative humidity (greater than 75% relative humidity) should be considered equivalent to rain events once onsite or nearby seasonal wetlands have become inundated with standing water, regardless of its depth, surface area, or duration. The above guidance should be followed until 20 nights of surveying under the proper conditions has been conducted. After 20 nights of surveying is completed, and until March 15, pitfall buckets should be opened before sunset if there was any rain during the day, or if at 2 PM rain is forecast for the remainder of the day or subsequent night with 70% or greater probability. Traps will be checked the next morning, and unless it is still raining or more rain is forecast, the traps can be closed until the next rain event.

3. Drift fences should be constructed from a material that is durable, weather resistant, and **appropriate for the area in which it will be installed; proposals should describe the materials to be used**. Examples include aluminum flashing, silt fencing, untreated wood particle board, shade cloth, window screen, Vexar plastic mesh, etc. Hardware cloth may be useful for short segments of fence that experience heavy overland water flow. Drift fences should be buried at least 3 inches (8 cm) underground and extend at least 1 ft (31 cm) above the ground. All drift fences require regular inspections and maintenance, especially after each significant storm event. If drift fences are installed incorrectly and/or have insufficient maintenance this may call into question the reliability of the data. Unless special authorization is received from the Service and Department to maintain drift fences through non-sampling months, drift fencing should be disassembled by April 1.

4. Pitfall traps should not be placed in a manner that will disturb or destroy rodent burrows or other refugia that could be used by CTS.

5. Excessive pitfall flooding may invalidate a study. To avoid flooding traps should be placed preferentially in slightly elevated locations where flooding is less likely. Pitfalls in locations likely to flood should be free of holes. If ground saturation forces a pitfall out of the soil it can be weighted down with cement, gravel or other suitable materials.

6. All pitfall traps should have a rigid lid that closes securely. When not in use, traps should be closed in a manner that precludes entry by CTS and other animals.

7. Pitfall traps should be cylindrical, non-galvanized, metal or plastic containers. They should be at least 2-gallons in size and 8 in (20 cm) deep.

8. Each pitfall trap should contain noncellulose sponges or other nontoxic absorbent material which should be kept moist at all times.

9. Each pitfall trap should have a rigid cover with legs one to two inches high to provide shade and shed water during extreme rain events.

10. When in use, pitfall traps should be checked as often as necessary, but at a minimum one time a day, with one of these checks occurring between one hour before sunrise and noon. Whenever possible, traps should be opened just before dark and checked and closed the following morning.

11. When not in use, the drift fence and pitfall traps should be inspected weekly to ensure the system has not been disturbed by vandals, wildlife, fallen trees, wind, etc. Repairs to fences should be completed prior to the next night of sampling.

12. Pitfall traps should be placed as far as possible from ant nests. If an ant nest develops within 10 feet of an existing pitfall trap, the pitfall trap should be moved, removed from the field, or closed.

13. Captured CTS should be released as near as possible to the point of capture, in a manner that maximizes their survival. CTS should be released into the mouth of a small mammal burrow or other suitable refugia. CTS should be watched after release to be sure that they are in a safe location and are not susceptible to increased predation risk.

14. Once a CTS is captured, all traps and drift fences should be emptied and removed within 24 hours, and holes in the ground which contain traps should be filled in.

15. In addition, to minimize mortality of small mammals that may become trapped during surveys, each pitfall trap should also incorporate either jute twine, as described in Karraker (2001; http://www.fs.fed.us/psw/rsl/projects/wild/karraker/karraker4.pdf), a rodent safe-house as described in Padgett-Flohr and Jennings (2001), or other material as approved by the Service and Department.

16. Each pitfall trap should be marked with the name, telephone number, and Department permit number.

Other methods

Other methods, such as visual egg surveys, night driving, nocturnal surveys, fiber optic scoping and cover-boards, may be used to determine presence of the CTS, but these techniques may not be accepted in support of a negative finding. Deviations from this guidance may be approved on a case-by-case basis if a strong rationale can be presented.

Reporting

If one or more CTS are captured or detected a representative sample of the embryo(s), larva(e), or transformed salamander(s) should be photographed. The Service and the Department should be contacted by telephone within 3 working days if CTS are captured. If any mortality of California tiger salamander occurs, specimens should be collected, preserved by freezing, and the Service and the Department contacted by telephone within 1 work day.

For each survey location, a final report detailing the survey results should be submitted to the Service and the Department within one month of the last site visit. The written report should include, but is not be limited to, the following information: names of surveyors and copies of permits and authorizations, a description and map at the appropriate resolution of the type and quality of upland and aquatic habitats and land uses at the site; a map indicating the location of water bodies sampled for larvae; a map indicating the location of drift fences and pitfalls. The survey report also should include survey methods used, the dates and times of surveys, rainfall totals by date, nightly minimum temperatures, number and length of dipnet sweeps made, number of passes with seine, total estimated area seined, records of upland and aquatic animals captured, and pond water temperature, turbidity, and maximum depth at each aquatic sampling. If CTS are detected on the site, the report should include a map indicating the precise location of all CTS observations and captures, the number of CTS egg masses, larvae, sub-adults and adults observed, and photographic verification of CTS from the site. Site photographs may also be helpful in interpreting survey results. For the Department, survey reports should also include CNDDB field locality forms. Locality information should be in the form of UTM or latitude/longitude (degree, minute, second) coordinates.

In the case of a negative finding including a season with 70% of average rainfall, additional information (e.g., pond filling/drying dates, quantity and timing of rainfall during each sampling interval, temperatures) supplied by the surveyor, may assist the Service and the Department in their decision whether or not to accept the data.

Contact Information:

U.S. Fish and Wildlife Service

For an application or guidance on how to obtain a Federal permit or for reporting, please contact:

For areas within the Great Valley hydrobasin:
U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Attn: Permit Coordinator 2800 Cottage Way, W-2605
Sacramento, California 95825
(916) 414-6547

For hydrobasins south of and including Santa Cruz County:
U.S. Fish and Wildlife Service
Attn: Permit Coordinator
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B Ventura, California 93003
(805) 644-1766

http://www.fws.gov/endangered/permits/

Please refer to http://www.fws.gov/ventura/areas/responsibilities.html or http://www.fws.gov/sacramento/sfwo_jurisdiction.htm for a map showing U.S. Fish and Wildlife Office jurisdictions.

California Department of Fish and Game

For Department reporting or questions regarding land use activity guidance, a map of regional offices and telephone numbers is available at http://www.dfg.ca.gov/regions/regions.html

For State of California Scientific Collecting permit applications and information, please contact:
California Department of Fish and Game
License and Revenue Branch
3211 S Street
Sacramento, California 95816
(916) 227-2271

For additional State permit information, please refer to:

http://www.dfg.ca.gov/hcpb/ceqacesa/ceqacesa.shtml (How to Obtain a Scientific Collecting Permit)

http://www.dfg.ca.gov/hcpb/ceqacesa/rsrchpermit/mou/whenneedmou.shtml (When is the MOU Required?)

http://www.dfg.ca.gov/licensing/pdffiles/fg1476.pdf (Scientific Collecting Regulations)

http://www.dfg.ca.gov/licensing/pdffiles/fg1379e.pdf (Scientific Collecting Permit Attachment)

United States Department of the Interior
Fish and Wildlife Service
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825

Conservation Guidelines for the Valley Elderberry Longhorn Beetle

Revised July 9, 1999

The following guidelines have been issued by the U.S. Fish and Wildlife Service (Service) to assist Federal agencies and non-federal project applicants needing incidental take authorization through a section 7 consultation or a section 10(a)(1)(B) permit in developing measures to avoid and minimize adverse effects on the valley elderberry longhorn beetle. The Service will revise these guidelines as needed in the future. The most recently issued version of these guidelines should be used in developing all projects and habitat restoration plans. The survey and monitoring procedures described below are designed to avoid any adverse effects to the valley elderberry longhorn beetle. Thus a recovery permit is not needed to survey for the beetle or its habitat or to monitor conservation areas. If you are interested in a recovery permit for research purposes please call the Service's Regional Office at (503) 231-2063.

Background Information

The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), was listed as a threatened species on August 8, 1980 (Federal Register 45: 52803-52807). This animal is fully protected under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). The valley elderberry longhorn beetle (beetle) is completely dependent on its host plant, elderberry (Sambucus species), which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley. Use of the elderberry by the beetle, a wood borer, is rarely apparent. Frequently, the only exterior evidence of the elderberry's use by the beetle is an exit hole created by the larva just prior to the pupal stage. The life cycle takes one or two years to complete. The animal spends most of its life in the larval stage, living within the stems of an elderberry plant. Adult emergence is from late March through June, about the same time the elderberry produces flowers. The adult stage is short-lived. Further information on the life history, ecology, behavior, and distribution of the beetle can be found in a report by Barr (1991) and the recovery plan for the beetle (USFWS 1984).

Surveys

Proposed project sites within the range of the valley elderberry longhorn beetle should be surveyed for the presence of the beetle and its elderberry host plant by a qualified biologist. The beetle's range extends throughout California's Central Valley and associated foothills from about the 3,000-foot elevation contour on the east and the watershed of the Central Valley on the west (Figure 1). All or portions of 31 counties are included: Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, El Dorado, Fresno, Glenn, Kern, Kings, Lake, Madera, Mariposa, Merced, Napa, Nevada, Placer, Sacramento, San Benito, San Joaquin, San Luis Obispo, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare, Tuolumne, Yolo, Yuba.

If elderberry plants with one or more stems measuring 1.0 inch or greater in diameter at ground level occur on or adjacent to the proposed project site, or are otherwise located where they may be directly or indirectly affected by the proposed action, minimization measures which include planting replacement habitat (conservation planting) are required (Table 1).

All elderberry shrubs with one or more stems measuring 1.0 inch or greater in diameter at ground level that occur on or adjacent to a proposed project site must be thoroughly searched for beetle exit holes (external evidence of beetle presence). In addition, all elderberry stems one inch or greater in diameter at ground level must be tallied by diameter size class (Table 1). As outlined in Table 1, the numbers of elderberry seedlings/cuttings and associated riparian native trees/shrubs to be planted as replacement habitat are determined by stem size class of affected elderberry shrubs, presence or absence of exit holes, and whether a proposed project lies in a riparian or non-riparian area.

Elderberry plants with no stems measuring 1.0 inch or greater in diameter at ground level are unlikely to be habitat for the beetle because of their small size and/or immaturity. Therefore, no minimization measures are required for removal of elderberry plants with no stems measuring 1.0 inch or greater in diameter at ground level with no exit holes. Surveys are valid for a period of two years.

Avoid and Protect Habitat Whenever Possible

Project sites that do not contain beetle habitat are preferred. If suitable habitat for the beetle occurs on the project site, or within close proximity where beetles will be affected by the project, these areas must be designated as avoidance areas and must be protected from disturbance during the construction and operation of the project. When possible, projects should be designed such that avoidance areas are connected with adjacent habitat to prevent fragmentation and isolation of beetle populations. Any beetle habitat that cannot be avoided as described below should be considered impacted and appropriate minimization measures should be proposed as described below.

Avoidance: Establishment and Maintenance of a Buffer Zone

Complete avoidance (i.e., no adverse effects) may be assumed when a 100-foot (or wider) buffer is established and maintained around elderberry plants containing stems measuring 1.0 inch or greater in diameter at ground level. Firebreaks may not be included in the buffer zone. In buffer areas construction-related disturbance should be minimized, and any damaged area should be promptly restored following construction. The Service must be consulted before any disturbances within the buffer area are considered. In addition, the Service must be provided with a map identifying the avoidance area and written details describing avoidance measures.

Protective Measures

1. Fence and flag all areas to be avoided during construction activities. In areas where encroachment on the 100-foot buffer has been approved by the Service, provide a minimum setback of at least 20 feet from the dripline of each elderberry plant.

2. Brief contractors on the need to avoid damaging the elderberry plants and the possible penalties for not complying with these requirements.

3. Erect signs every 50 feet along the edge of the avoidance area with the following information: "This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment." The signs should be clearly readable from a distance of 20 feet, and must be maintained for the duration of construction.

4. Instruct work crews about the status of the beetle and the need to protect its elderberry host plant.

Restoration and Maintenance

Restore any damage done to the buffer area (area within 100 feet of elderberry plants) during construction. Provide erosion control and re-vegetate with appropriate native plants.

Buffer areas must continue to be protected after construction from adverse effects of the project. Measures such as fencing, signs, weeding, and trash removal are usually appropriate.

No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant should be used in the buffer areas, or within 100 feet of any elderberry plant with one or more stems measuring 1.0 inch or greater in diameter at ground level.

The applicant must provide a written description of how the buffer areas are to be restored, protected, and maintained after construction is completed.

Mowing of grasses/ground cover may occur from July through April to reduce fire hazard. No mowing should occur within five (5) feet of elderberry plant stems. Mowing must be done in a manner that avoids damaging plants (e.g., stripping away bark through careless use of mowing/trimming equipment).

Transplant Elderberry Plants That Cannot Be Avoided

Elderberry plants must be transplanted if they can not be avoided by the proposed project. All elderberry plants with one or more stems measuring 1.0 inch or greater in diameter at ground level must be transplanted to a conservation area (see below). At the Service's discretion, a plant that is unlikely to survive transplantation because of poor condition or location, or a plant that would be extremely difficult to move because of access problems, may be exempted from transplantation. In cases where transplantation is not possible the minimization ratios in Table 1 may be increased to offset the additional habitat loss.

Trimming of elderberry plants (e.g., pruning along roadways, bike paths, or trails) with one or more stems 1.0 inch or greater in diameter at ground level, may result in take of beetles. Therefore, trimming is subject to appropriate minimization measures as outlined in Table 1.

1. Monitor. A qualified biologist (monitor) must be on-site for the duration of the transplanting of the elderberry plants to insure that no unauthorized take of the valley elderberry longhorn beetle occurs. If unauthorized take occurs, the monitor must have the authority to stop work until corrective measures have been completed. The monitor must immediately report any unauthorized take of the beetle or its habitat to the Service and to the California Department of Fish and Game.

2. Timing. Transplant elderberry plants when the plants are dormant, approximately November through the first two weeks in February, after they have lost their leaves. Transplanting during the non-growing season will reduce shock to the plant and increase transplantation success.

3. Transplanting Procedure.

> a. Cut the plant back 3 to 6 feet from the ground or to 50 percent of its height (whichever is taller) by removing branches and stems above this height. The trunk and all stems measuring 1.0 inch or greater in diameter at ground level should be replanted. Any leaves remaining on the plant should be removed.
>
> b. Excavate a hole of adequate size to receive the transplant.
>
> c. Excavate the plant using a Vemeer spade, backhoe, front end loader, or other suitable equipment, taking as much of the root ball as possible, and replant immediately at the conservation area. Move the plant only by the root ball. If the plant is to be moved and transplanted off site, secure the root ball with wire and wrap it with burlap. Dampen the burlap with water, as necessary, to keep the root ball wet. Do not let the roots dry out. Care should be taken to ensure that the soil is not dislodged from around the roots of the transplant. If the site receiving the transplant does not have adequate soil moisture, pre-wet the soil a day or two before transplantation.
>
> d. The planting area must be at least 1,800 square feet for each elderberry transplant. The root ball should be planted so that its top is level with the existing ground. Compact the soil sufficiently so that settlement does not occur. As many as five (5) additional elderberry plantings (cuttings or seedlings) and up to five (5) associated native species plantings (see below) may also be planted within the 1,800 square foot area with the transplant. The transplant and each new planting should have its own watering basin measuring at least three (3) feet in diameter. Watering basins should have a continuous berm measuring approximately eight (8) inches wide at the base and six (6) inches high.
>
> e. Saturate the soil with water. Do not use fertilizers or other supplements or paint the tips of stems with pruning substances, as the effects of these compounds on the beetle are unknown.

f. Monitor to ascertain if additional watering is necessary. If the soil is sandy and well-drained, plants may need to be watered weekly or twice monthly. If the soil is clayey and poorly-drained, it may not be necessary to water after the initial saturation. However, most transplants require watering through the first summer. A drip watering system and timer is ideal. However, in situations where this is not possible, a water truck or other apparatus may be used.

Plant Additional Seedlings or Cuttings

Each elderberry stem measuring 1.0 inch or greater in diameter at ground level that is adversely affected (i.e., transplanted or destroyed) must be replaced, in the conservation area, with elderberry seedlings or cuttings at a ratio ranging from 1:1 to 8:1 (new plantings to affected stems). Minimization ratios are listed and explained in Table 1. Stock of either seedlings or cuttings should be obtained from local sources. Cuttings may be obtained from the plants to be transplanted if the project site is in the vicinity of the conservation area. If the Service determines that the elderberry plants on the proposed project site are unsuitable candidates for transplanting, the Service may allow the applicant to plant seedlings or cuttings at higher than the stated ratios in Table 1 for each elderberry plant that cannot be transplanted.

Plant Associated Native Species

Studies have found that the beetle is more abundant in dense native plant communities with a mature overstory and a mixed understory. Therefore, a mix of native plants associated with the elderberry plants at the project site or similar sites will be planted at ratios ranging from 1:1 to 2:1 [native tree/plant species to each elderberry seedling or cutting (see Table 1)]. These native plantings must be monitored with the same survival criteria used for the elderberry seedlings (see below). Stock of saplings, cuttings, and seedlings should be obtained from local sources. If the parent stock is obtained from a distance greater than one mile from the conservation area, approval by the Service of the native plant donor sites must be obtained prior to initiation of the revegetation work. Planting or seeding the conservation area with native herbaceous species is encouraged. Establishing native grasses and forbs may discourage unwanted non-native species from becoming established or persisting at the conservation area. Only stock from local sources should be used.

Examples

Example 1

The project will adversely affect beetle habitat on a vacant lot on the land side of a river levee. This levee now separates beetle habitat on the vacant lot from extant Great Valley Mixed Riparian Forest (Holland 1986) adjacent to the river. However, it is clear that the beetle habitat located on the vacant lot was part of a more extensive mixed riparian forest ecosystem extending farther from the river's edge prior to agricultural development and levee construction. Therefore, the beetle habitat on site is considered riparian. A total of two elderberry plants with at least one stem measuring 1.0 inch or greater in diameter at ground level will be affected by the proposed action. The two plants have a total of 15 stems measuring over 1.0 inch. No exit holes were found on either plant. Ten of the stems are between 1.0 and 3.0 inches in diameter and five of the stems are greater than 5.0 inches in diameter. The conservation area is suited for riparian forest habitat. Associated natives adjacent to the conservation area are box elder (Acer negundo californica), walnut (Juglans californica var. hindsii), sycamore (Platanus racemosa), cottonwood (Populus fremontii), willow (Salix gooddingii and S. laevigata), white alder (Alnus rhombifolia), ash (Fraxinus latifolia), button willow (Cephalanthus occidentalis), and wild grape (Vitis californica).

Minimization (based on ratios in Table 1):

• Transplant the two elderberry plants that will be affected to the conservation area.

• Plant 40 elderberry rooted cuttings (10 affected stems compensated at 2:1 ratio and 5 affected stems compensated at 4:1 ratio, cuttings planted:stems affected)

• Plant 40 associated native species (ratio of associated natives to elderberry plantings is 1:1 in areas with no exit holes):

5 saplings each of box elder, sycamore, and cottonwood

5 willow seedlings

5 white alder seedlings

5 saplings each of walnut and ash

3 California button willow

2 wild grape vines

Total: 40 associated native species

• Total area required is a minimum of 1,800 sq. ft. for one to five elderberry seedlings and up to 5 associated natives. Since, a total of 80 plants must be planted (40 elderberries and 40 associated natives), a total of 0.33 acre (14,400 square feet) will be required for conservation plantings. The conservation area will be seeded and planted with native grasses and forbs, and closely monitored and maintained throughout the monitoring period.

Example 2

The project will adversely affect beetle habitat in Blue Oak Woodland (Holland 1986). One elderberry plant with at least one stem measuring 1.0 inch or greater in diameter at ground level will be affected by the proposed action. The plant has a total of 10 stems measuring over 1.0 inch. Exit holes were found on the plant. Five of the stems are between 1.0 and 3.0 inches in diameter and five of the stems are between 3.0 and 5.0 inches in diameter. The conservation area is suited for elderberry savanna (non-riparian habitat). Associated natives adjacent to the conservation area are willow (Salix species), blue oak (Quercus douglasii), interior live oak (Q. wislizenii), sycamore, poison oak (Toxicodendron diversilobum), and wild grape.

Minimization (based on ratios in Table 1):

- Transplant the one elderberry plant that will be affected to the conservation area.

- Plant 30 elderberry seedlings (5 affected stems compensated at 2:1 ratio and 5 affected stems compensated at 4:1 ratio, cuttings planted:stems affected)

- Plant 60 associated native species (ratio of associated natives to elderberry plantings is 2:1 in areas with exit holes):

  20 saplings of blue oak, 20 saplings of sycamore, and 20 saplings of willow, and seed and plant with a mixture of native grasses and forbs

- Total area required is a minimum of 1,800 sq. ft. for one to five elderberry seedlings and up to 5 associated natives. Since, a total of 90 plants must be planted (30 elderberries and 60 associated natives), a total of 0.37 acre (16,200 square feet) will be required for conservation plantings. The conservation area will be seeded and planted with native grasses and forbs, and closely monitored and maintained throughout the monitoring period.

Conservation Area—Provide Habitat for the Beetle in Perpetuity

The conservation area is distinct from the avoidance area (though the two may adjoin), and serves to receive and protect the transplanted elderberry plants and the elderberry and other native plantings. The Service may accept proposals for off-site conservation areas where appropriate.

1. Size. The conservation area must provide at least 1,800 square feet for each transplanted elderberry plant. As many as 10 conservation plantings (i.e., elderberry cuttings or seedlings and/or associated native plants) may be planted within the 1800 square foot area with each transplanted elderberry. An additional 1,800 square feet shall be provided for every additional 10 conservation plants. Each planting should have its own watering basin measuring approximately three feet in diameter. Watering basins should be constructed with a continuous berm measuring approximately eight inches wide at the base and six inches high.

   The planting density specified above is primarily for riparian forest habitats or other habitats with naturally dense cover. If the conservation area is an open habitat (i.e., elderberry savanna, oak woodland) more area may be needed for the required plantings. Contact the Service for assistance if the above planting recommendations are not appropriate for the proposed conservation area.

No area to be maintained as a firebreak may be counted as conservation area. Like the avoidance area, the conservation area should connect with adjacent habitat wherever possible, to prevent isolation of beetle populations.

Depending on adjacent land use, a buffer area may also be needed between the conservation area and the adjacent lands. For example, herbicides and pesticides are often used on orchards or vineyards. These chemicals may drift or runoff onto the conservation area if an adequate buffer area is not provided.

2. Long-Term Protection. The conservation area must be protected in perpetuity as habitat for the valley elderberry longhorn beetle. A conservation easement or deed restrictions to protect the conservation area must be arranged. Conservation areas may be transferred to a resource agency or appropriate private organization for long-term management. The Service must be provided with a map and written details identifying the conservation area; and the applicant must receive approval from the Service that the conservation area is acceptable prior to initiating the conservation program. A true, recorded copy of the deed transfer, conservation easement, or deed restrictions protecting the conservation area in perpetuity must be provided to the Service before project implementation.

Adequate funds must be provided to ensure that the conservation area is managed in perpetuity. The applicant must dedicate an endowment fund for this purpose, and designate the party or entity that will be responsible for long-term management of the conservation area. The Service must be provided with written documentation that funding and management of the conservation area (items 3-8 above) will be provided in perpetuity.

3. Weed Control. Weeds and other plants that are not native to the conservation area must be removed at least once a year, or at the discretion of the Service and the California Department of Fish and Game. Mechanical means should be used; herbicides are prohibited unless approved by the Service.

4. Pesticide and Toxicant Control. Measures must be taken to insure that no pesticides, herbicides, fertilizers, or other chemical agents enter the conservation area. No spraying of these agents must be done within one 100 feet of the area, or if they have the potential to drift, flow, or be washed into the area in the opinion of biologists or law enforcement personnel from the Service or the California Department of Fish and Game.

5. Litter Control. No dumping of trash or other material may occur within the conservation area. Any trash or other foreign material found deposited within the conservation area must be removed within 10 working days of discovery.

6. Fencing. Permanent fencing must be placed completely around the conservation area to prevent unauthorized entry by off-road vehicles, equestrians, and other parties that might damage or destroy the habitat of the beetle, unless approved by the Service. The applicant must receive written approval from the Service that the fencing is acceptable prior to initiation of the conservation program. The fence must be maintained in perpetuity, and must be

repaired/replaced within 10 working days if it is found to be damaged. Some conservation areas may be made available to the public for appropriate recreational and educational opportunities with written approval from the Service. In these cases appropriate fencing and signs informing the public of the beetle’s threatened status and its natural history and ecology should be used and maintained in perpetuity.

7. Signs. A minimum of two prominent signs must be placed and maintained in perpetuity at the conservation area, unless otherwise approved by the Service. The signs should note that the site is habitat of the federally threatened valley elderberry longhorn beetle and, if appropriate, include information on the beetle's natural history and ecology. The signs must be approved by the Service. The signs must be repaired or replaced within 10 working days if they are found to be damaged or destroyed.

Monitoring

The population of valley elderberry longhorn beetles, the general condition of the conservation area, and the condition of the elderberry and associated native plantings in the conservation area must be monitored over a period of either ten (10) consecutive years or for seven (7) years over a 15-year period. The applicant may elect either 10 years of monitoring, with surveys and reports every year; or 15 years of monitoring, with surveys and reports on years 1, 2, 3, 5, 7, 10, and 15. The conservation plan provided by the applicant must state which monitoring schedule will be followed. No change in monitoring schedule will be accepted after the project is initiated. If conservation planting is done in stages (i.e., not all planting is implemented in the same time period), each stage of conservation planting will have a different start date for the required monitoring time.

Surveys. In any survey year, a minimum of two site visits between February 14 and June 30 of each year must be made by a qualified biologist. Surveys must include:

1. A population census of the adult beetles, including the number of beetles observed, their condition, behavior, and their precise locations. Visual counts must be used; mark-recapture or other methods involving handling or harassment must not be used.

2. A census of beetle exit holes in elderberry stems, noting their precise locations and estimated ages.

3. An evaluation of the elderberry plants and associated native plants on the site, and on the conservation area, if disjunct, including the number of plants, their size and condition.

4. An evaluation of the adequacy of the fencing, signs, and weed control efforts in the avoidance and conservation areas.

5. A general assessment of the habitat, including any real or potential threats to the beetle and its host plants, such as erosion, fire, excessive grazing, off-road vehicle use, vandalism, excessive weed growth, etc.

The materials and methods to be used in the monitoring studies must be reviewed and approved by the Service. All appropriate Federal permits must be obtained prior to initiating the field studies.

Reports. A written report, presenting and analyzing the data from the project monitoring, must be prepared by a qualified biologist in each of the years in which a monitoring survey is required. Copies of the report must be submitted by December 31 of the same year to the Service (Chief of Endangered Species, Sacramento Fish and Wildlife Office), and the Department of Fish and Game (Supervisor, Environmental Services, Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814; and Staff Zoologist, California Natural Diversity Data Base, Department of Fish and Game, 1220 S Street, Sacramento, California 95814). The report must explicitly address the status and progress of the transplanted and planted elderberry and associated native plants and trees, as well as any failings of the conservation plan and the steps taken to correct them. Any observations of beetles or fresh exit holes must be noted. Copies of original field notes, raw data, and photographs of the conservation area must be included with the report. A vicinity map of the site and maps showing where the individual adult beetles and exit holes were observed must be included. For the elderberry and associated native plants, the survival rate, condition, and size of the plants must be analyzed. Real and likely future threats must be addressed along with suggested remedies and preventative measures (e.g. limiting public access, more frequent removal of invasive non-native vegetation, etc.).

A copy of each monitoring report, along with the original field notes, photographs, correspondence, and all other pertinent material, should be deposited at the California Academy of Sciences (Librarian, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118) by December 31 of the year that monitoring is done and the report is prepared. The Service's Sacramento Fish and Wildlife Office should be provided with a copy of the receipt from the Academy library acknowledging receipt of the material, or the library catalog number assigned to it.

Access. Biologists and law enforcement personnel from the California Department of Fish and Game and the Service must be given complete access to the project site to monitor transplanting activities. Personnel from both these agencies must be given complete access to the project and the conservation area to monitor the beetle and its habitat in perpetuity.

Success Criteria

A minimum survival rate of at least 60 percent of the elderberry plants and 60 percent of the associated native plants must be maintained throughout the monitoring period. Within one year of discovery that survival has dropped below 60 percent, the applicant must replace failed plantings to bring survival above this level. The Service will make any determination as to the applicant's replacement responsibilities arising from circumstances beyond its control, such as plants damaged or killed as a result of severe flooding or vandalism.

Service Contact

These guidelines were prepared by the Endangered Species Division of the Service's Sacramento Fish and Wildlife Office. If you have questions regarding these guidelines or to request a copy of the most recent guidelines, telephone (916) 414-6600, or write to:

U.S. Fish and Wildlife Service
Ecological Services
2800 Cottage Way, W-2605
Sacramento, CA 95825

Literature Cited

Barr, C. B. 1991. The distribution, habitat, and status of the valley elderberry longhorn beetle *Desmocerus californicus dimorphus*. U.S. Fish and Wildlife Service; Sacramento, California.

Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. Unpublished Report. State of California, The Resources Agency, Department of Fish and Game, Natural Heritage Division, Sacramento, California.

USFWS. 1980. Listing the valley elderberry longhorn beetle as a threatened species with critical habitat. Federal Register 45:52803-52807.

USFWS. 1984. Recovery plan for the valley elderberry longhorn beetle. U.S. Fish and Wildlife Service, Endangered Species Program; Portland, Oregon.

Table 1: Minimization ratios based on location (riparian vs. non-riparian), stem diameter of affected elderberry plants at ground level, and presence or absence of exit holes.

Location	Stems (maximum diameter at ground level)	Exit Holes on Shrub Y/N (quantify)[1]	Elderberry Seedling Ratio[2]	Associated Native Plant Ratio[3]
non-riparian	stems >=1" & =<3"	No:	1:1	1:1
		Yes:	2:1	2:1
non-riparian	stems >3" & <5"	No:	2:1	1:1
		Yes:	4:1	2:1
non-riparian	stems >=5"	No:	3:1	1:1
		Yes:	6:1	2:1
riparian	stems >=1" & <=3"	No:	2:1	1:1
		Yes:	4:1	2:1
riparian	stems > 3" & < 5"	No:	3:1	1:1
		Yes:	6:1	2:1

riparian	stems >=5"	No:	4:1	1:1
		Yes:	8:1	2:1

[1] All stems measuring one inch or greater in diameter at ground level on a single shrub are considered occupied when exit holes are present anywhere on the shrub.

[2] Ratios in the Elderberry Seedling Ratio column correspond to the number of cuttings or seedlings to be planted per elderberry stem (one inch or greater in diameter at ground level) affected by a project.

[3] Ratios in the Associated Native Plant Ratio column correspond to the number of associated native species to be planted per elderberry (seedling or cutting) planted.

Click for range map

Appendix D. Protocols for Pre-project Surveys to Determine Presence or Absence of the Giant Garter Snake and to Evaluate Habitats (California Department of Fish and Game Inland Fisheries Division).

1. Qualifications of surveyors:

   A. Surveyors must demonstrate previous field experience with GIANT GARTER SNAKE or ecologically similar species. The Department shall evaluate and approve all surveyors. Persons lacking appropriate related field experience shall not be authorized to conduct pre-project surveys for GIANT GARTER SNAKE.

2. All surveyors must possess a valid Scientific Collecting Permit and appropriate Endangered Species permits.

3. Survey Protocols:

   A. Time of year: April 15 - June 1.

   B. Minimum effort: Ten surveys shall be conducted per mile of canal, slough or marsh edge *or* until GIANT GARTER SNAKE are positively identified (captured and photographed).

   C. Methodology: Surveys shall be conducted on foot between 0900 and 1400 hours. Surveyors shall carry binoculars to aid in detecting GIANT GARTER SNAKE. Surveys shall be conducted on different days with alternating starting points. GIANT GARTER SNAKE survey logs will be completed for each survey. Surveys shall not be conducted during rain or winds of 20 mph or greater.

   D. Surveys may be conducted during other times of year, but absence of GIANT GARTER SNAKE will not be accepted if-habitat evaluation indicates suitability.

   E. Trapping may be used to augment foot surveys upon prior written approval of the Department. Approval shall be based upon demonstrated previous trapping experience with GIANT GARTER SNAKE or ecologically similar species or proof of training by another person authorized by the Department to trap GIANT GARTER SNAKE. Trap design and methodology must be approved by the Department.

capture of GIANT GARTER SNAKE is considered trapping.

4.

A. Submit completed GIANT GARTER SNAKE Field Survey Report Form, Habitat Evaluation form, and GIANT GARTER SNAKE Survey

Prepared by: John M. Brode, Department of Fish and Game, Inland Fisheries Division, March, 1993.

Appendix D. con't. Giant Garter Snake (GIANT GARTER SNAKE)
Habitat Evaluation Form 1/

Site Name:____

Surveyor's Name and Affiliation:____

____

____

Factor	Present (+) or Absent (-)
1. Still or slow--flowing water over a mud or silt-substrate.	( )
2. Flowing water over sand, gravel, rock, or cement substrate.	( )
3. Water available:	
a) April through October only (irrigation).	( )
b) All year.	( )
c) During winter only (runoff).	( )
4. Banks are sunny.	( )(%)
5. Banks are shaded by overstory vegetation (large trees, willow thickets)	( )(%)
6. Aquatic or emergent vegetation present.	( )
7. Terrestrial vegetation present:	
a) On banks.	( )
b) In adjacent uplands.	
8. Subterranean retreats (broken concrete or animal burrows) present:	
a) in banks.	( )
b) In adjacent uplands.	( )
9. Small fish present.	( )
10. Introduced gamefish are present.	( )
11. Amphibians present.	( )
12. Site is subject to severe seasonal flooding.	( )
13. Site receives polluted runoff.	( )

Notes and Comments (attached additional pages if necessary):

____

____

____

1/ Complete this form for each site surveyed. If site has been recently disturbed (channel maintenance, bank repair), survey the nearest undisturbed similar site, preferably on the same water course.

Appendix D. con't. Giant Garter Snake (GIANT GARTER SNAKE)
Field Survey Report Form I/

Surveyor's Names and Affiliations:____

____
__

Site Name: ____
__Location: County _______________ Directions____________________________
___
____
__ ____
______
Quad Name:______________7 ½_____ 15 min___ T___ R ___ 1/4 sec________
-
Estimated Size: Acres of Marsh ____________

Miles of Canal/Slough ____________________

Land Uses (include 1/8 mile radius): _____________________________________
____
___

Habitat Description (general) 2/: ____
-
____
__
____
__ ____
______
Dominant Plant Species Present: ____
____
___

Prey Species Present: ____
____
____
Intro. Gamefish Present (basses, catfishes, sunfishes):________________________

____
__
Dates of Surveys (attached survey logs): 1__________ 2___________
3__________4 __________ 5 _________ 6 _________ 7 __________ 8 ________

9________ ___________

____

____

____

____

1/ Fill out this form for each site surveyed.

Appendix D. con't. Giant Garter Snake (GIANT GARTER SNAKE) Survey Log

____

and Affiliation: ____

____

____________ _______________ Start Time: ________

End Time: _____________ Air Temp. at Start: ______ Finish: __________

_________ Wind:____________ MPH from: _________

No. GIANT GARTER SNAKE Captured: _________

No. other Garter Snakes Captured: _______________

____ No. _____

Other Observations 2/: ____

____

____

____

____

Survey No.:__________ Date: _______________ Start Time: _______________

% Cloud Cover: _______ Wind: _______________ MPH from: _______________
-

No. GIANT GARTER SNAKE Captured: _____

No. Other Garter Snakes Captured: ___________

Photographs 1/: Yes _____ ______

Other observations 2/: ____
_
____
__

1/ All garter snakes captured shall be color photographed as follows: 1) close-up of the head and anterior 1/3 of the body, 2) close-up of the left side of the head,

2/ Include number of snakes observed but not captured.

Sacramento Fish and Wildlife Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

1-1-F-97-149

November 13, 1997

Mr. Art Champ
Chief, Regulatory Branch
Department of the Army
U.S. Army Engineer District,
Sacramento Corps of Engineers
Sacramento, California 95814-2922

Subject: Programmatic Formal Consultation for U.S. Army Corps of Engineers 404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo Counties, California.

Dear Mr. Champ:

This transmits our programmatic formal consultation pursuant to section 7 of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 *et seq.)*, regarding actions that the U.S. Army Corps of Engineers (Corps) may permit, pursuant to section 404 of the Clean Water Act, for projects with limited effects on the federally listed as threatened giant garter snake *(Thamnophis gigas)* or its habitat. Corps projects that meet the conditions specified below, or that the U.S. Fish and Wildlife Service (Service) determines will have similar effects, may be appended to this programmatic consultation. The geographic scope of this consultation includes eleven counties within the jurisdiction of the Service's Sacramento Fish and Wildlife Office. These eleven counties are: Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo Counties, California.

The purpose of this programmatic consultation is to expedite Corps permitted projects, including activities which may qualify for authorization under Nationwide permitting, with relatively small effects on the giant garter snake and its habitat. Projects which exceed the programmatic threshold will require individual biological opinions. The Service will re-evaluate this programmatic consultation annually to ensure that its continued application will not result in unacceptable effects on the giant garter snake or its habitat. Restricting this programmatic consultation to projects with permanent impacts of less than 3.00 acres (1.21 hectares) and temporary impacts of less than 20.00 acres (8.09 hectares) of giant garter snake habitat per project will limit the effects of the programmatic process on the giant garter snake and its habitat. Tracking and restricting project effects over time will serve to minimize cumulative effects at local and regional levels.

Consultation History

On June 25, 1997, June Deweese, Kelly Hornaday, Alison Willy and Steve Miller of my staff met with Kathy Norton of the Corps to discuss developing a programmatic biological opinion for projects with relatively small effects on giant garter snakes. Kathy Norton provided a list of Corps permits that would likely affect giant garter snakes and would likely result in only minor or temporary effects. The Corps August 20, 1997, request for formal consultation was received August 22, 1997. The Service submitted an administrative draft biological opinion to the Corps on September 19, 1997.

We received comments from members of your staff on the administrative draft of the programmatic biological opinion on October 2, 1997. We have addressed your comments by incorporating your suggestions into the programmatic biological opinion, and by providing clarification within the opinion where necessary concerning your request for a 10-day notification for formal consultation. Due to staffing constraints, the Service cannot notify the Corps whether separate formal biological opinion will be required. However, upon receipt of requests for formal Section 7 consultation, the Service will make every effort to promptly determine whether there is sufficient information to complete section 7 consultation and whether it is appropriate to append proposed projects to the programmatic biological opinion, and will respond within thirty days of receipt of request for consultation. A complete administrative record of this consultation is contained at the Service's Sacramento Fish and Wildlife Office.

Definitions

Giant Garter Snake Habitat. The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of (1) adequate water during the snake's active period (i.e., early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat; (3) upland habitat for basking, cover, and retreat sites; and (4) higher elevation uplands for cover and refuge from flood waters. For the purposes of this programmatic opinion, a basic giant garter snake habitat unit will incorporate 2.00 acres (0.81 hectares) of surrounding upland for every 1.00 acre (0.40 hectare) of aquatic habitat. The 2.00 acres (0.81 hectares) of upland also may be defined as 218 linear feet (66 meters) of bankside habitat which incorporates adjacent uplands to a width of 200 feet (61 meters) from the edge of the bank.

Disturbance Area. Primary disturbance acreage will be determined by project area; however, disturbance area may exceed project boundaries because a 200-foot radius (61 meters) from the edge of giant garter snake aquatic habitat is incorporated to include essential habitat components and determine potential take. Disturbance may be temporary and/or permanent and should consider: (1) opportunities to avoid habitat within the project area; (2) area of dewatering and period of time dewatered; and (3) temporary haul roads and equipment staging areas. The 200-foot radius (61 meters) also will be used to evaluate aquatic habitat disturbance during temporary alterations, i.e., upstream and downstream from berms placed for temporary dewatering.

Temporary Impacts. Temporary impacts are project activities which temporarily remove essential habitat components, but can be restored to preproject conditions of equal or greater habitat values. Projects which are to be considered temporary impacts must be able to implement the project and restore the affected habitat within two seasons.

Permanent Impacts. Permanent impacts are those project activities which result in loss of habitat and/or permanently remove essential habitat components. Temporary projects which exceed two seasons to complete will be considered permanent impacts and require mitigation equal to permanent impacts. Temporary projects which exceed two seasons may partially compensate the permanent impact ratio by completing restoration of the affected habitat.

Season. A season is defined as the calendar year period between May 1 and October 1, the active period for giant garter snake when mortality is less likely to occur. Project impacts and restoration of habitat that can be completed within this period or, if necessary, within the same calendar year with an approved extension, will be considered occurring within one season for the purposes of mitigation.

Monitoring. The following level of monitoring is required when specified: (1) photo documentation included in a report notifying the Service when the habitat restoration or creation was completed, what materials were used, plantings (if specified) and justification of any substitutions to the Service recommended guidelines included in Appendix A; (2) photo documentation and progress report submitted one year from restoration implementation, or years one, two, and five for replacement habitat; (3) justification from release of any further monitoring, if requested; and (4) recommendations for remedial actions and request for approval from the Service, if necessary.

Programmatic Consultation Guidelines

Initial project authorization under this programmatic opinion is dependent upon the following criteria:

1. Impacts will not exceed permanent losses of 3.00 acres (1.21 hectares) of giant garter snake habitat. Giant garter snake habitat includes both upland and aquatic habitat components. The aquatic habitat component of giant garter snake habitat will not exceed more than 1.00 acre (0.40 hectare) of the total permanent losses.

2. Impacts will not exceed permanent loss of 218 linear feet (66 meters) of bankside habitat.

3. Impacts will not exceed 20.00 acres (8.09 hectares) of temporary disturbance to giant garter snake habitat. This total includes both upland and aquatic habitat components of giant garter snake habitat.

4. The Scope of Work is one or more of the types listed below and routinely authorized under the Corps Nationwide permitting program, or by individual permit as appropriate.

Implementing Procedure

The following process will be used when implementing future proposed projects under this biological opinion:

1. The Corps will submit a letter requesting that the proposed project be appended to this programmatic biological opinion and provide the Service with a copy of the permit application package and a brief environmental assessment (see Appendix B, <u>List of Items Needed to Complete Consultation).</u>

2. The Service will review the proposed project to determine: (1) if the project is not likely to adversely affect giant garter snakes; (2) is appropriate to append to this programmatic biological opinion; or (3) needs a separate biological opinion.

3. Upon appending a proposed project to the programmatic biological opinion, the Service will determine whether one or a combination of the following is required: (1) restoration of the project site; (2) creation of replacement habitat and number of acres required; (3) a deed restriction or conservation easement on replacement habitat; (4) establishment of an endowment fund for management of large mitigation areas; (5) level of monitoring required to ensure success of mitigation implemented.

BIOLOGICAL OPINION

Description of the Proposed Action

Projects which meet the above criteria will be assigned to Level 1 through 3 by the amount of temporary and/or permanent impacts. All created habitat will be protected under a Service-approved conservation easement. The compensation ratio needed to mitigate project impacts will correspond to each of the three impact levels identified as follows:

Level 1

Level 1 project impacts result in minimal environmental effects, such as repair, rehabilitation, or replacement of previously authorized structures, installation of scientific measuring devices, survey activities, temporary recreational structures, utility lines installation by boring underneath irrigation canals or creek channels, and temporary cofferdams. Level 1 projects would include those routinely authorized under Nationwide Permit numbers 3, 5, 6, 11, 12, and 33. The work would not result in any permanent loss of habitat and the temporary disturbance area would not exceed 20.00 acres (8.09 hectares) of habitat.

1. Impacts

   A. No permanent loss of giant garter snake habitat

   B. Less than 20.00 acres (8.09 hectares) of temporary disturbances

   C. Temporary impacts will be restored to preproject conditions within the same season or, at most, the same calendar year

2. Mitigation

   A. Restoration of temporary impacts to giant garter snake habitat

   B. One year of monitoring with a photo documentation report due one year from the restoration implementation showing pre- and post-project area photos

Level 2

Level 2 project impacts also include activities routinely authorized under Nationwide Permits, but the project implementation needs greater than one season to complete. Projects authorized under Nationwide Permit No. 30 (i.e., land management for wildlife) also would qualify for Level 2 mitigation.

1. Impacts

   A. No permanent loss of giant garter snake habitat

   B. Less than 20.00 acres (8.09 hectares) of temporary disturbances

   C. Two (2) seasons of temporary disturbances

2. Mitigation

A. Restoration of temporary impacts to giant garter snake habitat

B. One year of monitoring restored habitat with a photo documentation report due one year from implementation of the restoration showing pre- and post-project area photos

C. Replacement of affected giant garter snake habitat at a 1:1 ratio

D. All replacement habitat must include both upland and aquatic habitat components. Upland and aquatic habitat components must be included in the replacement habitat at a ratio of 2:1 upland acres to aquatic acres

E. Five years of monitoring additional replacement habitat with photo documentation report due each year

<u>Level 3</u>

Level 3 project impacts may include minor discharges into wetland habitats, such as outfall structures, bank stabilization less than 218 linear feet (66 meters), road crossings, bridge replacements or improvements, single family housing construction, and wetland and riparian restoration and creation activities.

Projects may include those routinely authorized under Nationwide Permit numbers 7, 13, 14, 18, 26, 27, and 29, or could be projects requiring individual permitting and full Public Notice. Level 3 impacts may result in permanent losses of less than 3.0 acres of giant garter snake habitat and less than 1.0 acre (0.40 hectare) of aquatic giant garter snake habitat, and temporary disturbances of less than 20.00 acres (8.09 hectares) of giant garter snake habitat. Projects with temporary disturbances which require more than two seasons to complete will be categorized as Level 3 impacts.

1. Impacts

A. Less than 3.00 acres (1.21 hectares) permanent loss of giant garter snake habitat (includes aquatic and upland habitat)

B. Less than 1.0 acre (0.40 hectare) permanent loss of aquatic giant garter snake habitat

C. Less than 218 linear feet (66 meters) permanent loss of bank habitat

D. Less than 20.00 acres (8.09 hectares) of temporary disturbances over greater than two seasons

2. Mitigation

A. Replacement of affected giant garter snake habitat at a 3:1 ratio

B. All replacement habitat must include both upland and aquatic habitat components. Upland and aquatic habitat components must be included in the replacement habitat at a ratio of 2:1 upland acres to aquatic acres

C. If restoration of habitat is a component of the replacement habitat, one year of monitoring restored habitat with a photo documentation report due one year from implementation of the restoration with pre- and post-project area photos

D. Five years of monitoring replacement habitat with photo documentation report due each year

TABLE 1 - SUMMARY OF GIANT GARTER SNAKE PROGRAMMATIC MITIGATION LEVELS

	IMPACTS: DURATION	**IMPACTS:** ACRES	**MITIGATION:** COMPENSATION
LEVEL 1	1 season	Less than 20 and temporary	Restoration
LEVEL 2	2 seasons	Less than 20 and temporary	Restoration plus 1:1 replacement
LEVEL 3	More than 2 seasons and temporary Permanent loss	Less than 20 and temporary Less than 3 acres total giant garter snake habitat AND Less than 1 acre aquatic habitat; OR Less than 218 linear feet bank habitat	3:1 Replacement (or restoration plus 2:1 replacement) 3:1 Replacement

Section 404 Options

1. If the project proponent is required to replace permanently lost wetland habitat to meet obligations pursuant to section 404 of the Clean Water Act, the 404 wetland acreage, mitigated at a minimum ratio of 1:1, may fulfill a portion of the Level 3 acreage with a 3:1 mitigation obligation required for replacing giant garter snake habitat, if the wetland acreage provides giant garter snake habitat. In-kind, on-site mitigation is preferred; however, off-site out-of-kind mitigation may be accepted on a case by case basis.

   Example. A 3.00 acre (1.21 hectares) parcel of giant garter snake habitat containing one acre of wetlands is lost, 3.00 acres (1.21 hectares) of wetlands will need to be created and a minimum of 6.00 (2.43 hectares) acres of uplands surrounding these wetlands will need to be preserved for giant garter snake mitigation. To satisfy the mitigation requirements of 404, the project proponent will need to replace 1.00 acre (0.40 hectare) of wetlands. This acre of wetlands will be credited against the total mitigation obligation. The project proponent would not be asked to create the 404 wetland component in addition to the giant garter snake aquatic habitat component.

2. Bankside or riparian habitat which has greater than 25 percent canopy may contribute to the functional values of the aquatic resources and may require 404 mitigation. If the project proponent is required to replace riparian habitat to meet obligations under 404, this acreage may not be subtracted from the Level 3 with a 3:1 mitigation obligations for giant garter snake habitat. Riparian woodlands do not provide suitable habitat because of excessive shade, lack of basking sites, and absence of prey populations.

Preservation Options

If the project proponent needs to mitigate at Level 3 and wishes to secure existing giant garter snake habitat by fee title or conservation easement, preservation of the giant garter snake habitat may be credited against, but may not exceed, 50 percent of the aquatic habitat replacement. Because Level 2 impacts require restoration of existing habitat, preservation of additional habitat to mitigate for Level 2 impacts is not an option. Level 2 requires full restoration of the temporary impacts plus construction of additional habitat at a 1:1 replacement ratio.

Example. A 3.0 acre parcel of giant garter snake habitat containing one acre of wetlands is lost. The project proponent must replace permanently lost habitat at a 3:1 ratio. Therefore, 3.00 acres (1.21 hectares) of wetlands will need to be created and a minimum of 6.00 acres (2.43 hectares) of uplands surrounding these wetlands will need to be preserved for giant garter snake mitigation. The mitigation parcel purchased to construct giant garter snake habitat contains 3.00 acres (1.00 acre of wetlands and 2.00 acres of uplands) of existing giant garter snake habitat on a portion of the property. The 1.00 acre (0.40 hectare) of wetlands may be subtracted from the aquatic component because the acreage is less than 50 percent of the aquatic habitat needed to be constructed (3.0 acres). In addition, the 2.00 acres of uplands may be subtracted from the total of 6.00 acres (2.43 hectares) of surrounding uplands needed for the upland mitigation component.

After crediting the existing preservation habitat in this example towards the total compensation needed, a total of 2.00 acres (0.81 hectare) of aquatic habitat remain to be constructed and 4.00 additional acres (1.62 hectares) of uplands surrounding the aquatic habitat need to be preserved.

Status of the Species

The Service published a proposal to list the giant garter snake as an endangered species on December 27, 1991 (56 **FR** 67046). The Service reevaluated the status of the giant garter snake before adopting the final rule. The giant garter snake was listed as a threatened species October 20, 1993 (58 **FR** 54053).

Fitch (1940) described the historical range of the species as extending from the vicinity of Sacramento and Contra Costa Counties southward to Buena Vista Lake, near Bakersfield, in Kern County. Prior to 1970, the giant garter snake was recorded historically from 17 localities (Hansen and Brode 1980). Five of these localities were clustered in and around Los Banos, Merced County, and the paucity of infomation makes it difficult to determine precisely the species' former range. Nonetheless, these records coincide with the historical distribution of large flood basins, fresh water marshes, and tributary streams. Surveys over the last two decades have located the giant garter snake as far north as the Butte Basin in the Sacramento Valley.

As recently as the 1970s, the range of the giant garter snake extended from near Burrel, Fresno County (Hansen and Brode 1980), northward to the vicinity of Chico, Butte County (Rossman and Stewart 1987). California Department of Fish and Game (CDFG) studies (Hansen 1988) indicate that giant garter snake populations currently are distributed in portions of the rice production zones of Sacramento, Sutter, Butte, Colusa, and Glenn Counties; along the western border of the Yolo Bypass in Yolo County; and along the eastern fringes of the Sacramento-San Joaquin River delta from the Laguna Creek-Elk Grove region of central Sacramento County southward to the Stockton area of San Joaquin County.

The giant garter snake is one of the largest garter snakes, reaching a total length of at least 160 cm. Females tend to be slightly longer and stouter than males. The weight of adult female giant garter snakes is typically 1.1-1.5 pounds (500-700 grams). Dorsal background coloration varies from brownish to olive with a checkered pattern of black spots, separated by a yellow dorsal stripe and two light colored lateral stripes. Background coloration and prominence of black checkered pattern and the three yellow stripes are geographically and individually variable (Hansen 1980). The ventral surface is cream to olive or brown and sometimes infused with orange, especially in northern populations.

Endemic to wetlands in the Sacramento and San Joaquin valleys, the giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways and agricultural wetlands, such as irrigation and drainage canals and rice fields. Giant garter snakes feed on small fishes, tadpoles, and frogs (Fitch 1941, Hansen 1980, Hansen 1988). Habitat requisites consist of: (1) adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season; (3) grassy banks and openings in waterside vegetation for basking; and (4) higher elevation uplands for cover and refuge from flood waters during the snake's dormant season in the winter (Hansen 1980). Giant garter snakes are typically absent from larger rivers and other water bodies that support introduced populations of large, predatory fish, and from wetlands with sand, gravel, or rock substrates (Hansen 1980, Rossman and Stewart 1987, Brode 1988, Hansen 1988). Riparian woodlands do not provide suitable habitat because of excessive shade, lack of basking sites, and absence of prey populations (Hansen 1980).

The giant garter snake inhabits small mammal burrows and other soil crevices above prevailing flood elevations throughout its winter dormancy period (i.e., November to mid-March). Giant garter snakes typically select burrows with sunny exposure along south and west facing slopes. Giant garter snakes also use burrows as refuge from extreme heat during their active period. The Biological Resources Division (BRD) of the USGS (Wylie et al. 1997) has documented giant garter snakes using burrows in the summer as much as 165 feet (50 meters) away from the marsh edge. Overwintering snakes have been documented using burrows as far as 820 feet (250 meters) from the edge of marsh habitat. During radio-telemetry studies conducted by the BRD giant garter snakes typically moved little from day to day. However, total activity varied widely between individuals. Snakes have been documented moving up to 5 miles (8 kilometers) over the period of a few days (Wylie et al. 1997).

The breeding season extends through March and April, and females give birth to live young from late July through early September (Hansen and Hansen 1990). Brood size is variable, ranging from 10 to 46 young, with a mean of 23 (Hansen and Hansen 1990). Young immediately scatter into dense cover and absorb their yolk sacs, after which they begin feeding on their own. Although growth rates are variable, young typically more than double in size by one year of age (G. Hansen, pers. comm.). Sexual maturity averages three years in males and 5 years for females (G. Hansen, pers. comm.).

The giant garter snake currently is only known from a small number of populations. The status of these populations and the threats to these snakes and their habitats are detailed in the final rule that listed the giant garter snake as threatened (58 **FR** 54053). A number of land use practices and other human activities currently threaten the survival of the giant garter snake throughout the remainder of its range. Although some giant garter snake populations have persisted at low levels in artificial wetlands associated with agricultural and flood control activities, many of these altered wetlands are now threatened with urban development. Cities within the current range of the giant garter snake that are rapidly expanding include: (1) Chico, (2) Yuba City, (3) Sacramento, (4) Galt, (5) Stockton, (6) Gustine, and (7) Los Banos.

Environmental Baseline

Surveys over the last two decades have located the giant garter snake as far north as the Butte

Basin in the Sacramento Valley. Currently, the Service recognizes 13 separate populations of giant garter snake, with each population representing a cluster of discrete locality records (58 **FR** 54053). The 13 extant populational clusters largely coincide with historical riverine flood basins and tributary streams throughout the Central Valley (Hansen 1980, Brode and Hansen 1992): (1) Butte Basin, (2) Colusa Basin, (3) Sutter Basin, (4) American Basin, (5) Yolo Basin--Willow Slough, (6) Yolo Basin--Liberty Farms, (7) Sacramento Basin, (8) Badger Creek--Willow Creek, (9) Caldoni Marsh, (10) East Stockton--Diverting Canal and Duck Creek, (11) North and South Grasslands, (12) Mendota, and (13) Burrel/Lanare. These populations span the Central Valley from just southwest of Fresno (i.e., Burrell-Lanare) north to Chico (i.e., Hamilton Slough). The 11 counties where the giant garter snake is still presumed to occur are: Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo.

In 1994, the BRD (then the National Biological Survey [NBS]) began a study of the life history and habitat requirements of the giant garter snake in response to an interagency submittal for consideration as an NBS Ecosystem Initiative. Since April of 1995, the BRD has further documented occurrences of giant garter snakes within some of the 13 populations identified in the final rule. The BRD has studied populations of giant garter snakes at the Sacramento and Colusa National Wildlife Refuges within the Colusa Basin, at Gilsizer Slough within the Sutter Basin, and at the Badger Creek area of the Cosumnes River Preserve within the Badger Creek-Willow Creek area. These populations, along with the American Basin population of giant garter snakes represent the largest extant populations. With the exception of the American Basin, these populations are largely protected from many of the threats to the species. Outside of these protected areas, giant garter snakes in these population clusters are still subject to all threats identified in the final rule. The remaining nine population clusters identified in the final rule are distributed discontinuously in small isolated patches and are vulnerable to extirpation by stochastic environmental, demographic, and genetic processes. All 13 population clusters are isolated from each other with no protected dispersal corridors. Opportunities for recolonization of small populations which may become extirpated is unlikely given the isolation from larger populations and lack of dispersal corridors between them.

Effects of the Proposed Action

Proximity of the action - Projects which meet the criteria for inclusion in this consultation will be permitted under the Corps' Nationwide Permits or individual permits, as appropriate. All permits will be issued for projects that will impact wetlands, and thus all permitted activities may occur in potential giant garter snake habitat. Projects may involve direct work in aquatic giant garter snake habitat, such as dredging and filling, and construction of outfall or other structures in canals and waterways. Other activities associated with the permitted project may occur adjacent to aquatic giant garter snake habitat and thus may impact upland giant garter snake habitat or adjacent seasonal wetlands that provide seasonal foraging habitat. These activities may include grading, clearing, mowing, and equipment staging and access.

Distribution - Nationwide Permits and individual permits are issued for projects throughout the

11 counties from which the giant garter snake is currently known. Projects may occur throughout the range of the giant garter snake.

Timing - Most projects affecting wetlands are carried out during the dry season, from April through November. The active period of the giant garter snake is May 1 to October 1. During this period direct impacts are lessened because snakes are actively moving and avoiding danger. Projects occurring outside this period will have greater impacts to giant garter snakes since they are less likely to actively avoid danger, and essential feeding, reproductive, and sheltering behaviors may be disrupted.

Dispersal from wintering sites and breeding occurs from mid-March through April. Snakes are more vulnerable when they first become active. After the winter inactive period, initial successful foraging is critical to reproductive success, particularly for breeding females, and to juvenile survival. Snakes are also seeking mates and breeding at this period. Disturbance during this time may lessen reproductive success.

Snakes begin their winter inactive period in October. Snakes are vulnerable during their inactive period when they are occupying burrows and soil crevices because they are unlikely to leave their retreat sites and may be crushed, trapped, or buried during movement of heavy equipment or excavation.

Juveniles are born late July to early September, and because of their small size they may be vulnerable to predation when disturbed from cover. Adequate feeding before the inactive period is critical for juvenile survival through the winter. Disturbance of juveniles, disruption of normal foraging activity, or removal of prey base may reduce survival of juveniles through the inactive period.

Disturbance duration and frequency - Projects that would qualify for this programmatic consultation may have both temporary and permanent impacts. Projects may be completed within one season, or may require two or more seasons to complete. Some projects may result in permanent loss of habitat and in increased disturbance frequency associated with maintenance and recreation activities. Temporary loss of habitat and temporary disturbance may result from repairs, modifications, or maintenance (e.g., temporary fill for a construction access or detour, dredging of canals or waterways). Increased disturbance frequency from recreation, traffic, feral or domestic animals, or human intrusion may be an indirect effect of some projects. Completed projects that require routine maintenance activities in proximity to habitat have future potential to cause harm, harassment, or injury.

Disturbance intensity and severity - Projects which would qualify for this consultation have either small permanent impacts of less than 3.00 acres (1.21 hectares) of giant garter snake habitat or temporary impacts which can be restored at completion of the project. Projects qualifying under this opinion are expected to have only small effects on giant garter snake populations.

Direct effects - Construction activities may remove vegetative cover and basking sites necessary for thermoregulation, fill or crush burrows or crevices, dewater habitat and remove the prey base. Temporary fill of canals and waterways will remove giant garter snake habitat and may obstruct movement of giant garter snakes. Because giant garter snakes utilize small mammal burrows and soil crevices as retreat sites, giant garter snakes may be crushed, buried, or otherwise injured from construction activities. Snakes may be run over by construction equipment or other vehicles accessing the construction sites. The disturbance from construction activities may also cause giant garter snakes to move into areas of unsuitable habitat where they will experience greater risk of predation or other sources of mortality. Silting, fill, or spill of oil or other chemicals could cause loss of prey items on or downstream of the project sites.

Indirect effects - Utility lines, road improvements, drainage facility improvements, recreational structures such as boat ramps, and flood control projects, are all potentially growth inducing and may have indirect effects to giant garter snakes. These include: vehicular mortality, human intrusion, predation from domestic and feral animals, predation from raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), opossum (*Didelphis virginiana*) and other species attracted to suburban developments, dumping of garbage causing contamination or injury, reduced water quality from urban runoff contributing to a reduced prey base, and introduction of exotic species such as predatory game fish which may prey on juveniles or compete with giant garter snakes for prey. Increases in severity and frequency of flooding may be associated with development and may inundate overwintering snakes or force snakes to seek new flood refugia during their inactive period. Other potential habitat alterations include changes in fluvial morphology and floodplain configurations for flood control, resulting in lack of refugia, loss of aquatic corridors, and restriction of movement. Land conversions may change stream and wetland hydrology. Conversion of seasonal wetlands to perennial wetlands may allow populations of non-native predatory game fish or bullfrogs (*Rana catesbiana*), which may eat juvenile snakes and compete for prey, to become established or invade to nearby marshes, sloughs, and other wetlands supporting giant garter snake.

Beneficial effects. The programmatic process will expedite projects resulting in less than 3.00 acres (1.21 hectares) of permanent impacts to giant garter snake habitat and may encourage applicants to avoid greater impacts which would require a lengthier permit process. Project planning efforts that stay within the programmatic guidelines may facilitate giant garter snake recovery by resulting in significantly less habitat loss over time. Occupied habitat protected under conservation easements will provide population components that are not threatened by the factors that contributed to listing the species. The Service anticipates that the mitigation implemented now will lead to the development of protected habitat areas distributed across the landscape. Local communities can use these preserved areas as foundations for future habitat conservation plans.

Cumulative Effects

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

An undetermined number of future land use conversions and routine agricultural practices are not subject to Federal authorization or fundings and may alter the habitat or increase incidental take of giant garter snakes and are, therefore, cumulative to the proposed project. These additional cumulative effects include: (1) unpredictable fluctuations in aquatic habitat due to water management; (2) dredging and clearing vegetation from irrigation canals; (3) discing, mowing, ornamental cultivation, and routine grounds maintenance of upland habitat;

(4) increased vehicular traffic on access roads adjacent to aquatic habitat; (5) use of burrow fumigants on levees and other potential upland refugia; (6) contaminated runoff from agriculture and urbanization; and (7) predation by feral animals and pets.

Conclusion

After reviewing the current status of the giant garter snake, the environmental baseline for the action areas, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the projects which meet the qualifications for this programmatic consultation, and will be evaluated for cumulative take and habitat losses annually, are not likely to jeopardize the continued existence of the giant garter snake. No critical habitat has been designated for these species, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined by the Service as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding and sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, and sheltering. Incidental take is defined by the Service as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are nondiscretionary and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o) (2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Incidental Take

The Service anticipates incidental take of giant garter snakes will occur. The project sizes and impacts authorized under this programmatic will vary, but are expected to have small effects. Giant garter snakes are secretive and notoriously sensitive to human activities. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. The Service anticipates the following forms of incidental take:

1. The number of giant garter snakes that may be found in 250 acres (100 hectares) of habitat per year will be disturbed, harassed, harmed, or killed by project activities resulting in temporary impacts and permanent impacts, especially from dewatering, channel reconfiguration, and use of heavy equipment within or near aquatic habitat.

2. Fifty acres (20 hectares) of giant garter snake habitat per year may be permanently lost.

Effect of the Take

In the accompanying biological opinion, the Service has determined that this level of anticipated take is not likely to result in jeopardy to the giant garter snake or destruction or adverse modification of critical habitat.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of giant garter snakes.

1. Harassment, harm, or take of giant garter snakes during construction activities associated with implementing the projects shall be minimized (refer also to Appendix C, Standard Avoidance and Minimization Measures During Construction Activities in Giant Garter Snake Habitat).

2. Impacts of temporary losses and degradation of habitat of giant garter snakes shall be minimized and, to the greatest extent practicable, habitat restored to its pre-project condition. More than two season and temporary loss on any permanent loss of habitat

shall be compensated.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. The terms and conditions are non-discretionary.

1. The following terms and conditions implement reasonable and prudent measure number one:

   A. All construction activity within giant garter snake habitat shall be conducted between May 1 and October 1. This is the active period for giant garter snakes and direct impacts are lessened, because snakes are actively moving and avoiding danger. More danger is posed to snakes during their inactive period, because they are occupying underground burrows or crevices and are more susceptible to direct effects, especially during excavation. Between October 2 and April 30 contact the Service's Sacramento Fish and Wildlife Office to determine if additional measures are necessary to minimize and avoid take.

   B. Any dewatered habitat must remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat.

   C. Construction personnel shall participate in a Service-approved worker environmental awareness program. Under this program, workers shall be informed about the presence of giant garter snakes and habitat associated with the species and that unlawful take of the animal or destruction of its habitat is a violation of the Act. Prior to construction activities, a qualified biologist approved by the Service shall instruct all construction personnel about: (1) the life history of the giant garter snake; (2) the importance of irrigation canals, marshes/wetlands, and seasonally flooded areas, such as rice fields, to the giant garter snake; and (3) the terms and conditions of the biological opinion. Proof of this instruction shall be submitted to the Sacramento Fish and Wildlife Office.

   D. Within 24-hours prior to commencement of construction activities, the site shall be inspected by a qualified biologist who is approved by the Service's Sacramento Fish and Wildlife Office. The biologist will provide the Service with a field report form documenting the monitoring efforts within 24-hours of commencement of construction activities. Information that should be included in a field report form is provided in Appendix D. The monitoring biologist needs to be available thereafter; if a snake is encountered during construction activities, the monitoring biologist shall have the authority to stop construction activities until appropriate corrective measures have been completed or it is determined that the snake will not be harmed. Giant garter snakes encountered during construction activities should be allowed to move away from construction activities on their own. Capture and relocation of trapped or injured individuals can only be attempted by personnel or individuals with current Service recovery permits pursuant to section 10(a)1(A) of the Act. The biologist shall be required to report any incidental take to the Service immediately by telephone at (916) 979-2725 and by written letter addressed to the Chief, Endangered Species Division, within one working day. The project area shall be re-inspected whenever a lapse in construction activity of two weeks or greater has occurred.

E. Clearing of wetland vegetation will be confined to the minimal area necessary to excavate toe of bank for riprap or fill placement. Excavation of channel for removal of accumulated sediments will be accomplished by using equipment located on and operated from top of bank, with the least interference practical for emergent vegetation.

F. Movement of heavy equipment to and from the project site shall be restricted to established roadways to minimize habitat disturbance.

2. The following terms and conditions implement reasonable and prudent measure number two:

A. Preserved giant garter snake habitat shall be designated as Environmentally Sensitive Areas and shall be flagged by a qualified biologist approved by the Service and avoided by all construction personnel.

B. After completion of construction activities, any temporary fill and construction debris shall be removed and, wherever feasible, disturbed areas shall be restored to pre-project conditions. Restoration work may include replanting emergent vegetation (refer to Appendix A, Mitigation Criteria for Restoration and/or Replacement of Giant Garter Snake Habitat).

C. More than two season and temporary permanent losses of habitat shall be compensated at the ratios described in **Table 1** and meet the criteria listed in Appendix A, Mitigation Criteria for Restoration and/or Replacement of Giant Garter Snake Habitat).

D. All wetland and upland acres created and provided for the giant garter snake shall be protected in perpetuity by a Service-approved conservation easement or similarly protective covenants in the deed. The conservation easement on the mitigation habitat shall be recorded at the county recording office within 60 days of groundbreaking. The easement/deed, including a title report for the land area, shall be reviewed and approved by the Service prior to recording in the appropriate County Recorders Office(s). A true copy of the recorded easement/deed shall be provided to the Service within 30 days after recordation. Standard examples of deed restrictions and conservation easements are available from the Service upon request.

E. The Corps shall ensure compliance with the Reporting Requirements below.

Reporting Requirements

The Service-approved biologist shall notify the Service immediately if giant garter snakes are found on site as detailed in term and condition 1D, and will submit a report including date(s), location(s), habitat description, and any corrective measures taken to protect the snake(s) found. The Service-approved biologist shall submit locality information to the California Department of Fish & Game (CDFG), using completed California Native Species Field Survey Forms or their equivalent, no more than 90 calendar days after completing the last field visit of the project site. Each form shall have an accompanying scale map of the site such as a photocopy of a portion of the appropriate 7.5 minute U.S. Geological Survey map and shall provide at least the following information: township, range, and quarter section; name of the 7.5' or 15' quadrangle; dates (day, month, year) of field work; number of individuals and life stage (where appropriate) encountered; and a description of the habitat by community-vegetation type.

A post-construction compliance report prepared by the Service approved monitoring biologist shall be forwarded to the Chief, Endangered Species Division, at the Sacramento Fish and Wildlife Office within 60 calendar days of the completion of each project. This report shall detail (I) dates that construction occurred; (ii) pertinent information concerning the applicant's success in meeting project mitigation measures; (iii) an explanation of failure to meet such measures, if any; (iv) known project effects on federally listed species, if any; (v) occurrences of incidental take of federally listed species, if any; and (vi) other pertinent information.

The Sacramento Fish and Wildlife Office is to be notified within three working days of the finding of any dead listed species or any unanticipated harm to the species addressed in this biological opinion. The Service contact person for this is the Chief, Endangered Species Division at (916) 979-2725.

Review Requirements

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the effects of incidental take that might otherwise result from the proposed action. With implementation of this measure, the Service believes that no more than 200 acres (80 hectares) of habitat will be temporarily disturbed and no more than 50 acres (20 hectares) of habitat will be permanently lost per year for the duration authorized under this opinion, or a total of 5 years. In addition, the number of giant garter snakes that may be found within 250 acres (100 hectares) of habitat per year may be disturbed, harassed, harmed, or killed as a result of actions permitted under this opinion. If, during the course of the action, this minimized level of incidental take is exceeded prior to the annual review, such incidental take represents new information requiring review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures. This programmatic opinion will expire 5 years from the date of issuance. Issuance of a new programmatic opinion will be subject to evaluation of the recovery of the species.

CONSERVATION RECOMMENDATIONS

Section 7 (a) (1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's 7(a)(1) responsibilities for these species.

1. As a Recovery Plan for the giant garter snake is developed, the Corps should assist the Service in its implementation.

2. The Corps should incorporate into bidding documents the enclosed "Standard Avoidance and Minimization Measures for Construction Activities in Giant Garter Snake Habitat" when appropriate.

3. The Corps, in partnership with the Service, should develop maintenance guidelines for Corps projects that will reduce adverse effects of routine maintenance on giant garter snakes and their habitat. Such actions may contribute to the delisting and recovery of the giant garter snake by preventing degradation of existing habitat and increasing the amount and stability of suitable habitat.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the projects described in this opinion. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. In addition, if the Corps discovers that the conditions of the permit have not been followed, the Corps should review its responsibilities under section 7 of the Act and reinitiate formal consultation with the Service. We appreciate the cooperation of the Corps throughout this consultation process.

If you have any questions regarding this biological opinion, please contact Kelly Hornaday of my staff at (916) 979-2120.

Sincerely,

Wayne S. White
Field Supervisor

Enclosures (Appendices A-D)

cc: AES, Portland, OR
CESAC, Regulatory Branch
FWS-SFO, Wetlands Branch
CDFG, Region 2, David Zezulak

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Personal Communications

Hansen, G., Consulting Environmental Biologist, 3230 Brookwood Road, Sacramento, CA

95821.

RECOMMENDED TIMING AND METHODOLOGY FOR SWAINSON'S HAWK NESTING SURVEYS IN CALIFORNIA'S CENTRAL VALLEY

Swainson's Hawk Technical Advisory Committee

May 31, 2000

This set of survey recommendations was developed by the Swainson's Hawk Technical Advisory Committee (TAC) to maximize the potential for locating nesting Swainson's hawks, and thus reducing the potential for nest failures as a result of project activities/disturbances. The combination of appropriate surveys, risk analysis, and monitoring has been determined to be very effective in reducing the potential for project-induced nest failures. As with most species, when the surveyor is in the right place at the right time, Swainson's hawks may be easy to observe; but some nest sites may be very difficult to locate, and even the most experienced surveyors have missed nests, nesting pairs, mis-identified a hawk in a nest, or believed incorrectly that a nest had failed. There is no substitute for specific Swainson's hawk survey experience and acquiring the correct search image.

METHODOLOGY

Surveys should be conducted in a manner that maximizes the potential to observe the adult Swainson's hawks, as well as the nest/chicks second. To meet the California Department of Fish and Game's (CDFG) recommendations for mitigation and protection of Swainson's hawks, surveys should be conducted for a ½ mile radius around all project activities, and if active nesting is identified within the ½ mile radius, consultation is required. In general, the TAC recommends this approach as well.

Minimum Equipment

Minimum survey equipment includes a high-quality pair of binoculars and a high quality spotting scope. Surveying even the smallest project area will take hours, and poor optics often result in eye-strain and difficulty distinguishing details in vegetation and subject birds. Other equipment includes good maps, GPS units, flagging, and notebooks.

Walking vs Driving

Driving (car or boat) or "windshield surveys" are usually preferred to walking if an adequate roadway is available through or around the project site. While driving, the observer can typically approach much closer to a hawk without causing it to fly. Although it might appear that a flying bird is more visible, they often fly away from the observer using trees as screens; and it is difficult to determine from where a flying bird came. Walking surveys are useful in locating a nest after a nest territory is identified, or when driving is not an option.

Angle and Distance to the Tree

Surveying subject trees from multiple angles will greatly increase the observer's chance of detecting a nest or hawk, especially after trees are fully leafed and when surveying multiple trees in close proximity. When surveying from an access road, survey in both directions. Maintaining a distance of 50 meters to 200 meters from subject trees is optimal for observing perched and flying hawks without greatly reducing the chance of detecting a nest/young: Once a nesting territory is identified, a closer inspection may be required to locate the nest.

Speed
Travel at a speed that allows for a thorough inspection of a potential nest site. Survey speeds should not exceed 5 miles per hour to the greatest extent possible. If the surveyor must travel faster than 5 miles per hour, stop frequently to scan subject trees.

Visual and Aural Ques
Surveys will be focused on both observations and vocalizations. Observations of nests, perched adults, displaying adults, and chicks during the nesting season are all indicators of nesting Swainson's hawks. In addition, vocalizations are extremely helpful in locating nesting territories. Vocal communication between. hawks is frequent during territorial displays; during courtship and mating; through the nesting period as mates notify each other that food is available or that a threat exists; and as older chicks and fledglings beg for food.

Distractions
Minimize distractions while surveying. Although two pairs of eyes may be better than one pair at times, conversation may limit focus. Radios should be off, not only are they distracting, they may cover a hawk's call.

Notes and Species Observed
Take thorough field notes. Detailed notes and maps of the location of observed Swainson's hawk nests are essential for filling gaps in the Natural Diversity Data Base; please report all observed nest sites. Also document the occurrence of nesting great homed owls, red-tailed hawks, red-shouldered hawks and other potentially competitive species. These species will infrequently nest within 100 yards of each other, so the presence of one species will not necessarily exclude another.

TIMING

To meet **the minimum level** of protection for the species, surveys should be completed for **at least** the two survey periods immediately prior to a project's initiation. For example, if a project is scheduled to begin on June 20, you should complete 3 surveys in Period III and 3 surveys in Period V. However, it is always recommended that surveys be completed in Periods II, III and V. **Surveys should not be conducted in Period IV.**

The survey periods are defined by the timing of migration, courtship, and nesting in a "typical" year for the majority of Swainson's hawks from San Joaquin County to Northern Yolo County. Dates should be adjusted in consideration of early and late nesting seasons, and geographic differences (northern nesters tend to nest slightly later, etc). If you are not sure, contact a TAC . member or CDFG biologist.

Survey dates	**Survey time**	**Number of Surveys**
Justification and search image		

I. *January-March 20 (recommended optional)* — *All day* — *1*

Prior to Swainson's hawks returning, it may be helpful to survey the project site to determine potential nest locations. Most nests are easily observed from relatively long distances, giving the surveyor the opportunity to identify potential nest sites, as well as becoming familiar with the project area. It also gives the surveyor the opportunity to locate and map competing species nest sites such as great homed owls from February on, and red-tailed hawks from March on. After March 1, surveyors are likely to observe Swainson's hawks staging in traditional nest territories.

II. *March 20 to April 5* — *Sunrise to 1000*
1600 to sunset — *3*

Most Central Valley Swainson's hawks return by April 1, and immediately begin occupying their traditional nest territories. For those few that do not return by April 1, there are often hawks ("floaters") that act as place-holders in traditional nest sites; they are birds that do not have mates, but temporarily attach themselves to traditional territories and/or one of the site's "owners." Floaters are usually displaced by the territories' owner(s) if the owner returns.

Most trees are leafless and are relatively transparent; it is easy to observe old nests, staging birds, and competing species. The hawks are usually in their territories during the survey hours, but typically soaring and foraging in the mid-day hours. Swainson's hawks may often be observed involved in territorial and courtship displays, and circling the nest territory. Potential nest sites identified by the observation of staging Swainson's hawks will usually be active territories during that season, although the pair may not successfully nest/reproduce that year.

III. *April 5 to April 20* — *Sunrise to 1200*
1630 to Sunset — *3*

Although trees are much less transparent at this time, 'activity at the nest site increases significantly. Both males and females are actively nest building, visiting their selected site frequently. Territorial and courtship displays are increased, as is copulation. The birds tend to vocalize often, and nest locations are most easily identified. This period may require a great deal of "sit and watch" surveying.

IV. *April 21 to June 10* — *Monitoring known nest sites only*
Initiating Surveys is not recommended

Nests are extremely difficult to locate this time of year, and even the most experienced surveyor will miss them, especially if the previous surveys have not been done. During this phase of nesting, the female Swainson's hawk is in brood position, very low in the nest, laying eggs, incubating, or protecting the newly hatched and vulnerable chicks; her head may or may not be visible. Nests are often well-hidden, built into heavily vegetated sections of trees or in clumps of mistletoe, making them all but invisible. Trees are usually not viewable from all angles, which may make nest observation impossible.

Following the male to the nest may be the only method to locate it, and the male will spend hours away from the nest foraging, soaring, and will generally avoid drawing attention to the nest site. Even if the observer is fortunate enough to see a male returning with food for the female, if the female determines it is not safe she will not call the male in, and he will not approach the nest; this may happen if the observer, or others, are too close to the nest or if other threats, such as rival hawks, are apparent to the female or male.

V. ***June 10 to JuIy 30 (post-fledging)***	***Sunrise to 1200*** ***1600 to sunset***	***3***

Young are active and visible, and relatively safe without parental protection. Both adults make numerous trips to the nest and are often soaring above, or perched near or on the nest tree. The location and construction of the nest may still limit visibility of the nest, young, ‘and adults.

DETERMINING A PROJECT'S POTENTIAL
FOR IMPACTING SWAINSON'S HAWKS

LEVEL OF RISK	REPRODUCTIVE SUCCESS (Individuals)	LONGTERM SURVIVABILITY (Population)	NORMAL SITE CHARACTERISTICS (Daily Average)	NEST MONI-TORING
HIGH	Direct physical contact with the nest tree while the birds are on eggs or protecting young. (Helicopters in close proximity)	Loss of available foraging area. Loss of nest trees.	Little human-created noise, little human use: nest is well away from dwellings, equipment yards, human access areas, etc. *Do not include general cultivation practices in evaluation.*	**MORE**
	Loss of nest tree after nest building is begun prior to laying eggs.	Loss of potential nest trees.		
	Personnel within 50 yards of nest tree (out of vehicles) for extended periods while birds are on eggs or protecting young that are < 10 days old.	Cumulative: Multi-year, multi-site projects with substantial noise/personnel disturbance.		
	Initiating construction activities (machinery and personnel) within 200 yards of the nest after eggs are laid and before young are > 10 days old.	Cumulative: Single-season projects with substantial noise/personnel disturbance that is greater than or significantly different from the daily norm.		
	Heavy machinery only working within 50 yards of nest.			
	Initiating construction activities within 200 yards of nest before nest building begins or after young > 10 days old.		Substantial human-created noise and occurrence: nest is near roadways, well-used waterways, active airstrips, areas that have high human use.	
LOW	All project activities (personnel and machinery) greater than 200 yards from nest.	Cumulative: Single-season projects with activities that "blend" well with site's "normal' activities.	*Do not include general cultivation practices in evaluation.*	**LESS**

State of California

M e m o r a n d u m

: "Div. Chiefs - IFD, BDD, NED, & WMD
Reg. Mgrs. - Regions 1, 2, 3, 4, & 5

Date : October 17, 1995

From : Department of Fish and Game

Subject : Staff Report on Burrowing Owl Mitigation

I am hereby transmitting the Staff Report on Burrowing Owl Mitigation for your use in reviewing projects (California Environmental Quality Act [CEQA] and others) which may affect burrowing owl habitat. The Staff Report has been developed during the last several months by the Environmental Services Division (ESD) in cooperation with the Wildlife Management Division (WMD) and regions 1, 2, and 4. It has been sent out for public review and redrafted as appropriate.

Either the mitigation measures in the staff report may be used or project specific measures may be developed. Alterative project specific measures proposed by the Department divisions/regions or by project sponsors will also be considered. However, such mitigation measures must be submitted to ESD for review. The review process will focus on the consistency of the proposed measure with Department, Fish and Game Commission, and legislative policy and with laws regarding raptor species. ESD will coordinate project specific mitigation measure review with WMD.

If you have any questions regarding the report, please contact Mr. Ron Rempel, Supervising Biologist, Environmental Services Division, telephone (916) 654-9980.

COPY Original signed by C.F Raysbrook

C. F. Raysbrook
Interim Director

Attachment

cc: Mr. Ron Rempel
Department of Fish and Game
Sacramento

STAFF REPORT ON BURROWING OWL MITIGATION

Introduction

The Legislature and the Fish and Game Commission have developed the policies, standards and regulatory mandates to protect native species of fish and wildlife. In order to determine how the Department of Fish and Game (Department) could judge the adequacy of mitigation measures designed to offset impacts to burrowing owls *(Speotyto cunicularia;* A.O.U. 1991) staff (WMD, ESD, and Regions) has prepared this report. To ensure compliance with legislative and commission policy, mitigation requirements which are consistent with this report should be incorporated into: (1) Department comments to Lead Agencies and project sponsors pursuant to the California Environmental Quality Act (CEQA); and (2) other authorizations the Department gives to project proponents for projects impacting burrowing owls.

This report is designed to provide the Department (including regional offices and divisions), CEQA Lead Agencies and project proponents the context in which the Environmental Services Division (ESD) will review proposed project specific mitigation measures. This report also includes preapproved mitigation measures which have been judged to be consistent with policies, standards and legal mandates of the Legislature,. the Fish and Game Commission and the Department's public trust responsibilities. Implementation of mitigation measures consistent with this report are intended to help achieve the conservation of burrowing owls and should compliment multi-species habitat conservation planning efforts currently underway. The *Burrowing Owl Survey Protocol and Mitigation Guidelines* developed by The California Burrowing Owl Consortium (CBOC 1993) were taken into consideration in the preparation of this staff report as were comments from other interested parties.

A range-wide conservation strategy for this species is needed. Any range-wide conservation strategy should establish criteria for avoiding the need to list the species pursuant to either the California or federal Endangered Species Acts through preservation of existing habitat, population expansion into former habitat, recruitment of young into the population, and other specific efforts.

California's burrowing owl population is clearly declining and, if declines continue, the species may qualify for listing. Because of the intense pressure for urban development within suitable burrowing owl nesting and foraging habitat (open, flat and gently rolling grasslands and grass/shrub lands) in California, conflicts between owls and development projects often occur. Owl survival can be adversely affected by disturbance and foraging habitat loss even when impacts to individual birds and nests/burrows are avoided. Adequate information about the presence of owls is often unavailable prior to project approval. Following project approval there is no legal mechanism through which to seek mitigation other than avoidance of occupied burrows or nests. The absence of standardized survey methods often impedes consistent impact assessment.

Burrowing Owl Habitat Description

Burrowing owl habitat can be found in annual and perennial grasslands, deserts, and arid scrublands characterized by low-growing vegetation (Zarn 1974). Suitable owl habitat may also include trees and shrubs if the canopy covers less than 30 percent of the ground surface. Burrows are the essential component of burrowing owl habitat. Both natural and artificial burrows provide protection, shelter, and nests for burrowing owls (Henny and Blus 1981). Burrowing owls typically use burrows made by fossorial mammals, such as ground squirrels or badgers, but also may use man-made structures such as cement culverts; cement, asphalt, or wood debris piles; or openings beneath cement or asphalt pavement.

Occupied Burrowing Owl Habitat

Burrowing owls may use a site for breeding, wintering, foraging, and/or migration stopovers. Occupancy of suitable burrowing owl habitat can be verified at a site by detecting a burrowing owl, its molted feathers, cast pellets, prey remains, eggshell fragments, or excrement at or near a burrow entrance. Burrowing owls exhibit high site fidelity, reusing burrows year after year (Rich 1984, Feeney 1992). A site should be assumed occupied if at least one burrowing owl has been observed occupying a burrow there within the last three years (Rich 1984).

CEQA Project Review

The measures included in this report are intended to provide a decision-making process that should be implemented whenever-there is potential for-an action or project to adversely affect burrowing owls. For projects subject to the California Environmental Quality Act (CEQA), the process begins by conducting surveys to determine if burrowing owls are foraging or nesting on or adjacent to the project site. If surveys confirm that the site is occupied habitat, mitigation measures to minimize impacts to burrowing owls, their burrows and foraging habitat should be incorporated into the CEQA document as enforceable conditions. The measures in this document are intended to conserve the species by protecting and maintaining viable' populations of the species throughout their range in California. This may often result in protecting and managing habitat for the species at sites away from rapidly urbanizing/developing areas. Projects and situations vary and mitigation measures should be adapted to fit specific circumstances.

Projects not subject to CEQA review may have to be handled separately since the legal authority the Department has with respect to burrowing owls in this type of situation is often limited. The burrowing owl is protected from “take” (Section 3503.5 of the Fish and Game Code) but unoccupied habitat is likely to be lost for activities not subject to CEQA.

Legal Status

The burrowing owl is a migratory species protected by international treaty under the Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703-711). The MBTA makes it unlawful to take, possess, buy, sell, purchase, or barter any migratory bird listed in 50 C.F.R. Part 10, including feathers or other parts, nests, eggs, or products, except as allowed by implementing regulations (50 C.F.R. 21). Sections 3505, 3503.5, and 3800 of the California Department of Fish and Game Code prohibit the take, possession, or destruction of birds, their nests or eggs. To avoid violation of the take provisions of these laws generally requires that project-related disturbance at active nesting territories be reduced or eliminated during the nesting cycle (February 1 to August 31). Disturbance that causes nest abandonment and/or loss of reproductive effort (e.g., killing or abandonment of eggs or young) may be considered "take"' and is potentially punishable by fines and/or imprisonment.

The burrowing owl is a Species of Special Concern to California because of declines of suitable habitat and both localized and statewide population declines. Guidelines for the Implementation of the California Environmental Quality Act (CEQA) provide that a species be considered as endangered or "rare" regardless of appearance on a formal list for the purposes of the CEQA (Guidelines, Section 15380, subsections b and d). The CEQA requires a mandatory findings of significance if impacts to threatened or endangered species are likely to occur (Sections 21001 (c), 2103; Guidelines 15380, 15064, 15065). To be legally adequate, mitigation measures must be capable of "avoiding the impact altogether by not taking a certain action or parts of an action"; "minimizing impacts by limiting the degree or magnitude of the action and its implementation"; "rectifying the impact by repairing, rehabilitating or restoring the impacted environment"; "or reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action" (Guidelines, Section 15370). Avoidance or mitigation to reduce impacts to less than significant levels must be included in a project or the CEQA lead agency must make and justify findings of overriding considerations.

Impact Assessment

Habitat Assessment

The project site and a 150 meter (approximately 500 ft.) buffer (where possible and appropriate based on habitat) should be surveyed to assess the presence of burrowing owls and their habitat (Thomsen 1971, Martin 1973). If occupied habitat is detected on or adjacent to the site, measures to avoid, minimize, or mitigate the project's impacts to the species should be incorporated into the project, including burrow preconstruction surveys to ensure avoidance of direct take. It is also recommended that preconstruction surveys be conducted if the species was not detected but is likely to occur on the project site.

Burrowing Owl and Burrow Surveys

Burrowing owl and burrow surveys should be conducted during both the wintering and nesting seasons, unless the species is detected on the first survey. If possible, the winter survey should be conducted between December 1 and January 31 (when wintering owls are most likely to be present) and the nesting season survey should be conducted between April 15 and July 15 (the peak of the breeding season). Surveys conducted from two hours before sunset to one hour after, or from one hour before to two hours after sunrise, are also preferable.

Surveys should be conducted by walking suitable habitat on the entire project site and (where possible) in areas within 150 meters (approx. 500 ft.) of the project impact zone. The 150-meter buffer zone is surveyed to identify burrows and owls outside of the project area which may be impacted by factors -such as noise and vibration (heavy equipment, etc.) during project construction. Pedestrian survey transects should be spaced to allow 100 percent visual coverage of the ground surface. The distance between transect center lines should be no more than 30 meters (approx. 100 ft.) and should be reduced to account for differences in terrain, vegetation density, and ground surface visibility. To effectively survey large projects (100 acres or larger), two or more surveyors should be used to walk adjacent transects. To avoid impacts to owls from surveyors, owls and/or occupied burrows should be avoided by a minimum of 50 meters (approx. 160 ft.) wherever practical. Disturbance to occupied burrows should be avoided during all seasons.

Definition of Impacts

The following should be considered impacts to the species:

- Disturbance within 50 meters (approx. 160 ft.) Which may result in harassment of owls at occupied burrows;

- Destruction of natural and artificial burrows (culverts, concrete slabs and debris piles that provide shelter to burrowing owls); and

- Destruction and/or degradation of foraging habitat adjacent (within 100 m) of an occupied burrow(s).

Written Report

A report for the project should be prepared for the Department and copies should be submitted to the Regional contact and to the Wildlife Management Division Bird and Mammal Conservation Program. The report should include the following information:

- Date and time of visit(s) including name of the qualified biologist conducting surveys, weather and visibility conditions, and survey methodology;

- Description of the site including location, size, topography, vegetation communities, and animals observed during visit(s);

- Assessment of habitat suitability for burrowing owls;

- Map and photographs of the site;

- Results of transect surveys including a map showing the location of all burrow(s) (natural or artificial) and owl(s), including the numbers at each burrow if present and tracks, feathers, pellets, or other items (prey remains, animal scat);

- Behavior of owls during the surveys;

- Summary of both winter and nesting season surveys including any productivity information and a map showing territorial boundaries and home ranges; and

- Any historical information (Natural Diversity Database, Department regional files? Breeding Bird Survey data, American Birds records, Audubon Society, local bird club, other biologists, etc.) regarding the presence of burrowing owls on the site.

Mitigation

The objective of these measures is to avoid and minimize impacts to burrowing owls at a project site and preserve habitat that will support viable owls populations. If burrowing owls are detected using the project area, mitigation measures to minimize and offset the potential impacts should be included as enforceable measures during the CEQA process.

Mitigation actions should be carried out from September 1 to January 31 which is prior to the nesting season (Thomsen 1971, Zam 1974). Since the timing of nesting activity may vary with latitude and climatic conditions, this time frame should be adjusted accordingly. Preconstruction surveys of suitable habitat at the project site(s) and buffer zone(s) should be conducted within the 30 days prior to construction to ensure no additional, burrowing owls have established territories since the initial surveys. If ground disturbing activities are delayed or suspended for more than 30 days after the preconstruction survey, the site should be resurveyed.

Although the mitigation measures may be included as enforceable project conditions in the CEQA process, it may also be desirable to formalize them in a Memorandum of Understanding (MOU) between the Department and the project sponsor. An MOU is needed when lands (fee title or conservation easement) are being transferred to the Department.

Specific Mitigation Measures

1. Occupied burrows should not be disturbed during the nesting season (February 1 through August 3 1) unless a qualified biologist approved by the Department verifies through non-invasive methods that either: (1) the birds have not begun egg-laying and incubation; or (2) that juveniles from the occupied burrows are foraging independently and are capable of independent survival.

2. To offset the loss of foraging and burrow habitat on the project site, a minimum of 6.5 acres of foraging habitat (calculated on a 100 m {approx. 300 ft.} foraging radius around the burrow) per pair or unpaired resident bird, should be acquired and permanently protected. The protected lands should be adjacent to occupied burrowing owl habitat and at a location acceptable to the Department. *Protection of additional habitat acreage per pair or unpaired resident bird may be applicable in some instances.* The CBOC has also developed mitigation guidelines (CBOC 1993) that can be incorporated by CEQA lead agencies and which are consistent with this staff report.

3. When destruction of occupied burrows is unavoidable, existing unsuitable burrows should be enhanced (enlarged or cleared of debris) or new burrows created (by installing artificial burrows) at a ratio of 2:1 on the protected lands site. One example of an artificial burrow design is provided in Attachment A.

4. If owls must be moved away from the disturbance area, passive relocation techniques (as described below) should be used rather than trapping. At least one or more weeks will be necessary to accomplish this and allow the owls to acclimate to alternate burrows.

5. The project sponsor should provide funding for long-term management and monitoring of the protected lands. The monitoring plan should include success criteria, remedial measures, and an annual report to the Department.

Impact Avoidance

If avoidance is the preferred method of dealing with potential project impacts, then no disturbance should occur within 50 meters (approx. 160 ft.) of occupied burrows during the nonbreeding season of September 1 through January 31 or within 75 meters (approx. 250 ft.) during the breeding season of February 1 through August 31. Avoidance also requires that a minimum of 6.5 acres of foraging habitat be *permanently* preserved contiguous with occupied burrow sites for each pair of breeding burrowing owls (with or without dependent young) or single unpaired resident bird. The configuration of the protected habitat should be approved by the Department.

Passive Relocation - With One-Way Doors

Owls should be excluded from burrows in the immediate impact zone and within a 50 meter (approx. 160 ft.) buffer zone by installing one-way doors in burrow entrances. One-way doors (e.g., modified dryer vents) should be left in place 48 hours to insure owls have left the burrow before excavation. Two natural or artificial burrows should be provided for each burrow in the project area that will be rendered biologically unsuitable. The project area should be *monitored daily for one* week to confirm owl use of burrows before excavating burrows in the immediate impact zone. Whenever possible, burrows should be excavated using hand tools and refilled to prevent reoccupation. Sections of flexible plastic pipe should be inserted into the tunnels during excavation to maintain an escape route for any animals inside the burrow.

Passive Relocation - Without One-Way Doors

Two natural or artificial burrows should be provided for each burrow in the project area that will be rendered biologically unsuitable. The project area should be *monitored daily until the owls have relocated to the new burrows.* The formerly occupied burrows may then. be excavated. Whenever possible, burrows should be excavated using hand tools and refilled to prevent reoccupation. Sections of flexible plastic pipe should be inserted into burrows during excavation to maintain an escape route for any animals inside the burrow.

Projects Not Subject to CEQA

The Department is often contacted regarding the presence of burrowing owls on construction sites, parking lots and other areas for which there is no CEQA action or for which the CEQA process has been completed. In these situations, the Department should seek to reach agreement with the project sponsor to implement the specific mitigation measures described above. If they are unwilling to do so, passive relocation without the aid of one-way doors is their only option based upon Fish and Game Code 3503.5.

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Reproductive Success of Burrowing Owls Using Artificial Nest Burrows in Southeastern Idaho

by Bruce Olenick

Artificial nest burrows were implanted in southeastern Idaho f'or burrowing owls in the spring of 1986. These artificial burrows consisted of a 12" x 12" x 8" wood nesting chamber with rernovable top and a 6 foot corrugated and perforated plastic drainage pipe 6 inches in diameter (Fig. 1). Earlier investigators claimed that artificial burrows must provide a natural dirt floor to allow burrowing owls to modify the nesting tunnel and chamber. Contrary to this, the artificial burrow introduced here does not allow owls to modify the entrance or tunnel. The inability to change the physical dimensions of the burrow tunnel does not seem to reflect the owls' breeding success or deter them from using this burrow design.

In 1936, 22 artificial burrows were inhabited. Thirteen nesting attempts yielded an average clutch size of 8.3 eggs per breeding pair. Eight nests successfully hatched at least 1 nestling. In these nests, *67 of 75* eggs hatched (59.3%) and an estimated 61 nestlings (91.0%) fledged. An analysis of the egg laying and incubation periods showed that incubation commenced well after egg laying bega. Average clutch size at the start of incubation was 5.6 eggs. Most eggs tended to hatch synchronously in all successful nests.

Although the initial cost of constructing this burrow design may be slightly higher than a burrow consisting entirely of wood, the plastic pipe burrow offers the following advantages: (1) it lasts several field seasons without rotting or collapsing; (2) it may prevent or retard predation; (3) construction time is minimal; (4) it is easy to transport, especially over long distances; and (5) the flexible tunnel simplifies installation. The use of this artificial nest burrow design was highly successful and may prove to be a great resource technique for future management of this species.

For additional information on constructing this artificial nest burrow, contact Bruce Olenick, Department of Biology, Idaho State University, Pocatello, ID 83209.

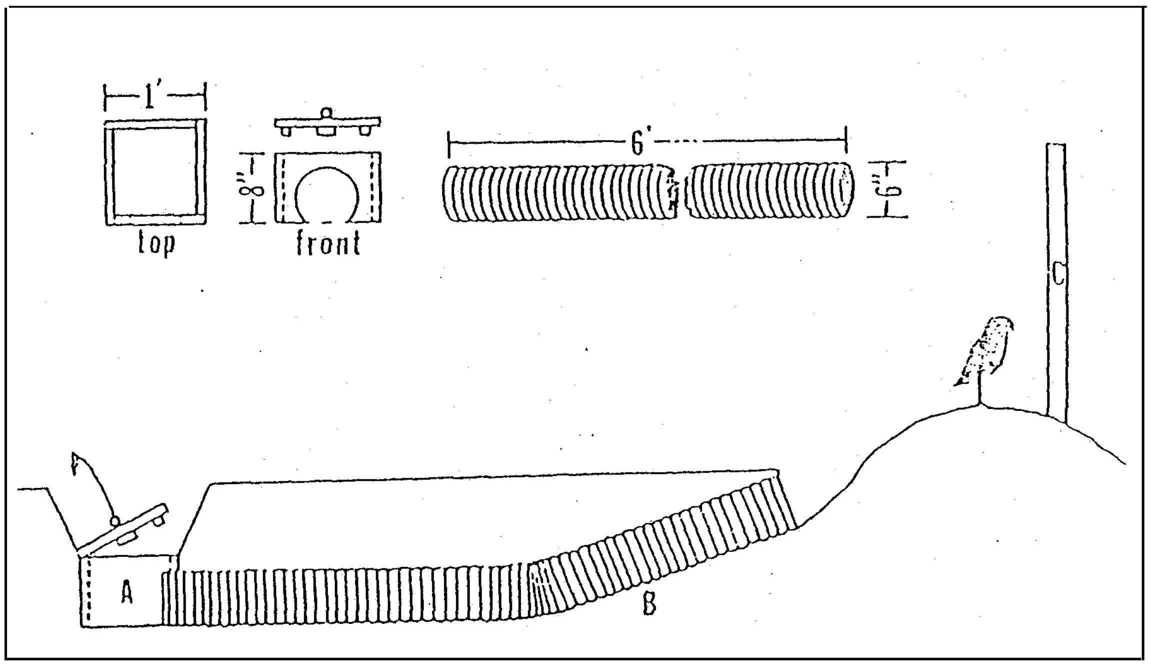

fig. 1 Artificial nest burrow design for burrowing owls Entire unit (including nest chamber) is buried 12" -- 18" below ground for maintaining thermal stability of the nest chamber. A= nest chamber, B = plastic pipe. C = perch.

ATTACHMENT A

Appendix D
Air Quality Analysis

APPENDIX D
Air Quality Analysis

D.1 Introduction to Air Quality Models and Results

Two separate air quality models were used to quantify criteria pollutant emissions during construction and operation of the proposed Project options. The California Air Resources Board (CARB) URBEMIS 2002 (version 8.7) model calculates emissions of reactive organic gases (ROG), NOx, CO, and PM10 from off-road construction equipment, based on the number and type of equipment. Emission factors from the EMFAC2007 model, also supplied by CARB, were used to determine on-road vehicle emissions in Yolo County for the years 2012 and 2015. This would cover emissions from construction workers and haul trucks as well as operational vehicle trips. Results from the URBEMIS2002 and EMFAC2002 modeling studies are presented below in Section 1 and Section 2, respectively.

D.2 URBEMIS 2002 v. 8.7 Data

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Page: 1
02/27/2007 3:52 PM



               URBEMIS 2002 For Windows   8.7.0

File Name:                      C:\Documents and Settings\mxm\Desktop\205413 - Yolo
Regional Water\Revised URBEMIS for Davis Woodland.urb
Project Name:                   Davis Woodland Project
Project Location:               Lower Sacramento Valley Air Basin
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

                       SUMMARY REPORT
                    (Pounds/Day - Summer)

CONSTRUCTION EMISSION ESTIMATES
                                                                           PM10      PM10
PM10
 *** 2012 ***                        ROG       NOx        CO       SO2     TOTAL
EXHAUST     DUST
 TOTALS (lbs/day,unmitigated)      78.36    468.61    668.43      0.01    115.05     15.01
100.04



AREA SOURCE EMISSION ESTIMATES
                                     ROG       NOx        CO       SO2      PM10
 TOTALS (lbs/day,unmitigated)       0.00      0.00      0.00      0.00      0.00


OPERATIONAL (VEHICLE) EMISSION ESTIMATES
                                     ROG       NOx        CO       SO2      PM10

 TOTALS (lbs/day,unmitigated)       0.00      0.00      0.00      0.00      0.00

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES
                                     ROG       NOx        CO       SO2      PM10
 TOTALS (lbs/day,unmitigated)       0.00      0.00      0.00      0.00      0.00




Page: 2
02/27/2007 3:52 PM



               URBEMIS 2002 For Windows   8.7.0

File Name:                      C:\Documents and Settings\mxm\Desktop\205413 - Yolo
Regional Water\Revised URBEMIS for Davis Woodland.urb
Project Name:                   Davis Woodland Project
Project Location:               Lower Sacramento Valley Air Basin
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

                        DETAIL REPORT
                    (Pounds/Day - Summer)

Construction Start Month and Year: January, 2012
Construction Duration: 11
Total Land Use Area to be Developed: 200 acres
Maximum Acreage Disturbed Per Day: 10 acres
```

Single Family Units: 0 Multi-Family Units: 0
Retail/Office/Institutional/Industrial Square Footage: 0

CONSTRUCTION EMISSION ESTIMATES UNMITIGATED (lbs/day)

Source	ROG	NOx	CO	SO2	PM10 TOTAL	PM10 EXHAUST	PM10 DUST
*** 2012***							
Phase 1 - Demolition Emissions							
Fugitive Dust	-	-	-	-	0.00	-	0.00
Off-Road Diesel	0.00	0.00	0.00	-	0.00	0.00	0.00
On-Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker Trips	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum lbs/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phase 2 - Site Grading Emissions							
Fugitive Dust	-	-	-	-	100.00	-	100.00
Off-Road Diesel	77.75	467.47	655.43	-	14.98	14.98	0.00
On-Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker Trips	0.61	1.14	13.00	0.01	0.07	0.03	0.04
Maximum lbs/day	78.36	468.61	668.43	0.01	115.05	15.01	100.04
Phase 3 - Building Construction							
Bldg Const Off-Road Diesel	0.00	0.00	0.00	-	0.00	0.00	0.00
Bldg Const Worker Trips	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arch Coatings Off-Gas	0.00	-	-	-	-	-	-
Arch Coatings Worker Trips	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Asphalt Off-Gas	0.00	-	-	-	-	-	-
Asphalt Off-Road Diesel	0.00	0.00	0.00	-	0.00	0.00	0.00
Asphalt On-Road Diesel	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Asphalt Worker Trips	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum lbs/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max lbs/day all phases	78.36	468.61	668.43	0.01	115.05	15.01	100.04

Phase 3 - Building Construction Assumptions: Phase Turned OFF

Phase 2 - Site Grading Assumptions
Start Month/Year for Phase 2: Jan '12
Phase 2 Duration: 11 months
On-Road Truck Travel (VMT): 0
Off-Road Equipment

No.	Type	Horsepower	Load Factor	Hours/Day
2	Cranes	190	0.430	8.0
8	Excavators	180	0.580	8.0
2	Graders	174	0.575	8.0
4	Off Highway Tractors	255	0.410	8.0

4	Off Highway Trucks	417	0.490	8.0
4	Other Equipment	190	0.620	8.0
6	Rubber Tired Loaders	165	0.465	8.0
4	Scrapers	313	0.660	8.0
6	Tractor/Loaders/Backhoes	79	0.465	8.0

Page: 3
02/27/2007 3:52 PM

AREA SOURCE EMISSION ESTIMATES (Summer Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.00	0.00	0.00	0	0.00
Hearth - No summer emissions					
Landscaping	0.00	0.00	0.00	0.00	0.00
Consumer Prdcts	0.00	-	-	-	-
Architectural Coatings	0.00	-	-	-	-
TOTALS(lbs/day,unmitigated)	0.00	0.00	0.00	0.00	0.00

Page: 4
02/27/2007 3:52 PM

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
TOTAL EMISSIONS (lbs/day)	0.00	0.00	0.00	0.00	0.00

Does not include correction for passby trips.
Does not include double counting adjustment for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2005 Temperature (F): 85   Season: Summer

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Acreage	Trip Rate	No. Units	Total Trips

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	56.10	2.30	97.10	0.60
Light Truck < 3,750 lbs	15.10	4.00	93.40	2.60
Light Truck 3,751- 5,750	15.50	1.90	96.80	1.30
Med Truck 5,751- 8,500	6.80	1.50	95.60	2.90
Lite-Heavy 8,501-10,000	1.00	0.00	80.00	20.00
Lite-Heavy 10,001-14,000	0.30	0.00	66.70	33.30
Med-Heavy 14,001-33,000	1.00	10.00	20.00	70.00
Heavy-Heavy 33,001-60,000	0.80	0.00	12.50	87.50
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.10	0.00	0.00	100.00
Motorcycle	1.60	87.50	12.50	0.00
School Bus	0.30	0.00	0.00	100.00

Motor Home	1.40	14.30	78.60	7.10

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	9.7	3.8	4.6	7.8	4.5	4.5
Rural Trip Length (miles)	16.8	7.1	7.9	14.7	6.6	6.6
Trip Speeds (mph)	35.0	35.0	35.0	35.0	35.0	35.0
% of Trips - Residential	27.3	21.2	51.5			

Page: 5
02/27/2007 3:52 PM

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Construction

Changes made to the default values for Area

Changes made to the default values for Operations

D.3 On-Road Vehicle EMFAC 2002 Emission Factors for Yolo County

Table AQ-1: Yolo County Onroad Vehicle Emission Factors – Year 2012

LDA	ROG	CO	NOx	PM10
2012	0.054	2.03	0.16	0.031
LDT	**ROG**	**CO**	**NOx**	**PM10**
2012	0.089	2.991	0.315	0.039
MDT	**ROG**	**CO**	**NOx**	**PM10**
2012	0.1	2.587	0.634	0.042
HDT	**ROG**	**CO**	**NOx**	**PM10**
2012	0.463	3.358	7.76	0.313

Paved Road
lbs/VMT
Entrained
PM10
0.00148

Assumed average speed of vehicles type to be 35 mph to and from the project site.
Assumed average distance to and from the project site to be 10 miles each way.

,

Emissions = Vehicle Type x Emission Factor x Miles/Trip x Trips/Day

Note: Doubled trip length to take into account round trips
Mobile Emissions Associated with Construction Worker and Haul trips in 2012

Emission Factors

				ROG	CO	Nox	PM10
LDV	2012 emissions (grams/mile)			0.0715	2.5105	0.2375	0.035
	2012 emissions (pounds/mile)			1.58E-04	5.53E-03	5.24E-04	1.56E-03
	Miles/Trip	Trips/Day	Miles/Day	Mobile Source Emissions (pounds per day)			
	20	45	900	0.14	4.98	0.47	1.40
MDT				ROG	CO	Nox	PM10
	2012 emissions (grams/mile)			0.1	2.587	0.634	0.042
	2012 emissions (pounds/mile)			2.20E-04	5.70E-03	1.40E-03	1.57E-03
	Miles/Trip	Trips/Day	Miles/Day	Mobile Source Emissions (pounds per day)			
	20	168	3360	0.74	19.16	4.70	5.28
HDT				ROG	CO	Nox	PM10
	2012 emissions (grams/mile)			0.463	3.358	7.76	0.313
	2012 emissions (pounds/mile)			1.02E-03	7.40E-03	1.71E-02	2.17E-03
	Miles/Trip	Trips/Day	Miles/Day	Mobile Source Emissions (pounds per day)			
	20	56	1120	1.14	8.29	19.16	2.43

Construction Trip Emissions
2012 - Construction Crew and # Haul Trucks per day

	ROG	CO	Nox	PM10
lbs/day	2.0	32.4	24.3	9.1

Table AQ-2: Yolo County Onroad Vehicle Emission Factors – Year 2015

LDA	**ROG**	**CO**	**NOx**	**PM10**
2015	0.033	1.463	0.111	0.03
LDT	**ROG**	**CO**	**NOx**	**PM10**
2015	0.059	2.259	0.231	0.039
MDT	**ROG**	**CO**	**NOx**	**PM10**
2015	0.077	2.119	0.499	0.042
HDT	**ROG**	**CO**	**NOx**	**PM10**
2015	0.364	2.535	5.561	0.244

Paved Road
lbs/VMT
Entrained
PM10
0.00148

Assumed average speed of vehicles type to be 35 mph to and from the project site.
Assumed average distance to and from the project site to be 10 miles each way.

Emissions = Vehicle Type x Emission Factor x Miles/Trip x Trips/Day

Note: Doubled trip length to take into account round trips
Mobile Emissions Associated with Employee and Haul/Delivery Truck Trips, 2015

				Emission Factors			
				ROG	CO	Nox	PM10
LDV	2015 emissions (grams/mile)			0.046	1.861	0.171	0.0345
	2015 emissions (pounds/mile)			1.01E-04	4.10E-03	3.77E-04	1.56E-03
	Miles/Trip	Trips/Day	Miles/Day	Mobile Source Emissions (pounds per day)			
	20	17	340	0.03	1.39	0.13	0.53
MDT				ROG	CO	Nox	PM10
	2015 emissions (grams/mile)			0.077	2.119	0.499	0.042
	2015 emissions (pounds/mile)			1.70E-04	4.67E-03	1.10E-03	1.57E-03
	Miles/Trip	Trips/Day	Miles/Day	Mobile Source Emissions (pounds per day)			
	20	2	40	0.01	0.19	0.04	0.06
HDT				ROG	CO	Nox	PM10
	2015 emissions (grams/mile)			0.364	2.535	5.561	0.244
	2015 emissions (pounds/mile)			8.02E-04	5.59E-03	1.23E-02	2.02E-03
	Miles/Trip	Trips/Day	Miles/Day	Mobile Source Emissions (pounds per day)			
	20	1	20	0.02	0.11	0.25	0.04

Construction Trip Emissions
2015 - Employee and Truck Trips for Project Ops

	ROG	CO	Nox	PM10
lbs/day	0.06	1.69	0.42	0.63