This document was funded by the CALFED Water Quality Program as an initial effort to create Regional "Equivalent Level of Public Health Protection" Plans and to assist in establishing a uniform framework in such planning. It is not intended to be a final document.

California Bay-Delta Authority and CALFED WQP Implementing Agency staff have not had the opportunity to review and comment on this document, and any opinions or interpretations of the CALFED program expressed within the document are solely those of its authors.

The CALFED WQP is committed to working with these and other parties to continue development and refinement of Regional Plans.

CALFED
BAY-DELTA
PROGRAM

DELTA REGION

DRINKING WATER QUALITY MANAGEMENT PLAN

JUNE 2005

DRAFT FINAL

SOLANO COUNTY WATER AGENCY

CALFED
BAY-DELTA
PROGRAM

Stockton
All-America City
2004
1999

CONTRA COSTA
WATER DISTRICT

DELTA REGION
DRINKING WATER QUALITY MANAGEMENT PLAN

Solano County Water Agency

CALFED
BAY-DELTA
PROGRAM

DRAFT
FINAL

June 2005

CONTRA COSTA
WATER DISTRICT

Stockton
All-America City
2004
1999

Funding for this project was made possible by a CALFED Grant through the Drinking Water Quality Program

EXECUTIVE SUMMARY

In 2004, the CALFED Bay-Delta Program (CALFED) commissioned a pilot program for development of regional drinking water quality management plans (i) to identify the drinking water quality issues and needs of drinking water agencies in different regions of California and (ii) to develop solutions to address those needs. This Delta Region Drinking Water Quality Management Plan (DRDWQMP) was developed jointly by Contra Costa Water District (CCWD), the city of Stockton (COS), and Solano County Water Agency (SCWA). **Figure ES-1** shows the Sacramento-San Joaquin Delta (Delta) region, with an outline representing Delta boundaries as defined in California Water Code Section 12220, along with the service areas of the three participating agencies. These three agencies represent the largest urban water users within the Delta region.

The objectives of the DRDWQMP include understanding existing water quality conditions (and anticipated future water quality conditions absent proactive actions) at the urban intakes within the Delta, identifying challenges and issues confronting agencies diverting water from the Delta, and developing projects and programs at the local, regional, and statewide level to address these issues and to ensure that in-Delta agencies can meet their water quality goals in the future.

Bromide and salinity concentrations in central and south Delta in the fall, which decreased from the mid-1940s to the 1970s, increased appreciably over the past two decades (see **Figure ES-2**). The fall is when Delta outflows are lowest and salinities are highest. Organic carbon concentrations in the interior Delta remain high and have not shown a significant degradation or improvement. Runoff from the Barker Slough watershed continues to result in high organic carbon and turbidity at SCWA's in-Delta intake. The decline in Delta water quality has negatively impacted agencies that divert water from the Delta for drinking water purposes. Evidence points to the risk of additional Delta water quality degradation in the future.

The majority of the adverse impacts on Delta water quality and the in-Delta diverters are the result of actions by others, outside the control of in-Delta diverters. Population increase, global warming, and the risk of more frequent levee failures will likely continue this degradation trend unless actions are taken. At the same time, the prospect of new operational constraints to protect fish and more stringent drinking water regulations in the future are additional major challenges facing in-Delta drinking water providers.

A number of projects and programs are being developed, or are in place, to address Delta water quality degradation at the statewide level through CALFED, and through local and regional projects, such as those discussed in this DRDWQMP.

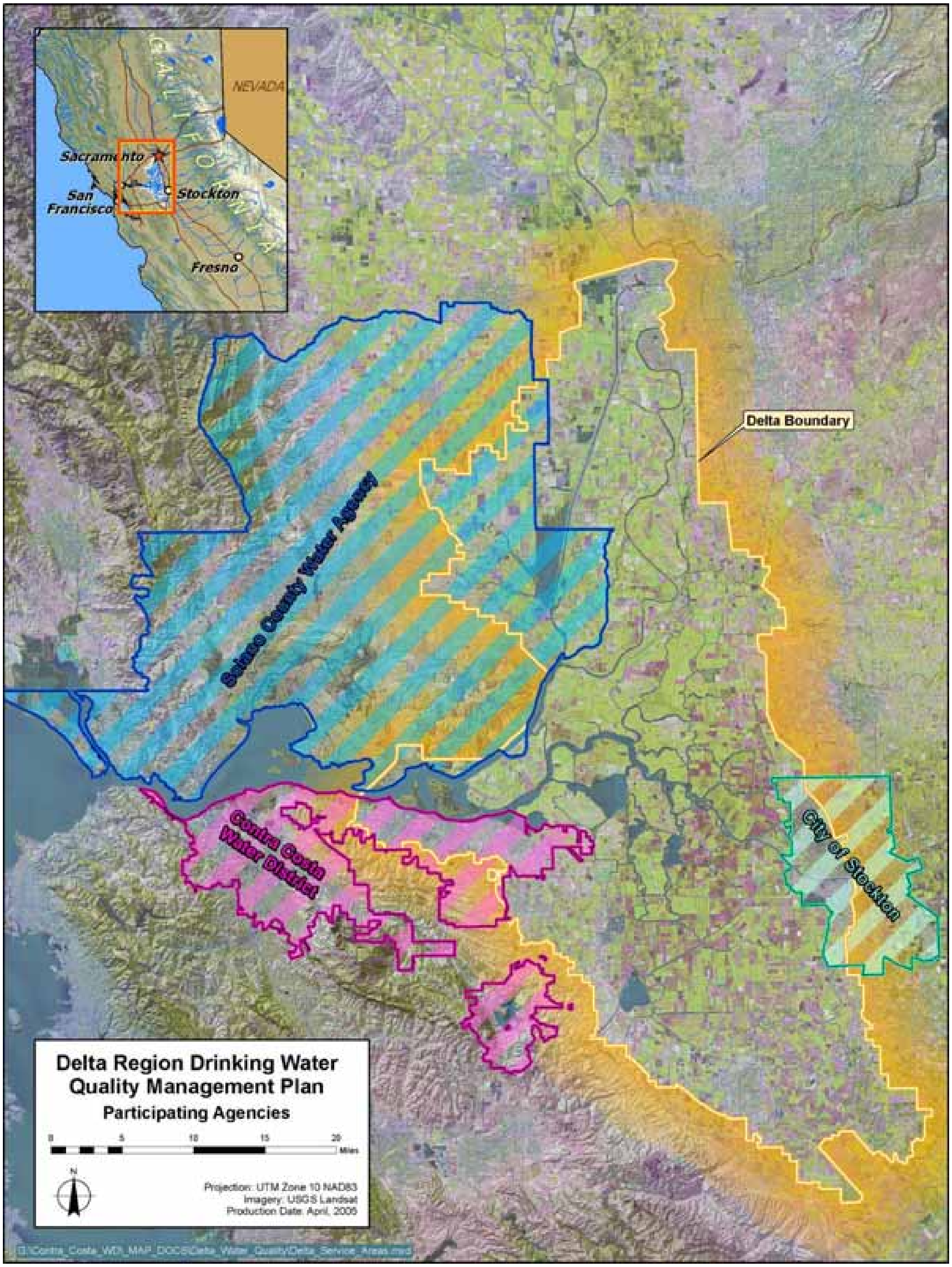

Figure ES-1 Sacramento-San Joaquin Delta Boundary and Boundaries of Delta Region Drinking Water Quality Management Plan Participating Agencies

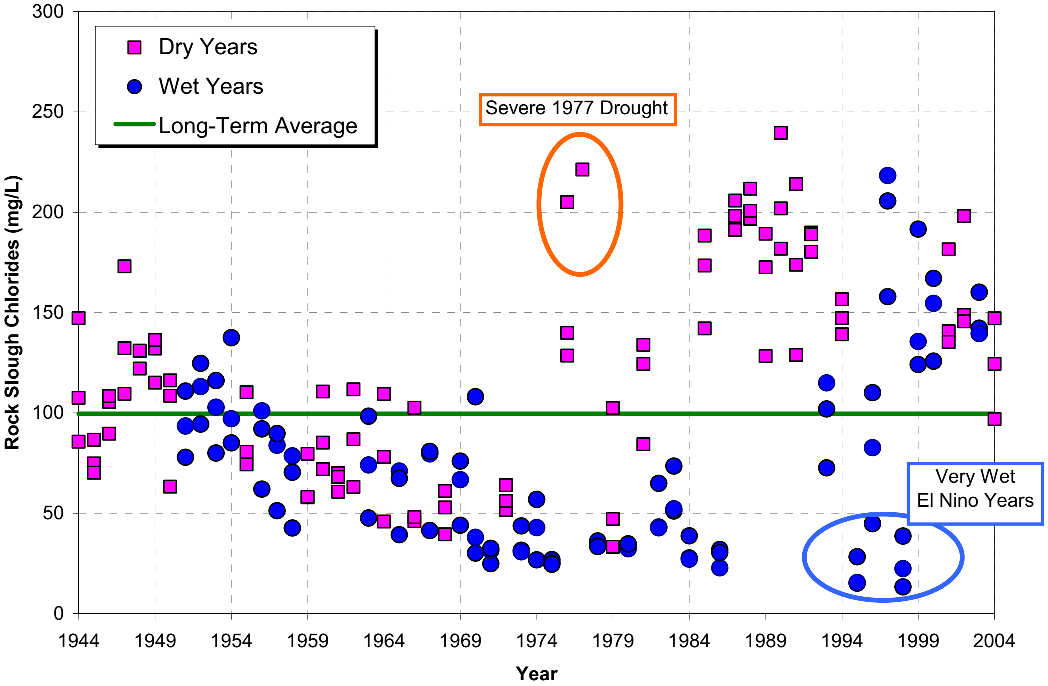

Figure ES-2 Fall Chloride Concentration in Rock Slough, 1944 to 2004

Over the last two decades, wet year salinities have been higher in the fall than those experienced during the drier 1960s and 1970s.

CALFED BAY-DELTA PROGRAM

CALFED has prepared a long-term comprehensive plan that will restore ecological health and improve water quality and water supply for beneficial uses of the San Francisco Bay/Sacramento-San Joaquin Delta system. The August 2000 CALFED programmatic Record of Decision (ROD) identified 11 "action plans." Some of the action plans will improve drinking water quality for users of Delta water; however, other actions (e.g., wetlands restoration projects and projects to increase exports from the Delta) have the potential to negatively impact Delta water quality.

CALFED WATER QUALITY PROGRAM

The specific target of the CALFED Water Quality Program (WQP) is to provide safe, reliable, and affordable drinking water in a cost-effective way by achieving either of the following:

a) Average concentrations at Clifton Court Forebay and other central and south Delta drinking water intakes of 50 micrograms per liter (µg/L) bromide and 3.0 milligrams per liter (mg/L) total organic carbon (TOC), or

b) An equivalent level of public health protection (ELPH) using cost-effective combinations of alternative source waters, source control, and treatment technologies (August 28, 2000, CALFED ROD, page 65)

The WQP is investing in projects and programs to continuously improve water quality for the more than 23 million Californians who rely on the Delta for their drinking water supply.

"EQUIVALENT LEVEL OF PUBLIC HEALTH" (ELPH) MODEL

In 2002, the CALFED Bay-Delta Advisory Committee, Drinking Water Subcommittee, developed a framework for drinking water quality management: the "Equivalent Level of Public Health Protection Decision Tree."[1] The ELPH model is a conceptual model of the multibarrier approach needed to fully ensure that the state's drinking water and public health are protected, and is being used to guide implementation of the CALFED WQP.

The ELPH model provides a conceptual representation of the relationships between various water management operations, reduction of contaminant discharges into the Delta and its tributaries, and changes in source water quality to the Delta. The ELPH model, applied at the local, regional, and statewide level, is an excellent tool for identifying potential water management operations to improve Delta water quality and for developing strategies for implementing those operations (including the appropriate role of local, state, and federal agencies). The ELPH model implicitly recognizes that water quality objectives in source waters and water quality regulations protecting consumers are dynamic, and are best met with flexible plans that consider the entire drinking water system from source to tap.

The DRDWQMP uses an "in-Delta" version of the ELPH conceptual model to present water quality solutions for the Delta urban agencies (see **Figure ES-3**).

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[1] http://calwater.ca.gov/BDPAC/Subcommittees/DrinkingWaterQualitySubcommittee.shtml

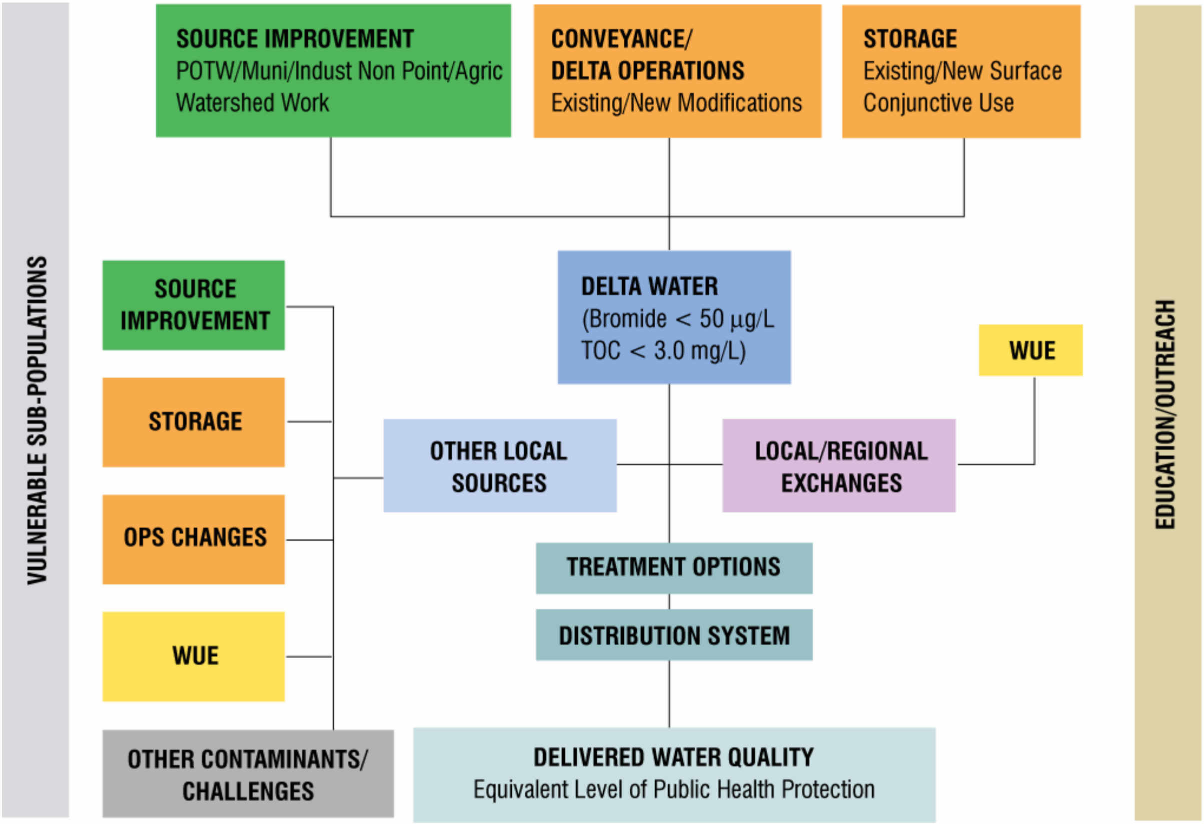

Figure ES-3 CALFED Equivalent Level of Public Health Model Adapted to Delta Region

POTENTIAL PROJECTS AND PROGRAMS

Strategies are currently being implemented or considered locally, regionally, and statewide that would address the challenges and issues presented by the impacts on Delta water quality. DRDWQMP participating agencies, CCWD, City of Stockton Municipal Utility District (COSMUD), and SCWA, have identified potential projects and programs to improve and protect Delta water supplies and to improve the drinking water quality delivered to their customers. Projects, programs, and operational changes currently under consideration that have the potential to improve Delta water quality and/or the quality of water diverted from the Delta for drinking water purposes are presented and discussed below within the construct of the ELPH model developed by CALFED (see **Figure ES-4**).

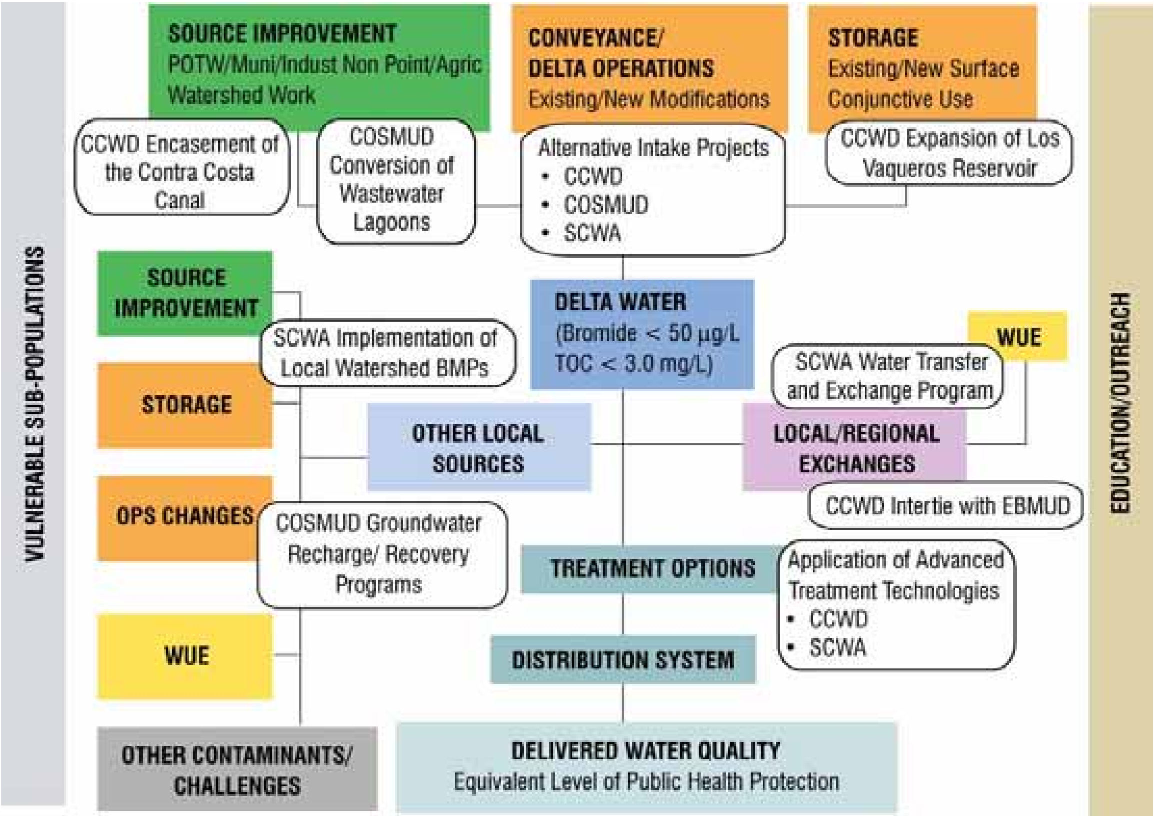

Figure ES-4 Potential Projects and Programs of Delta M&I Water Users in the Equivalent Level of Public Health Model

Analysis of existing water quality conditions indicated that CCWD's primary water quality issue is high bromide concentrations at its Delta intakes. Organic carbon concentrations are generally higher than the CALFED target of 3.0 mg/L, but are currently manageable. CCWD is developing several major projects and programs to protect its future water quality needs and to improve the drinking water quality delivered to its customers:

- An "Alternative Intake Project" to evaluate other points of diversion from the Delta for the purpose of improving water quality (both for direct delivery and storage in Los Vaqueros Reservoir for later blending to improve delivered water quality). The new intake will, at times, have lower bromide concentrations than CCWD's existing intakes, which will help CCWD meet anticipated future drinking water regulations.
- Encasement of the Contra Costa Canal to improve source water quality delivered to the Bollman and Randall-Bold water treatment plants (WTPs). This will eliminate seepage and runoff into the canal from adjacent areas and improve security.
- An intertie with the East Bay Municipal Utility District (EBMUD) Mokelumne Aqueduct developed to offset the impacts of the Freeport Regional Water Authority project on CCWD. This intertie also will be used to provide emergency supplies between CCWD and EBMUD, and to facilitate potential transfers of higher quality water to CCWD.

- An expansion of the Los Vaqueros Reservoir to enhance the improved water quality and emergency water supply benefits of the existing Los Vaqueros Reservoir, and to extend those benefits, along with additional water supply reliability and environmental benefits, to other Bay Area urban agencies.
- Application of advanced water treatment technologies at the Bollman and Randall-Bold WTPs.

COSMUD is developing several major projects and programs to protect its future water quality needs and to improve the drinking water quality delivered to its customers:

- The Delta Water Supply Project (DWSP), which will permit COS to divert high quality water from the Delta. Existing concentrations of bromide and organic carbon in the vicinity of this proposed intake are typically very low.
- A groundwater recharge and recovery program using surplus Stanislaus River flows to recharge the groundwater basin, or treated surface water supplies diverted through the DWSP facilities and directly injected into the groundwater aquifer.
- Conversion of wastewater treatment lagoons at the Stockton Regional Wastewater Control Facility to wetlands to improve the quality of wastewater effluent discharged to the Delta by the facility. [Note: The intake for the DWSP is downstream of this point of discharge.]

Analysis of existing water quality conditions near the North Bay Aqueduct intake confirmed that SCWA's main water quality issue is very high organic carbon and turbidity from local runoff into Barker Slough. Organic carbon concentrations as high as 23 mg/L have been measured. SCWA is developing several major projects and programs to protect its future water quality needs and to improve the drinking water quality delivered to its customers:

- An "Alternate Intake Project" to evaluate other points of diversion from the Delta for the purpose of improving water quality.
- Best Management Practices for watershed protection to reduce organic loading and turbidity in Barker Slough.
- Additional internal water transfer and exchange programs (and the required facilities) to provide operational flexibility with respect to source water.
- Application of advanced water treatment technologies at SCWA member agency facilities.

Figure ES-5 illustrates these projects and programs within the Delta region.

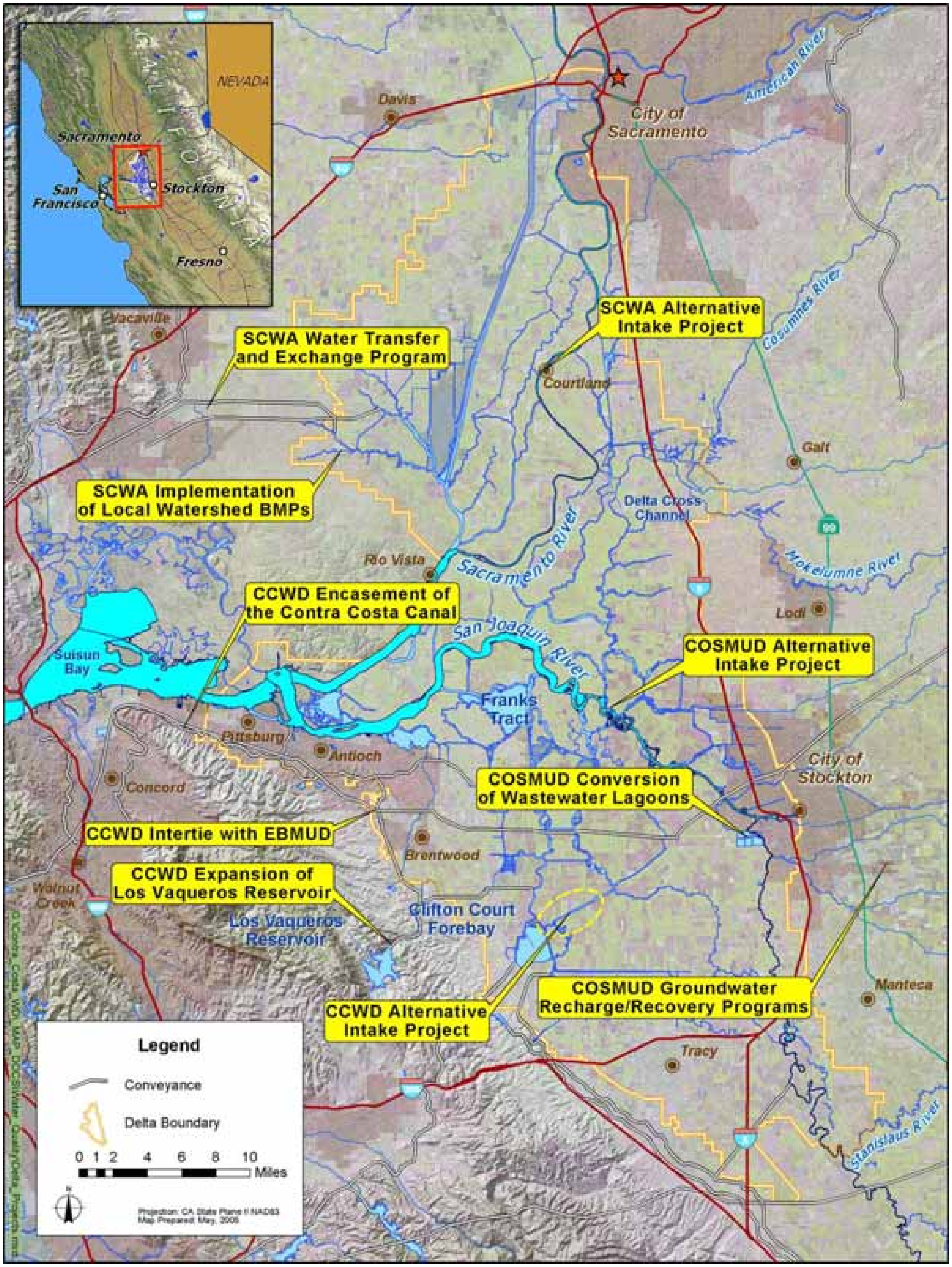

Figure ES-5 Proposed Delta Region Projects and Programs[1]

[1] *CCWD and SCWA also are pursuing advanced treatment technologies. The locations of these water treatment plants are not depicted in this figure.*

IMPLEMENTATION STRATEGIES

Given the intent of CALFED to support regional cooperation, the proposed Delta Region ELPH provides an effective tool for identifying combinations of local, regional, state, and federal actions that could benefit urban agencies that divert drinking water from the Delta. The challenge is to develop local and regional projects and programs with the following attributes:

- Multiple beneficiaries or the opportunity to partner
- Linkage to CALFED goals and objectives
- No significant redirected impacts
- Water quality benefits (or projects with multiple benefits)
- Public and stakeholder support
- Geographic parity
- Compliance with regulatory objectives
- Sound technical basis
- Information to guide development of statewide strategies

Implementation of efforts at the local and/or regional level would be in addition to, and building upon, any system-wide improvements undertaken by CALFED. Demonstrating the linkage between local/regional goals and actions and statewide goals and actions (or at least identifying synergies where they exist) will increase the likelihood that a project or program will be successfully implemented.

Potential regional partnerships include continued coordination by CCWD, COSMUD, and SCWA on the Delta projects identified in the Delta Region ELPH, regional partnerships on expansion of Los Vaqueros Reservoir, partnerships on advanced treatment research and pilot projects, cooperation among Delta agencies on technology to reduce capital costs of constructing water conveyance facilities in the Delta, and potential interrelationships in water exchanges among the agencies

A number of agencies in addition to CCWD, SCWA and COS depend directly on the Delta for at least a portion of their drinking water supplies. These agencies include both other in-Delta diverters and urban agencies south of the Delta that rely on exports from the CVP and/or the SWP. These agencies and entities also are greatly affected by both increases and decreases in Delta water quality. Development of other partnerships between agencies that depend on the Delta for their water supply could be the subject of future phases of development of the DRDWQMP.

CONCLUSIONS AND RECOMMENDATIONS

It is important that CALFED seek to identify the most cost-effective combination of local, regional, and statewide actions that will result in continuous improvement in drinking water quality throughout the CALFED solution area, and ensure balance in the Bay-Delta Program. Funding should be directed at core implementation projects that result in quantifiable improvements in drinking water quality and public health protection. The purpose of the DRDWQMP and other regional plans is to help the CALFED Water Quality Program clarify drinking water quality needs and goals, identify solutions, and understand the economics and tradeoffs of alternative solutions.

The Delta ELPH model can be used as a rationale tool to explore the relationship between various water management operations and changes in water quality. The Delta ELPH model construct implicitly recognizes that water quality objectives in source waters and water quality regulations protecting consumers are dynamic, and are best met with a multibarrier approach that considers the entire drinking water system from source to tap. It recognizes the need for improvements in the Delta and in local systems to meet the equivalent level of the 50 µg/L bromide and 3 mg/L TOC goal for Delta water.

CCWD, COSMUD, and SCWA have taken common approaches to addressing the impacts of declining Delta water quality. Each has identified the need to construct new Delta intake facilities in pursuit of higher quality diversions. Each is pursuing storage projects within its respective service areas to address year-to-year and seasonal episodes of poor water quality. These three agencies also are pursuing advanced treatment technologies and local watershed protection. This joint regional effort to develop the Delta Region Drinking Water Quality Management Plan has identified the efforts of CCWD, COSMUD, and SCWA to continue to deliver high quality drinking water in the future and how CALFED can support the work of these agencies in improving water quality through its program.

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CHAPTER 1. INTRODUCTION

More than 23 million Californians rely on the Sacramento-San Joaquin Delta (Delta) for at least a portion of their drinking water supply. However, Delta water quality has degraded dramatically over the past two decades as a result of increased upstream and Delta diversions; increased runoff from cities and farms; and modifications to upstream reservoir and diversion operations to protect fisheries and other environmental resources. Delta flow patterns also have been modified by barriers constructed to offset the impacts of export pumping in the south Delta. Sea level rise and changes in runoff patterns and volumes resulting from global climate change also may have contributed to this degradation. All these factors point to the risk of even greater Delta water quality degradation in the future.

CALFED BAY-DELTA PROGRAM

The CALFED Bay-Delta Program (CALFED) has developed a long-term comprehensive plan that will restore ecological health and improve water quality and water supply for beneficial uses of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) system. CALFED, which began in 1995, is a consortium of state and federal agencies working together to "fix the Delta." CALFED has a general target of continuously improving Delta water quality for all uses, including drinking water and in-Delta environmental and agricultural uses.

CALFED WATER QUALITY PROGRAM

The CALFED Water Quality Program (WQP) is investing in projects and programs to improve water quality -- from source to tap -- for those whose drinking water supplies come from the Delta. The goal of the WQP is to support efforts to provide safe, reliable, and affordable drinking water through cost-effective continuous improvement to source water quality, water management, and drinking water treatment. The CALFED Programmatic Record of Decision (ROD) of August 28, 2000, identified certain initial program activities in support of these efforts.

The specific target of the CALFED drinking water quality program is to provide safe, reliable, and affordable drinking water in a cost-effective way by achieving either of the following:

a) Average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 micrograms per liter (μg/L) bromide and 3.0 milligrams per liter (mg/L) total organic carbon (TOC)

b) An equivalent level of public health protection using cost-effective combinations of alternative source waters, source control, and treatment technologies (August 28, 2000, CALFED ROD, page 65)

Since the issuance of the ROD, the Delta Drinking Water Council and its successor, the Drinking Water Subcommittee (DWS) of the California Bay-Delta Public Advisory Committee (BDPAC), have provided important review and comments on implementation of the WQP by the implementing agencies.

In 2002, DWS developed a framework for drinking water quality management: the "Equivalent Level of Public Health (ELPH) Protection Decision Tree."[1] The ELPH model is a conceptual model of the multibarrier approach needed to fully ensure that the state's drinking water and public health are protected, and is being used to guide implementation of the CALFED WQP.

The ELPH model provides a conceptual representation of the relationships between various water management operations (e.g., changing the timing, duration, and volume of Delta export pumping; modifying Delta outflows via system operational changes; or installing or changing the operation of flow barriers), reduction of contaminant discharges into the Delta and its tributaries, and changes in source water quality to the Delta. The ELPH model is an excellent tool for identifying potential water management operations to improve Delta water quality and for developing strategies for implementing those operations (including the appropriate role of local, state, and federal agencies). The ELPH model implicitly recognizes that water quality objectives in source waters and water quality regulations protecting consumers are dynamic, and are best met with flexible plans that consider the entire drinking water system from source to tap.

CALFED DRINKING WATER QUALITY MANAGEMENT PLANS

In 2004, CALFED commissioned the development of regional drinking water quality management plans as part of a pilot program to identify the drinking water quality issues and needs of urban water agencies in different regions of California, and to develop solutions to address those needs. The plans were to be completed by May 30, 2005.

The *Delta Region Drinking Water Quality Management Pla*n (DRDWQMP) that is the subject of this report was developed jointly by the Contra Costa Water District (CCWD), the City of Stockton Municipal Utilities Department (COSMUD), and the Solano County Water Agency (SCWA). CCWD administered the CALFED grant through a contract with the Association of Bay Area Governments (ABAG). The DRDWQMP uses an "in-Delta" version of the ELPH conceptual model to present water quality solutions for the Delta urban agencies. Similar grants were awarded to the Mono Lake Committee for development of the *Southern California Regional Drinking Water Quality Management Plan* and Glenn County for development of the *Northern Sacramento Valley Regional Drinking Water Quality Management Plan*.

Figure 1-1 shows the Delta region with an outline representing Delta boundaries as defined in California Water Code Section 12220, along with the service areas of the three participating agencies. These three agencies represent the largest urban water users in the Delta region.

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[1] http://calwater.ca.gov/BDPAC/Subcommittees/DrinkingWaterQualitySubcommittee.shtml

APPENDICES

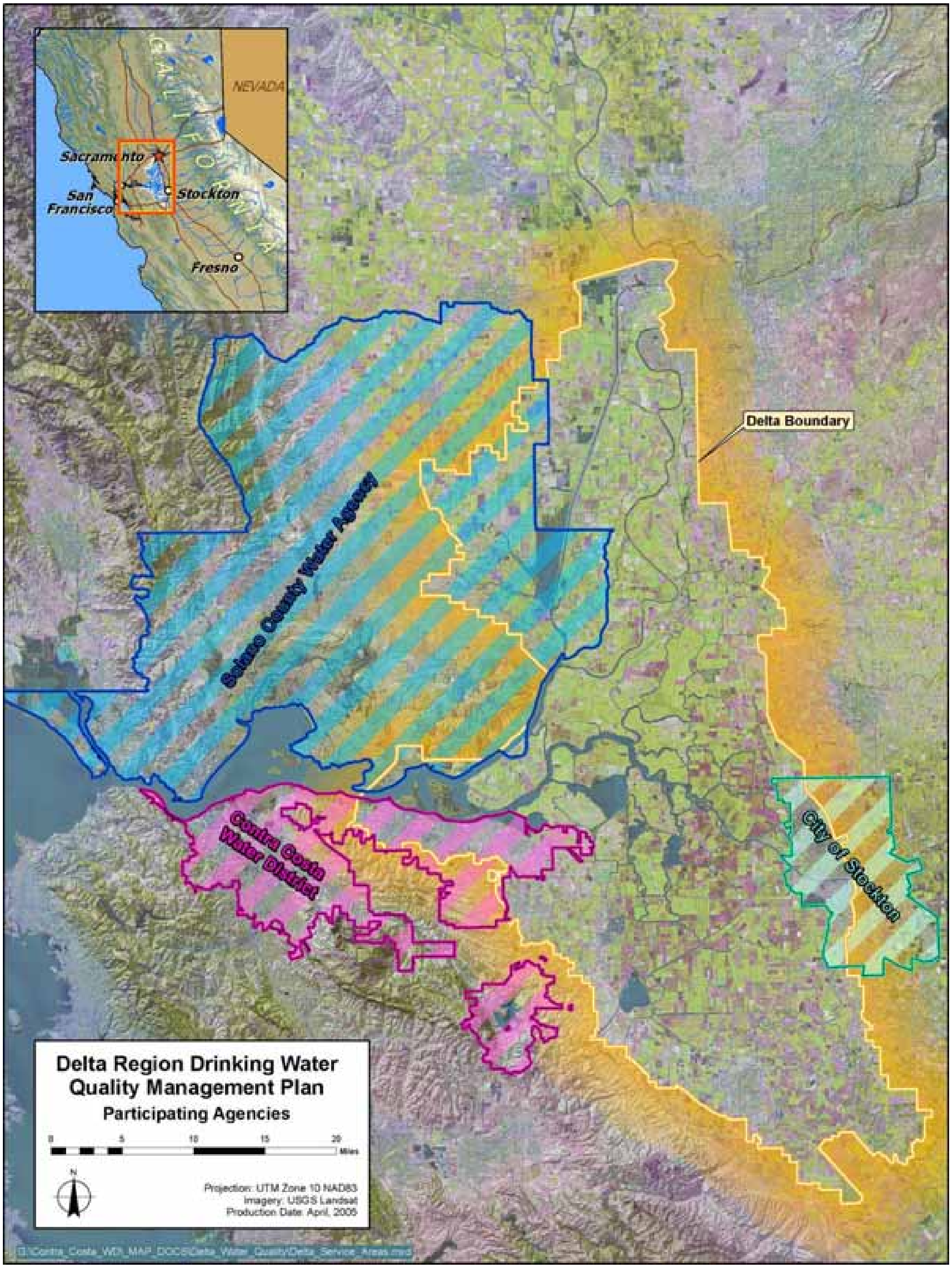

Figure 1-1 Sacramento – San Joaquin Delta Boundary and Boundaries of Delta Region Drinking Water Management Plan Participating Agencies

The geographies of the three participating agencies capture the range of water quality issues faced by in-Delta diverters. CCWD's intakes are located in an area strongly influenced by the intrusion of seawater from Suisun Bay and the ocean. SCWA's Delta intake, however, is located far enough upstream on a tributary to the Sacramento River that seawater is not a major factor in determining water intake quality, but local runoff is a major concern. COSMUD, although not currently diverting water from the Delta, is completing environmental review for a Delta intake located on the lower San Joaquin River north of COSMUD. The choice of location for this new intake is strongly dependent on selection of a cost-effective solution for maximizing water quality by avoiding diversion of poor quality water entering the Delta from the San Joaquin Valley.

Figure 1-2 shows population density per square mile throughout the Delta and within the service areas of the three Delta water agencies. These three agencies represent the majority of the highly populated areas within and adjacent to the Delta. Other areas of higher population density include the city of Sacramento and the city of West Sacramento to the north, and the city of Tracy to the south.

OBJECTIVES OF THE PLAN

The principal objectives of the Delta Region Drinking Water Quality Management Plan are as follows:

- To understand existing water quality conditions (and anticipated future water quality conditions absent proactive actions) at the urban intakes within the Delta
- To document the existing institutional setting and water system operations and to anticipate resulting impacts on the quality of Delta water supplies
- To document proposed regulatory changes and to anticipate potential resulting impacts on treatment requirements for Delta water supplies
- To document existing water resources planning and management activities of agencies diverting water supplies from the Delta (including projected needs, sources of supply, and water treatment capabilities) for the purpose of establishing a "baseline" against which the impacts and costs of potential projects and programs can be measured
- To identify challenges and issues confronting agencies diverting water from the Delta by comparing their water resources planning and management objectives with anticipated future institutional, operations, and regulatory settings
- To identify potential projects and programs for addressing those challenges and issues within the construct of the ELPH structure; the intent is to develop projects and programs that provide mutual benefit to multiple agencies, whenever possible
- To develop strategies for implementing those projects and programs, including identifying potential partnerships; delineating the appropriate roles of local, state, and federal interests; and developing outreach strategies

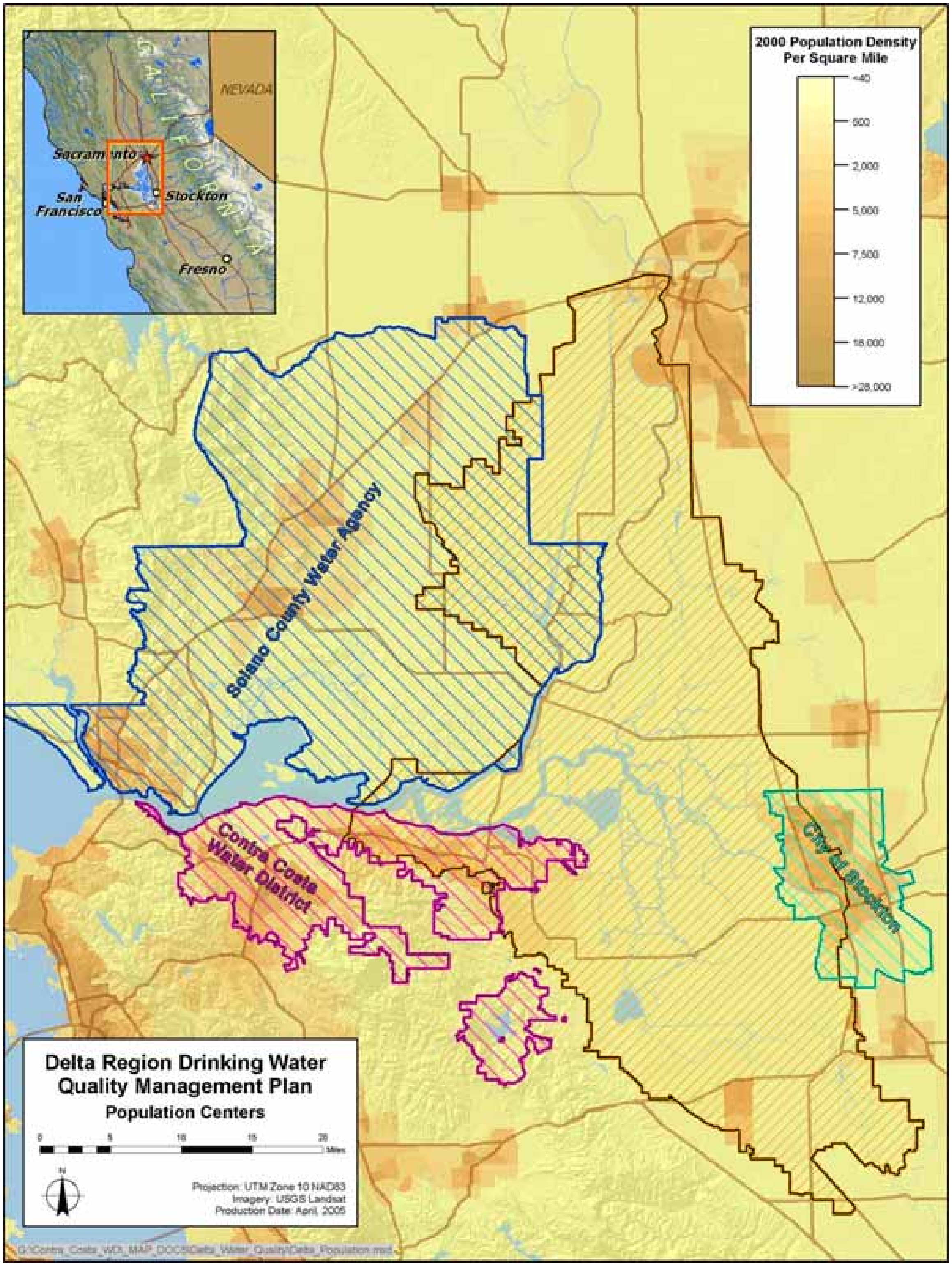

Figure 1-2 Population Centers in Delta Region Drinking Water Quality Management Plan Area

ORGANIZATION OF THIS REPORT

This report is organized by chapter to provide a logical progression of (1) some of the historical (and current) actions and activities that negatively impact Delta water quality, (2) challenges that degradation of Delta water quality presents to those agencies that divert from the Delta for drinking water purposes, (3) actions being taken by those agencies at the local and regional level to address Delta water quality degradation (within the context of their respective water resources planning and management activities), (4) actions being taken at the state (and/or federal) level to address Delta water quality degradation, and (5) potential future phases of preparation of a DRDWQMP (with a particular emphasis on defining appropriate roles and responsibilities for Delta water quality improvement).

The **Executive Summary** included with this report is meant to provide an overview suitable for use by policy makers and the general public. The main body of the report provides additional information for stakeholders interested in further detail. Appendices are included for more technical discussions and to facilitate a clear presentation of information.

Chapter 1: Introduction – This chapter provides background information on the preparation of the DRDWQMP and an overview of the content of the plan.

Chapter 2: Water Resources Setting – This chapter presents an overview of how Central Valley-wide operations affect the hydrology and water quality of the Delta, documents the historical degradation of Delta water quality (in particular, increases in bromide concentrations), and analyzes factors affecting source water quality at specific drinking water intakes in the Delta. In addition, the chapter discusses current and anticipated future drinking water regulations and water treatment technologies required to meet those regulations. **Appendices 2A** through **2C** include more technical aspects of these discussions.

Chapter 3: Planning and Management Objectives – This chapter identifies some of the challenges and issues that historical (and continued) Delta water quality degradation present for individual Delta urban agencies that divert water from the Delta for drinking water purposes. Those challenges and issues are discussed in the context of the overall water resources planning and management objectives of the agencies.

Chapter 4: Potential Projects and Programs – The objective of this chapter is to describe projects and programs that are currently being considered by individual Delta agencies to address the challenges and issues presented by the degradation of water from the Delta. These projects and programs are presented and described within the construct of a "Delta Region ELPH" model. Some of the physical and operational system-wide changes being contemplated by CALFED that could be made to improve the overall health of the Delta also are discussed.

Chapter 5: Implementation Strategies – This chapter presents a future strategy for subsequent phases of the DRDWQMP effort.

Chapter 6: Findings, Conclusions, and Recommendations – This chapter contains findings, conclusions, and recommendations of the DRDWQMP.

Chapter 7: References – This section contains a list of the reference material used in preparing the DRDWQMP.

Chapter 8: Glossary and Acronyms/Abbreviations – This section provides definitions of key terms and acronyms used in the report.

Chapter 9: List of Preparers - This section provides a list of the contributors to the report.

Appendix 1A – Outreach Work Plan - This appendix describes the outreach plan implemented for completion of the DRDWQMP.

Appendix 2A – Regulatory Setting - This appendix presents the current regulatory setting affecting Delta management, including a review of significant, historical regulations that have guided and influenced current Delta management practices.

Appendix 2B – Delta Hydrology – This appendix presents the complexity of Delta hydrology, focusing on water balance, inflow and outflow management, Delta exports and diversions, tidal influences, and structural changes to the Delta system that impact water flow.

Appendix 2C – Factors Affecting Delta Water Quality - This appendix provides the modeling and analyses underlying key water quality influences, including seawater intrusion, tributary inflow, and agricultural drainage and urban runoff. Specific consideration is given to existing chloride and bromide concentrations, relationships, and sources for the CCWD Delta intakes at Rock Slough and Old River, and SCWA intake for the North Bay Aqueduct (NBA) on Barker Slough. Modeling results are presented for the COSMUD proposed Delta Water Supply Project (DWSP) intake location and CCWD alternative intake locations on Victoria Canal.

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CHAPTER 2. WATER RESOURCES SETTING

The water resources setting impacting drinking water quality in the Sacramento-San Joaquin Delta (Delta) region comprises various agencies and management groups, hydrology, geography, and operations. Each of these factors influences water quality at drinking water intakes in the Delta.

Delta management issues include water supply and water quality to meet both human and ecosystem needs. Examples of management actions taken to meet the many Delta requirements include the following:

- Storage of water for water supply and downstream flood control
- Releases to supply water uses downstream and export pumps in the Delta
- Releases to produce instream flows, minimum water levels, and improved temperature and other ecosystem habitat conditions for fish
- Flood control releases to make room for runoff upstream of the reservoirs
- Releases to meet Delta water quality and flow requirements in the State Water Resources Control Board (SWRCB) Bay-Delta Water Quality Control Plan (WQCP)

Hydrologic variation, lunar cycles, export pumps, and structural modifications to the Delta environment influence delta hydraulics. Exports, diversions, and barriers change flow patterns and therefore alter the amount of seawater that intrudes into the Delta or redirect other sources of contamination to a different area of the Delta.

This chapter first introduces the Delta region under consideration. Because management groups formally influence Delta conditions through regulations, and informally through relationships, key agency and governmental relationships and regulations are presented next. A discussion of Delta hydrology follows, including Delta inflows and outflows, exports and diversions, tidal flows, in-Delta consumptive uses, and interior Delta flows. Fourth, Delta water quality is presented with a focus on historical changes in water quality, variation in water quality within the Delta, and key factors that influence Delta water quality. **Chapter 2** concludes with a summary of particular drinking water quality factors and Delta intake issues relating to Contra Costa Water District (CCWD), Solano County Water Agency (SCWA), and the city of Stockton (COS).

OVERVIEW OF THE DELTA

The San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) Estuary and Suisun Marsh are located at the confluence of California's two major river systems, the Sacramento River and San Joaquin River, and San Francisco Bay. The Delta was formally defined in the Delta Protection Act of 1959 (California Water Code Section 12220). The legal Delta encompasses an area of approximately 851,000 acres (of which approximately 135,000 acres consist of waterway, marshland, or other water surfaces) bordered by the cities of Sacramento, Stockton, Tracy, and Pittsburg.

The Delta has been reclaimed into more than 60 islands and tracts, interlaced with about 700 miles of waterways. About 520,000 acres are devoted to farming. An approximate 1,100-mile network of levees protects the reclaimed land, most of which lies near or below sea level, from flooding. Some of the island interiors are as much as 25 feet below sea level (SWRCB, 1999). Water flowing into the Delta is used for urban and agricultural use, recreation, navigation, and wildlife and fisheries. The Delta provides drinking water for about 23 million Californians. **Figure 2-1** displays key Delta facilities from the Freeport Intake in the north to the Vernalis water quality monitoring station in the south, and from Chipps Island in the west to the COS in the east. The "legal Delta" boundary is outlined in yellow.

Water movement in the Delta responds to four primary forcing mechanisms: (1) freshwater inflows draining to the ocean, (2) Delta exports and diversions, (3) operation of water control facilities such as dams, export pumps, and flow barriers, and (4) the regular tidal movement of seawater into and out of the Delta. In addition, tidal and salinity behavior within the Delta generate a number of secondary currents, which while of low velocity, are of considerable significance with respect to transporting contaminants and mixing different sources of water.

Changes in flow patterns within the Delta, whether caused by export pumping, winds, flow barriers, or spring-neap (14-day) tidal variations, can significantly influence water quality at drinking water intakes. Each of these influences is presented in the hydrology discussion of this section.

INSTITUTIONAL AND REGULATORY SETTING

Management of the Delta is partly determined by federal and state regulations developed to protect both the human and environmental beneficial uses. Primary institutional and regulatory influences on the use and management of the Delta include the Federal Central Valley Project (CVP), the State Water Project (SWP), direct Delta diverters, including CCWD, SCWA, and City of Stockton Metropolitan Area (COSMA), San Francisco Bay water quality needs, and multiple endangered species protection regulations.

AGENCIES AND INSTITUTIONS WITH PRIMARY INFLUENCE ON DELTA WATER QUALITY

At the local level, water agencies that divert from the Delta have both strong interest in and influence on Delta water quality management. These agencies include CCWD, SCWA, and COS. At the state level, the SWRCB, and the Regional Water Quality Control Boards (RWQCB) regulate and monitor Delta water quality. Nine regional boards oversee water quality in the state. Two of these, the Central Valley Regional Water Quality Control Board (CVRWQCB) and the San Francisco Bay Regional Water Quality Control Board, oversee Delta water quality.

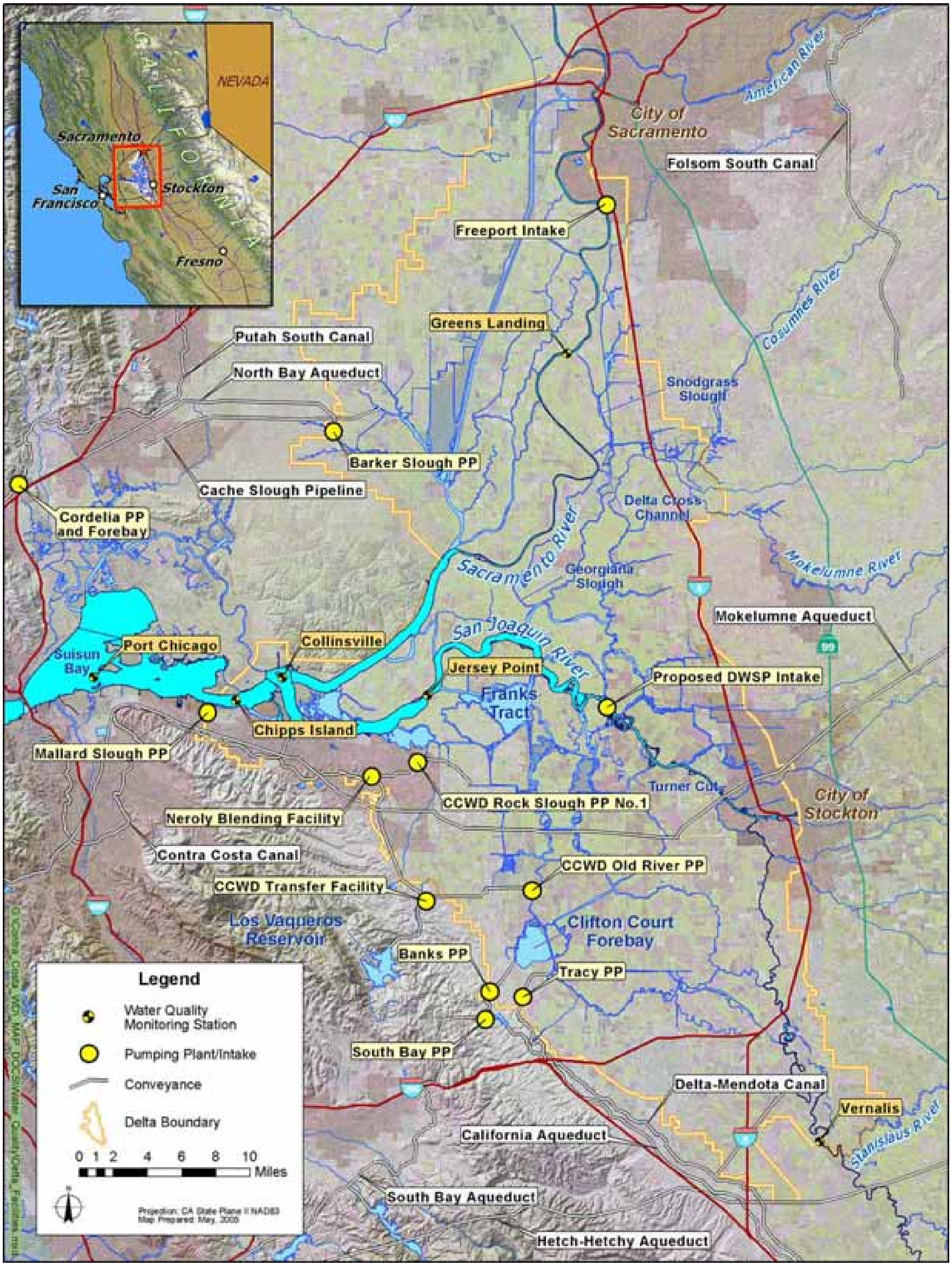

Figure 2-1 Delta Region Drinking Water Quality Management Study Area

The United States Environmental Protection Agency (EPA) also plays an important role under the auspices of the federal Clean Water Act (CWA) and Safe Drinking Water Act (SDWA). The California Department of Health Services (DHS) has an interest in the Delta because it is the source of drinking water for over 23 million Californians. The California Department of Water Resources (DWR) extensively monitors Delta water quality as part of its Municipal Water Quality Investigation (MWQI) program, and DWR in cooperation with the United States Department of the Interior, Bureau of Reclamation (Reclamation), monitors Delta water quality under SWRCB's compliance monitoring requirements.

OTHER DELTA PLANNING AGENCIES

Two agencies with key planning roles in the Delta are the California Bay-Delta Authority (CBDA) and the Delta Protection Commission. CBDA became a state agency in January 2003, and is responsible for implementing the Bay-Delta Program. State legislation created the Delta Protection Commission in 1992 with the goal of developing regional policies for the Delta to protect and enhance existing land uses. In 2000, the Commission was made a permanent state agency. The Delta Protection Commission comments on applications for CALFED ecosystem restoration grants that affect the Delta and participates in meetings with other CALFED agencies to provide input to CALFED Program management decisions.

KEY REGULATIONS INFLUENCING DELTA WATER QUALITY

Key regulations influencing Delta management and water quality are summarized below, and are presented in greater detail in **Appendix 2-A**.

The first water quality standards for the Delta were adopted in May 1967, when the State Water Rights Board (predecessor to SWRCB) released Water Right Decision 1275, approving water rights for the SWP while setting agricultural salinity standards as terms and conditions. These requirements were changed in 1971 under Decision 1379 (D-1379), which added standards that the CVP and SWP were required to meet for non-consumptive uses (water dedicated to fish and wildlife) and agricultural and municipal and industrial (M&I) consumptive use standards.

In 1978, SWRCB issued Water Right Decision 1485 (D-1485) and the Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh (1978 WQCP), which together revised flow and salinity standards, and required Reclamation and DWR to reduce pumping, release stored water upstream, or both to meet the standards. D-1485 superseded all previous water rights decisions for the CVP and SWP operations in the Delta. Among beneficial uses to be protected by the decision were (1) M&I water supply, (2) agriculture, and (3) fish and wildlife.

In May 1995, SWRCB adopted a new Bay-Delta Water Quality Control Plan, which incorporated most of the features of the December 15, 1994, Bay-Delta Accord (see **Appendix 2A**). The 1995 WQCP introduced new flow requirements in the spring

(February to June) to provide improved habitat for Bay-Delta fish species. The 1995 WQCP was implemented by Water Rights Decision 1641 (D-1641) in March 2000.

SWRCB is currently implementing a Periodic Review of its 1995 WQCP. As part of this process, SWRCB received input on setting specific drinking water objectives based on bromide concentration.

DELTA HYDROLOGY

The flow-related factors that influence Delta water quality include freshwater Delta inflow, Delta outflow, exports and diversions, tidal flows, and other physical features such as temporary and permanent barriers. **Figure 2-2** depicts the key Delta islands, waterways, M&I intakes, and water control facilities that influence Delta hydrology. Each of these Delta hydrologic impacts is discussed below. **Appendix 2-B** provides additional data and information underlying the analysis and discussion presented. Because water resources management for human and environmental purposes, in addition to hydrologic factors, also influences Delta water quality, the evolution of Bay-Delta system management is presented first in this section. This evolution can be broadly grouped into four periods:

- 1956 – 1967, pre-SWP deliveries (CVP only)
- 1968 – 1978, pre-Water Rights Decision 1485
- 1979 – 1995, pre-Bay-Delta Accord, pre-1995 SWRCB WQCP
- 1996 – to date, post Bay-Delta Accord

The first period is prior to SWP exports at Banks Pumping Plant coming on line, but after the CVP began exporting from the Delta through Tracy Pumping Plant. In 1956, the first flow data became available from DWR's DAYFLOW database, although some water quality data is available prior to 1956. During this time, the total annual Delta export (CVP only) was 1.65 million acre-feet (MAF). Total annual exports have increased considerably since and in recent years have been as high as 6.2 MAF. During this time, the state has become increasingly dependent on the Delta for conveyance of water supplies from north to south in California, while water quality and environmental purposes have gained increasing attention and regulation.

The second period is the time frame leading up to SWRCB's D-1485. In D-1485, SWRCB adopted M&I objectives of 250 milligrams per liter (mg/L) chlorides year-round (about 850 micrograms per liter (µg/L) bromide) and 150 mg/L chloride (about 550 µg/L bromide) at Contra Costa Canal Pumping Plant No. 1 (Pumping Plant No. 1) or the City of Antioch's pumping plant for 155 to 240 days per year depending on water year type. Between 1978 and 1995, these chloride objectives governed Delta operations in many months, particularly in the fall. D-1485 also introduced standards to protect Delta agriculture.

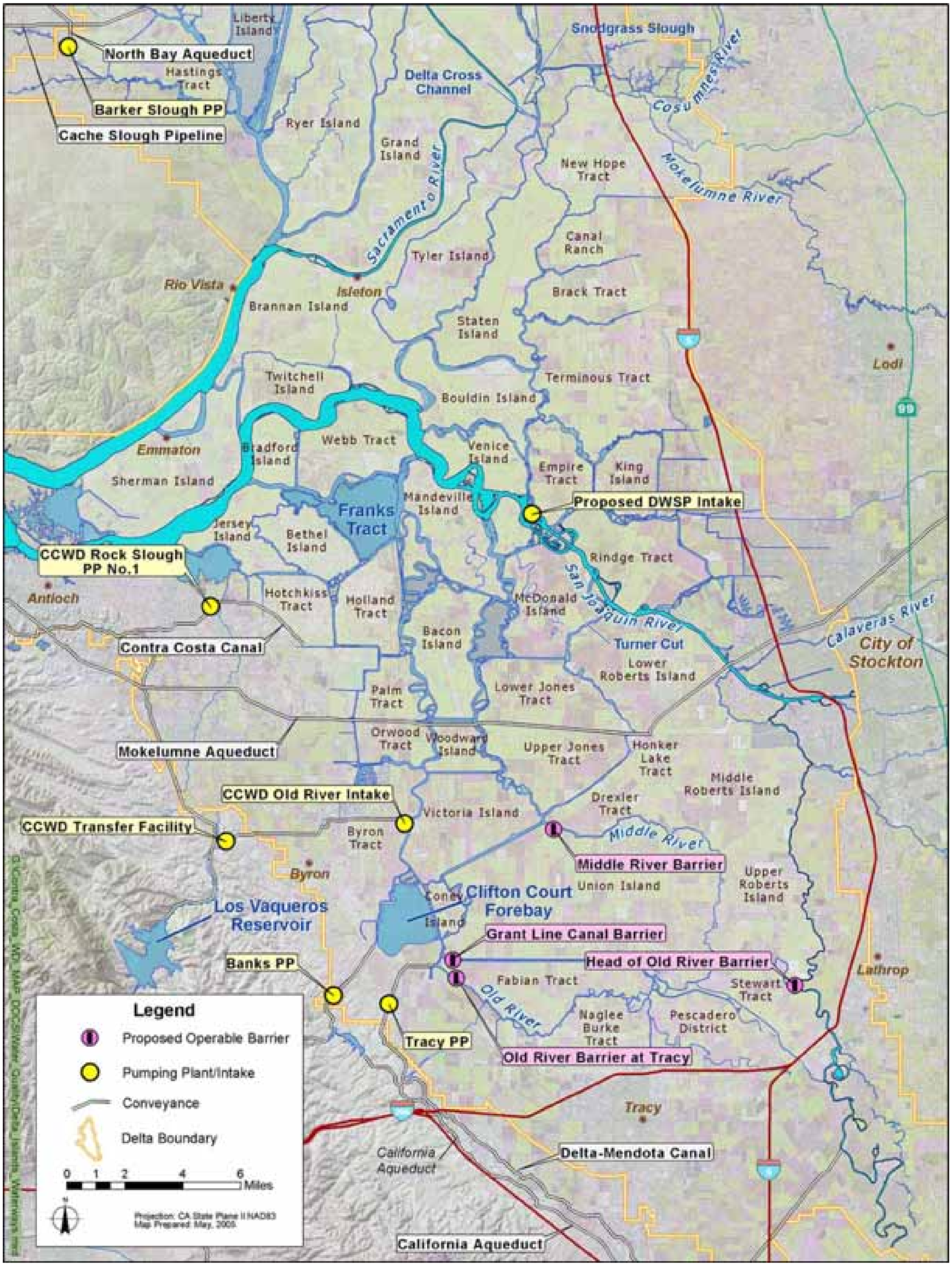

Figure 2-2 Delta Islands, Waterways, M&I Intakes, and Water Control Facilities

The third period is the time prior to implementation of the December 15, 1994, Bay-Delta Accord and adoption of the May 1995 SWRCB Bay-Delta Water Quality Control Plan. The 1995 WQCP introduced new flow requirements in the spring (February to June) to provide improved habitat for Bay-Delta fish species. The flows required to meet this estuarine habitat objective (referred to as X2) are 7,100, 11,400 and 29,200 cubic feet per second (cfs) for Collinsville X2, Chipps Island X2, and Port Chicago X2, respectively.

These flows are much higher than the Delta outflow required to meet 150 mg/L chloride at Pumping Plant No. 1 (about 4,700 cfs) and therefore represent improved spring water quality in the western Delta since 1995.

The fourth period represents the time frame when X2 objectives were in effect and endangered species biological opinions (BO) required that export pumping be reduced at certain times. These BOs have resulted in a shift in export pumping from the April to June period to later in the fall. The outcome of this pumping shift is that Delta water has become more salty in the fall, and exports of fresher water in the late spring and early summer have been replaced by exports of much more saline water in the fall.

DELTA INFLOW

Freshwater inflow to the Delta is derived primarily from the Sacramento and San Joaquin rivers. However, additional flows also arrive via the eastside tributaries, namely the Mokelumne, Calaveras, and Cosumnes rivers (see **Figure 2-1**). Inflow to the Delta controls the intrusion of seawater and flushes out contaminants. Source water contaminant issues, primarily from urban and agricultural runoff, are a major factor affecting Delta water quality.

DELTA OUTFLOW

Water flowing into the Delta is either diverted by direct Delta diverters, exported by the CVP or SWP pumps in the south Delta, or it flows out of the San Francisco Bay and to the Pacific Ocean. Delta outflow is the primary factor controlling water quality in the Delta. Freshwater flows provide a barrier against seawater intrusion, and can be strategically managed through various physical barriers and water management operations. When Delta outflow is low, seawater can intrude further into the Delta, impacting salinity and bromide concentrations at drinking water intakes.

DELTA EXPORTS AND DIVERSIONS

When more Delta outflow is available than is needed to meet Delta water quality standards (excess conditions), Delta exports can reduce Delta outflow and cause degradation in water quality. When the Delta is "in balance," so that Delta outflow is equal to that needed to meet water quality control standards, Delta exports can still change flow patterns in the Delta and result in increased salinities at Delta M&I intakes.

The federal CVP exports water from the Delta at the Tracy Pumping Plant, located in the south Delta about 5 miles northwest of the City of Tracy. The Tracy Pumping Plant has a pumping capacity of about 4,600 cfs. The SWP Banks Pumping Plant has an installed capacity of 10,300 cfs. However, under current operational constraints, exports from Banks Pumping Plant are generally limited to a maximum of 6,680 cfs, except between December 15 and March 15, when exports can be increased by 33 percent of San Joaquin River flow at Vernalis (if greater than 1,000 cfs).

DWR is continuing environmental analysis and permitting for operation of Banks Pumping Plant at 8,500 cfs. DWR currently is scheduled to release in late May or June 2005 a new draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the South Delta Improvements Program that includes operation of Banks at 8,500 cfs and new permanent operable flow barriers. Eventually, DWR may obtain permits to operate Banks at the full installed capacity of 10,300 cfs.

Similarly, Reclamation and the San Luis Delta Mendota Water Authority recently released environmental documentation for a 400 cfs intertie between the Delta-Mendota Canal (DMC) and California Aqueduct. During the winter non-irrigation season, when irrigation demands are low in the upper reaches of the DMC, only about 4,200 cfs can be conveyed in the DMC upstream of the O'Neill Forebay and San Luis Reservoir. The intertie connection would allow Reclamation to more fully use the pumping capacity at the Tracy Pumping Plant. Reclamation also is considering a future expansion of the intertie to 900 cfs to allow Tracy pumping capacity to be increased to 5,100 cfs. This additional export pumping, and corresponding decrease in Delta outflow could contribute to further degradation in Delta water quality.

TIDAL FLOWS

Except under conditions of high runoff, Delta outflow is dominated by tidal ebb and flood. Over the tidal cycle, flows move downstream toward San Francisco Bay during ebb tides and move upstream during flood tides. Maximum downstream tidal flows at Martinez in almost all months are between 600,000 cfs and 700,000 cfs. Minimum tidal flows at Martinez are between negative 600,000 cfs and negative 650,000 cfs. The tidal excursion at Martinez has a typical range of 6 to 8 miles. During rising tides, strong tide currents may create reverse flows (landward flows) in some Delta waterways. The magnitude of reverse flows, however, depends on other factors such as Delta tributary inflows, CVP-SWP operations and local pumping.

The tidal pattern for San Francisco Bay and the Delta is a mixed diurnal tide with two tides of unequal magnitude each lunar day (24.9 hours); a higher-high and lower-high tide occur each day. The lowest low tides and highest high tides occur during the lunar-spring tide periods (i.e., new moon and full moon). Tides during the lunar-neap tide period are smaller and nearly equal in magnitude. Tidal variations over the approximately 14-day spring-neap cycle also have a definite effect on flows and water quality in the Delta (see **Appendix 2-B**).

Tidal flows in the Delta bring salty water into the Delta on the flood (landward) stage of the tide and expel a mixture of salty and freshwater on the ebb (seaward) stage of the tide. When Delta outflows decrease, typically a net exchange of salt occurs in the landwards direction. When Delta outflows increase, tidal exchange typically results in a net transport of salt in the seaward direction, "freshening" the Delta.

While the tidal influence cannot be directly controlled, it is clear that changes in freshwater Delta inflow and pumping can manage the effects of tidal action on regional water quality. As a corollary, Delta operations also can exacerbate the water quality impacts of tidal action.

DELTA CONSUMPTIVE USE

Delta farmers divert water directly from Delta channels for irrigation and leaching (leaching is the application of additional irrigation water to flush salts from the root zone). These diversions reduce Delta outflow, which can increase seawater intrusion. Return flows discharged back into the Delta from Delta farms also can contribute to higher levels of bromide, salinity, and organic carbon. During the summer, when irrigation of Delta farmland is at a peak, net diversions for Delta farms may exceed 4,000 cfs. This is similar in magnitude to CVP exports from the Delta in summer.

INTERIOR DELTA FLOWS

Flows within the Delta are directed by geographical boundaries such as levees and waterways, physical structures such as barriers and channels, and pumping. This section provides an overview of key forces directing interior Delta flows. (For additional information on each of these forces, see **Appendix 2-B**.)

Flow Barriers

Several flow barriers located in the Delta can play a major role in determining flow patterns through the Delta and water quality. These physical barriers include the Delta Cross Channel at Walnut Grove, south Delta temporary barriers, the Suisun Marsh Salinity control gate, and the Sandmound Slough tide gate linking Rock Slough with Sandmound Slough.

Delta Cross Channel

The Delta Cross Channel connects the Sacramento River to the Mokelumne River via Snodgrass Slough (see **Figure 2-3**). Water is already able to enter the central Delta via Georgiana Slough, but the Delta Cross Channel effectively doubles the flow into the central Delta. Its purpose is to improve central Delta water quality, particularly at the CCWD Rock Slough intake and the Tracy and Banks export pumps, by increasing the flow of higher-quality Sacramento River water into the lower San Joaquin River.

However, the Delta Cross Channel has been closed more often due to regulatory requirements aimed at preventing out-migrating salmon from being misdirected into the central Delta where their chance of survival and reaching the ocean is reduced. As discussed in more detail in Appendix 2A, this reduction in the flow of fresher Sacramento River water into the interior Delta has degraded water quality, particularly in the fall when Delta outflow is already low.

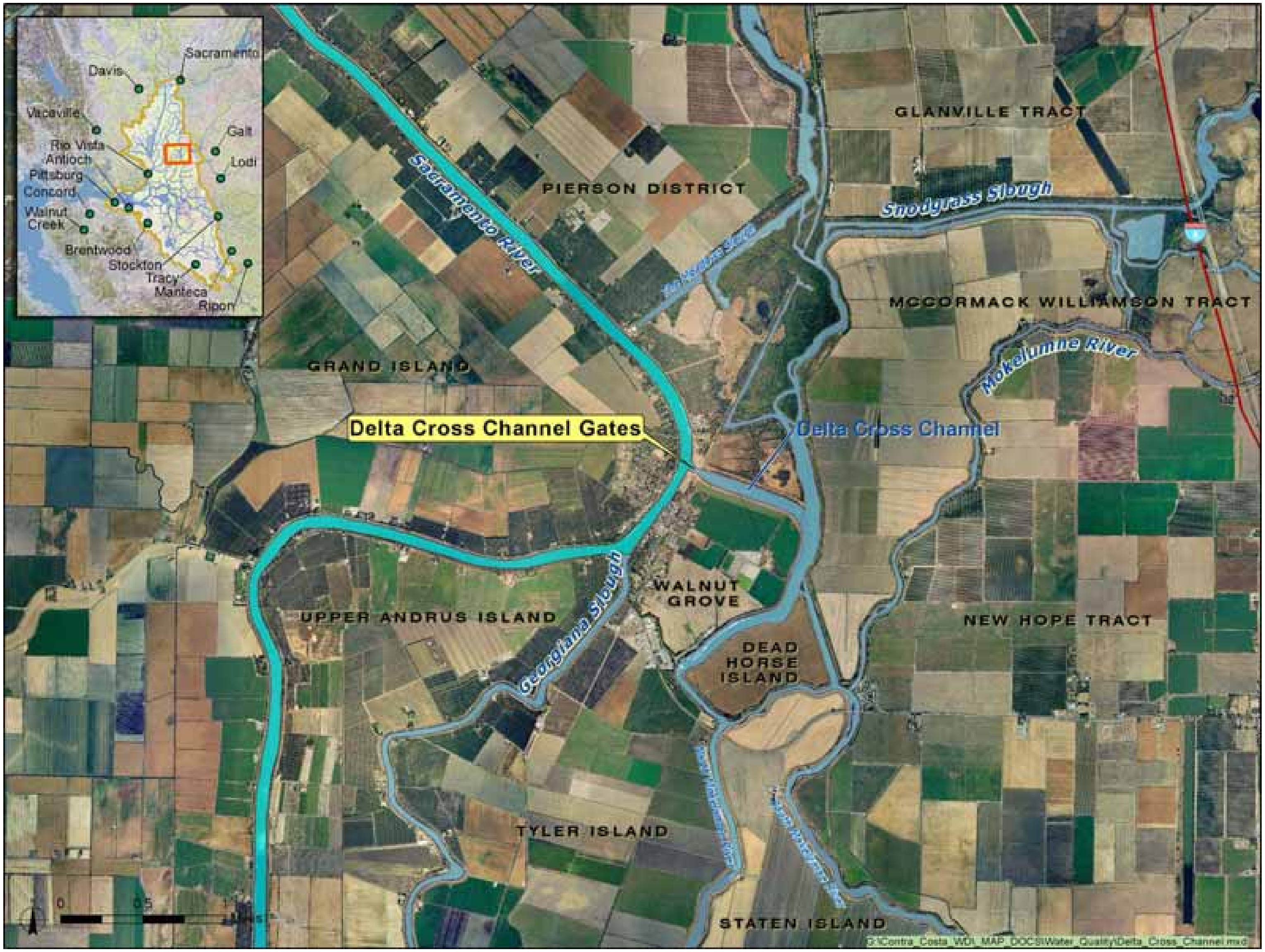

Figure 2-3 Delta Cross Channel

Delta Cross Channel

The control gates at the federal Delta Cross Channel allow additional Sacramento flow into the interior Delta to improve Delta water quality.

South Delta Temporary Barriers

DWR first began installing temporary rock barriers in south Delta channels in 1987. The project now consists of four rock barriers: a barruer at the Head of Old River to keep migrating fish in the San Joaquin River, and three agricultural barriers that are installed between April and September each year. The three agricultural barriers, located at Old River near Tracy, in Middle River, and in Grant Line Canal, are intended to increase water levels, circulation patterns, and water quality in the south Delta area for local irrigation diversions.

Permanent Operable South Delta Barriers

DWR has been studying installation of permanent operable barriers at the Head of Old River, Old River near Tracy, Middle River, and Grant Line Canal since the 1980s. The barrier at the Head of Old River would be would be open most of the year and closed to keep young salmon in the San Joaquin River as they outmigrate to the ocean in the spring. The barrier also would be closed in the fall to keep adult salmon in the San Joaquin River as they migrate upstream.The three agricultural barriers, Old River near Tracy, Middle River and Grant Line Canal, would be operated year-round to meet water level, water quality, and water supply needs. DWR is scheduled to release in late May or June 2005 a new draft EIS/EIR for the South Delta Improvements Program, which includes operation of the four permanent barriers.

Agricultural barriers, in conjunction with the Head of Old River barrier, can reduce the amount of San Joaquin inflow reaching the Tracy Pumping Plant for re-export to the San Joaquin Valley. These barriers redirect poor quality San Joaquin water north down the San Joaquin River, then west via Turner Cut, where it can increase the concentration of salinity and other contaminants of concern (COC) in the lower San Joaquin River near Stockton's proposed intake and at CCWD's drinking water intakes. Water quality impacts of these south Delta flow barriers, combined with increased exports, are a major concern for CCWD.

DELTA WATER QUALITY

The variation of water quality in the Delta with respect to both location and season is the result of tidal exchange with San Francisco Bay, variations in freshwater inflow, and agricultural and urban diversions and return flows.

In response to Delta water quality concerns, projects and programs have already been implemented to improve the quality of Bay Area water supplies. DWR's MWQI and other state, federal, and local programs include detailed monitoring of Delta water quality. The CVRWQCB is moving toward requiring tertiary treatment and limitations of the contaminant load for municipal wastewater treatment plants (WWTP). The CVRWQCB also is implementing a watershed approach for monitoring sources of contaminants from agricultural drainage. This monitoring is under the conditional waiver program that replaced the RWQCB's 20-year-old waiver of the requirement to obtain Waste Discharge Requirements (WDR) for discharges resulting from agricultural return flows and stormwater runoff.

HISTORICAL CHANGES IN DELTA WATER QUALITY

During the 1970s and 1980s, the Delta witnessed a dramatic degradation in salinity, which subsequently persisted through the wet years of the late 1990s. The water quality record at Rock Slough can be used as a surrogate for overall Delta water quality**. Figure 2-4** shows the chloride concentrations at Rock Slough at CCWD's intake since 1944. The data are monthly averaged Rock Slough chlorides for the fall months (October, November, and December) color-coded into wet (above normal and wet) and dry (below normal, dry, and critical) years.

From the 1940s through to the mid-1970s, Delta water quality in the fall improved such that even in drier years the water quality was better than the long-term average. However, since the 1980s, increased diversions by the Delta exporters, and the shift from pumping in the spring to pumping in the fall to protect fish, have resulted in a dramatic degradation of Delta water quality. Indeed, the best months currently are worse than the worst months prior to the mid-1970s.

As demands for water increase, increased Delta exports are likely to contribute to a general decline in Delta water quality. The seasonal degradation of Delta water quality in the late summer and fall will likely continue into the future as rising demands for water in the Central Valley exert pressure on the system. As shown in **Figure 2-4**, longer-term degradation of water quality has occurred during the fall since the mid-1980s.[1] This can be attributed in part to increased CVP and SWP export demand, and environmental regulations, which have, for example, reduced export pumping at Banks and Tracy in the spring to protect endangered fish species and shifted export pumping to the fall. This degradation of chloride concentration in the fall, and the shift in export pumping to the

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[1] Water year 1977 is the driest year in the historical 1906-2004 hydrologic record for the Sacramento River basin. Similarly, 1995 and 1998 were very wet El Nino years. Data from these 3 years represent extreme events and are not representative of the general trend of central Delta salinity.

fall, also have increased the salinity load for exported water. As Delta water quality degrades, it will become more difficult and costly for urban water agencies in the Delta to provide high quality water in the future.

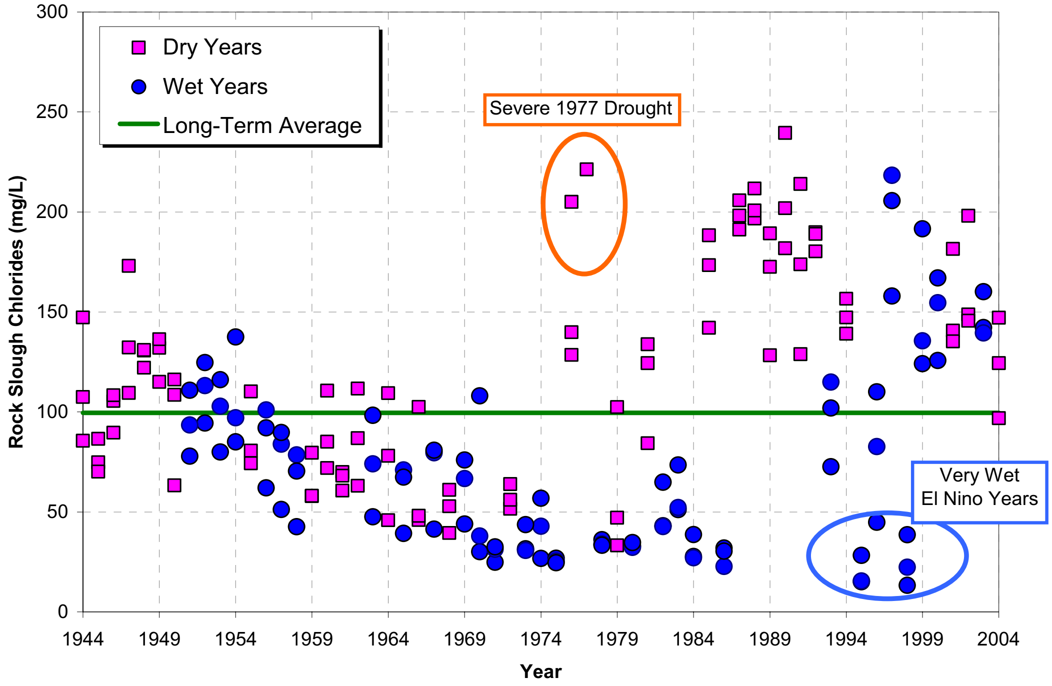

Figure 2-4 Rock Slough Fall Chloride Concentration, 1944 to 2004

The long-term historical record of salinity in the central Delta at Rock Slough (1944 to 2004) shows a consistent decrease in salinity in the fall through the early 1970s, followed by a dramatic increase in fall salinity since the 1980s. Currently, the salinities during wet years are higher than those experienced in drier years during the 1960s and early 1970s.

Organic Carbon

Unlike salinity, historical measurements of organic carbon concentration do not show a clear trend. Organic carbon data are not available from MWQI prior to 1986, and until recently the data were analyzed as total organic carbon (TOC) or dissolved organic carbon (DOC) but not both. **Figure 2-5** shows the variation in TOC and DOC at two MWQI stations in Rock Slough: Contra Costa Canal at Pumping Plant No. 1 (CCC PP No. 1) and just inside the entrance to Rock Slough off Old River (RS entrance). Organic carbon peaks each year in the winter months but no obvious long-term trend exists in this short data set.

Figure 2-6 shows a similar variation in TOC and DOC at the SWP Banks Pumping Plant. The peaks of organic carbon are generally higher than at Rock Slough. The Banks Pumping Plant data also show no noticeable long-term trend.

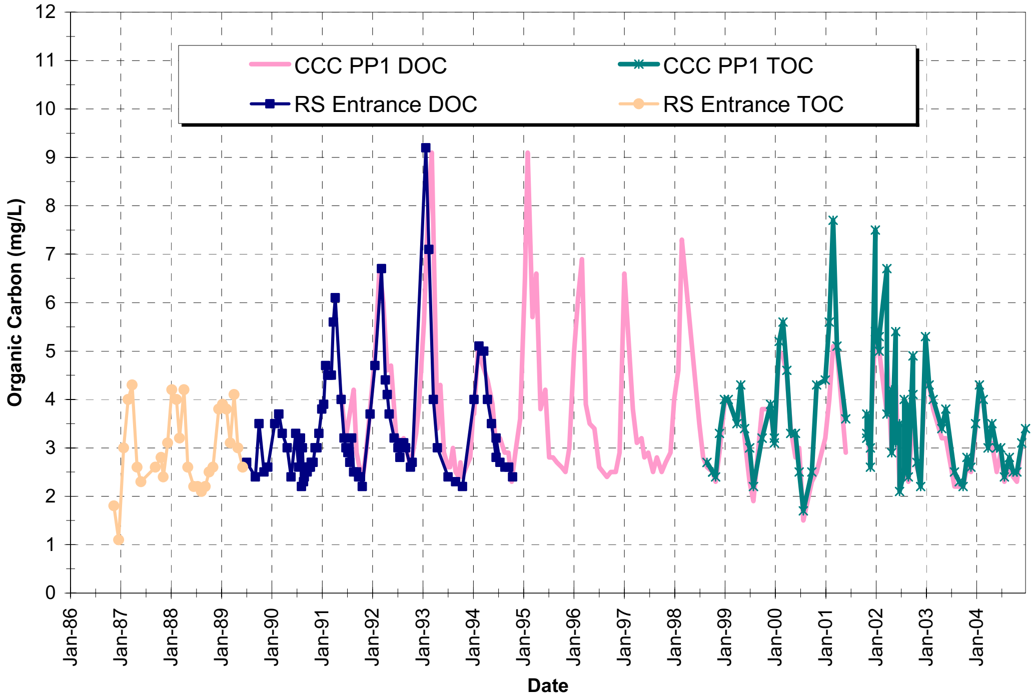

Figure 2-5 Seasonal Variation of Organic Carbon at Two Rock Slough Stations, 1986 to 2004

No noticeable long-term trend exists of either increasing or decreasing concentration.

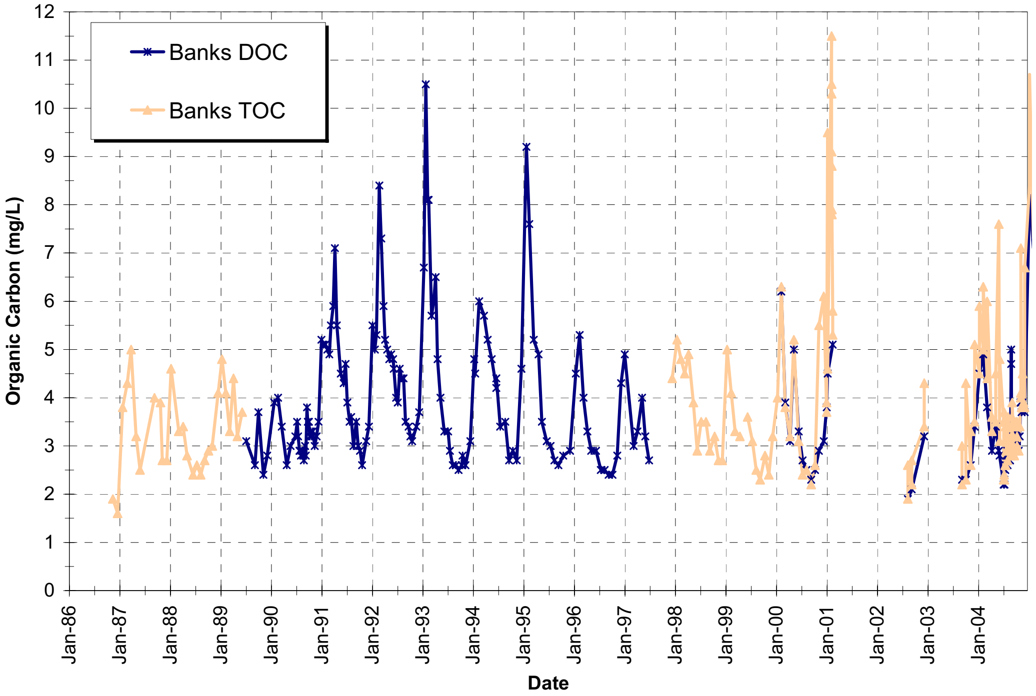

Figure 2-6 Seasonal Variation of Organic Carbon at the SWP Banks Pumping Plant, 1986 to 2004

No noticeable long-term trend exists of either increasing or decreasing concentration. Peak concentrations tend to be higher than at Rock Slough.

The United States Geological Survey (USGS) analyzed organic carbon, nutrient, and suspended sediment concentration data for the Sacramento and San Joaquin river basins for the period 1980 to 2000 under a grant from the CALFED Drinking Water Program (Saleh et al., 2003). The report looks for long-term trends in organic carbon, nutrients, and suspended sediment in tributaries flowing into the Delta. USGS found statistically significant downwards trends in DOC concentrations in the Sacramento River near Freeport, and the American River at Sacramento. The USGS also found significant decreasing trends in DOC in the San Joaquin River near Vernalis. However, as shown in **Figure 2-7**, the long-term reduction in organic carbon concentration in the Sacramento River at Freeport is not large.

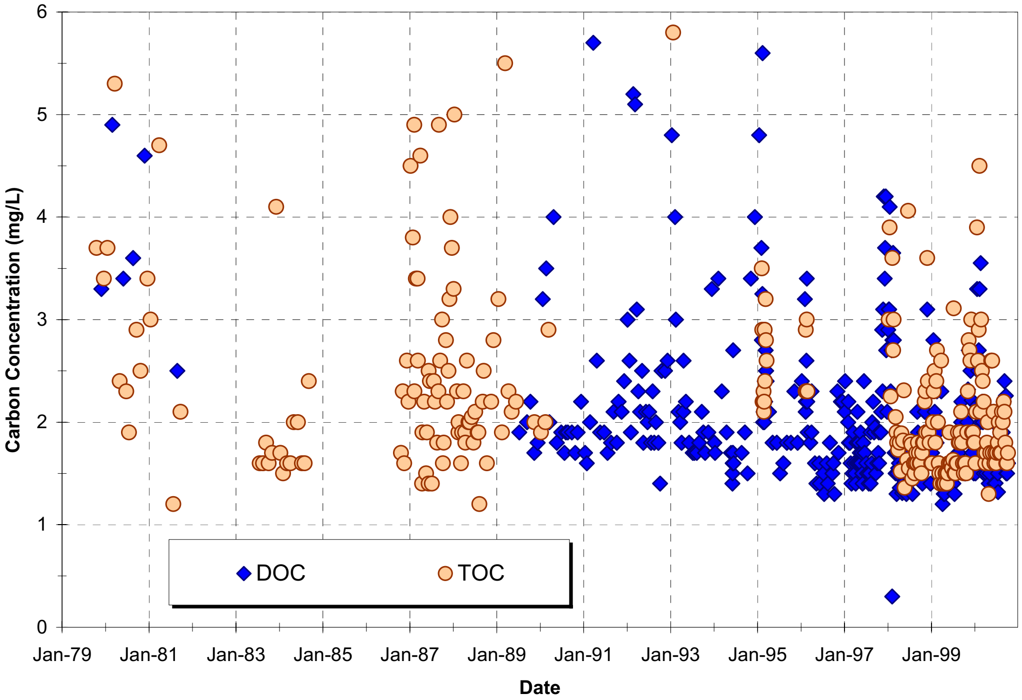

Figure 2-7 Organic Carbon Data Collected by USGS for the Sacramento River at Freeport

USGS found a statistically decreasing long-term trend in TOC and DOC at this location.

GEOGRAPHIC VARIATION OF DELTA WATER QUALITY

The north Delta tends to have better water quality in terms of salinity, in large part because of inflow from the Sacramento River and Yolo Bypass. Sacramento River flow in the summer months is supplemented by reservoir releases of low salinity water. Water diverted for the North Bay Aqueduct (NBA) at Barker Slough in the north of the Delta is heavily dominated by local runoff at times, and the contribution of salinity from Sacramento River flow is typically relatively small.

The quality of water in the west Delta is strongly influenced by tidal exchange with Suisun Bay and the ocean. During low-flow periods, seawater intrusion dominates, resulting in high salinities. CCWD diverts water at Mallard Slough, near Chipps Island in Suisun Bay, but diversions occur infrequently and only after periods of very high Delta outflow (typically 40,000 cfs or greater) when chloride concentrations are 65 mg/L or more. Generally, salinities in Suisun Bay make the water unsuitable for drinking water purposes.

Looking south along Sacramento River near Walnut Grove at Delta Cross Channel (from the middle to the top left) and the entrance to Georgiana Slough (in the top right-hand corner).

Water quality in the south Delta is affected by the combination of inflows of poor water quality from the San Joaquin River, discharges from south and central Delta islands, local municipal runoff and discharges, and the effects of exports and barriers, which can sometimes cause additional seawater intrusion from Suisun Bay or redirection of poor quality water. The Delta Cross Channel near Walnut Grove increases the flow of fresher Sacramento River into the central and south Delta. Closure of the Delta Cross Channel to protect outmigrating anadramous fish, particularly in the fall, can dramatically increase salinity concentrations in the south Delta. Barriers installed at the Head of Old River, at its junction with the San Joaquin River north of Vernalis and in south Delta channels, can redirect poorer quality San Joaquin River water to drinking water intakes. Higher Vernalis inflows to the Delta are generally associated with better water quality at Vernalis but the relationship between Vernalis flow and salinity (measured as electrical conductivity (EC)) has changed since 1995 after implementation of the May 1995 WQCP, the Grassland Bypass Project, and other actions on the San Joaquin River upstream of the Delta that have reduced the salt load from agricultural drainage. Releases are made from New Melones Reservoir to meet the 1995 Water Quality Control Plan EC standard at Vernalis. Higher Vernalis flows also result in more San Joaquin River water reaching drinking water intakes in the south and central Delta (typically by displacing Sacramento River water). The CALFED Delta Improvements Package was developed in part to ensure that actions to increase water supply and improve water levels and water quality for south Delta farmers do not result in further degradation of water quality at drinking water intakes in the south and central Delta, but rather contribute to continuous improvement.

Table 2-1 identifies current mean water quality concentrations of selected constituents at various locations in the Delta. Water quality in the north Delta is generally better than in the south Delta, although variability exists.

Table 2-1 Water Quality for Selected Stations in the Delta

Location Constituent(1)	Mean TDS (mg/L)	Mean EC (µS/cm)	Mean Chloride (mg/L)	Mean Bromide (mg/L)	Mean DOC (mg/L)
Sacramento River at Greens Landing	100	160	7	0.018	2.5
North Bay Aqueduct at Barker Slough	192	332	26	0.015	5.3
SWP Clifton Court Forebay	286	476	77	0.269	4.0
CVP Tracy Pumping Plant	258	482	81	0.269	3.7
CCWD Intake at Rock Slough	305	553	109	0.455	3.4
San Joaquin River at Vernalis	459	749	102	0.313	3.9

Key:

Source: CALFED, 2000; ESA, 2004

µS/cm = microSiemens per centimeter
CCWD = Contra Costa Water District
CVP = Central Valley Project
DOC = dissolved organic carbon
EC = electrical conductivity
mg/L = milligrams per liter
SWP = State Water Project
TDS = total dissolved solids

(1) Sampling period varies, depending on location and constituent, but generally is between 1990 and 1998.

FACTORS AFFECTING DELTA WATER QUALITY

The quality of drinking water diverted from the Delta is affected by four major factors:

- Seawater intrusion from San Francisco Bay
- Inflows of water of variable quality from the Sacramento River, San Joaquin River, and other tributaries
- Agricultural and municipal discharge both within the Delta, and from upstream sources
- Agricultural and municipal diversions

Source water quality has significant impact on the quality and safety of delivered water. Bromides associated with seawater lead to the formation of brominated compounds (suspected carcinogen) when Delta water is disinfected for drinking water supply. Agricultural drainage into the Delta can contain elevated levels of organic carbon, which in conjunction with chlorine, chloramines, ozone, or other disinfectants, can further increase the formation of disinfection byproducts (DBP).

Discharges into the Delta also contain elevated concentrations of nutrients, suspended solids, selenium, boron, and pesticides, all of which are drinking water contaminants of concern. Heavy metals, including cadmium, copper, mercury, and zinc, continue to enter the Delta. Sources of these metals include runoff from abandoned mine sites, tailings deposits, downstream sediments where metals have been deposited over the past 150 years, urban runoff, and M&I wastewater. Seawater intrusion, freshwater inflow, and agricultural discharge quality effects are presented below. A more thorough technical presentation of these source issues is presented in **Appendix 2-C**.

Seawater Intrusion

Seawater intrusion into the Delta increases salt levels in diverted water, making treatment and use of the water more difficult. The amount of seawater in the Delta varies by annual hydrology and season. Seawater intrusion is influenced by tides, wind, and barometric pressure, runoff from unregulated tributaries, and releases from upstream reservoirs. When Delta outflows become too low and exports are too high, additional intrusion of seawater can occur because of the change in flow patterns due to the exports. Salinity is highest for the western Delta because of its proximity to the ocean, and lowest in the north region, which has the most freshwater inflow.

Managing seawater and corresponding salinity levels in the Delta is complicated by the amount of time it takes for upstream releases to reach the Delta, and for the Delta to adjust to new effective outflows.

Tributary Inflow

The Sacramento and San Joaquin rivers are the two primary tributaries that influence Delta freshwater inflow. Other tributaries include the Mokelumne, Calaveras, and Cosumnes rivers. This discussion focuses on the contribution of the Sacramento and San Joaquin rivers to Delta water quality.

Freeport (Greens Landing) is a historical water quality monitoring location for the Sacramento River and is depicted in **Figure 2-8**. The quality of the water varies both seasonally and annually.

Appendix 2-C provides detailed data for EC, a measure of salinity, between 1965 and 1998 at Greens Landing. In addition to the absolute EC level, variability also creates drinking water quality management and treatment challenges. It is notable that while EC decreases at higher flows, it is highly variable over low flows, from approximately 60 microSiemens/cm (µS/cm) to over 250 µS/cm.

San Joaquin River flows are primarily controlled at Friant, New Don Pedro and at New Melones dams. Vernalis is a primary water quality control location, as shown in **Figure 2-9**. The San Joaquin River has a historically higher EC level than the Sacramento River. The variability band of EC levels on the San Joaquin River is significantly greater than that of the Sacramento River, ranging from approximately 180 µS/cm to over 1,600 µS/cm.

Agricultural Drainage

Water in the Delta from agricultural drainage contains high levels of nutrients, suspended solids, organic carbon, minerals (salinity), and trace chemicals such as the organophosphate, carbamate, and organochlorine pesticides. This drainage can come from both in-Delta and upstream tributary sources. Incremental addition of salts from extensive irrigated agricultural areas in the San Joaquin Valley result in typically elevated total dissolved solids (TDS) concentrations in the San Joaquin River. The salinity of agricultural drainage follows a seasonal trend; highest concentrations occur during the runoff season in late winter and spring, with peak concentrations occurring in January or February. Minimum salinity levels occur in July and August.

Appendix 2-C provides greater technical detail on agricultural COCs, with special attention to chloride, bromide, calcium and sulfates.

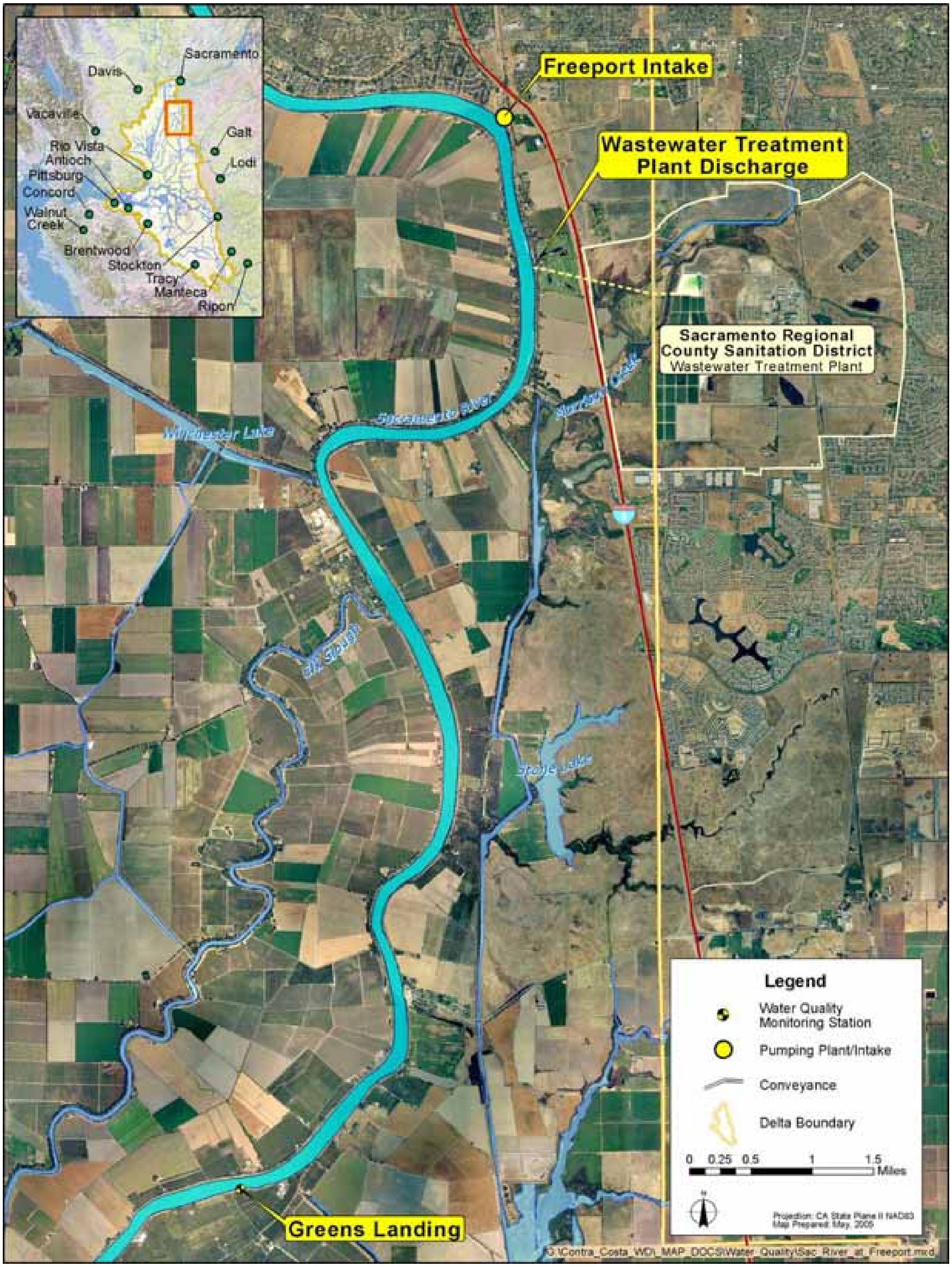

Figure 2-8 Sacramento River at Freeport Intake and Water Quality Monitoring at Greens Landing

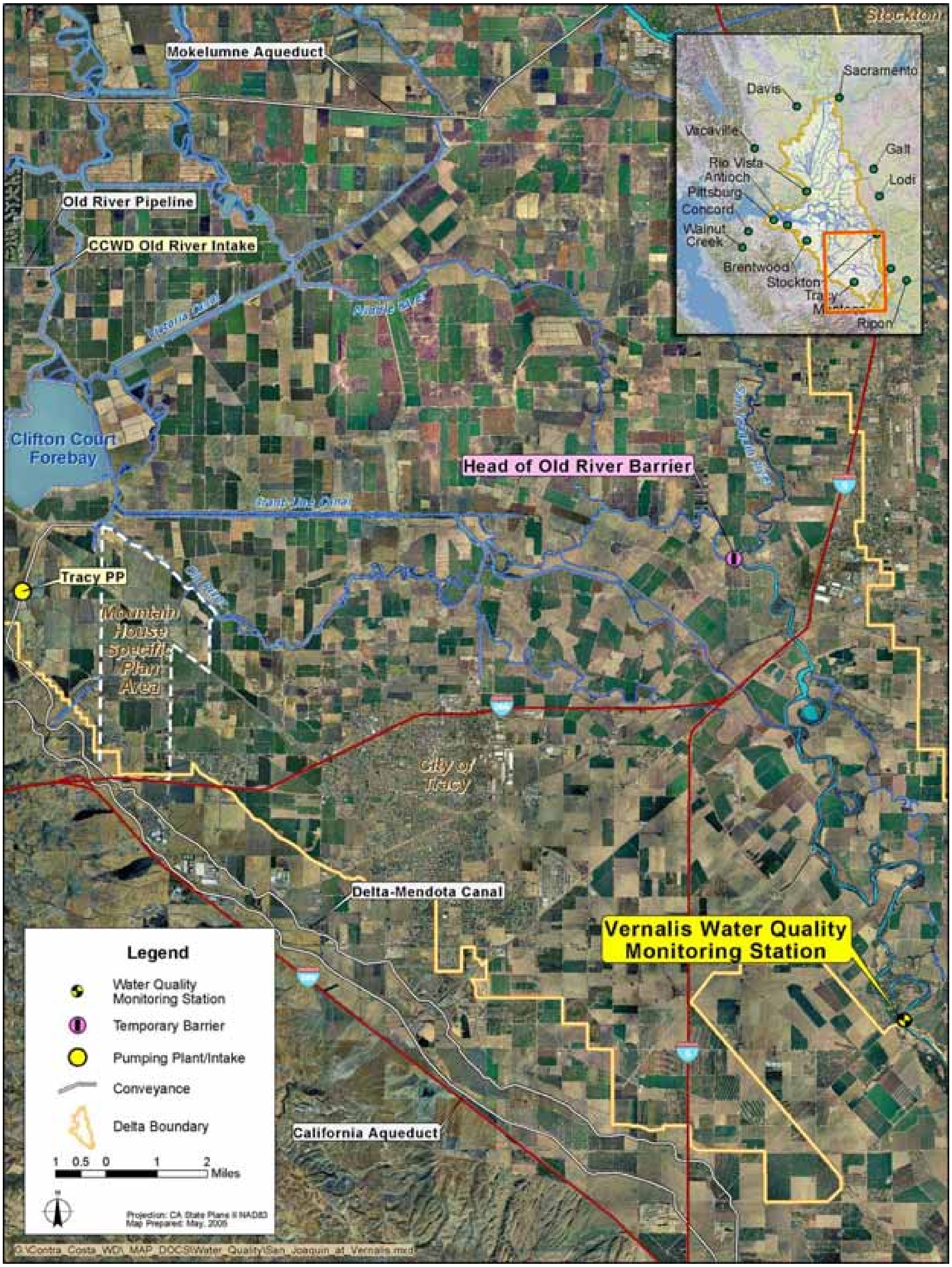

Figure 2-9 San Joaquin River at Vernalis

ASSESSMENT OF SOURCE WATER QUALITY

This section discusses existing water quality at M&I intakes for CCWD and NBA, and the COS proposed intake site under the Delta Water Supply Project (DWSP). Water quality is discussed in terms of bromide and DOC concentrations, based on water sampling data for the period from January 1992 to June 2004. The primary source of the water quality data is the DWR MWQI, which collects monthly grab samples for a wide range of constituents at a large number of locations throughout the Delta.

Results from the Delta Simulation Model 2 (DSM2) water quality modeling were used to identify the contributing sources of water at each intake site using a technique known as fingerprinting. Fingerprinting analysis was undertaken for water years 1980 to 1990. **Figure 2-10** shows the water year classification for this period based on the Sacramento Valley 40-30-30 index.[2] The period of 1980 to 1990 is characterized by 3 wet years in a row early in the period (1982 to 1984) and ends with a relatively dry period of 4 dry or critical years (1987 to 1990). This period therefore indicates the range of wetter and drier period responses of flows and water quality in the Delta.[3]

DELTA SIMULATION MODEL 2

DSM2 is a branched one-dimensional, physically based numerical model of the Delta, developed at DWR in the late 1990s. DSM2-Hydro, the hydrodynamics module, is derived from the 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 on model development is discussed in annual reports to the SWRCB. Key DSM2 inputs include tidal stage, boundary inflow and associated salinity concentration, and operation of flow control structures. DSM2 uses EC as a substitute for salinity.

A constituent fingerprinting technique has been developed for which a single simulation using DSM2 can be used to estimate the concentration of any conservative constituent at any specified time and location in the Delta. Transport of conservative tracer constituents is simulated to determine volume contributions from various sources. These volume contributions can then be used to determine the relative contributions of conservative constituent sources to the concentration at any specified location. This technique is illustrated in **Figure 2-11**. For this Management Plan, fingerprinting results are presented as contributions to total EC at a given location from each source.

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[2] The Sacramento Valley 40-30-30 index is defined in SWRCB D-1641 (page 188) as 40 percent of the current year's April to July Sacramento Valley unimpaired runoff, plus 30 percent of the current October to March Sacramento unimpaired runoff, plus 30 percent of the previous year's index. The final 30 percent takes into account any carryover storage from the previous water year (e.g., the CVP and SWP may still be able to meet higher Delta flow requirements and deliver more water in a drier year following a wet year because the reservoirs start off full.)

[3] The historical water year type as determined at the end of the water year is used in the figure. Decision 1641 requires that the Delta water quality objectives after May 1 is based on the official May 1 forecast, even if the water year conditions change after that date.

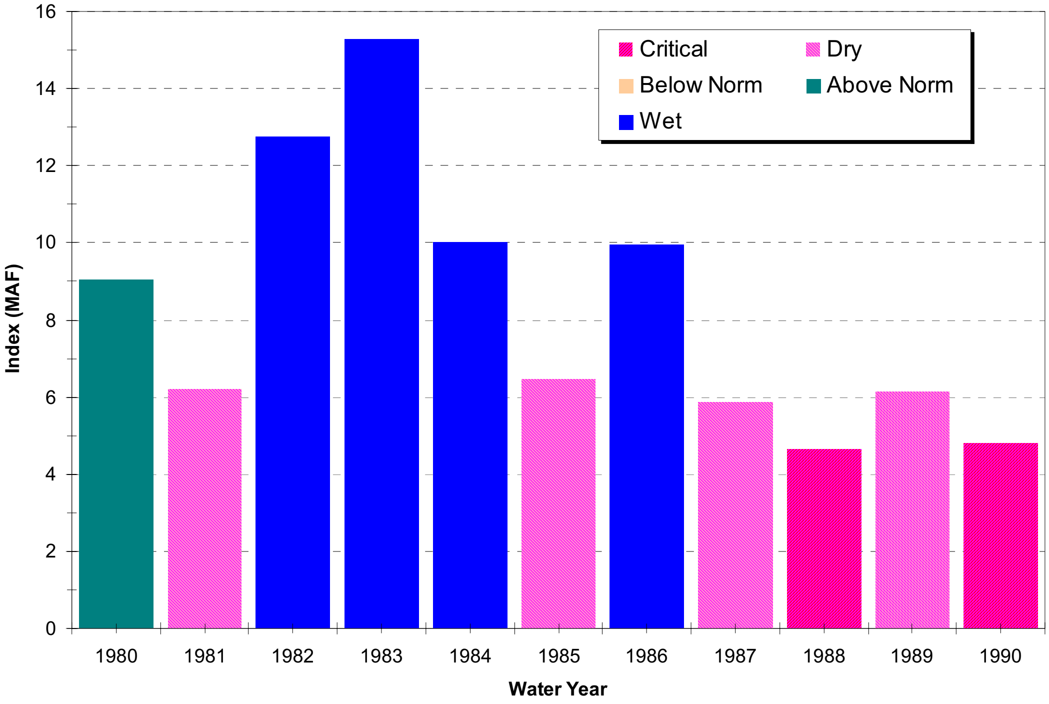


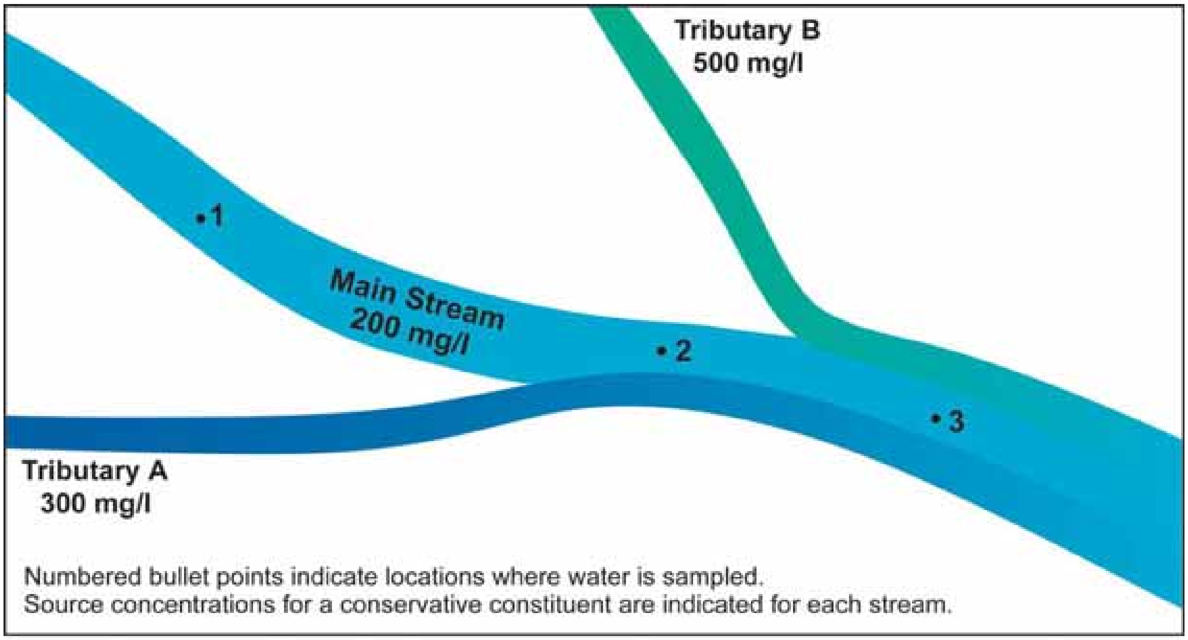
Figure 2-10 Water Year Classification 1980 to 1990

The Sacramento Valley Index is used to determine the annual water year classification.

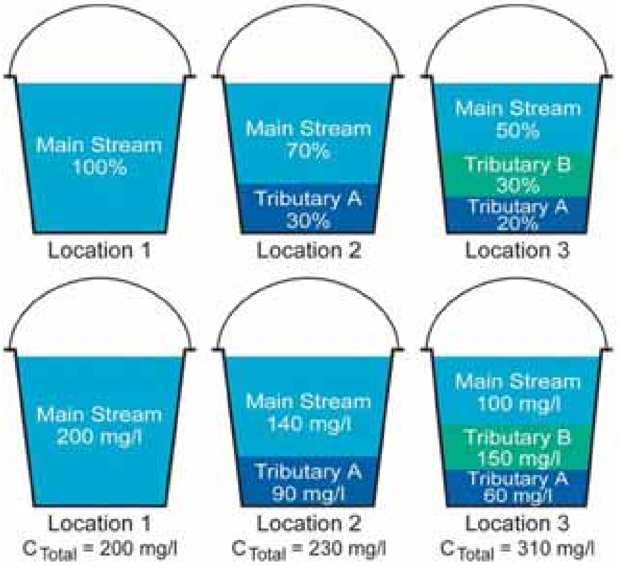
CONTRA COSTA WATER DISTRICT'S ROCK SLOUGH AND OLD RIVER INTAKES

In 1998, CCWD completed construction of the $450 million Los Vaqueros Project, which provided CCWD with a new intake on Old River near Highway 4 where water quality was better than the CCWD Rock Slough intake. The Los Vaqueros Project also included a new 100,000 acre-foot (AF) offstream reservoir to store water diverted from the Delta during periods of higher water quality, to be used for blending when Delta water quality was poor, primarily in the fall. CCWD also has a Delta intake at Mallard Slough near Chipps Island in Suisun Bay. However, this intake can be used only after periods of very high Delta outflow (about 40,000 cfs) when saltier water is pushed out of Suisun Bay and the water at the CCWD intake is 65 mg/L chlorides (about 200 µg/L bromide) or better.

CCWD's 100,000 AF Los Vaqueros Reservoir near Byron improves water quality and emergency water supply reliability for CCWD customers. The reservoir is typically filled in the spring and early summer when Delta water quality is good, and used to blend with Delta water in the fall when Delta water quality is typically poor. (Photo by Stephen Joseph)



Numbered bullet points indicate locations where water is sampled.
Source concentrations for a conservative constituent are indicated for each stream.



Source	% Volume, V%	Source Concentration, C (mg/l)	V%/100 x C (mg/l)
Location 1			
Main Stream	100	200	200
Tributary A	0	300	0
Tributary B	0	500	0
Total	*100*		***200***
Location 2			
Main Stream	70	200	140
Tributary A	30	300	90
Tributary B	0	500	0
Total	*100*		***230***
Location 3			
Main Stream	50	200	100
Tributary A	20	300	60
Tributary B	30	500	150
Total	*100*		***310***

Figure 2-11 Illustration of the Constituent Fingerprinting Analysis[5]

Fingerprinting is a technique that can be used to identify the relative contributions of different sources of water at M&I intakes at any specified time.

Figure 2-12 shows the variation of bromide and DOC concentration in monthly grab samples taken by the DWR MWQI at Contra Costa Canal Pumping Plant No. 1 and the CCWD Old River intake. Bromide concentrations are substantially above the CALFED goal of 50 µg/L (0.05 mg/L), and can be in excess of 750 µg/L. The organic carbon concentrations are typically well above the CALFED goal of 3.0 mg/L TOC.

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[5] Source: Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh, 23rd Annual Progress Report, June 2002, Chapter 14: DSM2 Fingerprinting Methodology, Department of Water Resources.

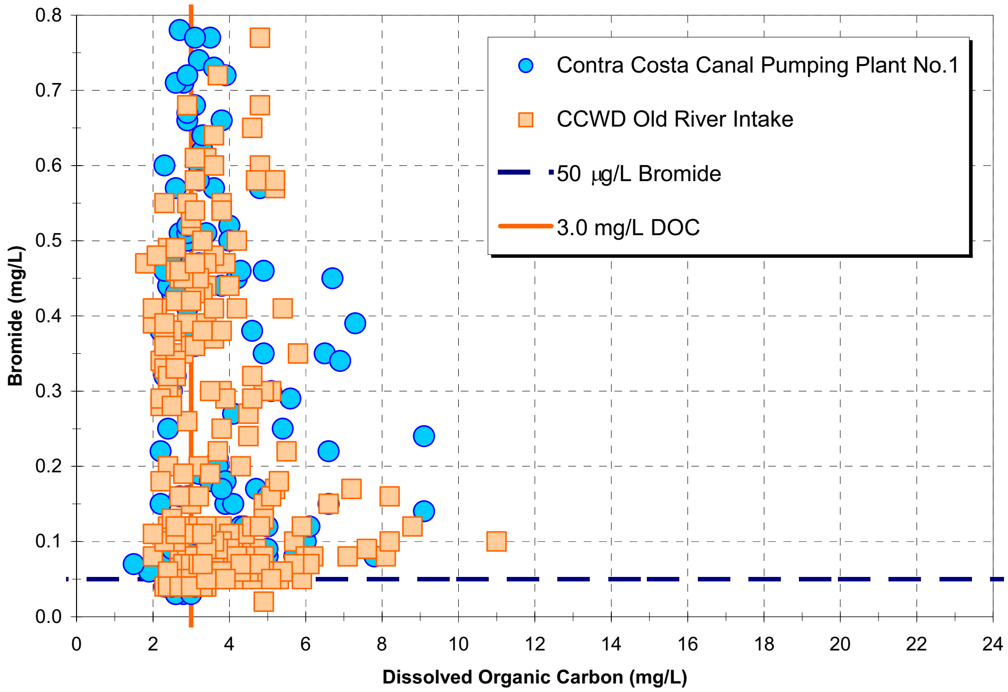

Figure 2-12 Monthly Grab Samples at Contra Costa Water District Rock Slough and Old River Intakes

These grab samples show very high bromides and organic carbon concentrations, above the 50 µg/L bromide and the 3.0 mg/ L TOC CALFED goals.

Figures 2-13 through **Figure 2-16** show variations with time of bromide and DOC at Contra Costa Canal Pumping Plant No. 1 and the CCWD Old River intake from January 1990 to December 1996. The highest DOC concentrations typically occur after the first storms following peak bromide concentrations in the fall.

Contra Costa Canal Pumping Plant No. 1 near Oakley

The 350 cfs pumping capacity is used to lift water out of the Delta. Groundwater seepage into the unlined canal just upstream of Pumping Plant No. 1 causes salinities to increase during periods of low diversions.

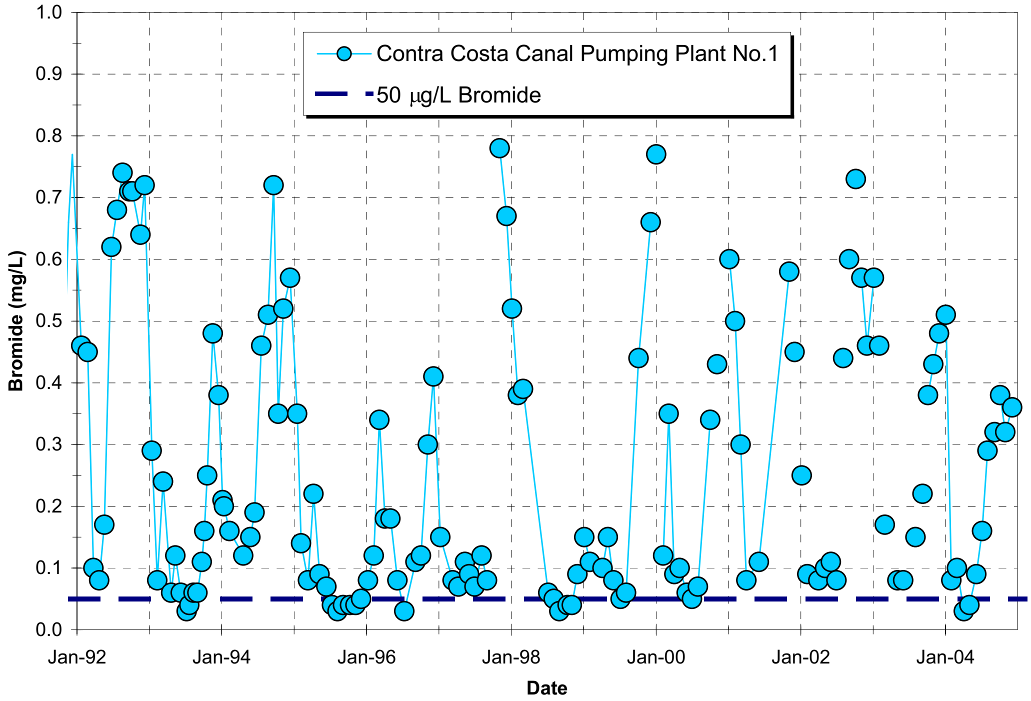

Figure 2-13 Bromide Concentrations at Contra Costa Canal Pumping Plant No. 1 (Rock Slough), January 1992 to June 2004

Bromide levels at Pumping Plant No. 1 are typically well above the CALFED goal of 50 µg/L.

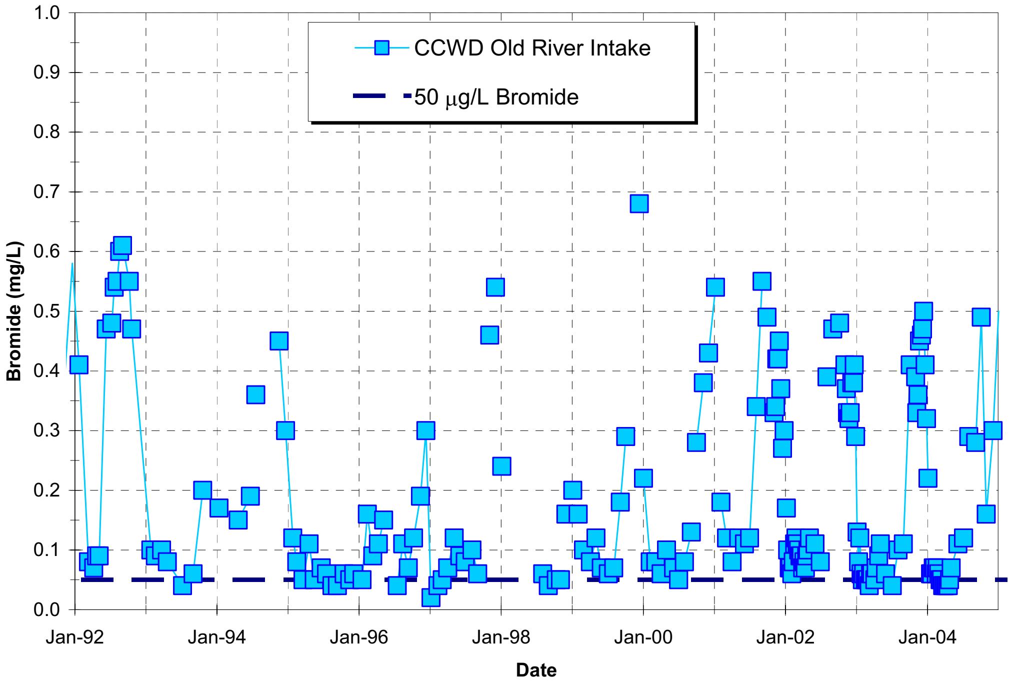

Figure 2-14 Bromide Concentrations at Old River Intake, January 1992 to June 2004

Bromide levels at the Old River intake are typically well above the CALFED goal of 50 µg/L.

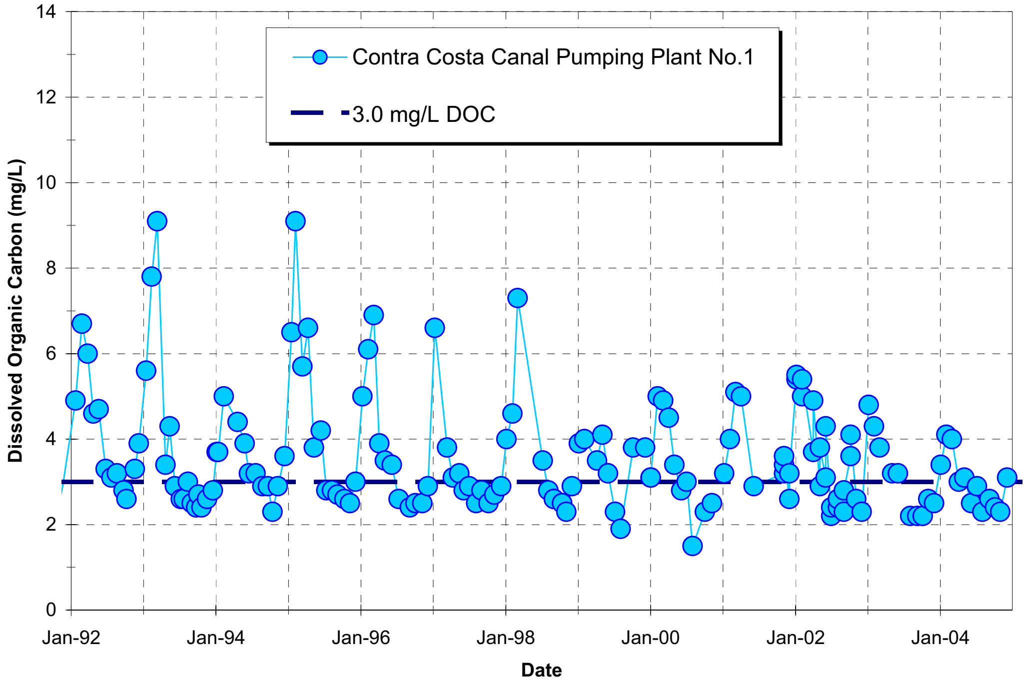

Figure 2-15 Dissolved Organic Carbon Concentrations at Contra Costa Canal Pumping Plant No. 1, January 1992 to June 2004

High dissolved organic carbon concentrations at Pumping Plant No. 1 typically occur in January and February of wetter year and are well in excess of the CALFED 3.0 mg/L goal.

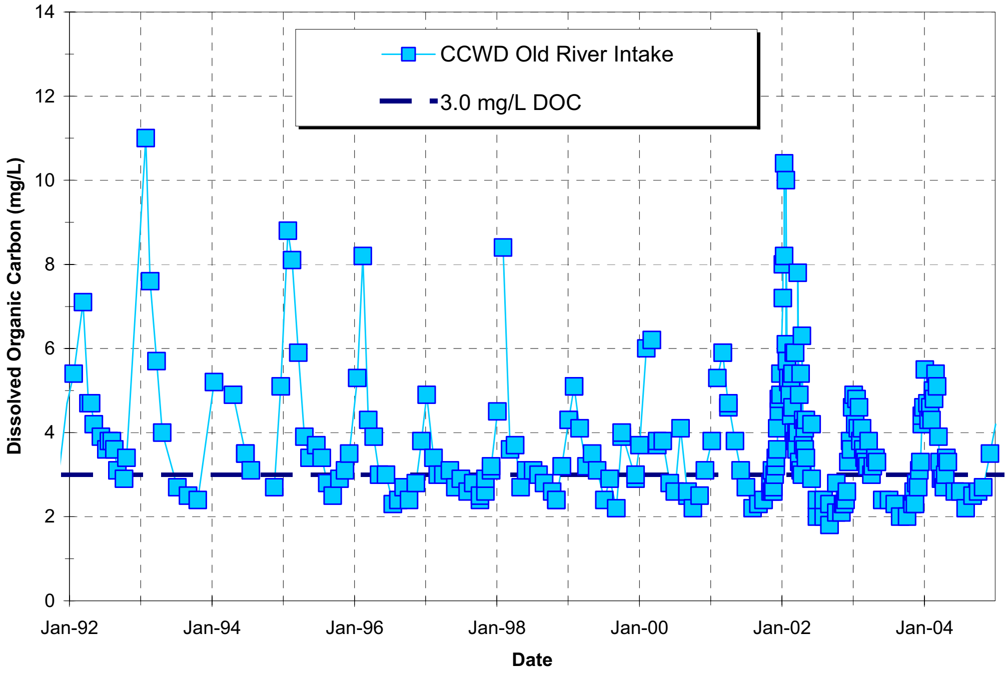

Figure 2-16 Dissolved Organic Carbon Concentrations at Contra Costa Water District Old River Intake, January 1992 to June 2004

High dissolved organic carbon concentrations at the Old River intake typically occur in January and February of wetter years and are well in excess of the CALFED 3.0 mg/L goal

Figure 2-17 shows key features within the vicinity of Rock Slough. Monthly samples taken by DWR's MWQI at multiple stations throughout the Delta can be used to illustrate the different constituents of drainage water compared to seawater. These differences can then be used as another method for identifying different sources of water at drinking water intakes at different times of the year. In general, for salty water with an EC above about 300 µS/cm, the chloride concentration will be higher if the source of salinity (EC) is seawater rather than agricultural drainage. Agricultural drainage contains many other salts that contribute to EC.

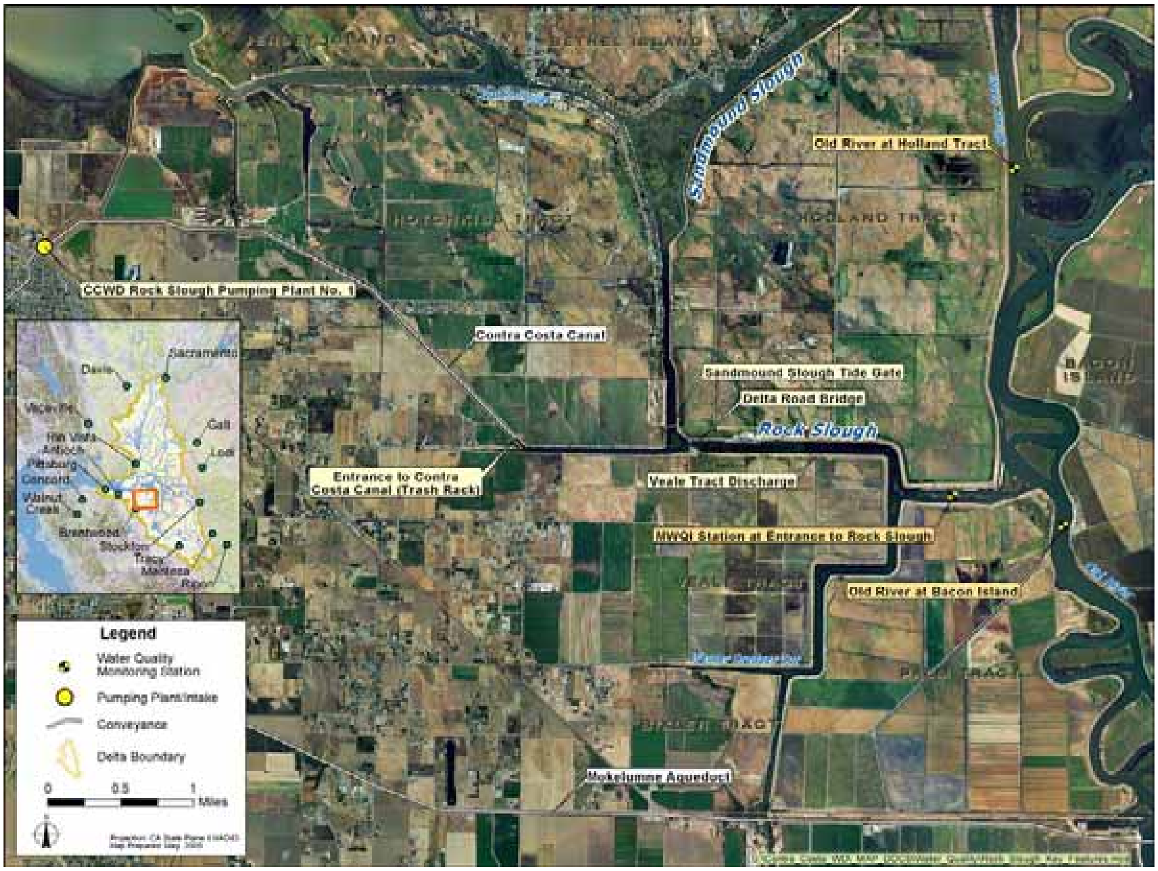

Figure 2-17 Rock Slough and Contra Costa Canal Pumping Plant No. 1

Figure 2-18 compares historical measurements of specific conductance (EC normalized to a temperature of 25 degrees Centigrade (ºC) and chloride concentration for three MWQI stations in the vicinity of Rock Slough: Contra Costa Canal Pumping Plant No. 1 (data from 1991-2005), a station just inside the entrance to Rock Slough off Old River (1983-1994), and Holland Tract on Old River north of the entrance to Rock Slough (1988-1994). The entrance to Rock Slough location is well east of the Veale Tract and its historical discharge point. This discharge does not appear to affect the water quality at the entrance to Rock Slough. The Holland Tract station, which is located on Old River north of Rock Slough is similarly unaffected by the local drainage that influences water quality at Pumping Plant No. 1.

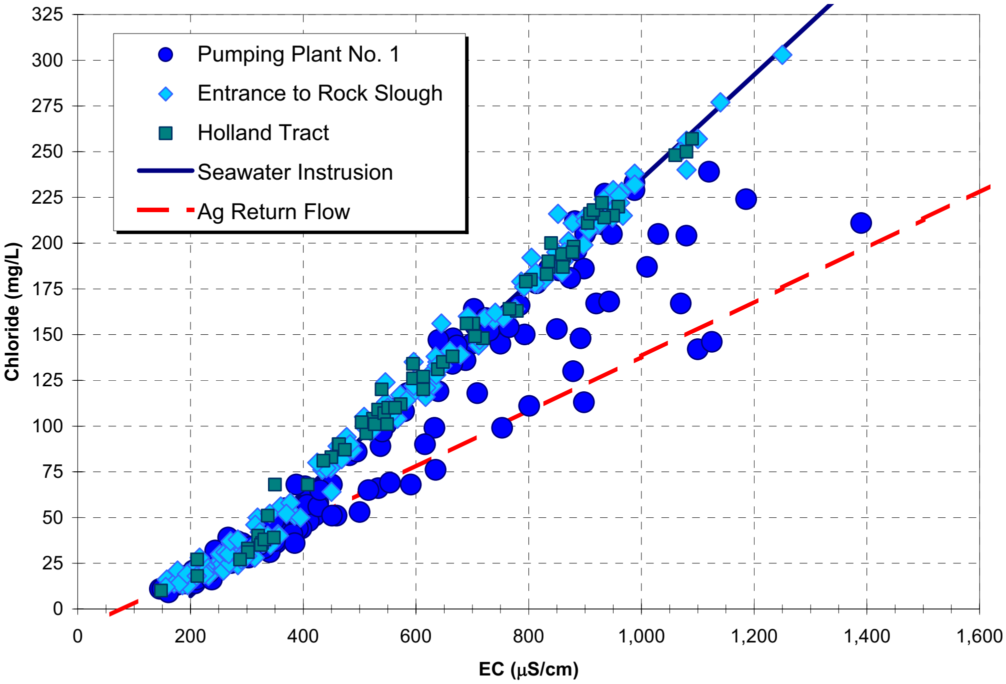

Figure 2-18 Monthly MWQI EC and Chloride Data at Contra Costa Canal Pumping Plant No. 1

The plot show months when the water diverted at Pumping Plant No. 1 is primarily from agricultural return flows. The corresponding data from the entrance to Rock Slough and from Holland Tract on Old River north of Rock Slough only show the effects of seawater intrusion. The entrance to Rock Slough location is well east of the Veale Tract discharge and does not appear to be influenced by that discharge.

The Veale Tract Water Quality Improvement Project, funded by CALFED, will eliminate the impacts of Veale Tract discharge on Pumping Plant No. 1 water quality. This project relocates the discharge point to the southern end of Veale Tract, on Indian Slough.

Figure 2-19 shows the variation of DOC and bromide concentrations in monthly grab samples for CCWD's proposed alternative intake at Victoria Canal. **Figure 2-20** compares chloride concentrations at the existing intake on the Old River to the proposed alternative intake. Chloride concentrations are significantly reduced relative to those at the CCWD Old River intake. The CCWD Alternative Intake Project is discussed in more detail in **Chapter 4** and on the Web site at http://www.ccwater-alternativeintake.com/.

Figure 2-21 shows results from a DSM2 fingerprinting analysis of water in Rock Slough for water years 1981 to 1990. Sources of EC in the vicinity of Rock Slough include seawater intrusion, San Joaquin River water, Sacramento River water, agricultural drainage, and inflow from the eastside streams. The Sacramento River provides an approximately constant contribution of about 150 µS/cm, except in spring 1982, 1983, 1984, and 1986. In those years, all classified as wet years, San Joaquin River inflow was high and San Joaquin salinity and salinity from agricultural discharges dominated. Seawater intrusion is the major source of salinity during periods of low Delta outflow (i.e., primarily in the fall of all but the wettest years).

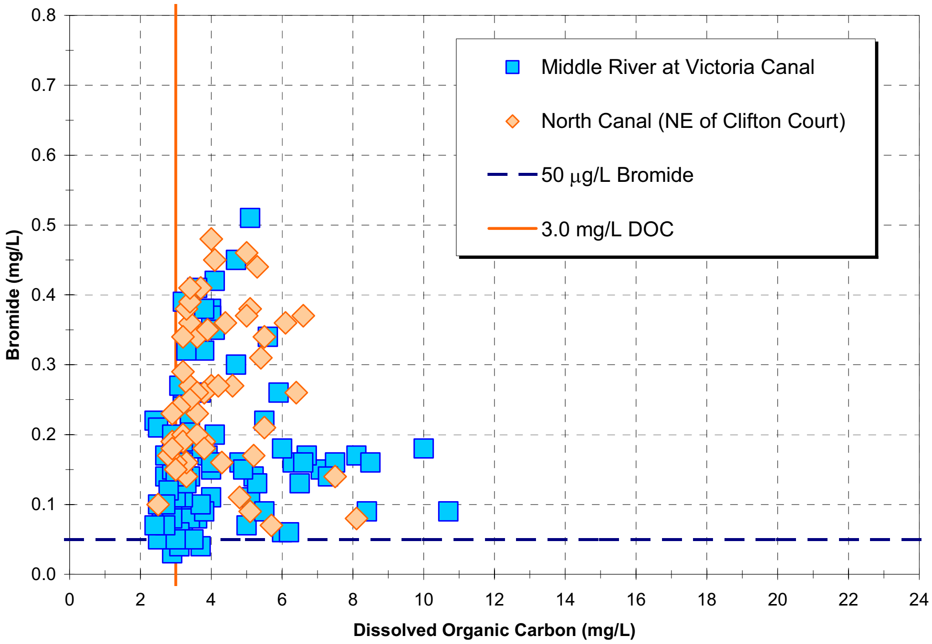

Figure 2-19 Dissolved Organic Carbon and Bromide Concentration in Monthly Grab Samples in Victoria Canal

Victoria Canal is one potential location for the CCWD Alternative Intake Project. Bromide concentrations are much lower than at the CCWD Old River intake (compare to Figure 2-12).

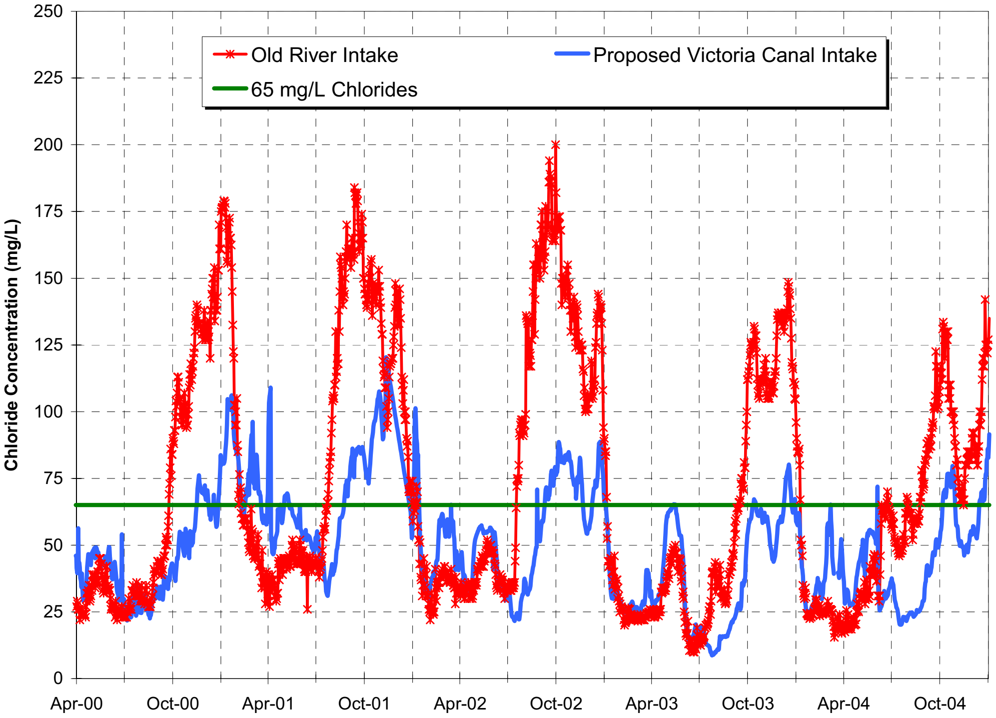

Figure 2-20 Comparison of Chloride Concentration at CCWD Old River Intake and Victoria Canal, April 2000 to December 2004

Chloride concentrations at CCWD's proposed new intake on Victoria Canal are typically lower than at the Old River intake in summer, fall, and early winter during periods of low Delta outflow.

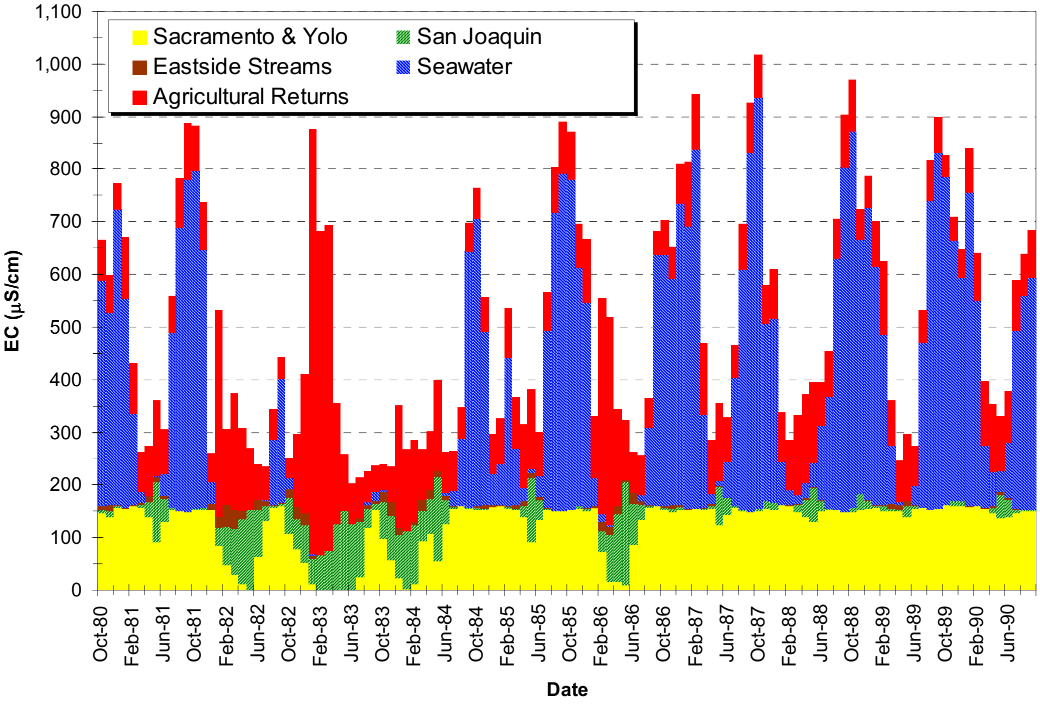

Figure 2-21 Sources of Electrical Conductivity at Contra Costa Water District Rock Slough Intake (water quality model fingerprinting, water years 1981 to 1990)

During periods of low Delta outflow in the summer and fall, seawater intrusion is the major source of salinity. During wetter months, agricultural runoff is the dominant source of salinity.

Note the large agricultural runoff contribution at Rock Slough in 1982, which results in a maximum EC of about 880 µS/cm. This is equivalent to a chloride concentration of about 120 mg/L (using the relationship between EC and chloride for agricultural return flows). Large peaks in salinity have been measured historically at the CCWD Rock Slough intake when local farmers pump off their islands after large storms. Actual chloride concentrations during early 1982 at CCWD's Pumping Plant No. 1 reached a peak of 144 mg/L on January 20, 1982, and another peak of 152 mg/L chloride on April 23, 1982, even though no contribution occurred from seawater intrusion.

Figure 2-22 shows similar results for CCWD's Old River intake near Highway 4 for water years 1981 to 1990. There is less seawater intrusion at this intake because its is further from the ocean than Rock Slough but more San Joaquin River water reaches the Old River. The contribution from agricultural runoff at the Old River intake in the winter of 1982 is dramatically less than at Rock Slough.

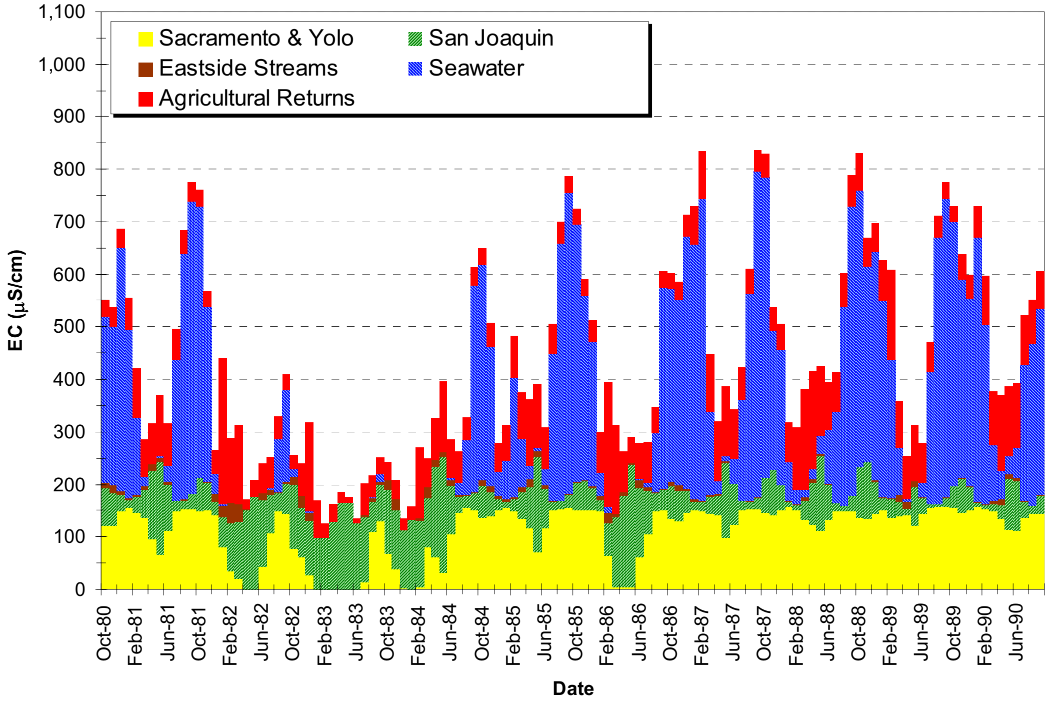

Figure 2-22 Sources of Electrical Conductivity at Contra Costa Water District Old River Intake (water quality model fingerprinting, water years 1981 to 1990)

Compared to Rock Slough the San Joaquin River plays a more important role in determining the salinity at the Old River intake and the role of agricultural runoff is reduced.

CCWD is currently studying an alternative intake location in the central Delta, possibly on Victoria Canal. As shown in **Figure 2-19**, this location has lower bromide concentrations than the CCWD Old River intake. The new intake would allow CCWD to fill Los Vaqueros Reservoir with higher quality water for longer periods of time than are currently possible with the Old River intake. The new intake also would reduce CCWD's need to blend reservoir water to meet its 65 mg/L delivered chloride goal (about 200 μg/L bromide), making the available blending water in Los Vaqueros reservoir last longer in the fall. **Figure 2-20** similarly shows how chloride concentrations on Victoria Canal are typically much lower than Old River intake chlorides.

SOLANO COUNTY WATER AGENCY DRINKING WATER INTAKE AT BARKER SLOUGH (NORTH BAY AQUEDUCT)

The location of the Barker Slough intake is shown in **Figure 2-23**. **Figure 2-24** illustrates the variation of bromide and DOC concentrations in monthly grab samples taken by the DWR MWQI in the vicinity of Barker Slough. Although bromide concentrations remain low and are close to the CALFED goal of 50 μg/L, the organic carbon concentrations are typically well above the CALFED goal of 3.0 mg/L TOC.

Figures 2-25 and **2-26** show variations with time of bromide and DOC in the vicinity of Barker Slough from January 1990 to December 1996. The periods of highest organic carbon occur primarily in winter months and coincide with periods of high runoff from the surrounding watershed.

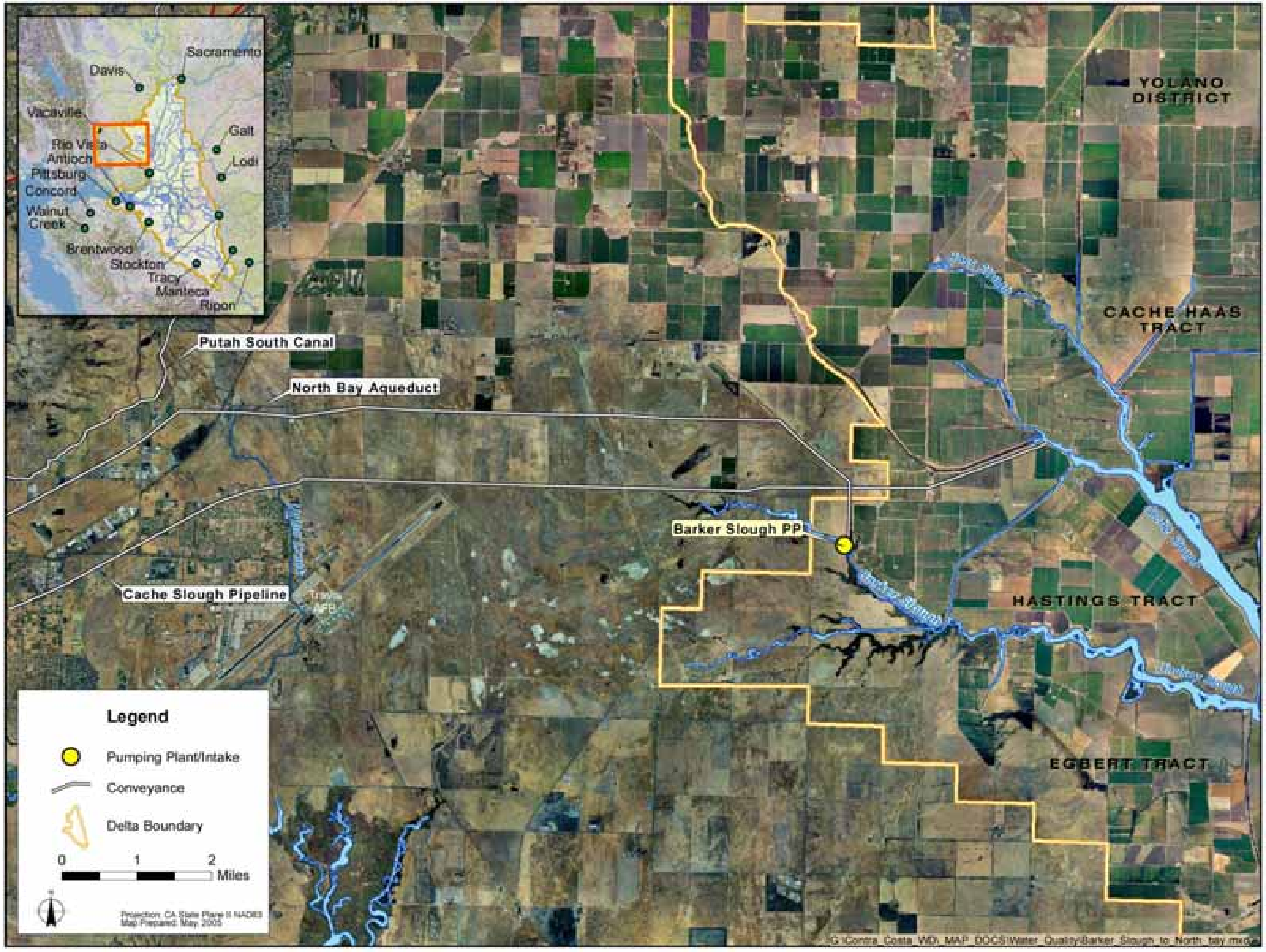

Figure 2-23 Barker Slough Pumping Plant, Intake for North Bay Aqueduct Supplies

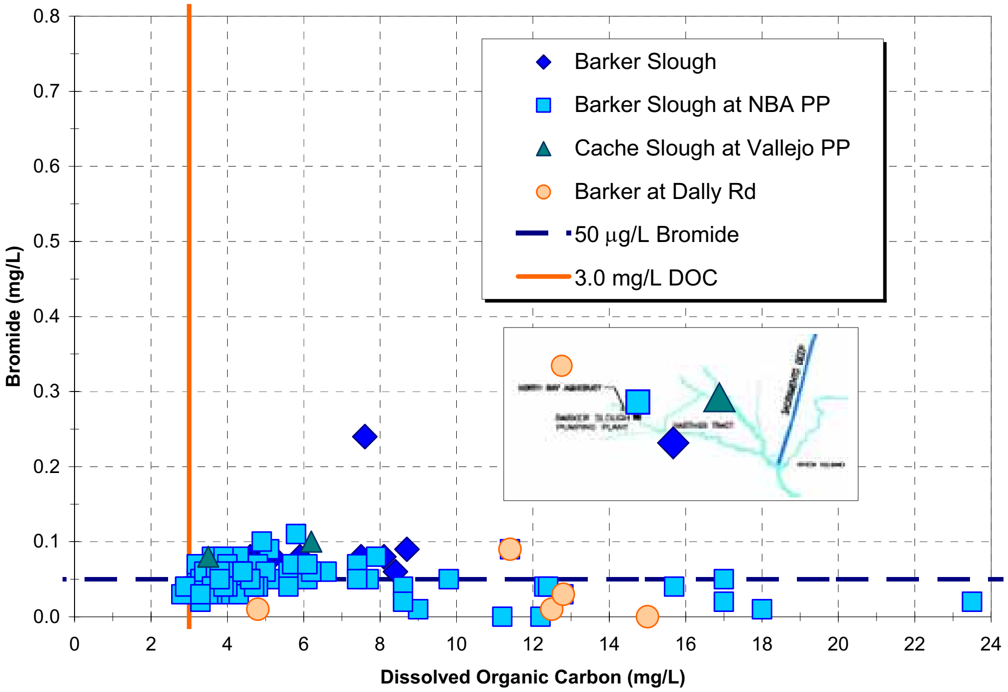

Figure 2-24 Dissolved Organic Carbon and Bromide Concentrations in Monthly Grab Samples Taken Near Barker Slough

Although bromide concentrations remain low and are close to the CALFED goal of 50 µg/L, organic carbon concentrations are typically well above the CALFED goal of 3.0 mg/L TOC.

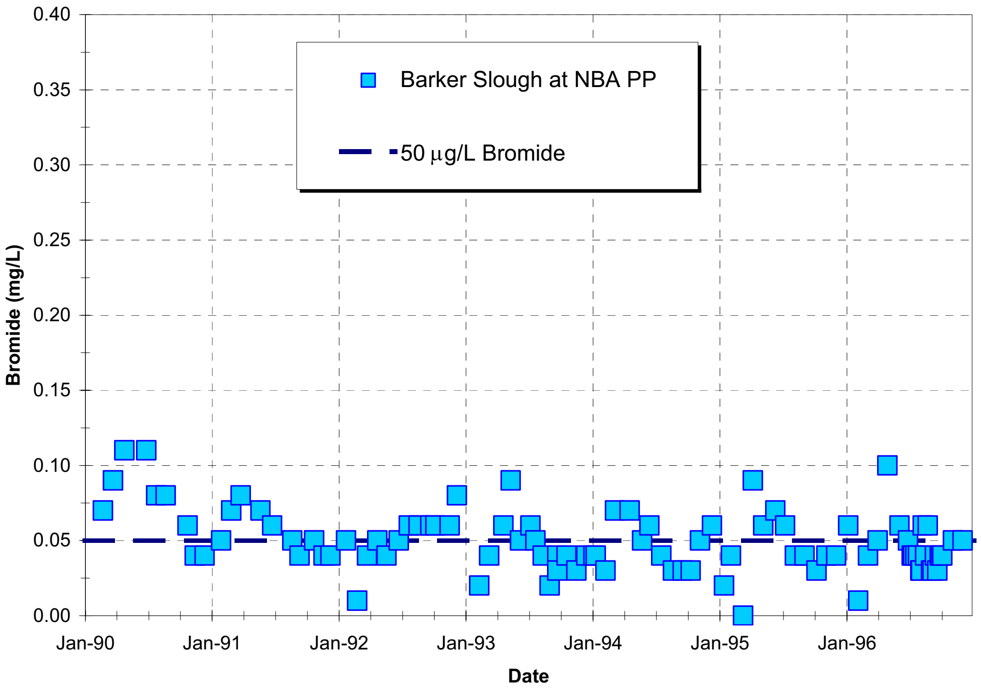

Figure 2-25 Bromide Concentrations at Barker Slough, 1990 to 1996

Bromide concentration at Barker Slough varies seasonally.

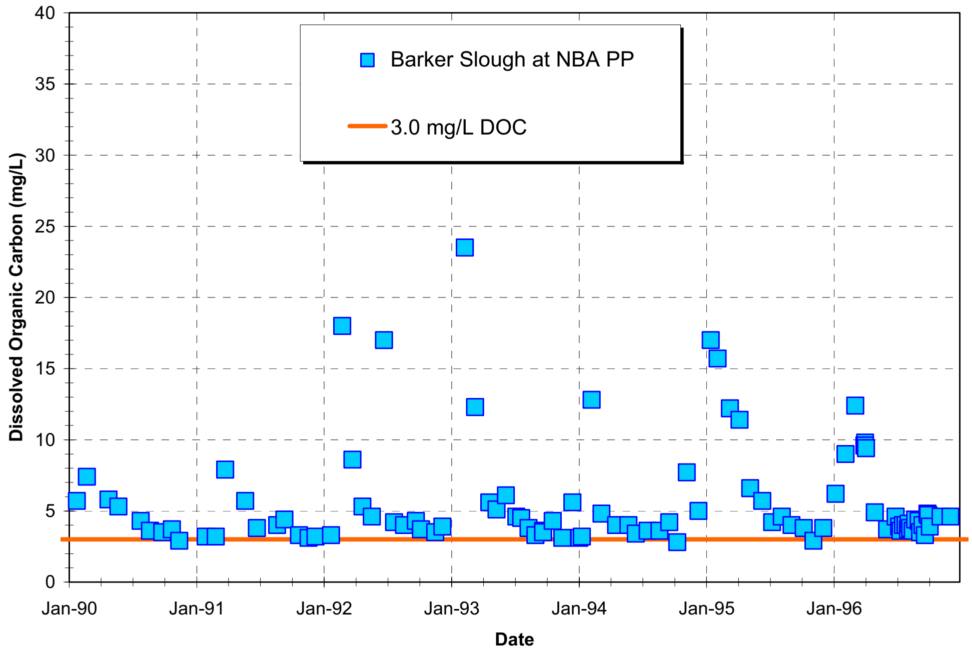

Figure 2-26 Dissolved Organic Carbon at Barker Slough, January 1991 to December 1996

The periods of highest organic carbon occur primarily in winter months and coincide with periods of high runoff from the surrounding watershed.

EC data from the DWR California Data Exchange Center (CDEC) also can be used to determine whether a strong relationship exists between Sacramento River water quality near Barker and Lindsey sloughs and the quality of water diverted into the NBA. **Figure 2-27** shows Barker Slough EC for 2003 to 2005 compared to EC at Rio Vista downstream of Barker Slough on the Sacramento River. Variations in EC at Barker Slough are independent of Rio Vista EC, confirming previous findings by SCWA that local agricultural runoff rather than seawater intrusion is the primary source of this salinity. The highest EC at Barker Slough during this time was about 600 µS/cm, which in this location is about 50 mg/L chloride and 100 µg/L bromide.

Figures 2-28 and **2-29** show additional evidence that local agricultural drainage is the key determinant of water quality of Barker Slough. **Figure 2-28** illustrates the relationship between chloride concentration and EC for waters in Barker Slough and Cache Slough. This relationship is closer to San Joaquin agricultural return flows than seawater intrusion.

Figure 2-29 shows the relationship between chloride concentration and EC for the Sacramento River at Greens Landing. The chloride concentration is consistently less than 20 mg/L. The variation of chloride concentration with EC suggests that seawater intrusion is not a major factor at this location, far upstream on the Sacramento River.

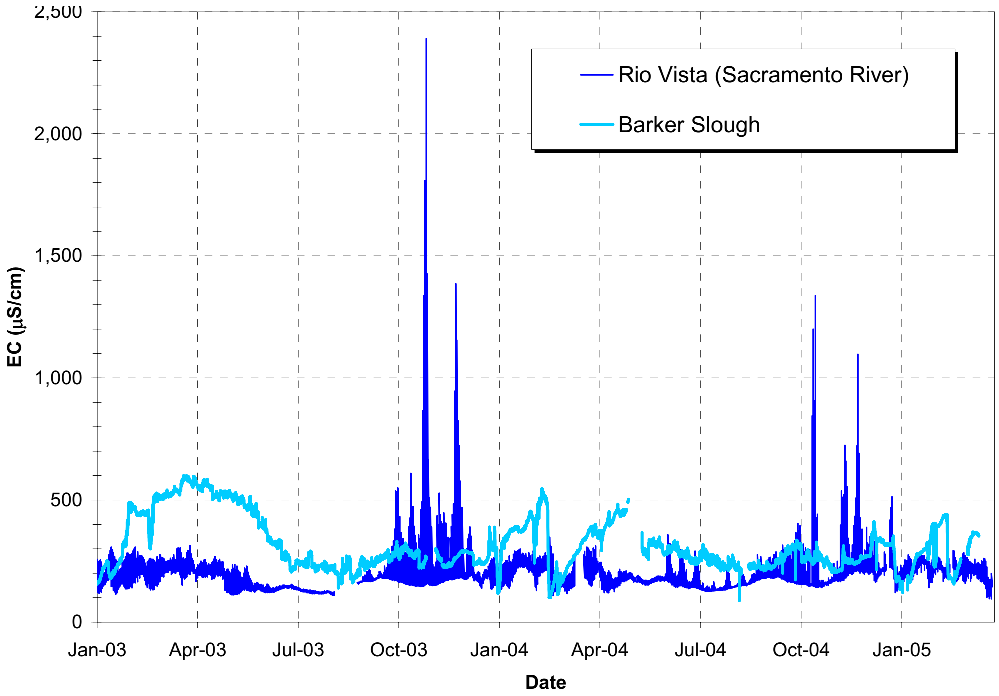

Figure 2-27 Comparison of Electrical Conductivity at Barker Slough Pumping Plant and at Rio Vista, January 2003 to March 2005

Electrical conductivity at Barker Slough Pumping Plant, the intake for the North Bay Aqueduct, often indicates higher salinities than at Rio Vista on the Sacramento River. This suggests that the source of salinity is from the local watershed rather than the river.

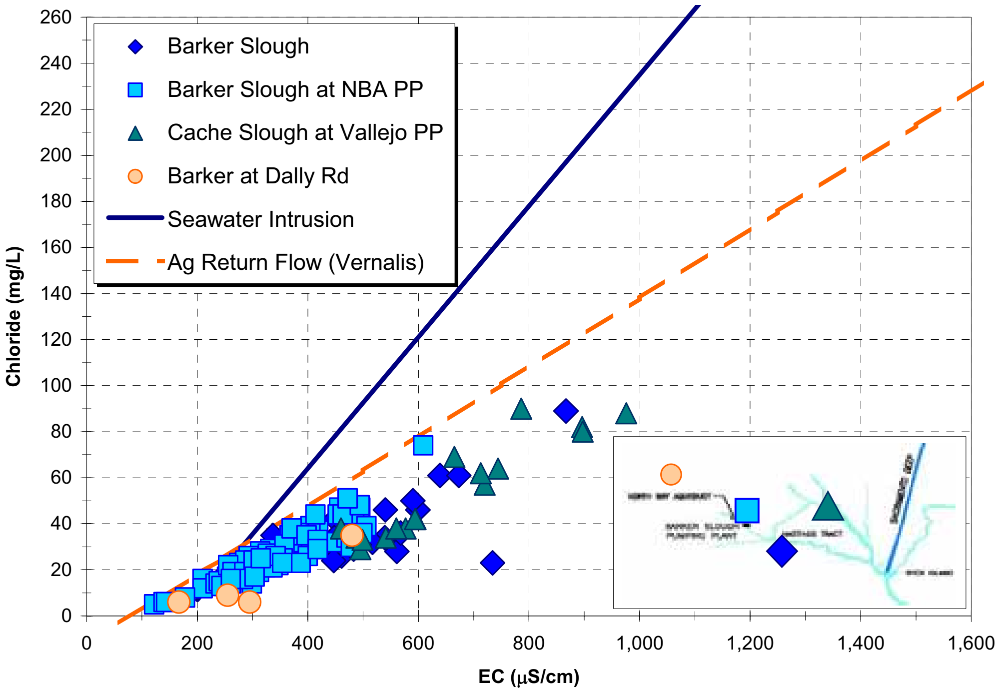

Figure 2-28 Variation of Chloride Concentration with Electrical Conductivity for Barker Slough and Cache Slough

The data depict a much lower chlorides-to-EC relationship than observed in the south and central Delta.

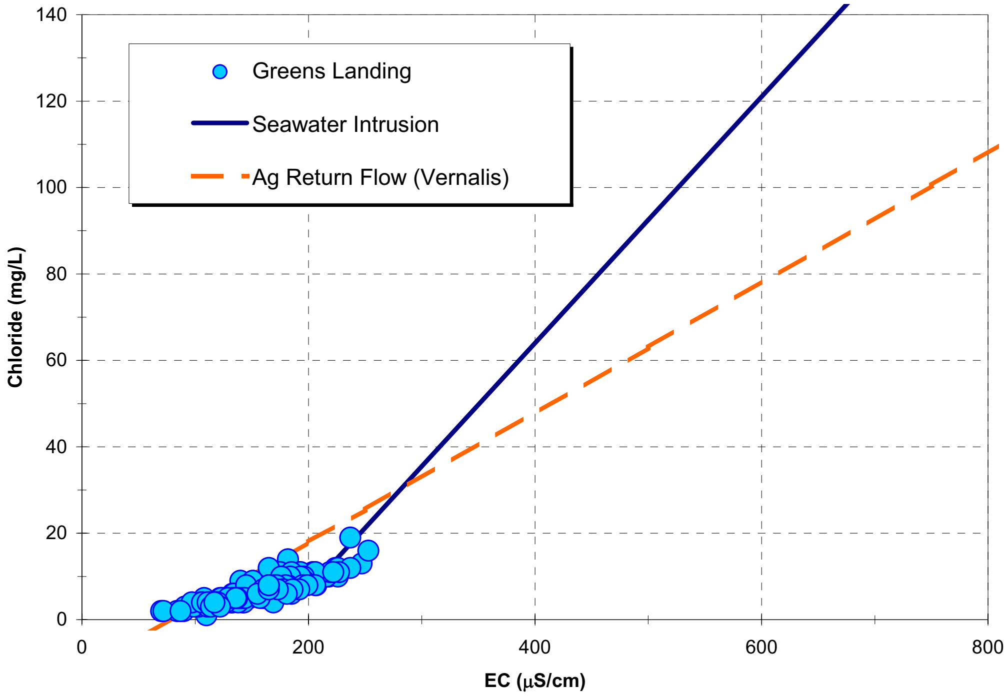

Figure 2-29 Variation of Chloride Concentrations with Electrical Conductivity for the Sacramento River at Greens Landing

Chloride concentration at Greens Landing, near SCWA's proposed Courtland alternate intake location, is consistently less than 20 mg/L. The variation of chloride concentration with EC suggests that seawater intrusion is not a major factor at these locations.

Figure 2-30 and **Figure 2-31** show results from a DSM2 fingerprinting analysis for water years 1981 to 1990. The source of EC at Barker Slough is a mixture of agricultural return flows and the Sacramento River. The Sacramento River provides an approximately constant contribution of about 150 µS/cm, except in spring 1982, 1983, and 1986. Those years are classified as wet years, when runoff from agricultural land dominated, and EC peaked at over 600 µS/cm. The contribution of agricultural drainage to EC typically falls from March to November. This suggests again that the primary contribution to salinity and EC is runoff rather than irrigation return flows.

Figure 2-31 shows that as much as 90 percent of the water diverted at the Barker Slough intake and used by SCWA typically comes from the Sacramento River. However, during wet months, such as April 1983, as much as 85 percent may come from local agricultural runoff.

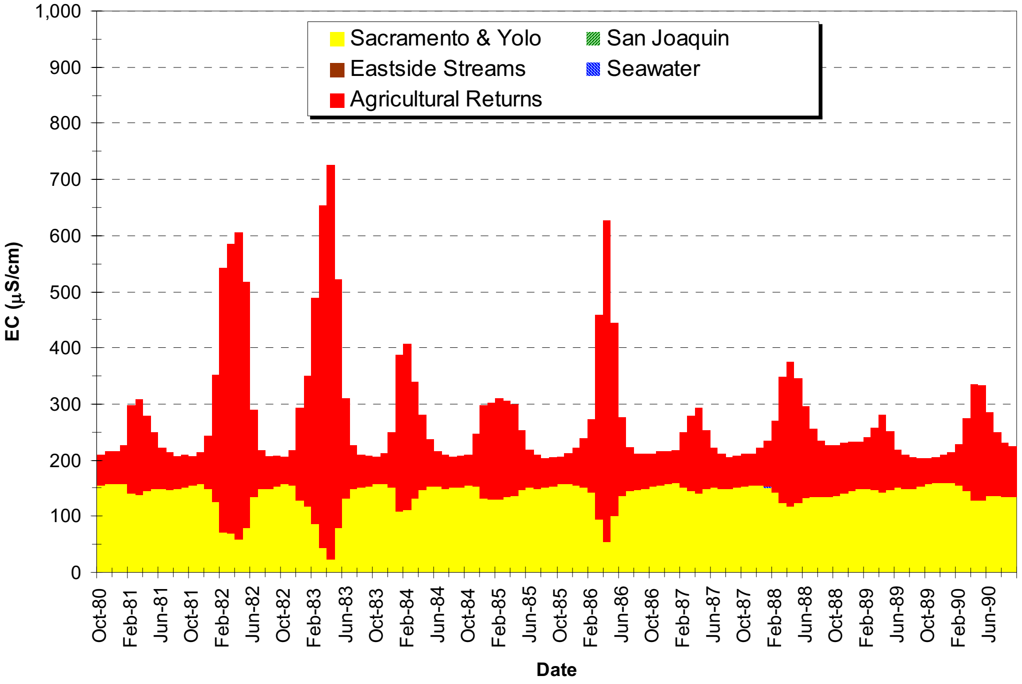

Figure 2-30 Fingerprinting Analysis of Barker Slough Electrical Conductivity, Water Years 1981 to 1990

The data suggest that local agricultural return flows are a major source of salinity at this location.

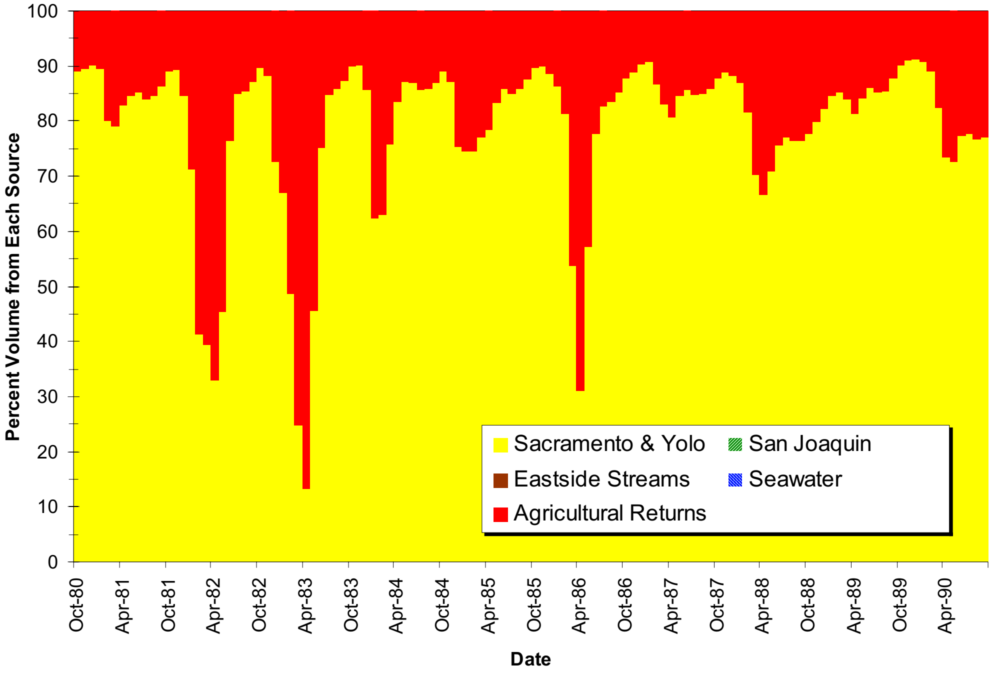

Figure 2-31 Model Simulation of Volumetric Relationship of Source Water at Barker Slough Intake

Model simulation suggests that as much as 90 percent of the water diverted at the Barker Slough intake and used by SCWA typically comes from the Sacramento River. However, during wet months, such as April 1983, as much as 85 percent may come from local agricultural runoff.

CITY OF STOCKTON PROPOSED DRINKING WATER INTAKE ON THE SAN JOAQUIN RIVER NEAR EMPIRE TRACT

COS is currently studying the best location for a new municipal intake in the eastern Delta north of Stockton. The location of this proposed new intake needs to be as far north as possible to avoid diverting poorer quality San Joaquin River water, and to avoid the areas on the San Joaquin River that suffer from poor circulation and low dissolved oxygen. The proposed location near Empire Tract is far enough north to provide access to Sacramento River water, particularly Sacramento River water entering the central Delta through Georgiana Slough and the Delta Cross Channel. The location of the COS proposed Delta intake is shown in **Figure 2-32**.

Figure 2-33 shows the variation of bromide and DOC concentrations in monthly grab samples taken by the DWR MWQI at Honker Cut at the Atherton Road Bridge, and Little Connection Slough (see **Figure 2-32** for location). The bromide concentrations are low compared to the CCWD intakes but in many cases are above the CALFED goal of 50 µg/L, and up to 170 µg/L. In many cases the organic carbon concentrations are well above the CALFED goal of 3.0 mg/L TOC.

Figure 2-34 shows the relationship between chloride concentration and EC at Honker Cut and Little Connection Slough. Insufficient data exist for high EC to determine whether water from Honker Cut and Little Connection Slough has a similar chloride-to-EC relationship to seawater or San Joaquin agricultural return flows.

Figure 2-35 shows results from a DSM2 fingerprinting analysis for water years 1981 to 1990. Sources of EC in the vicinity of Empire Tract include seawater intrusion, San Joaquin River water, Sacramento River water, agricultural drainage, and inflow from the eastside streams. Except in wet years, the Sacramento River contributes roughly half of the EC. In wet years, the contribution to EC from the San Joaquin River is dominant. Similarly, an eastside stream contribution to EC only occurs in the winter and spring of wet years. Seawater intrusion is only significant in dry years. The impact of agricultural return flows is evident in all years.

Northern entrance to Georgiana Slough off the Sacramento River.

Flow of Sacramento River water through Georgiana Slough, combined with flow through the Delta Cross Channel, helps control water quality in the central and south Delta.

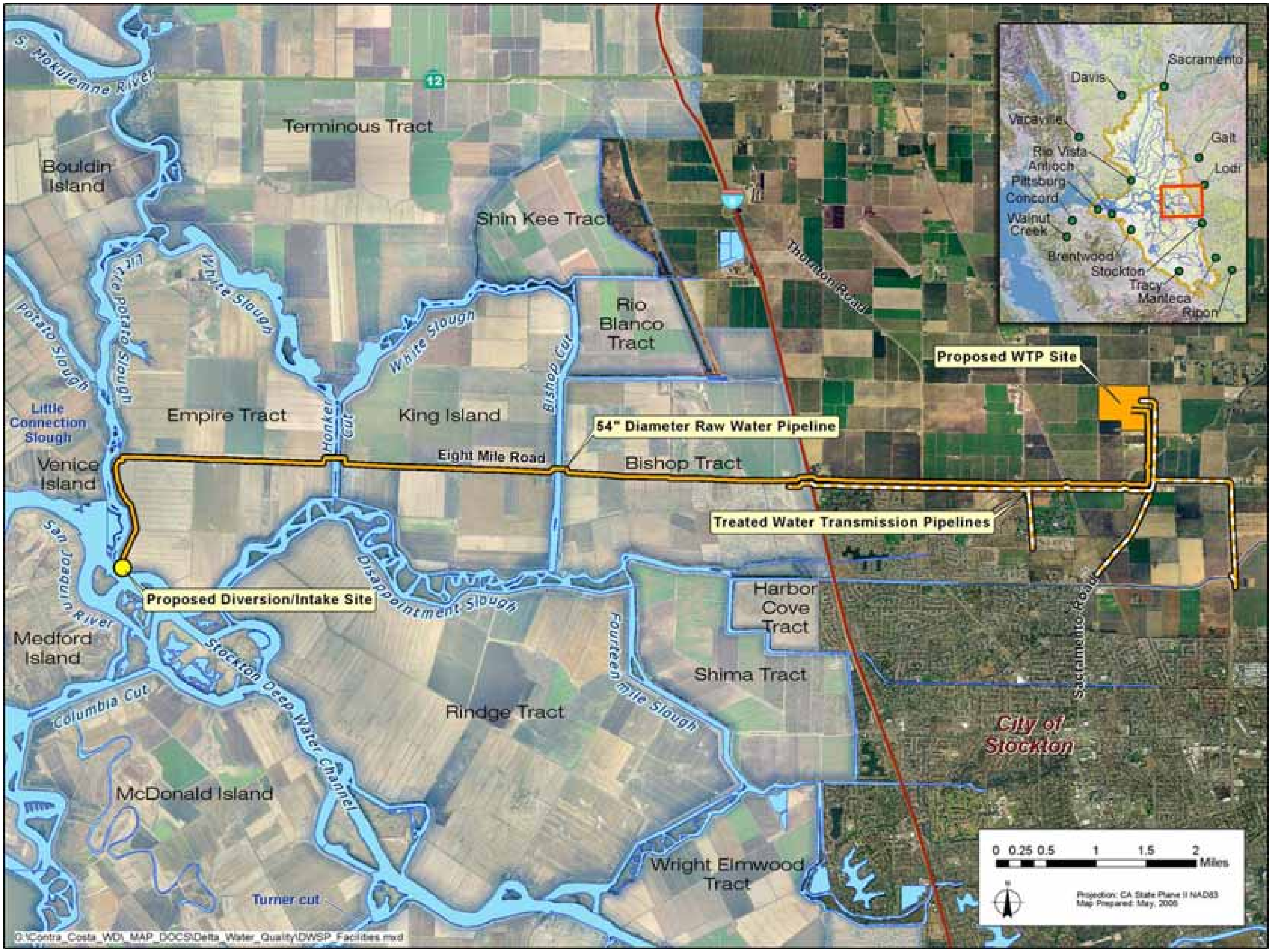

Figure 2-32 Location of Proposed City of Stockton Delta Intake as Part of the Delta Water Supply Project

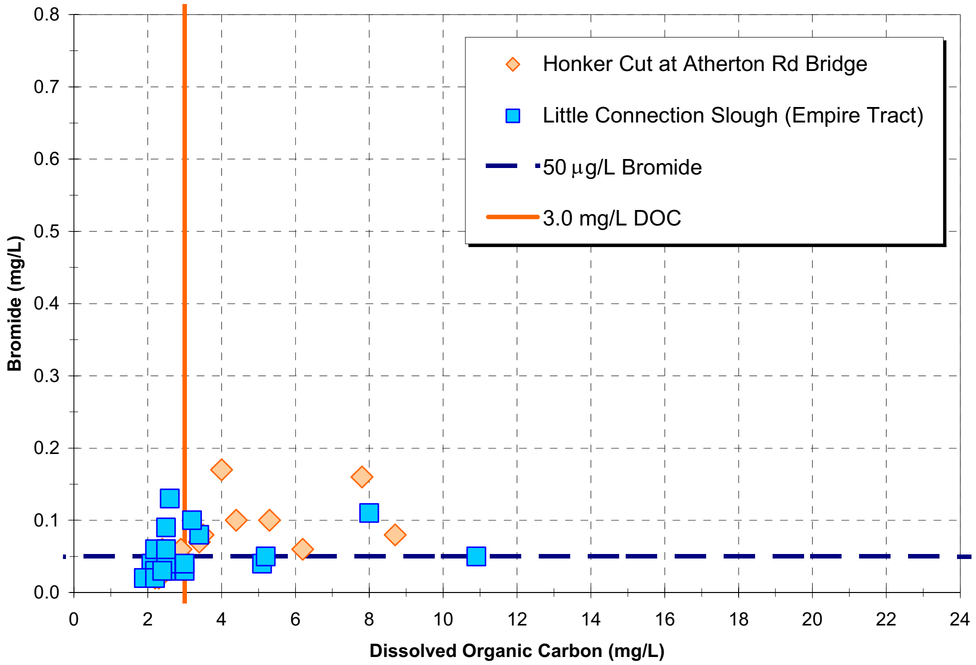

Figure 2-33 Dissolved Organic Carbon and Bromide Concentrations in Monthly Grab Samples from Honker Cut and Little Connection Slough

Bromide and organic carbon concentrations in the vicinity of the City of Stockton's proposed Delta intake often are above the CALFED goals of 50 µg/L and 3.0 mg/L TOC.

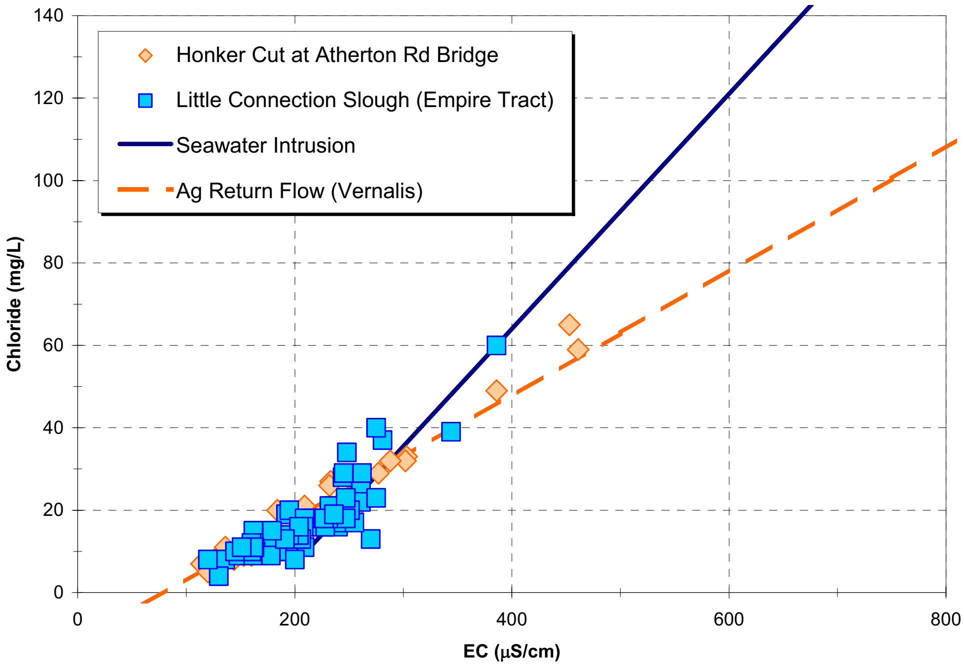

Figure 2-34 Variation of Chloride Concentrations with Electrical Conductivity for Honker Cut and Little Connection Slough

Insufficient data exist to determine whether the source of chloride in the vicinity of the City of Stockton's proposed Delta intake is seawater intrusion or San Joaquin agricultural return flows

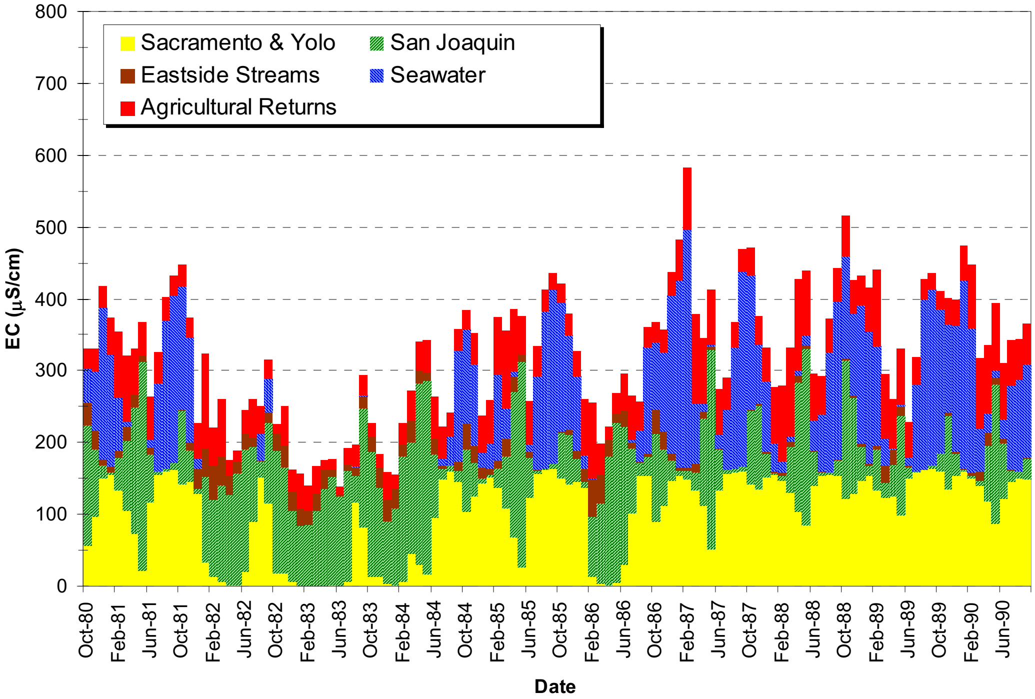

Figure 2-35 Fingerprinting Analysis of Electrical Conductivity at Empire Tract, Water Years 1981 to 1990

Model simulations show that in wet years during periods of high runoff, the San Joaquin River is the principal contributor to EC, although EC is relatively low. In dry years, under low flow conditions, when EC is high, the Sacramento River and seawater intrusion are the main sources of EC.

Figure 2-36 shows the effect of closing the Delta Cross Channel on water quality in the vicinity of the proposed new COS DWSP intake. These historical data were obtained from the DWR CDEC database from December 2004 through January 2005. Closure of the Delta Cross Channel in early December 2004 reduced the supply of Sacramento River flow into this area and caused salinities at Prisoner's Point and San Andreas Landing to increase by a relatively small amount initially. However, later in December, when Delta outflow dropped to 3,000 cfs and exports were maintained at 10,000 cfs, EC increased dramatically. The Delta Cross Channel was opened briefly near the end of December but a large storm runoff occurred immediately after increasing Delta outflow, which drove down salinity. Without this large storm, EC at Prisoner's Point could have continued to increase beyond what was actually measured.

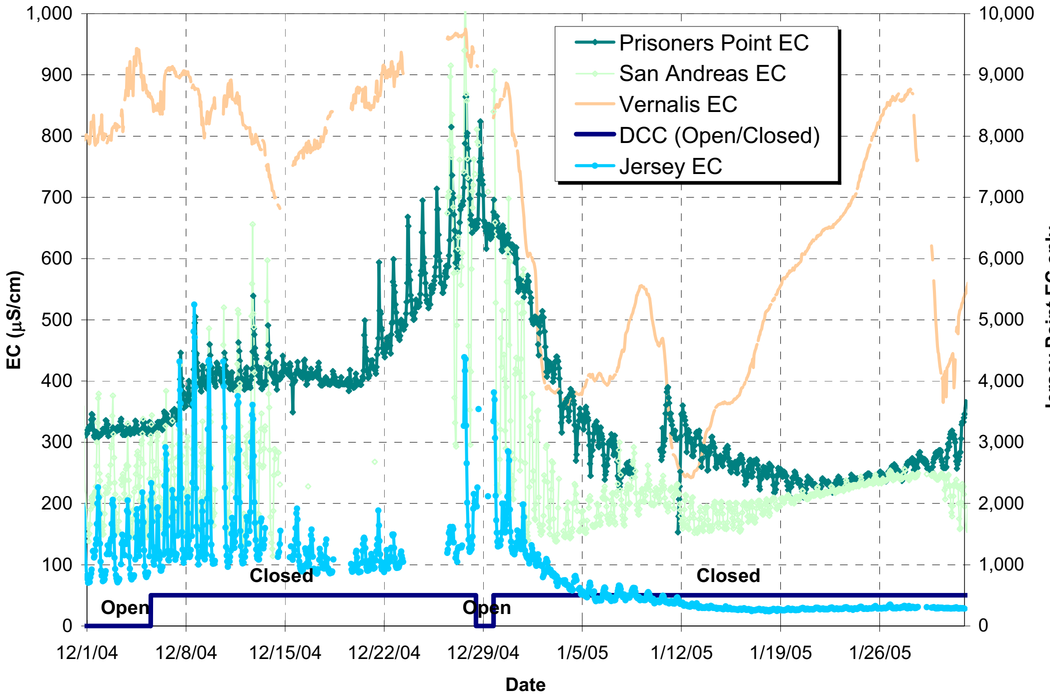

Figure 2-36 Influence of Delta Cross Channel Closure on Electrical Conductivity at Potential Stockton Intake Location

Closure of the Delta Cross Channel can cause a significant increase in salinity in the lower San Joaquin River in the vicinity of the City of Stockton's proposed Delta intake. During the first period the Cross Channel was closed, Delta outflow dropped to about 3,500 cfs and exports were as high as 10,000 cfs. During this period, Prisoner's Point EC increased dramatically. The Cross Channel was opened to help interior Delta water quality but was closed again soon after because of a substantial increase in storm runoff on the Sacramento River.

FUTURE DELTA WATER QUALITY CONDITIONS

Global climate change, increasing population, and increased Delta diversions and exports are likely to result in further degradation of Delta water quality. Without implementation of specific projects to restore and enhance Delta water quality, water agencies are likely to face continued and greater problems in meeting delivered water quality goals.

CHAPTER 3. PLANNING AND MANAGEMENT OBJECTIVES

Building on the Sacramento-San Joaquin Delta (Delta) water resources setting discussion presented in **Chapter 2**, the principal objective of **Chapter 3** is to describe the ongoing water resources planning and management activities of municipal water supply agencies that either (1) are dependent on diversions from the Delta or (2) undertake activities that can impact Delta hydrology and water quality.

Although many urban and agricultural users/agencies divert water for use in the Delta Region (or in the case of the south-of-Delta agencies, export water at Banks and Tracy pumping plants), the focus of this plan is on activities of the three study participants and their activities specifically related to maintaining or improving the delivered water quality of diversions from the Delta for drinking water purposes.

However, the planning and management objectives of other agencies are briefly summarized at the end of this chapter. The issues and concerns of these other agencies would be developed in future phases of the work.

CONTRA COSTA WATER DISTRICT

AGENCY OVERVIEW

The Contra Costa Water District (CCWD) serves treated and raw (untreated) water to approximately 500,000 people in central and eastern Contra Costa County in Northern California (see **Figure 3-1**). 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 provides treated water to Clayton, Clyde, Concord, Pacheco, Port Costa, and parts of Martinez, Pleasant Hill, and Walnut Creek. In addition, the District sells wholesale treated water to Antioch, the California Cities Water Company in Bay Point and Brentwood.

CCWD operates the Randall Bold Water Treatment Plant (WTP) (jointly owned with the Diablo Water District), which provides treated water to Antioch, Diablo Water District (Oakley), and Brentwood. CCWD sells raw water to the cities of Antioch, Martinez, and Pittsburg, the California Cities Water Company in Bay Point, and industrial and irrigation customers.

The source of CCWD's water is the Delta. CCWD's intakes are located at Rock Slough and on Old River, both in eastern Contra Costa County, and Mallard Slough in central Contra Costa County. The backbone of the District's water conveyance system is the 48-mile Contra Costa Canal, which extends from the Rock Slough intake to the Mallard Reservoir in central Contra Costa County.

Contra Costa Canal

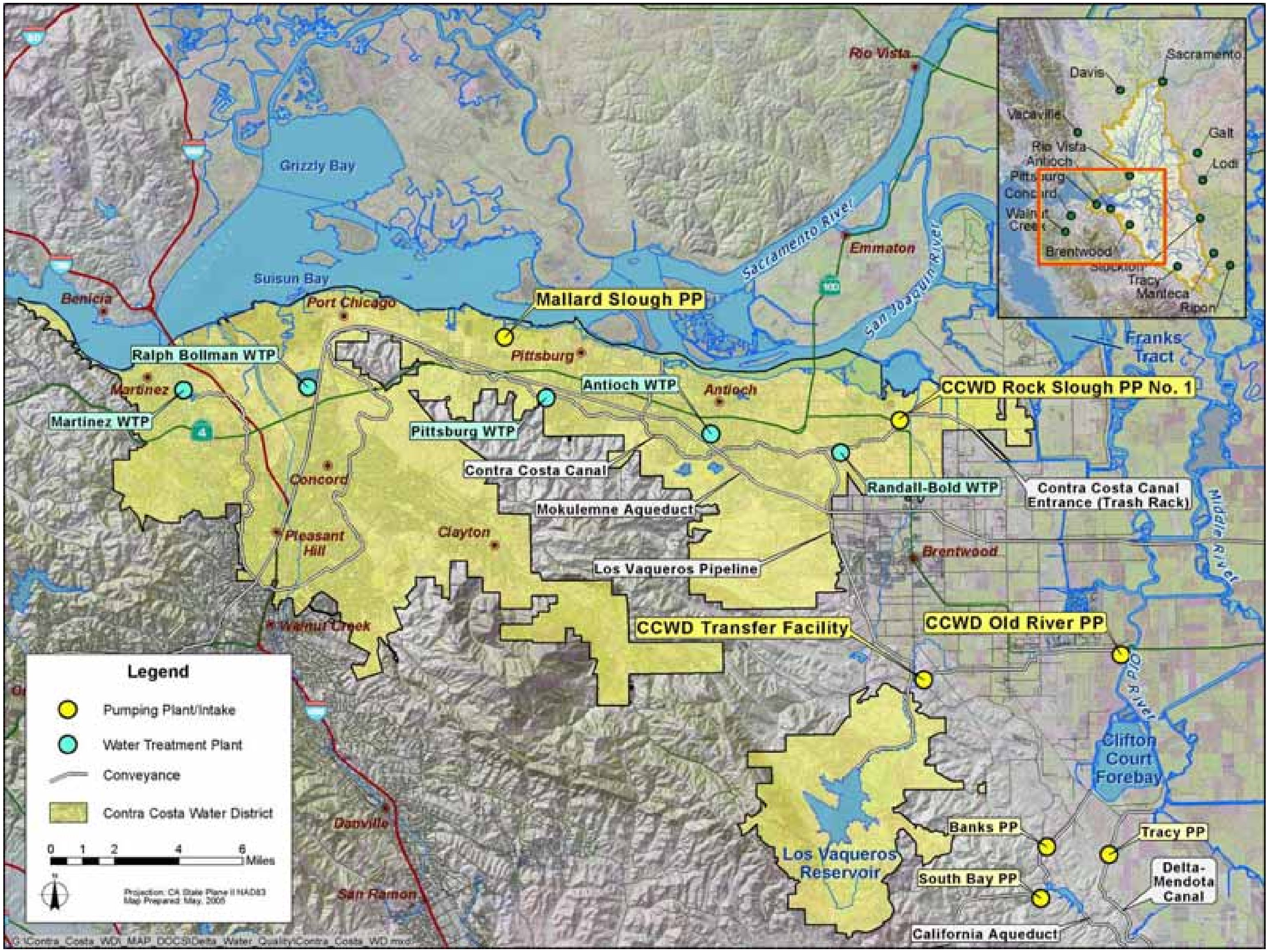

Figure 3-1 Contra Costa Water District Service Area and Delta Diversion Facilities

CCWD WATER QUALITY GOALS

In 1993, CCWD formally adopted treated water quality goals to guide planning for future treatment requirements. Similarly, source water quality goals were approved in 1998. CCWD's current water quality goals were revised in 2002 to reflect the requirements of the Microbial Disinfectant Byproducts Regulation and the Long Term Enhanced Surface Water Treatment Rule. **Table 3-1** and **Table 3-2** summarize CCWD's source water and treated water quality goals and objectives, respectively.

Table 3-1 CCWD Source Water Quality Objectives

Parameter	Unit	Objective (1)
Salinity		
Chloride	mg/L	50 (1)
DBP Precursors		
Bromide	µg/L	50
TOC	mg/L	< 3.0
Microbiological		
Cryptosporidium	oocyst/L	0.0075 (2)

Key: mg/L = milligrams per liter oocyst/L = oocysts per liter µg/L = micrograms per liter

(1) *Maximum monthly average for filling Los Vaqueros Reservoir.*

(2) *Based on 24-month average.*

Table 3-2 CCWD Treated Water Quality Objectives

Parameter	Unit	Future Regulatory Standards	Current Quality	Objective
General Chemical/ Physical				
Chloride	mg/L	250	30-80	65
Turbidity	NTU	0.3	<0.1	0.10
TOC	% reduction	25-45	25-45	30-45
Odor as MIB/Geosmin	mg/L	None	0-14	6
Microbiological				
Total Coliform	number of positive	< 5% positive	< 1% positive	< 1% positive
Fecal Coliform	presence/absence	Absent	ND	ND
Giardia	cysts	3 log removal	ND	ND
Virus	viruses	4 log removal	ND	ND
Cryptosporidium	cysts	2 log removal	ND	ND
Disinfection Byproducts				
THMs	µg/L	80 (2)	40 (2)	20 (1)
HAA5s	µg/L	60	30	20 (1)
Bromates	µg/L	10	10	5
Disinfectant Residual				
Chloramine	mg/L	> 0.2 and < 4.0	2.7	> 0.2 and < 3.0

Key: HAA5 = haloacetic acid µg/L = micrograms per liter NTU = nephelometric turbidity unit THM = trihalomethane
mg/L = milligrams per liter ND = non-detect TOC = total organic carbon

(1) *Locational Running Annual Average*

(2) *System-Wide Running Average*

SUMMARY OF EXISTING AND FUTURE WATER SUPPLY NEEDS

Table 3-3 summarizes the water demand projections for CCWD's service area. These projections are based on estimates of future land use changes and population growth.

Table 3-3 Water Demand Projections for the Contra Costa Water District

Type of Water Demand	Volume (acre-feet per year)					
	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
Retail Treated	47,092	50,797	54,430	55,697	56,930	58,142
Wholesale Treated	41,436	56,604	54,430	55,697	56,930	58,142
Industrial	52,607	68,887	68,887	68,887	68,887	68,887
Irrigation/Agriculture	3,290	3,290	3,290	3,290	3,290	3,290
Other Areas	446	582	695	779	865	960
Unaccounted for	12,500	12,500	12,500	12,500	12,500	12,500
TOTAL DEMAND	**157,371**	**192,660**	**207,145**	**214,485**	**220,592**	**223,769**

(1) Demands are calculated irrespective of the source of supply and include savings from passive conservation.

(2) "Unaccounted for" include seepage, evaporative losses, and other losses from the Contra Costa Canal, and the Contra Loma, Mallard, and Los Vaqueros reservoirs.

SOURCES OF SUPPLY

CCWD is almost entirely dependent on diversions from the Delta for its water supply. CCWD principal sources of supply include the following:

- A contract entitlement from the United States Department of Interior, Bureau of Reclamation (Reclamation) Central Valley Project (CVP)
- A water right from the State Water Resources Control Board (SWRCB) for diversion of surplus flows from the Delta associated with the Los Vaqueros Reservoir project
- Water rights held by CCWD and its municipal and industrial (M&I) customers for diversion from Mallard Slough and the San Joaquin River
- A water transfer agreement with the East Contra Costa Irrigation District (ECCID)
- Recycled water
- Groundwater
- Desalinated seawater

Each of these sources of supply is discussed briefly below.

Central Valley Project Contract Entitlement

CCWD's primary source of supply is a contract entitlement from the Reclamation CVP. This contract entitlement provides for the diversion of water for storage and direct use (contract water year defined as March 1 through February 28) with a maximum annual diversion of 195,000 acre-feet (AF) per year. Many factors, including hydrologic conditions and implementation of federal and state regulations and laws, can reduce CCWD's annual allocation. CCWD diverts CVP water at the Contra Costa Canal

Pumping Plant No. 1 at Rock Slough and at the Los Vaqueros intake at Old River south of the Highway 4 crossing (see **Figure 3-1**).

Los Vaqueros Reservoir Project Water Right

CCWD's Los Vaqueros Water Right (SWRCB Decision 1629, June 2, 1994) permits the District to divert surplus Delta flows from the District's Old River Intake near Highway 4 (see **Figure 3-1**) to Los Vaqueros Reservoir for storage from November 1 through June 30.[1] The maximum annual diversion of Los Vaqueros Right water is 95,850 AF. The maximum annual combined diversion of its CVP contract entitlement and water right water under D-1629 is limited to 242,000 AF annually. The combined amount of CVP and Los Vaqueros water that can be delivered to CCWD's customers annually is limited to 195,000 AF. Water only may be diverted by CCWD under the Los Vaqueros water right when the Delta is in a "surplus" condition. Very little water is available for diversion under this water right in dry years. The total amount of CVP and Los Vaqueros water that can be delivered to CCWD's customers currently is limited to 148,000 AF annually until the East Contra Costa County Habitat Conservation Plan (HCP) is completed.

San Joaquin River Water Rights

CCWD, the city of Antioch, and several industrial customers have additional water rights for diversion from the San Joaquin River. Actual diversions from the San Joaquin River are limited when poor water quality conditions (high salinity) prevail. CCWD can divert up to 26,780 AF per year at a maximum diversion rate of 39.3 cubic feet per second (cfs) under its Mallard Slough water rights. However, in dry years, little or no water is available from this source because of salinity intrusion.

East Contra Costa Irrigation District

CCWD has an agreement with the ECCID and a joint agreement with ECCID and the California Department of Water Resources (DWR) to purchase surplus irrigation water to be used for M&I purposes within ECCID's service area. The current ECCID agreement allows CCWD to purchase up to 8,200 AF per year of surface water for delivery in the overlapping service areas of CCWD and ECCID. The agreement allows for purchase by CCWD of an additional 4,000 AF per year made available through groundwater substitution when CCWD's CVP supplies are deficient.

Recycled Water

Recycled water is used to meet non-potable water demands within CCWD's service area. Recycled water is provided by the Central Contra Costa Sanitary District (CCCSD) and the Delta Diablo Sanitation District (DDSD). CCCSD provides recycled water to areas of Concord and Pleasant Hill, including a golf course, two parks, a community college, and the city of Pleasant Hill's community center and corporation yard. In 2002, DDSD's 12.5 million gallons per day (mgd) recycled water facility came on-line to serve recycled

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[1] CCWD uses either its Los Vaqueros Water Right water to fill Los Vaqueros Reservoir (when available) or its CVP contract entitlement. CCWD uses water stored in Los Vaqueros Reservoir for blending with Delta water when Delta water is more saline than CCWD's delivered water chloride concentration goal of 65 mg/L chlorides.

water to the newly constructed Delta Energy Center and Los Medanos Energy Center. This facility currently produces approximately 9,000 AF per year of recycled water for cooling water and boiler water for the power plants and landscape irrigation at parks and ball-fields in the city of Pittsburg.

Groundwater

An undetermined number of wells throughout the CCWD service area are owned by industries, private individuals, and public municipal water utilities. However, groundwater resources in the CCWD service area do not supply significant amounts of water to meet or augment drinking water demands. Existing sources of groundwater include CCWD's Mallard Wells, and wells owned and operated by the city of Pittsburg, the Southern California Water Company (SCWC), and the Diablo Water District. It is estimated that total groundwater use within the CCWD service area is approximately 3,000 AF per year.

Desalinated Seawater

The Bay Area Regional Desalination Project involves a partnership among East Bay Municipal Utility District (EBMUD), San Francisco Public Utilities Commission (SFPUC), Santa Clara Valley Water District (SCVWD), and CCWD. Project partners are exploring the development of regional desalination facilities that could supply up to 5.4 million Bay Area residents and businesses during emergencies, droughts, and facility maintenance, in addition to increased system reliability. The Bay Area Regional Desalination Project may consist of one or more desalination facilities, with an ultimate capacity of up to 120 mgd. Project goals and benefits include the following:

- Providing additional sources of water during emergencies such as earthquakes
- Providing a supplemental supply source during extended drought periods
- Allowing other major facilities such as treatment plants, transmission mains, and pump stations to be taken out of service for an extended period of time for maintenance or repairs
- Providing a full-time supplemental water supply to increase agencies' water supply portfolio and increase reliability

In October 2003, the regional partner agencies jointly completed a Phase 1 Pre-Feasibility study that evaluated the construction of regional desalination facilities. The Phase 1 Pre-Feasibility Study concluded that at least three locations exist in the Bay Area where a regional desalination facility could be located without any fatal flaws: Mirant Pittsburg power plant site, Pittsburg; near the Bay Bridge site, Oakland; and the Oceanside site, San Francisco.

SURFACE WATER DIVERSION FACILITIES

CCWD diverts its surface water supplies from the Rock Slough, Old River, and Mallard Slough intakes (see **Figure 3-1**). **Figure 3-2** illustrates the relative volumes of water diverted by CCWD from each of its Delta diversion facilities. Each of these facilities is described further on the following pages.

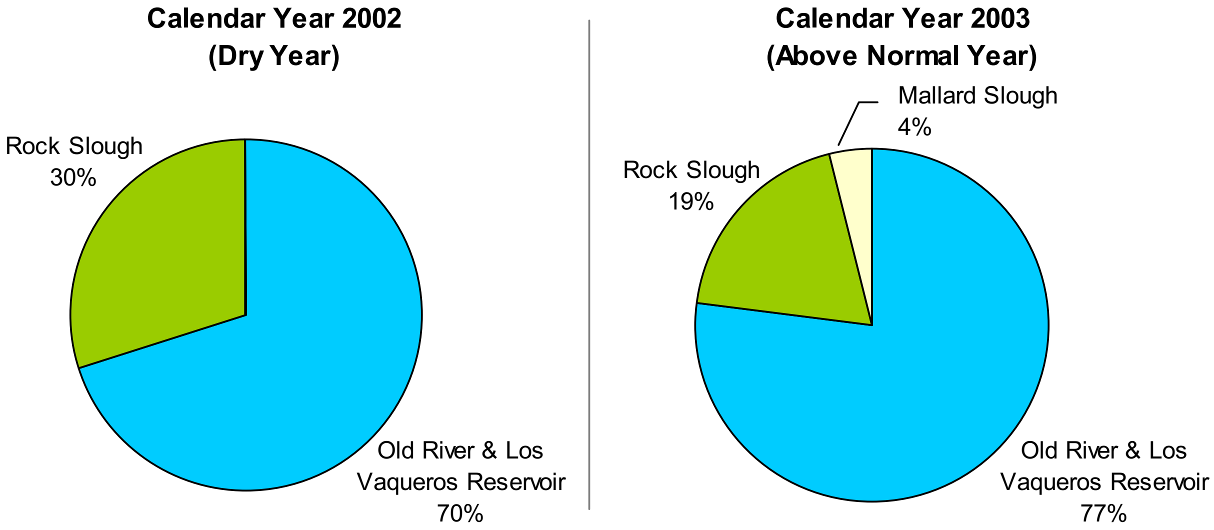

Figure 3-2 Contra Costa Water District Delta Diversions by Intake Facility

Surface water also is supplied from releases of previously stored higher quality water from the Los Vaqueros Reservoir. The Los Vaqueros Reservoir was constructed as part of the Los Vaqueros Project. The 100,000 AF Los Vaqueros Reservoir is located 8 miles south of the city of Brentwood and stores higher quality Delta water for blending with the Delta supply during dry periods when sodium and chloride levels typically increase. The reservoir filled for the first time in January 1999. In addition to improving water quality for CCWD, the reservoir provides the ability to store a 3-month to 6-month emergency water supply and affords Delta fisheries protection.

Rock Slough Intake Facility

The Rock Slough Intake Facility pumps water using four pumping plants located on the Contra Costa Canal between mileposts 3.95 and 7.04. The varying pump capacities allow for flow rates ranging from 31 cfs to 384 cfs. Water diverted at Rock Slough is more severely impacted by Delta operations than water diverted at the Old River Intake. Water diverted at Old River is of higher quality than water diverted from Rock Slough in the fall.

Old River Intake Facility

The Old River Intake Facility pumps both CVP and Los Vaqueros water rights water from the Delta. The facility contains five pumps and has a capacity of 250 cfs. This intake, which has a state-of-the-art fish screen, was constructed as part of the Los Vaqueros Project in 1997. Old River pumping facilities supply raw water to the Contra Costa Canal and/or the Los Vaqueros Reservoir via the 4 million-gallon (MG) Transfer Reservoir.

Looking southwestward at CCWD'S Old River at Highway 4 intake, completed in 1997.

Mallard Slough Pump Station

The original Mallard Slough Pump Station was built in 1930 and is located at the western-most end of the Delta in Suisun Bay near Bay Point. The pump station was replaced in 2001 and a state-of-the-art fish screen was installed. The pump station has a capacity of 39 cfs and pumps water directly into Contra Costa Canal. Diversions from Mallard Slough are unreliable due to frequently poor water quality, specifically high chlorides, in the San Joaquin River at this point of diversion. CCWD only diverts at Mallard Slough when chlorides are 65 milligram per liter (mg/L) or less. Water quality conditions have limited diversions from Mallard Slough to approximately 3,500 AF per year, on average.

Contra Costa Water District's Mallard Slough Pumping Station, west of Pittsburg, is only used after periods of high Delta outflow when the water in Suisun Bay near Chipps Island is fresh enough to meet CCWD's delivered chloride goal.

WATER QUALITY IMPACTS AFFECTING CCWD'S USE OF DIFFERENT SOURCES OF WATER

Figure 3-3 shows CCWD's mix of sources of supply for a 3-year period. **Figure 3-4** shows chloride concentrations at the Contra Costa Canal Pumping Plant No. 1 and CCWD's Old River intake during the same time period compared to delivered chloride concentration. Data from within Rock Slough at the Delta Road Bridge also are shown to illustrate this location is unaffected by the seepage that occurs into the unlined Contra Costa Canal near Pumping Plant No. 1. During periods of low diversions at Pumping Plant No. 1, the difference in salinity between these two locations can become quite large (e.g., see October 2003 through March 2004 in **Figure 3-4**). CCWD currently evaluates and blends its raw water sources according to chloride levels. As regulations continue to become more stringent and as the Delta source continues to degrade, operational guidelines and strategies may need to be refined.

CCWD operates its intake facilities based on a long-term goal of delivering water with chloride concentrations of 65 mg/L or better (i.e., less) to its customers. This water quality is equivalent to water with bromide concentrations of 200 micrograms per liter (µg/L). As was discussed in the portion of **Chapter 2** regarding water quality in the Delta, the chloride concentration at CCWD's Rock Slough intake often exceeds this value. Consequently, CCWD meets its delivered chloride goal in two ways: (1) by using the intake at Old River, which provides access to higher quality water during dry fall months and drought years, and (2) by using high-quality water from Los Vaqueros Reservoir to blend with Delta water when Delta chloride concentrations are above 65 mg/L.

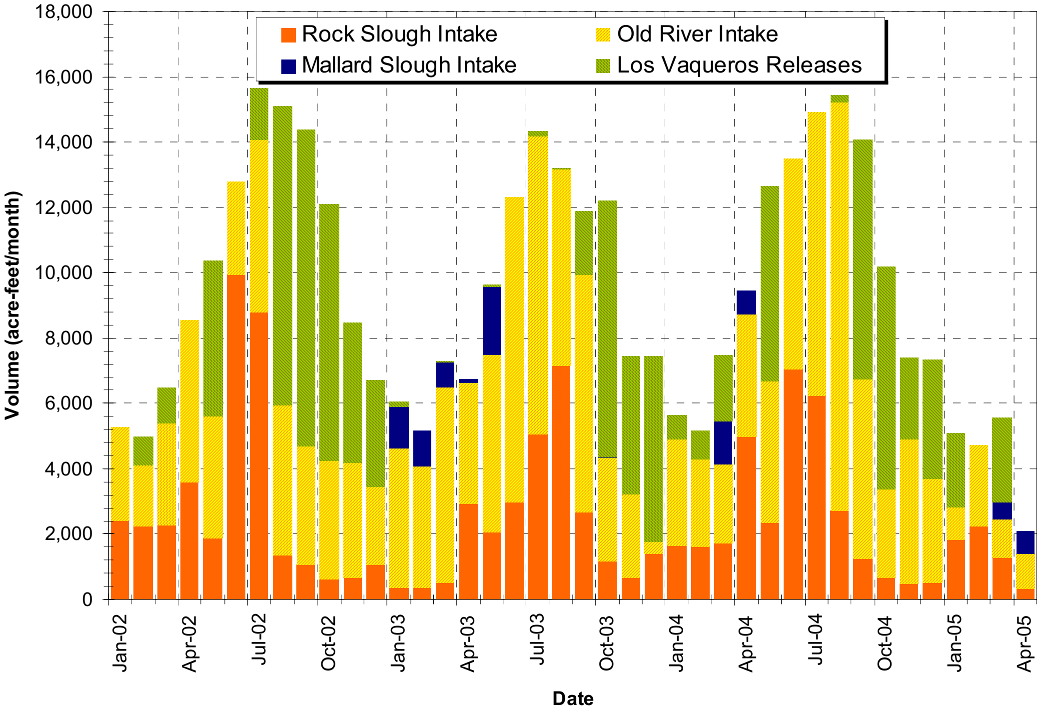

Figure 3-3 Contra Costa Water District Mix of Sources of Supply

CCWD uses different water sources based on Delta pumping limitations and the relative quality of water sources.

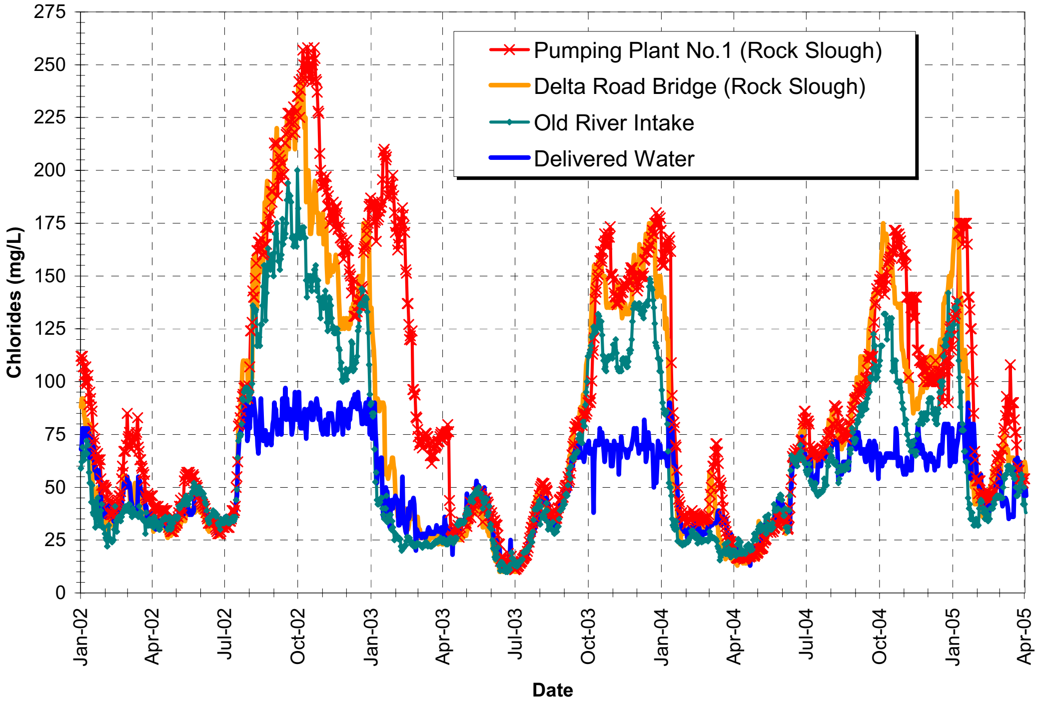

Figure 3-4 Water Quality at Contra Costa Water District Delta Diversions

CCWD intake facilities are operated based on the long-term goal of delivering water to customers with chloride concentrations of 65 mg/L or better (i.e., less).

Los Vaqueros Reservoir is typically used to blend with Delta water during late September through early January. In early fall, Delta outflow requirements are low and high salinity water often intrudes into the Delta, even in wet years. October and November are usually the months of highest salinity in the Delta. During that time, chloride concentrations can exceed 150 mg/L at Old River and releases from Los Vaqueros Reservoir are used to blend and achieve the delivered chloride goal. In drought years, blending water from Los Vaqueros can be needed for extended periods during the year. **Figures 3-5**, **3-6**, and **3-7** present CCWD delivered water chloride concentrations for calendar years 2002, 2003, and 2004, respectively. These 3 years were designated as dry, above normal, and below normal, respectively, based on the Sacramento River 40-30-30 Index. Also plotted on these figures is the water quality at Contra Costa Canal Pumping Plant No. 1 at Rock Slough and the Old River intake.


Photo by Stephen Joseph

In addition to providing improved water quality and emergency water supply for CCWD's customers, the 100,000 acre-feet Los Vaqueros Reservoir provides recreational hiking and fishing opportunities. The 18,500-acre watershed provides valuable open space and terrestrial habitat in eastern Contra Costa County. This view looks northwestward across the reservoir toward Mount Diablo. The dam is on the right-hand side at the back of the photo.

Although Los Vaqueros Reservoir has clearly helped CCWD work toward meeting its delivered water chloride goals, additional actions will be needed for CCWD to consistently meet future more stringent drinking water regulations. Los Vaqueros Reservoir only has a limited amount of water available for blending, and modeling studies suggest that CCWD could run out of blending water during prolonged droughts and would have to rely on the quality of water in the Delta. During droughts, Delta chlorides are much higher, and for longer periods, making it difficult to fill the reservoir with high quality water and putting a greater demand on the blending water remaining in the reservoir. Projects that CCWD is studying to improve the performance of Los Vaqueros Reservoir and improve CCWD's ability to deliver high quality water, even during prolonged drought periods, are discussed in more detail in **Chapter 4**.

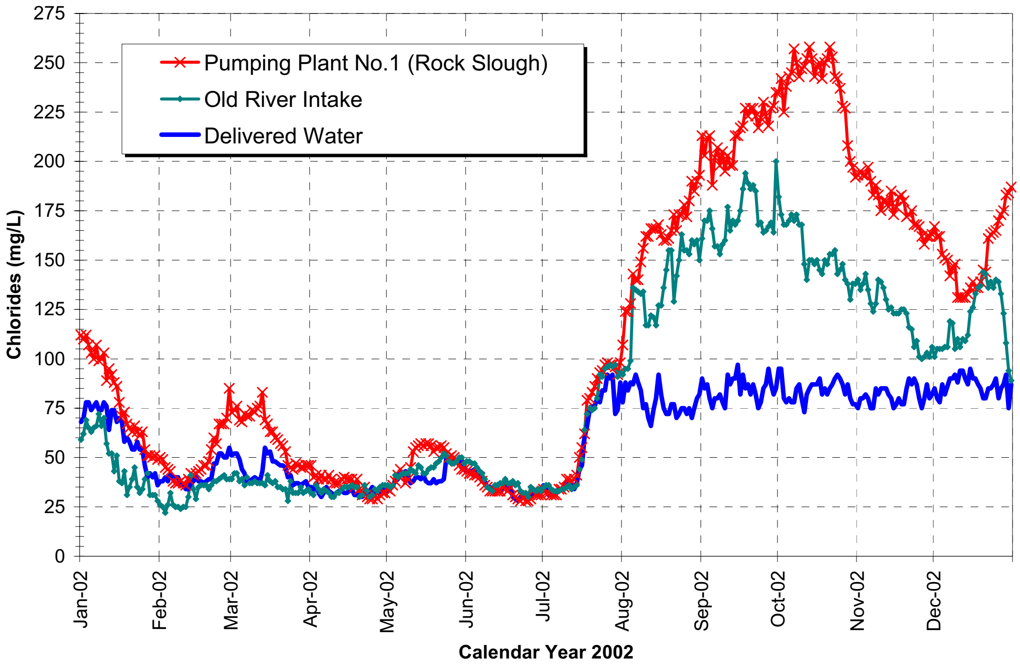

Figure 3-5 Year 2002 Intake and Delivered Water Chloride Concentrations

During 2002, a dry year, chloride concentrations of over 250 mg/L were observed at Pumping Plant No. 1, while delivered water chloride concentrations were kept below 95 mg/L.

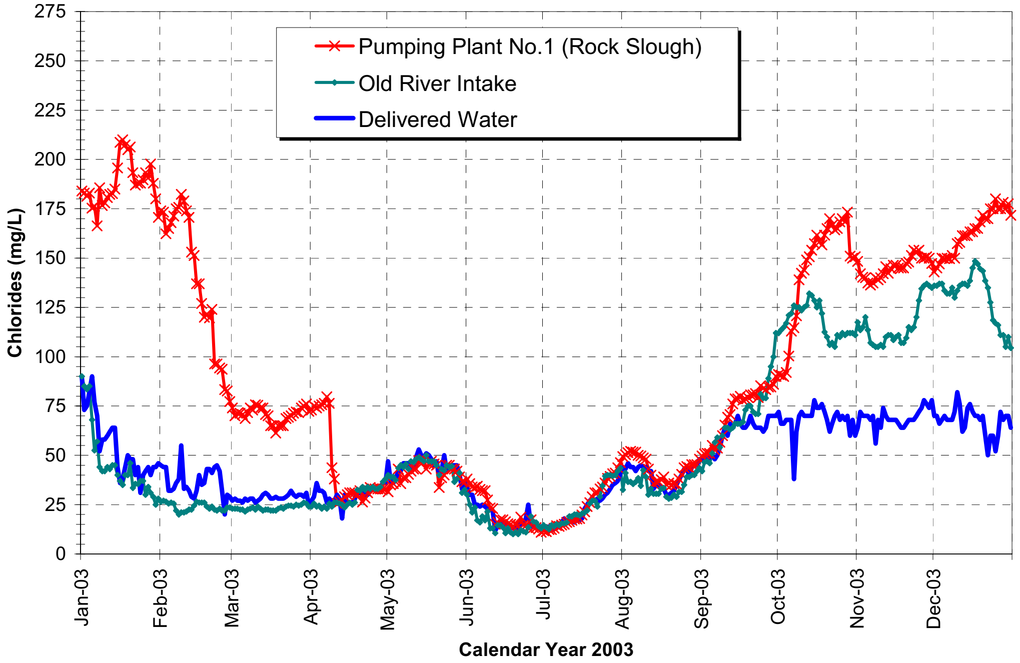

Figure 3-6 Year 2003 Intake and Delivered Water Chloride Concentrations

During the fall of 2003, an above normal year, chloride concentrations at Pumping Plant No. 1 peaked at about 180 mg/L, while delivered water chloride concentrations were kept below about 75 mg/L.

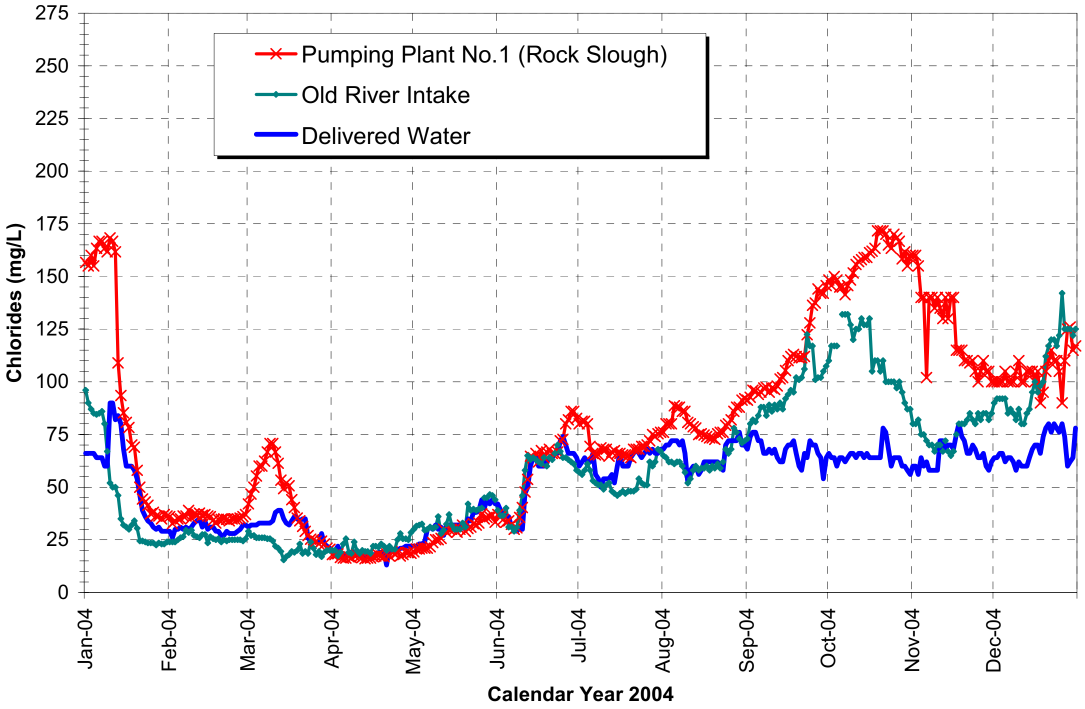

Figure 3-7 Year 2004 Intake and Delivered Water Chloride Concentrations

During 2004, a below normal year, chloride concentrations at Pumping Plant No. 1 peaked at about 175 mg/L, while chloride concentrations of delivered water were typically kept below 75 mg/L.

Seasonal Variations of Total Organic Carbon and Disinfection By-Products

Although most utilities experience low trihalomethanes (THM) and haloacetic acids (HAA5) concentrations in the winter months, and higher concentrations in the summer months, this is not necessarily true for the in-Delta diverters. Raw water bromide and total organic carbon (TOC) significantly impact THM and HAA concentrations in treated water. And, as illustrated and discussed in **Chapter 2**, these parameters vary significantly on a seasonal basis within the Delta. In particular, bromide concentrations are highest in the fall, near the end of the dry season, whereas TOC concentrations peak during the wet season.

A water quality analysis conducted as part of the ongoing Advanced Treatment Study determined that THM and HAA concentrations were more likely to be higher during the winter months than during the summer months. Disinfectant byproducts (DBP) for CCWD were more severely impacted by raw water TOC rather than temperature and distribution system water age. **Figure 3-8** illustrates the seasonal variability of raw and finished water for TOC. **Figure 3-9** illustrates the correlation between THM and finished water TOC.

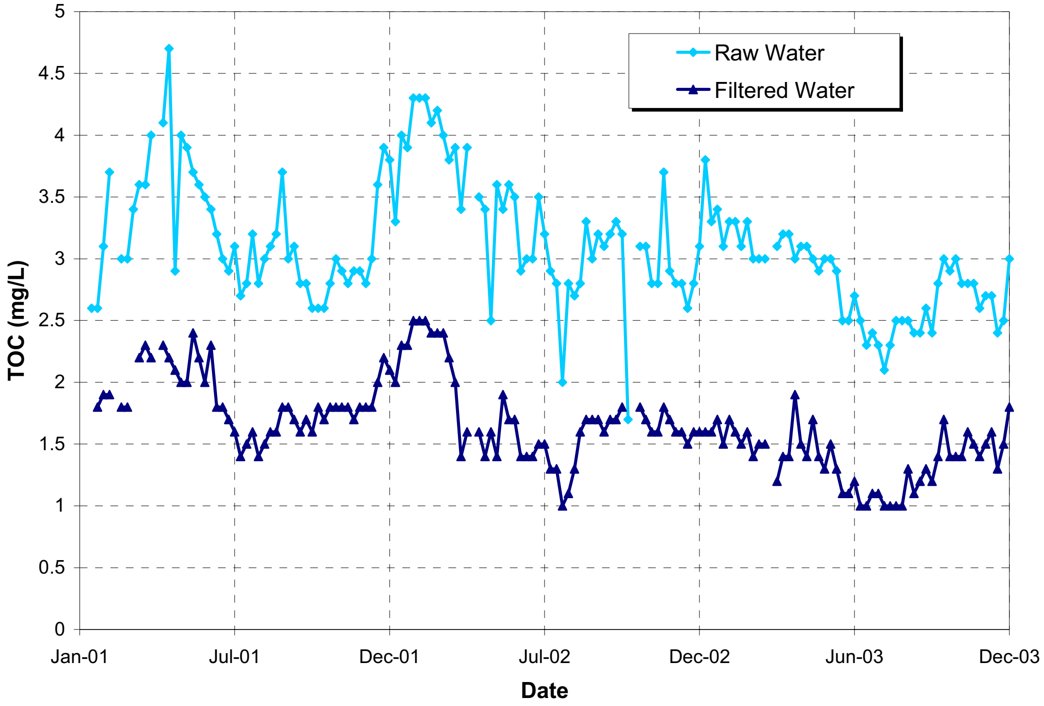

Figure 3-8 Seasonal Variability of Raw Water and Finished Water TOC

TOC in raw and treated water tends to be higher during winter months.

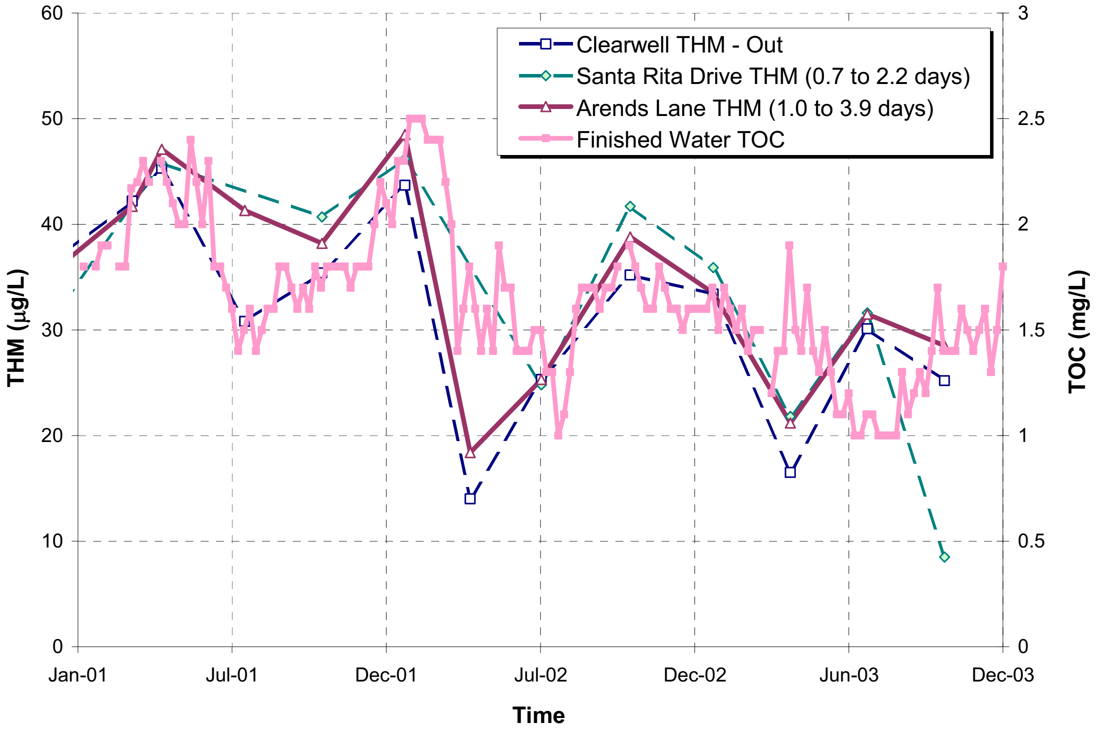

Figure 3-9 Correlation Between THM and Finished Water TOC

There is a strong correlation between the formation of disinfectant byproducts and treated water TOC.

Endocrine Disrupting Chemicals and Pharmaceutical and Personal Care Products

Neither endocrine disrupting chemicals (EDC) nor pharmaceutical and personal care products (PPCP) are currently regulated. However, the United States Environmental Protection Agency (EPA) is evaluating their occurrence and effects on humans. Because the Delta watershed includes industrial, agricultural, and urban runoff, CCWD anticipates that it would be potentially vulnerable to any regulations implemented in the future.

WATERSHED PROTECTION

Los Vaqueros Reservoir

CCWD has historically taken an active role in protecting its sources of drinking water.[2] As part of the Los Vaqueros Project, CCWD purchased 99 percent of all the land (approximately 18,500 acres) within the watershed of the Los Vaqueros Reservoir to protect source water quality. This provides maximum control of all land use within the watershed. This action helps ensure high water quality, while also providing important terrestrial habitat for several protected species of fairy shrimp and red-legged frogs. CCWD also restricted boating on the reservoir to electric-powered craft owned and maintained by CCWD to eliminate fuel contamination.

Contra Loma Reservoir and Swimming Lagoon

CCWD also has taken steps to protect the source water quality in Contra Loma Reservoir, a federal CVP facility operated by CCWD. Contra Loma Reservoir provides operational flexibility, flow regulation, and emergency storage for CCWD. In response to a 1997 California Department of Health Services (DHS) order to either cease body-contact recreation or stop using the reservoir for domestic water supplies, CCWD constructed a $2.2 million swimming lagoon at one end of the reservoir. In the past, extremely high levels of fecal coliform were measured in the reservoir, in particular in the swimming areas during high summer swimming usage. The new chlorinated lagoon allows swimming to continue, while protecting CCWD's drinking water supply (and protecting swimmers from pollution caused by body contact).

The swimming lagoon at Contra Loma Reservoir was completed in spring 2002. The almost one-acre lagoon protects public health by eliminating body contact with CCWD's drinking water supply stored in the 2,500 acre-foot Contra Loma Reservoir in Antioch.

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[2] CCWD's watershed protection actions are discussed in more detail on the EPA's source water protection Web site (*http://www.epa.gov/safewater/protect/casesty/contracosta.html).*

Grasslands Bypass Agreement

In cooperation with agricultural and environmental stakeholders, CCWD helped develop the November 1995 Grasslands Bypass Use Agreement, a program that allowed Grasslands area irrigators on the west side of the San Joaquin Valley to use an existing federal conveyance facility for their drainage provided they agreed to reduce their total monthly loads of selenium, each year after the first 2 years. This was the first time in California that farmers had been subject to Waste Discharge Requirements (WDR). The selenium load limits have encouraged water conservation in the drainage area to reduce discharges and pollutant loads.

Other management measures include irrigation system improvements, recirculation of drainage water, use of selenium-laden waters for dust control and irrigation of salt-tolerant crops, and low-pressure reverse osmosis and solidification treatments. The program has since been extended to include load limits for salt. Reducing the mass loads in the San Joaquin River reduces the concentrations of bromide and chlorides at CCWD's intakes as well as Stockton's proposed Delta Water Supply Project (DWSP) intake. The watershed approach implemented by the Grasslands area farmers has been highly successful and served as an example for other watershed coalitions developed as part of the Central Valley Regional Water Quality Control Board's (CVRWQCB) conditional waiver program for irrigated lands.

WATER TREATMENT AND DISTRIBUTION CAPABILITIES

CCWD operates two WTPs: the Ralph D. Bollman WTP and the Randall-Bold WTP. Each is discussed further below. Both facilities meet all current and foreseeable future water quality regulations given current Delta water quality conditions. However, CCWD would face significant treatment challenges in the future if increasing levels of bromide and organic carbon (TOC) in the Delta were to coincide with a lowering of the DBP standard to 5 µg/L, lowering of regulatory limits for other DBPs, or more stringent regulatory requirements for *Cryptosporidium*.

Ralph D. Bollman Water Treatment Plant

The Ralph D. Bollman WTP treats water diverted from the Contra Costa Canal in Concord (see **Figure 3-1**). It was originally constructed in 1968, but has undergone two major upgrades to enhance delivered water quality, safety, and reliability. The nominal capacity of the facility is 75 mgd. The Bollman WTP provides conventional treatment with intermediate ozonation (treatment of settled water with ozone). The finished water is chloraminated before introduction to the distribution system to provide for a disinfection residual.

Sedimentation basins at CCWD's Bollman Water Treatment Plant. Shown in background is Mallard Reservoir, the 3,000 acre-feet forebay for the drinking water treatment plant.

The two principal water quality concerns at the Bollman WTP are taste and odor (T&O) control and potential future requirements for *Cryptosporidium* inactivation/removal under the proposed Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (see **Chapter 2** for a discussion of current and anticipated water quality and treatment regulations). Requirements will remain uncertain until the *Cryptosporidium* monitoring period ends in 2006 or 2007.

Taste and Odor Control at the Bollman WTP

The treatment processes at the Bollman WTP include ozonation and granular activated carbon (GAC) media filters. The GAC media was recently added to help control T&O. Even with these additional tools, CCWD has experienced difficulty controlling periodic poor T&O episodes. High organic loads in water diverted from the Delta are considered to be responsible for these problems. A screening level evaluation of T&O control approaches was included in the District's Water Treatment Plant Master Plan. As a result of the study, CCWD has increased the frequency of filter media replacement to provide better GAC absorptive capacity. Other potential mechanisms for T&O control evaluated in the Water Treatment Plant Master Plan included increased ozone dosage, GAC post-contactors, and hydrogen peroxide used in combination with ozone (peroxone). If more frequent media replacement does not sufficiently reduce T&O, CCWD intends to further evaluate the following strategies: (1) increased ozone dose followed by ozone quenching or (2) ozonation in combination with hydrogen peroxide (peroxone).

Cryptosporidium Inactivation/Removal at the Bollman WTP

The Bollman WTP is not expected to require additional treatment under the LT2ESWTR based on monitoring for *Cryptosporidium* to date. However, if Bollman's water source degrades sufficiently to require additional treatment for *Cryptosporidium* control, the following strategies would be further evaluated: (1) applying for filtration performance credit, (2) ozone contactor modifications to maximize disinfection, and (3) ultraviolet (UV) disinfection.

Randall-Bold Water Treatment Plant

The Randall-Bold WTP treats water diverted from the Contra Costa Canal near Oakley (see **Figure 3-1**). The WTP was constructed in 1992 and has since undergone only minor modifications. It is jointly owned with the Diablo Water District.

The original nominal capacity of the Randall-Bold WTP was 40 mgd. However, the facility currently cannot operate at that capacity because of solids loading from the raw water source. Ongoing improvement to the facility (namely, the Sedimentation Basin Improvement Project) will increase the capacity of the Randall-Bold WTP to 42 mgd.

Randall-Bold WTP was designed as a direct filtration plant, with pre- and post-ozone contactors, and deep-bed, biologically activated GAC filters. The finished water is chloraminated before introduction to the distribution system to provide a disinfection residual. The two principal water quality concerns at Randall-Bold WTP are bromate control and potential future requirements for *Cryptosporidium* inactivation/ removal.

Bromate and DBP Control at the Randall-Bold WTP

CCWD does meet the 10µg/L bromate concentration regulatory limit at the Randall-Bold WTP. However, it has not always met CCWD's more stringent goal of 5 µg/L. Chlorine dioxide was shown to be effective for bromate control on an experimental basis at the Randall-Bold facility. However, CCWD is evaluating additional strategies for bromate control, including pH suppression and converting pre-ozone to intermediate ozone.

Cryptosporidium Inactivation/Removal at the Randall-Bold WTP

Similar to the Bollman WTP, the Randall-Bold facility may require additional treatment under the LT2SWTR. The strategies at the Randall-Bold WTP are the same as those described for the Bollman WTP.

PROJECTS AND PROGRAMS RELATED TO EFFORTS TO DIVERT WATER FROM THE DELTA

Although CCWD has already achieved major improvements in its delivered water quality, much more needs to be done to ensure CCWD can reliably meet future drinking water regulations or the 50 µg/L bromide and 3 mg/L TOC targets specified by CALFED, particularly during prolonged droughts. CCWD is developing several major projects and programs to address its future water quality needs. These projects and programs, more fully discussed in **Chapter 4,** include the following:

- An Alternative Intake Project to evaluate other points of diversion from the Delta for the purpose of improving water quality (both for direct delivery and diversion to Los Vaqueros Reservoir)
- Encasement of the Contra Costa Canal to reduce seepage and to improve source water quality delivered to the Bollman and Randall-Bold WTPs, as well as to add flexibility for the District relative to the operations of the CVP and State Water Project (SWP).
- An intertie with the EBMUD Mokelumne Aqueduct
- An expansion of Los Vaqueros Reservoir
- Application of advanced water treatment technologies at the Bollman and Randall-Bold WTPs

CITY OF STOCKTON

AGENCY OVERVIEW

Two water purveyors primarily serve the City of Stockton Metropolitan Area (COSMA): the City of Stockton Municipal Utilities Department (COSMUD) and the California Water Service Company (Cal Water). San Joaquin County (through the Lincoln and Colonial Heights Maintenance Districts) and the Stockton East Water District (SEWD) also provide water service to small chapters of the COSMA service area. Besides the areas serviced by SEWD directly, SEWD also provides treated surface water supplies on a wholesale basis to the other three water purveyors in COSMA. **Figure 3-10** displays the division of these service areas within the city's General Plan Planning Area Boundary. Brief descriptions of these service areas are provided below.

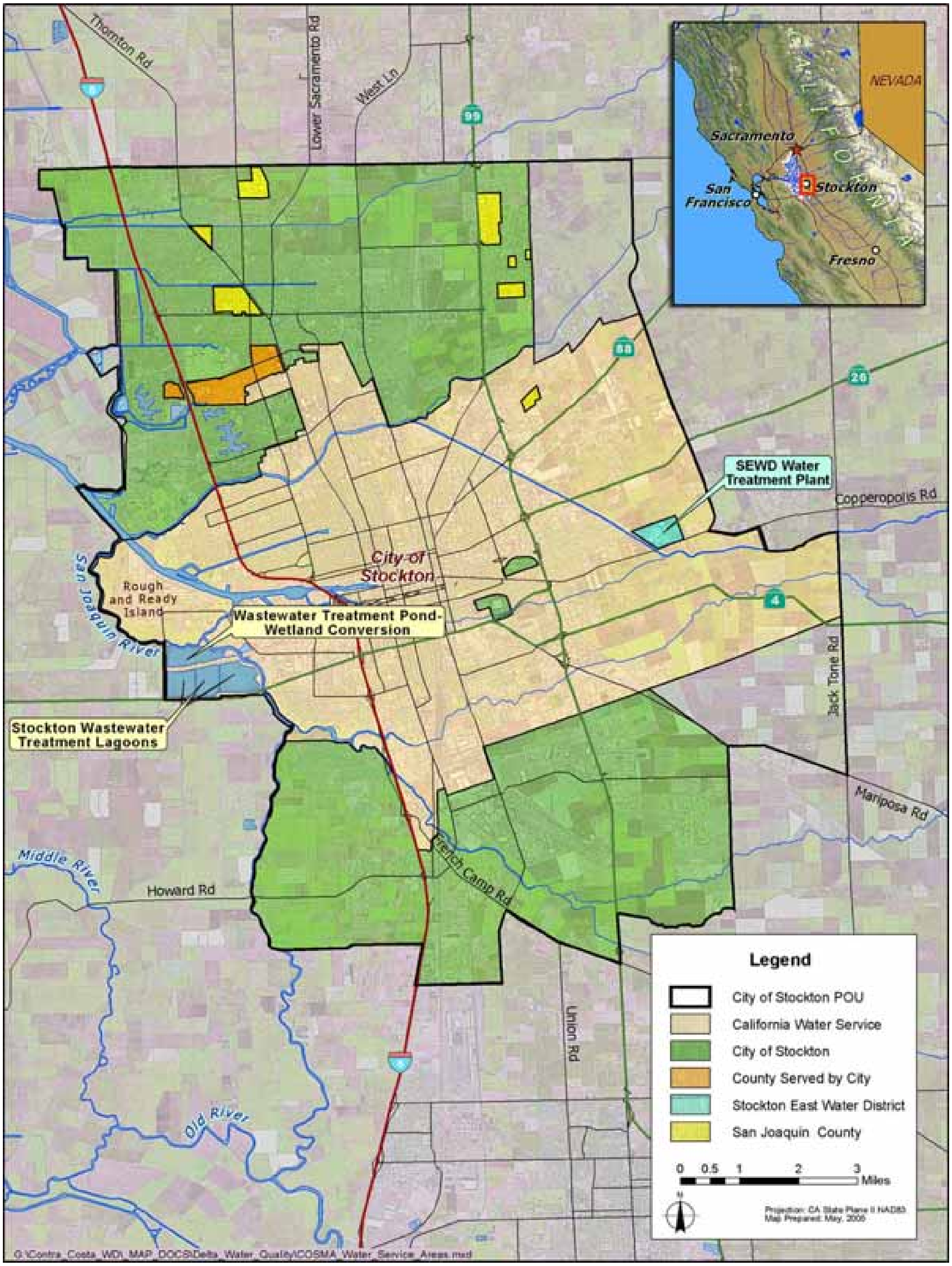

Figure 3-10 City of Stockton Metropolitan Area Water Service Area Boundaries

City of Stockton Municipal Utilities Department

COSMUD currently serves its municipal customers a blended supply of groundwater and treated surface water purchased from SEWD. About 41 percent of the potable water supplied by COSMUD is groundwater extracted from 24 wells interspersed throughout the COSMUD service area. The remaining 59 percent of treated water deliveries are surface water supplies purchased from SEWD. Operationally, COSMUD principally provides service via two separate water systems (see **Figure 3-10**): one serving North Stockton, and the second serving South Stockton. The South Stockton service area includes the Metropolitan Airport, the San Joaquin County Hospital, and the San Joaquin County Jail. In addition to these two major service areas, COSMUD provides water service to the Blue Diamond Walnut Plant in south central Stockton.

California Water Service Company

Cal Water also serves its customers a blended supply of groundwater and treated surface water purchased from SEWD. Cal Water's blend of groundwater and surface supplies is similar to that of COSMUD. Cal Water has a single treated surface water connection with SEWD.

San Joaquin County: Lincoln Village and Colonial Heights Water Maintenance Districts

The Lincoln Village and Colonial Heights water maintenance districts receive much of their potable water supply pursuant to a treated water purchase agreement with COSMUD, although Colonial Heights supplements it's supplies with groundwater extractions. In summer months, Colonial Heights meets nearly 50 percent of its water demand with groundwater. In the months, however, groundwater is typically used to meet less than 10 percent of demand.

Stockton East Water District

SEWD diverts raw surface water from releases from New Hogan and New Melones reservoirs pursuant to water contract entitlements from the CVP. SEWD treats these supplies for delivery on a wholesale basis to COSMUD, Cal Water, and San Joaquin County. In addition, SEWD provides treated surface water to customers on a retail basis and sells raw surface water to various San Joaquin County agricultural water users.

SUMMARY OF EXISTING AND FUTURE WATER SUPPLY NEEDS

COSMA currently has a population of about 270,000 people. The corresponding water demand is about 70,000 AF per year. Approximately 60 percent of these demands are met with treated surface water supplies. The remaining water demand is met with groundwater supplies. An aggressive demand management program also is in place.

The city of Stockton is experiencing substantial population growth and associated increases in water demand. The expected population and water demand of COSMA is projected to approach 490,000 people and 177,900 AF per year, respectively, by 2050 (see **Table 3-4**). Studies have determined that the surface water and groundwater supplies currently available to Stockton are not sufficient to meet existing and projected municipal and agricultural water needs without continuing groundwater overdraft. The threat of overdraft has required the city to strictly manage its groundwater supplies, cutting back on available deliveries. This management, along with the uncertain availability of some surface water supplies in the future, has threatened the reliability of COSMA's water supply.

Table 3-4 Water Demand Projections for City of Stockton Metropolitan Service Area

	Year 2005	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
Water Demand (acre-feet per year)	70,000	79,208	98,575	111,821	125,066	177,900

Sources of Supply

COSMUD relies on a combination of groundwater and surface water to meet its water demands within its service area. Until 1977, groundwater was the sole source of water supply for the city of Stockton. At that time, it was determined that supplemental surface water supplies were necessary to address the "critically overdrafted" condition of the east San Joaquin County groundwater basin. To that end, SEWD was formed for the purposes of pursuing surface water rights and contract entitlements and financing and constructing a surface WTP. SEWD currently holds contracts for up to 205,000 AF per year of surface water for delivery into COSMA. However, under the various applicable supply restrictions and hydrologic conditions, actual surface water supply availability for COSMA ranges from about 100,000 AF per year in "wet" years to about 30,000 AF per year (or less) in "critically dry" years.

Construction of the SEWD surface WTP permitted COSMA to broaden its portfolio of water supplies, which now includes the following[3]:

- A contract entitlement with the CVP (held by SEWD) from the Calaveras River out of New Hogan Reservoir
- A contract entitlement with the CVP (held by SEWD) from the Stanislaus River out of New Melones Reservoir
- Interim water transfer agreements with the Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID), both from the Stanislaus River out of New Melones Reservoir (held by SEWD)
- Recycled water
- Groundwater

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[3] Note that COSMA's existing surface water supplies are received pursuant to water service agreements with SEWD. The underlying water rights and contract entitlements are held by SEWD.

Figure 3-11 illustrates the geographic variation of COSMUD's sources of surface water supplies. Each of the sources of supply mentioned above is discussed briefly below.

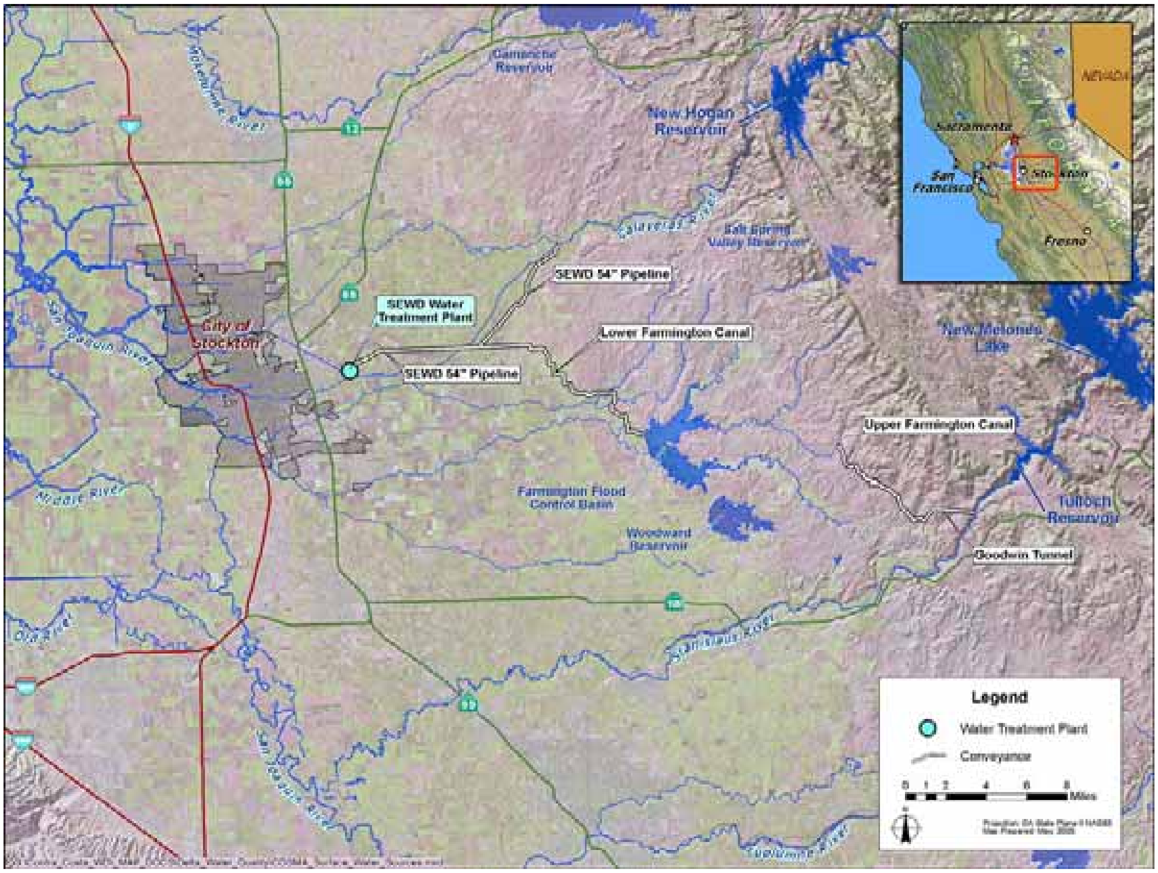

Figure 3-11 City of Stockton Metropolitan Area
Sources of Surface Water Supplies

Calaveras River/New Hogan Reservoir Central Valley Project Contract Entitlement

SEWD receives water from New Hogan Reservoir pursuant to a contract made between Reclamation, Calaveras County Water District (CACWD) and SEWD. Of the total 84,100 AF per year contracted amount, SEWD is entitled to 40,200 AF per year. In addition to its contracted amount, SEWD also has an agreement with CACWD to receive a portion of CACWD's allocation (currently, 10,000 AF per year), pending future development and additional water needs of Calaveras County. The future reliability of this supply is questionable as a result of impacts from implementation of requirements of the Central Valley Project Improvement Act (CVPIA) and other regulatory actions. Currently, in "dry" years, as little as 12,000 AF per year of surface water is available to SEWD (and in turn, to COSMA).

Stanislaus River/New Melones Reservoir Central Valley Project Contract Entitlement

SEWD receives water from New Melones Reservoir pursuant to a contract made with the CVP for up to 75,000 AF per year. This supply is diverted from the river at the Goodwin Diversion Dam and conveyed via the Goodwin Tunnel and the upper and lower Farmington canals to SEWD's WTP (see **Figure 3-11**). Similar to the New Hogan supply, the future reliability of this supply is questionable as a result of impacts from implementation of requirements of the CVPIA and other regulatory actions. In the future, SEWD is projected to receive no water from New Melones Reservoir, further increasing the gap between supply and demand in COSMA.

Oakdale Irrigation District/ South San Joaquin Irrigation District Water Transfers

OID and SSJID both hold senior appropriative water rights on the Stanislaus River. Under a current agreement, up to 600,000 AF per year are released by Reclamation from New Melones Reservoir for diversion by OID and SSJID.

SEWD currently has a water transfer agreement with OID/SSJID for an interim water transfer of up to 30,000 AF per year. Actual deliveries to SEWD pursuant to the transfer agreement are based on unimpaired inflow to New Melones Reservoir and can be reduced in "dry" years to as little as 8,000 AF per year. This agreement is reduced by 50 percent in 2009 and expires entirely in 2019. SEWD and the city of Stockton (COS) are currently exploring an extension of this water transfer agreement.

"Section 215" Central Valley Project Contract

SEWD holds "Section 215" (or "spill water") contracts with Reclamation for both the New Melones and the New Hogan reservoirs. "Section 215" water supplies are water surplus to the Delta that is deemed under the operational control of CVP. It is only available on an intermittent basis, and typically only in "wet" years.

Recycled Water

COS owns and operates the Stockton Regional Wastewater Control Facility, which currently produces about 31,000 AF per year of treated wastewater effluent. This effluent is currently discharged to the San Joaquin River and the Delta. Currently, less than 30 AF per year is recycled from this facility, entirely for agricultural irrigation purposes.

Groundwater

The groundwater basin underlying San Joaquin County (and COSMA) is part of the contiguous Central Valley aquifer system, which supplies groundwater to agricultural, domestic, and industrial water users from Redding to Bakersfield. The thickness of the useable aquifer in the eastern portion of San Joaquin County ranges from less than 100 feet in the eastern edge of the county to over 3,000 feet in the southwestern edge. It is approximately 1,000 feet thick beneath the majority of COSMA.

Groundwater in the San Joaquin County area moves from sources of recharge to areas of discharge. Most recharge to the aquifer system occurs from the Delta and along active stream channels where extensive sand and gravel deposits exist. Consequently, the highest groundwater elevations typically occur near the Delta, Stanislaus River, and San Joaquin River. Other sources of recharge within the service area include subsurface recharge from fractured geologic formations to the east, as well as deep percolation from applied surface water and precipitation. Groundwater underlying COSMA generally flows to the east toward a cone-of-depression that exists in the central portion of the county (see further discussion below). **Figure 3-12** provides a conceptual view of the groundwater system located beneath eastern San Joaquin County (including COS).

Extraction of groundwater from the basin underlying eastern San Joaquin County has resulted in a persistent groundwater cone of depression and a groundwater gradient that has induced the migration of highly saline groundwater under the influence of the Delta to migrate eastward (see **Figure 3-11**). This saline intrusion has threatened the city's groundwater supply, particularly in "dry" years, since the late 1970s. Consequently, the city has established a 0.6 AF per acre long-term groundwater extraction operational safe yield as part of its groundwater management program. The objective is to reduce, or even eliminate, the existing cone of depression. Application of this groundwater extraction limitation equates to an annual groundwater extraction of about 40,000 AF per year across COSMA.

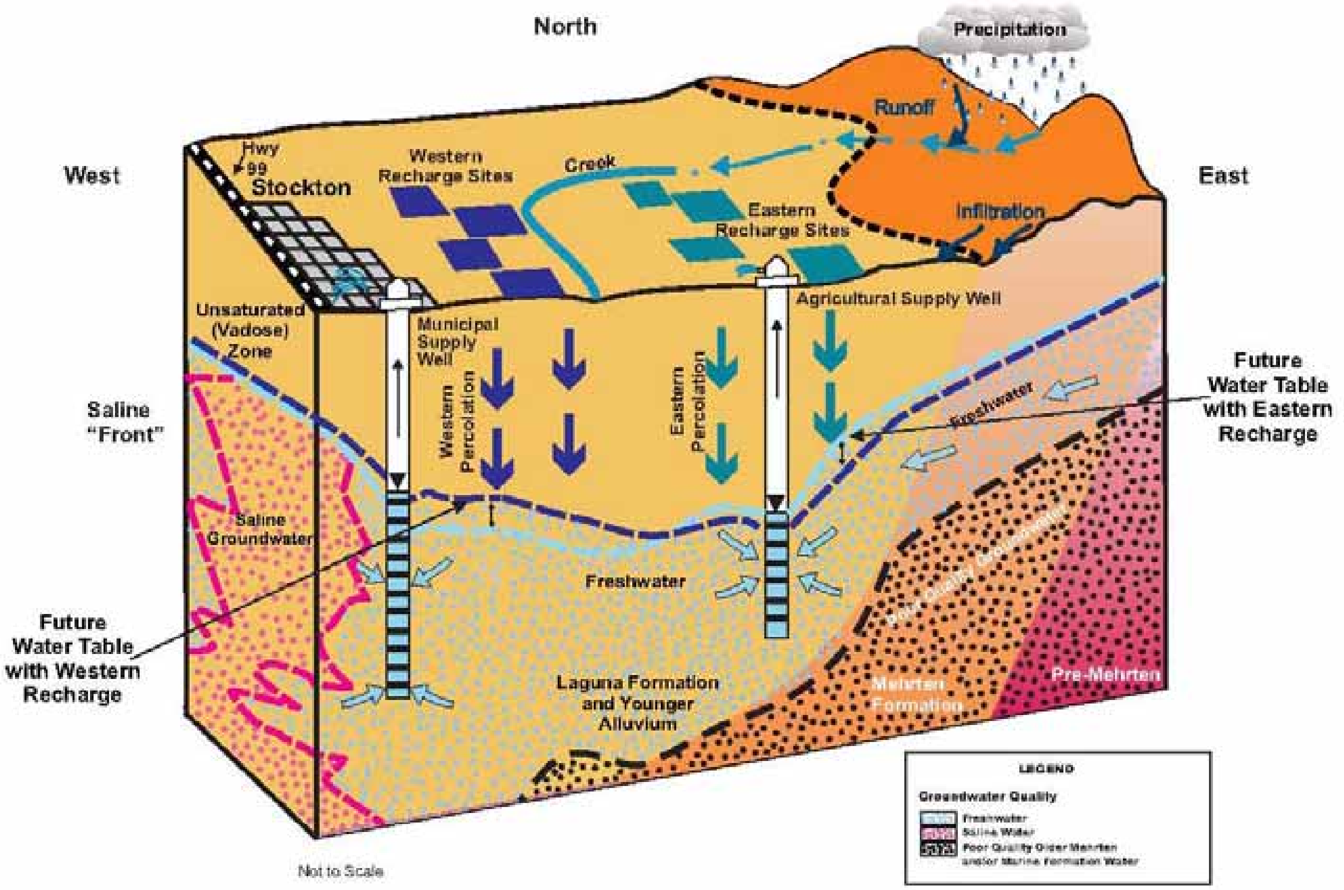

Figure 3-12 Conceptual Model of the Eastern San Joaquin County Groundwater System

Potential "Future" Surface Water Supplies

Current surface water availability for COSMA ranges from 100,000 AF per year in a "wet" year to 30,000 AF per year in "critically dry" year. However, surface water availability from the SEWD is projected to decrease in the future as the interim water transfer agreements with OID and SSJID expire and SEWD relinquishes some of the water it receives from New Hogan to CACWD. Consequently, COS is currently pursuing new surface water supplies as part of its proposed DWSP. Specifically, the city of Stockton has filed an application with the SWRCB to divert water from the Delta pursuant to two water rights:

- A diversion under Chapter 1485 of the California Water Code[4]
- A diversion under Chapters 11460 through 11465 of the California Water Code (the "Area of Origin" statutes)

COS also is pursuing other potential sources of surface water supply from the Mokelumne, Calaveras, and Stanislaus rivers (on either an interim or long-term basis) that include (1) an appropriative water right from the Calaveras River, (2) a water transfer agreement from the "Farmington Groundwater Recharge Project" under development by the SEWD, (3) a contract entitlement with the CVP for water supplies made available through the reoperation of New Hogan Reservoir in combination with a groundwater banking program, and (4) water transfer agreements with the cities of Lodi and Lathrop and the Woodbridge Irrigation District. Discussions on all of these potential future supplies are very preliminary at this stage of development.

WATER QUALITY CONSIDERATIONS

Groundwater

The principal water quality concern for COSMA existing supplies is the degradation of groundwater quality (namely saline intrusion) that has occurred as a result of groundwater overdraft and the persistent cone of depression in the central portion of San Joaquin County (see **Figure 3-13**). Groundwater use within the San Joaquin County region has resulted in the decline of groundwater elevations by 40 to 60 feet over the last 20 to 30 years. This decline in groundwater elevation has created a gradient that has allowed saline water underlying the Delta region to migrate northeast into the southern portion of COSMA. This saline intrusion has degraded water quality, threatening the long-term productivity of the groundwater basin and compromising the future of the basin as a source of agricultural and municipal water supply.

Currently, a number of wells within COSMA contain arsenic concentrations above the newly established 10 mg/L level set by EPA. Low arsenic concentrations, below the new standard, also have been detected in numerous wells throughout COSMA. All of these wells are being closely monitored, as arsenic is a known carcinogen for humans.

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[4] California Water Code Chapter 1485 essentially permits any municipality disposing of treated wastewater into the San Joaquin River to seek a water right to divert a like amount of water, minus losses, from the San Joaquin River of the Delta downstream of the point of wastewater discharge. The city of Stockton seeks to recover a portion of the treated wastewater effluent it currently discharges to the San Joaquin River and the Delta from the Stockton Regional Wastewater Control Facility.

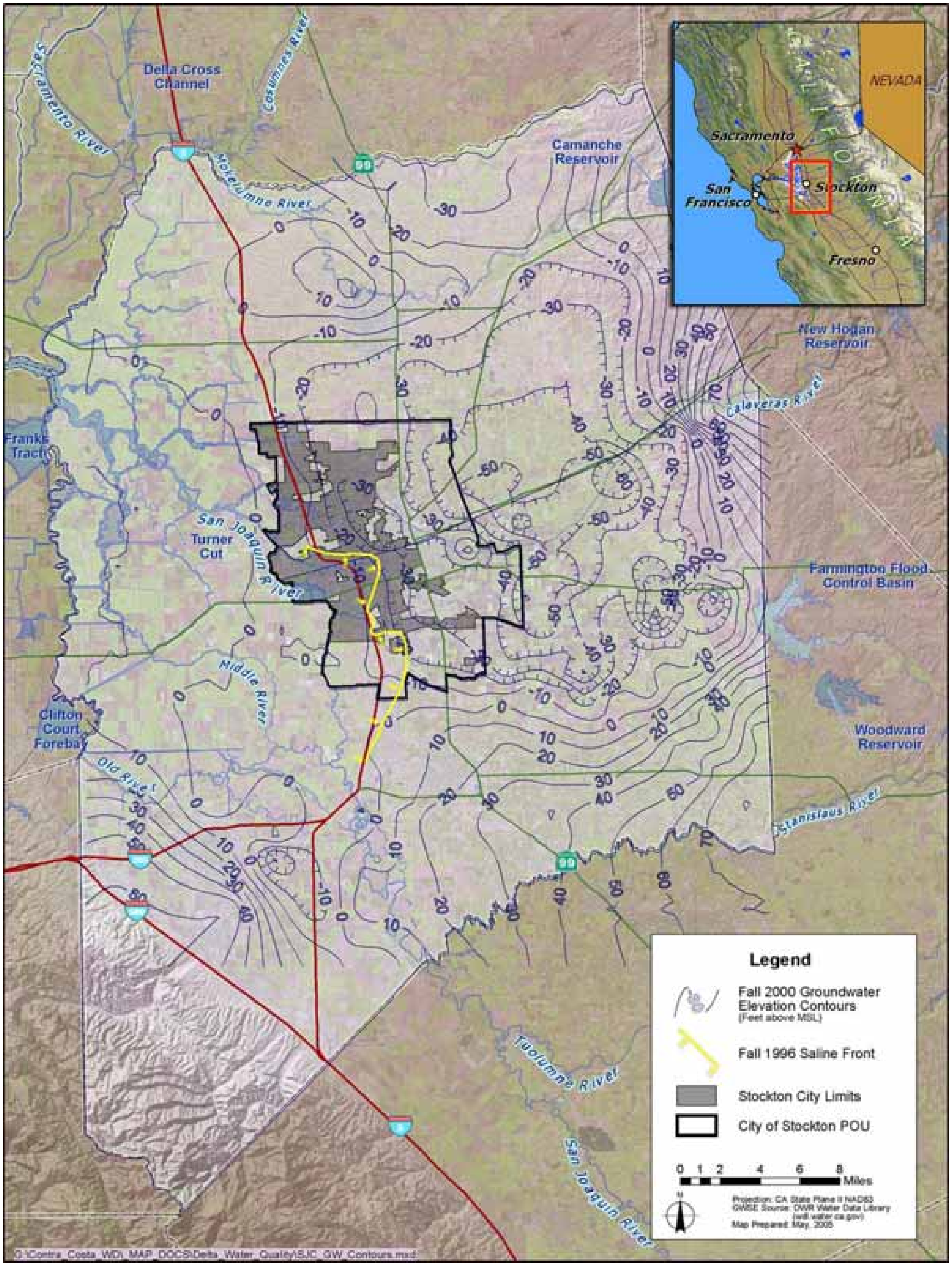

Figure 3-13 San Joaquin County Groundwater Contours (Fall 2000) and Approximate Position of Front of Induced Salinity Intrusion (Fall 1996)

Although concentrations never exceeded the maximum concentration limits (MCL) allowed, elevated concentrations of nitrate have been detected in two wells in the city's North System. High concentrations of nitrate (above 45 mg/L) are a health risk for infants less than 6 months old.

Concentrations of iron and manganese in have been found to exceed the secondary MCLs of 300 and 50 µg/L, respectively. These high concentrations are thought to be due to leaching of natural deposits. Iron and manganese, while not health hazards at these concentrations, cause color and T&O concerns in the water supply.

Surface Water

The surface water supplies diverted, treated, and delivered by SEWD are of high quality and meet all state and federal water quality regulations and standards. It should be noted, however, that degradation of water quality at the logical points of a diversion from the Delta by COS has impacted the location of the planned point of diversion for the aforementioned DWSP (see **Chapter 4** for a further discussion).

WATER TREATMENT AND DISTRIBUTION CAPABILITIES

Stockton East Water District WTP

The 45 mgd SEWD WTP treats water from the Calaveras and Stanislaus rivers, using GAC treatment, and distributes the treated water to COSMUD, Cal Water, and San Joaquin County (through the Lincoln and Colonial Heights maintenance districts). Water is delivered to these water purveyors based on the percent water use each agency comprises in the Stockton region (e.g., COSMUD's current allocation is approximately 50 percent, meaning it comprises 50 percent of the water demand of COSMA). From December through April, high turbidity levels in the influent water limit treated water supply peak production at the SEWD WTP. Diversions from the Stanislaus River are preferred over the Calaveras River due to its higher water quality.

PROJECTS AND PROGRAMS RELATED TO EFFORTS TO DIVERT WATER FROM THE DELTA

COSMUD is developing several major projects and programs to address its future water quality needs and to improve the drinking water quality delivered to customers. These projects and programs, each of which is more fully discussed in **Chapter 4** within the context of the CALFED ELPH construct, include the following:

- DWSP described above
- Groundwater aquifer storage and recovery (ASR) program utilizing raw surface water used to recharge the groundwater basin (see Farmington Groundwater Recharge Program) or treated surface water supplies diverted through the DWSP facilities and directly injected into the groundwater aquifer
- Conversion of wastewater treatment lagoons at the Stockton Regional Wastewater Control Facility to wetlands to improve the quality of effluent discharged to the Delta by the facility

SOLANO COUNTY WATER AGENCY

AGENCY OVERVIEW

Solano County Water Agency (SCWA), originally the Solano County Flood Control and Water Conservation District (SCF&WCD), was formed in 1951. The boundary of the agency encompasses all of Solano County, portions of the University of California at Davis (UC Davis), and 2,800 acres of Reclamation District No. 2068 (RD 2068) in Yolo County (see **Figure 3-14**).

SCWA is responsible for providing wholesale, untreated water supplies; protecting existing water rights and contract entitlements; protecting the quality of existing water supplies; and securing new water supply sources to meet the future demands of its customers. In terms of flood control, SCWA has authority for all flood control efforts within its boundaries, including operation and maintenance of the Ulatis and Green Valley flood control projects.

SCWA member agencies include the cities of Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo; California State Prison-Solano (CSP-Solano); UC Davis; Solano Irrigation District (SID); Maine Prairie Water District (MPWD); and RD 2068. **Table 3-5** summarizes SCWA member agencies, divided between municipal and agricultural districts. The governing board of SCWA includes the five-member Board of Supervisors of Solano County (the County), the mayors from all seven cities in the county, and a board member from each of the three agricultural irrigation districts.

Table 3-5 Member Agencies of the Solano County Water Agency

Municipal Water Service Providers

- City of Benicia
- City of Dixon
- City of Fairfield
- City of Rio Vista
- Suisun City
- City of Vacaville
- City of Vallejo
- Travis Air Force Base
- California State Prison-Solano
- Solano Irrigation District

Agricultural Water Service Providers

- Solano Irrigation District
- Maine Prairie Water District
- University of California at Davis
- RD 2068
- California State Prison-Solano

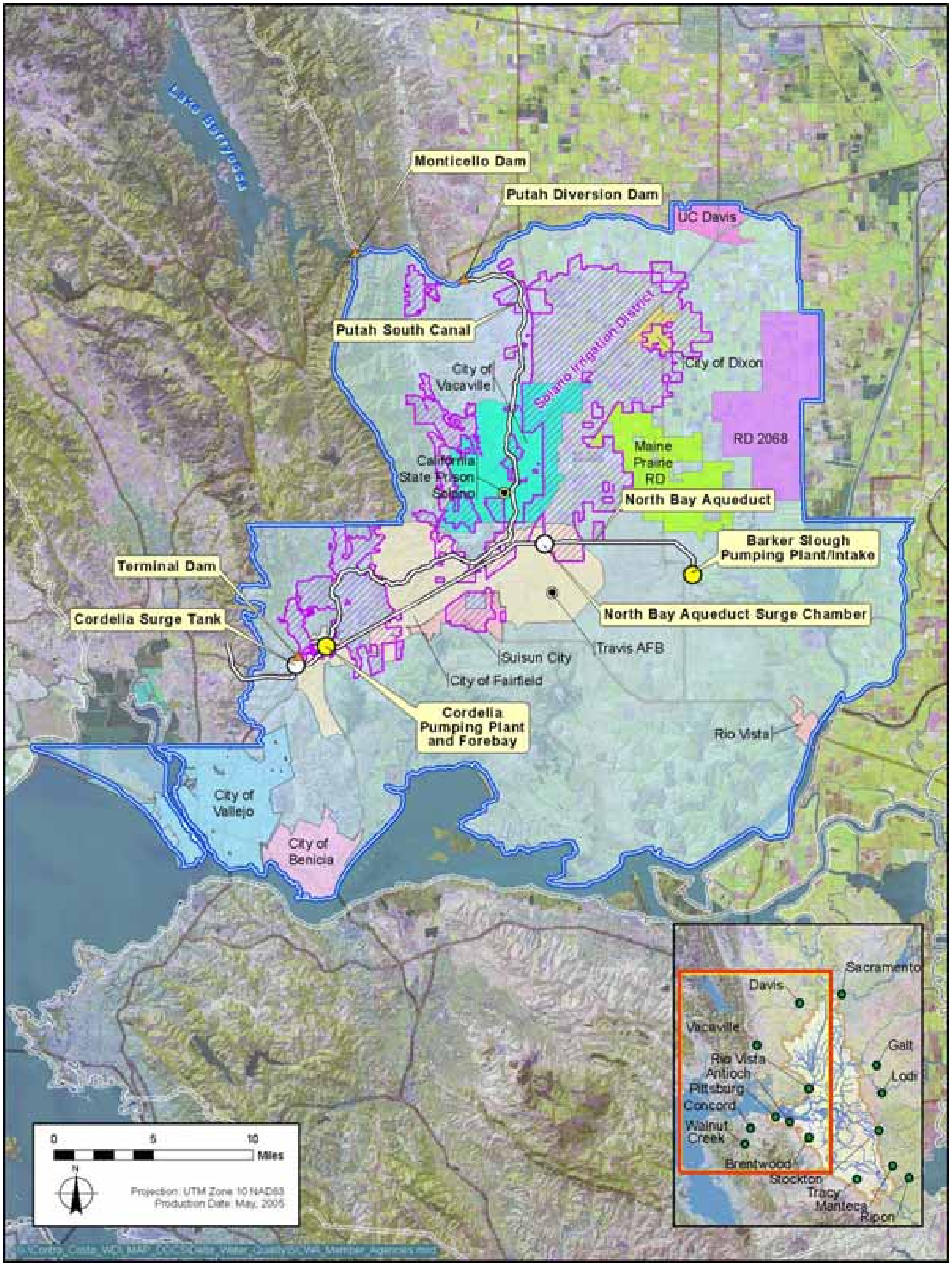

Figure 3-14 Service Areas of Solano County Water Agency and Member Agencies

SUMMARY OF EXISTING AND FUTURE WATER SUPPLY NEEDS

Water demands within the SCWA are met principally with surface water. Some use of groundwater occurs by SCWA member agencies (typically less than 5 percent). Currently, all water customers within SCWA have enough available supply during "wet" and "normal" hydrologic year conditions. During drought, some deficiencies do occur, requiring purchase of additional water supplies or internal "transfer" agreements between SCWA members.

Unless new water sources of supply are developed, "normal" year deficiencies are expected to occur by 2020. Although it is anticipated that agricultural water use will remain relatively constant at about 210,000 AF per year, M&I demand is expected to increase from about 94,000 AF per year in 2000 to about 126,000 AF per year in 2020 (see **Table 3-6**). This anticipated increase is a result of a projected population increase of over 100,000 people by the year 2020. Though the SCWA expects to be able to manage short-term dry periods through local transfer agreements and exchanges with agricultural water users, during an extended dry period, SCWA would have a shortage of available water supply for M&I use.

Table 3-6 Water Demand Projections for the Solano County Water Agency Service Area

Water Demand	Year 2000 (AF per year)	Year 2020 (AF per year)
Agricultural	207,488	210,000
Municipal	93,870	126,000
TOTAL DEMAND	**301,958**	**336,000**

SOURCES OF SUPPLY

SCWA meets the majority of its water demands with surface water. Principal sources of supply for SCWA and its member agencies include the following:

- Non-Delta surface supply via the Reclamation Solano Project out of Lake Berryessa
- Delta diversion via the North Bay Aqueduct (NBA) of the California SWP
- Water right for diversion from the Delta held by the city of Vallejo
- Area of Origin Settlement agreement with DWR and the SWP
- Several surface water rights associated with local watersheds
- Recycled water
- Groundwater

Each of these sources of supply is discussed briefly below.

Solano Project

Reclamation completed construction of the Solano Project in 1959. The principal purpose of the project was to offset the groundwater overdraft in the region. Local runoff from Putah Creek is collected behind Monticello Dam, creating about 1.6 million AF of storage in Lake Berryessa. Water is released from Monticello Dam into the Lower Putah Creek. That water is then impounded by the Putah Diversion Dam, forming the 750 AF Solano Lake. The Putah Diversion Dam diverts water to the 33-mile, 956 cfs (maximum conveyance) Putah South Canal (PSC), which then delivers the Solano Project member agencies (which include members of SCWA). SCWA holds a contract entitlement with Reclamation for 207,350 AF per year of Solano Project water stored in Lake Berryessa. Each Solano Project member agency has an annual entitlement. SCWA operates with an estimated average annual system loss rate of 15,000 AF per year.

Putah Creek Diversion Dam

The Putah Creek Diversion Dam diverts water into Putah South Canal for delivery to Solano Project member agencies.

Unlike most federal water projects, the underlying water rights of the Solano Project are held in trust by Reclamation for the SCWA member agencies. Once the water rights associated with the Solano Project are perfected, the license will be issued in the name of the SCWA and its Solano Project member agencies. The agencies that receive water from SCWA via the Solano Project include Fairfield, Suisun City, Vacaville, Vallejo, SID, MPWD, UC Davis, and CSP-Solano (see **Figure 3-14**).

The Solano Project has proven to be an extremely reliable source of water for SCWA, with the ability to deliver its nominal firm yield even during short-term drought events. When reductions in deliveries are required, municipal and agricultural contractors receive reductions on an equal basis. Development of Solano Project carryover storage and exchange agreements has increased the reliability of the Solano Project supply for M&I users. These agreements facilitate the sale of water by SID to M&I users during drought.

The water quality of supplies from the Solano Project also is high from the perspective of both M&I and agricultural users. This high quality is attributed to the majority of the watershed still remaining in its natural, undeveloped state. However, although the quality of Solano Project water typically is high, seasonal water quality problems still occur (usually, turbidity during periods of high runoff).

North Bay Aqueduct

The NBA was completed by the SWP in 1988, delivering water to the cities of Benicia and Vallejo (see **Figure 3-14**). In 1990, the North Bay Regional Water Treatment Plant

(NBRWTP) was completed and allowed for delivery and treatment of NBA water to the cities of Fairfield and Vacaville. The aqueduct also serves Napa County and Travis Air Force Base (AFB). The cities of Suisun City, Rio Vista, and Dixon all have contract entitlements to water from the NBA but currently do not have facilities to receive this supply.

The 27-mile-long NBA begins a few miles north of Rio Vista at the 175 cfs capacity (154 cfs current capacity) Barker Slough Pumping Plant. The Barker Slough facility is located on the north shore of Barker Slough, one half-mile east of State Highway 113. Increasing the NBA capacity to 248 cfs is currently being investigated.

SCWA has a contract with DWR to receive 47,756 AF per year through the NBA. Diversions from the Delta at Barker Slough for delivery to the NBA account for approximately one-third of the SCWA's total water supply. Currently, this entire supply is delivered for M&I use. This SWP allocation includes a water entitlement purchase from the Kern County Water Agency (KCWA) for the exchange of up to 5,756 AF per year to be delivered to the cities of Fairfield and Vacaville.

The reliability of the NBA water supply is marginal, with the full contract entitlement being delivered only in very wet years. The potential development of new SWP storage and conveyance facilities may increase the reliability of the NBA, but construction of such facilities is uncertain. The quality of water drawn from Barker Slough at the NBA Pumping Plant is poor. In particular, TOC and turbidity have been problematic at the NBA diversion.

City of Vallejo Water Right

An appropriative water right held by the city of Vallejo allows for the diversion of up to 31.52 cfs from the Delta. The place of use (POU) for this permit includes Vallejo, Benicia, parts of Fairfield, and the American Canyon area in Napa County. [Note: American Canyon is not part of SCWA.] Initially, water diverted under this permit was delivered via the Cache Slough Pipeline. However, since the construction of the NBA, the point of diversion has been moved to Barker Slough. An interconnection with the NBA allows some of the Cache pipeline to convey some of Vallejo's water from the NBA. When using the NBA, use of Vallejo's water right is limited to 17,287 AF per year. Vallejo's water right is senior to the SWP (and the NBA) and is therefore more reliable than SCWA SWP supplies, particularly in "dry" years.

Settlement Agreement Water

Settlement water is a relatively new source of supply for the cities of Benicia, Fairfield, and Vacaville. In 1990, these three cities filed a water rights application with the SWRCB for appropriation of surface water under Chapters 11460 through 11465 of the California Water Code (the "Area of Origin" statutes). This application was withdrawn after a settlement agreement was made with the DWR that provided an equivalent water supply to the cities from the SWP. This settlement agreement provides for delivery to the cities of Benicia, Fairfield, and Vacaville of up to 10,500 AF per year, 11,800 AF per year, and 9,320 AF per year, respectively (for a total of 31,620 AF per year). The principal restriction on the settlement supply is that it is not available when Standard Water Right Term 91 (Term 91) is in effect. The settlement runs through 2035 and can be renewed under the same terms as SCWA's NBA SWP contract.

Surface Water from Local Watersheds

The city of Vallejo owns and operates a group of reservoirs known as the Vallejo Lakes System. Currently, water stored in these reservoirs serves the unincorporated communities of Suisun Valley and Green Valley. However, Vallejo is presently working with Reclamation on a means of tying into PSC to deliver water from the reservoir system to its Fleming Hill WTP. The system has a storage capacity of about 10,700 AF and an associated annual yield of about 3,750 AF per year.

Lake Herman, owned by the city of Benicia, is operated as a terminal reservoir, storing excess water delivered from the NBA. Approximately 500 to 1,000 AF per year are available from the reservoir; however, this supply is principally available only in "wet" years. No yield is available in "dry" years.

Throughout Solano County, particularly those areas adjacent to the Delta, agricultural water users hold both riparian and appropriative rights to divert water directly from local waterways. These supplies are not under the operational or administrative control of SCWA.

Recycled Water

The Fairfield/Suisun Sewer District (FSSD) maintains one of the longest operating wastewater recycling facilities in California. Wastewater from the Fairfield/Suisun area is recycled and used for agricultural irrigation, as well as for providing a source of fresh water to the Suisun Marsh. In addition, the city of Fairfield, in cooperation with FSSD, has constructed a recycled wastewater distribution system for landscape irrigation throughout portions of the city.

The city of Vacaville discharges its treated wastewater into local waterways that drain into the Ulatis Flood Control Project facilities and eventually to the Delta through Hass and Cache sloughs. During the summer irrigation season, this treated wastewater, agricultural return flows, natural runoff, and Solano Project releases are stored behind temporary dams constructed by MPWD and SID, then rediverted for agricultural irrigation. This practice can be considered water recycling as very little water leaves Solano County.

Recycled water is used to recharge Suisun Marsh and help support ecosystem functions.

The city of Benicia is considering development of a wastewater-recycling program that would deliver treated wastewater to the Valero refinery, in turn reducing the refinery's demand for NBA water. In addition, SCWA, a member of the Northern California Salinity Coalition, is currently investigating multiple projects that would remove salts in recycled water, making the water more easily used for industrial processes.

Groundwater

The largest groundwater basin in Solano County is located in the northeastern portion of the county, bound by the Vacaville foothills and Sacramento River on the west and east, respectively, and by Putah Creek and Fairfield to the north and south. The cities of Rio Vista and Dixon rely entirely on groundwater for their water supplies, while Vacaville uses groundwater deliveries to meet about one-third of its M&I demand. SID supplements its Solano Project supplies with groundwater, and individual wells also are present in the majority of rural areas throughout SCWA. Recent reports has indicated the delivery of surface water from the Solano Project and NBA have stabilized the groundwater basin and no immediate threat exists of further groundwater overdraft given the current usage volume and pattern. SCWA, in coordination with its member agencies currently using groundwater, is investigating whether the increased use of the underlying groundwater basin can be developed as a reliable long-term source of water supply.

WATER QUALITY CONSIDERATIONS

As noted previously, the Solano Project water supply is typically of high quality, with only some slight seasonal variations attributed primarily to high runoff conditions. Principal water quality concerns of the SCWA and its member agencies are related to the NBA. NBA water is diverted from the Delta at the agency's Barker Slough Pumping Plant. Studies have shown that the NBA has the poorest water quality of all SWP contractors for some water quality constituents, particularly, TOC. Samples taken from Barker Slough typically do not meet the CALFED water quality targets of 3.0 mg/L DOC and 50 µg/L of bromide (see **Figure 2-23** in **Chapter 2**), nor do samples meet the SCWA requirements for turbidity. The poorest water quality conditions in the NBA usually occur during the winter months when runoff from the Barker Slough watershed, used mainly for livestock grazing, is pumped into the aqueduct, increasing the turbidity and organic carbon content in the water supply. The increases in turbidity can also result in low alkalinity levels.

Total/Dissolved Organic Carbon and Turbidity

Organic carbon is produced naturally in the SCWA watershed and is found in soils, sediments, and decomposing algae, plant, and animal waste. It is believed that during winter months, organic carbon in Barker Slough originates from land sources, while during the summer months it is generally produced directly by decaying material in the slough. Previous investigations have indicated it is not practical to effectively control organic carbon in the watershed.

The soils in the SCWA watershed consist of very fine particles that do not settle well. As a result, they stay in suspension for long periods of time. For these fine particle soils, typical Best Management Practices (BMP) such as buffer strips and settling ponds do not reduce the turbidity. However, removal of livestock from waterways and erosion control have been found to be beneficial. Typically, turbidity in the NBA is between 30 and 80 nephelometric turbidity unit (NTU).

The combination of high organic load and elevated turbidity is especially problematic for SCWA's M&I member agencies. Treatment of the NBA supply for drinking water purposes can result in high concentrations of DBPs. Free chlorine added during the disinfection stage of water treatment reacts with the organic material to form THMs and HAA5, both of which are regulated DBPs. Elevated turbidity exacerbates the problem, as additional disinfection is required for turbid supplies.

Bromide

Bromide concentrations in the NBA vary from 25 mg/L to 80 mg/L, which is less than south-of-Delta water supplies. However, some of the SCWA member agencies use ozone for disinfection. In such cases, a reaction can occur with bromide present in the water creating bromate, a regulated DBP. Possible sources of bromide in the NBA include seawater, ancient marine sediments in one of the geologic formations of the watershed, and the runoff from irrigated fields.

Cryptosporidium

The average *Cryptosporidium* reading in the NBA at Barker Slough is 0.08 oocysts/L, just above the EPA threshold of 0.075 oocysts/L. During times of winter storm runoff, when turbidity and TOC are both high, effective coagulation decreases, resulting in less effective removal of *Cryptosporidium*.

Endocrine Disrupting Chemicals and Pharmaceutical and Personal Care Products

Currently, neither EDCs nor PPCPs are regulated. However, EPA is evaluating their occurrence and effects on humans. Because the NBA watershed includes industrial, agricultural, and urban runoff, SCWA member agencies would be potentially vulnerable to any regulations implemented in the future.

Algae and Byproducts

Concerns regarding the production of algae in the Delta include T&O issues as a result of algae byproducts, filter clogging, and decreased treatment plant production, and impacts to human liver and kidney function due to the production of algal toxins.

Other Concerns

According to the North Bay Aqueduct, Barker Slough Watershed Water Quality-Phase I Report (July 1998), increased levels of E. coli, total aluminum, iron, and manganese have required treatment plants to increase their level of disinfection, in turn increasing treatment costs.

WATER TREATMENT AND DISTRIBUTION CAPABILITIES

SCWA delivers raw water supplies on a wholesale basis and is not responsible for delivering water directly to individual M&I or agricultural customers. The cities and other entities that receive water from SCWA are responsible for water treatment and distribution. Below is a description of the various WTPs owned and operated within SCWA.

City of Benicia WTP

Benicia owns and operates a 12 mgd water treatment facility. The facility uses conventional water treatment processes that include alum/cationic polymer coagulation-flocculation; dual GAC/sand gravel media filtration; and free chlorine disinfection. The majority of the raw water entering the treatment plant comes from the NBA and originates from the Delta. Because the city does not have an alternate water source to blend with or switch to during poor raw water quality months in the winter, its water treatment concerns and costs are elevated. If the quality of Delta water degrades in the future, the result will be significantly increased treatment costs.

North Bay Regional WTP

The cities of Fairfield and Vacaville jointly own the NBRWTP. The plant has a design capacity of 40 mgd, and was designed to treat NBA Delta water, Solano Project Lake Berryessa water, or a blend of the two. Treatment processes include pre-ozonation, coagulation/flocculation, sedimentation, GAC filtration, ozone disinfection, caustic soda for pH adjustment, fluoride, and free chlorine for final disinfection. During winter months when raw water quality from the Delta is poor, Fairfield and Vacaville have the option of switching their supplies to Lake Berryessa water, improving the quality of water to be treated, and in turn decreasing their treatment costs. However, the cities' ability to preferentially abandon their NBA supply for Solano Project water will become less feasible as demand increase within the cities' service areas.

Fleming Hill WTP

The Fleming Hill WTP is the only source of water for the city of Vallejo, typically treating a blend of Lake Berryessa and NBA water. Treatment processes at this 42 mgd facility include flow blending, pre-ozonation, flash and rapid mixing, flocculation, sedimentation, intermediate ozonation, and GAC filtration. Gaseous chlorine is used for final disinfection. During winter months, when raw water quality from the Delta is poor, Vallejo has the option of switching its supplies to Lake Berryessa water, improving the quality of water to be treated, and in turn decreasing its treatment costs. However, the city's ability to preferentially abandon its NBA supply for Solano Project water will become less feasible as demand increases within the city's service area. The result will be significantly increased treatment costs.

Travis AFB WTP

The Travis AFB WTP receives all of its water from the NBA. The facility is managed and operated by the city of Vallejo. Treatment processes at this 7 mgd facility include conventional filtration with pre-ozone and GAC. All the raw water delivered to the facility originates in the Delta. Because Travis AFB does not have an alternate water source to blend with or switch to during poor raw water quality months in the winter, its water treatment concerns and costs are elevated.

PROJECTS AND PROGRAMS RELATED TO EFFORTS TO DIVERT WATER FROM THE DELTA

SCWA is developing several major projects and programs to address its future water quality needs and to improve the drinking water quality delivered to its customers. These projects and programs include the following:

- Alternate Intake Project to evaluate other points of diversion from the Delta for the purpose of improving water quality
- BMP for watershed protection to reduce organic carbon loading and turbidity in Barker Slough
- Additional internal water transfer and exchange programs (and the required facilities) to provide operational flexibility with respect to source water
- Application of advanced water treatment technologies at SCWA member agency facilities

Each of these potential projects or programs is more fully discussed in **Chapter 4**.

TREATMENT OF DELTA DIVERSIONS FOR DRINKING WATER PURPOSES

AVAILABLE TECHNOLOGIES

Based on current and anticipated drinking water standards, known Delta water quality constituents of concern, and current in-Delta drinking water supply needs, a number of water treatment technologies are available that are proven to be effective in treating Delta water supplies. **Table 3-7** summarizes constituents of concern and applicable control technologies.

EXISTING DELTA WATER TREATMENT FACILITIES

The various agencies treating Delta water in northern California have responded to the regulatory requirements in a variety of ways, as shown in **Table 3-8** summarizing existing treatment plants and processes.

Table 3-7 Technologies Available to Treat Delta Diversions for Drinking Water Purposes

Treatment Process	TOC/ DOC	Turbidity Spikes	Bromide	D/ DBPs	*Crypto*	EDC/ PPCP	T&O	Algae & By-products
Improved Clarification								
MIEX	X	X	X	X				
Enhanced coagulation	X	X		X	X	X		
Actiflo	X	X		X	X			
DAF	X	X		X	X			
Coagulant change	X	X		X				
Filtration	X	X			X			
Separation Membranes								
MF/UF	X			X	X	X		
RO			X			X		
Adsorption								
PAC	X						X	X
GAC	X			X		X	X	X
Disinfection and oxidation								
Ozone	X			X	X			
UV				X	X		X	
Low pH	X		X					

Key:	Crypto = *Cryptosporidium*	GAC = granular activated carbon	RO = reverse osmosis
	DAF = dissolved air flotation	MEIX = magnetic ion exchange	T&O = taste and odor
	DBP = disinfection byproduct	MF/UF = microfiltration/ultrafiltration	TOC = total organic carbon
	DOC = dissolved organic carbon	PAC = powdered activated carbon	UV = ultraviolet

TREATMENT OF DISINFECTION BYPRODUCT PRECURSORS

The DBP issue for Delta water agencies relates to two constituents:

- **Total Organic Carbon** – The CALFED goal is 3.0 mg/L to minimize formation of DBPs from reaction of chlorine used as a disinfectant with TOC precursors from natural organics. Urban agencies are using or considering alternative disinfectants alone or in combination, adsorption on magnetic ion exchange (MIEX) particles, or enhanced coagulation to reduce concentrations and reduce disinfection byproduct formation.
- **Bromide** – The CALFED goal is 50.0 µg/L since bromide can react with ozone used for disinfection, oxidation, or T&O control to form bromate. This bromide goal is met part of the time at the NBA intake, but is hardly ever met at any of the south and central Delta diversions. Agencies that rely on Delta water adjust their treatment processes to promote reactions other than bromate formation (for example, by decreasing pH to favor hypobromous acid or adding ammonia to form bromamines) or they use other treatment technologies.

Table 3-8 Existing Water Treatment Facilities Treating Delta Water

Process	South Bay Aqueduct							Contra Costa Canal/ Los Vaqueros		North Bay Aqueduct			
	Zone 7		Alameda County Water District		Santa Clara Water District			Contra Costa Water District		Fairfield/ Vacaville	Benicia	Vallejo	
	PP[1] 20 mgd	DV[2] 36 mgd	MSJ[3] 10 mgd	TP 2 21 mgd	Penitencia 42 mgd	Rinconada[4] 80 mgd	Santa Teresa 100 mgd	Randall-Bold[5] 40 mgd	Bollman[6] 75 mgd	NBR 40 mgd	Benicia 10 mgd	Fleming Hill 42 mgd	Travis AFB 7 mgd
Clarification													
Horizontal Sedimentation			x	x	x		x	(x)	x	x	x	x	x
Superpulsator		x											
Upflow Clarifier	x					x							
DAF		x											
Ozonation													
Preliminary				x				x		x		x	x
Intermediate					x	(x)	(x)	(x)	x			x	
Post								x		x			
Filtration													
Anthracite/Sand	x	x		x							x		
GAC/Sand					x	x	x	x	x	x		x	x
Membranes	x		x										
Disinfection													
Chlorine	x	x	x		x	x	x			x	x	x	x
Chloramines	x	x	x	x	x	x	x	x	x				
Ultraviolet													

Key: AFB = Air Force Base
DAF = dissolved air flotation
DV = Del Valle WTP
GAC = granular activated carbon
MGD = million gallons per day
NBR = North Bay Regional WTP
PP = Patterson Pass WTP
MSJ = Mission San Jose WTP
TP = Treatment Plant #2
WTP = water treatment plant

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(1) *Patterson Pass WTP has 12 mgd granular media and 8 mgd membrane filtration trains*

(2) *Del Valle WTP has 26 mgd Superpulsators and (in design) 10 mgd DAF clarification; space for future intermediate ozonation*

(3) *Mission San Jose WTP was converted from granular media to membrane filtration*

(4) *Rinconada WTP has intermediate ozonation planned and increase capacity to 100 mgd in 2011*

(5) *Randall-Bold WTP is converting from pre- to intermediate ozone, adding sedimentation basins in 2006*

(6) *Bollman WTP added intermediate ozone, converted filters from anthracite/sand to GAC/sand*

MULTIBARRIER APPROACH TO TREATMENT

With the complexity of regulations and the wide variety of contaminants in the Delta, agencies typically use a multibarrier approach to water treatment. This is a well-established public health principle. Examples of the multibarrier approach and it's application by Delta water utilities are as follows:

- **Microorganisms** – pretreatment and filtration for physical removal, followed by disinfection for inactivation. For example, California DHS has required plants with ultrafiltration membranes, which should remove Giardia physically by size exclusion, to add an additional 0.5 log inactivation by disinfection. This multibarrier standard has been applied by DHS to the Alameda County Water District's Mission San Jose WTP, which receives Delta water through the South Bay Aqueduct (SBA). Other actions that can be taken by water utilities are source water protection, best management practices in the watershed, eliminating swimming and body contact in drinking water reservoirs, and requiring additional treatment of municipal wastewater discharges. None of the three Delta agencies currently uses membranes, but this should be a consideration in future treatment. Another multibarrier approach to controlling microorganisms uses multiple disinfectants. CCWD is conducting pilot studies on different combinations of disinfectants (chlorine, chloramines, chlorine dioxide, ozone, ultraviolet light) to examine their synergistic effect on various microbiological targets.
- **Taste and Odor** – oxidation (e.g., ozone) and adsorption (e.g., on GAC filters) are often used in combination. The Fairfield/Vacaville WTP and CCWD's Bollman and Randall-Bold WTPs use both ozone and GAC filters. Taste and odor can also be reduced by controlling algae growth in reservoirs.
- **Total Organic Compounds** – clarification and adsorption or membranes. Some TOC can be removed by pretreatment (coagulation and sedimentation), followed by adsorption on GAC adsorbers. To date, none of the Delta water agencies have used GAC adsorbers, which are more expensive to operate than GAC as filter media. GAC filters may provide a nominal amount of TOC removal if they are allowed to remain biologically active (no chlorine added prior to filters). SCWA has piloted pretreatment using MIEX resin to adsorb DOC, followed by conventional coagulation, sedimentation, and filtration. Nanofiltration following clarification would also provide a multiple barrier, but no local utilities are using this technology; it is expensive, and unsolved issues exist with brine disposal. Agencies also use storage and blending with other sources to reduce TOC spikes in their raw water supply.

OTHER AGENCIES AFFECTED BY DELTA WATER QUALITY

A number of agencies (in addition to CCWD, COSMUD, and SCWA) depend directly on the Delta for at least a portion of their drinking water supplies (see **Table 3-9** at end of chapter). These agencies include both other in-Delta diverters and urban agencies south of the Delta that rely on exports from the SWP Banks Pumping Plant and/or the CVP Tracy Pumping Plant. A number of agencies and entities also undertake activities that can impact Delta hydrology (such as agricultural water users) and water quality (such as agricultural return flows, urban stormwater runoff, and municipal treated wastewater discharges).

These agencies and entities all are greatly affected by both increases and decreases in Delta water quality. Water diversions by these agencies (and others upstream of the Delta) decrease Delta outflow, impacting water quality through salinity increases. In turn, the effects of Delta diversions impact the diverters directly through decreased water quality and supplies. Similarly, degrading water quality portends more stringent regulatory requirements on agricultural and urban dischargers.

The demand for water by all in-Delta water users (both urban and agricultural users, as well as environmental needs) is increasing, resulting in greater stress on Delta supplies. As these stresses continue to increase so will the threat of poor water quality. And through the notion of pumping curtailments and other biological or water quality actions, the availability of the Delta water supply will continue to decrease. This decrease in supply, combined with the constant increase in demand, will require affected agencies to either find other sources to increase their water supply reliability, or to take actions to improve the reliability of their Delta water supply. For the reasons stated above, it can therefore be concluded that all Delta water users (both in-Delta and diverters) would be positively impacted by any means taken to improve Delta water quality.

Although the focus of this phase of the Delta Region Drinking Water Quality Management Plan (DRDWQMP) is on CCWD, COS, and SCWA, an outreach effort was conducted to open discussion with other in-Delta diverters and stakeholders (e.g., agricultural and point-source dischargers, environmental interests, and non-governmental organizations). The outreach program is summarized in **Appendix 1A**. The objectives of this outreach effort included the following:

- Informing interested stakeholders about the goals and objectives of the DRDWQMP
- Providing an opportunity to review and comment on the draft DRDWQMP report
- Collecting information on issues and areas of concern for use in future phases of the DRDWQMP

As part of the outreach effort, a survey was sent to a wide range of other agencies and potential stakeholders. Attempts also were made to contact many of the parties directly. Brief descriptions of the principal issues and areas of concern expressed by those who responded to the survey are provided below. **Table 3-9** provides an overview of the agencies contacted, along with a listing of their principal issues and areas of concern.

SOURCES OF SUPPLY

Delta-dependent diverters supply sources vary from either 100 percent Delta dependence to a mix of supplies, including groundwater, local and/or imported surface water sources, and in some cases, recycled water. Other surface water sources include, but are not limited to, the CVP and the SWP, local reservoirs and streams, and various agreements, including transfers, with other agencies. Groundwater sources include direct pumping and a number of conjunctive use management systems with both active recharge through injection wells and spreading basins, and passive in-lieu recharge.

The water supply portfolios of most of the agencies are supplemented by water conservation and other practices (e.g., water recycling). It should be noted that each agency's water supply portfolio is unique to its needs and source availability. **Table 3-9** reports the percent breakdown of each agency's drinking water supplies into the categories of Delta water, other surface water sources, groundwater, and other sources.

CHALLENGES AND ISSUES

Water quality is a key issue for in-Delta agencies that rely on Delta water supplies to meet some or all of their drinking water demands. South-of-Delta export agencies also face water supply shortfalls because of Delta water quality standards and environmental requirements. Reduced export pumping in the spring to protect fishery resources results in a shift in pumping to the summer and fall. The shift in export pumping from the spring when water quality is generally very good to the late summer and fall, when salinities at the export pumps are highest, represents a considerable increase in bromide concentrations in delivered water.

The outreach survey to other in-Delta and export water users led to the following findings. In addition to Delta water quality conditions that occur as a result of tidal, environmental and geographic influences, discharges from regional and statewide land and water uses also are of concern. Leaky sewer systems, agricultural runoff from both animal and crop production, wastewater discharge, urban runoff, and industrial runoff enter the Delta and impact drinking water quality. These impacts contribute to the degradation of water quality by introducing elevated levels of total dissolved solids (TDS), organic nutrients, minerals, and other compounds into the water supply. Many of these components require additional treatment and/or stress existing water treatment facilities.

Table 3-9 Summary of Water Quality Issues for Agencies Potentially Dependent on the Delta for a Portion of Their Drinking Water Supplies (1)

Agency/City	Current & Estimated Population		Current & Projected Demand (acre-feet/year)		Current Sources of Water (%)	Water Quality Issues
	2005	2030	2005	2030		
Antioch	101,000	154,000	25,200	34,200	96% Delta water 3% other surface water 1% groundwater	• San Joaquin River: chemical/petroleum processing storage, WWTPs, disposal facilities and salt water intrusion. • Antioch Municipal Reservoir: sewer collection system
Benicia	27,000	--	12,400	--	90% Delta water 10% other surface water 0% groundwater	• Lake Berryessa: boats, leaking underground fuel storage tanks, contaminant plumes, historic and active gas stations. • Lake Herman: urban runoff, herbicides and pesticides, animal feeding operations, historic mining operations North Bay Aqueduct: cattle and sheep grazing (turbidity, TOC, coliform bacteria)
Bethel Island Municipal Improvement District	3,700 (up to 5,000 in summer)	--	Currently about 20 small water companies supplying water to 3 to 200 people each. In the future, will use surface water to supply four major trailer parks.		0% Delta water 0% other surface water 100% groundwater	• Drainage improvement
Brentwood	41,300	67,200	10,800	17,700	40% Delta water 0% other surface water 60% groundwater	• Hardness from wells
Clarksburg	--	--	--	--	0% Delta water 0% other surface water 100% groundwater	• Food processing wastes
Contra Costa Water District	450,000		173,000	207,100	98% Delta water 0% other surface water 2% groundwater	• Delta: seawater intrusion agricultural drainage, recreational boating, point discharges • Groundwater: effects of salt and bromide concentrations in imported water
Courtland	--	--	--	--	0% Delta water 0% other surface water 100% groundwater	• Animal wastes

Table 3-9 continued on following page

Table 3-9 Continued

Agency/City	Current & Estimated Population		Current & Projected Demand (acre-feet/year)		Current Sources of Water (%)	Water Quality Issues
	2005	2030	2005	2030		
Delta Diablo Sanitation District	184,000	--	N/A	N/A	N/A	• Treated effluent discharged to New York Slough
Discovery Bay	2,700	6,600	--	--	0% Delta water 0% other surface water 100% groundwater	• Discharge South of Old River (WWTP 500 feet south)
Dixon	7,000	8,100	2,000	7,800	0% Delta water 0% other surface water 100% groundwater	• NO_3 at 37 mg/L
East Bay Municipal Utility District	1,340,000	2,120,000	295,000	312,500	0% Delta water 100% other surface water 0% groundwater	• Maintain or improve current water quality
Elk Grove	38,200	48,100	9,300	11,800	0% Delta water 5% other surface water 95% groundwater	• EGWS represents two service areas, Tariff Area No. 1 & 2. Tariff Area No. 2 is supplied wholesale water by the Sacramento County Water Agency • Iron, manganese, and arsenic are concerns
Fairfield	103,600	145,300	25,900	50,500	35% Delta water 65% other surface water 60% groundwater	• Arsenic, chromium, lead & copper, and Giardia & *Cryptosporidium* have been detected in source water • Delta: recreational use, grazing animals, herbicides, seawater intrusion • Lake Berryessa: herbicides, stormwater discharge, recreational areas
Freeport Regional Water Project	120,000 Zone 40 1,340,000 EBMUD	430,000 Zone 40 2,120,000 EBMUD	71,000 Zone40 23,00 EBMUD (2001 modeled demand)	71,000 Zone40 23,00 EBMUD (2001 modeled demand)	100% Delta water 0% other surface water 0% groundwater	• Mercury / Methylmercury • Chlorpyrifos and diazionon (pesticides) • Urban runoff • Sacramento River WWTP discharges
Galt	22,100	33,800	5,200	7,900	0% Delta water 0% other surface water 100% groundwater	• Iron and manganese

Table 3-9 continued on following page

Table 3-9 Continued

Agency/City	Current & Estimated Population		Current & Projected Demand (acre-feet/year)		Current Sources of Water (%)	Water Quality Issues
	2005	2030	2005	2030		
Isleton	1,000	1,400	--	--	0% Delta water 0% other surface water 100% groundwater	• EPA has no record of any health-based violations reported
Knightsen	1,200	--	--	--	0% Delta water 0% other surface water 100% groundwater	• Drainage impacts
Lathrop	22,800	68,800	4,500	15,900	0% Delta water 0% other surface water 100% groundwater	• TDS • Salinity
Lodi	62,400	91,200	18,200	24,400	0% Delta water 0% other surface water 100% groundwater	• White Slough Water Pollution Control Facility • DBCP • Arsenic • TCE/PCE • Radon
Manteca	59,700	--	--	--	0% Delta water 0% other surface water 100% groundwater	• Groundwater: leaking underground storage tanks, gas stations, chemical/petroleum processing/storage facilities, metal plating/finishing/fabricating facilities, automobile body/repair shops and sewer collection systems • Surface water (will receive water from Stanislaus River via the South County Water Supply Program in July 2005): boating (MTBE, gasoline) and from body contact (swimming)
Martinez	37,500	49,000	5,800	7,700	100% Delta water 0% other surface water 0% groundwater	• Salt water intrusion • Source water protection • Algae control
Mountain House Community Services District	--	43,500	--	--	100% Delta water 0% other surface water 0% groundwater	• Currently reclaims all water for use locally, but in the future intends to discharge to Old River

Table 3-9 continued on following page

Table 3-9 Continued

Agency/City	Current & Estimated Population		Current & Projected Demand (acre-feet/year)		Current Sources of Water (%)	Water Quality Issues
	2005	2030	2005	2030		
Napa	75,900	97,000	16,000	21,600	50% Delta water 50% other surface water 0% groundwater	• TOC • Turbidity • Agricultural runoff
Oakley	27,500	55,300	12,100	39,500	100% Delta water 0% other surface water 0% groundwater	--
Pittsburg	60,700	127,500	11,000	16,500	90% Delta water 0% other surface water 10% groundwater	• Wells: gas station contamination, animal grazing activities, sewer collection systems, utility stations and maintenance activities • TDS in groundwater
Rio Vista	6,800	4,900	250	220	0% Delta water 0% other surface water 100% groundwater	--
Sacramento County Water Agency	160,000	450,000	40,000	113,000	0% Delta water 64% other surface water 32% groundwater	• Iron and manganese in deeper groundwater wells treated with chlorine and filtration. • Groundwater contaminant plumes from Mather AFB, Aerojet, and Boeing
Santa Clara Valley Water District (Central Valley Project)	1,809,500	1,930,700	390,200	443,200	30% Delta water 40% other surface water 30% groundwater	• San Luis Reservoir Low Point • All sources: agricultural and urban runoff, recreational activities, livestock grazing, residential and industrial development • Imported sources: WWTP discharges, seawater intrusion, wildland fires in open space areas • Local sources: commercial stables, historic mining practices
Solano County Water Agency	427,500	677,600	264,400	296,200	31% Delta water 62% other surface water 7% groundwater	• Turbidity (North Bay Aqueduct) • Organic carbon (North Bay Aqueduct)
Southern California Water Company	18,100	20,400	2,900	3,500	92.40% Delta water 0% other surface water 7.6% groundwater	• TDS • Chlorides

Table 3-9 continued on following page

Table 3-9 Continued

Agency/City	Current & Estimated Population		Current & Projected Demand (acre-feet/year)		Current Sources of Water (%)	Water Quality Issues
	2005	2030	2005	2030		
State Water Project	23,000,000	53,000,000	3,000,000	4,100,000	100% Delta water 0% other surface water 0% groundwater	• Agricultural, industrial, and urban runoff • Salt water intrusion
Stockton	269,100	489,200	73,500	125,100	0% Delta water 75% other surface water 25% groundwater	• TDS • Salinity
Suisun City	27,400	31,400	4,800	--	0% Delta water 100% other surface water 0% groundwater	--
Tracy	74,100	133,600	17,700	31,600	51% Delta water 3% other surface water 46% groundwater	• Airports (maintenance and fueling areas), gas stations (historic and current), mining activities (active and historic), septic and waste landfill dumps (historic and current)
Vacaville	95,100	118,900	17,900	31,300	35% Delta water 28% other surface water 37% groundwater	• Arsenic • Turbidity, TOC and coliform contamination
Vallejo	165,000	200,000	37,800	37,800	62% Delta water 38% other surface water 0% groundwater	• Delta turbidity and TOC levels • Vallejo lakes • Organics control (algae)
Walnut Grove	7,000	--	--	--	0% Delta water 0% other surface water 100% groundwater	• Sewer collection systems, gas stations, chemical/petroleum processing/storage, dry cleaners, landfills, metal plating/finishing/fabricating, underground storage tanks, irrigated crops
West Sacramento	40,000	77,100	16,000	29,800	0% Delta water 100% other surface water 0% groundwater	• Concerns in Colusa Basin Drain that may affect Sacramento River: temperature, turbidity, herbicides and pesticides, recirculation of irrigation tailwater, and soil erosion and sedimentation

Key
DBCP = 1,2-dibromo-3-chloropropane
EBMUD = East Bay Municipal Utility District
EGWS = Elk Grove Water Service
EPA = Environmental Protection Agency
MTBE = methyl tertiary butyl ether
PCE = tetrachloroethylene
TCE = trichloroethylene
TDS = total dissolved solids
TOC = total organic carbon
WWTP = wastewater treatment plant

(1) *The data sources used in developing* ***Table 3-9*** *included responses to the survey instrument (****Appendix 1(1), Attachment (B)****), telephone interviews with district and agency staff, and Web-based data sources.*

KEY WATER QUALITY CONCERNS

Irrespective of the location or quantity of water diverted, principal water quality concerns for all Delta water supplies are increased salinity and/or organic carbon levels. However, while many of the agencies share certain water quality concerns, almost as many concerns exist as there are agencies. Geographic location, quantity/percentage of water demand met with Delta diversions, and the quality of supplemental supplies impact the magnitude of the impact of Delta quality issues on a specific agency. The sources of water quality degradation that are of most concern include the following:

- Agricultural runoff
- Animal grazing (erosion effects)
- Urban and industrial treated wastewater discharges
- Stormwater discharge
- Recreational activities (e.g., boating)
- Construction activities
- Septic tank seepage and underflow

Principal constituents of concern include:

- TDS
- Turbidity
- TOC
- Coliforms
- Nutrients
- Minerals (salinity)
- Pesticides and herbicides
- Algal blooms
- PPCPs and EDCs

Table 3-9 summarizes these water quality concerns by agency.

PLANNED PROGRAMS AND PROJECTS

Urban Agencies Providing Drinking Water

Each agency is currently implementing its own set of programs and projects to ensure the highest level of drinking water supply reliability possible and/or improve source water quality. Such programs may include conservation, water recycling, and water transfers. Various agencies also are planning to implement specific projects to help ensure their water source reliability and desired water quality. Activities to help combat some of the discharge issues these agencies face include the following:

- Implementing BMPs to decrease the impacts of erosion and urban stormwater runoff
- Monitoring and controlling of various discharges, including stormwater runoff, sewer discharges, and wastewater treatment plant (WWTP) discharges.

The CVRWQCB, through the Central Valley Drinking Water Policy, is developing technical information to inform urban agencies on this issue (see **Chapter 4**).

Wastewater Discharges Under NPDES Permits

Under National Pollutant Discharge Elimination System (NPDES) regulations, permitted municipalities can discharge treated wastewater effluent into source waters. Several California municipalities in and around the Delta use this practice, thereby increasing the organic carbon content, TDS levels, and metal content in the Delta. As California communities continue to expand, the quantity of wastewater discharge entering the Delta will increase. This increase in wastewater discharge volume will accelerate the degradation of Delta water quality.

Agricultural Discharges

The quality of water flowing into the Delta from the Sacramento River, San Joaquin River, and the eastside tributaries (Mokelumne, Calaveras, and Cosumnes rivers) is affected by drainage from agricultural lands. Water quality in the San Joaquin River, in particular, is dominated by agricultural drainage during much of the year. Discharges from wildlife refuges also contribute to the high concentrations of salt, organic carbon, and other constituents of concern flowing into the Delta from the San Joaquin River. Agricultural drainage into the Delta contains high levels of nutrients, suspended solids, organic carbon, minerals (salinity), and trace chemicals such as organophosphate, carbamate, and organochlorine pesticides. Incremental addition of salts from the extensive irrigated agricultural areas of the San Joaquin Valley result in typically elevated TDS concentrations in the San Joaquin River. Agricultural return flows to the San Joaquin River have significantly more calcium and sulfate than seawater.

CHAPTER 4. POTENTIAL PROJECTS AND PROGRAMS

Chapter 2 of this report provides an overview of how system-wide operations affect the hydrology of the Sacramento-San Joaquin Delta (Delta) and documents historical Delta water quality conditions, including dramatic increases in Delta salinities in the fall. **Chapter 3** identifies some of the challenges and issues these conditions present individual agencies that directly divert water from the Delta for drinking water purposes. Those challenges and issues are placed within the context of the overall water resources planning and management objectives of the agencies.

The objective of **Chapter 4** is to describe projects and programs currently being implemented or considered, locally, regionally, and statewide, that would address the challenges and issues presented by the impacts on Delta water quality.

The CALFED Bay-Delta Program (CALFED) has prepared a long-term comprehensive plan that has the objectives of restoring the ecological health and improving water quality and water supply for beneficial uses of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) system; the projects and programs include potential new facilities and system-wide operational changes. These projects and programs are being implemented at a statewide level.

In addition, specific projects and programs are currently being considered or implemented by Contra Costa Water District (CCWD), City of Stockton Municipal Utilities Department (COSMUD), and Solano County Water Agency (SCWA). These projects and programs, which also include potential new facilities and operational changes, would be implemented at the local (and potentially regional) level.

Projects, programs, and operational changes currently under consideration that have the potential to improve Delta water quality and/or the quality of water diverted from the Delta for drinking water purposes are presented and discussed below within the construct of the Equivalent Level of Public Health (ELPH) model developed by CALFED.

"EQUIVALENT LEVEL OF PUBLIC HEALTH" MODEL

The ELPH model was developed within the CALFED Water Quality Program (WQP). The California Bay-Delta Public Advisory Committee (BDPAC) Drinking Water Subcommittee has expressed support for the ELPH structure as the appropriate strategy to guide implementation of the WQP.

As stated on page 65 of the August 2000 CALFED Record of Decision (ROD), the WQP's <u>general</u> target is to "continuously [improve] Delta water quality for all uses, including in-Delta environmental and agricultural uses." Its specific target is for "providing safe, reliable, and affordable drinking water in a cost-effective way, to achieve either: (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 micrograms per liter (μg/L) bromide and 3.0 milligrams per liter (mg/L) total organic carbon (TOC), or (b) an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control and treatment technologies."

The specific bromide and organic carbon targets in the CALFED ROD were based on the findings of an expert panel convened in 1998 by the California Urban Water Agencies (CUWA). That panel determined the source water quality required to ensure urban agencies treating raw water diverted from the Delta with conventional drinking water treatment technology (including ozone disinfection) could meet reasonably foreseeable future drinking water regulations. In addition, Appendix D of the Water Quality Program Plan identified several additional numeric targets listed for drinking water intakes (**Table 4-1**).

Table 4-1 CALFED Water Quality Program Numeric Targets for Delta Drinking Water Intakes

Target Constituent	Numeric Target
Chloride	250 mg/L year-round or 150 mg/L for part of the year (essentially the same as SWRCB D-1485 and the current Sacramento-San Joaquin Bay Delta Water Quality Control Plan)
Nutrients (nitrate)	10 mg/L (no increase in nitrate concentrations)
Total Dissolved Solids	< 220 mg/L as a 10-year average (from the SWP Water Service Contracts may be changed to a 6-month or 1-year average target), or < 440 mg/L as a monthly average
Pathogens	No MCL standard; < 1 oocyst/100 L for *Giardia* and *Cryptosporidium*
Turbidity	0.5 or 1.0 NTU in treated water or 50 NTU in raw water (with the intent to reduce current variability in turbidity)

Key:
MCL = maximum contaminant level
mg/L = milligrams per liter
NTU = nephelometric turbidity unit
oocyst/L = oocysts per liter
SWP = State Water Project
SWRCB = State Water Resources Control Board

The strategy of "an equivalent level of public health protection" is to achieve an equivalence of the CALFED ROD targets through implementation of a cost-effective combination of activities, including the following:

- Source improvement (both tributary waters entering the Delta and improvement in other sources that help reduce reliance on imported water)
- Delta water management improvements (including activities that reduce seawater intrusion into Delta intakes)
- Local and regional infrastructure improvements and additions
- Regional water quality exchanges
- Improved treatment technology and distribution system modifications to ensure high quality water at the tap

The ELPH model (see **Figure 4-1**) can be used as a rationale tool to explore the relationship between various water management operations (e.g., changing the timing, duration, and volume of Delta export pumping; modifying Delta outflows via system operational changes; or installing or changing operation of flow barriers) and changes in water quality, and then to identify potential water management operations to improve Delta water quality and develop strategies for implementing those operations (including the appropriate role of local, state, and federal agencies). The ELPH model construct implicitly recognizes that water quality objectives in source waters and water quality regulations protecting consumers are dynamic, and are best met with flexible plans that consider the entire drinking water system from source to tap.

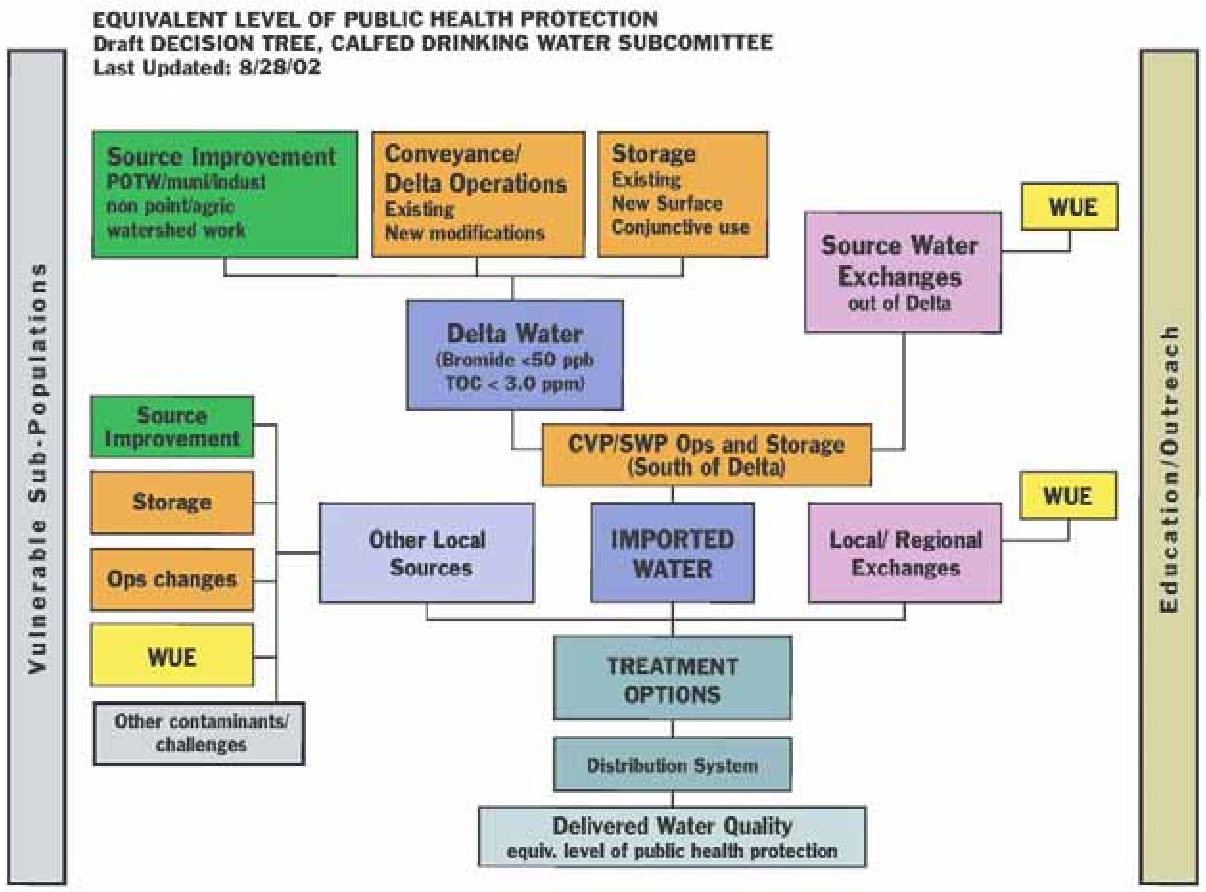

Figure 4-1 Equivalent Level of Public Health Model [1, 2]

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[1] The ELPH Model uses parts per million (ppm) and parts per billion (ppb). Note that ppm and ppb are equivalent to milligrams per liter (mg/L) and micrograms per liter (µg/L), respectively.

[2] Source: http://calwater.ca.gov/BDPAC/Subcommittees/DrinkingWater/ELPH_Decision_Tree_8-28-02.pdf

CALFED BAY-DELTA PROGRAM

CALFED has prepared a long-term comprehensive plan that will restore ecological health and improve water quality and water supply for beneficial uses of the Bay-Delta system. CALFED's four primary objectives include the following:

- To provide good water quality for all beneficial uses
- To improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species
- To reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system
- To reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees

The California Bay-Delta Act of 2003 established the California Bay-Delta Authority (CBDA) as a new governance structure and charged it with providing accountability, ensuring balanced implementation, tracking and assessing program progress, using sound science, assuring public involvement and outreach, and coordinating and integrating related government programs. The CBDA oversees a consortium of state and federal agencies working cooperatively to implement projects and programs to meet CALFED's objectives. In 2004, Congress passed the Water Supply, Reliability, and Environmental Improvement Act, also known as the CALFED Bay-Delta Authorization Act, to formalize federal participation in continued CALFED activities for implementing the CALFED ROD.

Following the issuance of a CALFED Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/EIR) in July 2000, the CALFED agencies issued a programmatic ROD in August 2000 that identified 11 "action plans," including plans for the following:

- Drinking Water Quality
- Watershed Protection
- Levee System Integrity
- Water Storage
- Water Conveyance
- Ecosystem Restoration
- Environmental Water Account (EWA)
- Water Transfers
- Water Use Efficiency
- Water Management
- Science Programs

Note the Water Management element encompasses the activities of other water supply reliability programs and is not a stand-alone program. CALFED agencies are currently implementing Stage 1 of the ROD, including the first 7 years of a 30-year program for establishing a foundation for long-term actions.

Some of the actions identified in the ROD will improve drinking water quality for users of Delta water; however, other actions (e.g., wetlands restoration projects) have the potential to negatively impact Delta water quality. Thus, it is important that there be balanced implementation of the CALFED Bay-Delta Program and that progress in implementing the drinking water program match progress made in implementing ecosystem projects and water supply actions. CALFED projects and programs with the potential for affecting Delta water quality are discussed below. **Figure 4-2** places these CALFED projects and programs within the context of the CALFED ELPH model. Note that it is not clear from the current format of the ELPH diagram where to place projects that improve the quality of water diverted from the Delta by relocating in-Delta diversion intakes. It could be argued, for example, that such projects belong after the Delta Water box, because they do not necessarily improve water quality in the Delta. However, for the purposes of this report, intake relocation projects will be considered as Conveyance Projects that result in the equivalent effect on delivered water quality as improving Delta water quality.

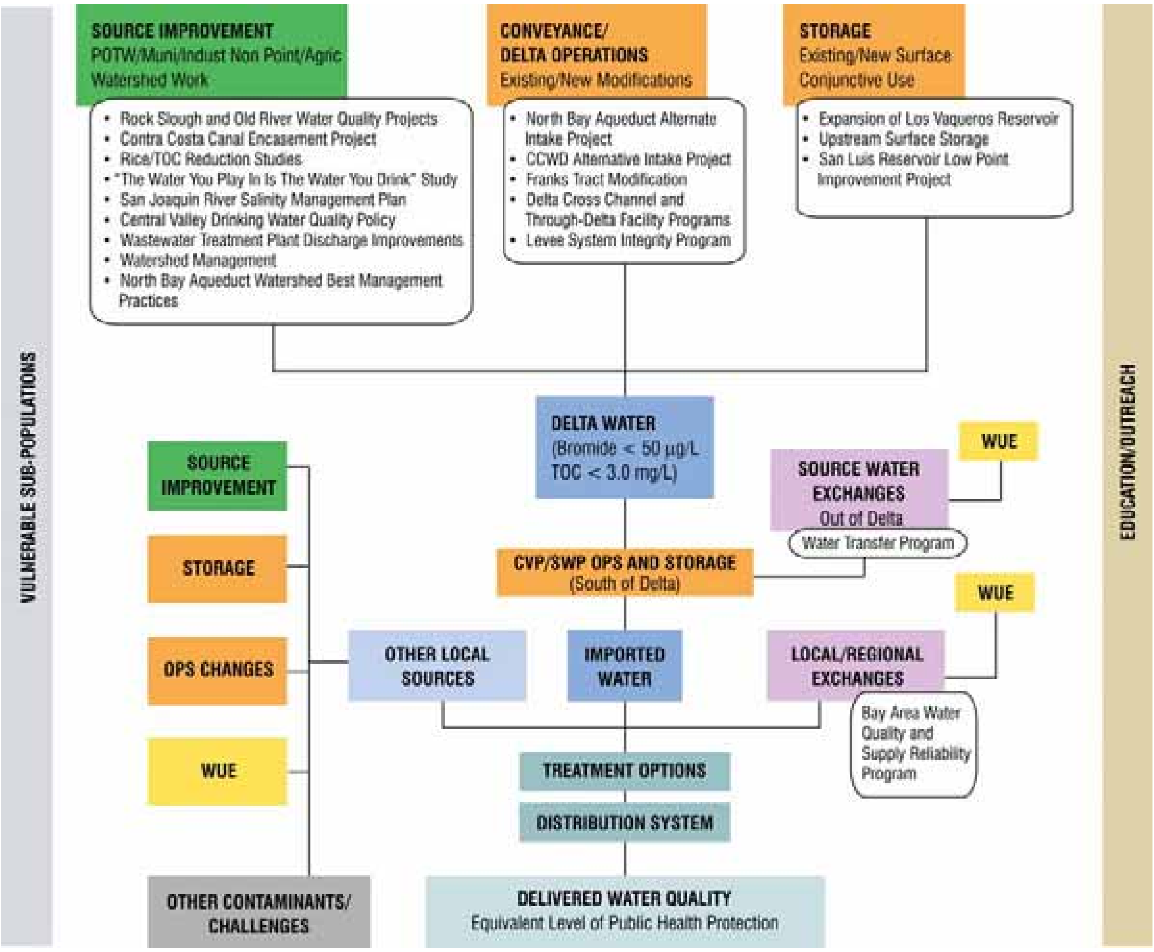

Figure 4-2 CALFED Projects and Programs Within the Equivalent Level of Public Health Model

DRINKING WATER QUALITY PROGRAM

Actions implemented under the Drinking Water Quality Program are intended to help CALFED meet its goal of continuous improvement in water quality. As discussed in more detail in the June 2005 CALFED Water Quality Program Assessment Report, the WQP awarded approximately $78 million in project funds and leveraged an additional $37 million in matching funds in its first four years. The majority of the projects are focused on research, planning, and demonstration, all necessary phases prior to on-the-ground implementation.

Projects have also been limited to the available funding conditions, so not all elements of the program have progressed at the same rate. As discussed on page 3-19 of the Assessment Report, the WQP is under-funded relative to many of the other CALFED programs, having received less than 5 percent of total CALFED funding to date.

CALFED has invested approximately $195 million in programs to improve drinking water quality through the Drinking Water Quality Program (63 projects), Watershed Management Program (3 projects), Conveyance Program (1 project), and Ecosystem Restoration Program (7 projects). About $18 million of the Water Quality Program projects (25%) has been awarded to projects in the Delta region. The Program Assessment Report found that less than 25 percent of the Water Quality Program funding went to implementation projects.

CALFED Water Quality Program Projects in the Delta Region

The following paragraphs describe some of the efforts that have been funded by CALFED in the Delta region. Additional detail is provided on some of these projects later in **Chapter 4**. These projects are also reviewed in the June 2005 CALFED Water Quality Program Assessment Report.

Rock Slough and Old River Water Quality Improvement Projects

The Rock Slough Water Quality Improvement Project (initially referred to as the Veale Tract Project) was developed as an alternative to eliminate the water quality impacts on CCWD of drainage discharges from Veale Tract. Contra Costa County also received CALFED funding for the Knightsen Water Quality/Drainage Improvement project to examine the feasibility of a bio-filter to reduce contaminant levels in runoff from the Knightsen area in the vicinity of Rock Slough. Similarly, the Old River Water Quality Improvement Project (initially referred to as the Byron Tract Project) includes construction of a new diffuser for Reclamation District 800 discharge to eliminate the effects of discharges from Byron Tract on water quality at CCWD's Old River intake. The 2000 CALFED ROD required that the impacts of local agricultural drainage from Veale and Byron Tracts on CCWD's drinking water quality be addressed before implementation of the permanent operable barriers in the south Delta. Completion of construction of new drainage discharge facilities to eliminate the impacts of local drainage from Veale Tract and Byron Tract on CCWD's drinking water supply is expected by August 2005. These actions are part of the CALFED Delta Improvements Package. **Figure 4-3** shows the locations of Veale and Byron Tracks within the Delta.

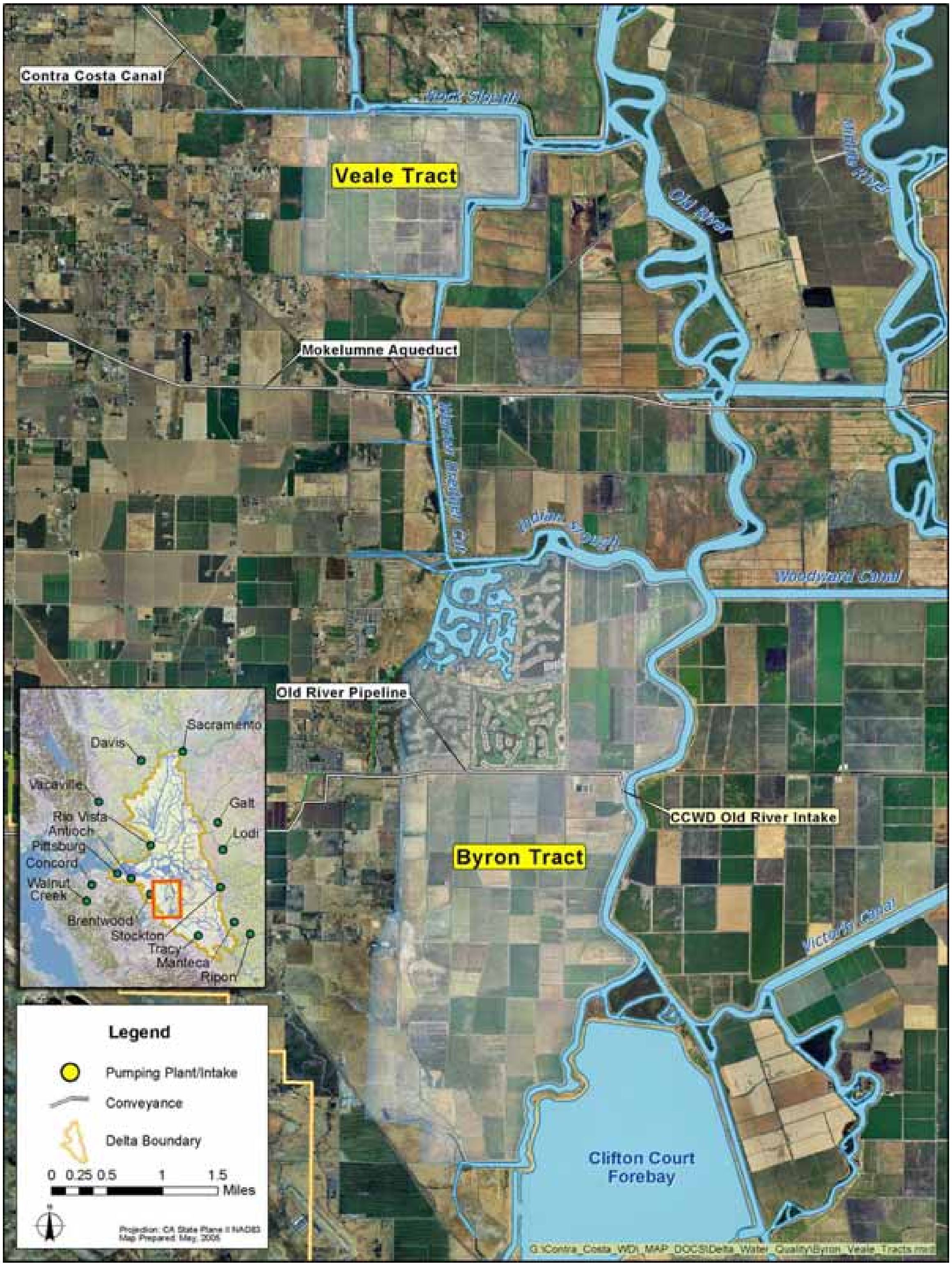

Figure 4-3 Veale Tract and Byron Tract: Locations of CALFED-Funded Water Quality Monitoring

Contra Costa Canal Encasement Project – Initial Phase

During the initial CALFED studies of Rock Slough drainage, additional water quality impacts were identified from groundwater seepage into the unlined section of the Contra Costa Canal near Pumping Plant No. 1. The August 12, 2004 CALFED Delta Improvements Package Implementation Plan states that "in addition and in support of the CALFED Program objective of continuous improvement in Delta drinking water quality, the state and federal agencies will work with CCWD to reduce seepage into the Contra Costa Canal."

The Contra Costa Canal Encasement Project is now in the initial stages of planning, design, and environmental review. The $7.3 million in grant funding from CALFED will be used to implement findings from previous studies and to replace a portion of the unlined section of the Contra Costa Canal (about 1900 meters near Pumping Plant No. 1) with a buried pipeline or conduit. It should be emphasized that this is only the initial phase of a much larger encasement effort. This project is integrated with the Dutch Slough Ecosystem Restoration Project. As currently planned, the Ducth Slough Ecosystem Restoration Project will be located immediately north of the canal.

Rice/TOC Reduction Studies

This CALFED project to reduce non-point sources and nitrogen exports has funded development and implementation of Best Management Practices (BMP) to reduce organic carbon and other disinfection byproduct (DBP) precursors, and nitrogen export from rice fields. Additionally, an objective of the project is to demonstrate that rice can be viably and cost-effectively grown throughout the Delta. Two hundred acres have been converted and seven test plots have been planted. The crops were harvested in late September/early October 2004. Farmers reported good quality and production of rice. A total of 300 acres of rice were planted in May 2005 for this year's crop.

"The Water You Play In Is the Water You Drink" Project

This project, managed by the Contra Costa County Clean Water Program, is developing and implementing a comprehensive, long-term public outreach and education program, and establishing a marina best management practices pilot program, focused on reducing contaminant loading associated with marinas, water contact sports, and recreational boating that affect drinking water quality in Delta waterways. This project will also help quantify the impact of other water quality programs as they are implemented.

Bay Area Water Quality and Supply Reliability Program

The Bay Area Water Quality and Supply Reliability Program (formerly the Bay Area Blending and Exchange Program) was established to identify regional opportunities for enhancing water supply and/or water quality for Bay Area agencies. The program was identified in the CALFED environmental review process and included as a complementary action in the CALFED ROD. The Program involves Bay Area agencies working cooperatively to address water quality and supply reliability concerns on a regionally focused basis. Alternatives evaluated included enhanced conservation, desalination, recycled water, and additional storage. Expansion of the Los Vaqueros

Reservoir was also evaluated as part of the program. The Los Vaqueros Reservoir Expansion project would provide dry-year reliability and water quality benefits to Bay Area agencies and water for Environmental Water Account (EWA) management. Additional evaluation and environmental work is continuing under the CALFED Los Vaqueros Reservoir Expansion Studies. Projects developed as part of this Bay Area effort are being incorporated into a Bay Area Integrated Regional Water Management Plan.

North Bay Aqueduct Studies

SCWA received grant funding for the following projects: Advanced Pretreatment Using Ion Exchange for Organic Carbon Removal from Delta Water, North Bay Aqueduct Alternative Intake Study, North Bay Aqueduct Watershed Best Management Practices, and Barker Slough Watershed Management Project. These projects focused on a variety of methods to manage high concentrations of organic carbon and turbidity in the Barker Slough watershed near the intake to the North Bay Aqueduct (NBA).

Delta Improvements Package

The CALFED Delta Improvements Package was developed in response to concerns raised by in-Delta urban and agricultural water users that the two major water supply and conveyance projects being developed to expand export capacity at the Central Valley Project (CVP) Tracy Pumping Plant and the State Water Project (SWP) Banks Pumping Plant, and the construction of permanent operable barriers in the south Delta, would impact drinking, ecosystem and agricultural water quality and water levels in the south and central Delta. A number of meetings were held from September 2003 through March 2004 between in-Delta and export water users at many locations. In August 2004, CBDA adopted a Delta Improvements Package Implementation Plan that included the following key water quality actions to address in-Delta drinking water quality concerns (none have been implemented yet).

San Joaquin River Salinity Management Plan

DWR and Reclamation, in cooperation with other CALFED agencies and local interests, will develop and implement a comprehensive San Joaquin River Salinity Management Plan (Plan) to maintain compliance with all existing Delta water quality salinity objectives for which the state and federal water projects have responsibility, as required by SWRCB Water Right Decision 1641. The Plan will address actions to improve water quality in the San Joaquin River such as management of agricultural drainage issues, including salt load reduction from Salt and Mud sloughs, recirculation of Delta exports into the San Joaquin River, voluntary water transfers to improve water quality, and real-time water quality monitoring. The Central Valley Regional Water Quality Control Board (CVRWQCB), in conjunction with the SWRCB, is also developing a total maximum daily load (TMDL) program to reduce mass loads of salinity, boron, and other pollutants in the San Joaquin Basin.

Contra Costa Canal Encasement Project - Completion

In the DIP Implementation Plan, the state and federal agencies committed to work with CCWD to reduce seepage into the Contra Costa Canal. This project would entail completing encasement of the remaining portions of the Contra Costa Canal not completed in the initial phase discussed above.

Franks Tract Modification

Through studies, pilot projects, and other actions, state and federal agencies will evaluate and implement, if appropriate and authorized, a strategy to (1) significantly reduce salinity levels in the South Delta and at the CCWD and SWP/CVP export facilities, and (2) improve water supply reliability by reconfiguring levees and/or Delta circulation patterns around Franks Tract while accommodating recreational interests. This may include modifying remnant levees, constructing tidal gates (for example at False River, and Dutch Slough) to inhibit salt trapping, and restoring tidal marsh habitat. Reconfiguring levees and Delta circulation patterns around Franks Tract may significantly reduce salinity levels in the central and south Delta. During the flood tide, salt water intrudes into, and is trapped in, Franks Tract. The salt water subsequently mingles with Old River water that provides a “fresh water corridor” to the south Delta. .

The actual water quality benefits of modifying Franks Tract will depend on how the Delta is operated by the CVP and SWP. If Franks Tract were merely used to make it easier for the CVP and SWP to meet Delta water quality standards under SWRCB D-1641, the benefits of this action would be an increase in export water supply rather than improved Delta water quality. Modifications of Franks Tract will need to be combined with modified operating criteria, and possibly new Delta standards or assurances, to ensure water quality benefits are realized.

Delta Cross Channel and Through-Delta Facility Programs

Reclamation and other state and federal agencies will evaluate Delta Cross Channel gate operational strategies to improve central and south Delta water quality while reducing fish passage through the Delta Cross Channel into the interior Delta. Simultaneously, DWR and the state and federal agencies will complete the feasibility studies on a 4,000 cubic feet per second (cfs) diversion facility in the north Delta to assess its potential benefits and impacts on water quality, water supply, and environmental conditions in the Delta. The diversion facility would move 4,000 cfs of water from the Sacramento River to the Mokelumne River and interior Delta to enhance water quality. The CALFED ROD (page 23) describes the screened diversion facility as “a measure to improve drinking water quality in the event that the Water Quality Program measures do not result in continuous improvements toward CALFED drinking water goals.”

CCWD Alternative Intake Project

The Delta Improvements Package Implementation Plan (page 4) states that if “water quality improvements from (other water quality) measures do not provide acceptable continuous improvements in Delta water quality, the state and federal agencies will evaluate, and if appropriate, work with the Contra Costa Water District to relocate their intake to the lower part of Victoria Canal, with appropriate environmental review and, if authorized and appropriated, cost-sharing.”

Relocation of CCWD's Old River intake to a location further east where water quality is typically better would help meet CALFED's goal of continuous improvement in water quality and the specific drinking water goal of 50 µg/L bromide and 3.0 mg/L TOC, or an equivalent level of public health protection. This project is expected to be connected to the existing Old River intake facilities, and at times, CCWD may choose to divert at Old River rather than at the new intake location depending on water quality conditions.

This CCWD project, now referred to as the Alternative Intake Project, has begun the National Environmental Policy Act (NEPA)/ California Environmental Quality Act (CEQA) environmental permitting process. The Alternative Intake Project is one of the management plan solutions discussed in more detail later. The project is discussed in more detail at: http://www.ccwater-alternativeintake.com/

Other Drinking Water Quality Actions

Other water quality actions that could improve drinking water quality for in-Delta agencies include the Central Valley drinking water policy, wastewater treatment plant (WTP) discharge improvements, and studies of the Colusa Basin Drain, as summarized below.

Central Valley Drinking Water Policy

CVRWQCB is currently developing a drinking water policy for surface waters in the Central Valley. Pollutants from a variety of urban, industrial, agricultural, and natural sources can enter Central Valley waters, leading to drinking water treatment challenges and potential public health concerns. Current policies and plans lack water quality objectives for several known drinking water constituents of concern and do not include implementation strategies to provide effective source water protection. In July 2004, CVRWQCB adopted Resolution R5-2004-0091, supporting development of a policy and committing to develop the policy using a collaborative, science-based approach. CVRWQCB is using a broadly representative stakeholder group to provide input on the technical work and policy development. The first phase of this multiyear effort is to develop the technical studies needed to support development of a policy. Technical studies will include pollutant load evaluations, evaluation of a range of water quality goals and policy options, and identification of potential control alternatives. These studies are focused on providing technical support for a Basin Plan Amendment. The work is currently funded through a joint agreement of CUWA, the Sacramento Regional County Sanitation District (which financially supports CVRWQCB staff), and through a Delta Water Quality Plan (DWQP) Proposition 50 grant administered by SWRCB and through United States Environmental Protection Agency (EPA) and the Sacramento River Watershed Program. The technical studies are scheduled to conclude in 2007. For more information, go to: http://www.swrcb.ca.gov/rwqcb5/available_documents/dw-policy/

Wastewater Treatment Plant Discharge Improvements

CVRWQCB has the primary responsibility of regulating wastewater discharges to surface waters of the Delta and its tributaries under the National Pollutant Discharge Elimination System (NPDES). The San Francisco RWQCB has jurisdiction over waste discharges into Suisun Bay that can also impact urban drinking water diverted from the Delta, specifically CCWD's intake at Mallard Slough. These regulatory activities include issuing NPDES permits, monitoring discharger compliance with permit requirements, and taking enforcement action as appropriate. In part in response to concerns expressed by urban drinking water agencies, CVRWQCB has begun requiring tertiary treatment for some urban wastewater discharges and monitoring for drinking water COCs. The Central Valley Drinking Water Policy will provide additional information to support this process.

As an example, the planned expansion of WTPs, such as the Sacramento Regional WTP, which discharges to the Sacramento River near Freeport, will add additional loads of salt, organic carbon, pathogens, and other contaminants to the Delta. Sacramento Regional County Sanitation District is working with CUWA and other urban agencies to develop projects to address Delta water quality issues.

Colusa Basin Drain Studies

Agricultural runoff and stormwater from towns in the Colusa Basin flow via the Colusa Basin Drain to the Sacramento River upstream of intakes for the cities of Sacramento, West Sacramento, and the proposed Freeport Regional Water Project intake for East Bay Municipal Utilities District (EBMUD) and the county of Sacramento. A group of stakeholders, including CCWD and other urban agencies, are participating in an initial study to characterize hydrology and water quality of the drain, and to evaluate impacts to the Sacramento River and Delta water users. Other stakeholders are expected to participate in this process while alternatives to improve water quality downstream from the drain are developed.

Agricultural Drainage Conditional Waiver Program

In January 2003, CVRWQCB's waiver of waste discharge requirements (WDRs) for irrigated lands sunsetted. In its place, CVRWQCB established a 10-year Conditional Waiver Program for irrigated lands. This resulted in the establishment of nine watershed coalitions that will represent identified groups of growers within their designated jurisdictions.[3] The groups will monitor the contaminant loads leaving their watershed areas, including drinking water COCs, and where necessary, identify major sources within the watershed and implement BMPs to reduce excessive loads. This Conditional Waiver Program has the potential to identify sources of drinking water COCs, and ways to reduce those sources.

WATERSHED MANAGEMENT PROGRAM

Many of the watershed management activities should result in improvement of source water quality in the Delta tributaries and the Delta by identifying and controlling non-point pollutant loads, and implementing programs to reduce or treat drinking water COCs.

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[3] The nine watershed groups are: Sacramento Valley Water Quality Coalition, California Rice Commission, San Joaquin County and Delta Water Quality Coalition, East San Joaquin Water Quality Coalition, Westside San Joaquin River Watershed Coalition, Westlands Water District, Southern San Joaquin Valley Water Quality Coalition, Root Creek Water District, and Goose Lake Coalition.

CALFED is considering watershed protection measures that reduce sources of turbidity, nutrients, and toxic substances that contribute to reducing the safety of drinking water supplies. Watershed projects to improve water quality may include efforts that seek improvement by reducing source water constituents such as bromide, natural organic matter, microbial pathogens, nutrients, total dissolved solids (TDS), salinity, and turbidity that have a negative impact on safe drinking water supply.

LEVEE SYSTEM INTEGRITY PROGRAM

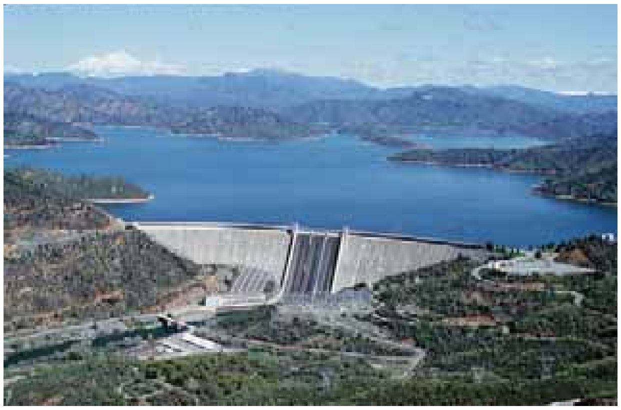
Actions implemented through the levee system program should also help protect drinking water quality. Improving stability of Delta levees will protect the Delta as a drinking water source by avoiding the chance of levee failure and island inundation that in many cases is accompanied by prolonged increases in seawater intrusion. The 1972 Andrus Island failure, for example, caused chlorides at CCWD's Rock Slough intake to spike up to 443 mg/L chloride, well in excess of the SWRCB municipal and industrial (M&I) objective of 250 mg/L chloride.

The Jones Tract levee failure in June 2004 occurred under conditions of relatively high Delta outflow, and DWR and Reclamation responded quickly (with a reduction in Delta exports, an increase in Delta inflow, and opening of the Delta Cross Canal) to minimize water quality impacts from seawater intrusion. When DWR began pumping water off Jones Tract on July 12, 2004, about 160,000 acre-feet (AF) of water was present on the island. Pump-off operations ended on December 18, 2004. Water pumped off the island had relatively low salinity and added to Delta outflow. These flows generally improved Delta salinities, but the pump-off also added organic carbon, taste and odor (T&O) producing compounds, and other COCs to the Delta.

STORAGE PROGRAM

Upstream Surface Storage

Surface storage projects can improve or harm water quality depending on how they are designed and operated. The three additional upstream storage projects being investigated by CALFED (expansion of Shasta Reservoir, a new offstream reservoir on the west side of the Sacramento Valley (Sites), and increased upper San Joaquin River reservoir storage) could be used to increase Delta outflow in the fall when Delta outflows are lowest, and to improve water quality in the San Joaquin River. However, these reservoirs also are likely to be used to meet other CALFED goals, which would reduce



The 4.5 million acre-foot Shasta Reservoir on the Sacramento River near Redding is part of the federal Central Valley Project. Releases from this reservoir play a major role in controlling water quality in the Delta. Raising Shasta Dam and increasing storage in the reservoir are part of the CALFED Surface Storage Program.

potential improvements in water quality. Delta water quality degradation also can occur if filling the reservoirs reduces inflow to the Delta and the periods when excess flow conditions occur in the Delta. Information regarding CALFED's surface storage projects is available through the following website: http://www.storage.water.ca.gov/index.cfm

Expansion of Los Vaqueros Reservoir

CALFED also is studying expanding CCWD's existing Los Vaqueros Reservoir to provide water quality and water supply reliability benefits to Bay Area water users and provide Environmental Water Account (EWA) benefits. The existing Los Vaqueros Reservoir operations to improve CCWD's delivered water quality tend to maximize diversions when Delta water quality is good (e.g., after periods of high Delta outflow) and reduce diversions during periods when Delta outflow is poor (e.g., in the fall when water is released from the reservoir for blending). An enlarged reservoir also would likely be filled when Delta water quality is good and Delta outflows are high enough to prevent water quality impacts in the Delta. This project is a good example of the potential for regional cooperation (in this case, within the Bay Area) to implement a project that could provide multiple benefits on a regional basis. More detailed information is provided at: http://www.lvstudies.com/

San Luis Reservoir Low Point Improvement Project

In addition, CALFED is evaluating alternatives for increasing the operational flexibility of storage in San Luis Reservoir while protecting the quality of water delivered to Santa Clara and San Benito Counties from San Luis Reservoir via the San Felipe Unit of the CVP. San Felipe contractors have historically been exposed to poor water quality when storage in San Luis Reservoir drops below about 300,000 AF. If an alternative means of supplying Santa Clara Valley Water District is feasible, the CVP and SWP could target drawing San Luis Reservoir down to approximately 79,000 AF and increase water supplies. This project was included in the CALFED ROD as a complementary action and referred to as the "San Luis Reservoir Low Point Improvement Project." More detailed information is given at: http://www.valleywater.org/Water/Where_Your_Water_Comes_From/Imported_Water/San_Luis_Reservoir_Low_Point_Improvement_Project/index.shtm

In-Delta Island Storage

CALFED is also studying storage of water on two in-Delta islands and use of two other islands for enhancement of terrestrial habitat based on the Delta Wetlands Project proposal. While the increased in-Delta storage could provide water for increasing exports and Delta flows, filling and draining of the reservoir islands has the potential to impact water quality, in particular through the discharge of organic carbon from the peat soil on these islands. These water quality issues are being analyzed as part of the CALFED study. More detailed information on this CALFED project is given at: http://www.calwater.ca.gov/Programs/Storage/InDeltaStorageReports.shtml

CONVEYANCE PROGRAM

Major actions proposed under the CALFED Conveyance Program include increasing permitted pumping at the SWP Banks Pumping Plant from 6,680 cfs to 8,500 cfs, constructing a 400 cfs intertie between the CVP Delta-Mendota Canal (DMC) and the SWP California Aqueduct to increase CVP exports at the Tracy Pumping Plant, dredging southern Delta channels, and installing four permanent operable barriers in the south Delta. As discussed earlier, each of these has the potential to degrade Delta water quality; the CALFED Delta Improvements Package was developed to address these issues. The CALFED ROD linked installation of the permanent operable barriers and increased SWP pumping to completion of the Veale/Byron Water Quality Improvement Projects to reduce the impacts of these conveyance actions on CCWD. The Veale/Byron Projects are expected to be completed by August 2005. A project-specific EIS/EIR and Action-Specific Implementation Plan for the South Delta Improvements Program are expected to be released for public review in August 2005.

The pattern of export pumping in the south Delta also will be affected by DWR and Reclamation's proposal to further integrate CVP and SWP operations and increase operational flexibility. This integration plan was developed as a result of negotiations between DWR, Reclamation, and their water supply contractors. The proposal, in conjunction with increased permitted capacity at Banks, will enable greater use of Banks to export water for the CVP and support additional water transfers for EWA and individual agencies. In the future, the SWP may seek to increase Banks pumping to the maximum installed capability of 10,300 cfs, and the CVP may increase the intertie capacity from 400 cfs to 900 cfs. These future actions would put further pressure on water quality in the south and central Delta. The water quality actions in the CALFED Delta Improvements Package were included to help address this issue.

ECOSYSTEM RESTORATION PROGRAM

Water quality problems for drinking water and the ecosystem often are associated with the same sources. In some cases, however, the contaminant concentration level for health effects on fish, for example, are much lower than for humans (e.g., selenium). Ecosystem projects to restore wetlands and create fish habitat can impact the Delta as a drinking water source by increasing the production of organic carbon.

ENVIRONMENTAL WATER ACCOUNT

EWA allows fishery agencies to ask for reduced exports and increased instream flows in for certain periods to protect anadromous and resident fish in the Bay-Delta system. The lost exports and additional releases are repaid to the water users from EWA, which deals in both water and monetary assets. The effects on Delta water quality from these fish actions will depend on timing of the export cuts or upstream reservoir releases. The August 2000 CALFED ROD also called for actions to increase EWA water supplies south of the Delta by relaxing the export/inflow cap on export pumping at Banks to export EWA water, pumping an additional 500 cfs above the Banks export limit in July through September for EWA, and giving EWA shared use of Joint Points of Diversion

(JPOD).[4] Increased exports for the EWA also have the potential to adversely impact Delta water quality.

WATER TRANSFERS PROGRAM

The transfer of additional water from north to south through the Delta increases Delta exports and puts additional pressure on Delta water quality. However, exchanges or transfers of high quality water from an agricultural water agency to an urban agency, for example, could dramatically improve drinking water quality. Examples of such transfers include transfers of federal Solano Water Project water to urban areas in Solano County, or between agricultural water agencies, using water from Friant Dam and the Metropolitan Water District of Southern California (MWD).

WATER USE EFFICIENCY PROGRAM

BMPs to reduce agricultural and urban water use can reduce the loads of drinking water pollutants of concern in agricultural return flows and urban wastewater discharges. Water use efficiency also reduces the demand for diversions and exports from the Delta and upstream. Water use efficiency is an important element of the CALFED ELPH diagram.

SCIENCE PROGRAM

The Science Program is charged with integrating world-class science and peer review into every aspect of CALFED to guide decisions and evaluate actions that are critical to its success. The Science Program has sponsored expert panel review of DBP formation issues, and the Third Biennial CALFED Science Conference, held in October 2004, included a special session on drinking water quality, which covered source water protection, watersheds, the Delta, and treatment technologies (http://iep.water.ca.gov/calfed/sciconf/2004/conference_program.pdf).

"DELTA REGION" ELPH MODEL

Since 2001, the CALFED Water Quality Program has worked to define what is meant by the ELPH model, and how such a standard can be achieved. A major component of this strategy is development of "Regional ELPH Plans," in which local agencies work at a regional level to identify a combination of local, regional, and statewide actions needed to achieve an equivalent level of public health protection. To that end, CCWD, the city of Stockton (COS), and SCWA have proposed a "Delta Region ELPH" (see **Figure 4-4**). This proposed model eliminates actions and activities not available to in-Delta diverters, namely "Out of Delta Source Water Exchanges," "South of Delta SWP and CVP Operational and Storage Modifications," and use of "Imported Water."

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[4] In D-1641, SWRCB set conditions for use of Banks Pumping Plant to export water for the CVP and use of Tracy Pumping Plant to export water for the SWP. This is referred to as Joint Points of Diversion.

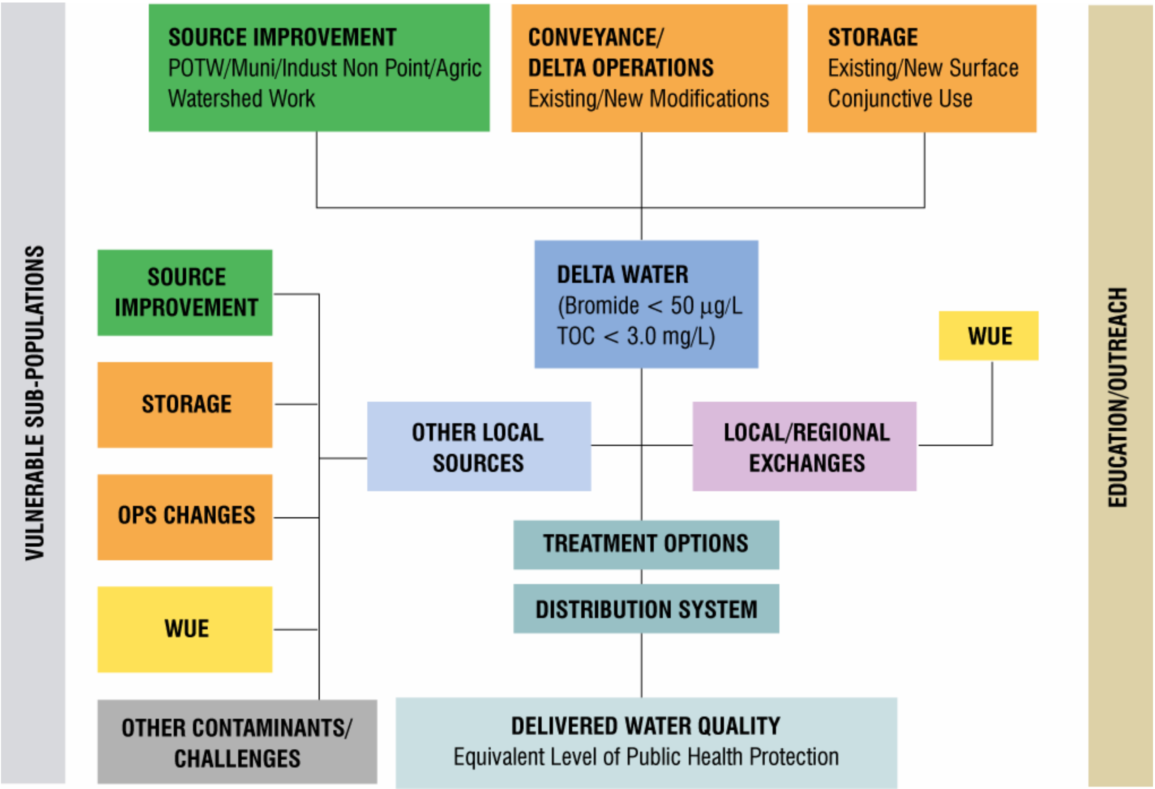

Figure 4-4 Proposed Delta Region
Equivalent Level of Public Health Model

PROPOSED IN-DELTA ELPH FOR THE CONTRA COSTA WATER DISTRICT

Figures 3-1 and **3-2** in **Chapter 3** delineated the very specific water quality objectives adopted by CCWD to provide high quality water to its customers. To meet those objectives, CCWD is developing several major projects and programs to protect its future water quality needs and to improve the drinking water quality delivered to the customers, including the following:

- An "Alternative Intake Project" (AIP) to evaluate other points of diversion from the Delta for the purpose of improving water quality (both for direct delivery and diversion to Los Vaqueros Reservoir). The new intake will have lower bromide concentrations than CCWD's existing intakes, which will help CCWD meet anticipated future drinking water regulations.
- Encasement of the Contra Costa Canal to improve source water quality delivered to the Bollman and Randall-Bold WTPs. This will eliminate seepage and runoff into the canal from adjacent areas and improve security.
- An intertie with the EBMUD Mokelumne Aqueduct developed to offset the impacts of the Freeport Regional Water Authority (FRWA) project on CCWD. This intertie also will be used to provide emergency supplies between CCWD and EBMUD, and to facilitate potential transfers of higher quality water to CCWD.

- Expansion of the Los Vaqueros Reservoir to enhance the improved water quality and emergency water supply benefits of the existing Los Vaqueros Reservoir and to extend those benefits, along with additional water supply reliability and environmental benefits, to other Bay Area urban agencies.
- Application of advanced water treatment technologies at the Bollman and Randall-Bold WTPs.

Figure 4-5 places these projects within the proposed Delta Region ELPH model.

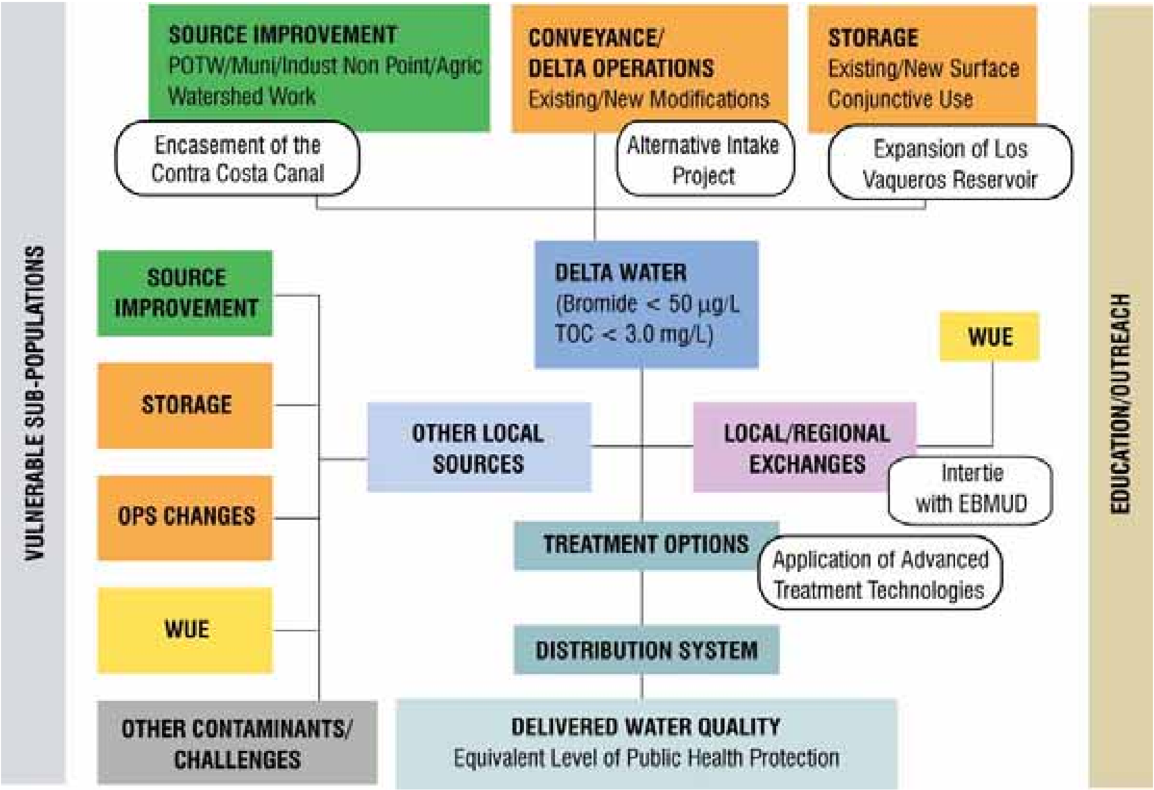

Figure 4-5 Proposed Contra Costa Water District Equivalent Level of Public Health Model

It is important to note that although CCWD is developing these projects and programs on its own (or in some cases, in partnership with other agencies), implementation of these projects and programs may require more than a local effort. Regional and statewide participation will likely be appropriate for some these projects and programs. In particular, many of the efforts of CCWD are being funded by CALFED and closely coordinated with others in the Delta. Each of these projects is described further below within the construct of **Figure 4-5**.

ALTERNATIVE INTAKE PROJECT

Project Description

Looking east at Victoria Canal from above Clifton Court Forebay. Victoria Canal is a potential location for CCWD's proposed alternative drinking water intake.

The AIP is a water quality project that will evaluate adding a new drinking water intake for CCWD in the central Delta. The alternative intake would enable CCWD to relocate some of its diversions to a Delta location with better source water quality than is currently available at CCWD's Old River and Rock Slough intakes. The project would tie into CCWD's existing Old River intake and conveyance system, which has a capacity of 250 cfs. It would allow CCWD to divert higher quality water while not increasing the amount of water pumped from the Delta (rate or annual quantity). Initial planning work has identified the lower third of Victoria Canal as the most feasible location for a new intake (see **Figure 4-6**). The project would include construction of a fish screen, pumping plant, and associated conveyance facilities from the new intake to CCWD's existing Old River conveyance system.

The AIP will both offset water quality degradation in the Delta and help meet CALFED drinking water quality improvement goals. The project is a water quality element of CALFED's Delta Improvements Package, which includes water supply, water quality, and ecosystem restoration elements. As of October 2004, the intake project is federally authorized for design and construction under the California Water Security and Environmental Enhancement Act, Public Law (PL) 108-361. AIP goals and benefits include the following:

- Ensuring that CCWD customers' delivered water quality remains high especially during droughts and in late summer/fall months, despite continuing and historical deterioration in Delta water quality.
- Helping to meet CALFED's goal of ELPH for CCWD and help ensure balanced implementation of the CALFED Program.
- Protecting the public health by helping to ensure CCWD consistently meets or exceeds current and future drinking water quality standards.
- Helping protect drinking water quality during emergencies such as Delta levee failures. An alternative intake location could help CCWD avoid areas of the Delta affected by an emergency.

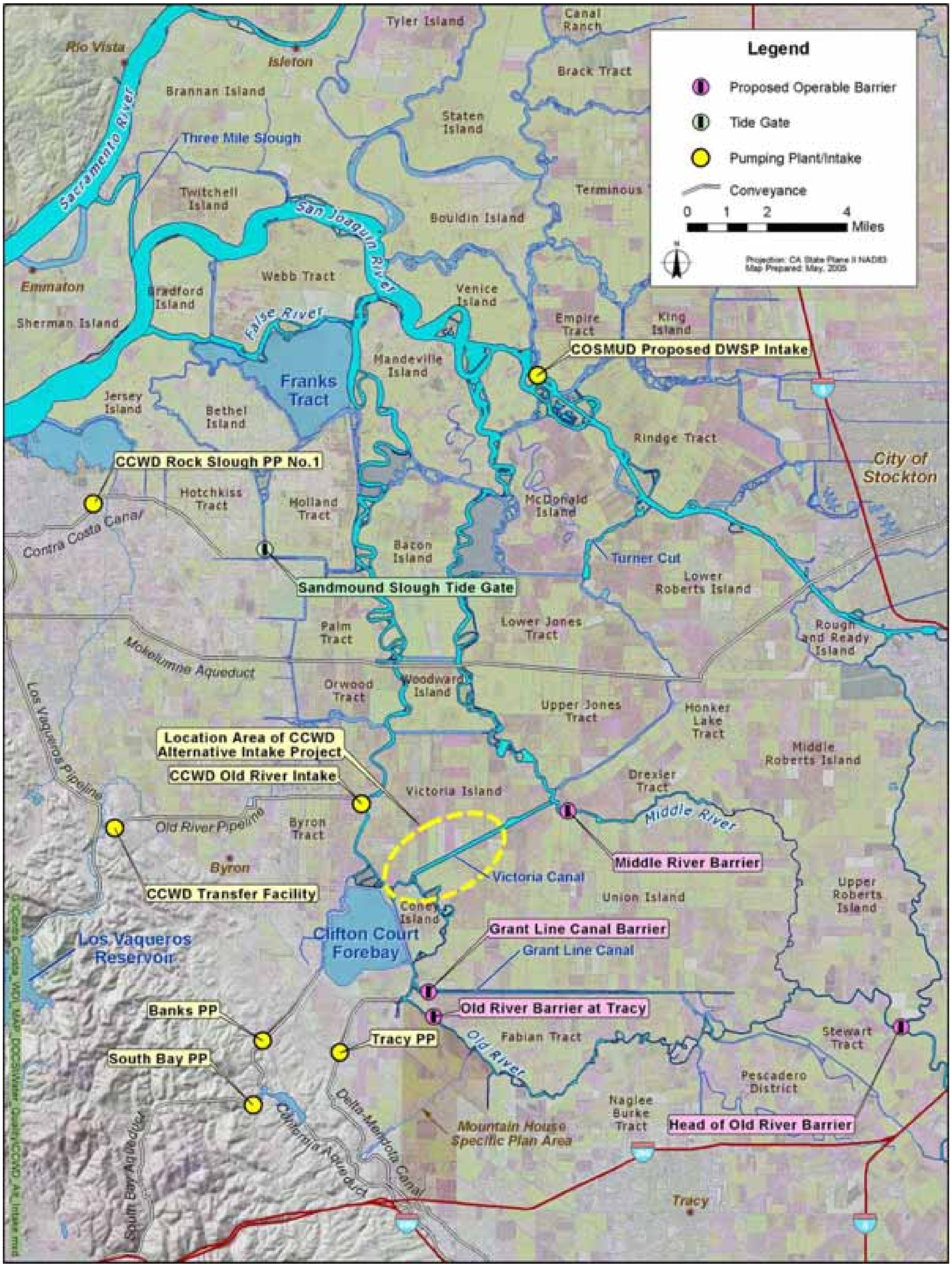

Figure 4-6 Location of Contra Costa Water District Alternative Intake Project on Victoria Canal

Relocation of CCWD's intake is authorized for design and construction in recent federal CALFED legislation, specifically, PL 108-361 §103 (f)(1)(E), which states:

"Funds may be expended for design and construction of the relocation of drinking water intake facilities to in-Delta water users…The Secretary shall coordinate actions for relocating intake facilities on a time schedule consistent with…[permanent agricultural barrier installation]…or take other actions necessary to offset the degradation of drinking water quality in the Delta due to the South Delta Improvement Program."

Delta Region ELPH Category

The AIP fits within the "Conveyance/Delta Operations" portion of the Delta Region ELPH model.

Project Status

The AIP is currently in the planning phase. On January 25, 2005, a Notice of Preparation (NOP) was released and a Notice of Intent (NOI) for the project was published in the Federal Register (Vol. 70, No. 15, pp. 3557-3558). Public scoping meetings were held in Concord, Sacramento, and Antioch on February 15, 16, and 17, 2005, respectively. A Draft EIS/EIR is anticipated in fall 2005. A Draft EIS/EIR is anticipated in fall 2005. The project is scheduled to proceed to design and construction in spring 2006. Estimated project completion is mid-2009.

Estimated Project Cost for Planning Purposes[5]

The estimated total project cost of the AIP is $96 million. CCWD is currently seeking state and federal cost-share funding for up to 50 percent of the construction cost. CCWD has budgeted $8 million to complete the planning and initial phases and has a 50 percent cost ($40 million) share for design and construction planned in its Capital Improvement Program.

Qualitative Evaluation of Anticipated Water Quality Improvements

Relocating CCWD's Old River intake to Victoria Canal or a location of similar or better water quality will make better water quality available to CCWD without increasing the amount of water diverted by CCWD from the Delta. During key periods (including summer, fall, and dry periods), the water quality in Victoria Canal is considerably better than at CCWD's Old River intake.

Figure 4-7 shows chloride concentrations (a measure of salinity and indicator of bromide concentrations) at CCWD's Old River intake and in Victoria Canal since April 2000.

Improved source water quality translates into a direct and measurable improvement in the quality of water CCWD delivers to its customers, in the performance of Los Vaqueros Reservoir as a water quality and emergency supply reservoir, and in the ability of CCWD to meet its delivered water quality goals (see **Table 3-2** in **Chapter 3**).

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[5] The estimated costs presented throughout **Chapter 4** are the most current available and are for planning purposes only. Costs will likely change as projects and programs are refined.

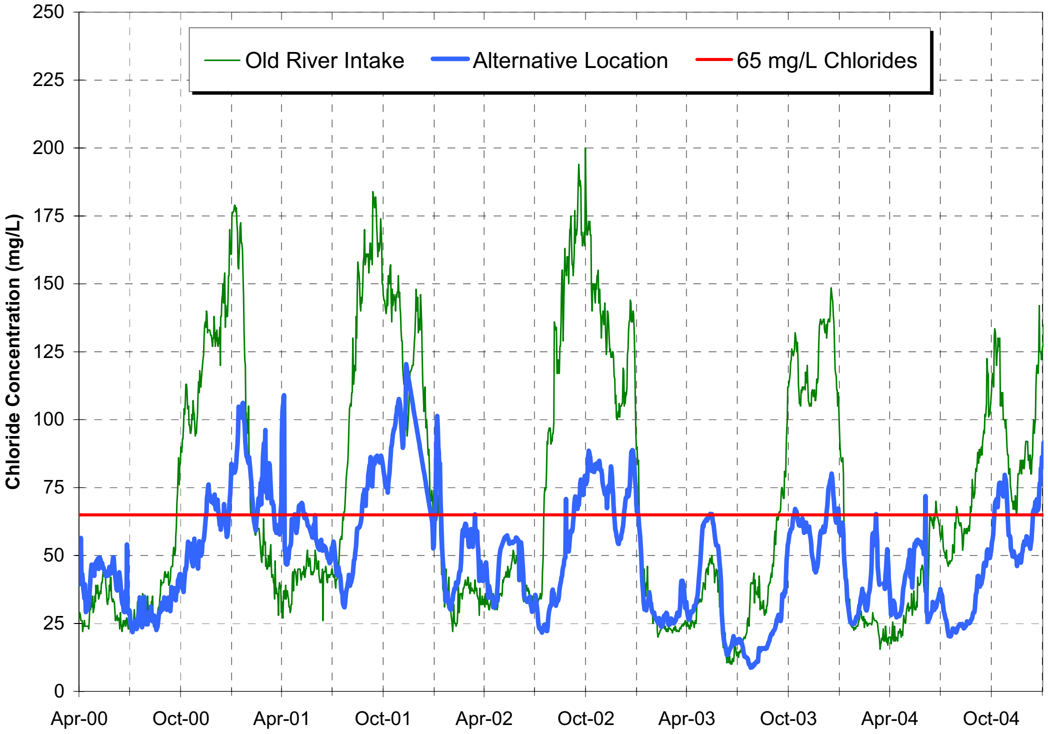

Figure 4-7 Comparison of Chloride Concentrations at Old River Intake Versus AIP

Chloride concentrations are consistently lower at the proposed Alternative Intake Project on Victoria Canal when compared to concentrations observed at the existing Old River intake.

CONTRA COSTA CANAL ENCASEMENT PROJECT

Project Description

In 2000, CCWD initiated the Rock Slough Water Quality Improvement Project with funding from CALFED. The project included a monitoring program to determine sources of degradation within the Contra Costa Canal and Rock Slough. The studies indicated a significant amount of seepage of high saline water occurs into the Contra Costa Canal from local groundwater.

The purpose of the Contra Costa Canal Encasement Project is to protect the drinking water supply of CCWD's 500,000 customers from existing and future degradation. The project will also increase the flexibility of the CVP and SWP by isolating sources of water quality degradation that affect the CVP's and SWP's ability to meet M&I chloride objectives at Contra Costa Canal Pumping Plant No. 1.

The project involves installing approximately 21,000 feet of buried pipeline or box culvert within the right-of-way (ROW) of the Contra Costa Canal and constructing a low-lift pump station. The pipeline installation will occur between Rock Slough and Pumping Plant No. 1. The remaining open-water canal will be modified to minimize seepage, to enhance security and public safety, and to minimize environmental impacts (see **Figure 4-8**).

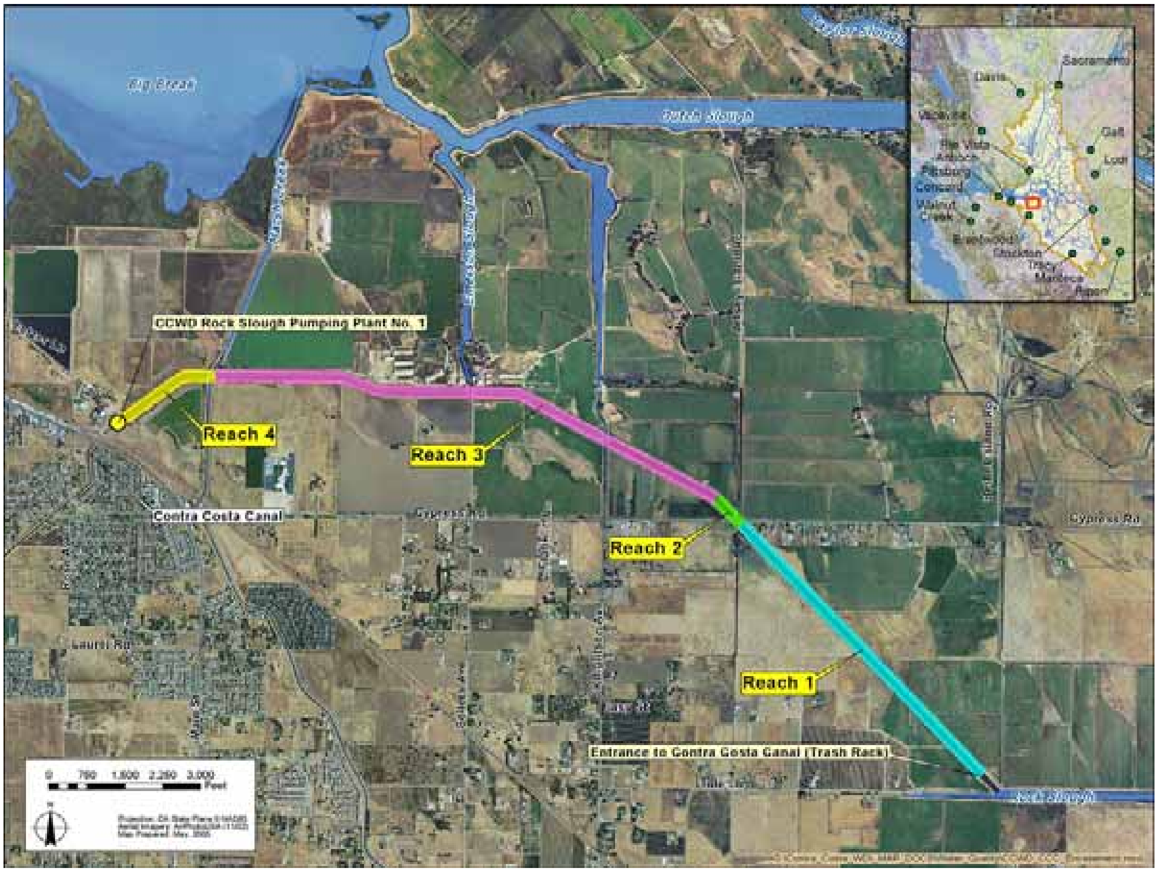

Figure 4-8 Location of the Contra Costa Canal Encasement Project

Project goals and benefits include the following:

- Ensuring CCWD customers' delivered water quality remains high. Rock Slough is an important raw water supply source during wet months when salinity in the Delta is good. Supplies diverted through the Canal also are used to blend with Los Vaqueros Reservoir water during dry months when salinity is higher in the Delta.
- Helping to meet CALFED's goal of an ELPH for CCWD and helping to ensure balanced implementation of the CALFED Program.
- Protecting public health by helping to ensure CCWD consistently meets or exceeds current and future drinking water quality standards.
- Improving security and public safety, improving flood control, reducing seepage, and assuring that CCWD's conveyance facility will be compatible with planned development in the project area.
- Improving flexibility of the CVP and SWP by eliminating sources of water quality degradation that make it more difficult to meet the Rock Slough water quality standards of D-1641.

Delta Region ELPH Category

The Contra Costa Canal Encasement Project fits within the "Source Improvement" portion of the Delta Region ELPH model.

Project Status

CCWD is in the initial stages of project planning, engineering design, and environmental compliance. The project is divided into four parts corresponding to reaches of the canal (see **Figure 4-8**). The schedule for the first portion of the project, from Pumping Plant No. 1 to Marsh Creek, is anticipated to be as follows:

Prepare Notice of Intent/Notice of Preparation ⇒ May 2005
Draft Initial Study/Environmental Assessment ⇒ December 2005
Draft Preliminary Design Report ⇒ March 2006
Final Design Report ⇒ July 2006
Construction ⇒ September 2007

Estimated Project Cost for Planning Purposes

The estimated total project cost is approximately $70.5 million. The project is subject to availability of funding. The canal is divided into reaches to enable construction completion as funds are procured. Estimated costs (by canal reach) are as follows:

• Reach 1 (Rock Slough to Cypress Road)	$6.5 million
• Reach 2 (Cypress Road Crossing)	$2.0 million
• Reach 3 (Cypress Road to Marsh Creek)	$51.0 million
• Reach 4 (Marsh Creek to Pumping Plant No. 1)	$11.0 million

Approximately $10.5 million has been expended on the project to date. Anticipated future expenditures are $12.0 million in fiscal year (FY) 2006, $16.0 million in FY 2007, $9.0 million in FY 2008, and $23.0 million in FY 2009.

Looking east from Contra Costa Canal Pumping Plant No. 1 at the unlined portion of the canal in the section where local groundwater seepage occurs, which is particularly noticeable at low diversion rates.

Potential sources of funding include Reclamation District 799, local land developers, State Proposition 50, the Federal Water Resources Development Act (WRDA), Reclamation, the CALFED/Dutch Slough Partnership, State Proposition 13 Grant funds, Ironhouse Sanitary District, and CCWD.

Qualitative Evaluation of Anticipated Water Quality Improvements

Seepage into the Contra Costa Canal near Pumping Plant No. 1 is most noticeable during periods when CCWD's diversions are low. This allows salinity and other potential contaminants to concentrate in the unlined section of the canal (see **Figure 4-8**). The open unlined canal is also vulnerable to runoff and other sources of contamination. This water quality solution will directly protect the public health of CCWD's customers by removing these current and potential future sources of contamination.

CCWD INTERTIE WITH EBMUD'S MOKELUMNE AQUEDUCT

Project Description

As part of a settlement agreement between CCWD, EBMUD, and other member agencies of the FRWA, EBMUD agreed to give CCWD access to Freeport Regional Water Project (FRWP) facilities for the purpose of wheeling up to 3,200 AF of water to CCWD each year. Under this arrangement, CCWD water that would normally be diverted in the Delta would instead be diverted from the Sacramento River at the FRWP intake and conveyed to CCWD through FRWP facilities, the Reclamation's Folsom South Canal, the Folsom South Canal Connection, and EBMUD's Mokelumne Aqueduct (see **Figure 4-9**). An intertie between the Mokelumne Aqueduct and CCWD's Los Vaqueros Pipeline near Brentwood would facilitate the delivery of water to CCWD. CCWD will design and construct interconnection facilities at the intersection of the Mokelumne Aqueduct and Los Vaqueros Pipeline.

CCWD water could be wheeled every year, on request by CCWD, unless unusual or emergency conditions exist that reduce the capacity of the system to the extent that FRWA and EBMUD are unable to wheel the water without impacting deliveries to their own systems. The rate of delivery of the wheeled water will be determined each year in conjunction with development of the wheeling schedule. The maximum wheeling rate would be 155 cfs (which corresponds to the full capacity of the Folsom South Canal Connection). The chloride concentrations of the wheeled water are expected to be 10 mg/L or better. The wheeled water will be placed into storage in Los Vaqueros Reservoir to offset the impacts of the Freeport Regional Water Authority project on CCWD.

Delta Region ELPH Category

The intertie with the Mokelumne Aqueduct fits within the "Local/Regional Exchange" portion of the Delta Region ELPH model.

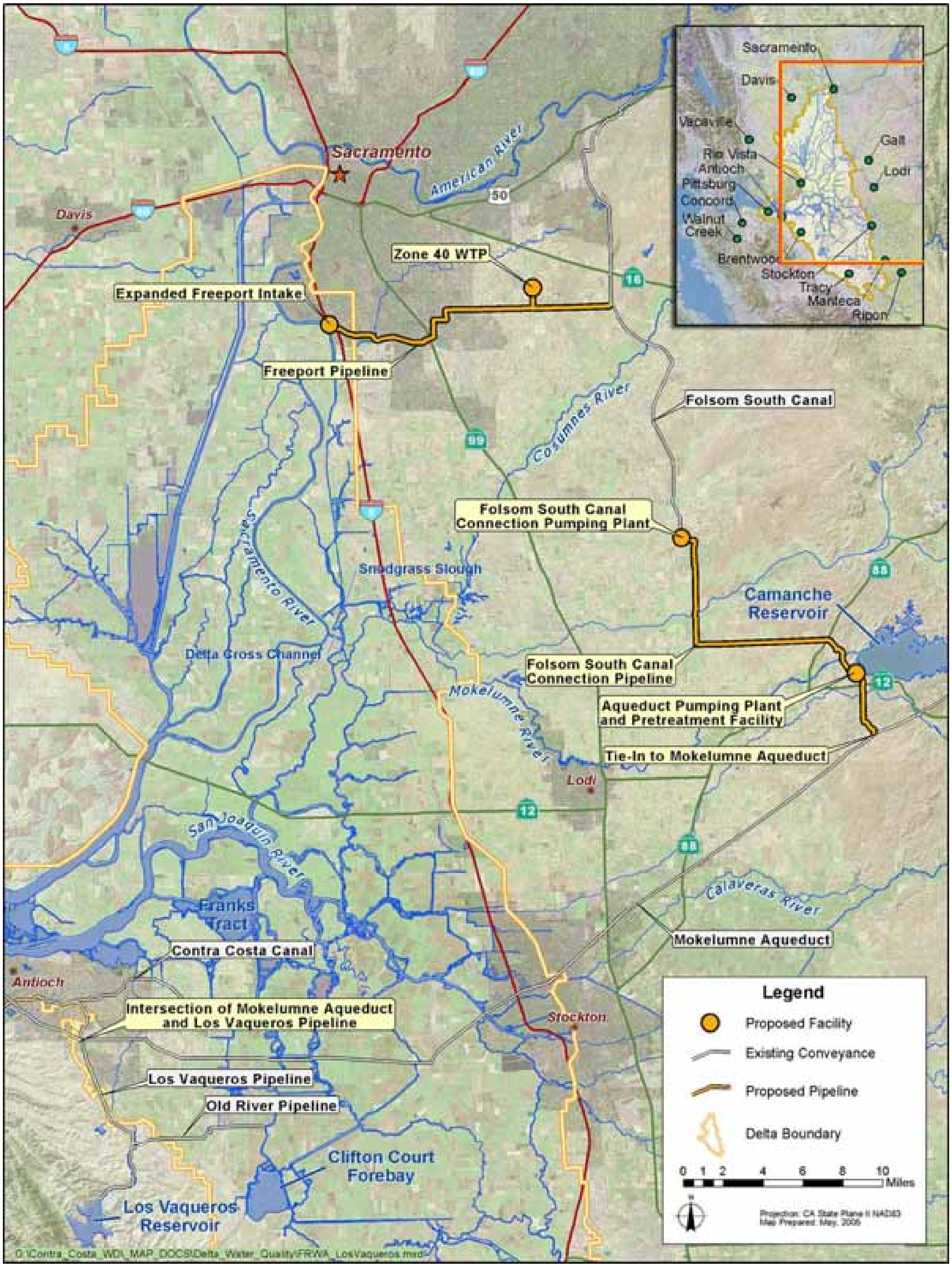

Figure 4-9 Freeport Regional Water Authority Project and Intertie with Los Vaqueros Pipeline

Project Status

This project is in the preliminary design phase. CCWD is preparing the required environmental documentation, consistent with CEQA, with action anticipated in December 2005. CCWD is pursuing the acquisition of property adjacent to the intersection of the Mokelumne Aqueduct and Los Vaqueros Pipeline. Construction is anticipated to take place during winter 2006/2007. Delivery of water will not take place until completion of construction of the FRWP, including joint FRWA and EBMUD facilities, which is currently scheduled to occur in spring 2008.

Estimated Project Cost for Planning Purposes

It is anticipated that the cost to CCWD for planning, environmental documentation, design, engineering services during construction, and construction management will total approximately $5.8 million. The cost of construction of the CCWD portion of the intertie is estimated to be approximately $2.1 million. Approximately $2.9 million has been expended to date. Anticipated future expenditures are $0.5 million in FY 2006 and $2.4 million in FY 2007.

Qualitative Evaluation of Anticipated Water Quality Improvements

Water delivered through the intertie will be placed into storage in Los Vaqueros Reservoir to offset the impacts of the FRWA project on CCWD. The intertie will also provide emergency supply for EBMUD and CCWD. For example, if water in the vicinity of CCWD's intakes were to be contaminated as a result of a chemical spill, CCWD could take water directly from EBMUD's system. Similarly, in an emergency, CCWD could release water from Los Vaqueros Reservoir and water diverted at the Old River intake into one of EBMUD's aqueducts. This intertie will also be used to facilitate potential transfers of higher quality water to CCWD.

LOS VAQUEROS RESERVOIR EXPANSION

Project Description

Expansion of the Los Vaqueros Reservoir from 100,000 AF of storage capacity up to 500,000 AF of storage capacity is currently being evaluated as part of the CALFED Storage Program to improve Bay Area drought supply and water quality and to contribute to the protection of Delta fisheries (see **Figure 4-10**). Reclamation and DWR are the lead federal and state CALFED agencies for the studies, respectively. CCWD is managing the environmental and engineering feasibility studies for CALFED.

Delta Region ELPH Category

The Los Vaqueros Reservoir Expansion fits within the "Storage" portion of the Delta Region ELPH model.

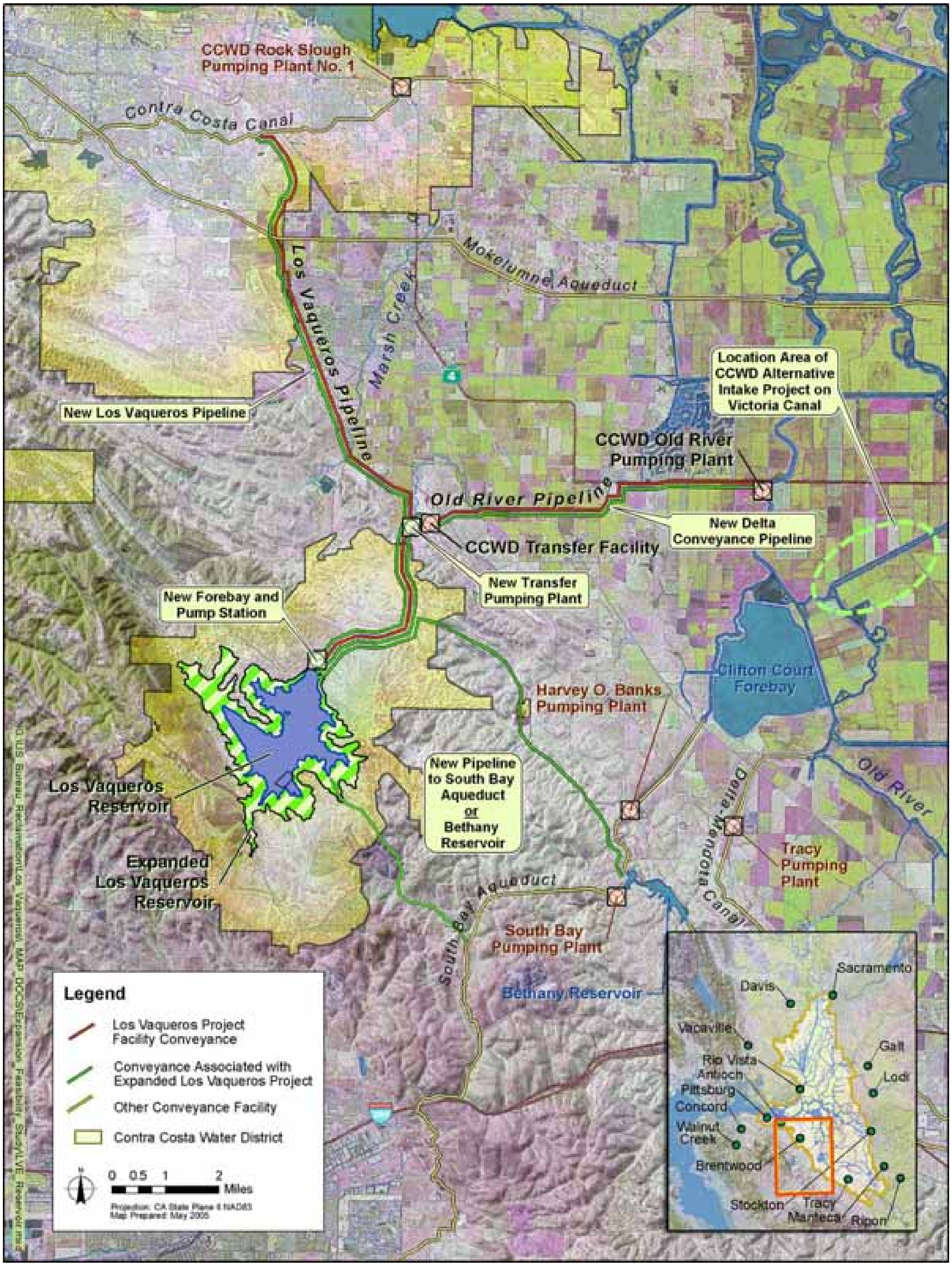

Figure 4-10 Los Vaqueros Reservoir Expansion Project

Project Status

In the March 2004 election, over 62 percent of the voters in CCWD's service area voted in favor of expanding Los Vaqueros Reservoir under certain conditions. A planning report was completed in April 2004. Completion of a federal feasibility study is underway. Scoping for an EIS/EIR is scheduled to begin in fall 2005.

Estimated Project Cost for Planning Purposes

Expansion of Los Vaqueros Reservoir in Contra Costa County could improve the quality of water supplies delivered to Bay Area agencies from the Delta.

The total estimated cost of the planning studies for the Los Vaqueros Reservoir Expansion project is about $36.6 million (including costs to date). About $17 million in state and federal funding has been received or budgeted to date. An additional $5 million has been identified in State Proposition 50 funds.

A $10 million federal share remains to be funded. CCWD is seeking state and federal funding for the project to complete the federal feasibility study, preliminary engineering evaluation and environmental documentation (EIS/EIR), as required by the CALFED ROD. Currently the EIS/EIR and feasibility studies are scheduled for completion in mid-2008. Approximately $16.9 million has been expended on the project to date. Anticipated future expenditures are $6.4 million in FY 2006, $6.8 million in FY 2007, $5.5 million in FY 2008, and $1.0 million in FY 2009. Estimated construction costs are not available at this time.

Qualitative Evaluation of Anticipated Water Quality Improvements

Anticipated water quality benefits of the project to expand Los Vaqueros Reservoir include the following:

- Improving the reliability of Bay Area water supplies during emergencies.
- Improving the quality of Bay Area water supplies delivered from the Delta during droughts and in late summer/fall months, despite deteriorating Delta water quality (see **Figure 4-11**).
- Improving and enhancing the Delta environment by protecting Delta fish populations affected by CVP and SWP Delta diversion facility operations.

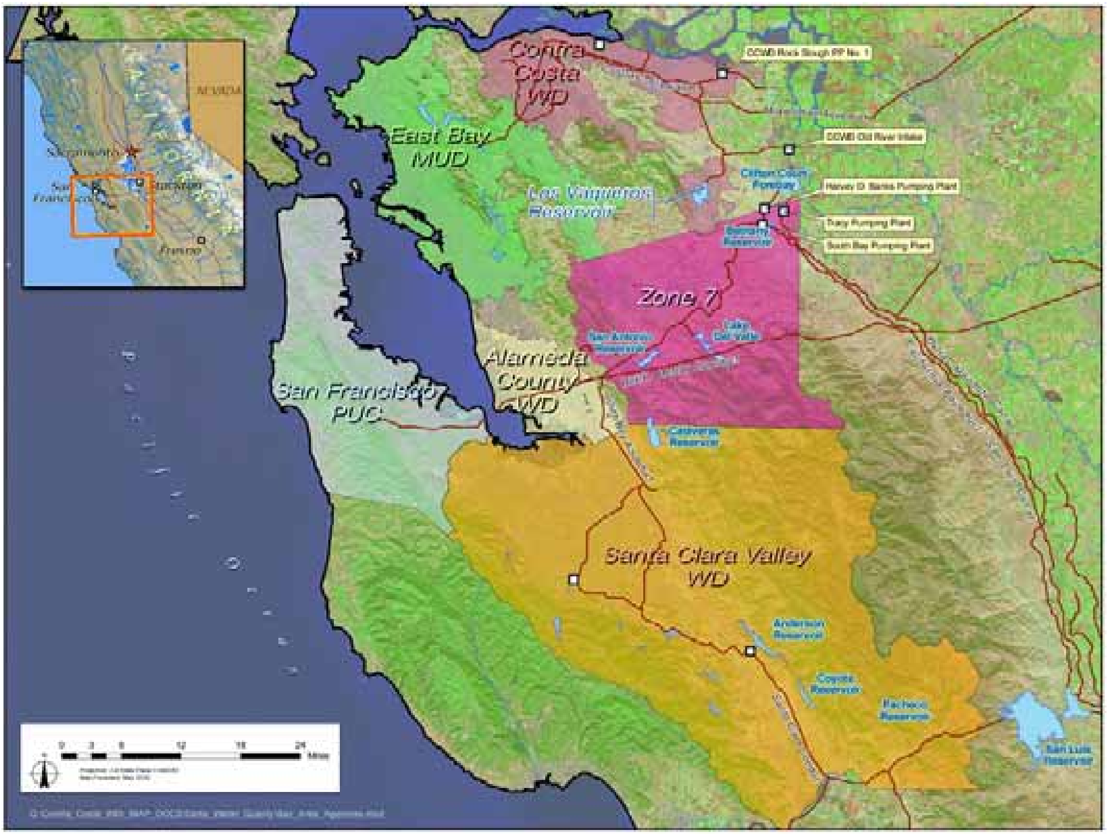

Figure 4-11 Bay Area Water Agencies that Could Potentially Benefit from an Expanded Los Vaqueros Reservoir

APPLICATION OF ADVANCED TREATMENT TECHNOLOGIES

Project Description

The "Advanced Treatment Demonstration Project" is a Bay Area collaborative research project. Participating agencies include EPA, the California Department of Health Services (DHS), CALFED, CCWD, Santa Clara Valley Water District, Alameda County Water District, Zone 7 Water District of Alameda County, SCWA, and the cities of Fairfield and Napa.

The project includes pilot-scale and demonstration-scale research of new treatment technologies applied to source water from the Delta. The research examines methods to produce safer drinking water with new and existing disinfectants and advanced filtration. Phase 1 of the project examines the use of disinfectant combinations to reduce DBP formation. Phase 2 will research advanced filtration techniques to remove bromide and T&O compounds. Results from this research will assist infrastructure and financial planning for water utilities that rely on diversions from the Delta for drinking water, as well as any utility relying on brackish water supplies for drinking water.

Project goals and benefits include the following:

- Information on contaminant removal technologies, including ion-exchange resins, advanced membrane filtration, conventional coagulants, and powdered activated carbon (PAC), and their effectiveness in treating Delta water.
- Detailed information on combinations of disinfectants to best reduce formation of potentially harmful DBPs in brackish water supplies.
- Economic analysis including life-cycle costs for implementing these technologies to guide investment decisions.
- Nationally applicable results for other systems using brackish source waters such as Chesapeake Bay and areas in Florida.

Delta Region ELPH Category

The Advanced Treatment Demonstration Project fits within the "Treatment Options" portion of the Delta Region ELPH model.

Project Status

Phase 1 of the project will be complete by March 2006. Phase 2 will begin in January 2006 and will be complete by September 2007.

Estimated Project Cost for Planning Purposes

CCWD is seeking state and federal funding for Phase 2 (advanced filtration experiments). The federal FY 2006 request is $1.6 million. The funding request from the state for FY 2006 is $1.0 million.

Qualitative Evaluation of Anticipated Water Quality Improvements

The multibarrier approach to protecting public health is implicit in the CALFED ELPH model. The principal benefit of this project is that it will provide pilot-scale information on the effectiveness of various treatment technologies for treating Delta diversions, as well as cost information. This information will be useful for comparing the cost of various other actions for the drinking water quality goals of CCWD and other urban agencies with the cost of advanced treatment.

PROPOSED ELPH FOR THE CITY OF STOCKTON METROPOLITAN AREA

COSMUD is developing several major projects and programs to address its future water quality needs and to improve the drinking water quality delivered to the customers, including the following:

- The DWSP, which will permit COS to divert high quality water from the Delta. The DWSP intake is being sited significantly downstream along the San Joaquin River into the Delta to provide access to a higher proportion of higher quality Sacramento River water.

- A groundwater ASR program using surplus Stanislaus River flows to recharge the groundwater basin (see the Farmington Groundwater Recharge Project investigation being led by the Stockton East Water District (SEWD)) or treated surface water supplies diverted through the DWSP facilities and directly injected into the groundwater.
- Conversion of wastewater treatment lagoons at the Stockton Regional Wastewater Control Facility to wetlands to improve the quality of wastewater effluent discharged to the Delta by the facility. The DWSP intake will be located well downstream from this discharge.

Figure 4-12 places these projects and programs within the proposed Delta Region ELPH model. It is important to note that although COSMUD is developing these projects and programs on its own (or in some cases, in partnership with other agencies), implementation of these projects and programs may require more than a local effort. Regional and statewide participation will likely be appropriate (and, in fact, a requirement) for some these projects and programs. Each of these projects is described further below within the construct of **Figure 4-12**.

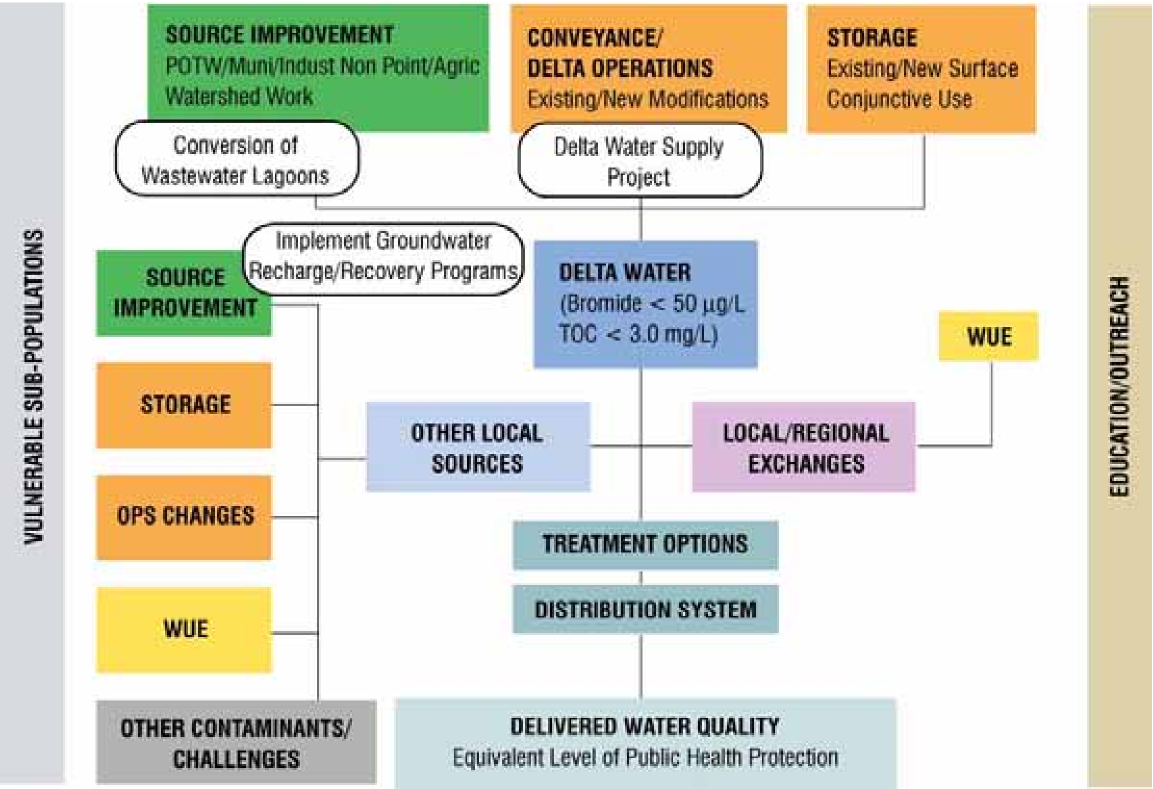

Figure 4-12 Proposed COSMA Equivalent Level of Public Health Model

DELTA WATER SUPPLY PROJECT

Project Description

COS is currently pursuing new surface water supplies as part of its proposed DWSP. Specifically, COS has filed an application with SWRCB to divert water from the Delta pursuant to two water rights:

- A diversion under Chapter 1485 of the California Water Code[6]
- A diversion under Chapters 11460 through 11465 of the California Water Code (the "Area of Origin" statutes)

The proposed project will be constructed in phases. The first phase of the project will provide for a 30 million gallon per day (mgd) diversion from the Delta with associated raw water pumping and conveyance, treatment, and treated water distribution facilities. Future phases of the project will increase the capacity of the facilities to 80 mgd, then to its ultimate planned capacity of 160 mgd.

Facilities for the proposed DWSP include a new diversion from the Delta at the southwest corner of Empire Tract (Site 2), approximately 13 miles of raw water pipelines, a WTP (Site C), and several miles of treated water pipelines to facilitate connection to the existing COSMA distribution system (see **Figure 4-13**). Siting the new intake is a major water quality issue.

Delta Region ELPH Category

The Delta Water Supply Project fits within the "Conveyance/Delta Operations" portion of the Delta Region ELPH model.

Project Status

A feasibility report for the DWSP was completed in January 2003. A Draft Environmental Impact Report (DEIR) was completed in spring 2005, along with a Biological Assessment. COS is currently pursuing a 404 permit from the United States Army Corps of Engineers (USACE) for the Delta intake facilities. A Final EIR is anticipated by fall 2005. The COS has recently begun a design/build procurement for the entire project and anticipates Notice To Proceed (NTP) with construction by July 2006. The objective is to have the facilities ready for commissioning by January 2010, with final completion and acceptance by January 2011.

Estimated Project Cost for Planning Purposes

The estimated capital cost of Phase 1 of the DWSP is $125 million (2003 dollars).

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[6] California Water Code Chapter 1485 essentially permits any municipality disposing of treated wastewater into the San Joaquin River to seek a water right to divert a like amount of water, minus losses, from the San Joaquin River or the Delta downstream of the point of wastewater discharge. COS seeks to recover a portion of the treated wastewater effluent it currently discharges to the San Joaquin River and the Delta from the Stockton Regional Wastewater Control Facility.

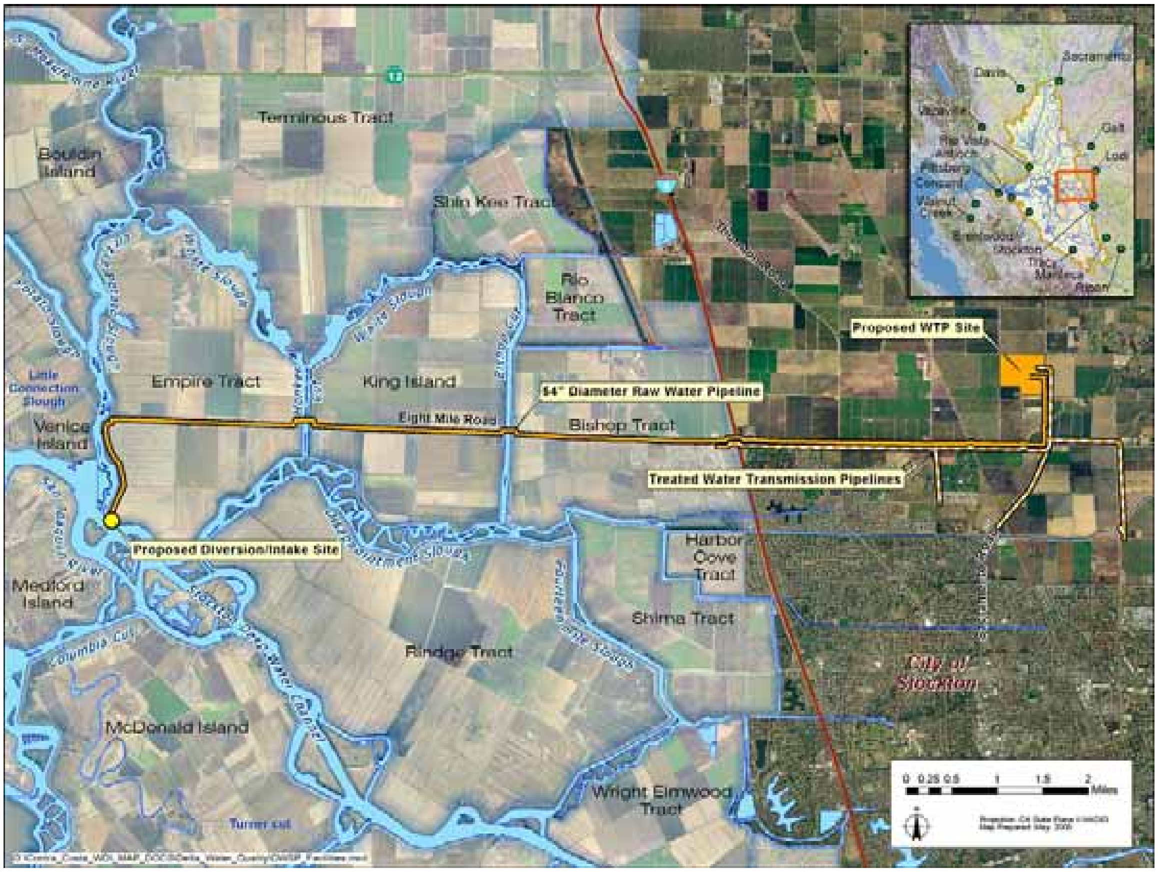

Figure 4-13 Facilities for the Delta Water Supply Project

Qualitative Evaluation of Anticipated Water Quality Improvements

Water quality in the San Joaquin River near COS has high concentrations of salt, organic carbon, and other drinking water constituents of concern. The new intake is being sited significantly downstream along the San Joaquin River to provide access to a higher proportion of high quality Sacramento River water.

AQUIFER STORAGE AND RECOVERY

A conjunctive use, or ASR, program relies on groundwater use in dry years, replenished through in-lieu pumping and/or direct recharge of surface water in wet years. This technique involves the development of a groundwater spreading or injection, storage, and recovery program. Depending on the choice of method, surplus surface water available in wet years is injected directly into the aquifer or delivered to recharge basins and allowed to infiltrate naturally, both of which increase groundwater supplies. Then, in dry years, groundwater stored in previous years is extracted, allowing for surface water curtailments, providing fisheries protection and water supplies for downstream users. During dry periods, groundwater pumping is necessary due to the lack of surface water supplies needed to meet demands. The goal of the storage, or banking, component of ASR is to reduce the impacts of this necessary pumping. COSMA is considering participation in two regional groundwater recharge projects: the "Farmington

Groundwater Recharge Program" and the "DWSP Conjunctive Management – Groundwater Injection and Recovery Program." Each is discussed further below.

DWSP Conjunctive Management – Groundwater Injection and Recovery

Project Description

The DWSP also has a conjunctive use component that integrates surface water and groundwater management. In wet years, when surface water is available, use of Delta diversions would be maximized and the groundwater would be allowed to recharge. In addition to allowing the basin to recharge naturally during wet years by minimizing pumping, artificial recharge techniques could be used to store excess Delta supplies during wet years for recovery and use during drier periods.

Delta Region ELPH Category

The DWSP Conjunctive Management Program fits within the "Source Improvement" and "Storage" portions of the Delta Region ELPH model.

Project Status

The DWSP Conjunctive Management Program was included in the DEIR completed for the DWSP in spring 2005. Timing on implementation of this project is tied to the success of the DWSP (see above).

Estimated Project Cost for Planning Purposes

No estimates of cost are available at this time.

Farmington Groundwater Recharge Program

Project Description

SEWD and USACE, along with other local water agencies have launched the "Farmington Groundwater Recharge Program." The objective of this program is to directly recharge an average of 35,000 AF per year of surface water into the eastern San Joaquin Basin through field flooding of 800 to 1,200 acres of land. The water to flood fields is provided by winter flows from the Calaveras, Mokelumne, Littlejohns, and Stanislaus watersheds, delivered through area rivers, canals, ditches, and irrigation pipes (see **Figure 4-14**). COSMUD would participate in the Farmington Groundwater Recharge Program by banking surface water supplies obtained through either a water transfer agreement with SEWD or a contract entitlement with Reclamation for water supplies made available through the reoperation of New Hogan Reservoir.

Delta Region ELPH Category

The Farmington Groundwater Recharge Program fits within the "Source Improvement" and "Storage" portions of the Delta Region ELPH model.

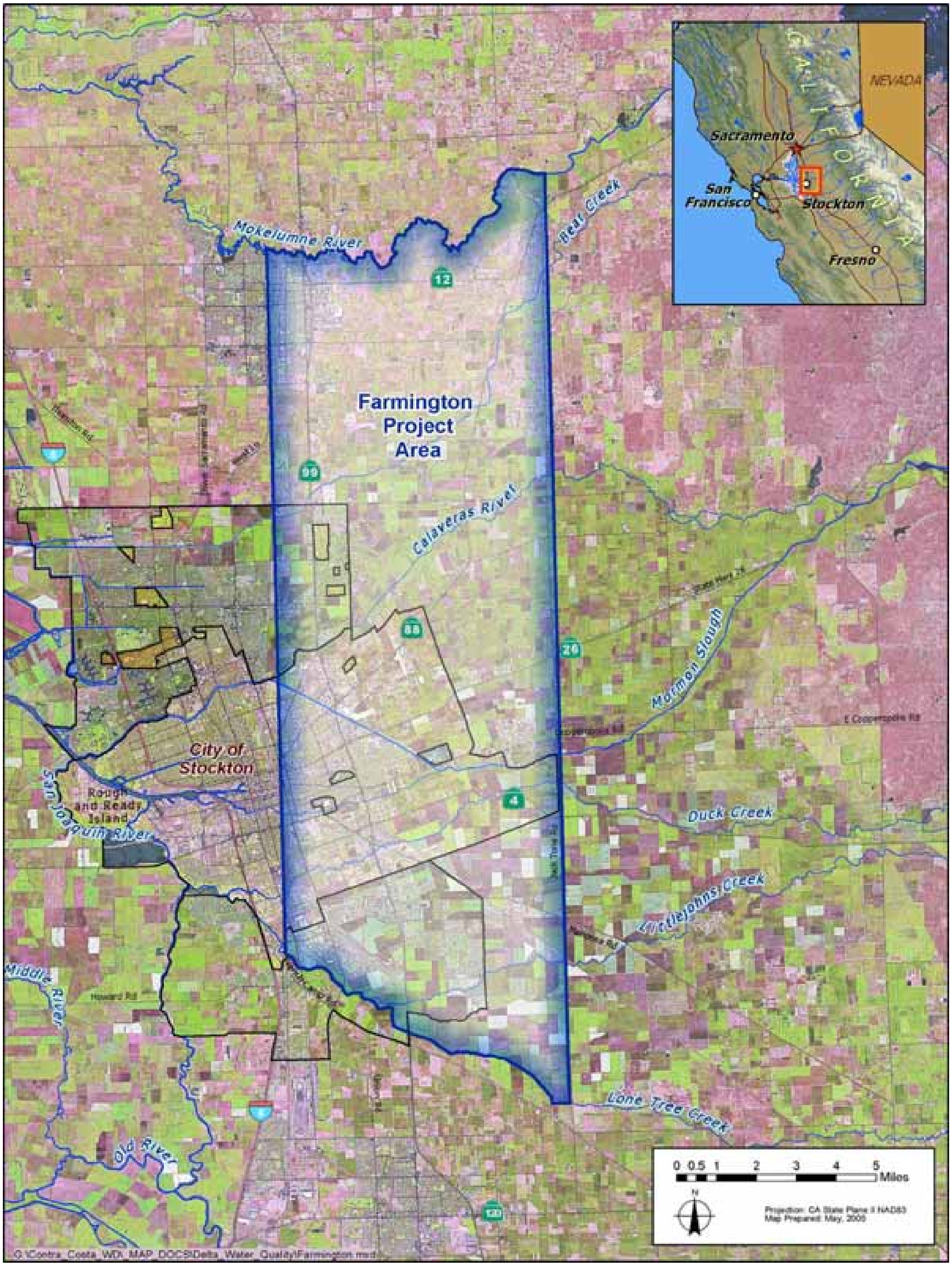

Figure 4-14 Farmington Groundwater Recharge Program Area

Project Status

The program has been active since 2003 and is currently awaiting approximately $1.1 million in federal appropriations to proceed to the next phase of the work.

Estimated Project Cost for Planning Purposes

The estimated cost of implementing the project is $33.5 million. Anticipated sources of funding include $25 million in federal appropriations and $8.5 million from Propositions 13 and 50 funds.

Qualitative Evaluation of Anticipated Water Quality Improvements

The objectives of these programs are to improve the quality of water available to COSMUD from groundwater sources by protecting against saline intrusion and the migration of poor quality groundwater from the west. The project will also increase stored groundwater in the basin for periods of surface water deficiency or poor quality.

CONVERSION OF WASTEWATER TREATMENT LAGOONS TO WETLANDS

Project Description

As part of the City of Stockton Regional Wastewater Control Facility Upgrade Project, Water Treatment Pond 4 would be converted to two parallel surface flow wetlands covering 130 acres. This improvement would increase total suspended solids (TSS), biochemical oxygen demand (BOD), and ammonia removal at the treatment plant (see **Figure 4-15**). Currently, the city does not meet CVRWQCB effluent standards for ammonia discharged to the San Joaquin River.

Delta Region ELPH Category

The conversion of COS's wastewater lagoon fits within the "Source Improvement" portion of the Delta Region ELPH model.

The City of Stockton's 48-million-gallon per-day Regional Wastewater Control Facility, located beside the San Joaquin River just north of Highway 4.

The mean flow in the San Joaquin River is from right to left. A portion of the oxidation ponds and tertiary treatment facilities, located west of the San Joaquin River, is shown in the bottom left of the photo. Stockton is proposing to convert an existing wastewater treatment pond into a wetlands treatment system to further improve the quality of wastewater discharged to the river

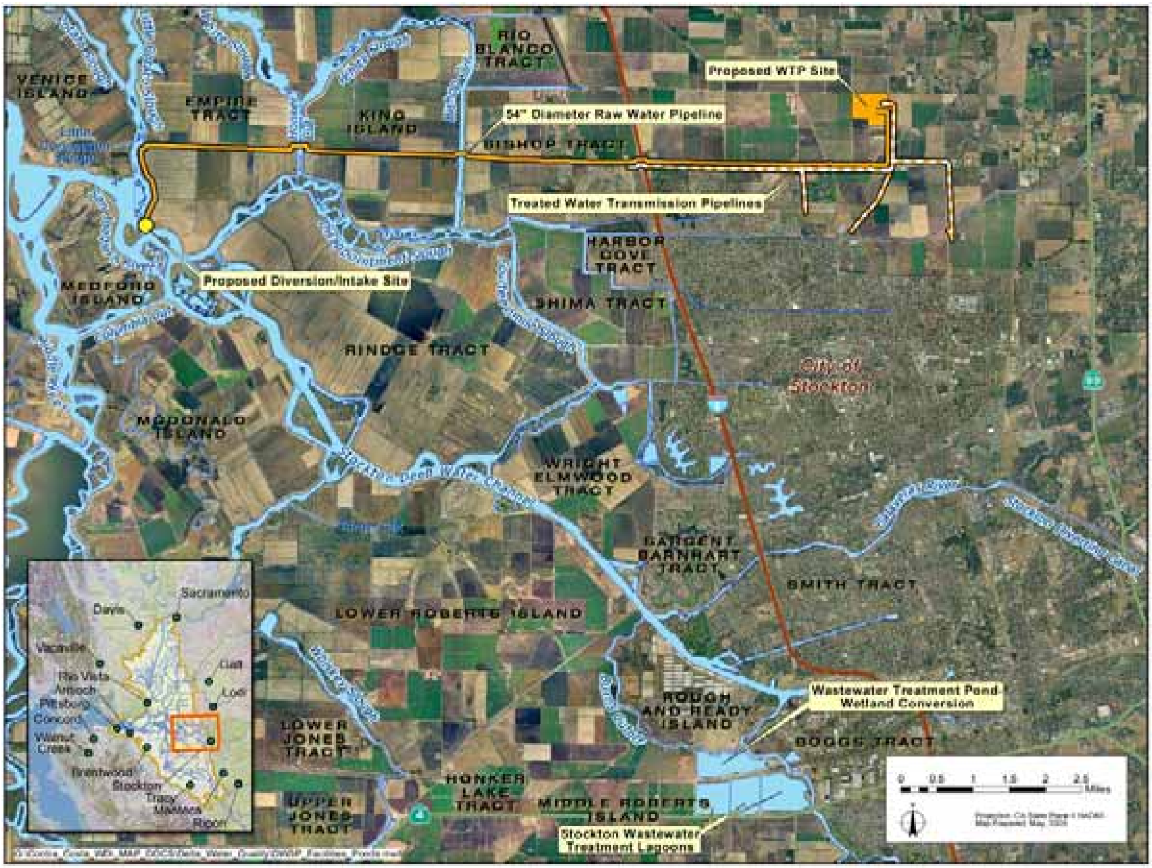

Figure 4-15 Treatment Ponds Identified for Potential Wetland Conversion, City of Stockton Regional Wastewater Control Facility Upgrade Project

Project Status

This project is currently under construction.

Estimated Project Cost for Planning Purposes

Based on the actual construction contract amount, the best estimate for the total cost of this project is $42 million.

Qualitative Evaluation of Anticipated Water Quality Improvements

The purpose of this and other upgrades to the plant are meant to enhance the treatment process to improve water quality in the San Joaquin River in the vicinity of COS and the Delta.

PROPOSED ELPH FOR THE SOLANO COUNTY WATER AGENCY

SCWA is developing several major projects and programs to address its future water quality needs and to improve the drinking water quality delivered to customers, including the following:

- An AIP to evaluate other points of diversion from the Delta for the purpose of improving water quality
- BMPs for watershed protection to reduce organic loading and turbidity in Barker Slough
- Additional internal water transfer and exchange programs (and the required facilities) to provide operational flexibility with respect to source water
- Application of advanced water treatment technologies at SCWA member agency facilities

Figure 4-16 places these projects and programs within the proposed Delta Region ELPH model. It is important to note that although SCWA is developing these projects and programs on its own (or in some cases, in partnership with other agencies), implementation of these projects and programs may require more than a local effort. Regional and statewide participation will likely be appropriate (and, in fact, a requirement) for some these projects and programs. In particular, many of the efforts of SCWA are being closely coordinated with others in the Delta and with the CALFED.

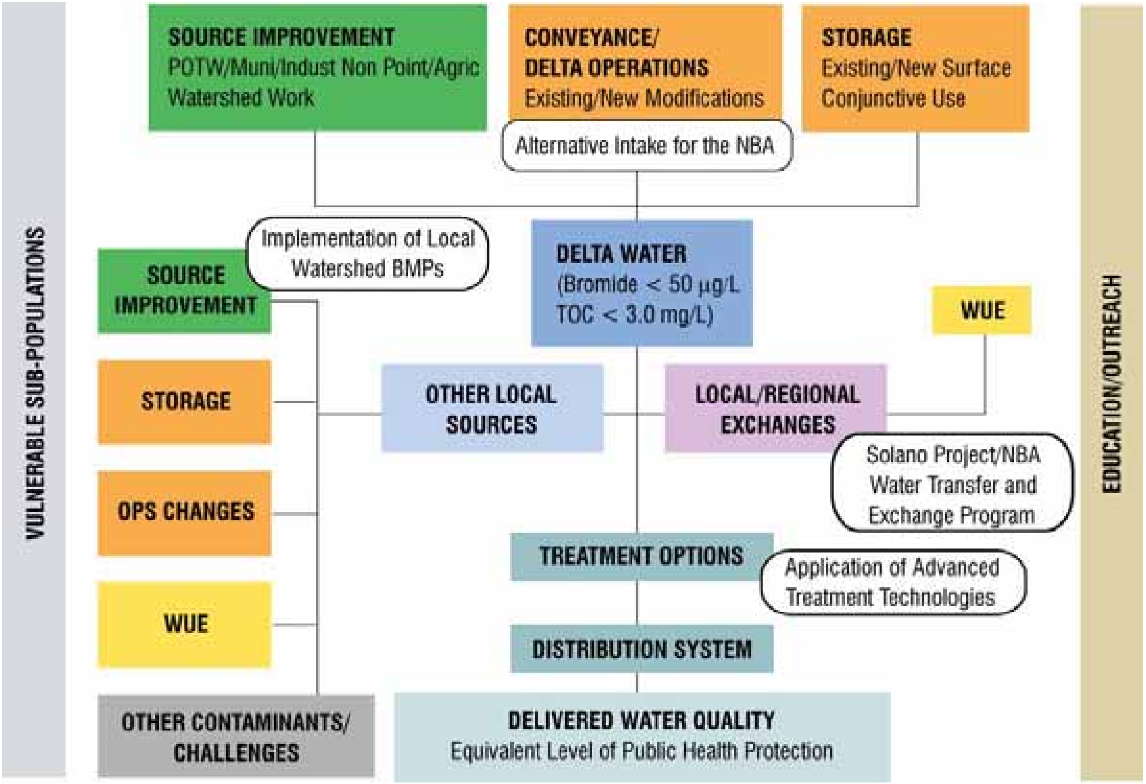

Figure 4-16 Proposed Solano County Water Agency Equivalent Level of Public Health Model

NORTH BAY AQUEDUCT ALTERNATE INTAKE PROJECT

Project Description

Due to the location of its current intake in Barker Slough, the NBA is known to have some of the worst water quality of any SWP Delta supplies. A proposed solution to this problem, included in the CALFED ROD, is establishing an alternative intake on the Sacramento River near Courtland (see **Figure 4-17**).

Delta Region ELPH Category

The NBA Alternate Intake Project fits within the "Conveyance/Delta Operations" portion of the Delta Region ELPH model.

Project Status

A feasibility report was completed in 2003. SCWA is currently reviewing other ELPH options to compare the costs and benefits of this project. SCWA also is pursuing grant funds to offset the costs of this project.

Estimated Project Cost for Planning Purposes

Estimated construction cost for the project is $175 million (2004 dollars).

Qualitative Evaluation of Anticipated Water Quality Improvements

This project would provide an alternate intake to the NBA away from the poor quality water in Barker Slough to the much higher quality water in the Sacramento River.

IMPLEMENTATION OF WATERSHED PROTECTION BEST MANAGEMENT PRACTICES

Project Description

Unlike many other locations in the Delta, water quality at Barker Slough is worst during winter months. The wet season runoff from the watershed carries high levels of contaminants, including organic carbon and fine sediments that increase turbidity in the slough.

A source water quality study titled "*Best Management Practices for Barker Slough*," funded by a CALFED grant through the SWRCB, was completed. The study evaluated which BMPs would most effectively control winter runoff from the Barker Slough watershed. SCWA is currently implementing some of these BMPs with grant assistance.

Studies have shown that it may not be practical to attempt to control the organic carbon content in the NBA watershed; however, eliminating livestock grazing in and adjacent to channels, erosion control, and other BMPs are anticipated to help reduce turbidity. SCWA has installed fencing and alternative water supplies to keep livestock away from waterways, in turn improving turbidity levels in the NBA.

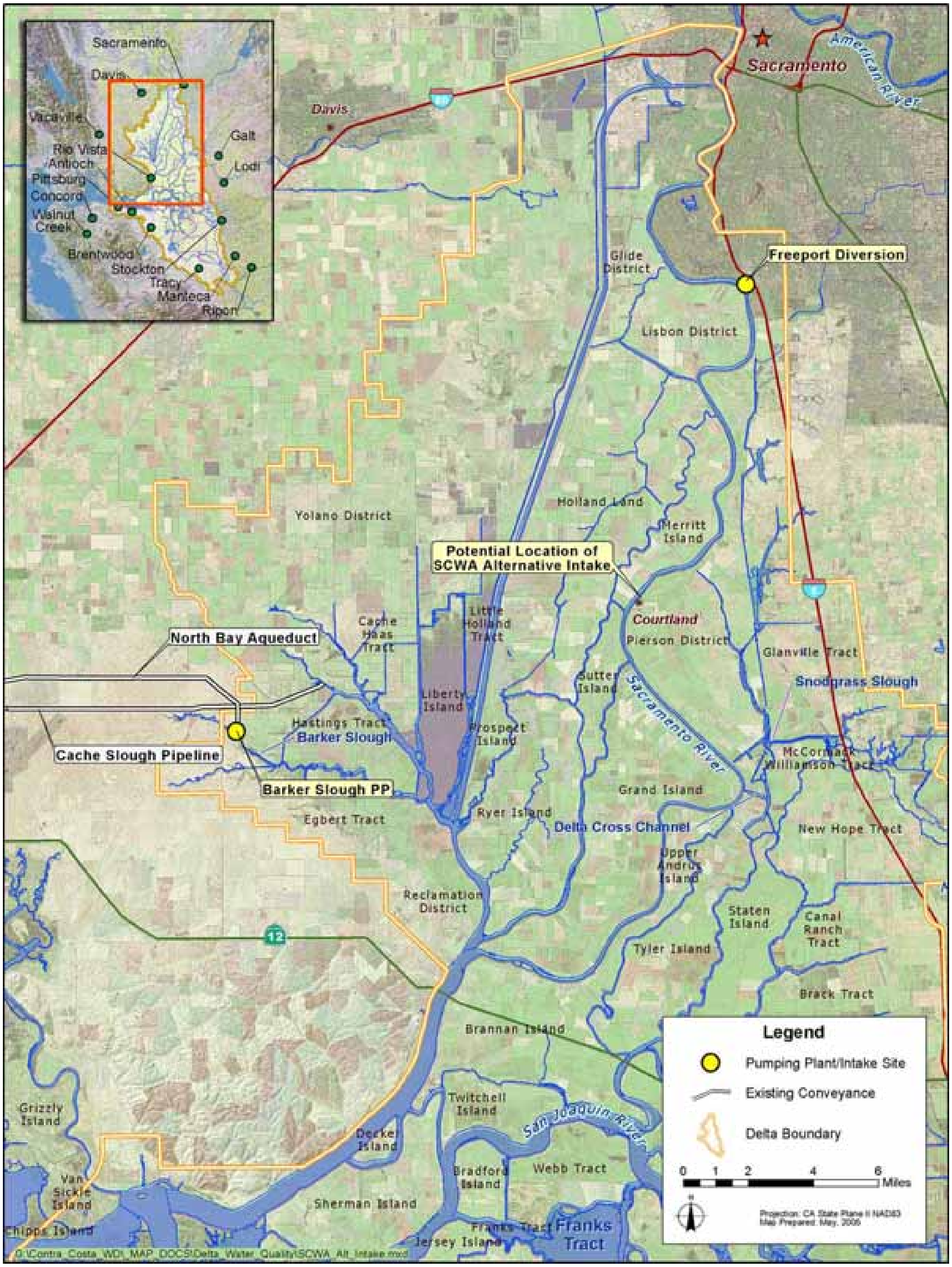

Figure 4-17 Potential Location of Solano County Water Agency Alternative Intake

Delta Region ELPH Category

Implementation of watershed BMPs within the Barker Slough watershed fits within the "Source Improvement" portion of the Delta Region ELPH model.

Project Status

To date, the study has found that only minimal improvements to water quality can be achieved through BMPs implemented in the Barker Slough watershed. SCWA has installed monitoring stations to evaluate water quality improvements over time. Some improvement in the reduction of turbidity is anticipated; however, little or no improvement regarding the reduction of organic carbon concentrations is expected.

Project Cost

Study and implementation of certain BMPs are being funded through a grant from SWRCB and SCWA matching funds.

Qualitative Evaluation of Anticipated Water Quality Improvements

Implementation of BMPs throughout the local watershed would improve the water quality in Barker Slough.

INTERNAL WATER TRANSFERS AND EXCHANGES

Project Description

Currently, Solano Project water is delivered via the Putah South Canal to both agricultural and municipal customers, while the lower quality NBA serves only municipal demands. SCWA is investigating the possibility of improving drinking water quality within its service area by delivering Solano Project water to municipal customers while maintaining agricultural deliveries using lower quality NBA water. A specific example of this type of water exchange can be seen below in the description of the Highline Canal Study.

Monticello Dam and Lake Berryessa, part of the federal Solano Project, provide high quality water to primarily irrigated lands in Solano County. The Solano Project also provides M&I water. Exchanging this high quality source for Delta water diverted at the North Bay Aqueduct is one possible solution for improving drinking water quality for the customers of Solano County Water Agency.

Highline Canal Study

Initially, this project was intended to be a blending facility for SWP from the NBA and Solano Project water from Lake Berryessa. However, the chosen location for the blending reservoir, just south of Vacaville, was found to have geotechnical problems, initiating plans for the Highline Canal Study. Currently, NBA allocations are not always fully used by the cities within the SCWA service area. The Highline Canal Study is evaluating ways to optimize the use of these NBA supplies that would otherwise become spilled carryover, or completely forgone diversions.

The proposed project would involve pumping water from the NBA into Solano Irrigation District's (SID) Highline Canal, a conveyance for Solano Project water, mixing the two water sources, and delivering it to SID growers. At times when NBA water is available for delivery, the cities of Fairfield, Vacaville, and Benicia would provide a portion of their NBA supplies (including the portion that would otherwise be forgone) to the project. In return, the cities would receive a portion of SID's Solano Project supply and the opportunity to take advantage of storage in Lake Berryessa. Solano Project water also would provide higher drinking water quality for the cities' municipal customers. Initially, it is expected that SID growers will receive a blend of NBA and Solano Project water; however, if the switch to 100 percent NBA water were made, the area served could use between 12,000 and 15,900 AF per year.

Facilities for this project would include a pumping facility to withdraw water from the NBA and a connection to deliver the NBA water to the SID Highline Canal. Potential exists to expand the project to other agricultural areas in the future; however, the construction of facilities at other locations would be more costly.

Delta Region ELPH Category

Internal regional water transfers and exchanges within the SCWA service area fit within the "Local/Regional Exchanges" category of the Delta Region ELPH model.

Project Status

SCWA has an ongoing program to facilitate internal regional water transfers and exchanges.

Estimated Project Cost for Planning Purposes

The capital cost of the Highline Canal project is estimated to be about $2 million. SCWA is seeking funding to improve the economics of the Highline Canal project.

Qualitative Evaluation of Anticipated Water Quality Improvements

This project will provide SCWA and its member agencies with access to higher quality water supplies during periods of poor water quality in the Delta.

APPLICATION OF ADVANCED TREATMENT TECHNOLOGIES

Project Description

Multiple clarification, adsorption, disinfection and oxidation, and membrane processes have been evaluated regarding their ability to address water quality issues from TOC to algae and its byproducts. Specifically, the reduction in organic carbon content through new water treatment technologies has been studied by SCWA. The current treatment process being studied at the Fairfield and Vacaville North Bay Regional Water Treatment Plant (NBRWTP) uses magnetic ion exchange (MIEX) resin to remove dissolved organic carbon (DOC), and DBPs, and to respond to high turbidity events.

A two-phased approach was taken to evaluate the effectiveness of the MIEX process. First, a bench-scale study was done to determine which resin worked best to remove organic material from the raw water. Then a pilot test was conducted to determine the effect of the ion exchange pretreatment on the rest of the water treatment process. This work has been funded through the CALFED Water Quality Program. SCWA also is participating in the advanced treatment study described in the CCWD section.

Delta Region ELPH Category

The MIEX Advanced Treatment Demonstration Project fits within the “Treatment Options” portion of the Delta Region ELPH model.

Project Status

Positive results of the study have resulted in further evaluation of costs. SCWA is seeking grant funding for this project. Also, consideration has been made regarding conversion of testing at the NBRWTP into a permanent pilot plant to address remaining water quality issues at the NBRWTP. SCWA is currently reviewing other ELPH projects to compare costs and benefits of this project. [Note: The city of Vallejo is constructing a MIEX pretreatment facility at its Green Valley WTP. Annual operation and maintenance (O&M) and other cost data will be collected from the city to aid in the evaluation.]

Project Cost

Tables 4-2 and **4-3** provide estimated construction and operational costs for a conventional treatment plant using NBA water and the MIEX system.

Table 4-2 Summary of Planning-Level Estimated Construction Costs

	Retrofits			New Plant
	10 mgd	50 mgd	150 mgd	150 mgd
Total Cost	$6,840,000	$17,050,000	$45,060,000	$51,790,000
Cost per Gallon	$0.68	$0.34	$0.30	$0.35

Key: mgd = million gallons per day

Table 4-3 MIEX Operational Unit Costs

Cost Category	Unit Cost
Energy	$7 / MG
Brine Sludge Disposal	$100 / ton dewatered solids
Salt	$50 / ton
Alum Sludge Disposal	$25 / ton of dried solids
Ferric Chloride	$350 / ton
MIEX Resin	$56 / MG for 150 mgd plant $63 / MG for 50 mgd plant $83 / MG for 10 mgd plant

Key:
MG = million gallons
mgd = million gallons per day
MIEX = magnetic ion exchange

Qualitative Evaluation of Anticipated Water Quality Improvements

Similar to the efforts being undertaken by CCWD, the principal benefit of this project is that it will provide pilot-scale information on the effectiveness of various treatment technologies for treating Delta diversions, as well as cost information. This information will be useful for comparing the cost of various other actions for the drinking water quality goals of SCWA and its member agencies with the cost of advanced treatment.

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CHAPTER 5. IMPLEMENTATION STRATEGIES

Chapter 2 of this report provided an overview of how system-wide operations affect the hydrology and water quality conditions of the Sacramento-San Joaquin (Delta). **Chapter 3** identified some of the challenges and issues those conditions present agencies that divert water from the Delta for drinking water purposes. **Chapter 4** described projects and programs currently being implemented or considered locally and regionally that could address those challenges.

This chapter describes strategies for implementing the elements of the Delta Region Drinking Water Quality Management Plan (DRDWQMP) and future expansion of the plan to include other in-Delta urban agencies and other entities that could participate in regional partnerships to improve Delta water quality. The objective is to describe strategies for developing potential local and regional partnerships; selecting and prioritizing projects; and delineating the appropriate roles of local, regional, state, and federal interests.

DEVELOPING POTENTIAL PARTNERSHIPS

Given the intent of CALFED Bay-Delta Program (CALFED) to support regional cooperation, the proposed Delta Region Equivalent Level of Public Health (ELPH) model (see **Figure 5-1**) provides an effective tool for identifying combinations of local, regional, state, and federal actions that could benefit urban agencies that divert drinking water from the Delta.

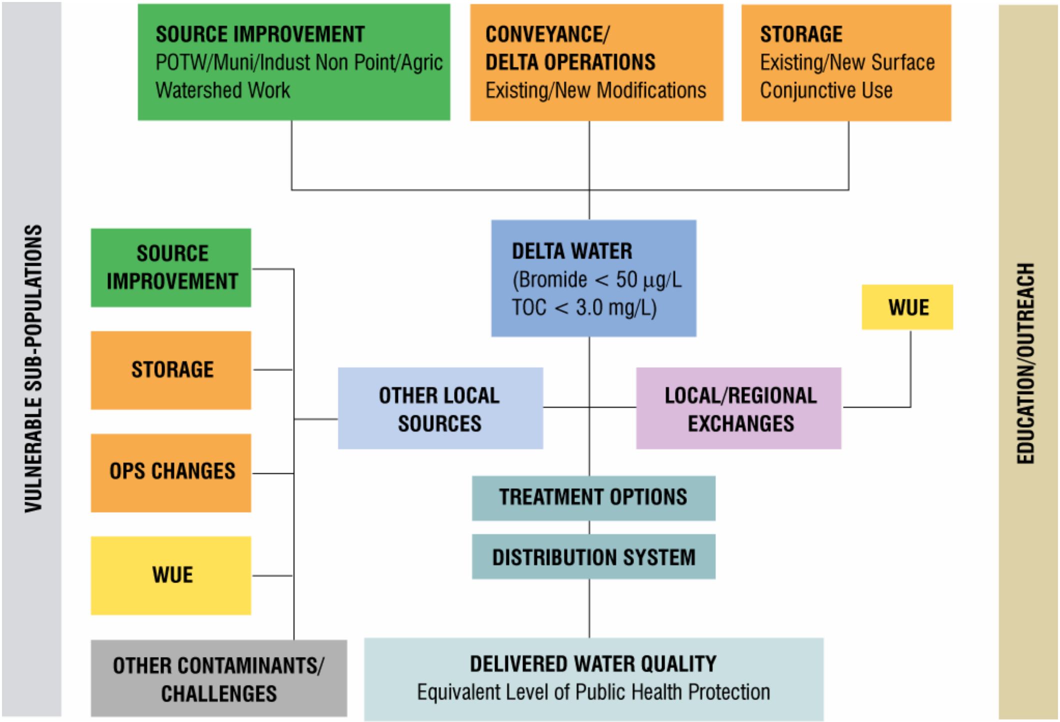


Figure 5-1 Proposed Delta Region Equivalent Level of Public Health Model

POTENTIAL REGIONAL PARTNERSHIPS

ATTRIBUTES OF A DESIRABLE PARTNERSHIP

A key assumption in development of “regional” ELPH models (and the DRDWQMP in particular) is that local agencies best know their respective water quality issues and how to address them. The challenge is to develop local and regional projects and programs that include the following:

- Public health protection equivalent to future drinking water regulations or better
- Multiple beneficiaries or the opportunity for partnerships
- Contribution to meeting CALFED goals and objectives
- Have no significant redirected impacts
- Ecosystem, water supply, levee stability, and the water quality benefits
- Public and stakeholder support
- Geographic parity
- Compliance with regulatory objectives
- Sound technical basis
- Information to support development of statewide strategies

Implementation of efforts at the local and/or regional level would be to enhance any system-wide improvements undertaken by CALFED. Demonstrating the linkage between local/regional efforts and statewide efforts (or at least identifying synergies where they exist) would increase the likelihood that a project or program will be successfully implemented. Examples of several potential partnerships with the attributes mentioned above are discussed below.

Potential Partnership between CCWD, COSMUD, and SCWA

Figure 5-2 presents some of the specific projects and programs currently under investigation by the Contra Costa Water District (CCWD), City of Stockton Municipal Utilities Department (COSMUD), and the Solano County Water Agency (SCWA) to address their respective Delta water quality challenges. Although each of the three participating agencies has a wide variety of projects and programs available to it to address poor Delta water quality, examination of **Figure 5-2** highlights several areas of common interests and opportunities to share information and environmental analyses.

All three agencies have an interest in delivering high quality water that is better than required by regulations at a low cost to their customers. All are challenged in meeting that goal by constituents found in their source water and by available technology. All have an interest in improving treatment techniques and in improving the quality of their source water. All are taking approaches that improve water quality through a multibarrier approach.

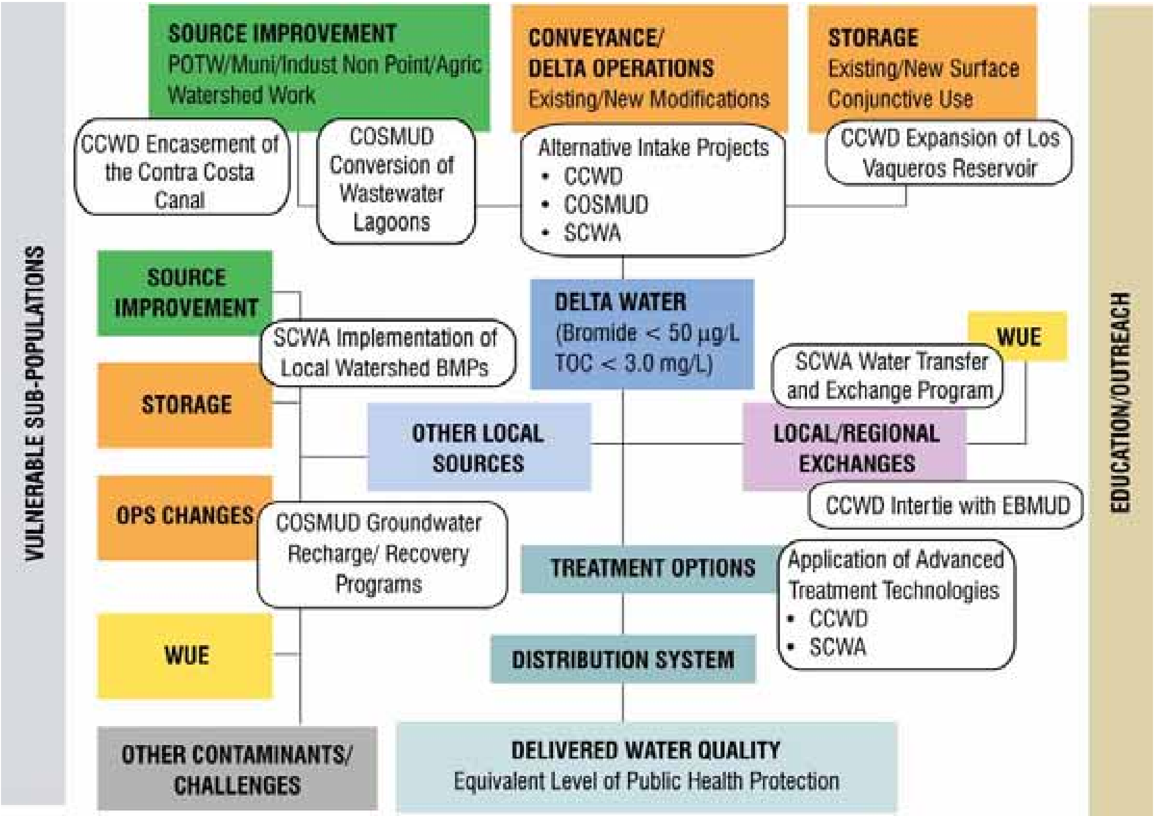


Figure 5-2 Proposed Delta Region Equivalent Level of Public Health Model for CCWD, COSMA, and SCWA

All three agencies have identified a need to construct new Delta intake facilities to improve the quality of their diversions from the Delta. CCWD is pursuing an alternative intake for the Los Vaqueros Reservoir at a location east or southeast of the Old River intake, in the vicinity of Victoria Canal. COSMUD has chosen its Delta Water Supply Project (DWSP) intake location at a point well downstream of Stockton to avoid the poorer quality water in the San Joaquin River. Because of the high organic carbon and turbidity issues in Barker Slough, SCWA is pursuing an alternative intake much further to the northeast on the Sacramento River at Courtland.

All three agencies also are pursuing storage projects within their respective service areas to address year-to-year and seasonal episodes of poor water quality. CALFED and CCWD are studying an expansion of Los Vaqueros Reservoir in partnership with other Bay Area agencies and possibly state and federal agencies for the Environmental Water Account (EWA) or similar program. COSMUD is pursuing a groundwater storage and recovery program, and developing programs to protect the quality of those groundwater supplies. SCWA is studying exchanges of generally poorer quality State Water Project (SWP) water from the Delta for irrigation water from federal Solano Project storage.

Finally, each of these agencies is developing additional projects to help meet its respective water quality objectives, either through research and implementation of advanced treatment technologies or local watershed protection projects. CCWD has embarked on a multiphased project to encase the Contra Costa Canal to eliminate local contamination from seepage and runoff. COSMUD is pursuing groundwater banking programs to combat the intrusion of saltier water and other potential contaminants into the aquifer. SCWA is implementing local watershed Best Management Practices (BMP) to protect its Barker Slough source water. As discussed in **Chapter 3**, each of these agencies is involved in developing and enhancing its treatment processes to improve delivered water quality.

Given the commonality of the local projects and programs identified by CCWD, COSMUD, and SCWA, a regional approach of mutual support and cooperation between these agencies and CALFED could prove to be very effective. CCWD and COSMUD have recently entered into a Memorandum of Understanding to work cooperatively on Delta issues and projects being pursued in the Delta by both agencies. Regional cooperation within the Delta has many of the desirable attributes listed above.

Potential Regional Partnership for Los Vaqueros Reservoir Expansion Project

CALFED and CCWD are studying expanding CCWD's existing 100,000 acre-feet (AF) Los Vaqueros Reservoir by as much as 400,000 AF. One objective is to provide high quality water and water supply reliability to South Bay Area agencies receiving water from the South Bay Aqueduct (such as the Santa Clara Valley Water District, Alameda County Water District, and Zone 7 Water Agency). The project also is studying partnering with EWA to provide it with its own surface storage capacity (rather than having to depend on temporary use of storage in San Luis Reservoir and upstream reservoirs, as is currently the case). Project goals and benefits include the following:

- Improving the reliability of Bay Area water supplies during droughts and emergencies
- Improving the quality of Bay Area water supplies delivered from the Delta during droughts and in late summer/fall months, despite deteriorating Delta water quality
- Improving and enhancing the Delta environment by protecting Delta fish populations affected by Central Valley Project (CVP) and SWP Delta diversion facility operations

This project also has many of the desirable attributes listed earlier in this chapter.

Other Potential Partnerships

An opportunity exists for in-Delta agencies, possibly in conjunction with Bay Area users of Delta water, to develop partnerships on advanced treatment research and pilot projects. As discussed in **Chapter 3**, Bay Area agencies, including CCWD, SCWA and the cities of Fairfield and Napa, already are collaborating on an Advanced Treatment Demonstration Project. Future demonstration-scale aspects of this research could be expanded to include additional partners, such as the city of Stockton (COS).

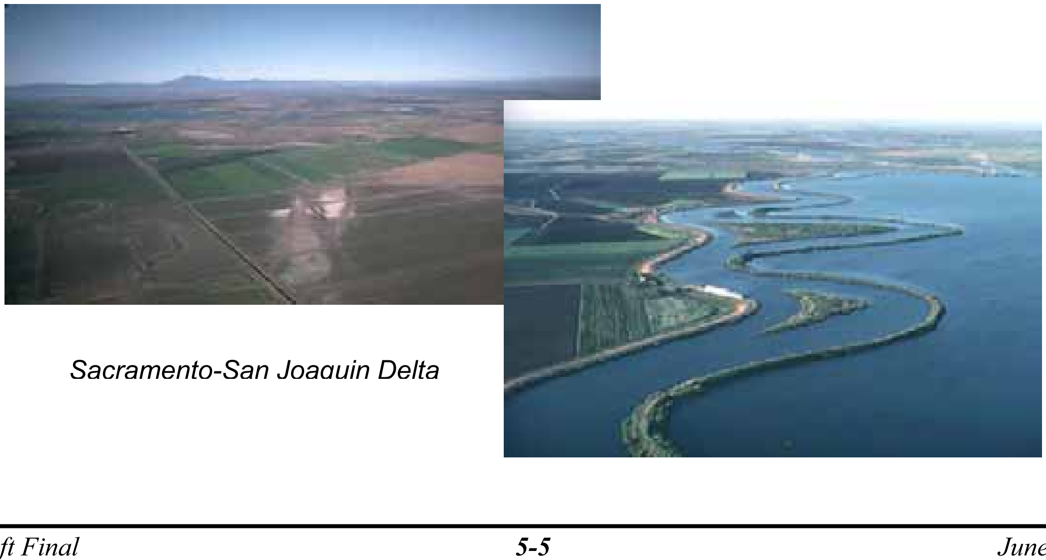
Other potential partnerships include cooperation on technology to reduce capital costs of constructing water conveyance facilities in the Delta (e.g., dealing with peat soils, crossing channels, and protecting levees) and potential interrelationships in water exchanges among the agencies (e.g., building upon the work of the Bay Area Water Quality and Water Supply Reliability Project).

A number of agencies in addition to CCWD, SCWA, and COS depend directly on the Delta for at least a portion of their drinking water supplies (see **Table 3-9**). These agencies include both other in-Delta diverters and urban agencies south of the Delta that rely on exports from the CVP and/or the SWP. These agencies and entities all are greatly affected by both increases and decreases in Delta water quality. One example is the Freeport Regional Water Project, which is a partnership between East Bay Municipal Utility District, Sacramento County, and the city of Sacramento. Development of other partnerships between agencies that depend on the Delta for their water supply could be the subject of future phases of development of the DRDWQMP.

PRIORITIZING PROJECTS AND PROGRAMS

The ELPH model represents a multibarrier approach for public health protection of drinking water. It can be used as a basis for comparing different projects and programs that deliver the same (or at least similar) level of public health protection.

To use the ELPH model approach, the existing water quality setting for an individual agency must be documented for the purpose of establishing a "baseline existing condition" against which potential projects and programs can be measured. This baseline condition would be used to determine what action (or combination of actions) would be needed to meet the CALFED drinking water quality program goals and future drinking water regulations. As discussed in **Chapter 2**, water quality in the Delta could get worse before it gets better, and it is becoming more critical that projects are implemented at the statewide, Delta, regional, and local level to provide the equivalent level of public health protection. Additional work is and will be done by the in-Delta agencies, in conjunction with CALFED and other regional and statewide entities, to develop the projects and programs identified in this DRDWQMP through the environmental review process, pilot studies, and future phases of development of the Delta Region Plan.



Sacramento-San Joaquin Delta

IDENTIFYING APPROPRIATE ROLES AND RESPONSIBILITIES

An important premise in identifying the appropriate roles and responsibilities for implementing projects and programs is to ensure the quality, reliability, and safety of drinking water diverted from the Delta. The decline of Delta water quality has not been caused solely (if at all) by in-Delta diverters. The majority of impacts on Delta water quality are the result of actions outside the control of in-Delta diverters. Such actions include the following:

- Policies and regulations of the state and federal governments in implementing laws and regulations (for example, the Clean Water Act, the Endangered Species Act (ESA), and Delta Protection Act)
- Diversions upstream of the Delta
- Discharges upstream of the Delta
- Impacts on quality of Delta inflow from urban areas discharging treated wastewater under National Pollutant Discharge Elimination System (NPDES) permits
- Stormwater and other runoff from urban areas
- Impacts from agricultural return flows within and from areas adjacent to the Delta
- Regulations and requirements on the operations of the facilities of the CVP and SWP; this includes the operation of upstream reservoirs and in-Delta and Delta export facilities
- Impacts from actions under the ESA and other regulatory actions to protect fish species
- Impacts that result from ecosystem restoration activities that increase organic loading

These impacts on Delta water quality were identified and described in detail in **Chapter 2** and **Appendices 2A, 2B,** and **2C**.

Similarly, improvement of drinking water quality for in-Delta agencies, and associated improvements in Delta water quality, can have more widespread public benefits related to, for example, ecosystem restoration and water supply reliability.

The actions required to address degradation of Delta water quality and improve public health protection involve a broad constituency, at the local, statewide, and federal level. The solutions will require involvement of a broad constituency to meet the CALFED goals of continuous improvement under the CALFED principles. Contributions to the overall integrated solution could come in the form of implementation of specific projects and programs that improve Delta water quality, and priority for in-Delta agencies (and partnerships) pursuing grant funding.

ROLE OF LOCAL AGENCIES (AND REGIONAL PARTNERSHIPS)

Principal roles and responsibilities of local agencies include the following:

- Supporting and encouraging local planning by agencies
- Having a clear understanding of future costs and funding requirements
- Creating partnerships to initiate integrated regional planning
- Developing projects that do not have any significant redirected impacts
- Identifying regional investment strategies and opportunities, and extra-regional partnerships
- Looking for “win-win” projects/programs that link to statewide efforts
- Identifying statewide interests and developing state and federal participation
- Developing Integrated Regional Water Management Plans, including Drinking Water Quality Management Plans, inform decision makers on funding and implementing projects and programs.

ROLE OF STATE AND FEDERAL AGENCIES

To meet the CALFED program water quality goals, it is essential that the state and federal CALFED agencies work together to implement projects at the local, regional, and statewide level to improve drinking water quality, on a schedule that will allow CALFED to achieve balance in the Bay-Delta Program in a timely fashion. Implementation of water quality projects that actually achieve improvements in water quality is lagging behind other elements of the CALFED Bay-Delta Program. Funding should be directed at core implementation projects that actually result in quantifiable improvements (as opposed to studies) in drinking water quality and public health protection, consistent with the ELPH goals.

The state and federal governments should support and/or fund projects that have broad public benefits or that address water quality impacts that are a result of the policy decisions and actions of state and federal agencies outside the control of local agencies. The CALFED Bay-Delta Program will continue to be an important venue for engaging state and federal agencies in the development, permitting, funding and implementing of projects and programs to improve drinking water quality for in-Delta agencies and all others that depend on the Delta for their water supply.

The State Water Resources Control Board (SWRCB), the Central Valley Regional Water Quality Control Board (Region 5) and San Francisco Bay Regional Water Quality Control Board (Region 2), through their regulatory authorities, are engaged in the development of drinking water objectives and other source water protection objectives for the Bay-Delta system. The SWRCB and Regional Water Quality Control Boards (RWQCBs), in conjunction with the California Department of Health Services and United States Environmental Protection Agency, already are working together to develop a Central Valley Drinking Water Policy. This is an important step in addressing constituents of concern as defined in the CALFED water quality goals.

In addition, the SWRCB is currently reviewing its 1995 Bay-Delta Water Quality Control Plan and plans to adopt a new plan by the end of 2005. Under consideration are drinking water objective alternatives in addition to the current municipal and industrial chloride objectives in the SWRCB's Bay-Delta Water Quality Control Plan and the extent to which they address the constituents of concern in Delta source water. For example, CCWD has recommended a drinking water objective alternative consistent with its ELPH plans of 300 micrograms per liter (µg/L) bromide that could be implemented based \on a reasonable schedule for the completion of CCWD's Alternative Intake Project and other Delta water quality actions. CCWD's intent is that the implementation schedule would allow such an objective to be met in a balanced fashion without redirecting impacts to other competing beneficial uses. CCWD believes a 300 µg/L bromide drinking water objective, in combination with other ELPH actions, could enable CCWD to meet its drinking water quality goals under the current drinking water regulations.

CHAPTER 6. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter summarizes major findings and principal conclusions, and provides recommendations for moving forward into future work phases.

MAJOR FINDINGS

Major findings of this analysis of Sacramento-San Joaquin Delta (Delta) water quality and the drinking water quality needs of in-Delta urban water agencies are summarized into three areas: (1) existing and future Delta water quality conditions, (2) actions and contributions of the CALFED Bay-Delta Program (CALFED) that could potentially contribute to addressing challenges and issues, and (3) potential actions of local agencies to address local and regional water quality issues.

EXISTING AND FUTURE DELTA WATER QUALITY CONDITIONS

Bromide concentrations in the central and south Delta in the fall, when Delta outflows are lowest and salinities are highest, have consistently increased since the 1980s. Whereas chlorides in Rock Slough were previously only worse than 150 milligrams per liter (mg/L) 5 percent of the time, chlorides are now worse than 150 mg/L 50 percent of the time. Organic carbon concentrations in the interior Delta remain high and have not shown a significant degradation or improvement. Runoff from the Barker Slough watershed continues to result in high organic carbon and turbidity at the Solano County Water Agency's (SCWA) in-Delta intake.

The decline in Delta water quality has negatively impacted agencies that divert water from the Delta for drinking water purposes.

The majority of the adverse impacts on Delta water quality and the in-Delta diverters are the result of actions by others, outside the control of in-Delta diverters. These actions include increased upstream and Delta diversions; increased runoff from cities and farms; modifications to upstream reservoir and diversion operations to protect fisheries and other environmental resources; and Delta flow patterns modified by barriers to offset the impacts of export pumping in south Delta channels.

Further population increases will further increase the factors that impact Delta water quality, as will global warming and the risk of more frequent levee failures. This suggests that Delta water quality will continue to degrade in the future unless actions are taken to improve water quality.

At the same time, new operational constraints to protect fish species may further change the timing of operations of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) system. Similarly, drinking water regulations are expected to become more stringent as more and more disinfection byproducts (DBP) are identified and regulated.

Treatment technology needs to advance to keep pace with these new regulations and public health protection needs.

These factors all represent major challenges for in-Delta drinking water providers in the future.

CALFED BAY-DELTA PROGRAM

Protection of public health and improvement of drinking water diverted from the Delta must be addressed at statewide, regional, and local levels. Water quality actions developed by CALFED under the Water Quality Program (WQP) and the Equivalent Level of Public Health (ELPH) model represent a comprehensive plan for achieving CALFED's goal of continuous improvement in water quality and providing a level of public health protection that is equivalent to or better than that necessary to meet expected, more stringent, future drinking water regulations. The CALFED WQP funded this Delta Region Drinking Water Quality Management Plan (DRDWQMP), two other regional plans, and the Bay Area Water Quality and Water Supply Reliability Project, as an initial pilot effort to develop regional ELPH plans. Eventually, these plans are intended to inform the capabilities and cost-effectiveness of local, regional and state actions to determine the combination of actions needed to achieve ELPH in the CALFED solution area. CALFED recognizes that more partners will need to participate in future stages of the Delta region's plan.

LOCAL SOLUTIONS

This Regional ELPH Plan for the Delta has been developed by three local agencies working at the regional level to identify local-only actions, explore regional opportunities, and support development of statewide strategies needed to achieve an equivalent level of public health protection. The plan identifies the following major local water quality projects for each agency:

- Contra Costa Water District (CCWD) is developing an Alternative Intake Project to give CCWD access to higher quality water in the central Delta; developing projects to encase the Contra Costa Canal to eliminate degradation from seepage and runoff and improve security; designing a raw water intertie with the East Bay Municipal Utility District's (EBMUD) Mokelumne Aqueduct to offset the impacts of the Freeport Regional Water Authority project on CCWD and allow emergency exchanges of raw water between CCWD and EBMUD. CCWD also is studying expansion of Los Vaqueros Reservoir, and pilot testing of advanced water treatment technologies to help meet CCWD's water quality goals in the future.
- The city of Stockton (COS), through its Municipal Utilities Department (COSMUD), is developing the Delta Water Supply Project (DWSP) to permit COS to divert high quality water from the Delta, developing a groundwater aquifer storage and recovery program to recharge the local groundwater basin, and converting a wastewater treatment lagoon at the Stockton Regional Wastewater Control Facility to a wetland to improve the quality of Stockton's wastewater discharge to the Delta.

- SCWA has developed several major project alternatives for addressing its major issue of high organic carbon and turbidity at the North Bay Aqueduct (NBA) intake. These include an alternate NBA intake location on the Sacramento River near Courtland, Best Management Practices (BMPs) for watershed protection to reduce organic loading and turbidity in Barker Slough, application of advanced water treatment technologies at SCWA member agency facilities to remove organics and turbidity, and additional internal water transfer and exchange programs (and the required facilities) to provide operational flexibility with respect to source water.

A number of other agencies in addition to CCWD, SCWA, and COS depend directly on the Delta for at least a portion of their drinking water supplies. These agencies include both other in-Delta diverters and urban agencies south of the Delta that rely on exports from the Central Valley Project (CVP) and/or the State Water Project (SWP). Some of these other agencies and entities also are developing local and regional projects to address their future drinking water quality needs. Development of the current DRDWQMP should be continued as a second phase to develop projects and programs for these other agencies, and address any future WQP requirements for developing regional plans.

REGIONAL SOLUTIONS

Partnerships between urban agencies in the Delta and in the Bay Area provide many opportunities for developing regionally applicable solutions. As discussed in **Chapter 5**, these include local, regional, state and federal partnership in expansion of Los Vaqueros Reservoir, partnerships on advanced treatment research and pilot projects, cooperation on technology related to constructing Delta water conveyance facilities, and potential inter-relationships in water exchanges among agencies.

CALFED already has played an important role in fostering this regional cooperation. The CALFED ELPH diagram (**Figure 4-1**) specifically contains key elements identifying regional components of the multibarrier approach to protecting public health, such as local/regional exchanges and source water exchanges. Each of the regional approaches discussed above fits well within the context of the ELPH diagram.

PRINCIPAL CONCLUSIONS

Principal conclusions that can be drawn from the data include the following:

- CALFED is developing projects at the local, regional, and statewide level to improve drinking water quality, and ensure balance in the Bay-Delta Program. Funding should be directed at implementation projects, not just studies.
- The Delta ELPH model can be used as a rationale tool to explore the relationship between various water management operations and changes in water quality. The Delta ELPH model construct implicitly recognizes that water quality objectives in source waters and water quality regulations protecting consumers are dynamic, and are best met with flexible plans that consider the entire drinking water system from

source to tap. The model combines local and regional capital improvements with improvements in the Delta to provide cost-effective water quality improvements.

- CCWD, COSMUD, and SCWA have taken a common approach to addressing the impacts of declining Delta water quality. Each has identified the need to construct new Delta intake facilities in pursuit of higher quality diversions. Each is pursuing storage projects within its respective service areas to address year-to-year and seasonal episodes of poor water quality. And each is implementing other projects to meet its respective water quality objectives, either through pursuit of advanced treatment technologies and/or local watershed protection.

RECOMMENDATIONS

Recommendations of the DRDWQMP include the following:

- It is important that CALFED seek to identify the most cost-effective combination of local, regional, and statewide actions that will result in continuous improvement in drinking water quality throughout the CALFED service area, and ensure balance in the Bay-Delta Program. The CALFED Bay-Delta Program provides the opportunity for financial assistance, in the form of grants, to local/regional partnerships to help meet the goals and objectives of the CALFED drinking water quality program.
- CCWD, COSMUD, and SCWA should continue to pursue the projects and programs identified in the DRDWQMP to address their respective drinking water quality objectives. These agencies should continue to identify linkages to CALFED goals and objectives.
- Development of partnerships with other agencies dependent on diversions from the Delta for a portion of their drinking water should be the subject of future phases of the DRDWQMP. The approach needs to be extended to include other urban areas in the Delta region that rely on Delta water for a portion of their drinking water.

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CHAPTER 8. GLOSSARY AND ACRONYMS/ABREVIATIONS

GLOSSARY

acre-foot	Volume of water required to cover 1 acre to a depth of 1 foot. Equal to 1,233.5 cubic meters (43,560 cubic feet).
aqueduct	Pipe or channel designed to transport water from a remote source, usually by gravity.
Bay-Delta	San Francisco Bay/Sacramento–San Joaquin Delta estuary.
Biological Opinion	Document issued under the authority of the Federal Endangered Species Act stating United States Fish and Wildlife Service and/or NOAA Fisheries (formerly the National Marine Fisheries Service) findings as to whether a federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.
bromide	A chemical compound of bromine with another element or radical. Bromides interact with disinfection agents used in water treatment to create hazardous disinfection byproducts that have potential adverse health effects.
bromate	A chemical compound of bromine that can be formed from the ozonation of raw waters containing bromide. A disinfection byproduct of ozone water treatment.
CALFED Bay-Delta Program	Joint state and federal program to address water-related issues in the Sacramento–San Joaquin Delta.
Cal Water	California Water Service Company.
Central Valley Project	Multiple-purpose water project in California extending from the Cascades to the Tehachapee mountains. Consists of 20 dams and reservoirs, 11 powerplants, and 500 miles of major canals, as well as conduits, tunnels, and related facilities. Manages some 9 million acre-feet of water.

Central Valley Project water	As defined by Section 3403(f) of the Central Valley Project Improvement Act (CVPIA), all water developed, diverted, stored, or delivered in accordance with statutes authorizing the CVP, in accordance with terms and conditions of water rights acquired pursuant to California law.
consumptive uses	The application of water to agricultural, municipal, or industrial uses. In contrast, non-consumptive uses would include water dedicated to fish and wildlife.
cryptosporidium	A waterborne intestinal parasite of the genus *Cryptosporidium* that can cause the disease cryptosporidiosis in humans and other vertebrates. The disease, characterized by vomiting, diarrhea, abdominal cramps, and fever, can be severe or fatal to immunosuppressed individuals.
Delta	A low, nearly flat alluvial tract of land formed by deposits at or near the mouth of a river. In this report, "Delta" refers to the delta formed by the Sacramento and San Joaquin rivers.
desalination	Process of removing salt from seawater or brackish water.
disinfection byproducts	Chemical, organic and/or inorganic substances that can form during a reaction of a disinfectant (such as chlorine) with naturally present organic matter in water.
diurnal	Having a daily cycle of variation.
electrical conductivity	A measure of salinity in water.
Environmental Impact Report	State-mandated written summary of the positive and negative effects on the environment caused by the construction and operation of a proposed project in California.
Environmental Impact Statement	A document required of federal agencies for major projects or legislative proposals significantly affecting the environment. Describes the positive and negative effects of the undertaking, lists alternative actions, and documents the information required to evaluate the environmental impact of a project.
Equivalent Level of Public Health (ELPH) Protection Decision Tree	The ELPH decision tree is a conceptual model of the multibarrier approach to ensuring the protection of the state's drinking water and public health. It is being used to guide implementation of the CALFED water quality program.
fish screen	Barrier on the front face of a river intake to prevent the entrainment of fish and debris.

flow	The volume of water passing a given point per unit of time.
flow barrier	Physical or operational means of controlling the movement of water, such as an operable gate or a passive channel constructed specifically to influence flow in the Delta.
geosmin	A non-harmful, naturally occurring compound associated with the growth of some species of blue-green algae and actinomycete bacteria in lakes and canals. Can cause taste and/or odor problems in drinking water.
HAA5	Haloacetic acids, including dibromoacetic, dichloroacetic, monobromoacetic, monochloroacetic, and trichloroacetic acids.
habitat	Specific area or environment in which a particular type of animal or plant lives.
MIB	2-Methylisoborneol (MIB) is a non-harmful, naturally-occurring compound associated with the growth of some species of blue-green algae and actinomycete bacteria in lakes and canals. Can cause taste and/or odor problems in drinking water.
modeling	Tool used to mathematically represent a process. Models can be computer programs, spreadsheets, or statistical analyses.
neap tides	Tides of decreased range or tidal currents of decreased speed occurring semimonthly as the result of the moon being in quadrature.
Oakley	Diablo Water District.
oocyst	The spore phase of cryptosporidium.
Ops Group	CALFED Operations Coordination Group.
QWEST	Net flow in the lower San Joaquin River that is used as a regulatory parameter in state and federal water project operations.
Reclamation	United States Department of the Interior, Bureau of Reclamation.

Record of Decision	Concise, public, legal document that identifies and officially discloses the responsible official's decision on an alternative selected for implementation. A ROD is prepared following completion of an environmental impact statement.
reservoir	Artificially impounded body of water.
Sacramento 40-30-30 Index	Measure of water supply conditions for Sacramento River watershed, including Feather, Yuba and American rivers (defined in SWRCB Water Right Decision-1641).
seawater intrusion	The intrusion and mixing of saline or brackish water into a body of freshwater, such as a groundwater aquifer or estuary.
South Bay Aqueduct	State Water Project facility that conveys water from Bethany Reservoir to Alameda and Santa Clara counties.
south-of-Delta storage	Water storage supplied with water exported south from the Delta.
State Water Project	Water supply project operated and maintained by the California Department of Water Resources that distributes water to contractors in the San Francisco Bay Area, Northern California, the San Joaquin Valley, and Southern California.
Table A	SWP table of annual amounts of water under contract for each SWP contractor. The basis for allocating water in shortage years.
total organic carbon	A measure of organic matter content in water, which plays a significant role in aquatic ecosystems and has direct implications to drinking water treatment.
total trihalomethanes	Sum of the trihalomethane compounds: trichloromethane (chloroform), dibromochloromethane, bromodichloromethane, tribromomethane (bromoform).
turbidity	A measure of the cloudiness of water caused by the presence of suspended matter. Turbidity in natural waters may be composed of organic and/or inorganic constituents, and has direct implications to drinking water treatment.
unregulated tributary	A tributary stream that does not have a reservoir or other feature used to restrain or control flows.
watershed	Region or area that ultimately drains to a particular watercourse or body of water.

watershed management	The net result of numerous and varied actions in a watershed that directly affect watershed function and productivity. Actions may include, but are not limited to, land use decision-making, restoration and enhancement projects, monitoring and assessment of watershed conditions, natural resources allocation and use, parcel management techniques, and education programs. Watershed management includes protection of existing healthy conditions.
X2	An index used to assess the location of, and thus the movement of, salinity inland from the ocean to the Delta. Used by regulatory agencies to establish estuarine habitat objectives, it is defined as the distance in kilometers inland from the Golden Gate Bridge of 2 parts per thousand salinity.

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ACRONYMS AND ABBREVIATIONS

^{o}C	degrees Centigrade
μg/L	micrograms per liter
μS	microSiemens
μS/cm	microSiemens per centimeter
ABAG	Association of Bay Area Governments
AF	acre-feet (measure of water volume)
AF/year	acre-feet per year
AFB	Air Force Base (e.g., Travis AFB in Solano County)
AIP	Alternative Intake Project
ASR	Aquifer Storage and Recovery
Authority	California Bay Delta Authority
Banks	Banks Pumping Plant
BAT	best available technology
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BDPAC	California Bay-Delta Public Advisory Committee
BMP	best management practices
BO	Biological Opinion
BOD	biochemical oxygen demand
Br	bromide (Br^-)
Ca	calcium
CACWD	Calaveras County Water District
Cal Water	California Water Service Company
CALFED	CALFED Bay-Delta Program established under the Framework Agreement
CBDA	California Bay-Delta Authority
CCCSD	Central Contra Costa Sanitary District
CCWD	Contra Costa Water District
CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
cfs	cubic feet per second
chromium-6	hexavalent chromium

Cl	chloride (Cl^-)
COA	Coordinated Operations Agreement
COC	contaminant of concern
COS	City of Stockton
COSMA	City of Stockton Metropolitan Area
COSMUD	City of Stockton Municipal Utilities Department
CSP-Solano	California State Prison-Solano
CUWA	California Urban Water Agencies
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
D/DBP	disinfectant/disinfection byproduct
DAF	dissolved air flotation
DBP	disinfection byproduct
DDSD	Delta Diablo Sanitation District
DEIR	Draft Environmental Impact Report
Delta	Sacramento-San Joaquin Delta
DHS	California Department of Health Services
DMC	Delta-Mendota Canal
DMC/CA	Delta-Mendota Canal/California Aqueduct
DOC	dissolved organic carbon
DRDWQMP	Delta Region Drinking Water Quality Management Plan
DSM2	Delta Simulation Model 2 (DWR Salinity Transport Computer Model)
DWR	California Department of Water Resources
DWS	Drinking Water Subcommittee (CALFED BDPAC)
DWSP	Delta Water Supply Project (City of Stockton)
D-XXXX	Decision-number
E/I	export-to-import ratio
EBMUD	East Bay Municipal Utility District
EC	electrical conductivity
ECCID	East Contra Costa Irrigation District
EDC	endocrine disrupting chemical

EIR	Environmental Impact Report (pursuant to CEQA)
EIS	Environmental Impact Statement (pursuant to NEPA)
EIS/EIR	EIS and EIR, combined in one document
ELPH	Equivalent Level of Public Health
EPA	United States Environmental Protection Agency
ESWTR	Enhanced Surface Water Treatment Rule
EWA	Environmental Water Account
FONSI	Finding of No Significant Impact
FRWA	Freeport Regional Water Authority
FRWP	Freeport Regional Water Project
FSSD	Fairfield/Suisun Sewer District
FY	fiscal year
GAC	granular activated carbon
HAA5	haloacetic acids
HCP	Habitat Conservation Plan
ICR	Information Collection Rule
IEP	Interagency Ecological Program
IOC	inorganic chemical
JPOD	Joint Point of Diversion (allowed under SWRCB Decision 1641)
KCWA	Kern County Water Agency
LCR	Lead and Copper Rule
LRAA	locational running annual average
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
m	meter
M&I	municipal and industrial
MAF	million acre-feet
MCL	maximum contaminant level
MG	million gallons
mg/L	milligram per liter
mgd	million gallons per day
MIEX	magnetic ion exchange
MPWD	Maine Prairie Water District
MTBE	methyl tertiary butyl ether

MWD	Metropolitan Water District of Southern California
MWQI	Municipal Water Quality Investigation
Na-	sodium
NBA	North Bay Aqueduct (SWP supply for Solano County Water Agency)
NBRWTP	North Bay Regional Water Treatment Plant
NDMA	N-nitrosodimethlyamine
NDOI	Net Delta Outflow Index
NEPA	National Environmental Policy Act
NIPDWR	National Interim Primary Drinking Water Regulations
NOAA	National Oceanic and Atmospheric Association
NOD	Notice of Determination (State CEQA)
NOI	Notice of Intent (to prepare an EIS)
NOM	natural organic material
NOP	Notice to Proceed
NPDES	National Pollutant Discharge Elimination System
NTP	Notice to Proceed
NTU	nephelometric turbidity unit
O&M	operations and maintenance
OID	Oakdale Irrigation District
oocyst/L	oocyst per liter
Ops Group	CALFED Operations Coordination Group
PAC	powdered activated carbon, or Public Advisory Committee
PEIS/EIR	Programmatic Environmental Impact Statement/Environmental Impact Report
PL	Public Law
POU	place of use
ppb	part per billion
PPCP	pharmaceuticals and personal care products
ppm	part per million
PP No. 1	Contra Costa Pumping Plant Number 1
ppt	part per thousand
PSC	Putah South Canal (Solano Project)
Reclamation	United States Department of the Interior, Bureau of Reclamation

ROD	Record of Decision (Federal NEPA)
ROW	right-of-way
RWQCB	Regional Water Quality Control Board
SBA	South Bay Aqueduct (State Water Project)
SCFC&WCD	Solano County Flood Control and Water Conservation District
SCWA	Solano County Water Agency
SCWC	Southern California Water Company
SDWA	Safe Drinking Water Act
SEWD	Stockton East Water District
SFEP	San Francisco Estuary Project
SID	Solano Irrigation District
SJRGA	San Joaquin River Group Authority
SOC	synthetic organic compound
SSJID	South San Joaquin Irrigation District
SVWM	Sacramento Valley Water Management
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWTR	Surface Water Treatment Rule
T&O	taste and odor
TAF	thousand acre-feet
TCR	total coliform rule
TDML	total daily maximum load
TDS	total dissolved solids
THM	trihalomethane
TOC	total organic carbon
Tracy	Tracy Pumping Plant
TSS	total suspended solids
TTHM	total trihalomethanes
UC Davis	University of California, Davis
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	ultraviolet

VAMP	Vernalis Adaptive Management Plan
VOC	volatile organic compound
WDR	Waste Discharge Requirement
WQCP	Water Quality Control Plan
WQP	Water Quality Program
WRDA	Water Resources Development Act
WTP	water treatment plant
WWTP	wastewater treatment plant
X2	2 parts per thousand isohaline

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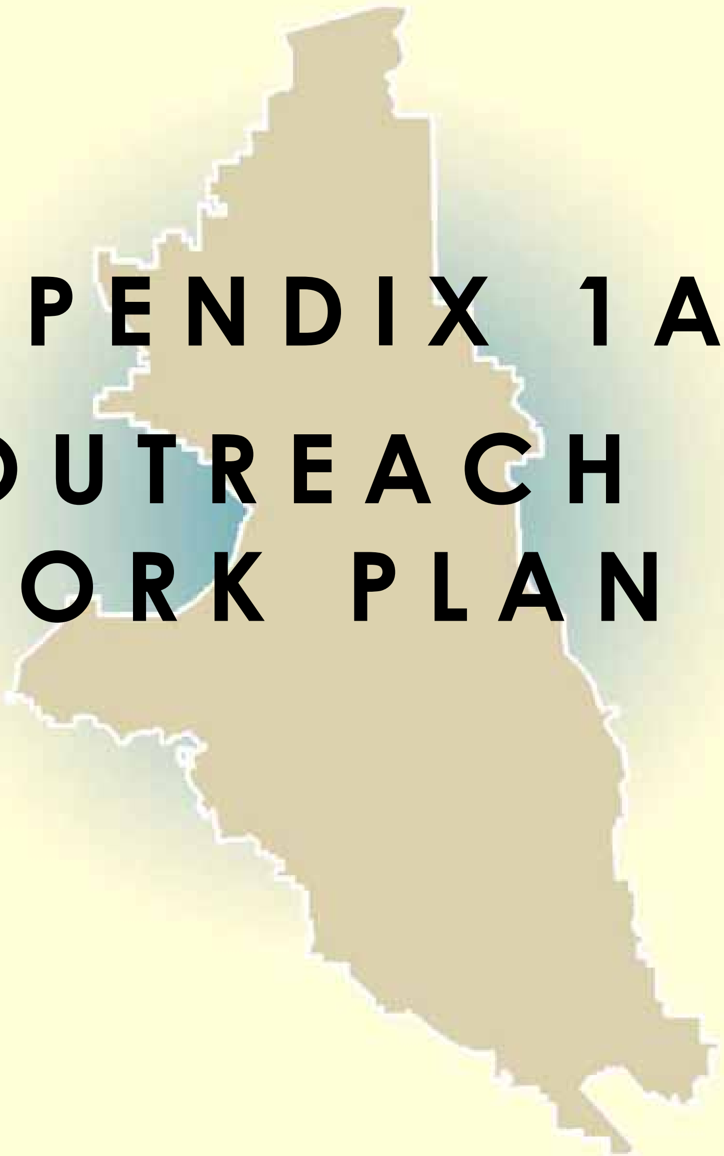
DELTA REGION

DRINKING WATER QUALITY MANAGEMENT PLAN

APPENDIX 1A

OUTREACH WORK PLAN



APPENDIX 1A. OUTREACH WORK PLAN

INTRODUCTION

The Contra Costa Water District (CCWD), city of Stockton (COS), and Solano County Water Agency (SCWA) are jointly developing a Delta Region Drinking Water Quality Management Plan (DRDWQMP) under a grant from the California Bay-Delta Authority (CALFED). The principal objectives for development of this plan are as follows:

- To understand existing water quality conditions (and anticipated future water quality conditions absent proactive actions) at urban intakes within the Sacramento-San Joaquin Delta (Delta)
- To document existing institutional setting and water system operations, and to anticipate resulting impacts on the quality of Delta drinking water supplies
- To document proposed regulatory changes and to anticipate potential resulting impacts on treatment requirements for Delta drinking water supplies
- To document existing water resources planning and management activities of agencies diverting drinking water supplies from the Delta (including projected need, sources of supply, and water treatment capabilities) for the purpose of establishing a "baseline" against which the impacts and costs of potential projects and programs can be measured
- To identify challenges and issues confronting agencies diverting drinking water from the Delta by comparing their water resources planning and management objectives with anticipated future institutional, operations, and regulatory settings
- To identify potential projects and programs for addressing those challenges and issues within the construct of the "equivalent level of public health" (ELPH) structure [Note: The intent is to develop projects and programs that provide mutual benefit to multiple agencies if and whenever possible.]
- To develop strategies for implementing those projects and programs, including identifying potential partnerships and delineating the appropriate roles of local, state, and federal interests

An "outreach" program will be a necessary element for a successful DRDWQMP.

ELEMENTS OF THE DRDWQMP OUTREACH PROGRAM

The Outreach Program for the DRDWQMP effort has three elements:

- Facilitating discussions with in-Delta diverters other than the three participating agencies. The purpose of these discussions will be to identify issues and areas of concern related to protecting and improving drinking water quality, and to provide information on the goals and objectives of the DRDWQMP. [Note: Both urban and agricultural diverters will be approached.]

- Facilitating discussions with other stakeholders (e.g., agricultural and point-source dischargers, environmental interests, and other non-governmental organizations). Similar to the above, the purpose of these discussions will be to identify issues and areas of concern, and to provide information on the goals and objectives of the DRDWQMP.
- Presenting the findings, conclusions, and recommendations of the plan to the CALFED Drinking Water Quality Program and Bay-Delta Public Advisory Committee, Drinking Water Subcommittee.

Specific activities that will be undertaken are described below.

OUTREACH PROGRAM ACTIVITIES AND SCHEDULE

The current phase of the DRDWQMP is being executed over a short time frame: from February 1 through June 30, 2005, with the Final Report due May 30, 2005. [Note: The three participating agencies consider the current effort as “Phase I” of a longer process for addressing the improvement of water quality in the Delta.] Consequently, the outreach efforts also are on a fast track (see **Attachment A** for schedule).

OUTREACH TO OTHER IN-DELTA WATER AGENCIES

Outreach to other in-Delta water agencies consists of four key elements:

- A notification letter to the agencies delineating the objectives and describing the process of the DRDWQMP effort.
- Providing the agencies an opportunity to voice key issues and concerns in response to a series of questions provided with the notification letter. This request for issues and areas of concern will be qualitative in nature (as opposed to the quantitative data that will be presented for CCWD, COS, and SCWA). A copy of the notification letter and issues and concerns questionnaire is attached (see **Attachment B**).
- Sending the agencies a draft of the DRDWQMP report and providing opportunity to provide comments that will be included in an appendix to the final report.
- Sending the agencies a copy of the final report.

A list of in-Delta water agencies to be contacted is provided in **Attachment C**.

OUTREACH TO OTHER STAKEHOLDERS

The outreach to a representative group of other stakeholders will have four elements:

- A notification letter delineating the objectives and describing the process of the DRDWQMP effort.

- Providing the agencies an opportunity to voice key issues and concerns in response to a series of questions included with the notification letter. This request for issues and areas of concern will be qualitative in nature (as opposed to the quantitative data that will be presented for CCWD, COS, and SCWA). A copy of the notification letter and issues and concerns questionnaire is attached (see **Attachment B**).
- Sending the representative group of other stakeholders a draft of the DRDWQMP report and creating an opportunity to provide comments that will be included in an appendix to the final report.
- Sending the representative group of the stakeholders a copy of the final report.

A list of other stakeholders to be contacted is provided in **Attachment C**.

OUTREACH TO CALFED AND BAY-DELTA PUBLIC ADVISORY COMMITTEE

Outreach to the CALFED Drinking Water Quality Program and Bay-Delta Public Advisory Committee, Drinking Water Subcommittee, will have three elements:

- Making a presentation to the Bay-Delta Public Advisory Committee, Drinking Water Subcommittee, at its scheduled meeting on or about March 25, 2005
- Sending each a draft of the DRDWQMP report and providing an opportunity to provide comments that will be included in an appendix to the final report
- Sending each a copy of the final report
- Making a final presentation to the Bay-Delta Public Advisory Committee, Drinking Water Subcommittee

SUMMARY OF OUTREACH EFFORTS AND RESPONSES TO COMMENTS TO DATE

The outreach letter attached (**Attachment B**) was sent to a number of agencies and stakeholders in the Delta region or to those with interests in the Delta region.

Table 3-9 of the main document summarizes comments received back from those agencies and interests. In addition to the comments in **Table 3-9**, an attempt was made to speak directly with a number of the agencies listed in **Table 3-9**. The majority of their comments, while summarized in **Table 3-9,** also are included within the report. Additional communication and outreach will be conducted as appropriate for the implementation of the projects and strategies identified by the DRWQMP participating agencies.

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ATTACHMENT A – DELTA REGION DRINKING WATER QUALITY MANAGEMENT PLAN REVISED SCHEDULE

Action/Deliverable	Tasks	Docu-ments	ABAG Due Date	MWH/CCWD Contract Date	MWH Submittals (Revised)
Notice-to-Proceed			February 14, 2005		February 1, 2005
Kick-Off Meeting	Task 0			January 27, 2005	January 27, 2005
Draft Outreach Work Plan	Task 1	Outreach Work Plan		NTP + 10 days February 11, 2005	February 11, 2005
Final Outreach Work Plan	Task 1	Outreach Work Plan	NTP + 60 days April 15, 2005	NTP + 17 days February 18, 2005	February 18, 2005
Data collection meetings with CCWD, Stockton, and SCWA	Task 1	-	January to March 2005	January to March 2005	Week of March 7, 2005
Draft Summary of Historical Water Quality and Flow Data	Task 2	TM 1		NTP + 42 days March 15, 2005	March 15, 2005
Final Summary of Historical Water Quality and Flow Data	Task 2	TM 1	NTP + 90 days May 15, 2005	NTP + 54 days March 27, 2005	March 28, 2005
Draft Technical Memorandum summarizing each urban agencies water quality goals and issues	Task 1	TM 2		March 14, 2005	March 15, 2005
Draft Conceptual Model	Task 3	TM 3		March 14, 2005	March 15, 2005
Draft Technical Analysis of Alternatives	Task 4	TM 4		March 21, 2005	March 21, 2005
Draft CALFED Presentation to CCWD	Task 5	-			March 18, 2005
Presentation to CALFED Bay-Delta PAC Drinking Water Quality Sub-Committee	Task 5				**April 1, 2005**
Draft Summary of Outreach and Stakeholder Involvement	Task 5	Appendix to Final Report		March 28, 2005	May 9, 2005 [Note: Comments must be received by May 2, 2005 to be included.]
Final Conceptual Model	Task 3	TM 3	NTP + 160 days July 24, 2005	April 4, 2005	April 4, 2005
Final Technical Analysis of Alternatives	Task 4	TM 4	May 6, 2005	April 11, 2005	April 11, 2005
Final Summary of Outreach and Stakeholder Involvement	Task 5	Appendix to Final Report	May 6, 2005	April 18, 2005	May 23, 2005
Internal Draft Project Report	Task 6	-		April 25, 2005	April 11, 2005
Draft Project Report Circulated to Stakeholders for Comment	Task 6	-			April 18, 2005

Continued on following page

Action/Deliverable	Tasks	Docu-ments	ABAG Due Date	MWH/CCWD Contract Date	MWH Submittals (Revised)
Final Project Report	Task 6	-		May 9, 2005	May 23, 2005
First Quarterly Project Report due to ABAG			ABAG/SFEP 10 days after close of quarter May 25, 2005	May 18 2005	May 18, 2005
Final Project Report to ABAG			**May 30, 2005**	**May 30, 2005**	**May 30, 2005**
Final Presentation to CALFED Drinking Water Subcommittee			June/July 2005	June/July 2005	June/July 2005

Key:

ABAG = Association of Bay Area Governments
CALFED = CALFED Bay-Delta Program
CCWD = Contra Costa Water District
NTP = Notice to Proceed
PAC = Public Advisory Committee
SCWA = Solano County Water Agency
SFEP = San Francisco Estuary Project
TM = Technical Memorandum

ATTACHMENT B - NOTIFICATION LETTER / QUESTIONNAIRE

NOTIFICATION LETTER

<date>

<name and title>
<agency or organization name>
<address>

Subject: Preparation of a Delta Region Drinking Water Quality Management Plan

Dear *<name>*:

The Contra Costa Water District (CCWD), the City of Stockton (COS), and the Solano County Water Agency (SCWA) are jointly developing a Delta Region Drinking Water Quality Management Plan (DRDWQMP) under a grant from the California Bay-Delta Authority. The objectives of this plan include:

- To understand existing water quality conditions (and anticipated future water quality conditions absent pro-active actions) at the urban intakes within Delta
- To document the existing institutional setting and water system operations, and to anticipate the resulting impacts on drinking water quality in the Delta
- To identify challenges and issues confronting agencies diverting drinking water from the Delta by comparing their water resources planning and management objectives with the anticipated future institutional, operations, and regulatory settings
- To identify potential projects and programs for addressing those challenges and issues within the construct of the "equivalent level of public health" (ELPH) structure [Note: The intent is to develop projects and programs that provide mutual benefit to multiple agencies if and whenever possible.]
- To develop strategies for implementing those projects and programs including identifying potential partnerships and delineating the appropriate roles of local, state, and federal interests

This effort is seen as "Phase I" of a longer process for addressing the improvement of drinking water quality in the Delta. [Note: The current phase of the DRDWQMP is being executed over a short time frame: from February 1 through June 30, 2005, with the final report due to CALFED on May 30, 2005.]

As part of this effort, CCWD, COS, and SCWA are conducting an outreach effort to facilitate discussion with other in-Delta diverters and other stakeholders (e.g., agricultural and point-source dischargers, environmental interests, and non-governmental organizations). The objectives of this outreach effort are three-fold:

- To inform interested stakeholders on the goals and objectives of the DRDWQMP

- To collect information on issues and areas of concern for use in "Phase II" of the DRDWQMP
- To provide an opportunity to review and comment on the draft "Phase I" final report. [Note: The draft report will be circulated for comment on April 18, 2005. Comments received on the draft report by May 2, 2005, will be summarized in an appendix to the final report.]

In furtherance of these objectives, the parties will be making a presentation to the Bay-Delta Public Advisory Committee Drinking Water Subcommittee at their scheduled meeting on Friday, April 1, 2005.

If you are interested in learning more about the DRDWQMP, would like to receive copies of the draft and final report, or would like to attend the Bay-Delta Public Advisory Committee Drinking Water Subcommittee on April 1, 2005, please contact:

Andrea J. Flores, P.E.
Project Engineer
Contra Costa Water District
Planning Department
2411 Bisso Lane (Location)
P.O. Box H2O (Mailing)
Concord, CA 94524-2099
Phone: (925) 688-8154
Fax: (925) 688-8142

Additional information from the Bay-Delta Public Advisory Committee is available on their web site: http://calwater.ca.gov/BDPAC/BDPAC.html.

Sincerely,

Richard A. Denton
Water Resources Manager
Contra Costa Water District

OUTREACH QUESTIONNAIRE

DELTA REGION DRINKING WATER QUALITY MANAGEMENT PLAN

The Contra Costa Water District (CCWD), the City of Stockton (COS), and the Solano County Water Agency (SCWA) are jointly developing a Delta Region Drinking Water Quality Management Plan (DRDWQMP) under a grant from the California Bay-Delta Authority. The objectives of this plan include:

- To understand existing water quality conditions (and anticipated future water quality conditions absent pro-active actions) at the urban intakes within Delta
- To document the existing institutional setting and water system operations, and to anticipate the resulting impacts on drinking water quality in the Delta
- To identify challenges and issues confronting agencies diverting drinking water from the Delta by comparing their water resources planning and management objectives with the anticipated future institutional, operations, and regulatory settings
- To identify potential projects and programs for addressing those challenges and issues within the construct of the "equivalent level of public health" (ELPH) structure [Note: The intent is to develop projects and programs that provide mutual benefit to multiple agencies if and whenever possible.]
- To develop strategies for implementing those projects and programs including identifying potential partnerships and delineating the appropriate roles of local, state, and federal interests

The purpose of this questionnaire is to solicit input from stakeholders and interested parties for use in the development of the DRDWQMP.

Name: ____

Agency or Organization: ____________________________________

Contact Information (phone and email): ___________________________

Mailing Address: ____

Would you like to receive a copy of the draft and final report? ____________

[Note: The draft report will be circulated for comment on April 18, 2005. Comments received on the draft report by May 2, 2005, will be summarized in an appendix to the final report.]

Are you aware of the on-going work of the Bay-Delta Public Advisory Committee Drinking Water Subcommittee to improve drinking water quality in the Delta? ____

____

What are the key issues and areas of concern for drinking water quality in the Delta? ____

____

____

____

____

____

How do these issues and areas of concern relate to the quality of water in the Delta used for other purposes (e.g., agricultural or environmental purposes)? __________

____

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____

What should be the principal goals and objectives of the DRDWQMP effort? ______

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Are you aware of any sources of information, reports, or data that could have relevancy to the completion of the DRDWQMP (if so, please list or provide a contact)? ____

____

____

____

____

Please return this questionnaire to:

Andrea J. Flores, P.E.
Project Engineer
Contra Costa Water District
Planning Department
2411 Bisso Lane (Location)
P.O. Box H2O (Mailing)
Concord, CA 94524-2099
Phone: (925) 688-8154 Fax: (925) 688-8142

ATTACHMENT C - LIST OF CONTACTS

Agency	Contact Name	Title	Telephone	Mailing Address	Agency/ Group Type
Central Delta Water Agency	Dante Nomellini	Manager and Co-Counsel	209/465-5883	PO Box 1461 Stockton, CA 95201	A
Contract Costa Water District	Richard Denton	Water Resources Manager	925/688-8187	1330 Concord Ave. Concord, CA 94524-2099	U
City of Antioch	Vince Varone	Superintendent of Water Operations	925/779-7027	PO Box 5007 Antioch, CA 94531-5007	U
City of Brentwood	John Stevenson	City Manager	925/516-6000	708 Third Street Brentwood, CA 94513	A,D
City of Martinez	Alan Pellegrini	Water Superintendent	925/372-3587	525 Henrietta Street Martinez, CA 94553	
City of Pittsburg	Richard McDonald	Water Plant Superintendent	925/252-4110	65 Civic Avenue Pittsburgh, CA 94565	U
Southern California Water Company	Ernie Geisler	Engineer	916/853-3600	3035 Prospect Park, Suite 60 Rancho Cordova, CA 95670	U
Central Valley Project	Stanley M. Williams	CEO	408/265-2600	5750 Aldamen Expressway San Jose, CA 95118-3686	A, U
Delta Diablo Sanitation District	Gary Darling	General Manager	925/756-1900	2500 Pittsburgh-Antioch Hwy. Antioch, CA 94509-1373	U
Delta Wetlands Properties	John Winter	President	510/283-4216	3697 Mt. Diablo Blvd, Suite 100 Lafayette, CA 94549	U
Discovery Bay	Bob Doren	President of the Board	925/634-1131	1800 Willow Lake Road Discovery Bay, CA 94514	D
Freeport Regional Water Project	Eric Mische	General Manager	916/643-1735	2710 Gateway Oaks Dr. #320-S Sacramento, CA 95833	U
East Bay Municipal Utility District	Dennis Diemer	General Manager	510/835-3000	375 11th Street Oakland, CA 94607	U
Sacramento County Water Agency	Keith DeVore	Director of Water Resources	916/874-6581	827 7th Street, Room 301 Sacramento, CA 95814	U
Ironhouse Sanitation District	Tom Williams	General Manager	925/625-2279	450 Walnut Meadows Drive Oakley, CA	D
Isleton	Jim Buell	City Manager	916/777-7770	101 Second Street Isleton, CA 95641	U,D
Lathrop	Cary Keaton	Director of Public Works	209/858-2860	16775 Howland Road Lathrop, CA 95330	U
Lodi	Richard Prima	Director of Public Works	209/333-6706	221 West Pine Street Lodi, CA 95240	D
Manteca	Michael Brinton	Director of Public Works	209/239-8461	1001 West Center Street Manteca, CA 95337	D
Mountain House Community Services District	Paul M. Sensibaugh	General Manager	209/468-9997	11 S. San Joaquin Street, 7th Floor Stockton, CA 95202	D
Reclamation District 800	Marsha Holmes	Administrative Officer	916/685-9461	PO Box 115 Elk Grove, CA 95759-0115	D

Continued on following page

Agency	Contact Name	Title	Telephone	Mailing Address	Agency/ Group Type
Sacramento Regional County Sanitation District	Robert Shanks	Director, Department of Water Quality	916/876- 6001	10545 Armstrong Avenue Sacramento, CA 95645	U,D
Solano County Water Agency	David Okita	General Manager	707/455-1103	PO Box 349 Elmira, CA 95625-0349	U
City of Benicia	Chris Tomasik	Assistant Public Works Director	707/746-4240	250 East L Street Benicia, CA 94510	U
City of Dixon	Warren Salmons	City Manager	707/678-7031	600 East "A" Street Dixon, CA 95620-3621	U
City of Fairfield	Rick Wood	Commission Member	707/428-7481	Dept of Public Works 1000 Webster Street Fairfield, CA 94533-4883	U
Maine Prairie Water District	Don Holdener	Manager	707/678-5332	PO Box 73 6595 Pitt School Road Dixon, CA 95620	A,D
City of Napa	Phil Brun	Manager	707/257-9520	Department of Public Works PO Box 660 Napa, CA 94559	U
Reclamation District No. 2068	T.M. (Mike) Hardesty	General Manager	707/678-5412	7178 Yolano Road Dixon, CA 95620-3621	A,D
City of Rio Vista	Felix Ajayi	Director of Public Works	707/374-6747	PO Box 745 Rio Vista, CA 94571	U
Solano Irrigation District	Suzanne Butterfield	Secretary/Manager	707/448-6847	508 Elmira Road Vacaville, CA 95687	D
City of Suisun City	Gerald (Gary) Cullent	Public Works Director	707/421-7346	Department of Public Works 701 Civic Center Blvd. Suisun City, CA 94585	U
City of Vacaville	Dave Tomkins	Assistant Public Works Director	707/449-5171	Department of Public Works 650 Merchant Street Vacaville, CA 95688	U, D
City of Vallejo	Eric Nugteren	Deputy Water Superintendent	707/648-4482	555 Santa Clara Street Vallejo, CA 94590	U
South Delta Water Agency	Jerry Robinson	Chairman	209/956-0150	4255 Pacific Avenue, Suite 2 Stockton, CA 95207	A
State Water Project Contractors	Terry Erlewine	General Manager	916/447-7357	455 Capitol Mall, Suite 220 Sacramento, CA 95814	U
Alameda County Water District	Paul Piraino	General Manager	510/668-4202	43885 South Grimmer Blvd. Fremont, CA 94538	U
Metropolitan Water District at Southern California	Tim Quinn, Ph.D	Vice President	213/217-6000	700 North Alameda Street Los Angeles, CA 90012-2944	U
Santa Clara Valley Water District	Stanley M. Williams	CEO	408/265-2600	5750 Aldamen Expressway San Jose, CA 95118-3686	U
Zone 7	Dale Myers	General Manager	924/454-5000	100 North Canyons Parkway Livermore, CA 94551	U
City of Stockton	Robert L. Granberg	Deputy Director, Water Resources Planning	209/937-8779	2500 Navy Drive Stockton, CA 95206-1191	U,D

Continued on following page

Agency	Contact Name	Title	Telephone	Mailing Address	Agency/ Group Type
City of West Sacramento	Jerry Lo	Director of Public Works	916/617-4850	1951 South River Road West Sacramento, CA 95691	D
City of Tracy	Nick Pinhey	Director of Public Works	209/831-4103	325 East 10th Street Tracy, CA 95376	U
Woodbridge Irrigation District	Andy Christensen	General Manager	209/369-6808	18777 N. Lower Sacramento Rd. Woodbridge, CA 95258	D
Bay Institute	Gary Bobker	Executive Director	415/506-0150	500 Palm Drive, Suite 200 Novato, CA 94949	E
Delta Keeper	Bill Jennings	Delta Keeper	209/464-5090	3536 Rainer Road Stockton, CA 95205	E
Environmental Defense Fund	Tom Graff	President	510/658-8008	5655 College Ave, Suite 304 Oakland, CA 94618	E
Natural Heritage Institute	Gregory A. Thomas	Founder and President	415/693-3000	100 Pine Street, Suite 1550 San Francisco, CA 94104	E
Natural Resources Defense Council	Hal Candee	Senior Attorney for Western Water	415/875-6100	111 Sutter St., 20th Floor San Francisco, CA 94104	E
Pacific Institute	Peter Gleick	President	510/251-2203	654 13th Street, Preservation Park Oakland, CA 94612	E

Key: A = agricultural water user D = discharger E = environmental stakeholder U = urban water user

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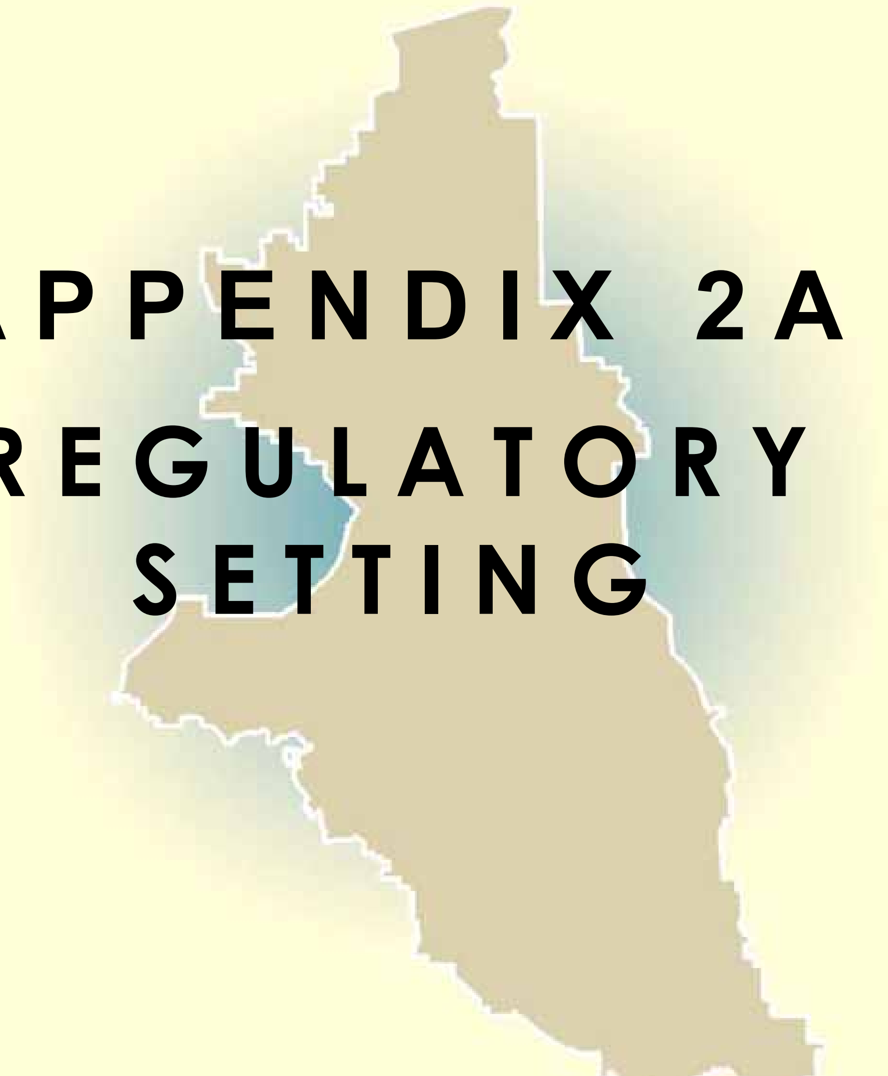
DELTA REGION

DRINKING WATER QUALITY MANAGEMENT PLAN



APPENDIX 2A

REGULATORY SETTING

APPENDIX 2A. REGULATORY SETTING

This appendix presents the current regulatory setting affecting Sacramento-San Joaquin Delta (Delta) management. Additionally, significant, historical regulations that have guided and influenced current Delta management practices are reviewed.

WATER QUALITY STANDARDS

As acknowledged by the inclusion of operations in the Equivalent Level of Public Health (ELPH) Protection diagram, drinking water quality can be affected by changes in operations, both within the Delta and upstream. Requirements of the State Water Resources Control Board (SWRCB) govern release of upstream storage and curtailment of export pumping to maintain Delta water quality and Delta outflow requirements. The first water quality standards for the Delta were adopted in May 1967 when the State Water Rights Board (predecessor to the SWRCB) released Water Right Decision 1275 (D-1275), approving water rights for the State Water Project (SWP) while setting agricultural salinity standards as terms and conditions. These requirements were changed in 1971 under Decision 1379 (D-1379), which added standards that the Central Valley Project (CVP) and SWP were required to meet, for non-consumptive uses (water dedicated to fish and wildlife), along with agricultural and municipal and industrial (M&I) consumptive use standards.

1978 WATER QUALITY CONTROL PLAN

In 1978, the SWRCB issued Water Right Decision 1485 (D-1485) and the Water Quality Control Plan (WQCP) for the Sacramento-San Joaquin Delta and Suisun Marsh, which together revised flow and salinity standards, and required the United States Department of the Interior, Bureau of Reclamation (Reclamation), and California Department of Water Resources (DWR) to reduce pumping, release stored water upstream, or both to meet the standards. D-1485 superseded all previous water rights decisions for the CVP and SWP operations in the Delta. Among beneficial uses to be protected by the decision were (1) M&I water supply, (2) agriculture, and (3) fish and wildlife. D-1485 standards included different levels of protection to reflect variations in hydrologic conditions during different types of water years. D-1485 introduced the M&I chloride objective of 250 milligrams per liter (mg/L) chloride all year at the major urban drinking water intakes, and 150 mg/L chloride for 155 to 240 days per year at the Contra Costa Water District (CCWD) Pumping Plant No. 1 intake, or the City of Antioch's intake, depending on water year type. These D-1485 M&I objectives provide only limited ancillary protection for water quality for drinking water use. D-1485 was challenged in the courts, and the decision was overturned in 1984. However, D-1485 standards remained in effect. In 2005, still no true drinking water objectives exist to protect public health.

1995 WATER QUALITY CONTROL PLAN

The 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (1995 WQCP) established water quality control measures that contribute to the protection of beneficial uses in the Delta. The 1995 WQCP identified (1) beneficial uses of the Delta to be protected, (2) water quality objectives for the reasonable protection of beneficial uses, and (3) a program of implementation for achieving the water quality objectives. The 1995 WQCP superseded the Water Quality Control Plan for Salinity (adopted in May 1991) and the Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh that was adopted in August 1978.

The 1995 WQCP was developed as part of the December 15, 1994, Bay-Delta Accord, which committed the CVP and SWP to new Delta habitat objectives. Since these new beneficial objectives and water quality standards were more protective than those of the previous D-1485, the new objectives were adopted by amendment in 1995 through a Water Rights Order for the operation of the CVP and SWP. One key feature of the 1995 WQCP was the estuarine habitat ("X2") objectives for Suisun Bay and the western Delta. The X2 objective required specific daily or 14-day surface electrical conductivity (EC) criteria, or 3-day averaged outflow requirements to be met for certain numbers of days each month, February through June. These requirements were designed to provide improved shallow water habitat for fish species in the spring. Because of the relationship between seawater intrusion and interior Delta water quality, the X2 criteria also improved water quality at Delta drinking water intakes. Other new elements of the 1995 WQCP included export-to-inflow (E/I) ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, and San Joaquin River EC and flow standards.

WATER RIGHT DECISION 1641

D-1641 and Order WR 2001-05 contain the current water right requirements to implement the 1995 WQCP. D-1641 incorporates water rights settlement agreements between DWR and Reclamation and certain water users in the Delta and upstream watersheds regarding contributions of flows to meet water quality objectives. However, DWR and/or Reclamation have the responsibility to ensure that objectives are met in the Delta. D-1641 also authorizes the CVP and SWP to use joint points of diversion (JPOD) in the south Delta, and recognizes the CALFED Operations Coordination Group (Ops Group) process for operational flexibility in applying or relaxing certain protective standards. The additional exports allowed under JPOD could result in additional degradation of water quality for water users in the south and central Delta, including CCWD. JPOD also could impact water levels in the south Delta and endangered fish species.

WATER QUALITY CONTROL PLAN PERIODIC REVIEW

The California Water Code and the federal Clean Water Act require a periodic and a triennial review, respectively of water quality objectives or standards. The SWRCB is currently conducting a Periodic Review of the 1995 WQCP. SWRCB (2004) describes the actions taken by the SWRCB to date for the Periodic Review and includes staff's recommendations for future actions. SWRCB recently completed a multiday workshop to receive information and conduct detailed discussion regarding specific plan amendments or revisions to the 1995 WQCP. A draft plan is anticipated in fall 2005.

MUNICIPAL AND INDUSTRIAL WATER QUALITY OBJECTIVES

In the 1978 WQCP, SWRCB set two objectives that it believed provided reasonable protection for M&I beneficial uses of Delta waters from the effects of salinity intrusion. The first objective established a year-round maximum mean daily chloride concentration measured at five Delta intake facilities, including Contra Costa's Pumping Plant Number 1 (PP No. 1), of 250 mg/L for the reasonable protection of municipal beneficial uses. This objective was consistent with the United States Environmental Protection Agency (EPA) secondary maximum contaminant level (MCL) for chloride of 250 mg/L, and is based only on aesthetic (taste) considerations. The second objective established a maximum mean daily chloride concentration of 150 mg/L (measured at either PP No.1 or the San Joaquin River at the Antioch water works intake) for the reasonable protection of industrial beneficial uses (specifically manufacture of cardboard boxes by Gaylord Container Corporation in Antioch). This requirement is in effect for a minimum of between 155 and 240 days each calendar year, depending on the water year type.

In the 1991 WQCP, SWRCB reviewed the water quality objectives for M&I use contained in the 1978 WQCP, and reviewed potential new objectives for trihalomethanes (THM) and other disinfection byproducts (DBP), including bromides. SWRCB concluded that technical information regarding THMs and other DBPs was not sufficient to set a scientifically sound objective. Accordingly, SWRCB continued the existing objectives for chloride concentration, and until more information is developed regarding these constituents, set a water quality "goal" for bromides of 0.15 mg/L (150 micrograms per liter (µg/L)). SWRCB also noted that the 150 mg/L chloride objective was maintained in part because it provides ancillary protection for other M&I uses in the absence of objectives for THMs and other DBPs. These objectives remained unchanged in the 1995 WQCP.

The 1995 WQCP failed to include specific objectives to protect drinking water quality and public health. However, SWRCB, as part of its current Periodic Review of the 1995 WQCP, is considering specific drinking water objectives, such as a bromide objective, that would help reduce the formation of DBPs during water treatment. CCWD submitted comments to the SWRCB requesting a 300 µg/L bromide objective applicable all year for at least one of CCWD's drinking water intakes. CCWD stated that this objective could be met without additional water cost if CCWD were to implement its current project to relocate its M&I intake on Old River further west to Victoria Canal, or a location of similarly better water quality (CCWD's Alternative Intake Project).

The SWRCB and Regional Water Quality Control Board (RWQCB) Basin Plans specify water quality objectives to protect designated beneficial uses, including municipal drinking water supply. The Central Valley RWQCB (CVRWQCB) is also currently developing a Central Valley Drinking Water Policy that may lead to regulations limiting the discharge of bromide, organic carbon, pathogens, and other drinking water constituents of concern. RWQCB took the significant step of adopting a resolution in July 2004 (Resolution No. R5-2004-0091) supporting development of the policy. Technical studies are due for completion in 2007. Basin Plan amendments could be completed by 2009.

COORDINATED OPERATIONS AGREEMENT

The Coordinated Operations Agreement (COA) defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and meet the water demands of senior water right holders. COA defines the Delta as being in either "balanced water conditions" or "excess water conditions." Balanced conditions are periods when Delta inflows are just sufficient to meet water user demands within the Delta, outflow requirements for water quality and flow standards, and export demands. Under excess conditions, Delta outflow exceeds the flow required to meet the water quality and flow standards. Typically, the Delta is in balanced water conditions from June to November, and in excess water conditions from December through May. However, depending on the volume and timing of winter runoff, excess or balanced conditions may extend throughout the year.

During excess water conditions, but during periods when Delta outflow is still relatively low, additional Delta diversions can degrade the water quality needed to meet drinking water standards, even when SWRCB M&I objectives are being met.

DRINKING WATER CONSIDERATIONS

Drinking water considerations include regulations and key water quality parameters, contaminants of concern (COC), and precursors, discussed below.

DRINKING WATER REGULATIONS

Drinking water quality is regulated at the federal and state level. The United States Congress enacted the Safe Drinking Water Act (SDWA) in 1974, giving EPA authority to set standards for contaminants in drinking water supplies. EPA was required to establish primary regulations to protect public health; these regulations are mandatory. In addition, EPA regulates compounds that affect the taste, odor, or aesthetics of drinking water through secondary standards, for which compliance is voluntary. In California, the Department of Health Services (DHS) is the primary agency for drinking water regulations. DHS must adopt standards at least as stringent as the federal standards, but may regulate contaminants to more stringent standards than EPA or develop additional standards. All regulations go through public and scientific review, with proposed regulations, a comment period, and final regulations.

The regulations cover a wide variety of contaminants, including microorganisms, particulates, inorganics, natural organics, synthetic organics, radionuclides, and DBPs. Since EPA developed the National Interim Primary Drinking Water Regulations (NIPDWR) in 1975, regulations for over 150 contaminants have been developed. For each contaminant, EPA is required to establish an MCL or a treatment technique to limit the level of these compounds in water. EPA also recommends a best available technology (BAT) for each contaminant. For carcinogens, EPA develops a public health goal that is lower than the MCL and often is zero. California DHS has some regulations in addition to those developed by EPA. The regulations promulgated by EPA and DHS since the SDWA was enacted are summarized in **Table 2A-1**.

Table 2A-1 Major Federal and State Drinking Water Regulations

Regulation	Year Promulgated	Contaminants
National Interim Primary Drinking Water Regulations (NIPDWR)	1975-1981	Inorganics, Organics, Physical, Radioactivity, Bacteriological
National Secondary Drinking Water Regulations	1979	Various Inorganics, Color, Corrosivity, Odor, Foaming Agents
Phase I Standards	1987	Volatile Organic Compounds (VOCs)
Phase II Standards	1991	VOCs, Synthetic Organics Compounds (SOCs), Inorganics Compounds (IOCs)
Phase V Standards	1992	VOCs, SOCs, IOCs
Surface Water Treatment Rule (SWTR)	1989	Microbiological and Turbidity
Total Coliform Rule (TCR)	1989	Microbiological
Lead and Copper Rule (LCR)	1991 / 2003	Lead, Copper
Drinking Water Source Assessment and Protection Program	1996	Source Water Protection
Information Collection Rule (ICR)	1996	Microbiological and Disinfectants / Disinfection Byproducts (D/DBPs)
Stage 1 Disinfectants/Disinfection Byproducts (D/DBP) Rule	1998	D/DBPs, Precursors
Interim Enhanced Surface Water Treatment Rule (ESWTR)	1998	Microbiological, Turbidity
Unregulated Contaminant Monitoring Rule	1999	Organics, Microbiological
Radionuclides Rule	2000	Radionuclides
Arsenic Rule	2001	Arsenic
Filter Backwash Rule	2002	Microbiological, Turbidity
Long Term 1 ESWTR	2002	Microbiological, Turbidity
Drinking Water Candidate Contaminant List	2003	Chemical, Microbiological

Regulations have evolved over the last three decades as additional information is available on the occurrence, health effects, and treatment techniques for drinking water contaminants. The NIPDWR essentially applied the previous United States Public Health Service standards to public water supplies. Secondary standards for aesthetics or consumer acceptance followed. As chemical detection limits were lowered and more information was available on their occurrence, organic chemicals became the focus, as shown by regulations for volatile organics, synthetic organics, naturally occurring organics, and DBPs. When utilities began to switch disinfectants to control DBPs, EPA began to focus on a lengthening list of microbiological contaminants (Giardia, viruses, *Cryptosporidium)* that were being detected with improved microbiological techniques. Thus, the current regulatory emphasis has been on maintaining balance between adequate disinfection and minimizing DBP formation, as evidenced by the various versions of the Surface Water Treatment Rules (SWTR) and D/DBP rules.

Regulations will continue to evolve. The SDWA requires EPA to publish candidate contaminant lists periodically, evaluate occurrence and health effects, and then promulgate new regulations, as appropriate.

Regulations currently under development or on the horizon include the following:

- Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), proposed in 2003
- Stage 2 D/DBP Rule, proposed in 2003
- Arsenic Rule, revisions under consideration by EPA and DHS
- Candidate Contaminant List, published in 1998; EPA narrowed the list to nine contaminants, evaluated further, and concluded no regulations were needed
- Hexavalent chromium (Chromium-6), under consideration by EPA and DHS
- Distribution System Rule, under development
- Perchlorate, from the candidate contaminant list, under consideration by EPA and DHS

In addition to the above contaminants currently under consideration, emerging issues that could evolve into regulations for additional contaminants include the following:

- Fuel oxygenates (such as methyl tertiary-butyl ether (MTBE))
- N-nitrosodimethlyamine (NDMA), an impurity in rocket fuel and a DBP
- Endocrine disrupter chemicals (EDC), pharmaceuticals and personal care products (PPCP), including analgesics, antibiotics, anti-epileptic medicines, anti-inflammatory medicines, bath additives, blood lipid regulators, cough syrup, detergents, fragrances, hormones, hair care products, oral hygiene products, sunscreens, skin care products, and stimulants (e.g., caffeine)
- Emerging microorganisms, such as those on the EPA candidate contaminant list for bacteria (*Aeromonas hydrophila, Helicobacter pylori, Mycobacterium avium intracellulare*, cyanobacteria or blue-green algae, other freshwater algae, and their toxins), viruses (adenoviruses, calciviruses, coxsackieviruses, and echoviruses), and protozoa (*Acantamoeba,* microsporidia)
- Veterinary medications that concentrate from animal feed lots
- Nanoparticles, extremely small particles for applications such as delivery of pharmaceuticals across the blood-brain barrier

Predicting regulations through 2030 is a difficult task because of the following:

- The number of potential organic, inorganic, or microbiological contaminants is large
- New products are being developed at an accelerating rate
- Analytical detection limits are decreasing and more information is being collected on the occurrence of contaminants
- Information continues be generated on health effects
- The link between wastewater discharge and drinking water sources is better understood

Whenever regulations are developed for one contaminant or group, implications may exist for other contaminants, as shown by the interaction between the various SWTRs and D/DBP rules.

Given the development of regulations from 1975 to 2005, the following trends have been observed and are expected to continue:

- An increasingly long list of contaminants will be regulated, covering a full range of microbiological, physical, inorganic, organic, and radiological contaminants
- MCLs for a given contaminant are likely to decrease with time as additional health effects information is available
- Regulatory approaches are focusing more on treatment techniques rather than MCLs, particularly for multiple or difficult to monitor contaminants
- Water treatment plants (WTP) are likely to employ new or additional technologies
- Multiple treatment barriers are likely to be required by DHS

KEY WATER QUALITY PARAMETERS, CONTAMINANTS OF CONCERN, AND PRECURSORS

The SCWA, CCWD, and Stockton water supplies are influenced by a unique set of circumstances particular to Delta usage: wastewater discharge, agricultural drainage, shipping, recreation, environmental protection goals, tidal variations, and operations of the federal CVP and California SWP (both freshwater releases and Delta export pumping). These three agencies, the South Bay Aqueduct users (Zone 7 Water Agency, Alameda County Water District, Santa Clara Valley Water District), and others that similar to CCWD, take raw water directly from the Delta as a live stream, are more subject to variability than others. For example, water from the Banks and Tracy pumping plants that flows to Southern California has seasonal storage in San Luis Reservoir, which attenuates variability in salinity. Large terminal reservoirs (provided by DWR and Metropolitan Water District of Southern California) and groundwater banking also serve to stabilize water quality variations in Southern California in comparison to direct Delta users.

For Delta water supplies, key water quality parameters of concern have evolved with the changing drinking water regulations, monitoring programs, research efforts, and individual agency goals. Key water quality parameters and COCs include the following:

- Total organic carbon (TOC), dissolved organic carbon (DOC), and DBP precursors from natural organic material (NOM) – DBP precursors
- Salinity, particularly bromide and chloride
- Microorganisms
- D/DBPs
- Turbidity
- Synthetic organics
- Algae and algal-derived byproducts
- EDCs and PPCPs

Total Organic Carbon, Dissolved Organic Carbon, and Disinfection Byproduct Precursors from Natural Organic Material – Disinfection Precursors

While TOC and DOC are not regulated directly as MCLs, they are addressed in the various SWTRs and recognized in CALFED's ELPH goals. When TOC, DOC, or NOM concentrations are high, they can require additional treatment. Possible responses include enhanced coagulation (higher coagulant dose and/or lower pH to achieve specified TOC removal) to meet the SWTR, optimized disinfection to minimize DBP formation, or other technologies such as membranes or magnetic ion exchange (MIEX) resin adsorption.

Recognizing this, CALFED established a goal of 3.0 mg/L TOC for raw water or an ELPH. The three Delta water agencies have higher concentrations of TOC in their raw water, either periodically or as a rule. The TOC in these sources is composed primarily of DOC. **Figure 2A-1** summarizes DOC concentrations at various locations in the Delta. SCWA, which draws water from the North Bay Aqueduct (NBA) at Barker Slough, has an average DOC of 5.3 mg/L in its raw water, which is higher than the mean at the state Banks pumping plant (3.7 mg/L) or the federal Delta-Mendota Canal (DMC) (4.1 mg/L). Furthermore, SCWA experiences extremely high TOC during winter storms; in a February 2004 storm, DOC ranged from 12 to 18 mg/L. The average for the CCWD Contra Costa Canal (Rock Slough) intake is 3.4 mg/L and for Vernalis is 3.9 mg/L. Clearly, Delta water supplies exceed the CALFED numeric TOC goal.

Salinity, Particularly Bromide and Chloride

The Delta water agencies also are impacted by fluctuating salinity caused by tidal variation, operation of the state and federal water projects, seasonal fluctuations, and intake locations. Salinity is not in itself regulated, other than the secondary standard of 500 mg/L total dissolved solids (TDS), which is a voluntary standard. Other expressions of salinity are EC and individual ionic constituents. Two individual components of TDS, namely bromide and chloride, are important to Delta water users.

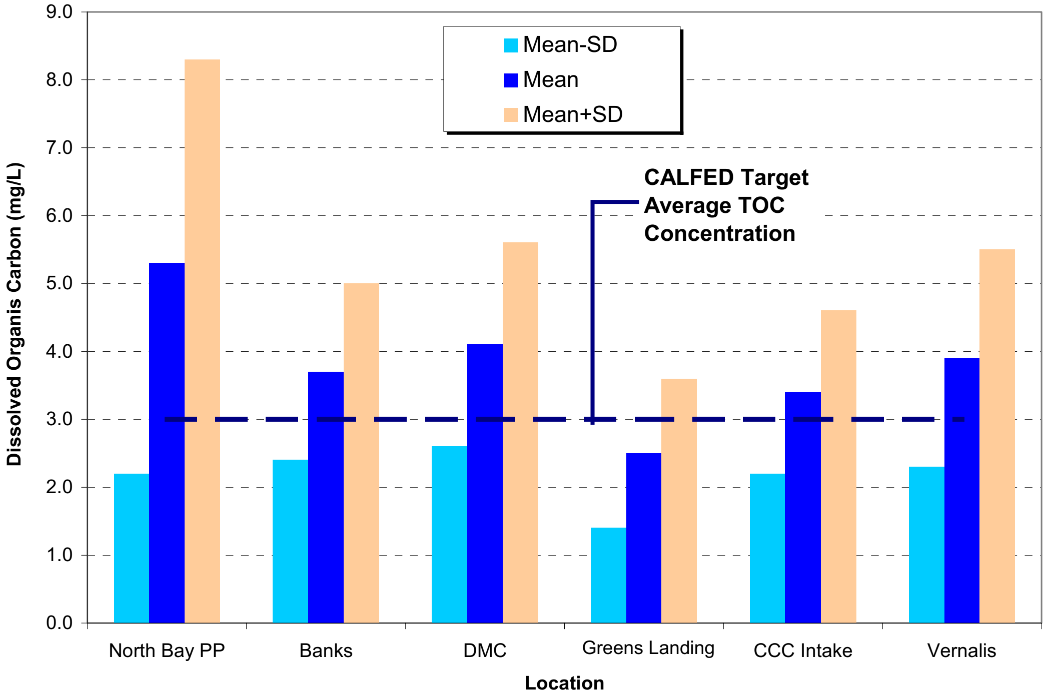


Figure 2A-1 Dissolved Organic Carbon in Delta Water Supplies

Currently, all sampling locations except Greens Landing exhibit DOC levels higher than the CALFED target.

Bromide is found in the Delta during periods of seawater intrusion. Bromide is a health concern because it reacts with ozone (used for disinfection or taste and odor control) to form bromate, a DBP currently regulated at 0.010 mg/L. Recognizing the importance of bromide, CALFED established a goal of 0.050 mg/L bromide or ELPH in source water.

Local water supplies exceed the CALFED goal for bromide. The SCWA source in the NBA varied from 0.025 to 0.080 mg/L in 2003, which is of concern since Fairfield, Vacaville, and Vallejo use ozone. Bromide in CCWD supplies, more subject to salinity intrusion, averaged 0.459 mg/L at Rock Slough and 0.256 mg/L at Old River (based on 1990 to 2003 weekly samples). When bromide is high, utilities may incur additional expenses for combinations of disinfectants (such as chlorine dioxide, ultraviolet light, chlorine, and chloramines), additional constraints on ozonation (lowering pH or adding ammonia), or other treatment techniques (membranes) to comply with water quality standards. Recent SCWA pilot tests found some removal of bromide with MIEX resin.

Chloride is another salinity-related issue. The secondary standard for chloride is 250 mg/L, based on its salty taste (about 850 µg/L bromide). CCWD has a long-established and more stringent goal of 65 mg/L chloride, based on meeting the needs of its domestic and industrial customers. The chloride goal was not routinely met with the Rock Slough (average 130 mg/L chloride from 1990 to 2003) and Mallard Slough intakes, so CCWD built the $450 million Los Vaqueros Reservoir and Old River Intake to improve water quality. The current chloride average at Old River is 74 mg/L (about 250 µg/L bromide), closer to the CALFED numeric goal, and diversions can be timed to take advantage of low chloride conditions.

Microorganisms

Since the Delta is downstream of municipal wastewater discharges and local and upstream agricultural discharges occur, issues exist with microorganisms in the source water. Currently regulated contaminants are total coliform (through the Total Coliform Rule (TCR)), Giardia, and viruses (through the current SWTR, requiring 3 log and 4 log removal/inactivation, respectively). The LT2ESWTR requires the equivalent of at least 3-log removal of *Cryptospodium*, with additional treatment if concentrations exceed a certain level. If average oocyst concentrations are below 0.075mg/L and the water falls into the Bin 1 designation, EPA has proposed that conventional treatment will be equivalent to the required *Cryptosporidium* removal/inactivation. Most sampling to date of Delta water indicates Bin 1 would be applicable.

Disinfectants/Disinfection Byproducts

D/DBPs are formed through reactions of disinfectants with constituents in the source water or through degradation of the disinfectant. Chlorine plus TOC/DOC forms THMs and haloacetic acids (HAA5), chlorine dioxide produces chlorite as a byproduct, and ozonation plus bromide forms bromate. Current MCLs for D/DBPs are shown in **Table 2A-2**.

Table 2A-2 Disinfectant/Disinfection Byproduct Standards

D/DBP	MCL (mg/L)
TTHM	0.080
HAA5	0.060
Chlorite	1.0
Bromate	0.010

Key:
D/DBP = disinfectant/disinfection byproduct
mg/L = milligrams per liter
HAA5 = haloacetic acids
MCL = maximum contaminant level
TTHM = total trihalomethanes

In the Stage 2 D/DBP rule, EPA has proposed changes which could make meeting DBPs more challenging, including moving the compliance point from a distribution system average to an individual locational running annual average (LRAA) approach. The current Stage 2 D/DBP proposal would establish the LRAA MCL of 0.120 mg/L for total trihalomethanes (TTHM) and 0. 100 mg/L for HAA5, to be lowered in 6 years to a LRAA MCL of 0.080 mg/L for TTHM and 0.060 for HAA5. Bromate will be reviewed after 6 years to determine whether the MCL should be lowered to 0.005 mg/L.

Because of the DOC and bromide in source water, Delta water suppliers face a challenge with disinfecting their water to meet standards for microorganisms while simultaneously meeting the MCLs for DBPs. Various approaches are being taken. CCWD is evaluating synergistic disinfectants (ozone, ultraviolet, chlorine, chlorine dioxide, chloramine) in an American Water Works Association Research Foundation /EPA research study; membranes and other techniques also will be tested. CCWD currently uses ozone followed by chloramines and is adding chlorine dioxide capability. SCWA serves agencies that use ozone and chloramine or chlorine and chloramine.

Turbidity

Turbidity (particulates) in the Delta can be high and variable. For SCWA, typical turbidity in the NBA is 30 to 80 nephelometric turbidity units (NTU), but it increases substantially following runoff from winter storms. In February 2004, turbidity in the NBA reached 150 NTUs. SCWA has found some success with pilot studies evaluating pretreatment with MIEX for its ability to help with turbidity removal or reduce coagulant dosage. The CCWD Bollman WTP has been able to handle turbidity with conventional treatment; however, CCWD is adding sedimentation basins to its Randall-Bold WTP to improve its capability in handling high turbidity events.

Synthetic Organics

Because of the influence of agricultural discharge and the potential for spills along shipping channels, the various agencies have had concerns regarding the potential for synthetic organic compounds (SOC), particularly pesticides and herbicides. Although most monitoring has not detected SOCs, both the Fairfield/Vacaville North Bay Regional WTP and the CCWD WTPs use granular activated carbon (GAC) as the filter media to handle periodic spills. Of the three agencies, Stockton may be the most vulnerable to SOCs due to proximity of the ship channel and San Joaquin River agricultural runoff.

Algae and Algal-Derived Byproducts

Although not currently regulated, algae and their byproducts can be a problem in Delta water supplies. A variety of algae, including diatoms and blue-greens, can be present; seasonal blooms are common in spring and summer. Since qualitative and quantitative analyses are time-related, Delta users typically face one to two algae blooms per year, with the most problematic during the high-demand periods in summer. Treatment techniques include copper sulfate application to kill algae in the canals and dissolved air flotation (DAF) to remove cells prior to filtration at the treatment plant. Taste and odor control options include oxidation using ozone, chlorine, or potassium permanganate or adsorption onto powdered activated carbon (PAC) in pretreatment or GAC filter media. Algal byproducts and their removal are not well understood.

Endocrine Disrupters, Pharmaceuticals, and Personal Care Products

These emerging contaminants are only in the initial stages of study. The Sonoma County Water Agency recently completed pilot tests of its recycled water and found that reverse osmosis membranes were highly effective in removing a wide variety of products.

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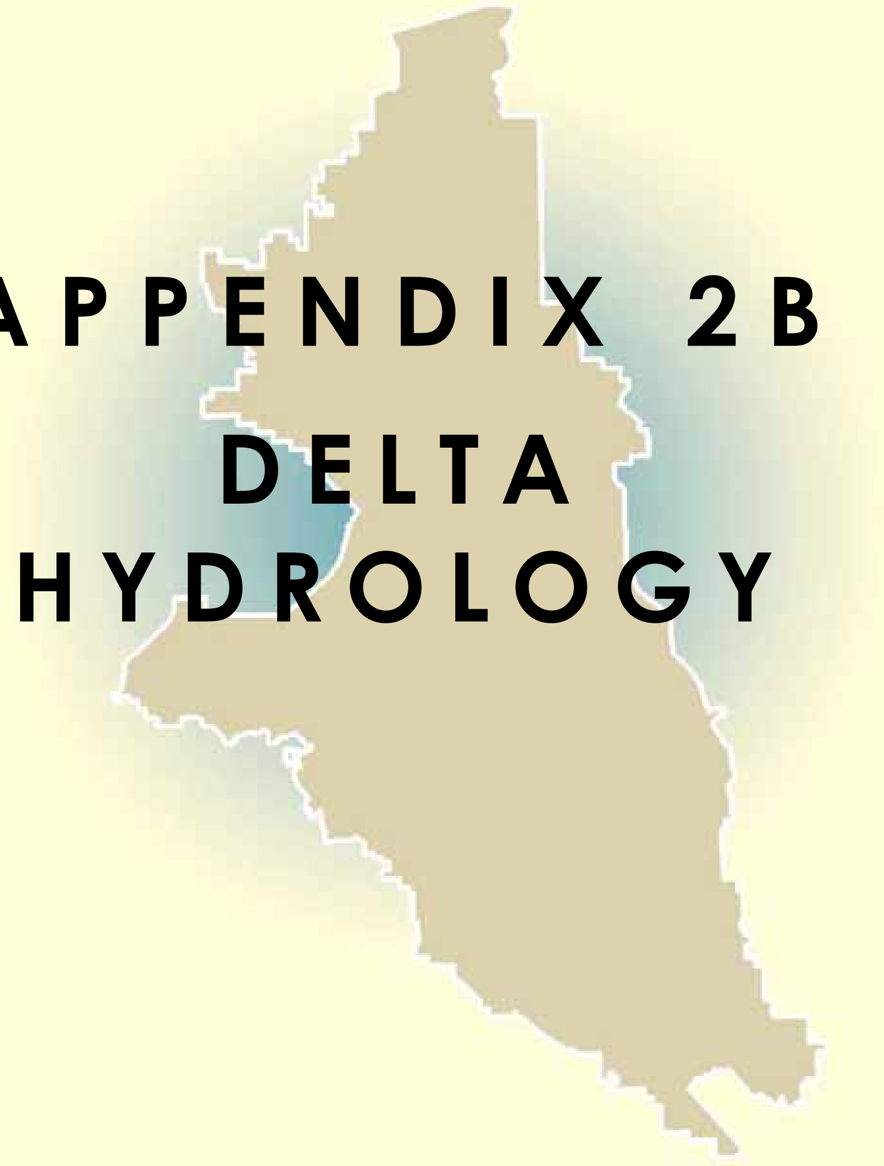
DELTA REGION

DRINKING WATER QUALITY MANAGEMENT PLAN



APPENDIX 2B

DELTA HYDROLOGY

APPENDIX 2B: DELTA HYDROLOGY

This appendix presents the complexity of Sacramento-San Joaquin Delta (Delta) hydrology, focusing on water balance, inflow and outflow management, Delta exports and diversions, tidal influences, and structural changes to the Delta system that impact water flow.

WATER BALANCE

The Delta water balance describes the relationship between freshwater and inflows and outflows. This relationship determines the quantity, timing, and quality of water available for export. Typically, tidal inflows and outflows, averaged over the approximately 14-day spring-neap cycle, are approximately equal. Tributary inflows, in-Delta consumptive use, and export and diversions are the other principal variables that determine Delta outflow and other flow conditions in the Delta and Suisun Bay. **Table 2B-1** presents annual water balances for the Delta for three recent years: 1998 - a wet year, 2000 – an above normal year, and 2001 – a dry year. Diversion patterns for the State Water Project (SWP), including the North Bay Aqueduct (NBA), Central Valley Project (CVP), and Contra Costa Water District (CCWD), provide one illustration of the users' corresponding Delta water use strategy. In wet years, CVP and SWP exports in the south Delta (Banks and Tracy pumping plants) and NBA diversions are less than or almost equal to average years. However, CCWD is likely to increase diversions in wet years, and take advantage of the additional higher quality Delta flows by diverting water to Los Vaqueros Reservoir. Historically, other project water users tend to rely more on local supplies in wet years, and avoid more costly water purchases. In the future, as water demands increase, it is likely that even in wet years, Delta demands will remain high as contractors require additional supplies.

Figure 2B-1 illustrates the Delta water balance for water year 2000. The Delta receives runoff from more than 40 percent of the state's land area. The three major sources of freshwater inflow are the Sacramento River, San Joaquin River, and eastside streams (Cosumnes River, Mokelumne River, and various tributaries, including the Calaveras River and Dry Creek). The Sacramento and San Joaquin rivers join at the western end of the Delta at Suisun Bay. The Sacramento River (including the Yolo Bypass) contributes about 77 to 85 percent of the freshwater inflow to the Delta, while the San Joaquin River contributes about l0 to 15 percent (**Figure 2B-2**). The main inflow clearly comes from the Sacramento River, which is controlled in large part by releases from the federal CVP reservoirs (Shasta and Folsom, and through water exported from the Trinity River system, Clair Engle), the SWP Oroville Reservoir, and Yuba County Water Agency's New Bullards Bar Reservoir. Minor flows from eastside streams contribute most of the remainder of Delta inflow. Approximately 10 percent of Delta inflow is withdrawn for local use, 30 percent is withdrawn for export by the CVP and SWP, 20 percent is required for salinity control, and the remaining 40 percent provides outflow to the San Francisco Bay ecosystem in excess of minimum identified requirements (CALFED, 2000).

Table 2B-1 Annual Water Balance for the Delta Region

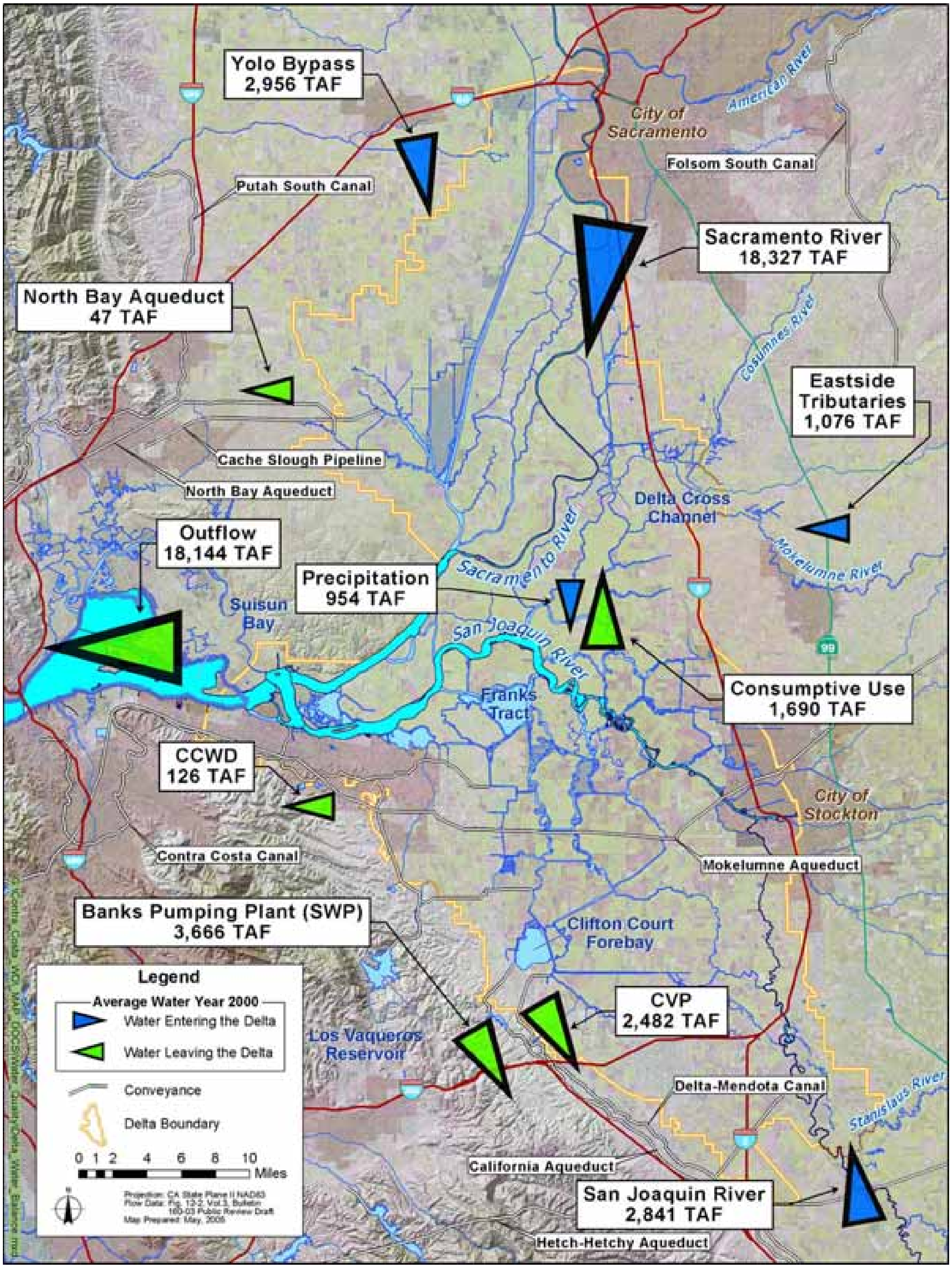
Water Year (Sacramento Valley 40-30-30 Index)	1998 (wet)		2000 (above normal)		2001 (dry)	
	(TAF/year)	(%)	(TAF/year)	(%)	(TAF/year)	(%)
Water Entering the Region						
Precipitation	1,421	2.8	954	3.6	762	5.6
Sacramento River	28,964	58.0	18,327	70.1	10,499	76.5
Yolo Bypass	8,980	18.0	2,956	11.3	366	2.7
San Joaquin River	8,441	16.9	2,841	10.9	1,729	12.6
Cosumnes River	785	1.6	372	1.4	116	0.8
Mokelumne River	969	1.9	360	1.4	127	0.9
Misc. Eastside Tributaries	339	0.7	344	1.3	128	0.9
Total	49,899	100.0	26,155	100.0	13,727	100.0
Water Leaving the Region						
Consumptive Use	1,688	3.4	1,690	6.5	1,688	12.3
SWP Exports						
Banks Pumping Plant	2,111	4.2	3,666	14.0	2,599	18.9
North Bay Aqueduct	39	0.1	47	0.2	45	0.3
CVP Exports	2,470	4.9	2,482	9.5	2,328	17.0
CCWD Diversions	160	0.3	126	0.5	104	0.8
Outflow to Bay/Ocean	43,430	87.0	18,144	69.4	6,963	50.7
TOTAL	**49,899**	**100**	**26,155**	**100**	**13,727**	**100**

Key:
CCWD = Contra Costa Water District
CVP = Central Valley Project
Misc. = miscellaneous
SWP = State Water Project
TAF/year = thousand acre-feet per year

Source: DWR, Bulletin 160-03 Public Review Draft, Table 12-2, Vol. 3.

DELTA INFLOW

Figure 2B-3 presents the monthly pattern of Delta inflow (Sacramento River, Yolo Bypass, San Joaquin River), Delta outflow, and CVP-SWP exports for water years 1956 to 2004. The figure indicates a high monthly variation in both inflows and outflows. Delta inflow and outflow typically peak in February, and at that time are approximately an order of magnitude greater than CVP-SWP exports. However, the pattern and volume of exports has changed significantly over the last 40 years. Delta inflow and outflow typically fall to a minimum during the August to September period. This late summer period of August and September indicates the likely precarious balance between inflows, outflows, and exports. As exports are typically about 40 percent of inflow during this period, the likelihood of lower quality water at Delta municipal and industrial (M&I) intakes is greater because less outflow is available to dilute salinity and control seawater intrusion.



Source: DWR, Bulletin 160-03 Public Review Draft, Vol. 3, Figure 12-2.

Figure 2B-1 Delta Water Balance, Water Year 2000

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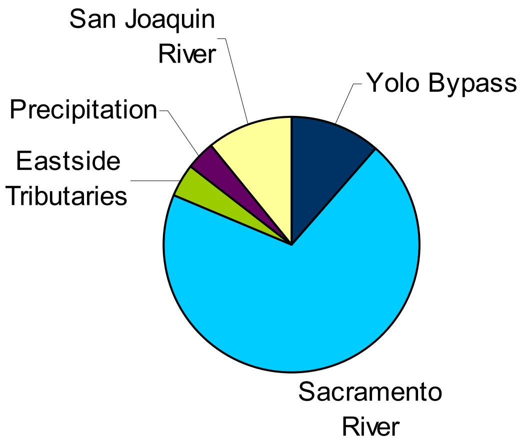

Figure 2B-2 Relative Share of Delta Inflows by Average Year Source

The combined inflow from the Sacramento River and Yolo Bypass accounts for over 80 percent of the total Delta inflow.

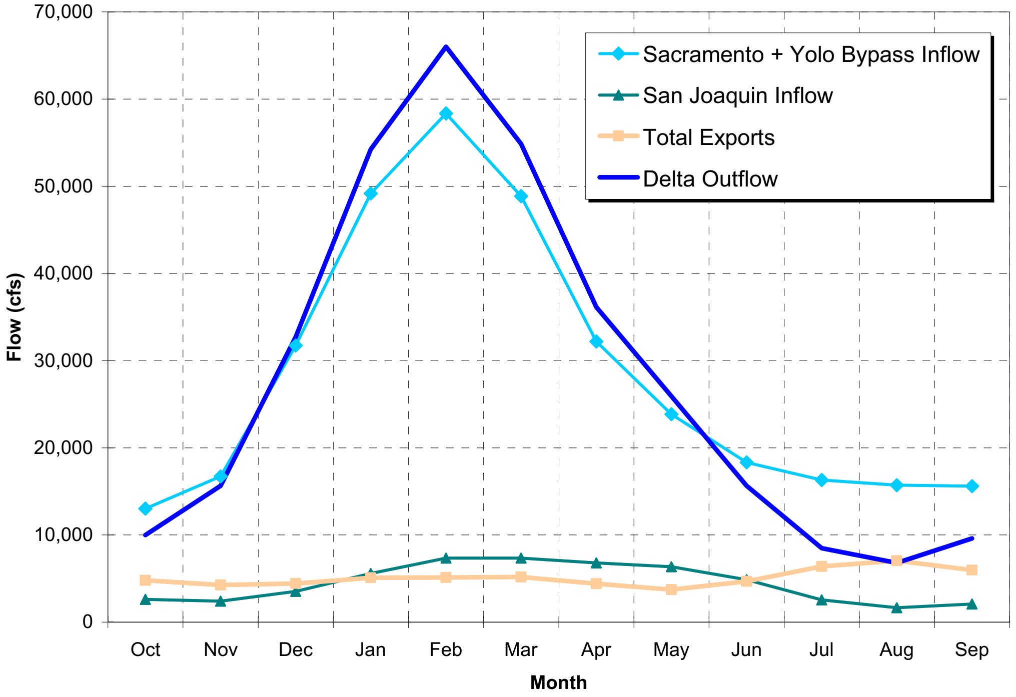

Figure 2B-3 Average Monthly Inflows, Outflows, and Exports for Water Years 1956 to 2004

In the winter and spring months, freshwater inflow is an order of magnitude greater than combined CVP-SWP exports. However, from August-September, when the inflow reaches a minimum, exports are about 40 percent of the total inflow.

Figure 2B-4 further highlights the impact of wet to dry water years on Delta inflows. Low inflow years mean less water not only to divert for CVP and SWP project users, but that less water is available for managing Delta water quality conditions.

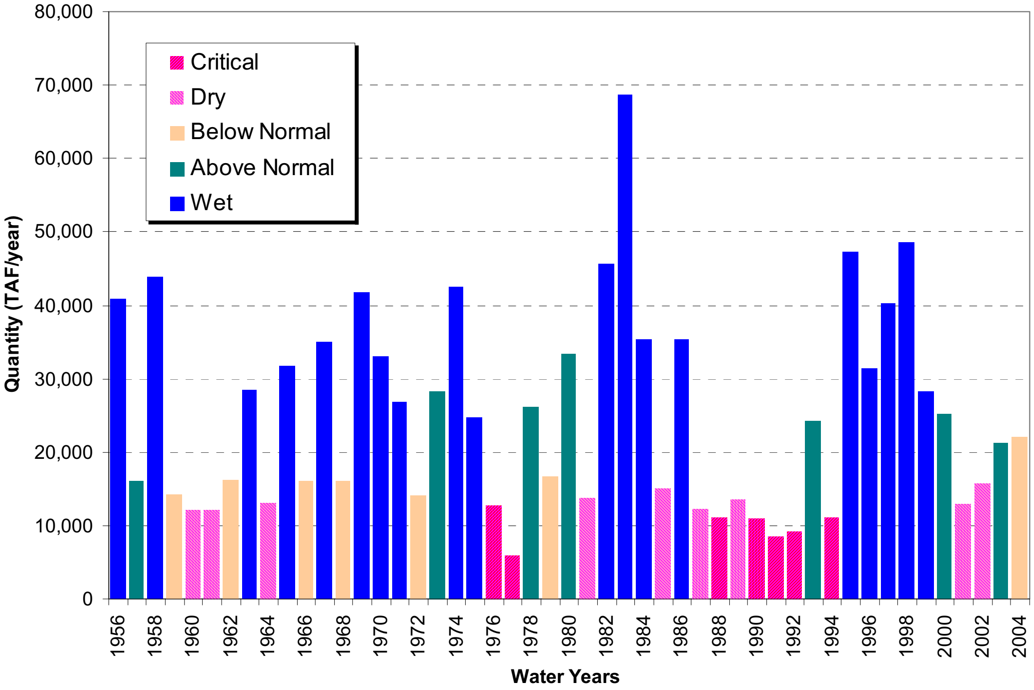

Figure 2B-4 Annual Delta Inflows for Water Years 1956 to 2004

This historical record shows great variation in Delta inflow between extremely dry years and very wet years.

Figure 2B-5 shows daily inflow from the combined Sacramento River and Yolo Bypass and the San Joaquin River in the form of a cumulative probability. The figure indicates that San Joaquin flows are low most of the time (below 5,000 cubic feet per second (cfs) 80 percent of the time, and above 15,000 cfs only 7 percent of the time). The Sacramento River, however, is above 15,000 cfs 57 percent of the time.

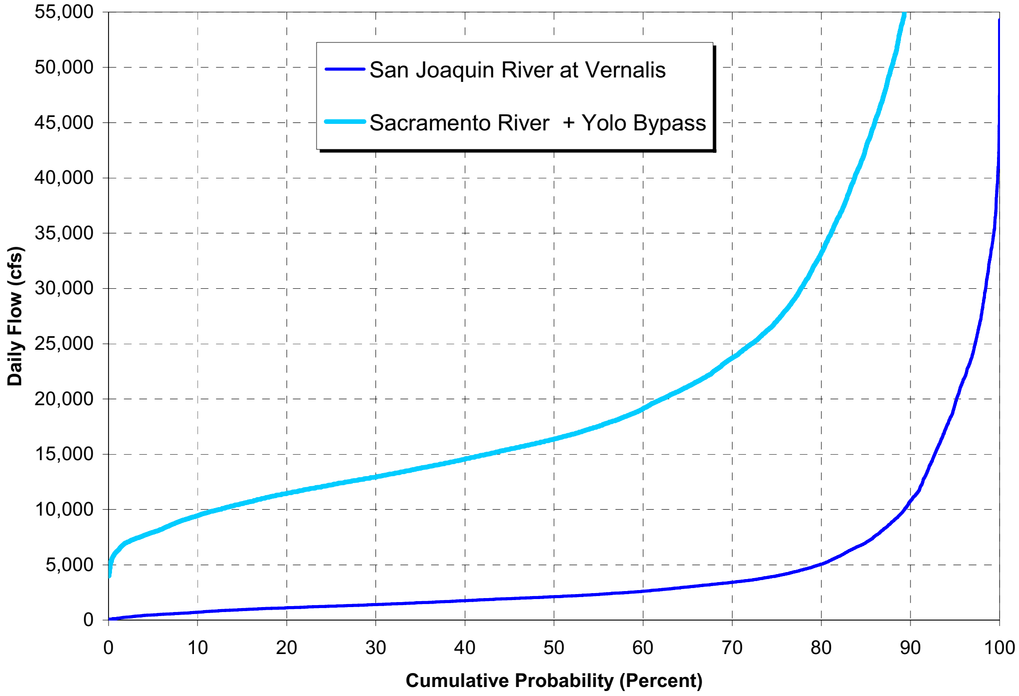

Figure 2B-5 Probability of Daily Flow Rates, Sacramento and San Joaquin Rivers

San Joaquin River inflow is below 5,000 cfs for 80 percent of the time. In contrast, the combined inflow from the Sacramento River and Yolo Bypass is above 15,000 cfs 50 percent of the time.

Figure 2B-6 shows seasonal, or quarterly, patterns of Delta inflow.[1] The largest inflows occur in the winter period. Operation of the upstream CVP and SWP reservoirs has resulted in a general increase in Delta inflows in the summer period, although that increase in inflow has not necessarily resulted in improved Delta water quality because Delta exports and diversions also have increased.

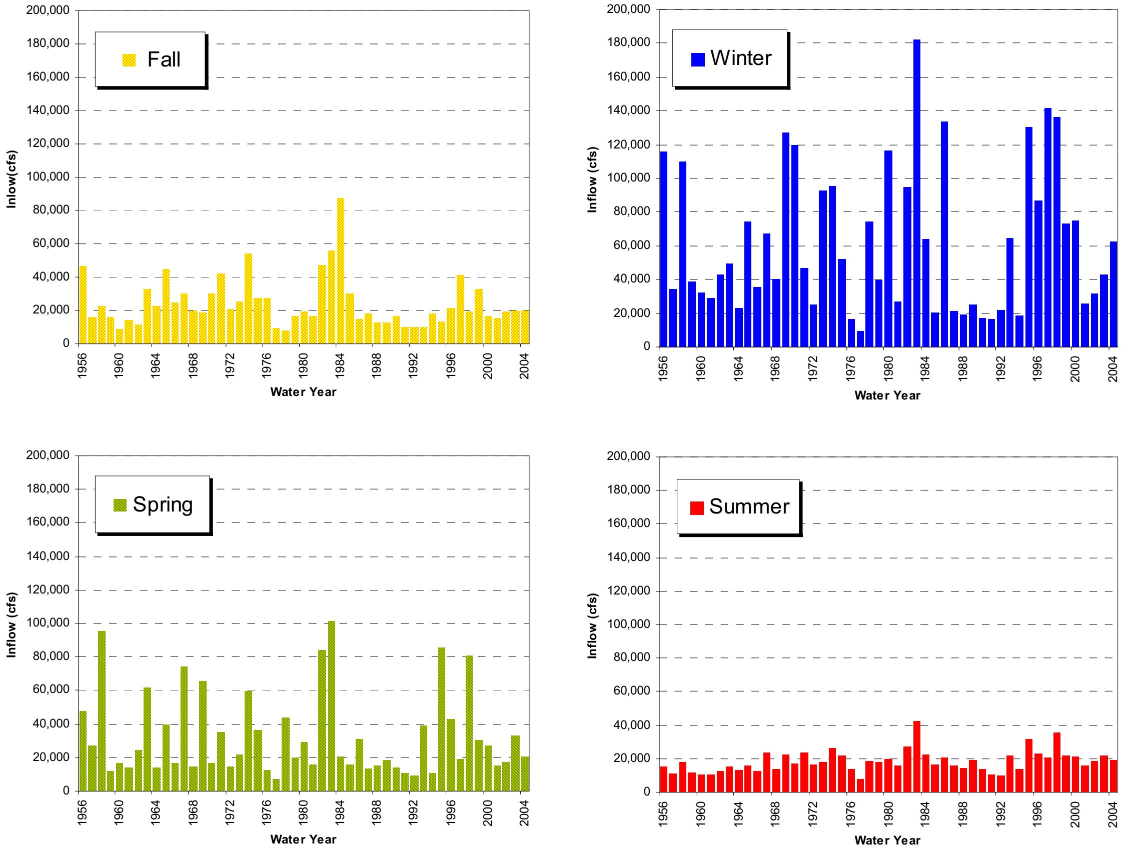

Figure 2B-6 Seasonal Delta Inflow, Water Years 1956 to 2004

The winter and spring months are periods of high runoff and high Delta inflow, and show considerable variation from year to year. In contrast, the summer and fall are months of low inflow. The majority of inflow during the summer and fall is from upstream releases from storage, and shows comparatively little variation from year to year.

Specific Inflow Patterns and Influences

The two primary influences on Delta inflow water availability are the Sacramento and San Joaquin rivers. The flow pattern of each of these rivers is described in greater detail below.

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[1] For purposes of illustrating the variation in flow and water quality conditions during the year, the data will be presented as 3-month (quarterly) averages. For simplicity, the period January-March will be referenced as winter, April-June as spring, July-September as summer, and October-December as fall.

Sacramento River

The Sacramento River enters the Delta at Freeport, where the river's average annual flow is 16 million acre-feet (MAF). The maximum monthly discharge of 87,110 cfs occurred in January 1997, and the minimum monthly discharge of 4,494 cfs occurred in October 1977 (DAYFLOW data). Most flood flows that come from the upper Sacramento River, Feather River, and Sutter Bypass are diverted west of Freeport and the Sacramento area into the Yolo Bypass through the Fremont Weir at Verona.

Figure 2B-7 shows the combined Sacramento River at Freeport and Yolo Bypass flow for each quarter for the recent 10-year period of 1995 to 2004. This inflow pattern underscores the water quality management challenge in the Delta. The summer is the highest water demand period, and is also the period of lowest Delta inflow. The fall has become a period of greater pumping because of environmental restrictions limiting pumping during the higher volume spring-flow periods.

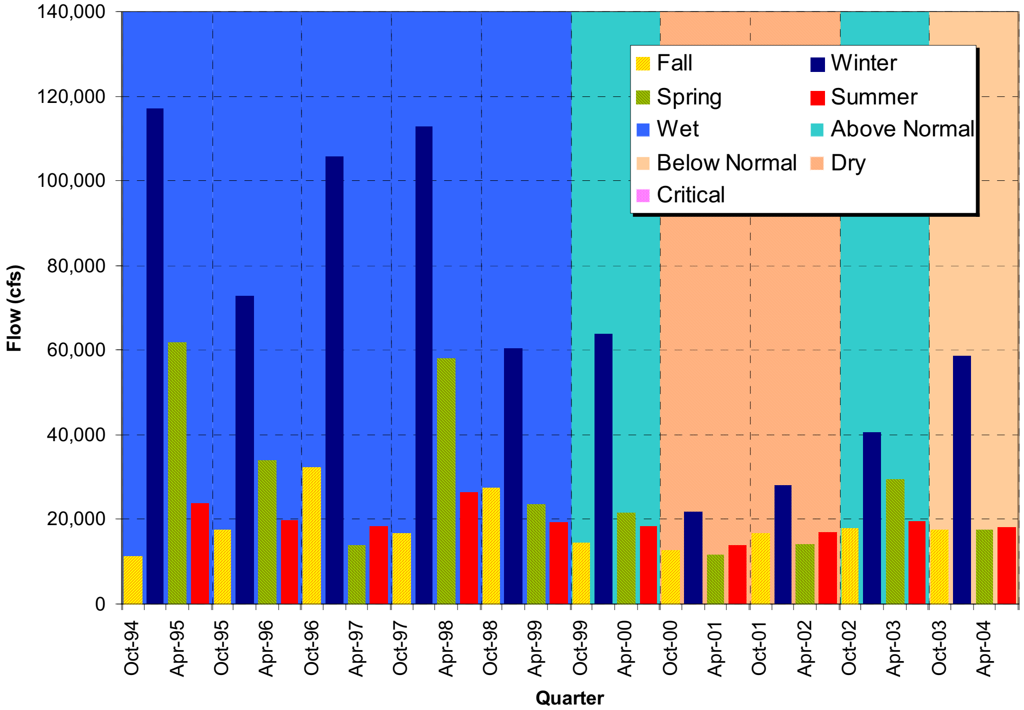

Figure 2B-7 Combined Sacramento River and Yolo Bypass Seasonal Delta Inflow, Water Years 1995 to 2004

Delta inflow during the summer and fall is relatively constant. In contrast, a large year-to-year variation is observed in the winetr and spring.

Figure 2B-8 shows the variation in monthly inflow from the Sacramento River at Freeport and Yolo Bypass, comparing average monthly flow (1956 to 2004) to monthly flow in 1977 (critical year) and 1983 (wet year). Flows typically peak between February to March, with a maximum average monthly flow of 58,000 cfs, and fall to a minimum in September, with a minimum average monthly flow of about 15,000 cfs.

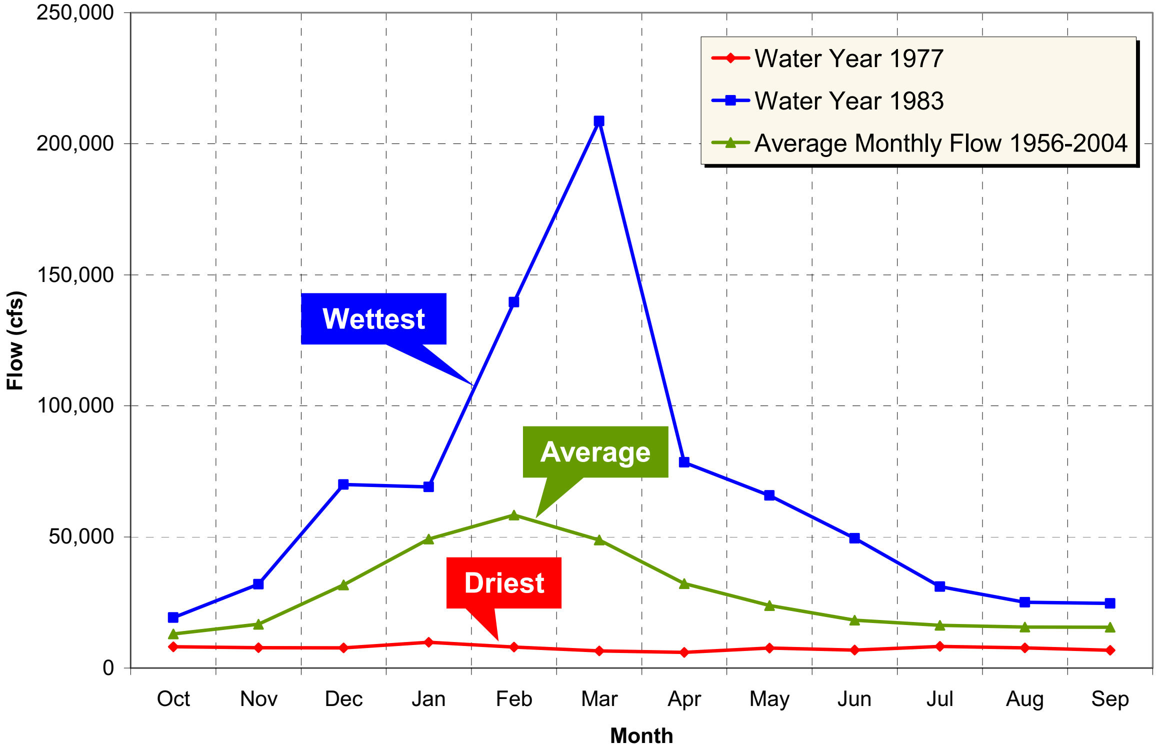

Figure 2B-8 Variation in Average Monthly Sacramento River Delta Inflow

This figure shows the extremes of hydrologic variation for the Sacramento River.

Major reservoirs on upstream tributaries dramatically alter runoff or "unimpaired" flow in the rivers. **Figure 2B-9** shows the estimated unimpaired flow that might have occurred in the Sacramento River near Shasta from January 2003 through the start of April 2005 if the dam were not present. The spikes in unimpaired flow represent large storm runoff events. In February 2004, the estimated unimpaired flow would have peaked at an estimated 117,000 cfs. However, because stormwater runoff was captured in Shasta Reservoir, actual maximum outflow from Shasta Dam was 50,000 cfs. In 2004 and 2005, the flow below the dam in May through September was larger than would otherwise have been present in the river because of releases to meet the State Water Quality Control Board's (SWRCB) Water Quality Control Plan (WQCP) and fisheries requirements.

Figure 2B-10 shows the corresponding variation in Shasta Lake volume. From October 1 through mid-June of each year, the maximum allowable conservation storage in Shasta Lake is influenced by a series of operational rules to ensure that sufficient storage remains for flood control. This storage is necessary to control releases from Shasta to a maximum of 79,000 cfs for the 100-year storm event. As shown in **Figure 2B-10**, in February 2004, the volume in Shasta began to encroach into the allowable flood control reservation (maximum conservation storage level) and increased releases (50,000 cfs) had to be made to evacuate the reservoir to regain the flood control reservation. Normal winter and spring releases from Shasta Dam and other reservoirs in the Sacramento River watershed for flood control, including the above type of relatively rare flood control release, help improve Delta water quality above that which would otherwise have been required by the SWRCB's Bay-Delta standards.

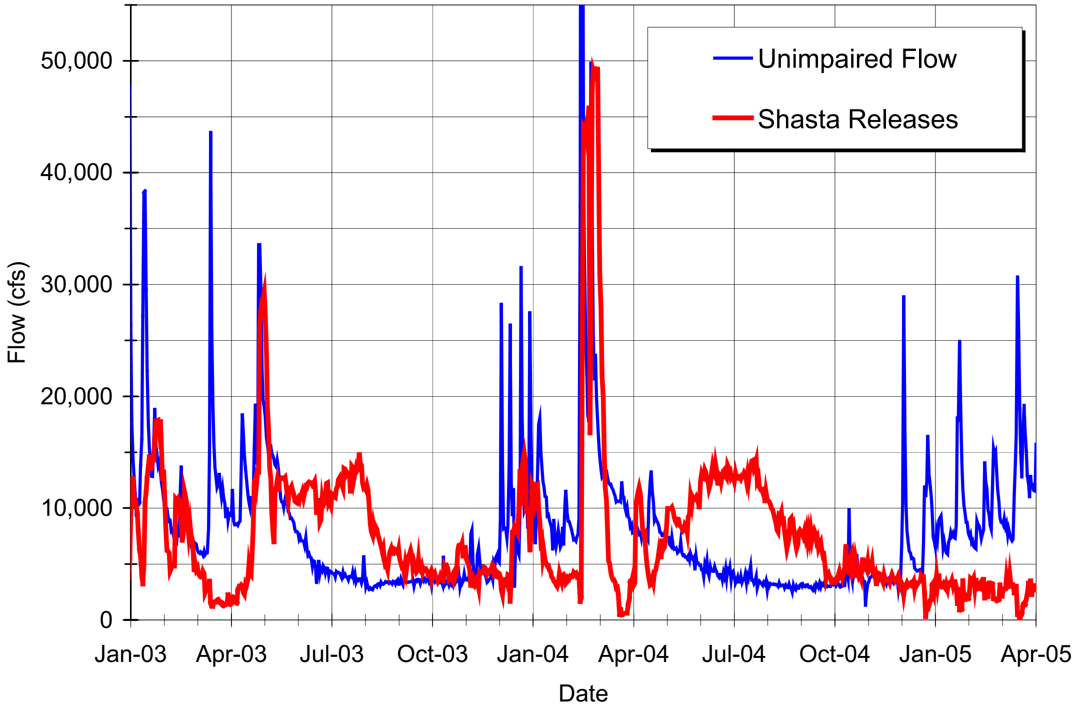

Figure 2B-9 Comparison of Actual Flow in Sacramento River Below Shasta (2003-2005) and Flow that Might Have Occurred if There Were No Dam

This figure illustrates the seasonal effects of upstream dams on tributary flows and Delta outflow.

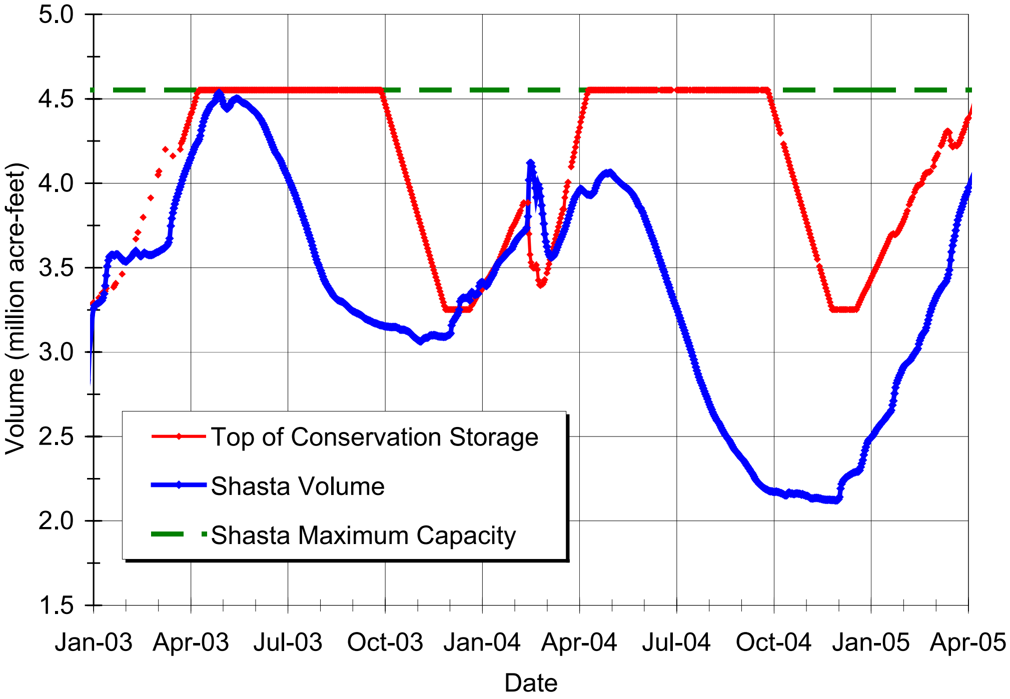

Figure 2B-10 Variation in Shasta Reservoir Volume from 2003 to April 2005

The figure illustrates the corresponding seasonal variation of reservoir storage and how limitations on storage for flood protection affect reservoir releases and Delta inflow.

San Joaquin River

Most of the inflow to the San Joaquin River region originates from the upper watershed on the west slope of the Sierra Nevada. Inflows from the Merced, Tuolumne, and Stanislaus rivers historically contribute over 60 percent of the flows in the San Joaquin River, as measured at Vernalis. Vernalis lies just inside the boundary of the Delta, and is widely used as a monitoring point for Delta inflows and standards. The United States Geological Survey (USGS) has operated a gaging station on the San Joaquin River near Vernalis since 1922. Flows from the San Joaquin River into the Delta are considerably lower than those from the Sacramento River. An average of about 3.0 MAF annually reaches Vernalis and contributes to Delta inflows (CALFED, 2000). The maximum monthly discharge was 40,040 cfs in March 1983, and the minimum monthly discharge was 93 cfs in July 1977 (DAYFLOW data).

Figure 2B-11 shows the San Joaquin River flow at Vernalis for each quarter for the recent 10-year period of 1995 to 2004. **Figure 2B-12** shows the variation in monthly inflow, comparing average monthly flow (1956 to 2004) to monthly flow in 1977 (critical year) and 1983 (wet year). Flows typically peak in March and fall to a minimum in August.

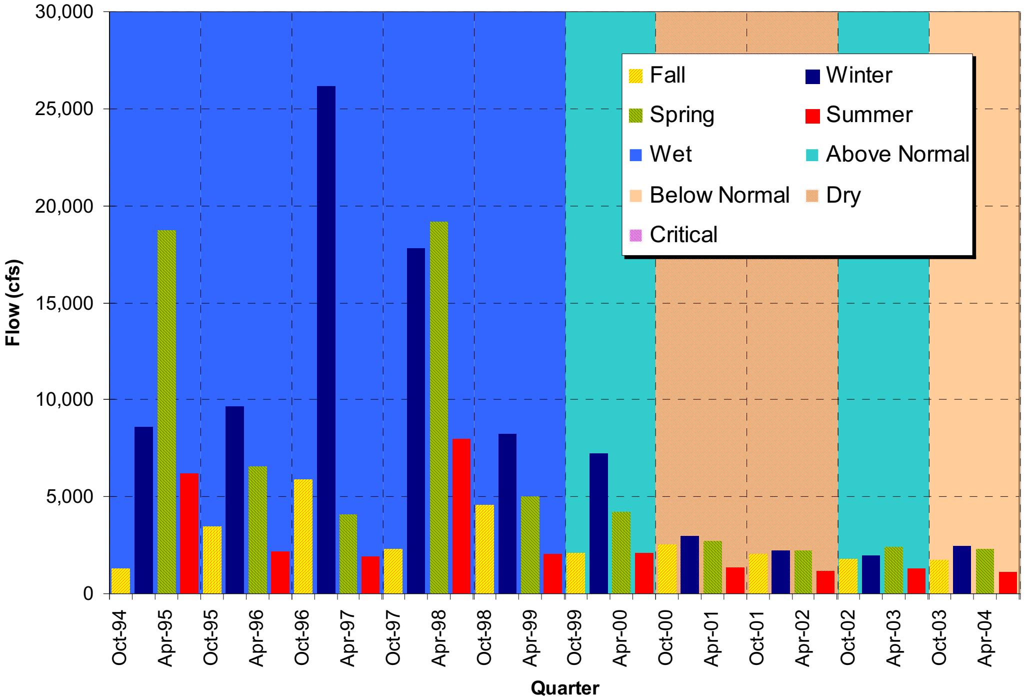

Figure 2B-11 San Joaquin River Seasonal Flow Measured at Vernalis

Inflows to the Delta affect Delta water quality. San Joaquin River inflow in the summer and fall shows comparatively little year-to-year variation, while winter and spring inflows vary considerably.

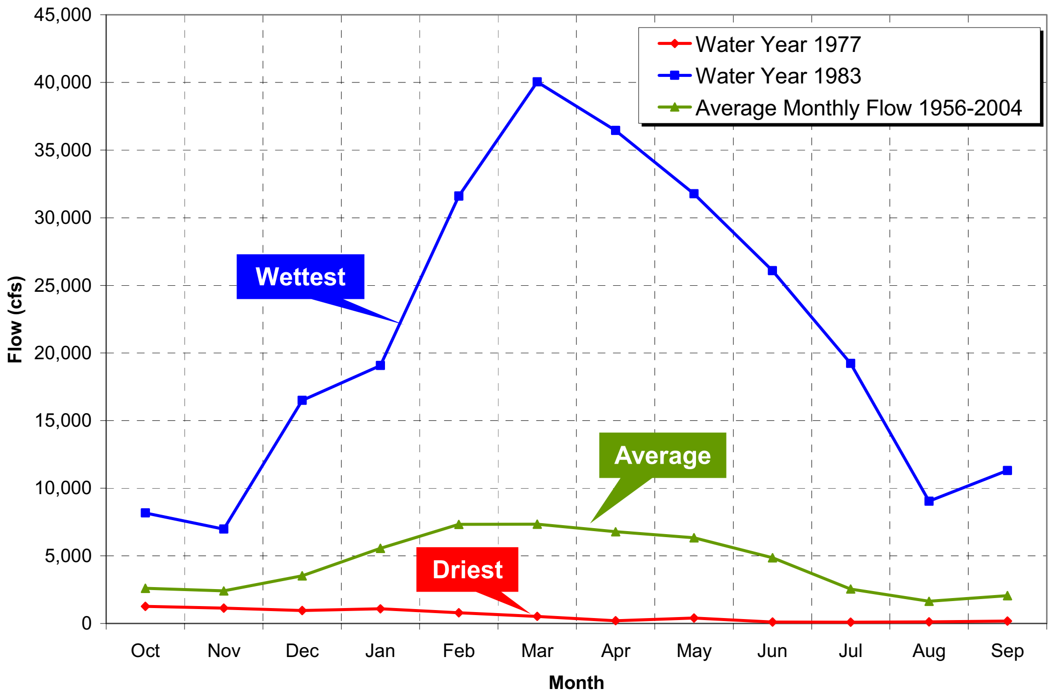

Figure 2B-12 Variation in Average Monthly San Joaquin River Flow

This figure shows the extremes of hydrologic variation for the San Joaquin River.

Agricultural runoff, especially from the west side of the valley, has severely degraded water quality in the San Joaquin River. SWRCB requires that water quality at Vernalis not exceed 700 microSiemens (µS/cm) (about 300 micrograms per liter (µg/L) bromide and 93 milligrams per liter (mg/L) chloride) from April through August each year and not exceed 1,000 µS/cm (about 450 µg/L bromide and 138 mg/L chloride) from September through March. Increased pulse flows are required for 31 days during April to May and for 28 days in October to provide improved conditions for fish passage.

The San Joaquin River Group Authority (SJRGA) was formed in the 1990s in response to the SWRCB 1995 WQCP. The SJRGA worked with other agencies to develop the Vernalis Adaptive Management Plan (VAMP) as a 10-year test program designed to study methods to improve salmon smolt survival in the lower San Joaquin River. Starting in 2000, VAMP has resulted in release of water from upstream San Joaquin reservoirs each spring to generate a calculated pulse flow in the San Joaquin River at Vernalis to help salmon smolts migrate to San Francisco Bay and the ocean. The timing and duration of this pulse flow is coordinated with reduced CVP and SWP Delta export pumping to improve Delta flow patterns that will guide the salmon smolts to the ocean.

The current trend in the San Joaquin Valley of agricultural land conversion to subdivisions is likely to continue. Urban expansion and urban water usage are expected to increase in the future, while agricultural water use is projected to decline slightly. Water demand from urban growth will be met by an expansion of groundwater pumping, and diversion of agricultural water supplies to urban use. The resulting impact on the San Joaquin River flow at Vernalis is difficult to predict.

The San Joaquin River Salinity Management Plan is being developed as part of the Delta Improvements Package. In addition to source control actions such as a coordinated agricultural and managed wetlands drainage strategy, and salt load management and reduction activities, the plan includes recirculation of Delta exports using excess conveyance capacity for subsequent release into the San Joaquin River. This recirculation can enhance the flow in the San Joaquin River and improve salinities at Vernalis.

DELTA OUTFLOW

Delta outflow, inflow that is not exported or diverted, is the primary factor controlling water quality in the Delta. When Delta outflow is low, seawater is able to intrude further into the Delta, impacting water quality at drinking water intakes. SWRCB uses a flow mass-balance approach in setting standards for Delta outflow. The Net Delta Outflow Index (NDOI), calculated by DWR is a measure of the net freshwater flow of water from the Delta into San Francisco Bay. The NDOI is derived from a water balance that considers river inflows, precipitation, agricultural consumptive demand, and project exports. The NDOI does not take into account the semi-diurnal tidal cycle, nor the net filling and draining of the Delta every 14 days as a result of the spring-neap tidal cycle. NDOI also relies on an imprecise estimate of Delta consumptive use.

Figure 2B-13 shows the calculated annual NDOI for water years 1956 to 2004. While it is difficult to identify long-term Delta outflow trends, the figure underscores the impact of hydrologic variability on Delta water management.

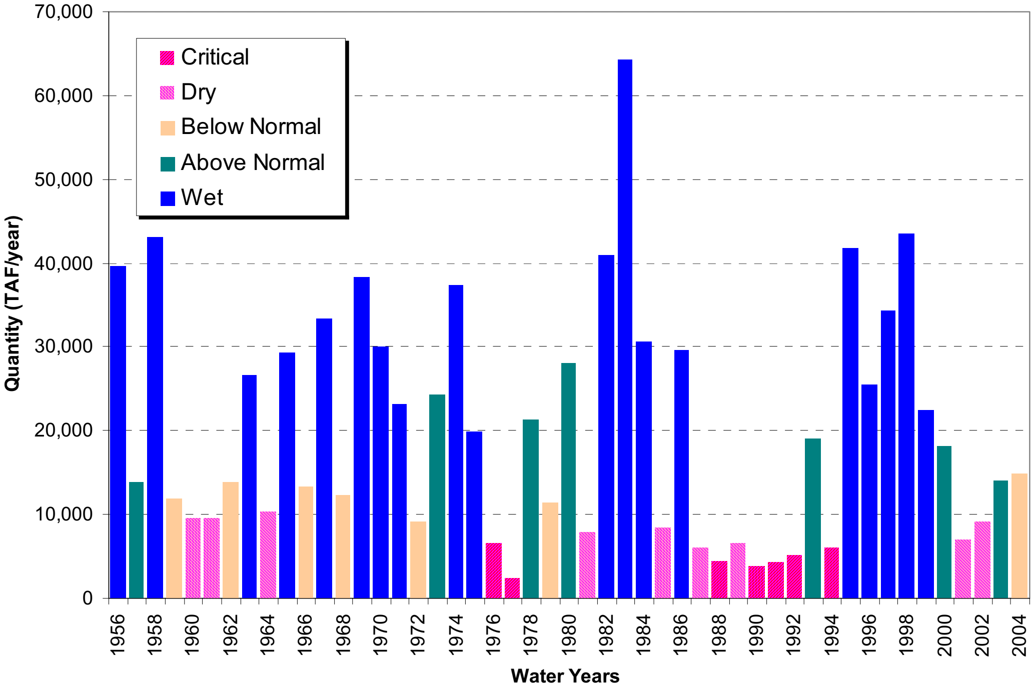

Figure 2B-13 Annual Net Delta Outflow Index, Water Years 1956 to 2004

Hydrology is highly variable, resulting in a wide range of water quality in the Delta.

Figure 2B-14 shows the NDOI for each quarter for the recent 10-year period of 1995 to 2004. While for a shorter duration, this figure emphasizes not only annual hydrologic impacts on outflows, but also seasonal outflow variation.

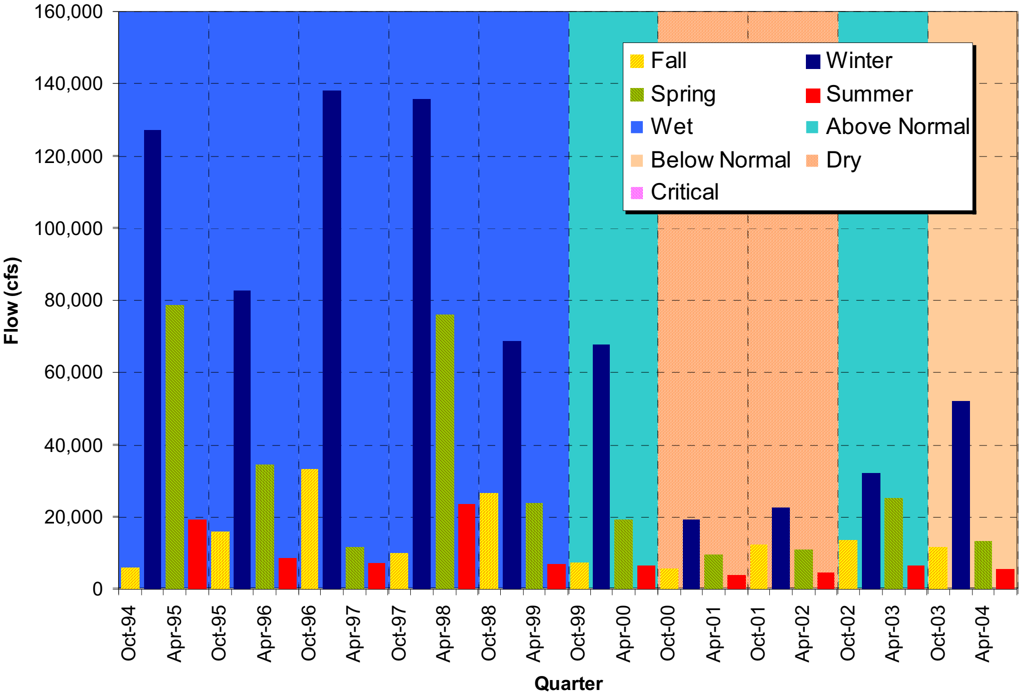

Figure 2B-14 Seasonal Net Delta Outflow Index, Water Years 1995 to 2004

Seasonal outflow is highly variable, with large winter outflows and very low outflows in late summer and early fall.

Figure 2B-15 presents the monthly pattern of the NDOI based on the period 1956 to 2004. Excess flow conditions, when Delta outflow exceeds that required to meet Delta standards, typically occurs from December through May. However, considerable variation occurs in the length of this period. Based on model study results (CALSIM-II), excess conditions can last from zero to 12 months. Delta outflow during balanced conditions is controlled by SWRCB water quality control standards that have changed and become more restrictive with time. **Figure 2B-15** shows the monthly outflow pattern for four periods, representing four different regulatory regimes:

- 1956 – 1967, pre-SWP deliveries
- 1968 – 1978, pre-Water Rights Decision 1485 (D-1485)
- 1979 – 1995, pre-Bay-Delta Accord, pre-1995 Water Quality Control Plan (WQCP)
- 1996 – to 2004, post-Bay-Delta Accord

Figure 2B-15 shows the effect of the 1995 WQCP estuarine habitat (X2) requirements, which increased Delta outflows from February through June, reducing salinity intrusion into the central and south Delta. However, a corresponding decrease has occurred in the amount of water made available for Delta outflow in the fall, which increases salinities in the central and south Delta during those months.

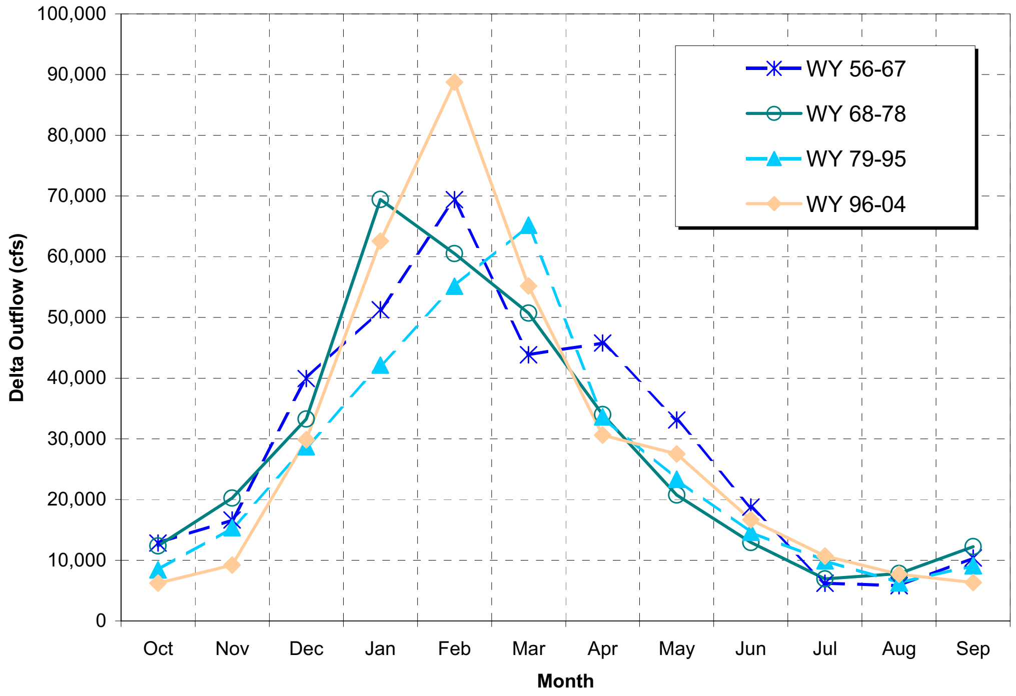

Figure 2B-15 Average Monthly Net Delta Outflow Index, Water Years 1956 to 2004

The Net Delta Outflow Index is now generally higher in February-June because of the SWRCB, WQCP X2 requirements, but lower in the fall.

DELTA EXPORTS AND DIVERSIONS

During times when more Delta outflow is available than is needed to meet Delta water quality standards (excess conditions), Delta exports reduce Delta outflow and can cause degradation in water quality. When no excess outflow exists, Delta exports can still change flow patterns in the Delta and increase salinities at Delta intakes.

Principal exports from the Delta are at Tracy Pumping Plant (CVP), and Banks Pumping Plant (SWP). CCWD diverts CVP water and water under its own water rights from the Delta from pumping plants at Rock Slough and Old River, and from Mallard Slough in Suisun Bay. SCWA diverts SWP water from the Delta at Barker Slough at the NBA intake. The City of Stockton does not currently divert from the Delta.

Figure 2B-16 shows the annual CVP-SWP exports at the Tracy and Banks pumping plants for water years 1956 to 2004. SWP exports have continued to increase whereas CVP exports reached a maximum based on pumping capacity and then decreased slightly because of fishery constraints. **Figure 2B-17** shows CVP-SWP exports for each quarter for the recent 10-year period of 1995 to 2004.

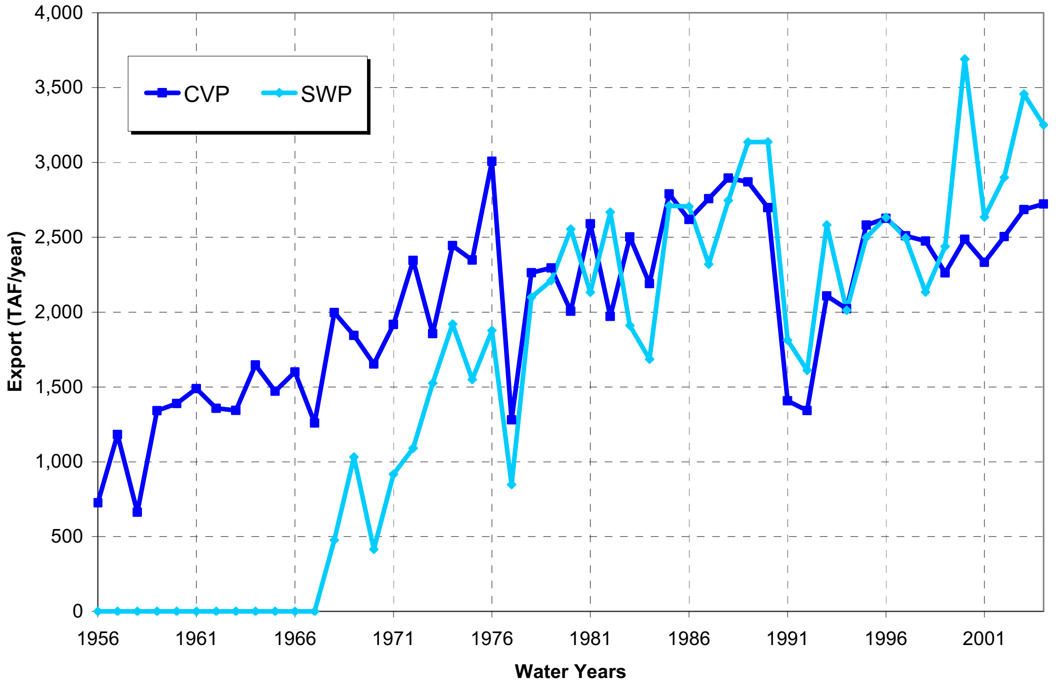

Figure 2B-16 CVP and SWP Annual Delta Exports, Water Years 1956 to 2004

Annual SWP exports, which began in 1968, are now greater than CVP exports. Exports will increase further if Banks Pumping Plant is permitted to increase its capacity to 8,500 cfs and a CVP-SWP intertie is implemented.

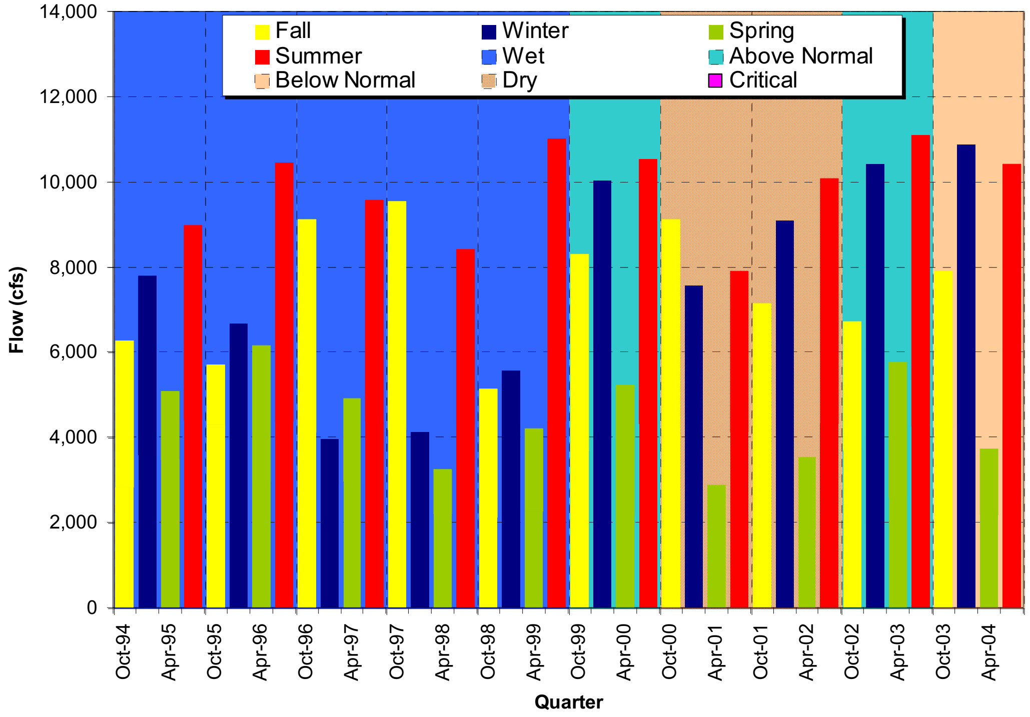

Figure 2B-17 Seasonal Pattern of Total Delta Exports, Water Years 1995 to 2004

These historical data demonstrate that the highest exports occur in the late summer and fall, while the lowest exports occur during April and June when fish protection limits are in place.

Tracy Pumping Plant (CVP)

The Tracy Pumping Plant, located in the south Delta about 5 miles northwest of the City of Tracy, has a pumping capacity of 4,600 cfs. Water exported at the Tracy pumps is conveyed via the Delta-Mendota Canal (DMC) to M&I and agricultural contractors in the San Joaquin Valley and in Santa Clara and San Benito counties. Water from the DMC also is pumped into San Luis Reservoir, a joint state and federal facility, where the water commingles with SWP water exported at Banks Pumping Plant. Tracy water also is transported with SWP water in the joint reach of the California Aqueduct south of Los Banos. Degradation of water quality at Tracy, therefore, also impacts drinking water quality for SWP urban contractors in Southern California.

When the water supply is available and exports are not limited by standards, the Tracy Pumping Plant is operated continuously at the DMC capacity limits. However, Tracy exports are typically reduced during the spring to meet endangered fish requirements. For example, during VAMP operations, typically April 15 through May 15, Tracy exports have been reduced to only 750 cfs in recent years.

Delta-Mendota Canal – California Aqueduct Intertie

The United States Department of the Interior, Bureau of Reclamation (Reclamation) and the San Luis Delta Mendota Water Authority recently released environmental documentation for a 400 cfs intertie between the DMC and California Aqueduct. During the winter non-irrigation season, when low irrigation demands exist in the upper reaches of the DMC, only about 4,200 cfs can be conveyed in the DMC upstream from the O'Neill Forebay and San Luis Reservoir. The intertie connection would allow Reclamation to use the full Tracy export pumping capacity year-round. Reclamation also is considering a future expansion of the intertie to 900 cfs to allow Tracy pumping capacity to be increased to 5,100 cfs. This additional pumping, and corresponding decrease in Delta outflow, could contribute to further degradation in Delta water quality.

California Aqueduct and
Delta Mendota Canal

Note that although high exports can result in additional seawater intrusion (the so-called "carriage water" effect), very low exports also can result in water quality degradation in the south Delta. During normal export conditions, Tracy pumping effectively re-exports agricultural runoff from the San Joaquin River and local south Delta drainage. When Tracy exports are only 750 cfs, this drainage builds up.

Reclamation estimates that for a 2020 level of development, without intertie improvements, CVP total exports from the Delta (including wheeling through the SWP Banks Pumping Plant) will range from 1.24 MAF/year to 2.98 MAF/year depending on hydrologic conditions. The average export will be 2.39 MAF/year. This compares with a demand equal to the full contract entitlement of 3.32 MAF/year.

Banks Pumping Plant (SWP)

The SWP Banks Pumping Plant supplies water for the South Bay Aqueduct (SBA) and the California Aqueduct. The pumping plant has an installed capacity of 10,300 cfs. However, under current operational constraints, exports from Banks Pumping Plant are generally limited to a maximum of 6,680 cfs, except between December 15 and March 15, when exports can be increased by 33 percent of San Joaquin River flow at Vernalis (if greater than 1,000 cfs). Flows into Clifton Court Forebay, which is the regulating reservoir for the Banks Pumping Plant, are controlled by two radial gates, which are generally operated according to the tidal cycle to reduce approach velocities, limit scour, and reduce water level fluctuations in the south Delta. Timing of gate operations has a major effect on the mix of San Joaquin and Sacramento river water and seawater exported at Banks (Montoya, 2004). DWR also is considering adjusting Clifton Court gate operations as part of the South Delta Improvements Program to improve the efficiency of the operable agricultural barriers.

The first SWP deliveries were made in 1967 to Alameda County via the SBA. Deliveries to the Tulare Basin commenced in 1968, and the first deliveries to Southern California were made in 1972. SWP contracts total 4.172 MAF (Table A), of which only 0.398 MAF is for service areas north of the Delta. In recent years, SWP contractors have requested 100 percent of their Table A contract amounts each year. From 1972 and 1998, Table A deliveries averaged 1.79 MAF, although deliveries during the 1976-1977 and 1987-1992 droughts were significantly less. In 1991, the SWP stopped deliveries to agricultural contractors and allocated only 30 percent of requested urban deliveries. SWP future deliveries will be primarily constrained by water supply, a shortage of reservoir storage, and the permitted capacity of Banks Pumping Plant. In 2002, DWR estimated that the future delivery capacity of the SWP from the Delta, based on full Table A demands at a 2020 level of development, ranged from 0.83 MAF/year to 4.13 MAF/year depending on hydrologic conditions. The median delivery is estimated to be 3.43 MAF/year. Actual average Table A delivery between 1975 and 1998 was 1.79 MAF/year. Projects and programs being considered to enhance the water supply reliability of the SWP are discussed under the section on the Delta Improvement Package.

South-of-Delta Exports

The CVP and SWP have joint responsibility to meet various Delta water quality control standards established by SWRCB. Four periods approximately define the different standards to which the projects have operated, described as follows:

- 1956 – 1967, pre-SWP deliveries
- 1968 – 1978, pre-Water Rights D-1485
- 1979 – 1995, pre-Bay-Delta Accord, pre-1995 WQCP
- 1996 – to date, post-Bay-Delta Accord

Figure 2B-18 shows the pattern of monthly diversions for these four defined periods. In general, the pattern of diversions since the Bay-Delta Accord is very different – less exports in the spring to protect fish, and more exports in the fall.

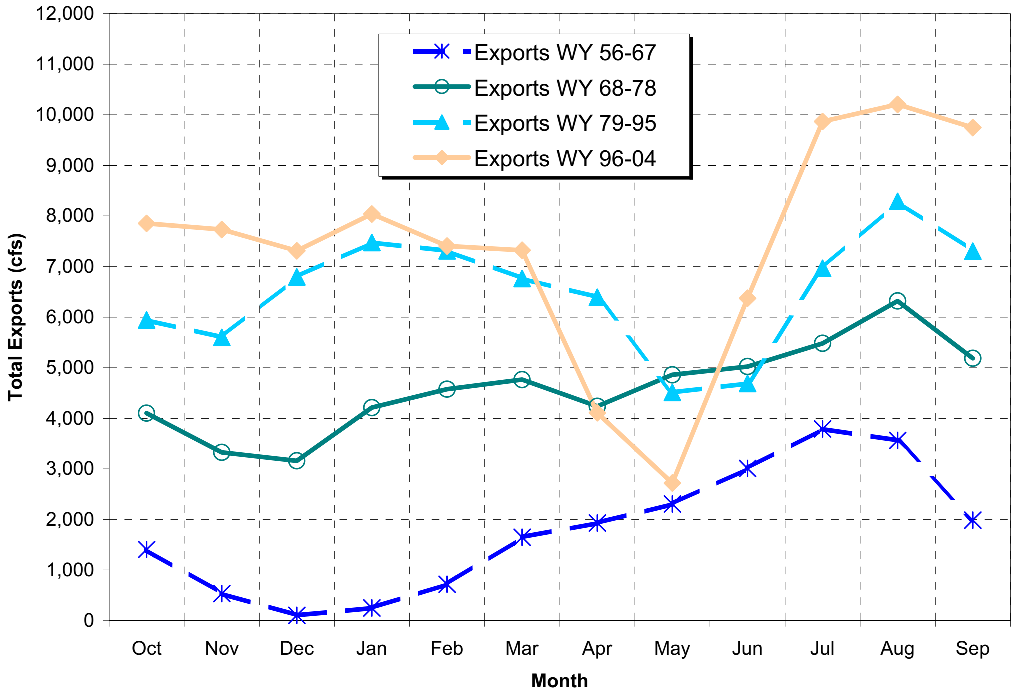

Figure 2B-18 Monthly Variation in Delta Exports, Water Years 1956 to 2004

As a result of increasing Delta region water regulation, a dramatic shift has occurred away from export pumping from April-June when Delta water quality is typically good, to the summer and fall. Delta water quality is typically poorest in the fall.

The 1995 WQCP introduced new export limits for the CVP and SWP in the form of an export to inflow (E/I) ratio, primarily to protect anadromous and resident fish species. The 1995 WQCP specifies an E/I ratio of 0.65 from July to January, and a value of 0.35 from March to June. In February, the E/I standard varies between 0.35 to 0.45 depending on hydrologic conditions. The E/I ratio also is indicative of flow conditions in the Delta.

DELTA CONSUMPTIVE USE

Delta farmers divert water directly from Delta channels for irrigation and leaching (the application of additional irrigation water to flush salts from the root zone). These diversions reduce Delta outflow, which can increase seawater intrusion. Return flows discharged back into the Delta from Delta farms (and from urban agencies) also can contribute to higher concentrations of bromide, salinity, and organic carbon in the Delta. There are about 1,800 agricultural diversions occur in the Delta. The volume of water diverted each year for in-Delta farming uses is significant, but has not changed much over the years. Agricultural applied water demand for an irrigated area of 425,700[2] acres is about 1,316,000 AF/year (DWR, 2004). Taking into account agricultural return flows,

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[2] The 2000 level crop acreage listed here (425,700 acres) is less than the 538,000 acres of agricultural land listed in the Delta Atlas (1991 land survey) for several reasons. The 2000 level only includes planted irrigated acres while the 1991 number includes other types of agricultural land, and the 2000 data are for the Delta Service Area – a smaller area than the Legal Delta used in the Delta Atlas. Urbanization of agricultural lands is another reason that the listed 2000 level of crop acreages is less than the agricultural land listed in the Delta Atlas.

Delta farms deplete Delta outflow by an average of about 960,000 acre-feet per year (AF/year). During the summer, when irrigation of Delta farmland is at a peak, the combined diversions for Delta farms may exceed 4,000 cfs (DWR, 1990). This is similar in magnitude to CVP exports from the Delta in the summer.

Significant urbanization of agricultural land has occurred within and surrounding the Delta. For example, Elk Grove has a growth rate of 27 percent per year – the highest growth rate in California; Tracy's growth rate is 5.9 percent per year; Brentwood's rate is 12.3 percent per year; and Rio Vista's is 11.1 percent per year. However, based on Bulletin 160-98 land use projections (DWR, 1998a), consumptive use of water within the Delta will not change significantly.

TIDAL FLOWS

Tidal fluctuations in the Pacific Ocean at the Golden Gate Bridge propagate upstream through Suisun Bay to the Delta. The tidal pattern at the Golden Gate Bridge is a mixed diurnal tide with two tides of unequal magnitude each lunar day (24.9 hours). A higher-high and a lower-high tide occur each day. The lowest low tides and the highest high tides occur during the lunar-spring tide periods (i.e., new moon and full moon). Tides during the lunar-neap tide period are smaller and nearly equal in magnitude.

Tidal influence is prominent in the Delta, especially in the west and central Delta. Its influence diminishes in the far northeast and southeast reaches of the Delta. **Table 2B-2** shows the approximate daily tidal fluctuations at selective locations in the Delta. Water levels vary greatly during each tidal cycle, from less than 1 foot on the San Joaquin River near I-5 to more than 5 feet near Pittsburg. The river stage at Martinez, in the western portion of the legal Delta, is primarily determined by the tides, although it is also affected by freshwater inflow during periods of high runoff.

Table 2B-2 Daily Tide Fluctuations at Selected Locations in the Delta

Tide Gage Location	Approximate Daily Tide Fluctuation (feet)	Tide Gage Location	Approximate Daily Tide Fluctuation (feet)
Martinez	5.6	Venice Island	3.8
Rio Vista	4.8	Freeport	1.7
Roaring River	4.4	Thornton	1.5
Mallard Island	5.1	"I" Street Bridge	1.1
Antioch	4.3	"H" Street Bridge	0.0
Tracy	3.0		

Source: CALFED, Levee System Integrity Program Plan, July 2000.

Except under conditions of high runoff, Delta outflow is dominated by tidal ebb and flood. Over the tidal cycle, flows move downstream toward San Francisco Bay during ebb tides and move upstream during flood tides. The maximum downstream tidal flows at Martinez in almost all months are between 600,000 cfs and 700,000 cfs. The minimum tidal flows at Martinez are between negative 600,000 cfs and negative 650,000 cfs. The tidal excursion at Martinez has a typical range of 6 to 8 miles.

During rising tides, strong tide currents may create reverse flows (landward flows) in some Delta waterways. The magnitude of reverse flows, however, depends on other factors such as Delta tributary inflows, CVP-SWP operations and local pumping. **Figure 2B-19** shows the tidal flow at CCWD's Old River intake at Highway 4 during periods of high and low export pumping at Banks and Tracy. During low export pumping, such as occurred April 15 through May 15, 2004, during the VAMP export shutdown, almost no net daily-averaged flow occurred but during high export pumping, the flow can remain landward (to the south) throughout the full tidal cycle. When freshwater outflow is relatively low, water with a higher salt concentration enters the central and south Delta through tidal exchange[3] from San Francisco Bay.

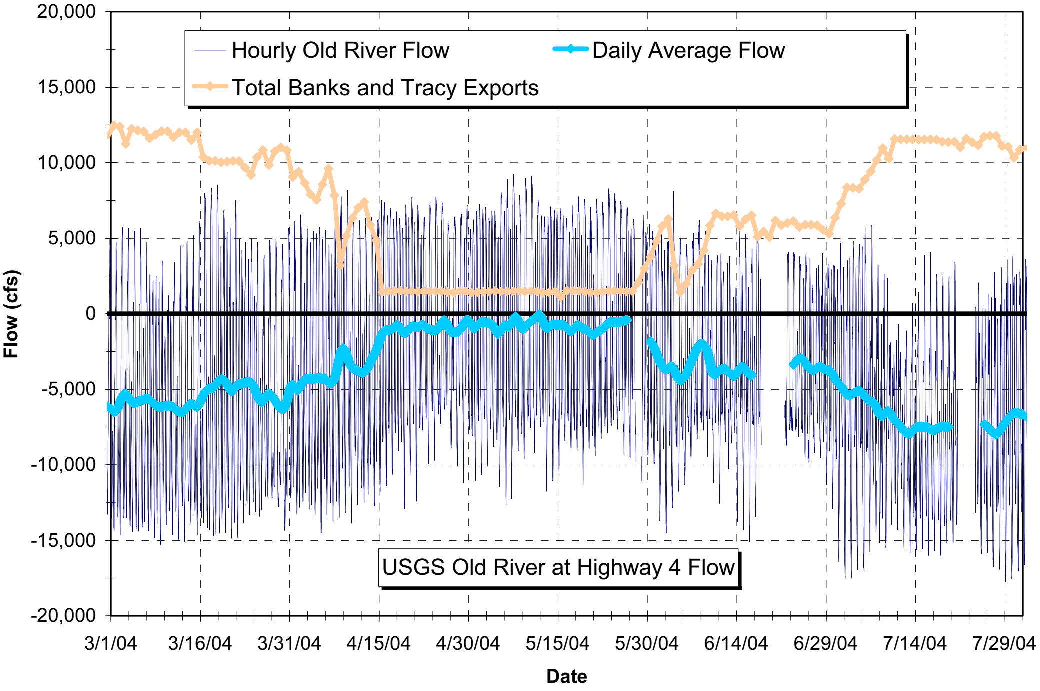

Figure 2B-19 Tidal Flow at Contra Costa Water District Old River Intake at Highway 4

High CVP-SWP exports from the South Delta create net reverse flows in the Old River.

Changes in flow patterns within the Delta, whether caused by export pumping, flow barriers or spring-neap (14-day) tidal variations, can significantly influence water quality at drinking water intakes. Tides also can increase the net movement of salt and other contaminants into or out of the Delta relative to the movement of contaminants that would occur by the mean (tidally averaged) flow alone.

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[3] Tidal exchange occurs when salty water is brought into the Delta on the flood (landward) stage of the tide and a mixture of salty water and fresh water goes out on the ebb (seaward) stage of the tide. When Delta outflows decrease, typically, a net exchange of salt occurs in the landward direction. When Delta outflow is increased, tidal exchange typically results in a net transport of salt in the seaward direction, freshening the Delta.

INTERIOR DELTA FLOWS

Each region in the Delta is dominated by different hydraulic variables during any given period of time. In the west Delta, for example, tidal influences are strong and tidal-driven reverse flows occur frequently. The north Delta is more dominated by Sacramento River and Mokelumne River inflows. The south Delta is more affected by both San Joaquin River inflows and export pumping. Several water management facilities located in the Delta can play a major role in determining flow patterns through the Delta and water quality. These include the Delta Cross Channel at Walnut Grove, CVP Tracy Pumping Plant near Tracy (described earlier), the SWP Clifton Court Forebay and Harvey O. Banks Delta Pumping Plant (described earlier), South Delta temporary barriers, Suisun Marsh Salinity control gate, and Sandmound Slough tide gate. The Sandmound Slough tide gate, which allows one-way (northwards) flow out of Rock Slough into Sandmound Slough, was constructed to improve circulation within Rock Slough and to prevent the generally saltier Sandmound Slough water from mixing with Rock Slough water (**Figure 2B-20**).

The primary source of water exported from the Delta at the Banks and Tracy pumping plants comes from the Sacramento River. Water flows across the Delta through Georgiana Slough and via the Delta Cross Channel through the north and south forks of the Mokelumne River, across the lower San Joaquin River, and into Old and Middle rivers. Sacramento River flow that does not travel into the Central Delta continues towards San Francisco Bay. Under certain conditions, additional Sacramento River water flows into the central and south Delta; water flows through Three Mile Slough, around the western end of Sherman Island, and up the San Joaquin River towards the export pumps. Net flows in Old River and Middle River depend on CVP–SWP exports and south Delta irrigation diversions (approximately 40 percent of total net Delta diversions).

Figure 2B-21 depicts the channels and islands of the interior Delta**.** Hydrodynamic model studies indicate that about 45 percent of south Delta exports flow through Old River or through the False River. About 40 percent of the south Delta exports flow through Middle River, and about 10 percent of the flow is through Turner Cut. Modeling suggests that the division of flow is not sensitive to the magnitude of exports (Jones and Stokes, 2004, Section D-5).

DELTA CROSS CHANNEL

The Delta Cross Channel was constructed in 1951 as part of the CVP. It connects the Sacramento River to the Mokelumne River via Snodgrass Slough (see **Figure 2B-22**). Water already can enter the central Delta via Georgiana Slough; the Delta Cross Channel effectively doubles the flow into the central Delta. The purpose of the Delta Cross Channel is to improve central Delta water quality, particularly at the CCWD Rock Slough intake and the Tracy and Banks export pumps, by increasing the flow of Sacramento River water into the lower San Joaquin River. The Delta Cross Channel gates are closed when Sacramento River flow is high (typically 25,000 cfs or larger) to prevent flooding on the lower Mokelumne River and elsewhere in the north Delta.

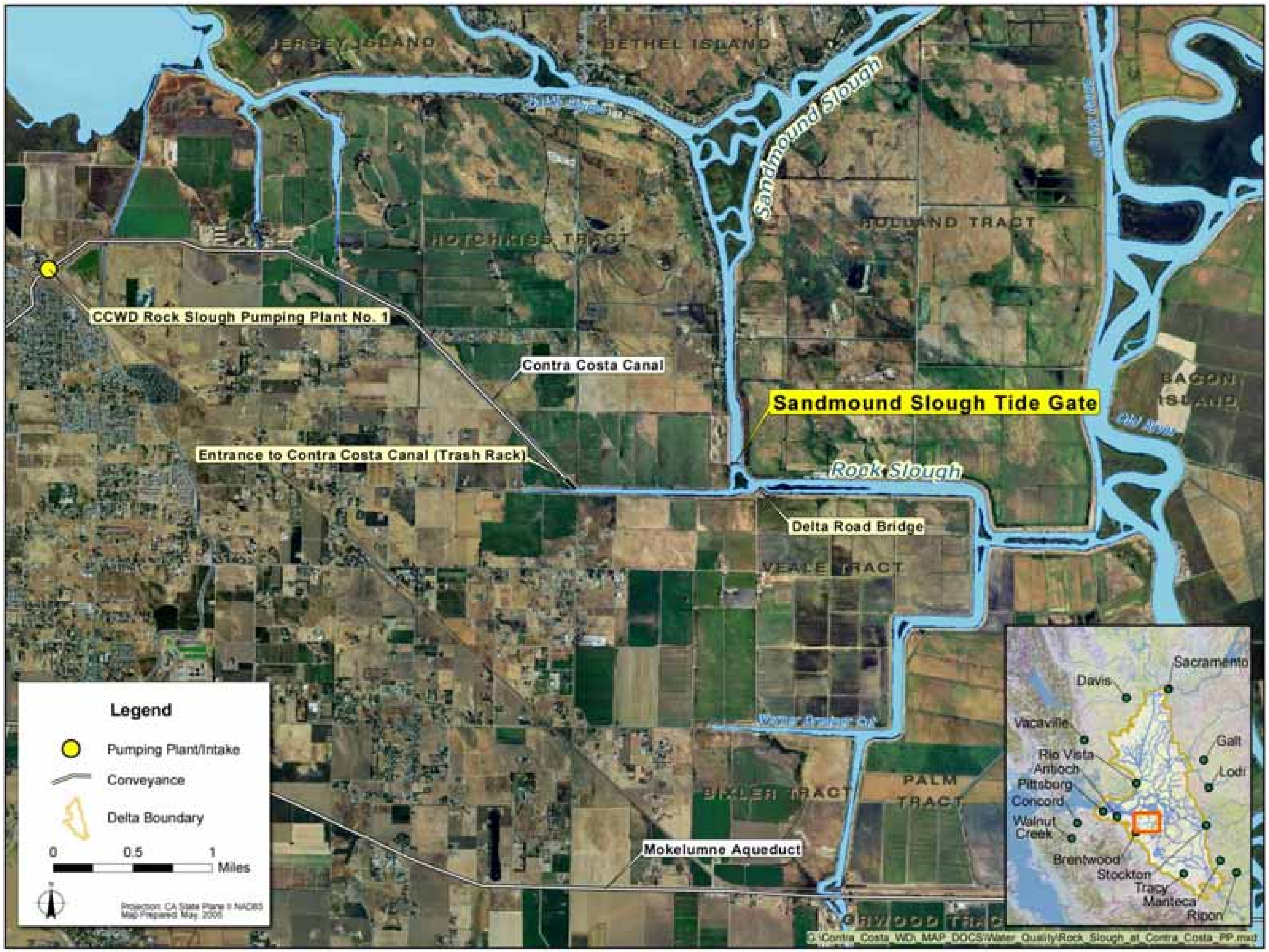

Figure 2B-20 Interior Delta Flow Controls at Sandmound Slough and Rock Slough

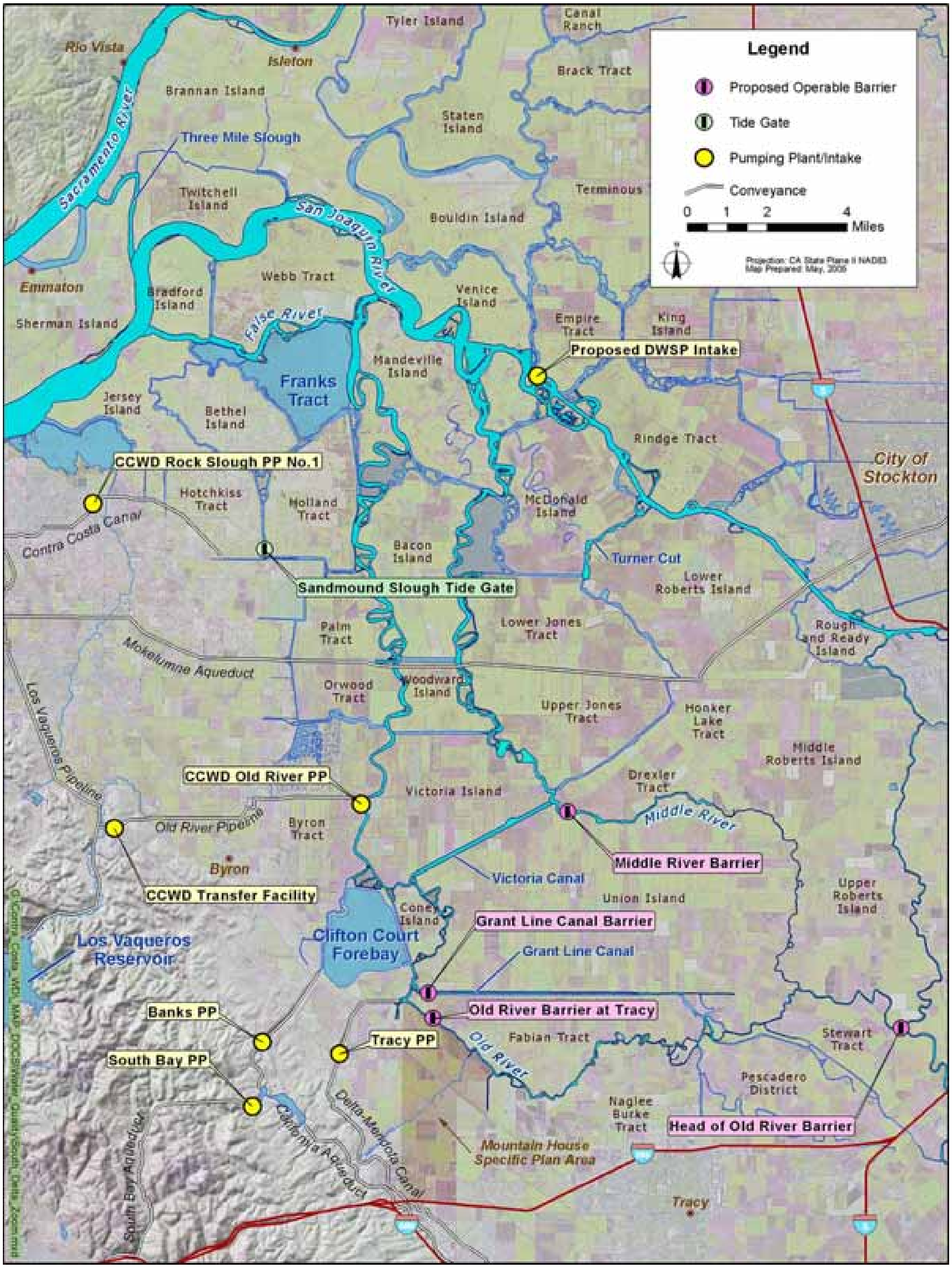

Figure 2B-21 Interior Delta

Figure 2B-22 Delta Cross Channel

Several regulatory requirements govern Delta Cross Channel gate operations. The purpose of these requirements is to prevent outmigrating salmon from being misdirected into the central Delta where their chance of survival and reaching the ocean is reduced. The SWRCB 1995 WQCP sets three time-periods when the Delta Cross Channel gates are required to be closed for salmon protection:

- November 1 through January 31 – the gates are required to be closed for a total of up to 45 days for fisheries protection as requested by the United States Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA) Fisheries, and California Department of Fish and Game (CDFG).
- February 1 through May 20 – the gates are required to be closed for the full period.
- May 21 through June 15 – the gates are required to be closed for a total of 14 days for fisheries protection as requested by USFWS, NOAA Fisheries, and CDFG.

However, closing the Delta Cross Channel gates during low flow conditions degrades interior Delta water quality. Closing the gates under conditions of low Delta outflow and high exports also will impact water quality at the City of Stockton's proposed Delta Water Supply Project intake. Closure of the gates in November 1999 dramatically increased chloride concentrations at CCWD's Rock Slough intake and elsewhere in the central and south Delta. **Figure 2B-23** shows the increase in EC at Jersey Point and the corresponding increase in chloride concentration during gate closure. In this case, as shown in **Figure 2B-24**, Delta exports were not reduced until almost 2 weeks after the gates were closed. Degradation of water quality could have been much worse if Delta exports had not been dramatically decreased.

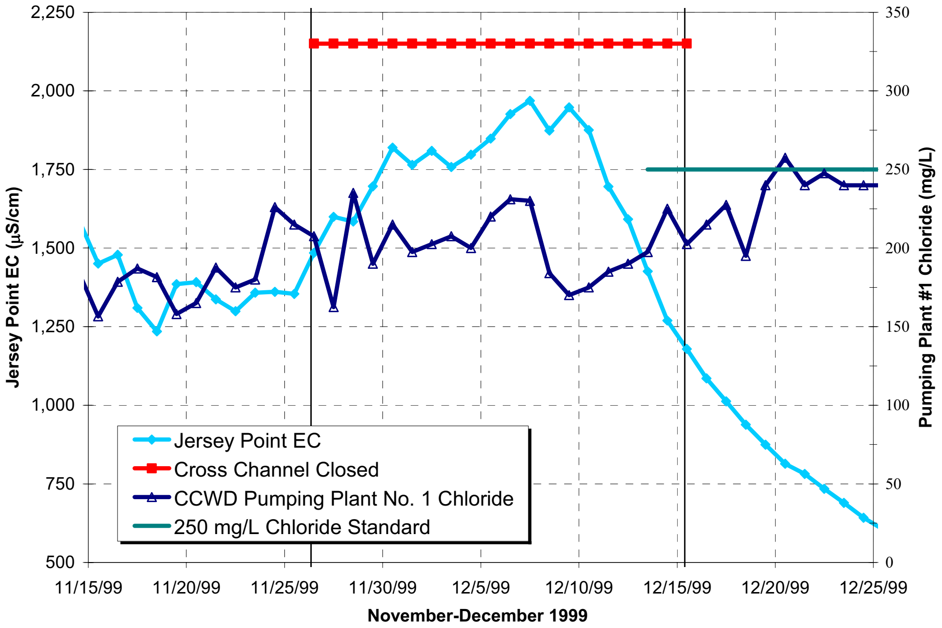

Figure 2B-23 Impact in 1999 of Closing Delta Cross Channel Canal Gates on EC and Chloride as Measured at Jersey Point and CCWD Pumping Plant No. 1

Closure of the Delta Cross Channel gates in November 1999 dramatically increased electrical conductivity at Jersey Point and resulted in exceedence of the Rock Slough chloride standard.

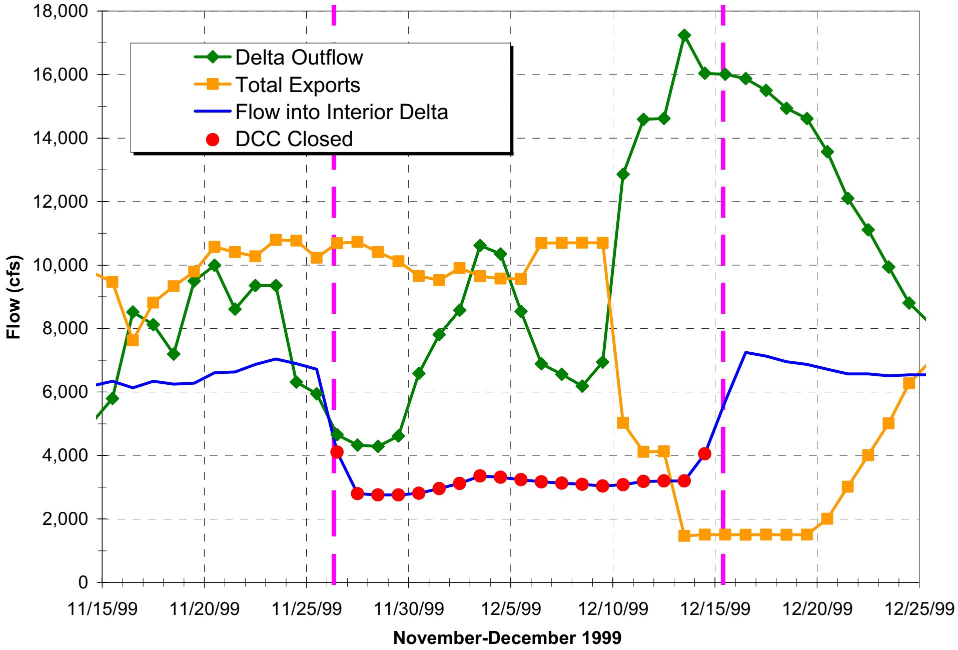

Figure 2B-24 Corresponding Delta Exports and Flows During November 1999 Delta Cross Channel Closure

Closing the Delta Cross Channel gates significantly reduced flow into the interior Delta via the Delta Cross Channel and Georgiana Slough.

Georgiana Slough looking north up the Sacramento River

In 2000, CALFED and the Interagency Ecological Program (IEP) began a 3-year study of the benefits and impacts of various gate closure scenarios. The goal of the study was to determine the best operational scenario to benefit both fisheries and water quality. Unfortunately, an earlier study of acoustic barriers to fish passage through Georgiana Slough was unable to show that fish could be directed away from Georgiana Slough by sound pulses emitted from underwater transmitters located in the northern entrance of Georgiana Slough.

SOUTH DELTA BARRIERS

Temporary 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 south Delta area for local agricultural diversions
- Improve operational flexibility of the SWP to help reduce fishery impacts and improve fishery conditions

However, the agricultural barriers, in conjunction with the Head of Old River barrier can reduce the amount of San Joaquin inflow reaching the Tracy Pumping Plant for re-export to the San Joaquin Valley. Instead, poor quality San Joaquin River water is redirected north, then east via Turner Cut, where it can increase the concentration of salinity and other contaminants of concern (COC) at CCWD drinking water intakes.

The Head of Old River barrier typically has been in place most years since 1963 between April 15 and May 15 and September 15 and November 30. The other three barriers are installed annually between April 15 and September 30 to maintain water levels and create circulation for water quality for south Delta farmers. Installation and removal dates of the barriers are based on the United States Army Corps of Engineers (USACE) Section 404 Permit, CDFG 1601 permit, and various temporary entry permits required from landowners and local reclamation districts. The Head of Old River temporary rock barrier is typically not installed if Vernalis flows are higher than 5,000 cfs, and the barrier needs to be removed to prevent local flooding if Vernalis flows exceed 7,000 cfs. Details of the temporary barriers can be found on the DWR Web site (http://sdelta.water.ca.gov).

Permanent Operable Barriers

Since the 1980s, DWR has been studying installation of permanent operable barriers at the Head of Old River, Middle River, Old River near Tracy, and Grantline Canal. These barriers will be able to be operated year-round depending on water level, water quality, and fishery and water supply needs. The Head of Old River barrier will serve as a fish barrier to prevent outmigrating San Joaquin salmon from being entrained at the export pumps in the spring, and to prevent salmon returning to spawn from being entrained into Old River and the export pumps in the fall. DWR is scheduled to release a new Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the South Delta Improvements Program, which includes operation of the four permanent barriers, in late May or June 2005. Water quality impacts of these flow barriers, combined with increased exports, are a major concern for CCWD.

SUISUN MARSH SALINITY CONTROL GATE

The Suisun Marsh salinity control gate limit flow in Montezuma Slough from Suisun Marsh during flood tide, and allow drainage from the marsh during ebb tide. The gates are not operated in the summer months (June to September) and are not operated at all in some wet years. The gates help maintain water quality at SWRCB compliance locations in Suisun Marsh. Allowing and restricting flow through Montezuma Slough also may have a slight effect on water quality at stations within the western Delta (i.e., affect the relationship between western Delta EC and Delta outflow) but this has not been researched in any detail.

REVERSE FLOW

CVP-SWP exports at the Banks and Tracy pumping plants can cause tidally averaged reverse or upstream flow in some of the channels in the south Delta. However, the term reverse flow is commonly used to describe upstream flow in the lower San Joaquin River (Jersey Point to the confluence with the Sacramento River). Similar to the NDOI, flow in the lower San Joaquin River is calculated using a water balance, which results in an index known as QWEST. Like the NDOI, QWEST does not account for the tidal filling and draining of the Delta. QWEST is a summation of San Joaquin River flow at Vernalis, inflow from the eastside streams, water entering the central Delta from the Sacramento River via the Delta Cross Channel and Georgiana Slough, less net Delta consumptive use, and less diversions (CCWD) and exports (CVP-SWP) from the south Delta.

As shown in **Figure 2B-25**, QWEST flow typically peaks in February. The greatest average monthly negative (reverse) QWEST flow typically occurs in October. Reverse flow is due to a combination of reduced reservoir releases and Delta exports.

QWEST is considered by some biologists to be indicative of passage and survival of outmigrating salmonids. However, the data supporting this theory are not well correlated. The 1993 Winter-Run Chinook Salmon Biological Opinion (BO) and the 1993 Delta Smelt BO established QWEST requirements to eliminate reverse flow. In 1995, NOAA Fisheries amended the BO for winter-run Chinook salmon, and long-term opinion for delta smelt, replacing the QWEST standard with an E/I requirement.

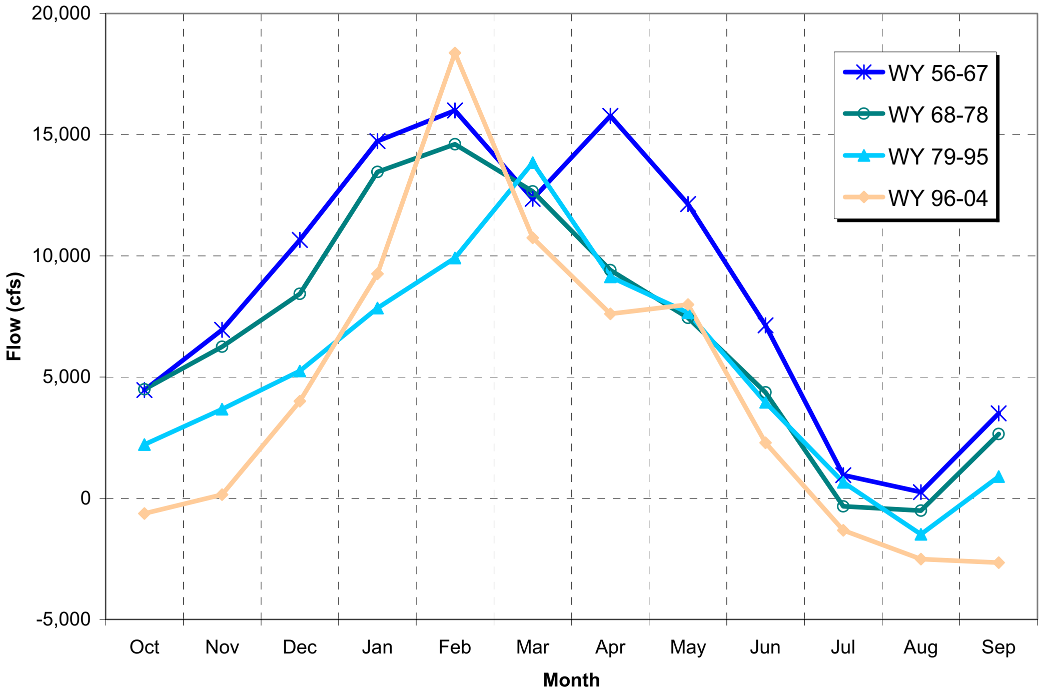

Figure 2B-25 Variation of Tidally Averaged Flow Out of Western Delta (QWEST)

This variation of flow shows occurrence of net reverse flows past Antioch in the fall.

Draining and filling of the Delta over a spring-neap tidal cycle can create actual hourly QWEST flows of plus or minus 100,000[4] cfs. The actual tidally varying flows are much greater than the magnitude of the daily mean flows used as a surrogate for fish transport. Similarly, daily averaged reverse flows at Antioch are not necessarily indicative of seawater intrusion into the Delta. The tidal exchange that results from tidal flows past Antioch and through Three Mile Slough is more likely to influence the passage of fish in this area than the tidally averaged (net) flows at any given location.

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[4] A more detailed discussion of QWEST is provided in a draft DWR report available at http://modeling.water .ca.gov/delta/studies/qwest/qwest.htm.

TIDAL PUMPING THROUGH THREE MILE SLOUGH

Three Mile Slough is the upstream boundary of Sherman Island. Under a phenomenon known as tidal pumping, a net circulation flow and salt transport is created by the daily ebb and flood tidal action from the Sacramento River to the San Joaquin River. At the end of an ebb tide, lower salinity water has been drawn into the interior part of the Delta. During the flood tide, a phase difference occurs in water levels at the northern end of the slough in the Sacramento River, and the southern end of the slough on the San Joaquin River. This difference in water levels causes an average flow of about 10,000 cfs in Three Mile Slough from the Sacramento River to the San Joaquin River during the flood tide. During the ebb tide, the opposite effect occurs with flows through the slough from the San Joaquin River to the Sacramento River in the range of 10,000 cfs. Because the flood tide moves saltier water into the Delta, water flowing north through the slough tends to be saltier than water flowing south. If tidal currents are averaged over a 14-day spring-neap tidal cycle, the net effect is to produce a mean tidally-averaged (residual) current.

The net effect of this tidal pumping is to move high quality water from the Sacramento River to the San Joaquin River. Tidal pumping offsets the salinity impacts of reverse flow in the lower San Joaquin River. Tidal pumping also is great enough to prevent a salinity increase in the San Joaquin River regardless of the export rate in the south Delta, provided that Sacramento River flows are sufficient to maintain low salinity in the Sacramento River at Three Mile Slough. Net flows from north to south through Three Mile Slough would reduce negative values of QWEST if included in the index.

FRANKS TRACT

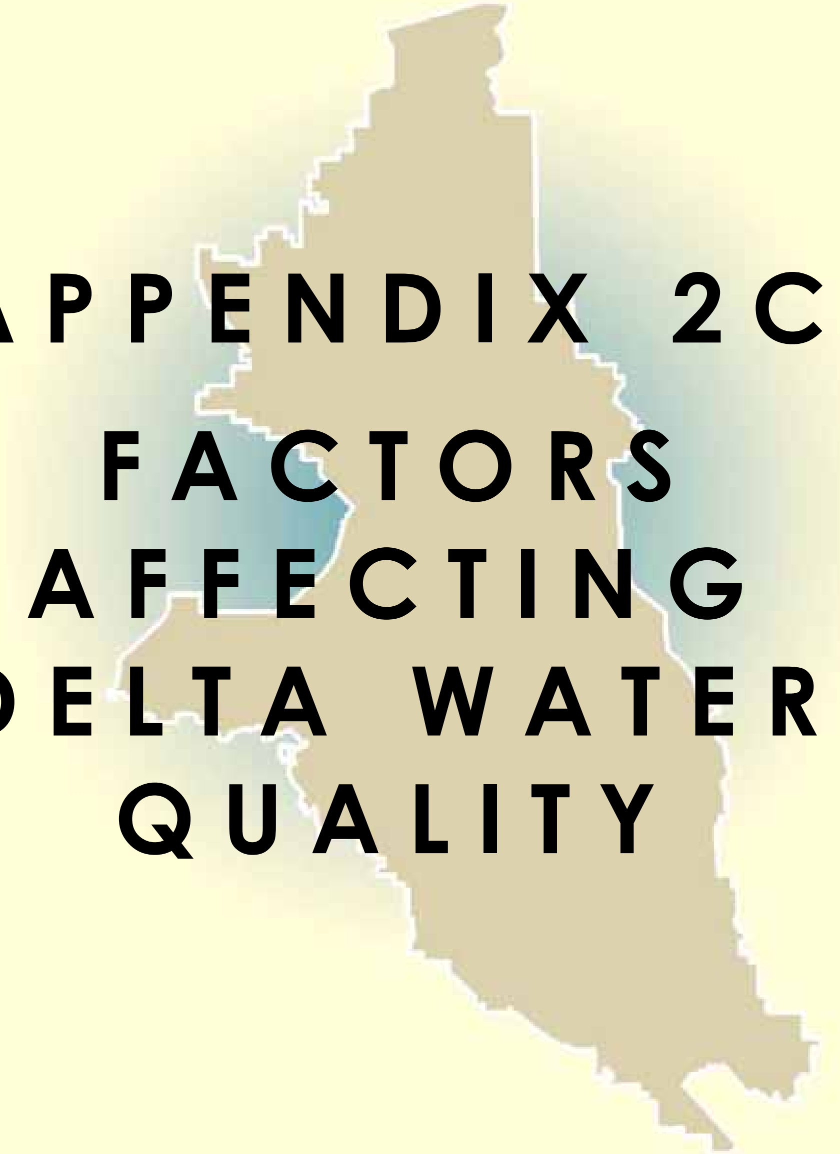
Large open water areas such as Franks Tract, a flooded Delta island (see **Figure 2B-26**) can trap salt from an incoming tide, resulting in a net exchange of salt into the Delta. DWR, together with USGS and Reclamation, is studying the potential to create ecosystem, water quality, recreational, and other benefits at Franks Tract by modifying remnant levees, constructing tidal gates to inhibit salt trapping, and restoring tidal marsh habitat. Reconfiguring levees and Delta circulation patterns around Franks Tract may significantly reduce salinity levels in the central and south Delta. During the flood tide, salt water intrudes into, and mixes with, the water in Franks Tract. Water leaving during the ebb tide is a less salty mixture. The result is a net trapping of salt in Franks Tract. This saltier water is then conveyed south via Old River past the CCWD Rock Slough and Old River intakes to the export pumps.

DWR and CALFED Bay-Delta Program (CALFED) stakeholders are currently studying ways to reduce salinity, including the construction of tidal gates at Franks Tract, False River, and Dutch Slough. Modification of Franks Tract is included as a water quality action within the CALFED Delta Improvements Package. Simulations of the water quality improvements vary from 10 percent to 30 percent depending on the particular simulation model.

Figure 2B-26 Franks Tract, a Potential Location for Interior Delta Flow Modification

DELTA REGION

DRINKING WATER QUALITY MANAGEMENT PLAN



APPENDIX 2C

FACTORS AFFECTING DELTA WATER QUALITY

APPENDIX 2C. FACTORS AFFECTING DELTA WATER QUALITY

This appendix describes the modeling and analyses of key water quality influences, including seawater intrusion, tributary inflow, and agricultural drainage and urban runoff. Specific consideration is given to the existing chloride and bromide concentrations, relationships, and sources for Contra Costa Water District's (CCWD) Sacramento-San Joaquin Delta (Delta) intakes at Rock Slough and Old River, and Solano County Water Agency's (SCWA) intake for the North Bay Aqueduct on Barker Slough.

SEAWATER INTRUSION

Saltwater intrusion into the Delta is controlled by tides, winds, barometric pressure, fresh water inflows from unregulated runoff and upstream reservoir releases, and Delta diversions. Compared to historical conditions, Delta salinity during low-flow periods is much lower since the construction of dams, which allow storage and freshwater releases during dry and critical periods. Seawater intrusion into the Delta can be intensified by diversion of freshwater and the corresponding decrease of freshwater outflow from the Delta. As a result, the western Delta often experiences increased salinity during summer and fall. High salinity adversely affects the quality of both drinking and irrigation water.

Twice-daily tides allow an exchange of ocean salts from San Francisco Bay with Delta water. The average incoming and outgoing Delta tidal flow is about 170,000 cubic feet per second (cfs) at Chipps Island (the interface between the Delta and Suisun Bay). By comparison, the current allowable Central Valley Project (CVP) and State Water Project (SWP) combined export capacity is about 11,000 cfs. Historically, during extremely low runoff periods in summer, salt from tidal flows intruded into the Delta as far as Hood. During winter and spring, freshwater from heavy rains pushed the saltwater back well into San Francisco Bay and sometimes beyond. With the construction of Shasta, Folsom, and Oroville dams, saltwater intrusion into the Delta during summer months has been controlled by reservoir releases during what were traditionally dry months under natural conditions (no dams). Flows from eastside streams and the San Joaquin River also contribute to controlling saltwater intrusion. Typically, peaks in winter and spring flows have been dampened, and summer and fall flows have been increased. In very wet years, reservoirs are unable to control runoff, and salinity in the bay is nearly reduced to freshwater levels.

The two major tributaries to the Delta, the Sacramento River flowing in from the north, and the San Joaquin River flowing in from the south through the south and central Delta, allow differing amounts of seawater intrusion into the Delta depending on the relative inflows from these two rivers. The relative contributions of these two inflows to repelling seawater can be further modified by opening and closing the Delta Cross Channel near Walnut Grove in the north Delta. When the Delta Cross Channel gates are open, more Sacramento River water enters the central Delta through the Delta Cross Channel and Georgiana Slough into the lower Mokelumne River system. This additional flow of Sacramento River water into the San Joaquin River side of the western Delta assists the San Joaquin River in flushing seawater out of the central and south Delta. Conversely, closing the Delta Cross Channel gates during times of low outflow can significantly increase seawater intrusion, as occurred to dramatic effect in November 1999.

CARRIAGE WATER

Under low outflow conditions, increases in CVP and SWP exports can cause additional seawater intrusion, even if the Delta outflow is not changed (i.e., additional releases are made from upstream reservoirs to match the increase in export pumping). Current proposals to increase the permitted export capacity at the SWP Banks Pumping Plant, and increase CVP export capacity at Tracy Pumping Plant, have the potential to further increase bromide concentrations in the central and south Delta even if Delta outflow requirements are being met.

This additional increment of inflow (and corresponding increase in Delta outflow) that would be needed to offset the additional effect of exports on seawater intrusion, and prevent degradation of water quality at Delta drinking water intakes, is referred to as "carriage water" or "marginal export cost."[1] However, during times when a small amount of outflow occurs in excess of State Water Resources Control Board (SWRCB) Water Quality Control Plan (WQCP) requirements, carriage water is not typically provided, and any increase in exports, for example, to transfer water from north of the Delta to south of the Delta, will degrade Delta water quality.

QUANTIFYING SEAWATER INTRUSION

Salinity in the west Delta is well correlated with net Delta outflow, as shown in **Figure 2C-1**. Empirical relationships have been developed to calculate the salinity concentrations resulting from seawater intrusion. The Kimmerer-Monismith model calculates the distance in kilometers inland from the Golden Gate Bridge of 2 parts per thousand (ppt) isohaline (salinity contour). If Delta outflow decreases, seawater will intrude further inland and the distance to the 2 ppt isohaline (referred to as "X2") will increase. The equation for daily X2 is as follows:

$$X2(t) = 10.16 + 0.945 * X2(t-1) - 1.487 \operatorname{Log}(Q)$$

where X2(t) is the location of the 2 ppt isohaline at time (t) in days, and Q is the daily-average Delta outflow in cfs. Note that this model assumes seawater intrusion into San Pablo Bay, Suisun Bay, and the west Delta is only affected by Delta outflow.

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[1] http://modeling.water.ca.gov/delta/studies/mec/ANNSummary.html

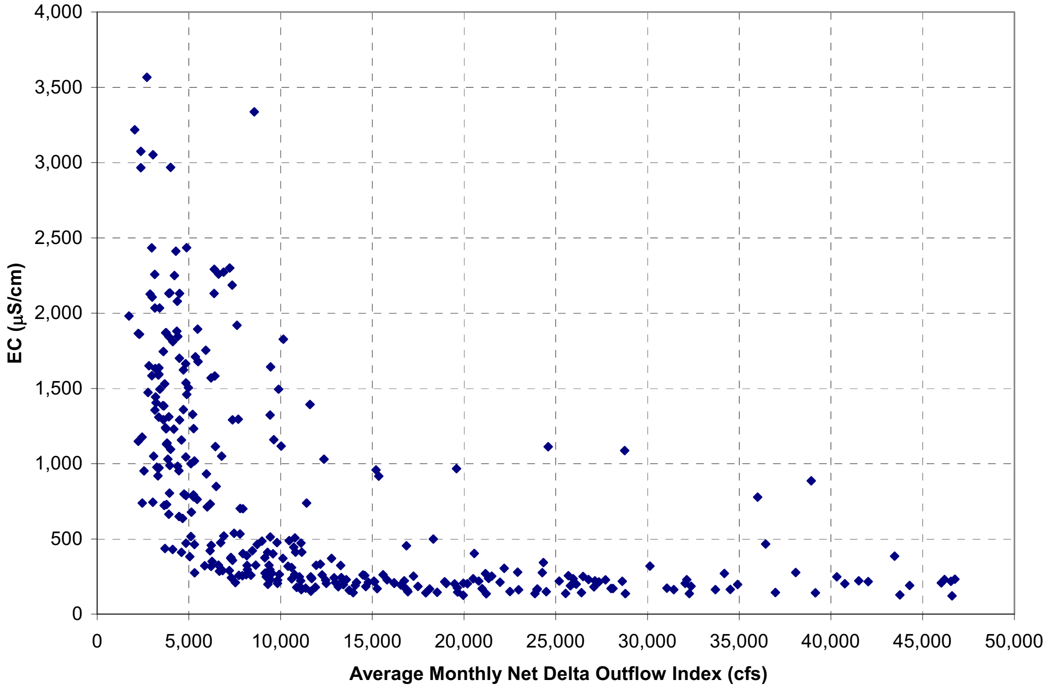

Figure 2C-1 Average Monthly Electrical Conductivity for the San Joaquin River at Jersey Point, Water Years 1965 to 1998

EC at Jersey Point decreases as average Delta outflow increases.

The second empirical model, a salinity-outflow model, typically referred to as the "G-model," (CCWD, 1992) assumes that the salinity at a fixed location in Suisun Bay or the west Delta is a function of the antecedent or effective steady-state Delta outflow. Because a week to several months may be needed for salinity to fully respond to a change in Delta outflow, today's salinity is not just the result of today's Delta outflow but the cumulative effect of the outflows in previous days, weeks, and even months. Today's effective steady-state outflow represents the Delta outflow that would produce today's salinity if salinity were able to respond instantly to changes in outflow.

The G-model calculates daily (or monthly) salinity using the following equations:

$$S(t) = (S_o - S_b) * e^{-\alpha G(t)} + S_b$$

where G(t) is the antecedent or equivalent steady-state Delta outflow, and α, S_o, and S_b are empirical constants for a given fixed location. G(t) is calculated from:

$$dG/dt = (Q - G) * G / \beta$$

where Q is the Delta outflow in cfs, and β is an empirical constant representing the rate of response of salinity to changes in outflow at a given location.

At a relatively low effective Delta outflow of 4,000 cfs, it will require about 3 months for salinity to fully adjust to a change in Delta outflow. If the effective Delta outflow were higher at 10,000 cfs, it would require about 2 months for the salinity to fully adjust to a change in outflow. And if the Delta outflow were 20,000 cfs, it would only require about 5 weeks for salinity to adjust to the new outflow.

The G-model can be used to calculate salinities at key monitoring locations such as Port Chicago, Chipps Island, Collinsville, Antioch, and as far inland as Jersey Point (typically expressed in electrical conductivity (EC)). To calculate the corresponding water quality at CCWD's intake at Rock Slough, a third equation is used:

$$\text{Rock Slough chlorides (mg/L)} = 0.11 * [0.0 * EC_{7JP}\,(t-6 \text{ to } t) + 0.5 * EC_{7JP}\,(t-13 \text{ to } t-7) + 0.4 * EC_{7JP}\,(t-20 \text{ to } t-14) + 0.1 * EC_{7JP}\,(t-27 \text{ to } t-21)]$$

Where EC_{7JP} is the 7-day average Jersey Point EC. This equation is based on the strong observed correlation between EC at Jersey Point and chloride concentrations due to seawater intrusion in Rock Slough about 14 days later.

The equation represents a time delay of about 14 days between the Jersey Point EC and the subsequent change in Rock Slough chlorides. The conversion factor of 0.11 can be used to quickly determine the approximate maximum chlorides at Rock Slough that will result from a peak EC at Jersey Point 14 days earlier. A peak EC of 220 microSiements per centimeter (µS/cm), for example, will likely result in a chloride concentration of 240 mg/L, which is very close to the maximum municipal and industrial (M&I) chloride objective set by SWRCB in D-1641. The California Department of Water Resources (DWR), United States Department of the Interior, Bureau of Reclamation (Reclamation), and CCWD use these relationships to forecast water quality conditions in the central and south Delta and to make operational decisions. However, as discussed below, intake water quality is not only affected by seawater intrusion and local runoff, but also by the quality of water entering the Delta from the tributaries.

This is important, for example, because the SWRCB X2 requirements for February-June in Suisun Bay also maintain lower salinities at Jersey Point, which in turn maintain very low salinities at CCWD's Rock Slough intake (provided there are no other sources of salinity such as local agricultural runoff).

Figure 2C-2 shows field data for Rock Slough daily chlorides, and Jersey Point EC weighted according to the equation above for a particularly dry period, 1987 to 1993. During this period, relatively low drainage from Delta islands occurred and San Joaquin River flows were low; therefore, no significant contribution to water quality occurred from local Delta island drainage or the San Joaquin River. The salinity at Rock Slough was related only to seawater intrusion into the west Delta.

Figure 2C-3 shows the correlation between Jersey Point EC and Rock Slough chloride concentration as a time series for the 1987-1992 drought. This relationship provides good estimates of Rock Slough chlorides, except in fall 1987 and 1988 when export pumping was high relative to Delta outflow and the carriage water effect may have increased seawater intrusion.

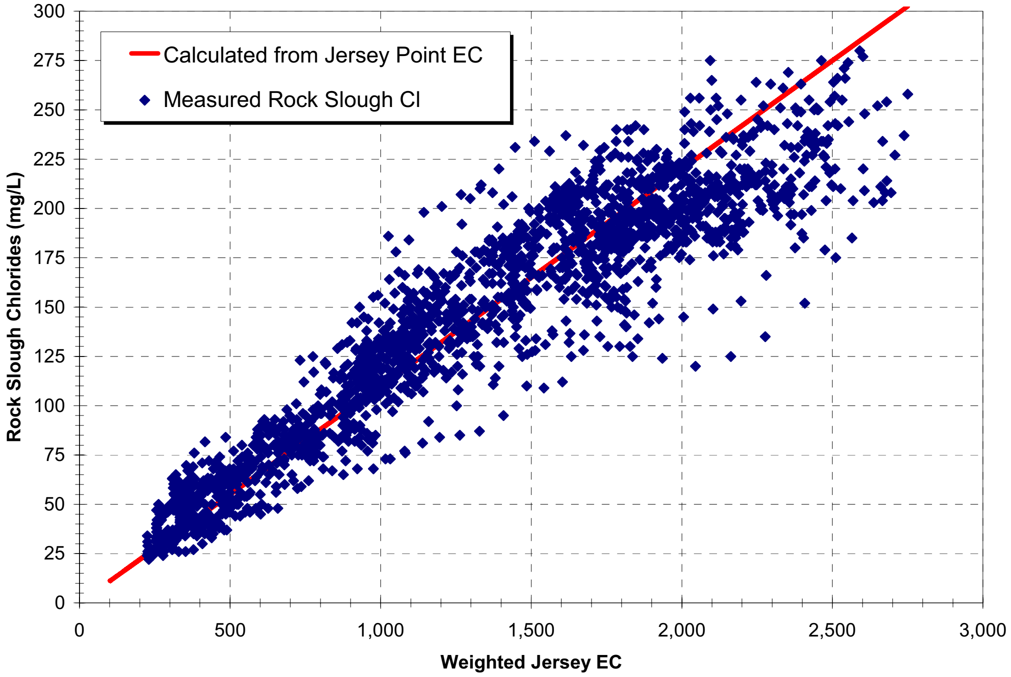

Figure 2C-2 Relationship Between Chloride Concentration at Rock Slough and Electrical Conductivity at Jersey Point

Rock Slough chlorides and Jersey Point EC are highly correlated in the absence of local agricultural runoff.

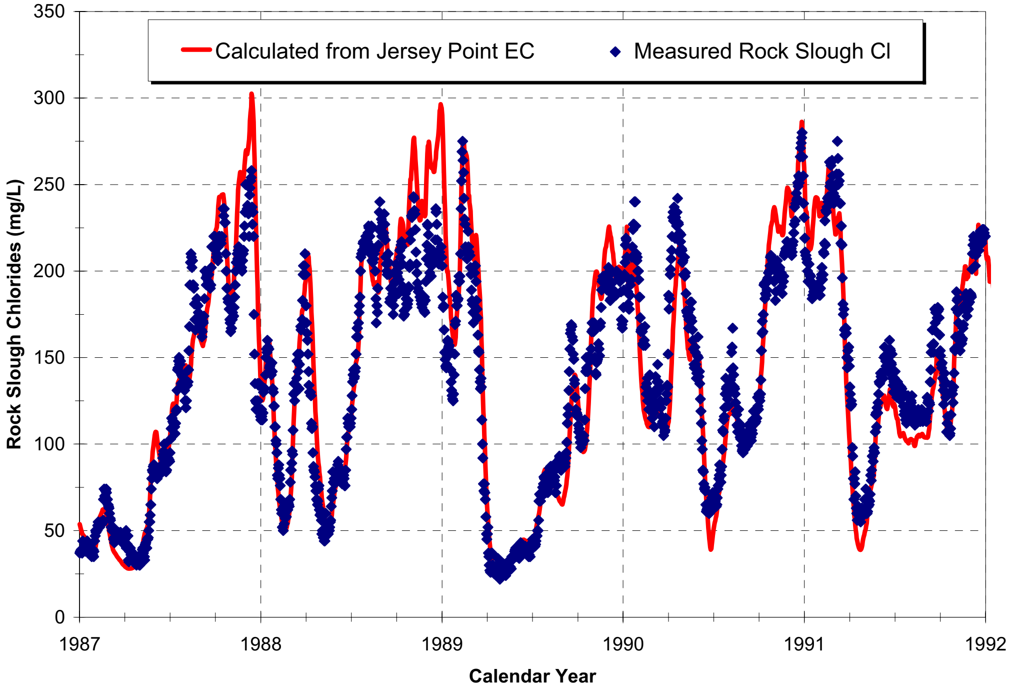

Figure 2C-3 Actual Versus Predicted Rock Slough Chloride Concentration, 1987 to 1992

The correlation between Jersey Point EC and Rock Slough chloride concentration can be used to provide a good estimate of Rock Slough chloride.

In contrast, **Figure 2C-4** shows Rock Slough chlorides predicted from Jersey Point EC for a wet period, 1995-2000, when the chloride-EC correlation is much weaker. Each winter during this period, high chlorides were measured at Rock Slough even though the high Delta outflows kept Jersey Point salinities very low. Prolonged periods of rainfall correspond to periods of very little seawater intrusion, but the same precipitation inundates farmers' fields and leaches salts from the soil. When the accumulated water is pumped off farmland and discharged to the Delta, sometimes a dramatic increase occurs in salinity at drinking water intakes. A net degradation of water quality can occur in the interior Delta, even if water in Suisun Bay downstream of the Delta is relatively fresh. The North Bay Aqueduct area also experiences high salinities, organic carbon, and turbidity due to local runoff during wet periods.

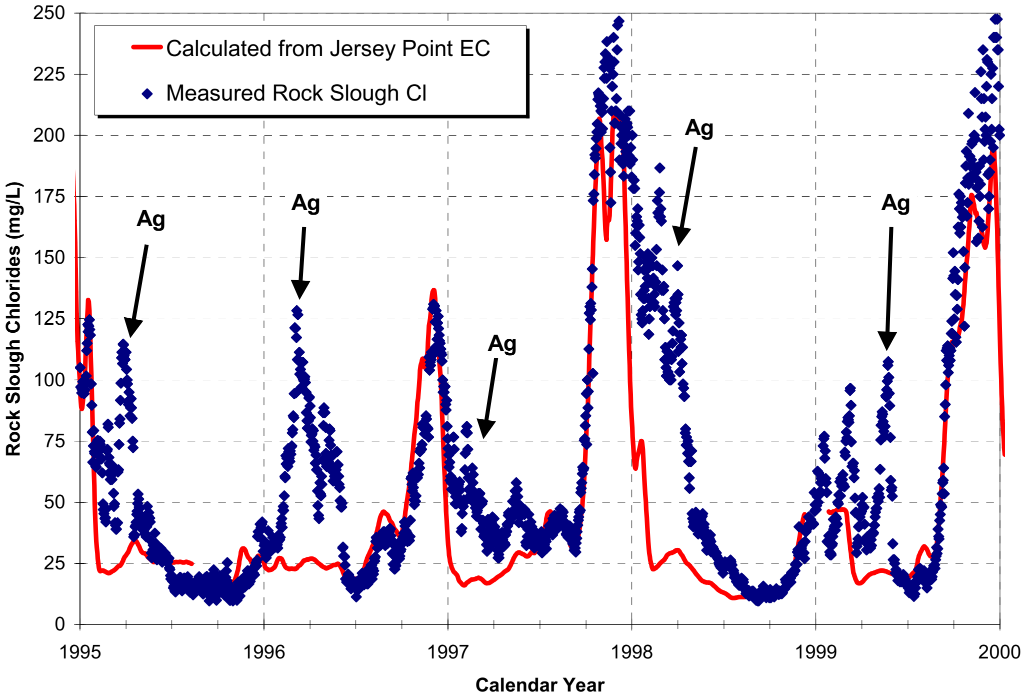

Figure 2C-4 Actual Versus Predicted Rock Slough Chloride Concentration, 1995 to 2000

During the wetter period of 1995-2000, Rock Slough water quality was affected by local agricultural drainage. Given the high outflow conditions in 1996, chloride levels should have been maintained at approximately 25 mg/L. However, local drainage effects resulted in a chloride level peak of over 125 mg/L.

TRIBUTARY INFLOW WATER QUALITY

Tributary inflow from the Sacramento and San Joaquin rivers strongly impacts key water quality parameters within the Delta, and specifically, at intakes of the direct diverters.

SACRAMENTO RIVER

Figure 2C-5 shows historical EC for the Sacramento River at Greens Landing (Freeport) as a function of flow. The salinities in the Sacramento River water are typically very low, with EC within the range of 100 to 200 µS/cm. A small decrease occurs in salinity at higher flows. **Figure 2C-6** shows the average monthly variation in EC.

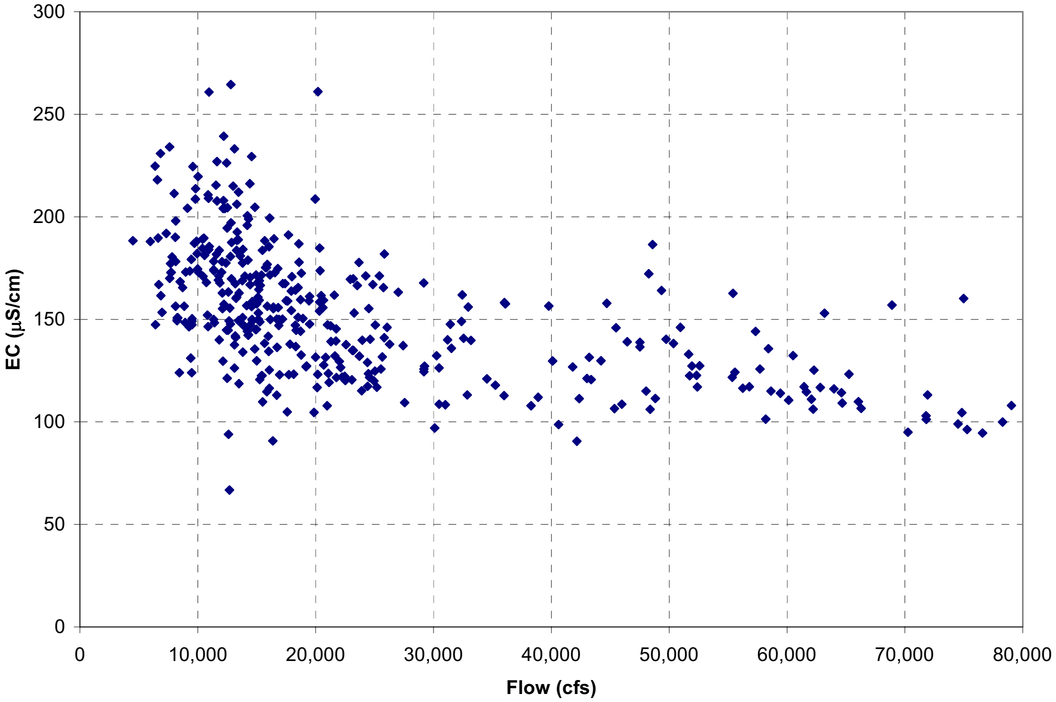

Figure 2C-5 Variation of Average Monthly Electrical Conductivity Versus Flow for the Sacramento River at Greens Landing, Water Years 1965 to 1998

The EC of Sacramento River water generally lies between 100 and 200 µS/cm.

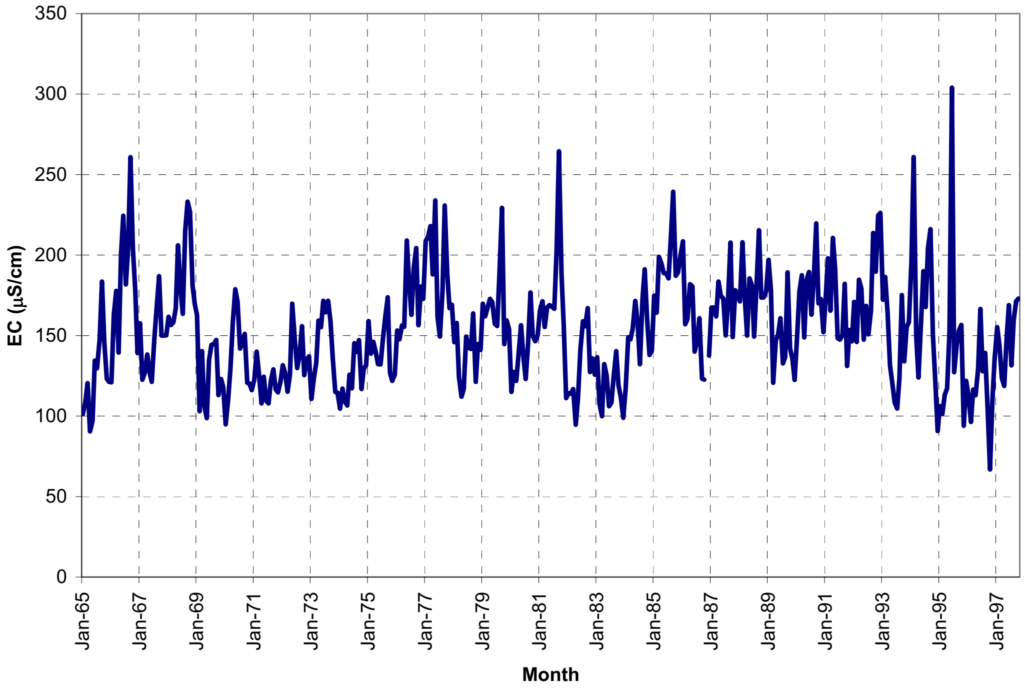

Figure 2C-6 Electrical Conductivity of the Sacramento River at Greens Landing, 1965 to 1998

The EC of Sacramento River water has ranged from just over 60 µS/cm to over 300 µS/cm.

SAN JOAQUIN RIVER

Salinity in the San Joaquin River at Vernalis generally decreases with increases in flow. During low flow periods, the source of San Joaquin River water is primarily more saline agricultural runoff. During the spring of wetter years, flood control releases of very fresh Sierra water can produce very high flows and very low salinities at Vernalis. However, in the case of the San Joaquin River, this high inflow, especially during the first major storms of the water year, brings with it accumulated salts from San Joaquin Valley farms and wildlife refuges. Monthly average EC values for the San Joaquin River are generally much higher than EC values for the Sacramento River, with typical values varying between 200 µS/cm and 1,000 µS/cm. **Figure 2C-7** shows the historical EC for the San Joaquin River at Vernalis as a function of flow. **Figure 2C-8** shows the corresponding average monthly variation in EC.

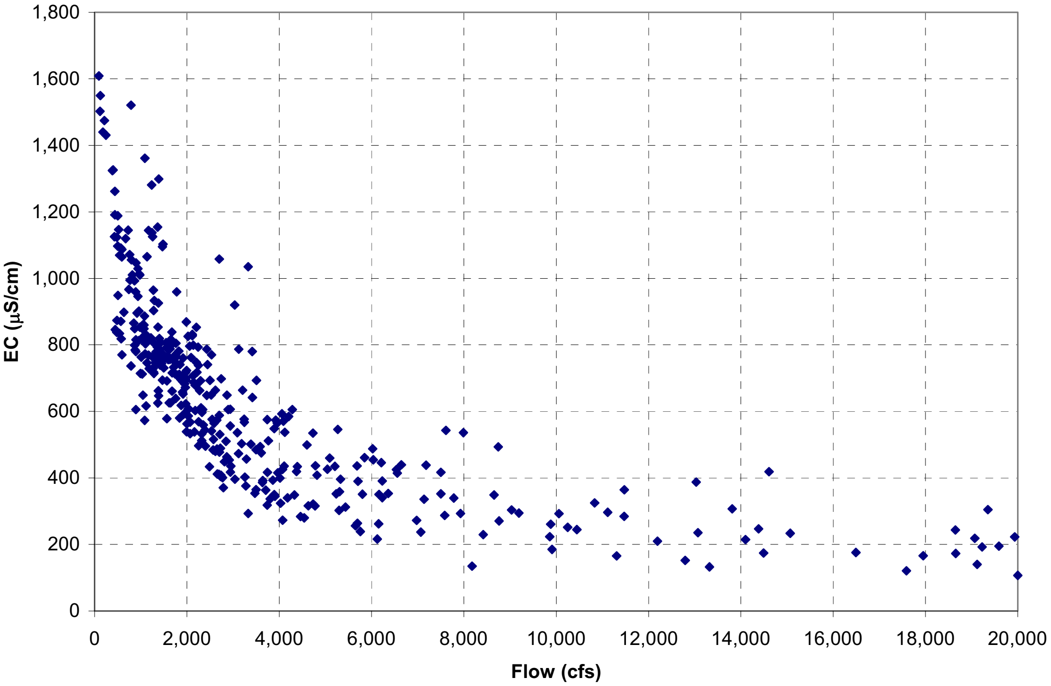

Figure 2C-7 Variation of Average Monthly Electrical Conductivity for the San Joaquin River at Vernalis with Flow, July 1964 through December 1998

The EC of the San Joaquin River water decreases significantly with increasing flow.

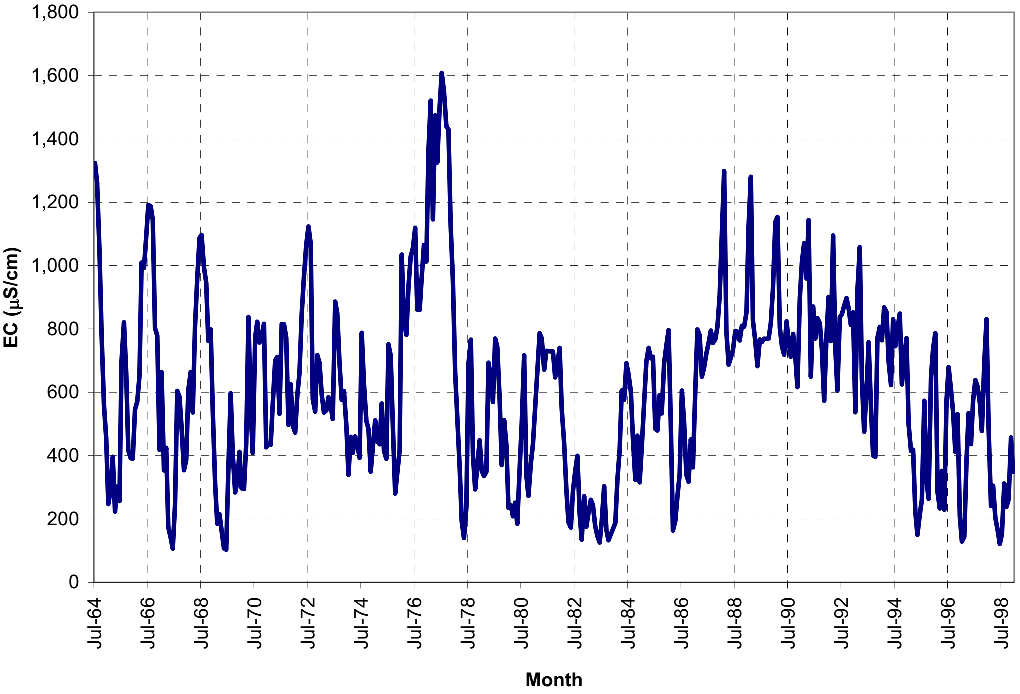

Figure 2C-8 Electrical Conductivity for the San Joaquin River at Vernalis

The EC of San Joaquin River water varies by an order of magnitude.

AGRICULTURAL DRAINAGE

The quality of water flowing into the Delta from the Sacramento River, San Joaquin River, and the eastside tributaries (Mokelumne, Calaveras, and Cosumnes rivers) is affected by drainage from agricultural lands. Water quality in the San Joaquin River, in particular, is dominated by agricultural drainage during much of the year. Discharges from wildlife refuges also contribute to high concentrations of salt, organic carbon, and other contaminants of concern (COC) flowing into the Delta from the San Joaquin River.

Agricultural drainage in the Delta contains high levels of nutrients, suspended solids, organic carbon, minerals (salinity), and trace chemicals such as the organophosphate, carbamate, and organochlorine pesticides. Incremental addition of salts from extensive irrigated agricultural areas of the San Joaquin Valley result in typically elevated total dissolved solids (TDS) concentrations in the San Joaquin River. The salinity of agricultural drainage follows a seasonal trend: the highest concentrations occur during the runoff season in late winter and spring, with peak concentrations occurring in January or February (north Delta, ~820 µS/cm; west Delta, ~1890 µS/cm; and southeast Delta, ~1350 µS/cm). Minimum salinity levels occur in July and August (north Delta, ~340 µS/cm; west Delta, ~920 µS/cm; and southeast Delta, ~740 µS/cm). Salinity is highest for the west region because of its proximity to the ocean, and lowest in the north region, which has the most freshwater inflow.

CHARACTERISTICS OF AGRICULTURAL DRAINAGE

Monthly samples taken by DWR's Municipal Water Quality Investigation (MWQI) at multiple stations throughout the Delta can be used to illustrate the different constituents of drainage water compared to seawater. These differences can then be used as another method for identifying different sources of water at drinking water intakes at different times of the year.

Figure 2C-9 shows the relationship between chloride concentration (Cl) and specific conductance (EC) data from MWQI for the San Joaquin River compared to data for Mallard Island and Jersey Point, where seawater intrusion dominates. A clear split occurs between seawater and San Joaquin agricultural return flow data. Note that the data are plotted only for just beyond the range of drinking water beneficial use (i.e., up to the SWRCB M&I chloride objective of 250 milligrams per liter (mg/L) chlorides).

Over this range of chlorides, the two relationships are as follows:

Seawater Intrusion: $\text{Chloride (mg/L)} = 0.285\ \text{EC}\ (\mu\text{S/cm}) - 50$

San Joaquin Agricultural Return Flow: $\text{Chloride (mg/L)} = 0.150\ \text{EC}\ (\mu\text{S/cm}) - 12$

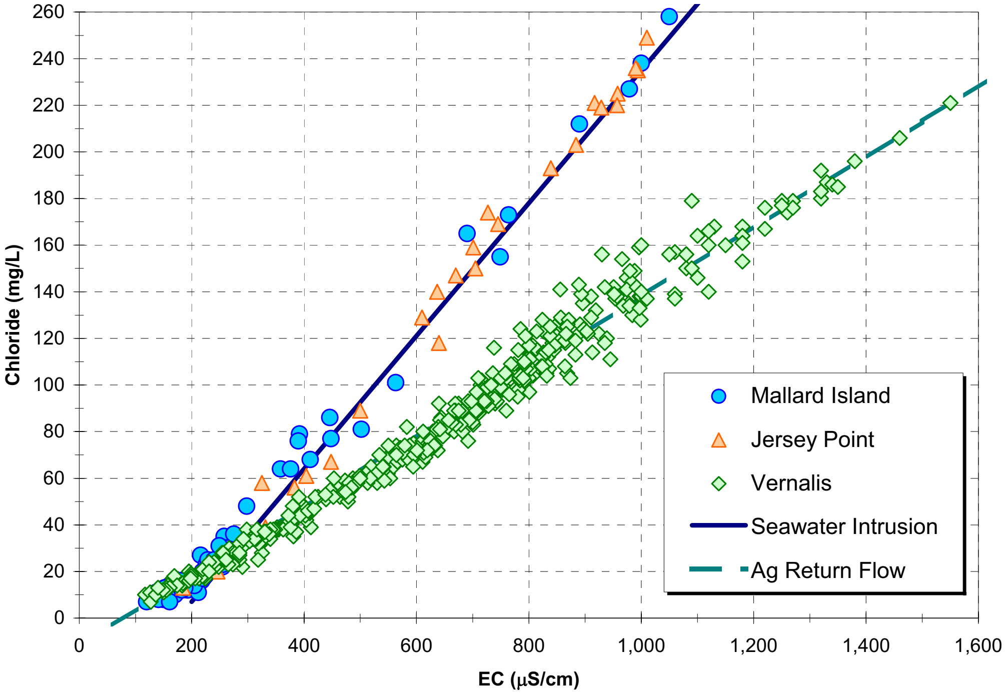

Figure 2C-9 Relationship between Chloride Concentration and Electrical Conductivity

This figure suggests that there is a difference between chloride concentrations and EC depending on whether the source is seawater or agricultural return flows from the San Joaquin River.

A similar difference is observed if bromide concentration is plotted versus EC. However, as shown in **Figure 2C-10**, the relationship between chloride and bromide for seawater intrusion and the San Joaquin River at Vernalis is very close. The seawater intrusion line shown in **Figure 2C-10** represents the ratio of bromide to chloride of 0.0034 found in seawater. As discussed in earlier MWQI data reports, this suggests that Delta water delivered to San Joaquin Valley farms via the Delta-Mendota Canal (DMC) is the primary source of bromide and that any bromide derived from the soils in those areas retains approximately the same bromide-to-chloride ratio as the source water.

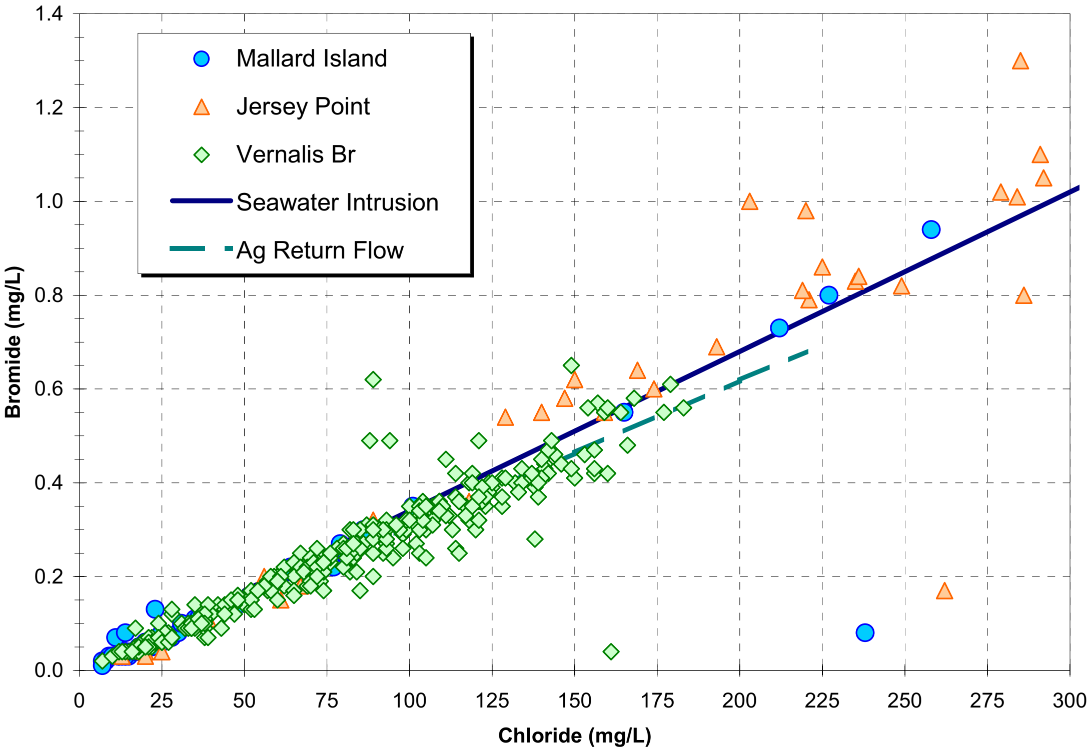

Figure 2C-10 Relationship Between Bromide Concentration and Electrical Conductivity

This figure suggests that a distinct difference does not exist between bromide concentrations and EC depending on whether the source is seawater or agricultural return flows from the San Joaquin River.

Although the primary focus for this Delta Region Drinking Water Quality Management Plan (DRDWQMP) is on bromide (and associated chloride) concentrations at Delta intakes, other minerals can be used to “fingerprint” the sources of water at Delta intakes. **Figure 2C-11** and **Figure 2C-12** show the relationship between calcium and EC and sulfate and EC, respectively, for seawater intrusion and San Joaquin River return flows. The agricultural return flows have significantly more calcium and sulfate than seawater. These plots of various mineral ions versus EC at various drinking water intakes in the Delta can be used to determine seasonal variations in the sources of water for those intakes. Note also that the relationship for San Joaquin return flows, a major source of Delta salinity, may not necessarily apply to other locations with other sources of agricultural and municipal drainage.

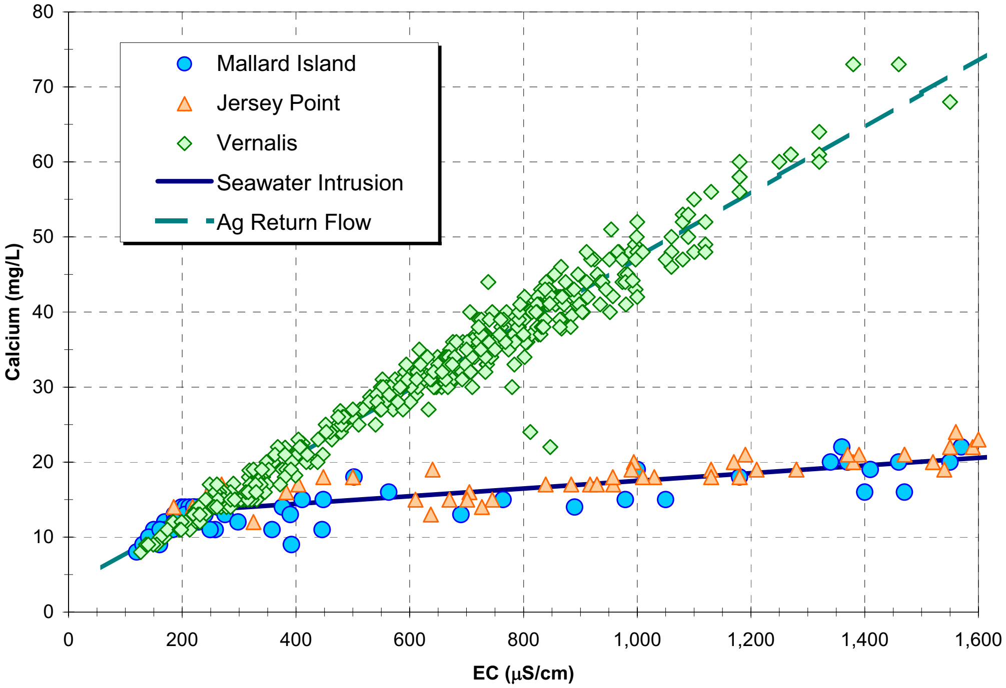

Figure 2C-11 Relationship Between Calcium Concentration and Electrical Conductivity

This figure shows that the calcium-to-EC relationship can be used to identify the source water.

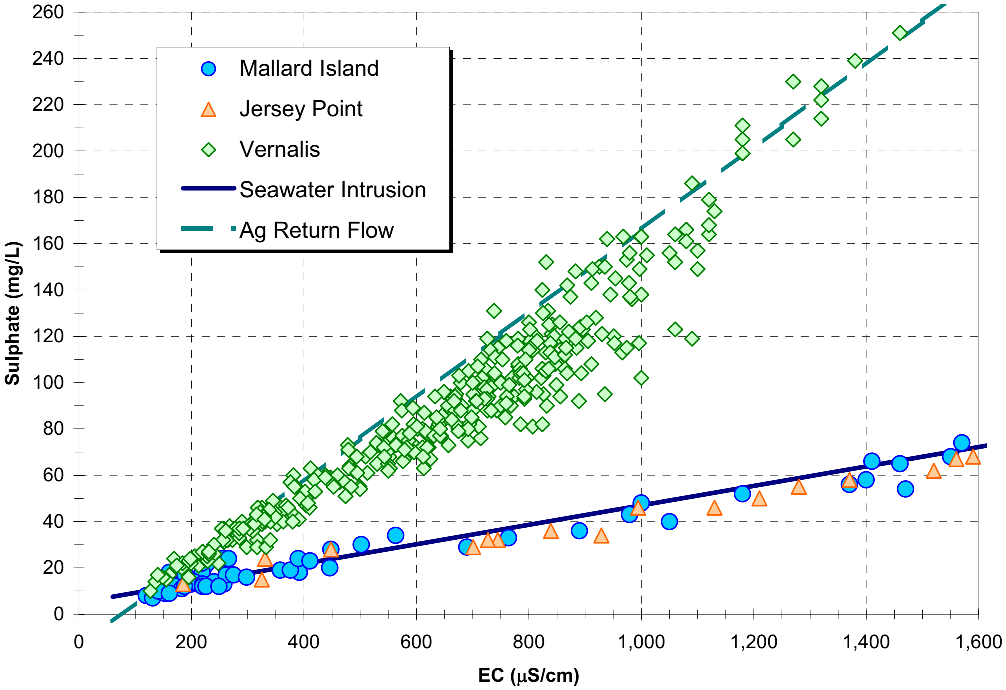

Figure 2C-12 Relationship Between Sulfate Concentration and Electrical Conductivity

This figure shows that the sulfate-to-EC relationship can be used to identify the source water.

The fate of the contaminants entering the Delta from the San Joaquin River depends on the amount of flow, the amount of Delta export pumping, and whether the Head of Old River barrier is in place. Much of the agricultural drainage entering the Delta at Vernalis flows via Old River to the CVP Tracy Pumping Plant where it is re-exported to the San Joaquin Valley. When the Head of Old River barrier is in place, at the junction of Old River with the San Joaquin River north of Vernalis, San Joaquin agricultural drainage cannot reach the Tracy pumps and flows north instead past Stockton, eventually reaching CCWD drinking water intakes.

Similarly, when CVP and SWP export pumps reduce pumping during VAMP (typically April 15 through May 15), local sources of agricultural drainage in the south Delta, and San Joaquin agricultural drainage that entered the Delta earlier, build up, increasing bromide, chloride, and organic carbon concentrations at CCWD intakes.

IMPACTS OF AGRICULTURAL DRAINAGE ON WATER QUALITY AT ROCK SLOUGH INTAKE

Figure 2C-13 shows the Contra Costa Canal at the west of Rock Slough, and the location of CCWD's Pumping Plant No. 1. Local agricultural drainage water is currently discharged directly to Rock Slough near Veale Tract. Seepage also occurs into the unlined section of the Contra Costa Canal near Pumping Plant No. 1. This later impact on CCWD water quality became noticeable after the Los Vaqueros Project was completed and CCWD was able to stop or reduce diversions from Rock Slough in some months. When CCWD is not diverting from Pumping Plant No. 1, local seepage can build up dramatically. **Figure 2C-14** shows the impact of agricultural drainage inflow on water quality between December 2002 and July 2003. During the period of low Pumping Plant No. 1 diversions through the end of March, significant seepage built up in the Contra Costa Canal adjacent to the pumping plant. When pumping resumed, poorer quality water was diverted and higher flow rates prevented the effects of ongoing seepage from being noticeable.

CCWD has identified several actions that could be implemented to eliminate the agricultural drainage problem in the 1993 Los Vaqueros Reservoir Project Environmental Impact Statement/Environmental Impact Report (EIS/EIR). These actions are currently being undertaken as part of CALFED projects (Byron Project, Veale Project). Construction already is underway for relocation of the Veale Tract drain to Indian Slough. Similarly, construction is underway for a new diffuser on the current discharge from Byron Tract. Both projects will effectively eliminate any diversion of these discharges by CCWD. CCWD is studying a project to encase the Contra Costa Canal near Pumping Plant No. 1 to eliminate the second source of contamination. This water quality project was discussed in more detail in **Chapter 4**.

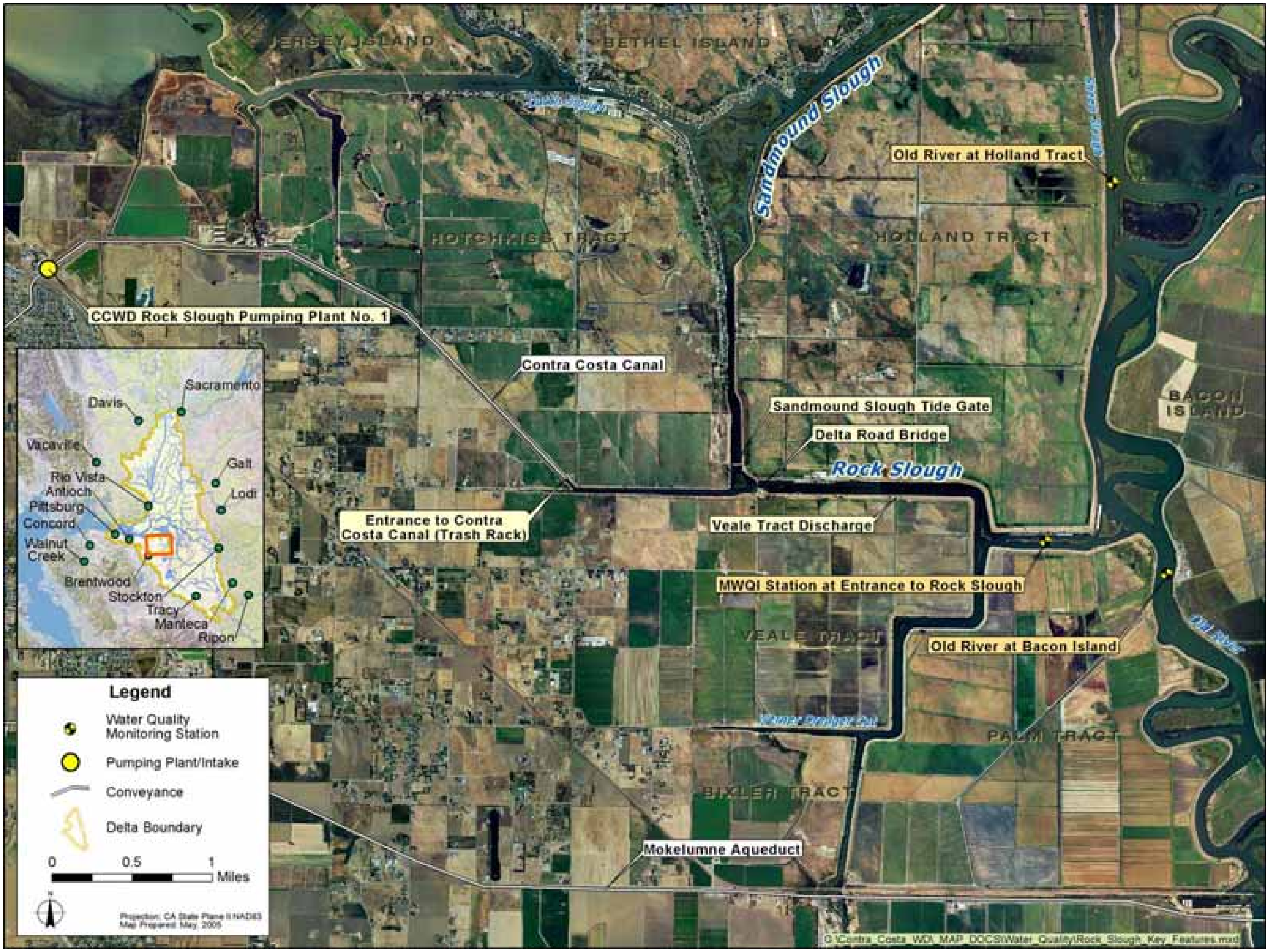

Figure 2C-13 Location of Rock Slough and CCWD Intake at Contra Costa Canal Pumping Plant No. 1

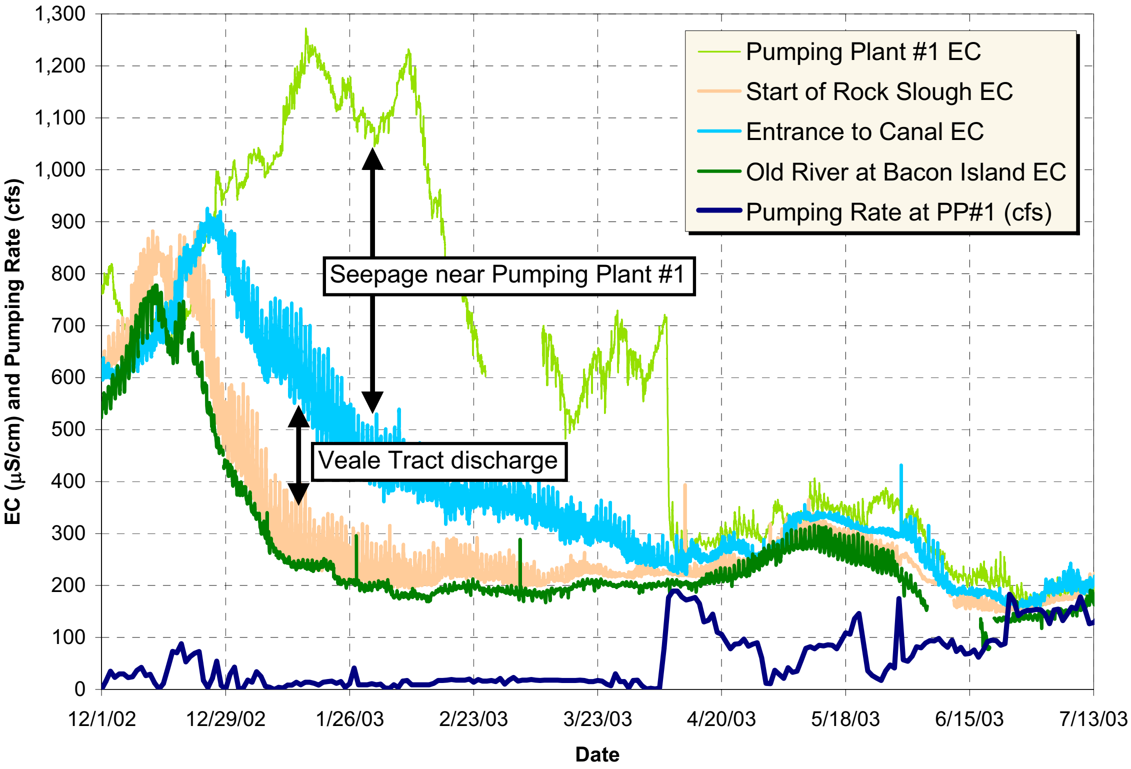

Figure 2C-14 Impact on EC of Agricultural Discharge into Rock Slough in Winter 2002 Combined with Buildup of Groundwater Seepage

The combined impact of agricultural discharge and groundwater seepage during a period of low pumping resulted in elevated salinities at the CCWD Rock Slough intake.

IMPACTS OF AGRICULTURAL DRAINAGE ON OLD RIVER INTAKE

Figure 2C-15 shows the effect of reducing export pumping on water quality at the CCWD Old River intake. VAMP calls for increased San Joaquin River inflows and reduced Delta exports during April and May (typically April 15 through May 15) to increase the survival of outmigrating San Joaquin salmon. Delta exports at Banks and Tracy pumping plants are typically reduced to a total of 1,500 cfs (only 13 percent of permitted capacity). Exports are often ramped up slowly post-VAMP to further protect fish. The long period of reduced exports allows a greater buildup in drainage in the south Delta and at the CCWD intake. This effect is significant for CCWD because chlorides can increase up to and potentially above 50 mg/L, making the water unsuitable for storage in Los Vaqueros Reservoir. With reduced availability of high quality water in Los Vaqueros Reservoir in the fall, CCWD's ability to blend to meet its delivered chloride goal of 65 mg/L (200 µg/L bromide) also will be diminished.

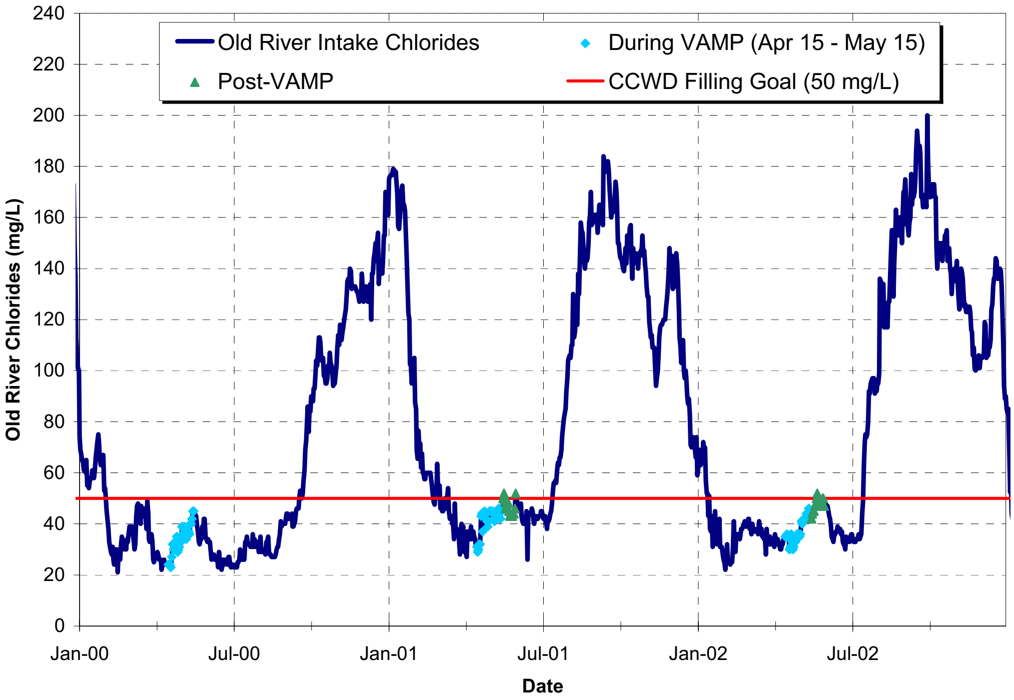

Figure 2C-15 Impact of Reduced CVP and SWP Exports on Chloride Concentration at Los Vaqueros Project Old River Intake During the April-May VAMP Period

Long periods of reduced exports can result in a buildup of drainage and associated salinity in the south Delta.

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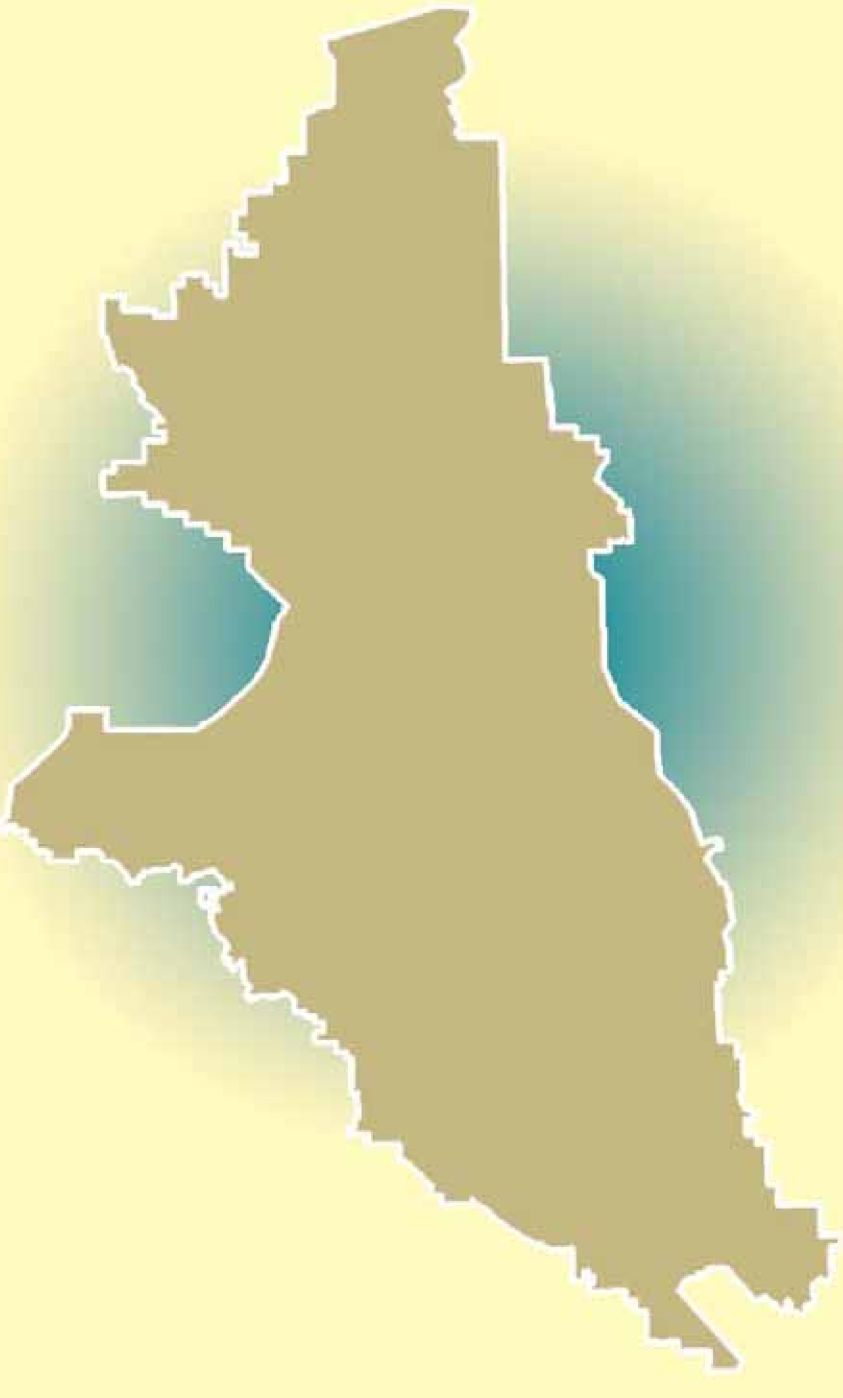

DELTA REGION

DRINKING WATER QUALITY MANAGEMENT PLAN

JUNE 2005

MWH