CALIFORNIA
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AUTHORITY

# CALFED Water Quality Program Assessment Report

June 2005

BROWN AND CALDWELL

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## APPENDICES

## ACROMYNS AND ABBREVIATIONS

| | |
|---|---|
| WQP | CALFED Water Quality Program |
| ROD | CALFED Record of Decision |
| DWS | CALFED Bay-Delta Public Advisory Committee's Drinking Water Subcommittee |
| CALFED | CALFED Bay-Delta Program |
| ELPH | Equivalent Level of Public Health Protection |
| TOC | total organic carbon |
| CUWA | California Urban Water Agencies |
| MWDSC | Metropolitan Water District of Southern California |
| CBDA | California Bay-Delta Authority |
| DHS | California Department of Health Services |
| EPA | U.S. Environmental Protection Agency |
| Bay-Delta System | The San Francisco Bay/Sacramento-San Joaquin River Delta |
| CVP | Central Valley Project |
| USBR | United States Bureau of Reclamation |
| SWP | State Water Project |
| DWR | California Department of Water Resources |
| cfs | cubic feet per second |
| MWQI | Department of Water Resources' Municipal Water Quality Investigations |
| CCWD | Contra Costa Water District |
| DMC | Delta-Mendota Canal |
| EC | electrical conductivity |
| TDS | total dissolved solids |
| THMs | trihalomethanes |
| HAAs | halaocetic acids |
| DOC | dissolved organic carbon |
| USGS | United States Geological Survey |
| TKN | Total Kjeldahl Nitrogen |
| TP | total phosphorous |
| SI-3D | Semi-Implicit-3D Model |
| NGO | non-governmental organization |
| BMP | best management practices |
| CVRWQCB | Central Valley Regional Water Quality Control Board |
| Work Group | The Central Valley Drinking Water Policy Work Group |
| TMDL | total maximum daily load |
| DBP | disinfection by-product |
| NGT | Nominal Group Technique |
| NBA | North Bay Aqueduct |
| SCWA | Solano County Water Agency |

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# EXECUTIVE SUMMARY

The CALFED Water Quality Program (WQP) contracted Brown and Caldwell to help conduct an assessment of the WQP to fulfill a requirement set forth in the CALFED Record of Decision (ROD): "The [Delta Drinking Water] Council [replaced by the Bay-Delta Public Advisory Committee's Drinking Water Subcommittee] will complete an initial assessment of progress toward meeting CALFED Bay-Delta Program (CALFED) water quality targets and alternative treatment technologies by the end of 2003." The ROD also calls for a "final assessment" in 2007. This initial assessment provides a summary of WQP progress to date and recommendations for the WQP. This assessment was developed in close coordination with the Bay-Delta Public Advisory Committee's Drinking Water Subcommittee (DWS).

## Initial Assessment Approach

For the purposes of this initial assessment, Brown and Caldwell and WQP staff have interpreted "progress toward meeting CALFED water quality targets" as progress toward numeric and narrative targets for source water quality and toward achieving an "equivalent level of public health protection" (ELPH). At the time the ROD was developed, the focus was on a balance between improving source water quality and demonstrating alternative treatment technologies. Over time, ELPH has been defined to include a broader array of components. This assessment attempts to evaluate progress throughout this broader array of ELPH components, as a function of progress on several individual ROD commitments. Assessing water quality improvement, or progress toward numeric and narrative targets, is challenging, because it is still too early to see measurable improvements from CALFED-funded projects and because of the complexities of Delta water quality and limitations of existing assessment tools. Progress toward "alternative treatment technologies" has been assessed on the basis of investments in alternative or creative conventional technology demonstrations.

The assessment of project performance is based on information gathered from CALFED staff, and surveys and interviews of project managers. More than half of the project managers provided updated information in response to surveys, and several project managers shared their perspectives and more detailed information through an interview process. A project database was developed and populated to track the progress and status of projects funded during 1999-2004. Performance of the program was then evaluated using four measures – administrative (funding statistics), progress toward ROD commitments, progress toward water quality targets, and progress toward treatment technologies.

An overview of existing Delta water quality data is provided to set the context of both drinking water quality in the Delta, where the largest drinking water intakes are located, and future assessment of programmatic water quality improvements. The complexities of the Delta and important data gaps/remaining questions are highlighted; they include an incomplete data record for constituents of concern, inconsistent analytical methods, and a lack of needed assessment tools to assess causative factors.

## Assessment of the Water Quality Program

Since 1999, CALFED has funded 74 projects focused on improving drinking water quality. Of these 74 projects, 63 were funded by the WQP and 11 were funded by other CALFED programs, including Ecosystem Restoration Program (7 projects), the Watershed Program (3 projects), and the Conveyance Program (1 project). Overall, the CALFED program has invested $195 million in 227 projects to improve both drinking and ecosystem water quality, and many watershed projects contribute to improving overall water quality. Performance of the WQP is evaluated through four categories of measures – administrative (funding statistics), progress towards ROD commitments, progress towards water quality targets, and progress towards treatment technologies. The later three measures consider progress towards achieving ELPH as well.

## Progress through Simple Administrative Measures

One level of assessment focused on administrative measures - funding statistics, the distribution of funds among several categories, and the level of project completion:

- *Project funding:* In the first four years of the program, the WQP has invested $78 million in projects and leveraged $37 million in matching funds. Other CALFED programs have invested $17 million in projects that support drinking water quality improvements.

- *Types of projects funded:* The majority of WQP funds ($58 million) are in the Source Improvement action area, followed by Science and Improved Understanding. As the WQP is in its early stages, more of the funding has been directed toward research and applied studies, versus implementation projects (27percent).

- *Project completion:* As of June 2005, approximately 26 of the WQP-funded projects will be complete, six will be greater than 50 percent complete, and 26 will be less than 50 percent complete.

- *Constituents addressed:* WQP-funded projects focus on organic carbon (28 percent), bromide (24 percent), nutrients (24 percent), and pathogens (17 percent). Many projects address more than one of these constituents.

- *Regional distribution:* Statewide / multiple region projects received the most WQP funding (about $23 million). Thirty-four percent of the WQP-funded projects ($15 million) are in the San Joaquin Valley, and 25 percent ($18 million) are in the Delta. The remaining projects are relatively evenly divided among the Sacramento, Bay Area, and Southern California regions.

## Progress towards ROD Commitments

The majority of WQP funding has been awarded through its implementing or participating agencies. ROD commitments were used to guide the program and its related grant funding processes. Each of the ten ROD commitments has therefore been addressed to some degree. A brief summary of progress on each ROD commitment is presented below:

- *Address drainage problems in the San Joaquin Valley to improve downstream water quality.* Ten projects ($5.3 million) address the recycling of salts from agricultural drainage and dairy farming, and animal feeding operations. A Salinity and Boron Total Maximum Daily Load and Basin Plan Amendment for the Lower San Joaquin River were adopted by the Central Valley Regional Water Quality Control Board in September 2004. The projects that have been funded to date provide an initial start, but considerably more work will be required to fully address this ROD commitment.

- *Implement source controls in the Delta and its tributaries.* 33 projects ($30 million) address nonpoint source improvement, ranging from improving agricultural runoff impairing Delta water quality to supporting development of a Central Valley drinking water policy. Progress on this ROD commitment is in the early stages, but with a comprehensive program to guide more implementation projects in the future, results should become more evident.

- *Support the ongoing efforts of the Delta Drinking Water Council or its successor.* The DWS, convened in February of 2002, has spent the past three years as the public involvement element of the WQP. A significant focus is reviewing program targets and priorities (especially the "equivalent level of public health protection") and providing both comments and stakeholder-level information to the program. This is an ongoing ROD commitment that has been adequately addressed over the first four years.

- *Invest in treatment technology demonstrations.* Four projects ($1.9 million) investigate drinking water treatment, including pH suppression to reduce bromate formation during ozonation, ion exchange resins to remove organic carbon, and UV disinfection. This ROD commitment has essentially been fulfilled, but the issue remains as to whether enough has been done in treatment to inform ELPH or to make progress towards it.

- *Control runoff into the California Aqueduct and other similar conveyances.* Eight projects ($17 million) address nonpoint source runoff into the Contra Costa Canal, the South Bay Aqueduct, and the California Aqueduct. This ROD commitment is essentially fulfilled, but actions to improve conveyances for water quality improvement may be needed to achieve ELPH.

- *Address water quality problems at the North Bay Aqueduct.* Two projects ($558,000) address the water quality improvement of the North Bay Aqueduct. Both aspects of this ROD commitment have been fulfilled.

- *Study recirculation of export water to reduce salinity and improve dissolved oxygen in the San Joaquin River.* A short pilot study of recirculation was conducted in the fall of 2004, showing a water quality improvement at Vernalis. This action is being considered as a part of the solution to the San Joaquin Valley drainage problem.

- *Complementary ROD Actions:* All Complementary ROD actions have made progress. The Bay Area Water Quality and Water Supply Reliability Program examined the feasibility of blending or exchanging source waters among Bay Area utilities to improve water quality. The Metropolitan Water District of Southern California Water Quality Exchange Partnership Program is evaluating the feasibility of water quality exchanges with San Joaquin

Valley partners and working to implement pilot projects. The California Department of Water Resources and the US Bureau of Reclamation are working to develop and implement plans to meet existing water quality standards and objectives for the state and federal water projects.

### Progress towards Water Quality Targets

Existing water quality at the Delta intakes consistently exceeds the ROD target for bromide (except for the Barker Slough intake) and frequently exceeds the target for total organic carbon (TOC). It is still very early in the program to expect measurable improvements from CALFED-funded projects in Delta water quality, and a construct for measuring improvements does not yet exist. However, there has been progress on the ROD commitments for the WQP, including many projects that directly or indirectly reduce constituents of concern in the Delta, through research and implementation of source control, improvements in San Joaquin Valley drainage, and other means. Regional ELPH planning is also in process and will provide frameworks for prioritization of future efforts to improve drinking water quality, from source protection to treatment. Taken together, ROD commitments supporting progress toward water quality targets represent the largest number of projects and funding by the WQP. They also represent the largest amount of work envisioned for the WQP within the ROD and, as a result, are still in process. As more of the projects are completed, and additional water quality improvement projects (e.g., water quality actions of the Delta Improvements Package) are funded and implemented, greater visible progress towards water quality targets, including ELPH, is expected.

### Progress on Treatment Technologies

The ROD commitment to invest in treatment technology demonstration projects has essentially been fulfilled, with two projects on UV disinfection, one on ozone disinfection, and one on ion exchange resins. The commitment to address desalination of agricultural drainage was addressed by a full-scale demonstration of agricultural drainage-water recycling in the San Joaquin Valley. The remaining issue is successful integration of treatment technology within the ELPH construct. As the WQP and the ELPH strategy evolve, more demonstration projects may be warranted or further work on treatment technologies may be identified as a high priority. Treatment will continue to be some part of the solution, just as source improvement will.

### Conclusions and Recommendations

*Comprehensive Understanding of Drinking Water Quality:* The WQP is making serious progress towards gaining an understanding of drinking water quality, through the funding of continuous water quality monitoring stations at key locations in the Delta and at Delta drinking water intakes, the development of high-priority constituent conceptual models by the Central Valley Drinking Water Policy project, and through a few key research studies. It is critical to the success of the Water Quality Program, especially given its shift in focus towards performance and in the overall CALFED emphasis on performance, that it develop a comprehensive understanding of drinking water quality. It can do this through support of the Central Valley Drinking Water Policy and development of regional ELPH plans and performance measures.

*Realistic Schedules and Expectations:* In its first four years, the WQP awarded approximately $78 million in project funds and leveraged an additional $37 million in matching funds. Translating those awards into contracts and project implementation has taken approximately one to two years, and in some cases much longer. The CALFED ROD calls for an evaluation of WQP progress at four and seven years (2004, 2007). The ROD also estimated spending $311 million in the first four years of the program. Although this assessment is an assessment of the first four years, it is not necessarily an assessment of the first four years as envisioned by the ROD. The ROD calls for an assessment of “water quality targets,” yet water quality trends are generally assessed in much longer timeframes, especially for water quality in the highly variable, complex Delta. The WQP needs to develop realistic schedules and expectations as to the outcomes of the program, both at a project level and at a program level. The program also needs to shift its focus to funding on-the-ground implementation projects, to capitalize investments in research, planning, and demonstration phases. Scarce funds should be used more effectively by prioritizing projects, so that funding goes first to projects that will contribute substantially to water quality improvements.

*Coordination between Projects and Program:* The WQP needs to improve coordination between projects and the overall program. Managers of projects funded through the WQP are not always aware of the source of their funding, or the purpose of that funding. Implementing agencies are not always allocated the resources to truly manage the contracted funds, and this lack of resources results in a low prioritization for communication of WQP goals, tracking relevant progress of funded projects, and feeding results back into the WQP. In 2004, several project managers were given their first opportunity to communicate their progress at the CALFED Science Conference, in a consolidated session on drinking water quality. Project management by implementing agencies and program coordination with projects should not be mutually exclusive, and agencies should receive the appropriate resources to manage WQP projects in coordination with the WQP. Communication methods should also be pursued to increase outreach to projects, implementing agency staff, and stakeholders.

*Central Valley Drinking Water Policy:* One of the most important projects in the WQP is the Central Valley Drinking Water Policy development project. This project is investigating the connection between source water quality and treated water quality and developing conceptual models critical to development of program performance measures. The WQP should continue its support of and coordination with the Central Valley Drinking Water Policy development project, including funding of the project through the basin planning phases.

*Role of CALFED in Treatment Technology:* The ELPH target embraces an improvement of drinking water quality through a cost-effective balance of source improvement, treatment improvement, and improvement through actions between source and treatment. The ROD committed to an initial investment in demonstrations of advanced treatment technology. This commitment, as described in the ROD, has been fulfilled. The WQP needs to reevaluate its role in treatment technology, considering the scale of involvement and the unique challenges facing different regions and utilities as identified through regional ELPH plans and stakeholder forums.

*Tools Linking Source and Treated Drinking Water Quality:* The WQP has been appropriately shifting its focus from fulfilling ROD commitments to considering its role in a more comprehensive results-based strategy, through its focus on achieving ELPH. The Central Valley Drinking Water Policy project, discussed in 4.2.4, is an important part of this shift. Another important tool is regional ELPH planning, which gathers local and regional drinking water quality data, strategy, and priorities to inform statewide strategy and priorities. The WQP should retain a high priority for the development of tools linking source and treated drinking water quality, especially regional ELPH planning, the Central Valley Drinking Water Policy, and the development of performance measures.

# SECTION 1

# INTRODUCTION

## 1.1 Project Objective

Brown and Caldwell was contracted to conduct an initial assessment of the CALFED Water Quality Program (WQP) to fulfill a requirement set forth in the CALFED Record of Decision (ROD). The ROD states that the, "[Delta Drinking Water] Council [or its successor] will complete an initial assessment of progress toward meeting CALFED water quality targets and alternative treatment technologies by the end of 2003." The ROD also requires a "final assessment" by 2007. The Delta Drinking Water Council, which was instrumental in informing the program's targets, has subsequently been replaced by the Drinking Water Subcommittee (DWS) of the CALFED Bay-Delta Public Advisory Committee. The DWS is a stakeholder group that reviews the WQP and provides comments, and as such, is a key audience for this initial assessment of WQP progress.

For the purposes of this initial assessment, Brown and Caldwell and WQP staff have interpreted "progress toward meeting CALFED water quality targets" as progress toward numeric and narrative targets for source water quality and ELPH. At the time the ROD was developed, the focus was on a balance between meeting numeric and narrative source water targets and investing in treatment technologies. Over time, ELPH has been defined to include a broader array of components. This assessment attempts to evaluate progress throughout this broader array of ELPH components, as a function of progress on several individual ROD commitments. Assessing water quality improvement, or progress toward numeric targets, is challenging, because it is still too early to see measurable improvements from CALFED-funded projects and because of the complexities of Delta water quality and limitations of existing tools. Progress toward "alternative treatment technologies" has been assessed on the basis of investments in alternative or creative conventional technology demonstrations. More specific performance measures are described below.

## 1.2 Background

For context, a brief description of the CALFED Bay-Delta Program (CALFED), the WQP, and documents relevant to the WQP assessment are provided. This background is not meant to be a comprehensive description of CALFED or the WQP.

**CALFED.** The CALFED Bay-Delta Program is a joint state-federal effort with four goals: to improve water supply reliability, water quality, and levee reliability, and to restore the largest estuary on the West Coast. CALFED is implemented by several state and federal agencies, with oversight and coordination by the California Bay-Delta Authority. The program was originally envisioned with a thirty-year planning horizon. The four goals are implemented through eleven CALFED program elements, which include the WQP and several other programs that can also positively affect water quality such as storage, conveyance, ecosystem restoration, and watershed. The ROD outlines a general water quality goal of "continuously improving Delta water quality for all uses, including in-Delta environmental and agricultural uses." CALFED also has programmatic goals of coordination, transparency, and accountability.

**Water Quality Program.** One of the eleven CALFED program elements, the WQP focuses on drinking water quality and indirectly on agricultural water quality. The WQP is implemented by the U.S. Environmental Protection Agency, the California Department of Health Services, the State Water Resources Control Board, and the Regional Water Quality Control Boards, referred to as "implementing agencies." The implementing agencies also coordinate closely with the California Department of Water Resources and the U.S. Geological Survey, referred to as "participating agencies."

As stated in the ROD, the goal of the WQP is to provide "safe, reliable, and affordable drinking water in a cost-effective way," with a target to "achieve either: (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 μg/L bromide and 3.0 mg/L total organic carbon, or (b) an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies." The ROD identifies ten WQP commitments - an initial list of projects/activities necessary to make progress toward water quality improvement (see Section 3.3 for more detail).

The WQP ROD targets are essentially surrogates for the recognition and continual linkage of source water quality with treated water quality, especially as treated water quality regulations grow increasingly stringent over time, the Delta system is changing in response to other needs, and treatment plants increasingly require higher quality raw water. The Central Valley Drinking Water Policy ROD commitment seeks to formalize this linkage between source and treated water quality. This "equivalent level of public health protection" (ELPH) approach is the backbone of the WQP, and the program is based on the concept of a "cost-effective combination of alternative source waters, source control, and treatment technologies." When the ROD targets were initially developed, more stringent regulations were anticipated. Although these regulations have been delayed, more stringent regulations are likely within the 30-year planning horizon of the program, which will require an adaptive approach to water quality constituents of concern

To better identify the elements of ELPH, the DWS assisted the WQP in developing a visual representation of the range of alternatives or tools to protect water quality from source water improvement, to conveyance and storage, to treatment technologies, given the geography of the Bay-Delta water operations systems. This representation is referred to as the "ELPH diagram" (Appendix A), and the representation is described in a narrative called the "CALFED Drinking Water Quality Conceptual Framework[1]." The challenge for the WQP is to combine this construct with conceptual models of constituents of concern to produce an overall strategy to achieve its water quality goals. Regional ELPH planning (or regional drinking water quality management planning) has emerged as a critical tool for making these important connections. In recognition of this shift, the WQP also classifies activities by "action areas" (Appendix A): source improvement, treatment options, regional ELPH planning, science and improved understanding (monitoring and assessment), and program management. These action areas form the structure for WQP planning documents, with the first attempt to formalize this approach being the Strategic Plan, which was developed over 2003-2004 and should be completed in 2005.

The WQP has identified a number of water quality constituents of concern in addition to bromide and total organic carbon (TOC). Numeric targets for these constituents were originally listed in the Appendix to the Water Quality Program Plan and have been reiterated in recent Multi-Year Program

[1] Available at the CALFED WQP Website: http://calwater.ca.gov/Programs/DrinkingWater/DrinkingWater.shtml.

Plans. Numeric targets include: chloride (250 mg/L, 150 mg/L, same as D1641), nutrients (10mg/L or no increase in nitrate levels), total dissolved solids (<220 mg/L 10-year average or <440 mg/L monthly average), pathogens (< 1 oocyst/100L for *Giardia* and *Cryptosporidium*), and turbidity (50 NTU). These key constituents are being addressed in the development of the Central Valley Drinking Water Policy. The relevance of these goals will continue to be examined through the Central Valley Drinking Water Policy process, conceptual model and performance measure development, and through adaptation to changing treatment regulations.

The types of projects funded by the WQP are highly reflective of the source of their funding. Bond funding, for example, has been very explicit in the categories and types of projects for which the funds can be used. Generally this funding does not support system-level monitoring and assessment, or performance measure development type activities, and often is restricted to construction projects. Only the 2001 grants program, funded by the State General Fund, permitted project funding in all areas, which allowed the program to fund the construction of water quality monitoring stations and installation of monitoring equipment. The following two rounds of funding (2002 and 2003) were restricted primarily to the Source Improvement action area. Most of the WQP-funded projects have been selected through open competitive grant programs. Outside of CALFED, implementing and participating agencies have existing water quality activities that also contribute to improving drinking water quality.

**Performance Measures.** Measuring performance and using performance to guide implementation is a major emphasis of the CALFED program, as seen in the ROD. The WQP has not yet developed comprehensive performance measures, although it is making some progress on data assembly and conceptual model development. For the purposes of this assessment, Brown and Caldwell worked with WQP staff to develop four types of interim measures, loosely based on CALFED Science Program guidance.

> *Simple administrative measures* include "funding statistics," such as the number of projects funded in a region, or funding to address specific water quality constituents. These indicators are an indirect measure of program progress, as they use funding and project status as a measure of progress towards WQP goals.
>
> *Progress towards ROD Commitments* breaks down progress into individual ROD commitments and action areas, examining the progress made in each action area through funding and project implementation status. These measures are examined for balanced implementation of program elements and status in fulfilling the original commitment or reason for change in priority.
>
> *Progress towards Water Quality Targets* responds to the ROD intent for the initial assessment of progress. This measure examines water quality throughout the Delta and the tributaries, to determine if the program has progressed towards its source water quality targets, while remaining mindful of the progress towards ELPH.
>
> *Progress towards Treatment Technologies* responds to the ROD intent for the initial assessment of progress. This measure examines treatment technology investments, to determine if the program has progressed in advancing treatment technology to improve water quality, while remaining mindful of the progress towards ELPH.

## 1.3 Program Assessment Approach

This report assesses WQP progress by evaluating the status and nature of project implementation, and by assessing progress toward drinking water quality targets and treatment technology. The assessment is made in a quantitative and qualitative manner, collecting and presenting both program statistics and individual experiences. The main focus of the assessment is on WQP-funded projects, while also including drinking water quality projects funded by the CALFED Ecosystem Restoration, Conveyance, and Watershed programs.

An overview of existing water quality in the Delta provides context for assessing progress towards program targets. Ideally, implementation follows program priorities and each project has measurable contributions to water quality improvement. At this stage in the program, however, many efforts have not reached the implementation stage, or where they have, they are not yet completed. The high variability and complexity of existing Delta water quality also poses a challenge for assessing progress, as well as the limitations of current tools and data. As tools and information improve in the future, projects are completed and WQP performance measures are developed, direct, detailed assessments will be possible. Given the status and schedules of current projects this information is unlikely to be available before 2007, the ROD date for a final assessment of the WQP.

### 1.3.1 Existing Delta Water Quality (Section 2)

The Bay-Delta system is a highly complex, highly managed and regulated water system which supports many uses throughout the state. This report provides context for the WQP by describing existing water quality of the Bay-Delta system. This is, however, only an initial step in establishing the context for the WQP, given that a multitude of drinking water systems across the state take Delta water, transport it, store it, blend it, and treat it in many different ways. Characterization of water quality at locations downstream of drinking water sources was beyond the scope of this initial assessment, but will be an important component of a more comprehensive final assessment.

The Delta itself is also very difficult to analyze, due to the variability in water quality and flow conditions, the limitations of data collection methods, the historic lack of focus on constituents of interest to drinking water, and the complexities of the constituents of concern. In spite of this, it is imperative for the WQP to more fully develop water quality information, to strategically implement the program and to fully transition to a performance-driven approach.

Water quality data were gathered and evaluated for the five principal water intakes in the Delta Harvey O. Banks Pumping Plant, Barker Slough Intake, Tracy Pumping Plant, Rock Slough Intake, and Old River Intake), as well as two tributary locations (at the downstream end of the Sacramento and the San Joaquin Rivers). Historical data at these locations for organic carbon, salinity, nutrients, and pumping and flow rates are presented in Section 2. In addition, this section provides some information on current models and other tools that are being developed to better characterize flow and constituents in the Delta and its tributaries.

Agencies treating Delta water have invested billions of dollars in recent years to upgrade water treatment plants so that drinking water regulations can be met or exceeded with Delta water. Treating Delta water will become increasingly challenging as drinking water regulations become more stringent and as the loads of constituents of concern discharged to the Delta and its tributaries increase as the population of the Central Valley grows. Although agencies try to stay ahead of regulations so that they will be in compliance when regulations go into effect, some agencies are finding this increasingly challenging.

### 1.3.2 Overview and Assessment of Water Quality Projects (Section 3)

Information was obtained from CALFED staff, implementing agency staff, and project managers to assess the degree of funding and implementation of projects funded by the WQP and other related CALFED programs. CBDA staff collected project lists, contact information, and proposals. Project managers were contacted through a survey to obtain detailed information on the objectives and status of each project. A number of project managers and agencies were interviewed to obtain additional information on selected projects.

A survey was developed with the assistance of a Technical Advisory Group that included members from the California Urban Water Agencies (CUWA), Metropolitan Water District of Southern California (MWDSC), California Bay-Delta Authority (CBDA), California Department of Health Services (DHS), and the U.S. Environmental Protection Agency (EPA). The survey was sent to project managers via email in August 2004. Questions addressed project status, key findings, changes in scope of work, difficulties encountered on the project, and other information. One of the goals of the survey was to ascertain the impacts these projects expected to have on the objectives of the WQP.

Information was then compiled into a project database, including project title, project description, project manager, contact information, project funding, project action area, and degree of implementation. This database was used to generate simple administrative measures, such as funding statistics, and to identify projects supporting the various ROD milestones.

A subset of project managers was interviewed to obtain more qualitative information regarding the potential contributions that many of these projects would make towards WQP goals. Project managers were also asked to provide recommendations on how the WQP could be improved and their views on the accomplishments of the WQP.

Finally, progress of the program was assessed in four categories, as described previously.

### 1.3.3 Conclusions and Recommendations (Section 4)

Conclusions from the WQP assessment and recommendations for future direction and improvements in the WQP are provided in the individual sections and summarized in Section 4.

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# SECTION 2

# EXISTING DELTA WATER QUALITY

This section presents a summary of the drinking water quality context of the San Francisco Bay/Sacramento-San Joaquin River Delta (Bay-Delta system) and data on the WQP priority drinking water constituents of concern. The objective of this section is to provide initial baseline data for the context of programmatic performance assessment and quantification of individual project contributions to water quality. It is not meant to be a comprehensive explanation of drinking water throughout the CALFED solution area or to encompass the breadth of the ultimate ELPH solution area, but instead highlights the water quality conditions at the major Delta drinking water intakes and at the end points of the major tributaries to the Delta. Initially we attempted to evaluate whether there were visible water quality improvements in the Delta resulting from implementation of WQP efforts. However, we quickly realized the challenge of quantifying water quality changes resulting from a program very early in its implementation.

## 2.1 Hydrologic and Hydrodynamic Influences

The Bay-Delta system is the largest estuary on the West Coast. It is a maze of tributaries, sloughs, and islands and a haven for plants and wildlife, supporting over 750 plant and animal species. The Bay-Delta includes over 738,000 acres in five counties and is critical to California's economy, supplying drinking water for two-thirds of Californians and irrigation water for over 7 million acres of the most highly productive agricultural land in the world. The Bay-Delta is also the hub of California's two largest water distribution systems - the Central Valley Project (CVP) operated by the United States Bureau of Reclamation (USBR) and the State Water Project (SWP) operated by the California Department of Water Resources (DWR). Together, these water development projects divert about 20 to 70 percent of the natural flow in the system depending on the amount of runoff available in a given year. These projects were developed to provide reliable water supply and water quality in spite of the natural seasonal and geographic variability of the California climate, where precipitation is concentrated in the late fall to mid-spring period and most of the precipitation falls in the northern part of the State.

Water quality in the Delta is influenced by a number of major factors, including the water quality of its tributaries, tidal cycles, Delta Island water quality influences, Delta bathymetry (depth and contours of the underwater surface), and tributary flow patterns. Water quality in the Delta is also highly dependent on the location of interest. For the purposes of this report, locations of interest are the drinking water intakes identified in the ROD and Water Quality Program Plan: the Barker Slough Intake on the North Bay Aqueduct, Harvey O. Banks Pumping Plant, Tracy Pumping Plant, Contra Costa Canal Pumping Plant #1, and the Contra Costa Water District (CCWD) Old River Intake. Some of the other constructed facilities that can affect water quality through flow manipulation and bathymetry changes are upstream storage reservoirs, the temporary South Delta barriers, the Delta Cross Channel, ecosystem restoration projects, and flood control projects.

### 2.1.1. Delta Tributaries

The major tributaries to the Delta are the Sacramento and San Joaquin Rivers, and the minor tributaries are the Mokelumne, Calaveras, and Cosumnes Rivers. Woodard reports that all the minor tributaries together, of generally high water quality, account for only 4 percent of tributary flow to the Delta[1]. The minor tributaries are not examined in this report. The Sacramento River provides the majority - 70 percent - of tributary flow (by volume) into the Delta, not counting water through the Yolo Bypass, and generally its water quality is indicative of the best water quality that can be seen in the Delta[1]. Daily flow values from 1983 to 2004 with hydrologic year type[2] for the Sacramento River at Freeport are shown in Figure 2-1. During wet years, wet season flows on the Sacramento River can be as high as 80,000 cubic feet per second (cfs). Figure 2-2 shows the flows diverted to the Yolo Bypass, which are dependent on the total flow in the Sacramento River. During extremely high flow periods, the flow in the Yolo Bypass can reach flows of four times that in the Sacramento River, otherwise, during dry and critical years, it remains low. The San Joaquin River provides 13 percent of tributary flow into the Delta, and is generally dominated by agricultural return flows. The flow rate in the San Joaquin River is frequently less than a third of the flow in the Sacramento River (Figure 2-3). During the wet-weather season the San Joaquin River rarely achieves flows of 40,000 cfs, except during wet years.

Tributary flows into the Delta are highly managed, with the exception of extreme flooding events. Regulatory objectives within the 1995 Bay-Delta Water Quality Control Plan for the Bay-Delta and within assigned water rights and biological opinions frequently dictate water operations of the SWP and CVP. Currently, water quality is most affected by compliance levels for Delta outflows (minimal freshwater flows required to flow into the Bay initiated to protect fishery habitat), agricultural and municipal water quality standards, and pumping regime changes to protect native fish. Tributary flows are provided by a combination of natural flow and controlled releases from upstream reservoirs, accompanied by agricultural return flows, natural runoff (originating from various land use types), and wastewater and industrial flows. Reservoir flows from upstream reservoirs can take several days to reach the Delta, based on the distance from reservoir to Delta. Water quality of tributary flows frequently varies seasonally and/or daily, dependent on the constituent of interest. Because of the highly regulated nature of these flows, the multiple purposes of flow management, and the complexity of activities occurring in their watersheds, it is challenging to pinpoint specific causes of water quality degradation.

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[1] Woodard, Richard. Sources and Magnitudes of Water Quality Constituents of Concern in Drinking Water Supplies taken From the Sacramento-San Joaquin Delta. Prepared for the CALFED Bay-Delta Program. September 2000.

[2] http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST, based on State Water Resources Control Board's Water Rights Decision 1641.

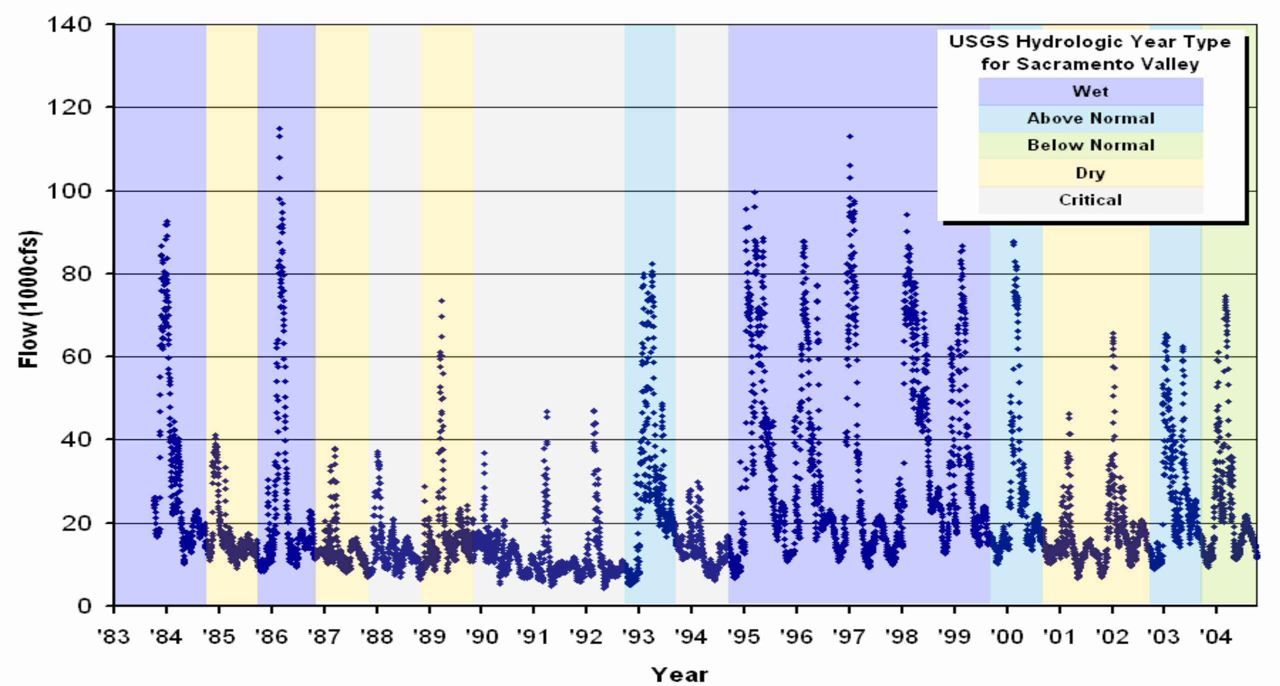


**Figure 2-1. Sacramento River flow at Freeport and hydrologic year type[3] [Data obtained from the DWR Interagency Ecological Program (IEP)]**

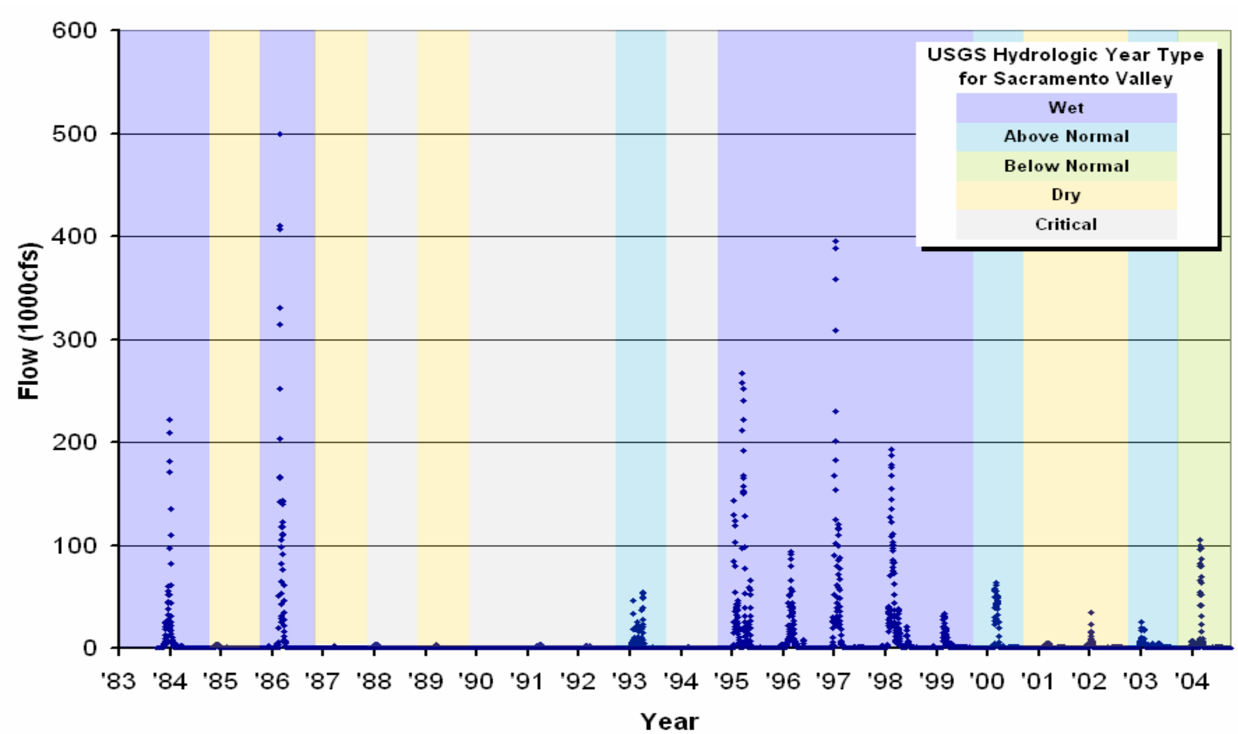


**Figure 2-2. Yolo Bypass flow and hydrologic year type for the Sacramento Valley [Data obtained from the DWR IEP]**

[3] Throughout this document, USGS Hydrologic Year Type is referenced – this is the same as described in SWRCB Water Rights Decision 1641.

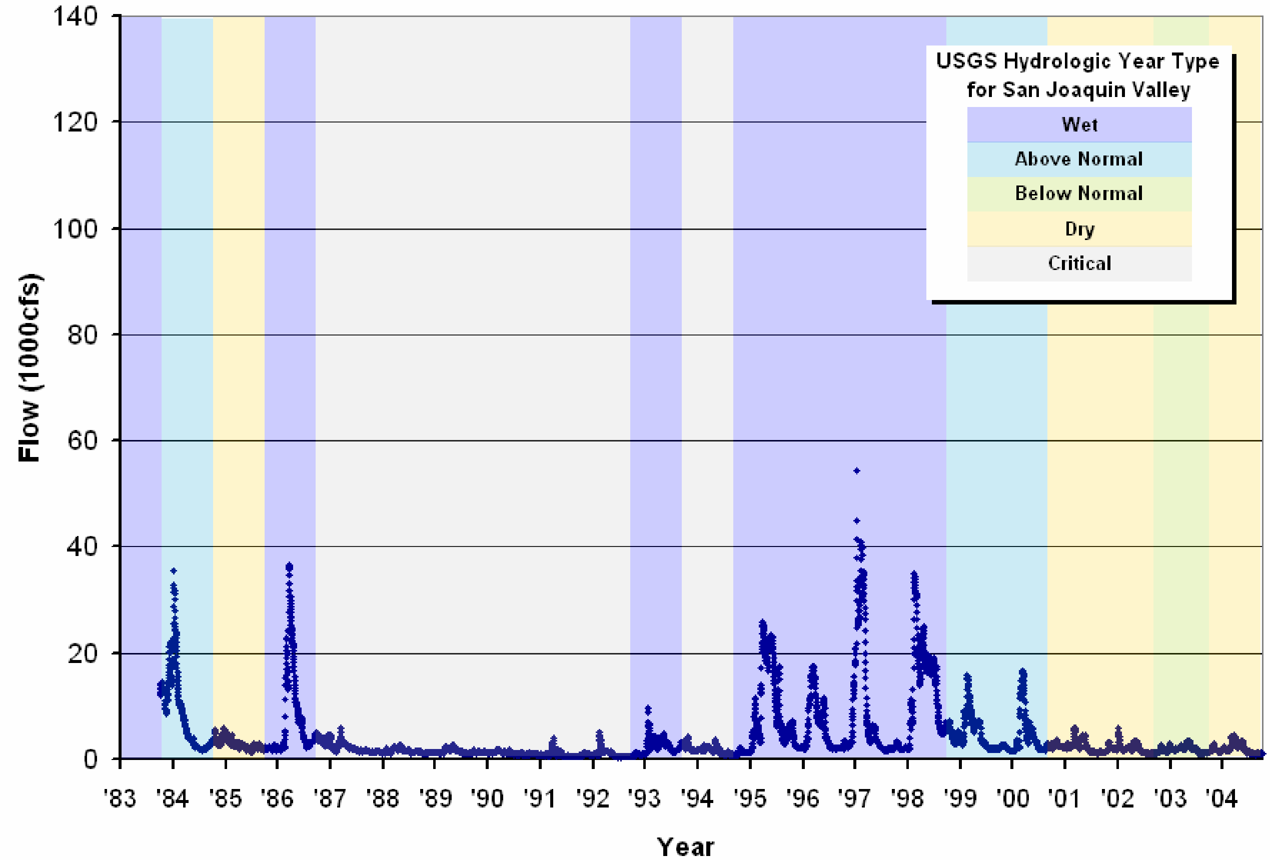


**Figure 2-3. San Joaquin River flow at Vernalis and hydrologic year type [Data obtained from the DWR IEP]**

## 2.2 Water Operations

### 2.2.1 Tidal Flows and Delta Island Effects

The Bay-Delta system is a large estuary, dominated by tidal cycles that dwarf the net flow in most of the Delta. The bathymetry of the Delta, combined with its hydraulic connection with the Pacific Ocean and lack of constant, high-volume tributary inflow, result in a dramatic push and pull between ocean and rivers. The tidal cycle fluctuates at three frequencies: twice fluctuating unevenly from high to low stages over a lunar day - 24 hours and 50 minutes (lunar declination effects), filling and draining the Delta over a 14.7-day spring-neap cycle (lunar phase effect), and fluctuating slightly on monthly and annual cycles (parallax effects)[4]. Tidal dynamics are also influenced by meteorological conditions, such as wind-caused mixing, and by bathymetry of the Delta, such as increased tidal fluctuations due to channelization of flows through sloughs and around Delta islands. Numerical models have been developed to mimic the system and help understand the dynamics of flow which can strongly influence water quality.

Delta islands were reclaimed through levee construction and today levees are crucial because islands are currently below sea level and still actively farmed. Water accumulates on the islands through the

[4] National Oceanic and Atmospheric Administration's "Our Restless Tides" at http://140.90.121.76/restles1.html.

hydrostatic pressure on groundwater, through-levee seepage, precipitation, and irrigation. The water levels on the islands are actively managed by pumping water from the islands into the Delta channels. Delta island agriculture is also a user of Delta water, pumping water directly from nearby channels for irrigation and using the same channels for agricultural return flows. Historical levee breaks that remained open have created large flooded islands which have significantly changed Delta bathymetry. Levee breaks, such as Andrus Island in 1972 and Upper Jones Tract in 2004, have altered bathymetry over a shorter-term, creating increased volume and pulling ocean water into the Delta, as well as storing water in large shallow areas until levees are repaired and pump out completed.

### 2.2.2 Water Operations within the Delta

The balancing of water supply, fishery, and water quality needs is a critical underpinning of Delta operations. Water supply systems, such as the CVP and SWP, were essentially designed to optimize water supply, and have since been constrained through regulations to protect threatened and endangered species and other beneficial uses of water, like drinking water and recreation. CVP and SWP reservoirs located upstream of the Delta on its major tributaries are managed for multiple purposes such as meeting water supply, water quality, ecosystem, recreation, and hydroelectric needs, and providing flood control space. The upstream reservoirs attenuate the highly variable natural flow of the tributaries, capturing high volume flows during short winter and spring periods and releasing water throughout the year. Bay-Delta operations are determined by a water rights system (where water can be attached to riparian lands, or be allocated to users based on a “first in time, first in right” system) and by numerous other regulatory and contractual constraints which dictate the needs of each of the multiple purposes, with the goal of maximizing water supply deliveries.

Flow-related fishery protections are afforded through cold water releases from upstream reservoirs, proscribed flow volumes in streams and rivers, salinity conditions in the Bay-Delta through tributary flows, and pumping reductions to prevent direct entrainment. Beneficial uses of surface water, including fisheries, municipal, industrial and agricultural, are protected through numerous water quality standards which are applied through discharge permits and waivers and through Total Maximum Daily Load programs. Some constituents of concern for drinking water, such as organic carbon, are not currently included in surface water regulatory programs.

The Delta itself has also been physically changed in response to specific needs. The Delta Cross Channel allows Sacramento River water to flow into the interior Delta to improve water quality but can be shut to prevent fish or flood flows from entering. The temporary South Delta barriers improve the water quality and water levels in the south Delta (the area within the barriers) but also redirect lower quality San Joaquin River water to the South Delta and Contra Costa Water District intakes. The South Delta intakes themselves exert an influence on the hydrodynamics of the Delta.

The CALFED Bay-Delta Program is considering additional physical changes – changing the operations of the Delta Cross Channel, building a Through Delta Facility (an additional “Delta Cross Channel” to increase conveyance capacity), increasing permitted pumping capacity at Banks Pumping Plant, building permanent South Delta barriers, and making physical changes to Franks Tract to reduce its transfer of ocean water into the south Delta.

The five principle intakes withdrawing water from the Delta ("Intakes") include Harvey O. Banks Pumping Plant (Banks), Tracy Pumping Plant, North Bay Aqueduct (Barker Slough Intake), Contra Costa Canal Pumping Plant #1 (Rock Slough Intake), and the CCWD Old River Intake. Monthly average pumping rates for calendar years 1998 to 2004 for the Intakes are shown in Figures 2-4 and 2-5. The years from 1998 to 2004 most closely represent the current pumping rates at these intakes after a number of pumping operation changes, including the addition of Los Vaqueros Reservoir and the most recent pumping changes for fishery protection. The pumping rates at Banks and Tracy Intakes follow a similar trend and intake rate, with the lowest pumping in spring months, and higher pumping rates for the other months. Pumping rates at Barker Slough and Rock Slough Intakes peak in June and July, with the lowest pumping rates during the wet-weather season. The pumping rates at the Old River Intake are the most variable, and in general, the pumping rate is lower in fall months and highest in April and June. In general, pumping rates are driven by the need to maintain a water system capable of meeting water use demand, which can include filling reservoirs south of the Delta (like San Luis, Los Vaqueros, or Diamond Valley) and operating water management programs (like groundwater banking), while being limited by regulatory, water supply, or water quality constraints.

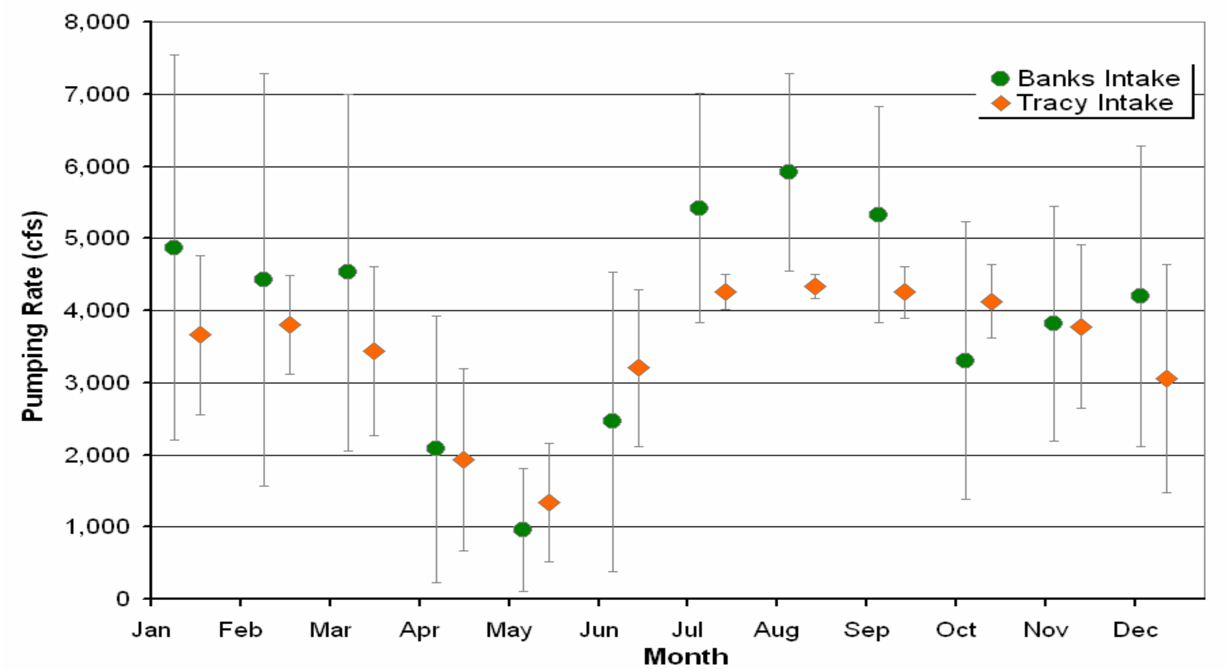


**Figure 2-4. Monthly average and standard deviation of pumping rates at Banks and Tracy Intakes (calendar year 1998-2004) [Data obtained from DWR and USBR]**

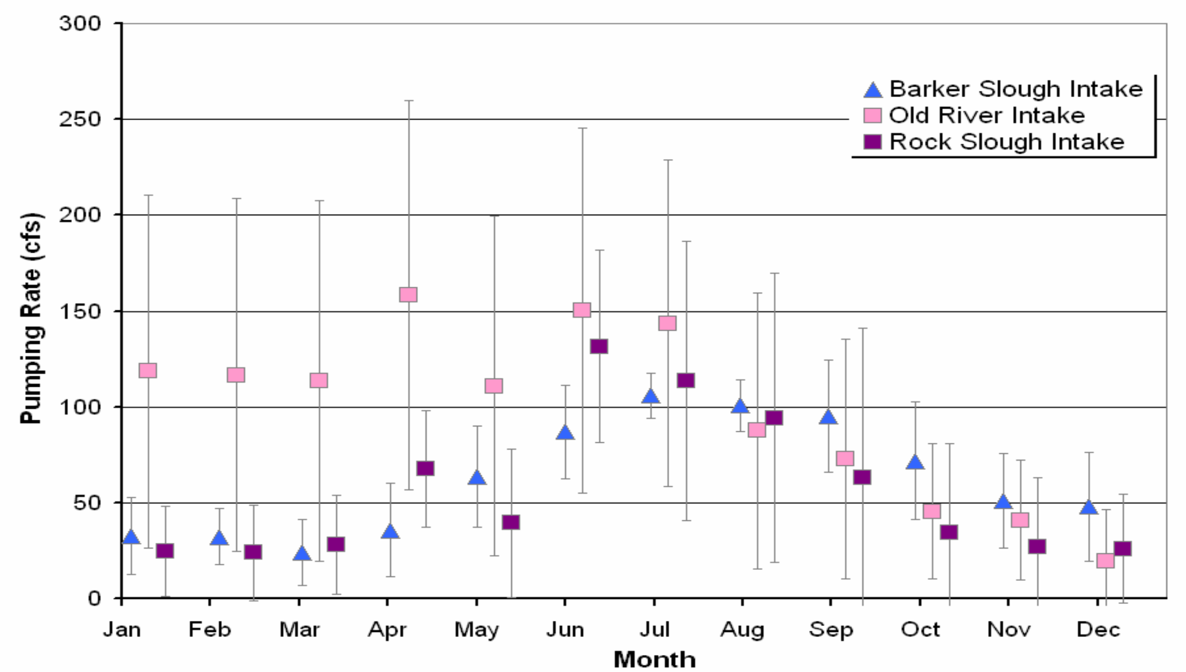


**Figure 2-5. Monthly average and standard deviation of pumping rates at Barker Slough, Old River, and Rock Slough Intakes (calendar year 1998-2004) [Data obtained from DWR and CCWD]**

The Calculated Delta outflow is an approximation of the amount of water flowing out of the Delta system to the San Francisco Bay, presented in Figure 2-6. Delta Outflow is calculated by the Interagency Ecological Program's Dayflow model[5]. The model, in its simplest form, calculates the total freshwater input to the Delta through river flows and precipitation measurements, and subtracts the sum of Delta pumping and estimated consumptive use; the remainder is the calculated Delta Outflow. While the calculated Delta Outflow does not demonstrate the tidal influences on the Delta system, it provides a perspective on the total freshwater flow leaving the Delta and the peaks in seasonal and hydrologic year flow.

[5] http://www.iep.ca.gov/dayflow/index.html.

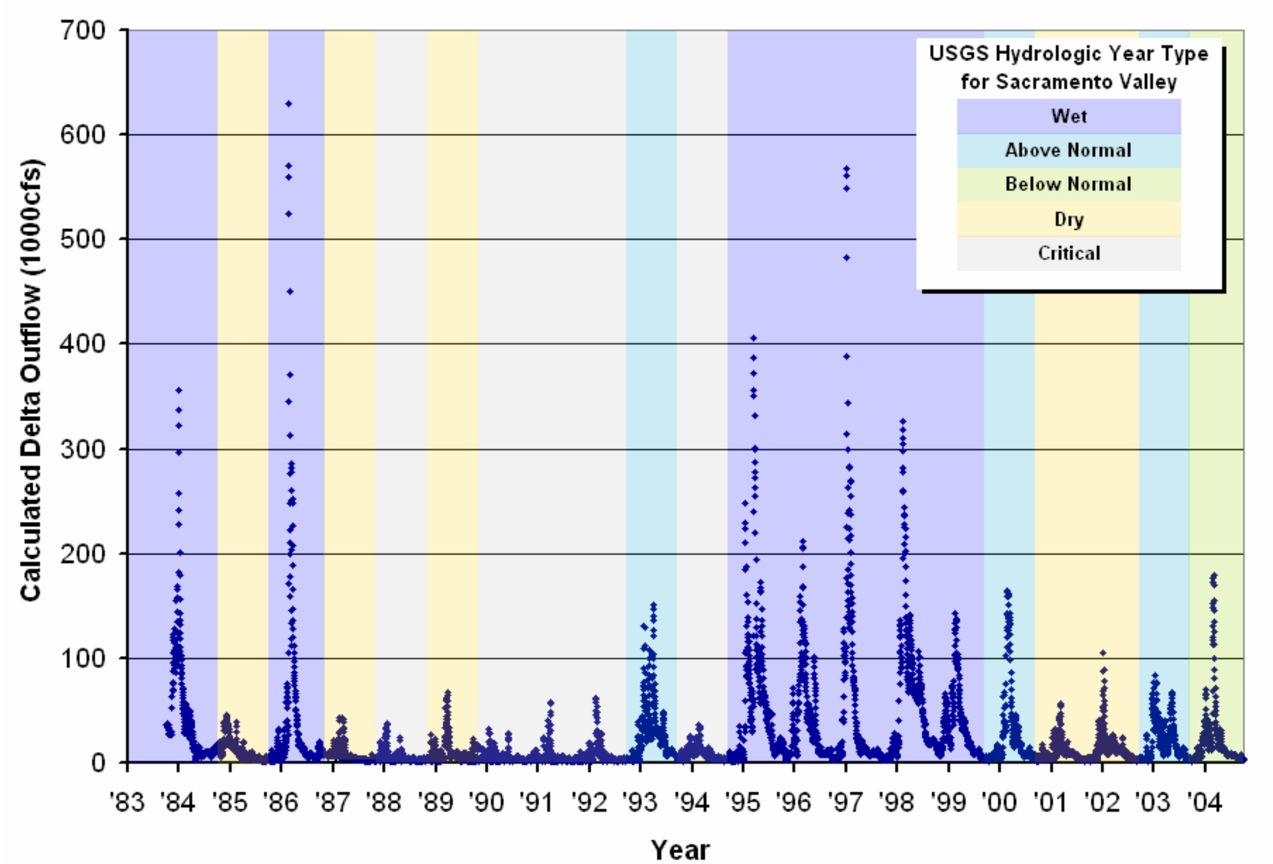


**Figure 2-6. Calculated Delta Outflow from the Dayflow model and Sacramento River hydrologic year type [Data obtained from DWR IEP]**

## 2.3 Water Quality Assessment

The Bay-Delta system is a source of drinking water to over 23 million Californians, primarily through the SWP. Bay-Delta treatment plants have considerable variability in size, location, treatment technologies, blending strategies, and treatment outcome preferences (in addition to regulatory requirements), and therefore, are impacted differently by Delta water quality. This assessment augments a number of previous assessments on Delta water quality that have been conducted and provides some relevant information from selected documents. One previous assessment, *Organic Carbon Trends, Loads, Yields to the Sacramento-San Joaquin Delta, California, Water Years 1980 to 2000*[6], looks at organic carbon and nutrients from the primary tributaries to the Delta but does not include information on water quality at the Delta intakes. Another, *Sources and Magnitudes of Water Quality Concerns in Drinking Water Supplies Taken from the Sacramento-San Joaquin Delta*[7], provides additional information on water quality in the tributaries and some intake information.

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[6] United States Geological Survey. 2003. Organic Carbon Trends, Loads, and Yields to Sacramento-San Joaquin Delta, California Water Years 1980 to 2000.

[7] Woodard, Richard. Sources and Magnitudes of Water Quality Constituents of Concern in Drinking Water Supplies taken From the Sacramento-San Joaquin Delta. Prepared for the CALFED Bay-Delta Program. September 2000.

From source water and Delta intakes through to the drinking water consumer, there are a number of locations that influence water quality, including conveyance. The WQP "equivalent level of public health protection" (ELPH) construct considers water quality at all relevant locations including conveyance, storage, treatment, and distribution. Impacts beyond the Delta are not investigated in this assessment.

### 2.3.1 Constituents of Concern

The ROD targets of 50 μg/L bromide and 3 mg/L TOC at Delta intakes are based on the anticipated lowering of the standard for bromate in treated water to 5 μg/L while providing 1 log *Cryptosporidium* inactivation, but they do not necessarily account for other operational concerns such as taste and odor compounds, emerging contaminants, or future regulatory constraints. In addition to bromide and TOC, the WQP has identified other water quality constituents of concern including chloride, nutrients, total dissolved solids, pathogens, and turbidity. This assessment examines the data and information available for all of these constituents of concern.

### 2.3.2 Sources of Data

Water quality data were assembled for the five principal intake locations in the Delta. For the purposes of this report, four of the intakes - Tracy, Banks, Old River, and Rock Slough - are referred to as the South Delta Intakes, primarily to describe common seasonal water quality patterns. In addition, locations on the two primary tributaries to the Delta, Sacramento River at Hood and at Freeport and the San Joaquin River at Vernalis, were chosen as indicators of tributary water quality where water quality is minimally impacted by tidal influences. Both locations for Sacramento River were used because the historical information available at each site is different and provides a more complete data representation. A map of the sampling locations is provided as Figure 2-7.

Data were primarily obtained from the Department of Water Resources' Municipal Water Quality Investigations (MWQI) Program and Water Data Library websites[8], because it provides the most comprehensive information for the five primary Delta Intakes. Other data sources were used to augment the data obtained from the MWQI website and summarized in Table 2-1, along with the specific constituents analyzed. Data for Old River Intake were obtained from Contra Costa Water District (CCWD), but are not available for a number of the constituents analyzed. Data representing the Tracy intake were obtained from both the USBR and DWR's MWQI sampling programs. In 2003, the USBR began collecting samples for bromide and organic carbon analysis at a station along the Delta-Mendota Canal (DMC) about 3.5 miles down from the diversion point at Old River. These data were utilized when available; however, prior to 2003 MWQI data were used from a station located about 67.2 miles down the canal. It is important to note that data were not available directly at the Tracy pumping plant, but these sites were used to generally represent the water quality exported through the DMC. Location is noted because water quality changes can occur while the water is conveyed and may not be directly representative of Delta water quality at Tracy Intake. Water quality data were obtained for most constituents of concern for the time period of 1990 to 2005, which was selected to encompass long-term hydrologic changes such as the drought years of the early 1990s and the El Niño year of 1997.

[8] http://wq.water.ca.gov/owq/Data/wqdata.htm.

Over this 15-year time period, monitoring frequencies occasionally varied for individual constituents at particular sites. The majority of sites were sampled on a monthly or weekly basis. For certain time periods, daily data were available (for chloride at Old River Intake and EC at Tracy Intake), so these data were filtered to show only values collected on the same days at a similar location, for consistency purposes.

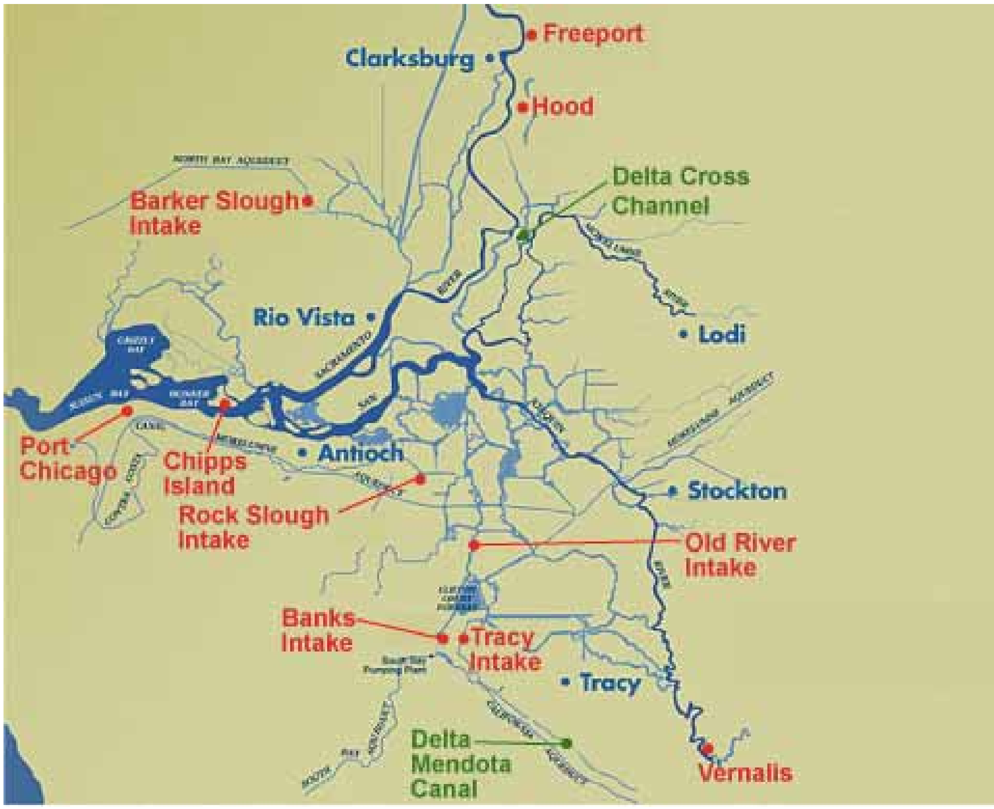


**Figure 2-7. Delta water quality and flow monitoring stations and selected Delta facilities [Adapted from DWR figure]**

**Table 2-1. Data sources used to assess water quality. MWQI = California Department of Water Resources, Municipal Water Quality Investigation Program, CCWD = Contra Costa Water District, NA = not available. Specific site names are noted.**

| | Delta Locations and Data Sources and Availability Used to Assess Water Quality | | | | | | |
|---|---|---|---|---|---|---|---|
| **Analyte** | **Sacramento River[a]** | **San Joaquin River[b]** | **Banks Intake[c]** | **Barker Slough Intake[d]** | **Old River Intake[e]** | **Rock Slough Intake[f]** | **Tracy Intake[g]** |
| Electrical Conductivity (EC) | DWR MWQI (1982 - 2005) | DWR MWQI (1982 - 2005) | DWR MWQI (1982 - 2005) | DWR MWQI (1988 - 2005) | CCWD (1997 - 2005) | DWR MWQI (1990 - 2005), CCWD (1980 - 2005) | DWR MWQI (1983 - 1999), USBR (1993 - 2005) |
| Bromide | DWR MWQI (1997 - 2005) | DWR MWQI (1990 - 2005) | DWR MWQI (1990 - 2005) | DWR MWQI (1990 - 2005) | NA | DWR MWQI (1990 - 2005) | DWR MWQI (1990 - 1997), USBR (2003 - 2005) |
| Chloride | DWR MWQI (1982 - 2005) | DWR MWQI (1982 - 2005) | DWR MWQI (1982 - 2005) | DWR MWQI (1988 - 2005) | CCWD (1980 - 2005) | DWR MWQI (1990 - 2005), CCWD (1980 - 2005) | DWR MWQI (1983 - 1999) |
| Dissolved Organic Carbon (DOC) | DWR MWQI (1997 - 2005) | DWR MWQI (1986 - 2005) | DWR MWQI (1989 - 2005) | DWR MWQI (1989 - 2005) | NA | DWR MWQI (1990 - 2005) | DWR MWQI (1989 - 1999), USBR (2003 - 2005) |
| Total Organic Carbon (TOC) | DWR MWQI (1998 - 2005) | DWR MWQI (1986 - 2005) | DWR MWQI (1986 - 2005) | DWR MWQI (1988 - 2005) | CCWD (1994 - 2004) | DWR MWQI (1991 - 2005) | DWR MWQI (1986 - 1989), USBR (2003 - 2005) |
| Nitrite + Nitrate | DWR MWQI (2002 - 2005) BDAT[h] (1990 – 2002) | DWR MWQI (2002 - 2005) BDAT (2000 – 2002) USGS[i] (1990 – 2000) | DWR MWQI (1995 - 2005) | DWR MWQI (1995 – 1997, 1998 – 2005) | NA | DWR MWQI (1995 - 2005) | DWR MWQI (1995 - 1997) |
| Total Phosphorus (TP) | DWR MWQI (2002 - 2005) BDAT (1990 – 2002) | DWR MWQI (2002 - 2005) BDAT (2000 – 2002) USGS (1990 – 2000) | NA | DWR MWQI (1997 - 2005) | NA | DWR MWQI (2002 - 2005) | NA |

[a] MWQI Station "SACRAMENTO R A HOOD";
[b] MWQI Station "VERNALIS";
[c] MWQI Station "BANKS";
[d] MWQI Station "BARKERNOBAY" and "KG000000";
[e] CCWD sampling;
[f] MWQI Station "CONCOSPP1" and CCWD sampling;
[g] MWQI Station "DMC" and USBR Stations at "DMC" and "DMC" at mi 3.5";
[h] BDAT = Bay Delta and Tributaries Project water quality database. Nutrient data utilized from this database was collected by various agencies including USGS, DWR, City of Stockton, and SWRCB;
[i] USGS = US Geological Survey report and website (USGS, 2003).

## 2.4 Salinity

Salinity is discussed as it relates to drinking water, how it is quantified, what is known about its primary sources to the Delta, and available data. This is followed by sections that present salinity time series plots and monthly averages of salinity at Delta intakes, measured as EC, bromide, and chloride.

### 2.4.1 Background

Salinity in the Delta is commonly measured in several different ways, including electrical conductivity (EC), total dissolved solids (TDS), bromide, and chloride. High concentrations of bromide and chloride are particularly a concern because they contribute to formation of total trihalomethanes (THMs) and bromate. Bromate and three of the four regulated THMs are probable carcinogens. The remaining THM and other regulated DBPs are possible or suspected human carcinogens. Salts can also contribute to taste and odor problems, impact water management programs such as water recycling, cause economic impacts on residential and industrial use due to increased corrosion of appliances, and impair use for agricultural irrigation.

EC is the simplest of the four analytical measurements and is closely correlated with salinity and TDS. EC represents the ability of water to carry electrical current (a physical property), and EC increases as concentrations of dissolved ions (a chemical property) increases. EC is routinely reported in two equivalent units, microSiemens per centimeter (µS/cm) and micromhos per centimeter (µmhos/cm). Throughout Delta waters, the EC/TDS ratio has been measured extensively and 1 EC unit is approximately equivalent to a TDS value of 0.64 mg/L. Of the four common salinity parameters measured in the Delta, the data record for EC is the most spatially and temporally complete for the selected locations. EC is a simple and accurate method for determining concentrations of TDS in water where an EC/TDS ratio is known but can also be used (albeit much more cautiously) to estimate concentrations of the specific anions bromide and chloride.

Quantitative concentrations of bromide and chloride are more typically measured by ion chromatography or colorimetry. These ions are often generally strongly correlated to EC and to each other, at specific points within the Delta. Correlations for EC, bromide, and chloride at Banks Intake and Rock Slough Intake are shown in Figures B-1 through B-3 in the Appendix. A comparison of the correlation between EC and chloride for the San Joaquin River at Vernalis, Mallard Island, and Jersey Island is presented in Figure B-4. These plots demonstrate that correlations are generally representative of the mixture of source waters at a location (i.e., Delta drainage, ocean water, tributary water), and can vary by location and sometimes by time (as mix composition changes). A correlation between bromide and EC for the San Joaquin River is shown in Figure B-5. Figure B-5 also shows water quality objectives for EC for the San Joaquin River at Vernalis and how those relate to current bromide levels in the San Joaquin River at Vernalis.

### 2.4.2 Sources of Salinity to the Delta

Tidal flows into the Delta contribute the largest amount of salinity, followed by salinity from agricultural drainage in the San Joaquin River and Delta (largely due to concentration of saline Delta water). The approximate TDS present in seawater is generally 965,517 mg/L, of which 65 mg/L is bromide and 19,000 mg/L is chloride[9]. Specific concentrations throughout the Delta, however, are highly dependent on a number of factors. Because of its higher salinity, ocean water is denser than fresh water. In an estuary, tidal mixing will often cause ocean water to move up and down stream along the bottom of a channel while freshwater outflow "floats" on top, forming a "salt wedge." Salinity concentrations in the Delta are a function of the quantity and quality of tributary inflows, primarily from the Sacramento and San Joaquin Rivers, the location of the salt wedge zone, Delta Island agricultural drainage impacts, and the hydrodynamic processes in Delta channels that govern mixing and transport of waters of differing salt content.

EC measured in the Sacramento River has rarely exceeded 250 µS/cm since 1982 (Appendix B, Figure B-9). In contrast, EC measured in the San Joaquin River at Vernalis often fluctuates between 400 and 1,000 µS/cm, with the highest concentrations occurring during dry years (Appendix B, Figure B-10). Figure 2-8 presents monthly averages and standard deviations of EC in the San Joaquin River during dry and wet years[10]. Monthly San Joaquin River EC average values during dry years range from 590 and 1,100 µS/cm. Whereas, during wet years, EC average values are within a lower range between 300 and 650 µS/cm and the lowest values occurring in mid to late spring. There is a slight increase in EC during the summer months for both year types. Water quality objectives for the San Joaquin River at Vernalis have been set by the SWRCB at 700 µs/cm during irrigation season (April - October) and 1000 µs/cm during the remainder of the year. Figure 2-8 shows that during higher flow years these objectives are currently met, however during lower flow years, these objectives have at times been exceeded.

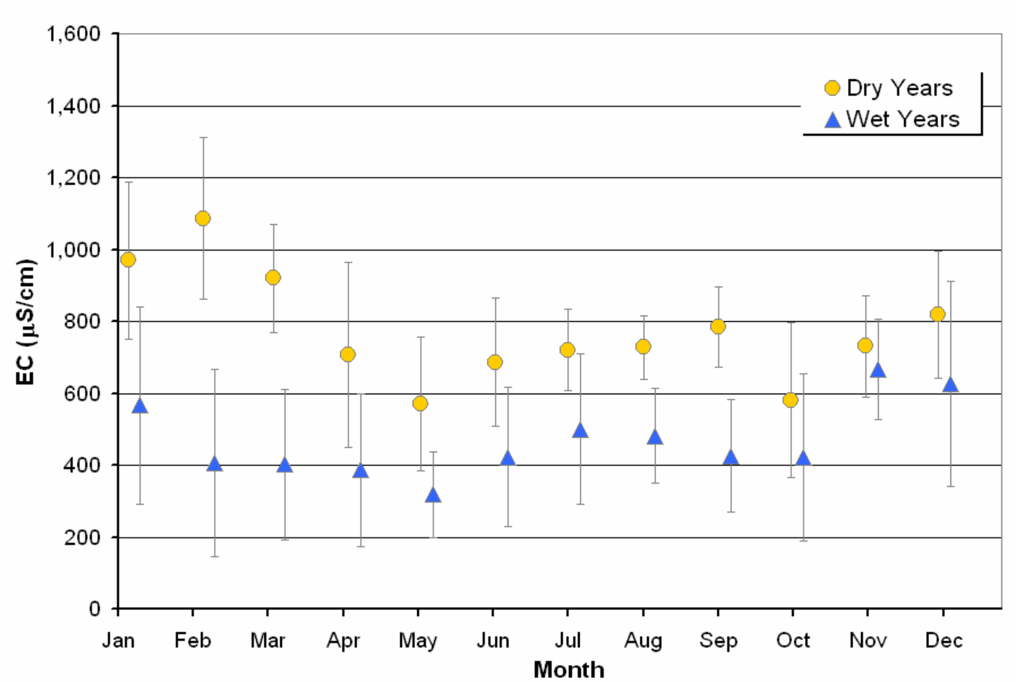


**Figure 2-8. Monthly average and standard deviation of electrical conductivity for dry and wet years for the San Joaquin River at Vernalis (WY 1984-2004) [Data obtained from MWQI, years classified per D-1641]**

[9] Snoeyink and Jenkins. Water Chemistry. 1980.

[10] http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST.

### 2.4.3 Electrical Conductivity

EC data collected at four of the Delta Intakes from 1990 to 2005 are presented in Figure 2-9. Over this 15-year period, EC measured at the South Delta Intakes typically varies between 200 and 1,200 µS/cm, with annual peaks at most locations occurring during the dry years of the early 1990s. In most years, the highest EC concentrations and variability are observed at the Rock Slough Intake. EC measured at Barker Slough Intake exhibits much less annual variation, with a typical range between 150 and 550 µS/cm.

Seasonal patterns are identified by calculating monthly averages of these measurements, shown in Figure 2-10. Monthly averages of EC measurements at the South Delta Intakes generally exhibit the highest concentrations during fall and winter months and the lowest EC concentrations during the spring and summer months. In contrast, the monthly average EC at Barker Slough Intake exhibits a somewhat opposite seasonal pattern, with higher concentrations in late spring/early summer and the lowest concentrations in the fall. A different value is obtained when hourly EC measurements are averaged for the month of March using the data from USBR Rock Slough station compared to the averaged value from the MWQI station data shown here. The value obtained keeps with a decreasing trend from February to April at Rock Slough as opposed to the outlier obtained with the MWQI data shown here. The values are likely skewed as MWQI data are from monthly grab samples whereas USBR data are from more representative hourly measurements that capture the daily and even hourly fluctuation of EC values.

### 2.4.4 Bromide

Of the tributary sources, the San Joaquin River contributes the highest bromide load to the Delta. Bromide measured in the San Joaquin River from 1990 to 2004 averages 256 µg/L (Figure 2-11). In the San Joaquin River, annual bromide peaks typically occur in the winter, with the highest bromide concentrations in dry years. During the same time period, bromide concentrations in the Sacramento River rarely exceeded 20 µg/L.

Bromide data collected at four of the Delta intakes from 1990 to 2005 are presented in Figure 2-12. The bromide concentrations measured at the South Delta Intakes typically vary between 25 and 800 µg/L. Similar to EC concentrations at the South Delta Intakes, the highest bromide concentrations and annual variability are observed at Rock Slough Intake. Bromide measured at Barker Slough Intake exhibits much less annual variability and is typically less than 100 µg/L.

Bromide seasonal patterns, monthly averages and standard deviations for the same time period (1990 to 2005) are shown in Figure 2-13. The ROD target of 50 µg/L bromide at Delta intakes is provided on the graph for comparison to Intake concentrations. Monthly averages of bromide at the South Delta Intakes exhibit increasing concentrations from late spring through late fall/early winter, and decrease during the winter months. In contrast, the monthly average of bromide at the Barker Slough Intake exhibits a somewhat opposite seasonal trend, with peaks in late spring and the lowest concentrations in the early fall. Monthly averages for bromide at all the South Delta Intakes exceed the ROD Intake target of 50 µg/L, whereas the monthly average at Barker Slough Intake only exceeds the ROD target during four months in late spring/early summer.

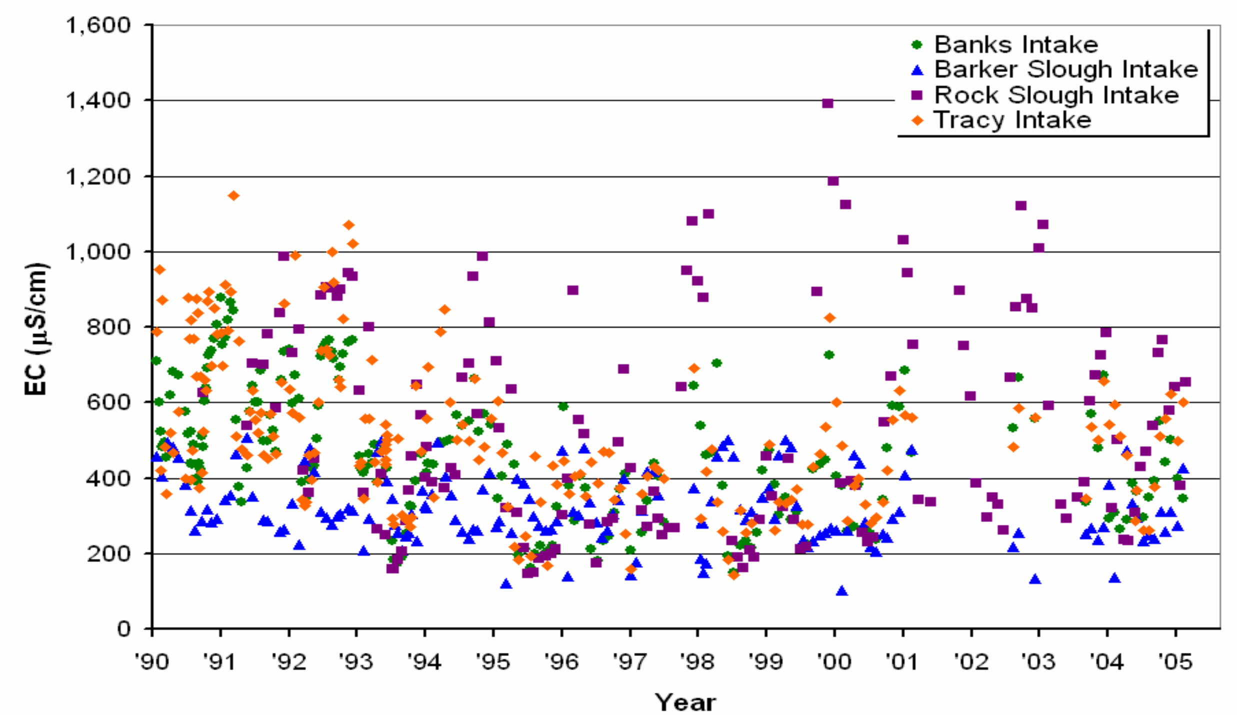


**Figure 2-9. Electrical conductivity at Delta Intakes[11] (calendar year 1990-2004) [Data obtained from MWQI and for Tracy data for years 1999-2005 from USBR]**

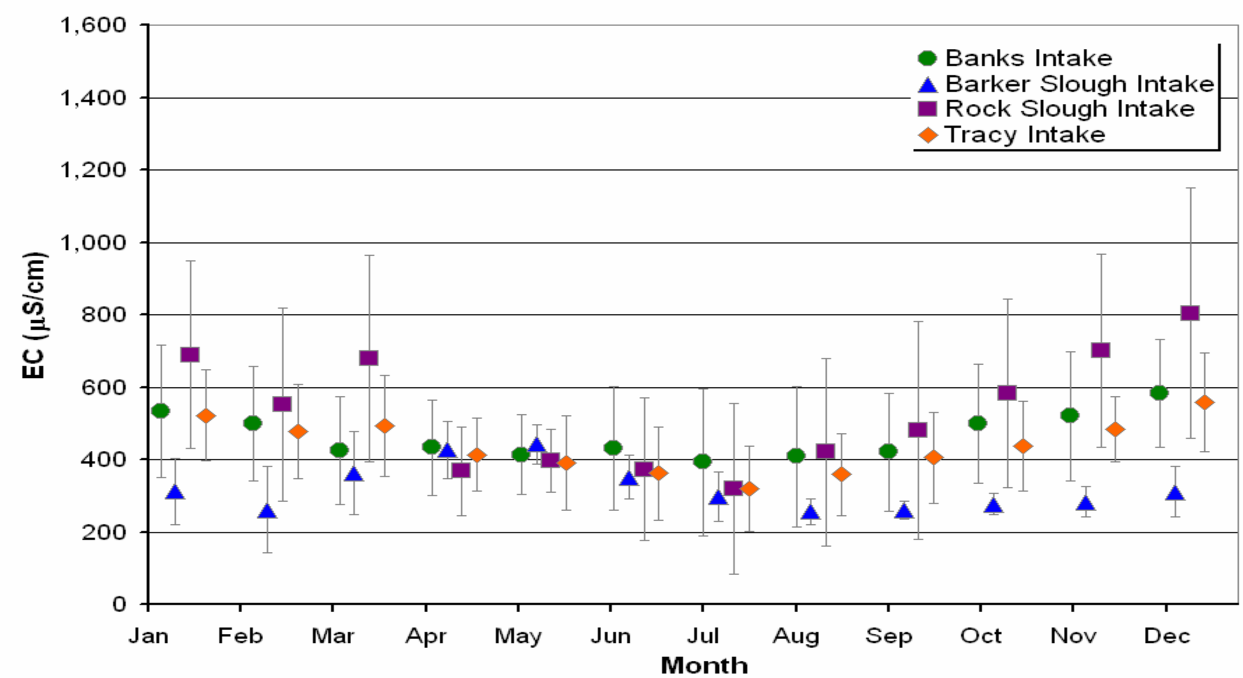


**Figure 2-10. Monthly average and standard deviation of electrical conductivity for Delta Intakes (calendar year 1990-2004)[11]**

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[11] For ease of comparison, daily data from Tracy (available June 1, 1993 – 2004) were filtered to show only the samples that were collected on the same date as at nearby Banks Intake.

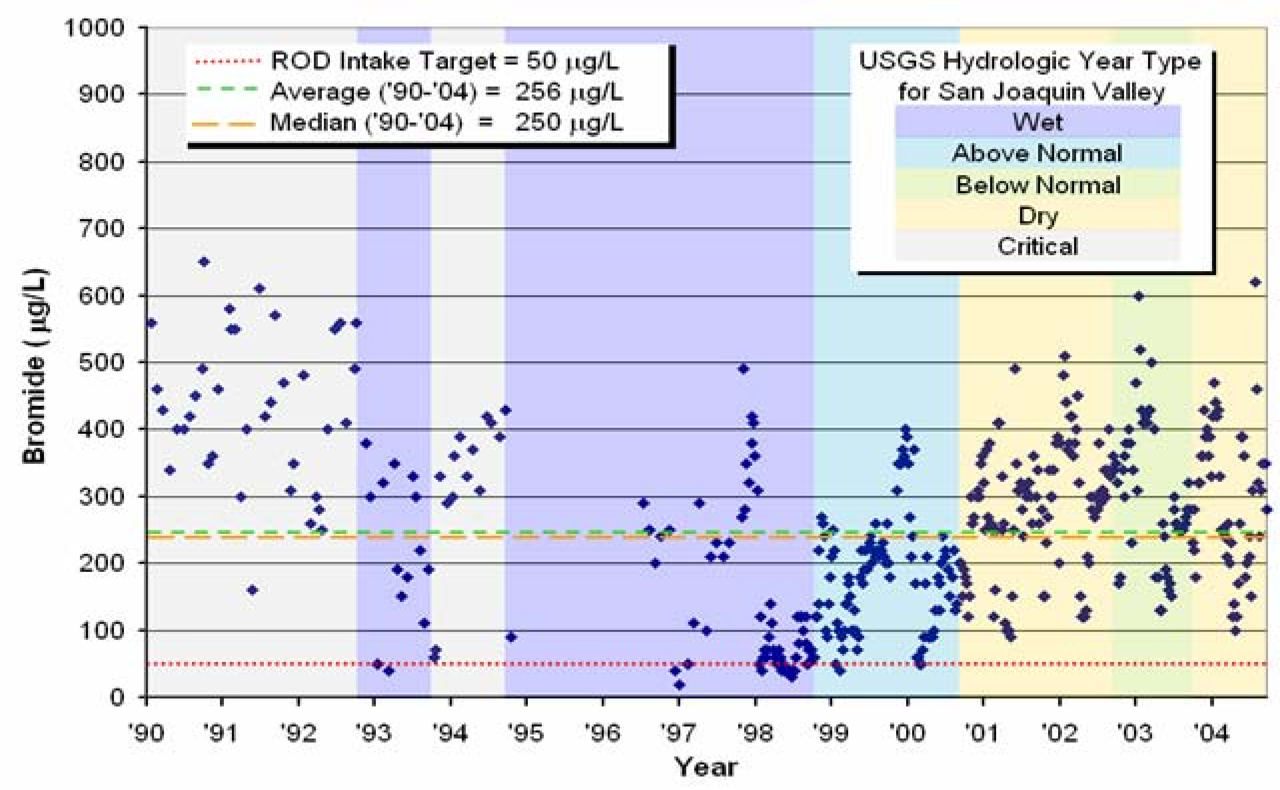


**Figure 2-11. San Joaquin River at Vernalis bromide concentrations and hydrologic year type [Data obtained from MWQI]**

### 2.4.5 Chloride

Chloride data collected at four of the Delta intakes from 1990 to 2005 are presented in Figure 2-14. Old River data is available only from 1998 to 2005. Chloride concentrations at all the South Delta Intakes typically vary between 10 and 250 mg/L, while concentrations at Barker Slough Intake vary between 5 and 50 mg/L. As observed for EC and bromide, the highest chloride concentrations and variability are observed at Rock Slough Intake and, chloride measurements at Old River Intake are similar to Rock Slough Intake. Monthly averages of chloride concentrations during this time period are presented in Figure 2-15. The same seasonal patterns observed for EC and bromide are observed for chloride at all intakes.

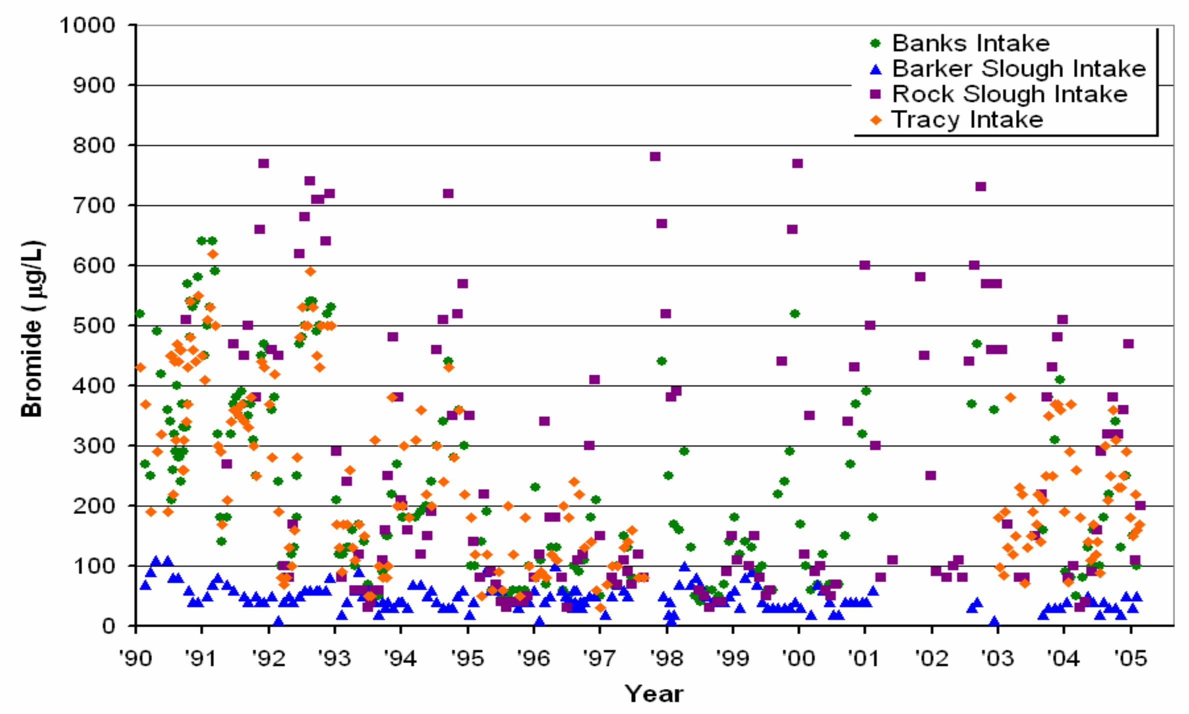


**Figure 2-12. Bromide at Delta Intakes (calendar year 1990-2004)**
**[Data obtained from MWQI and for Tracy 2003-2005 from USBR]**

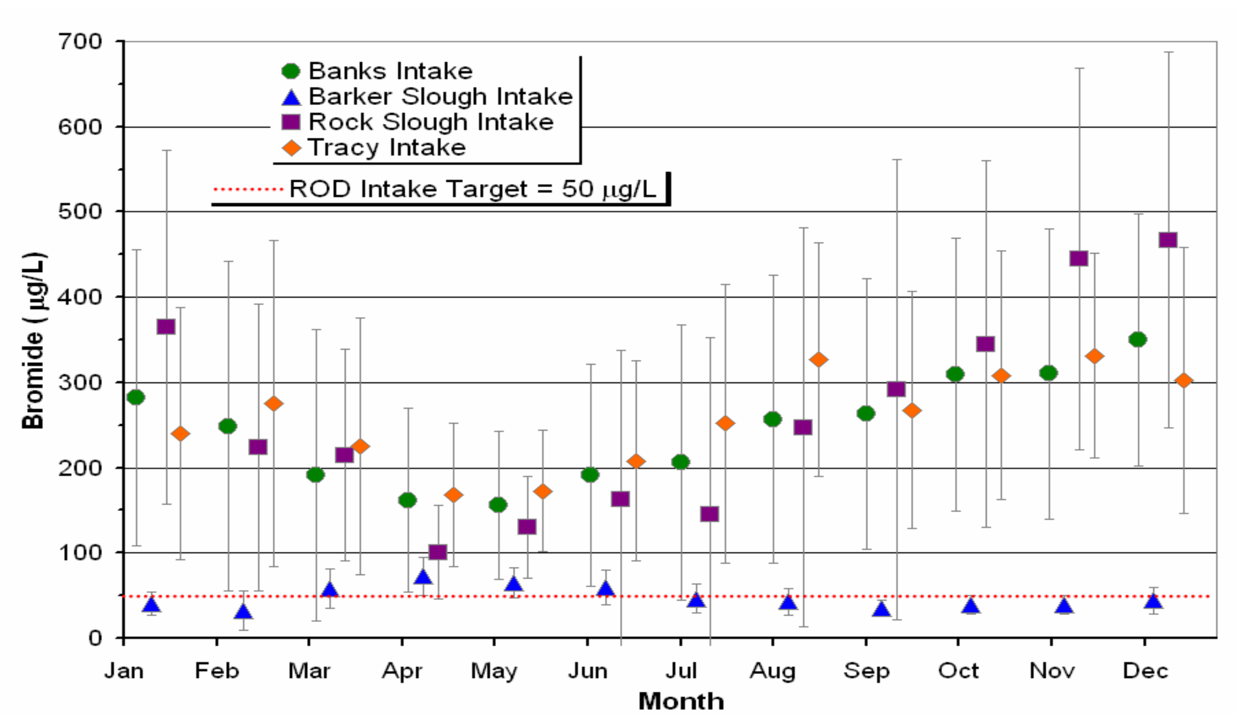


**Figure 2-13. Monthly average and standard deviation of bromide concentrations at Delta Intakes (calendar year 1990-2004)**

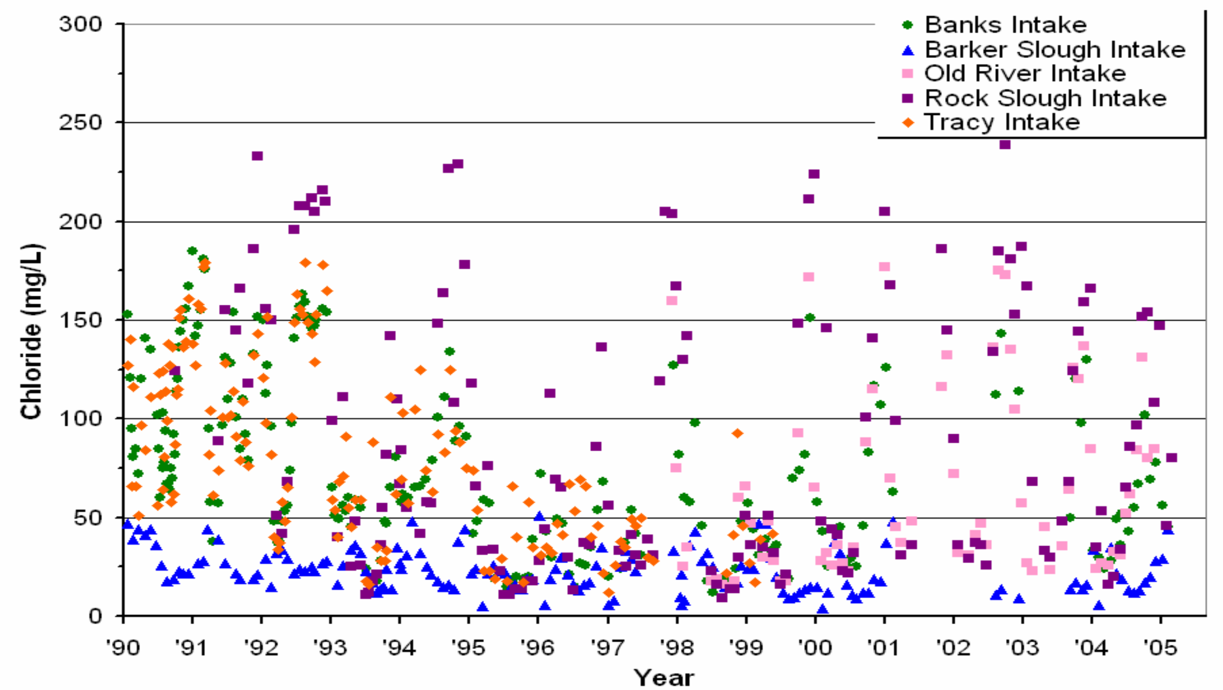


**Figure 2-14. Chloride at Delta Intakes[12] (calendar year 1990-2004) [Data obtained from MWQI for Banks, Barker Slough and Tracy, Rock Slough and Old River from CCWD]**

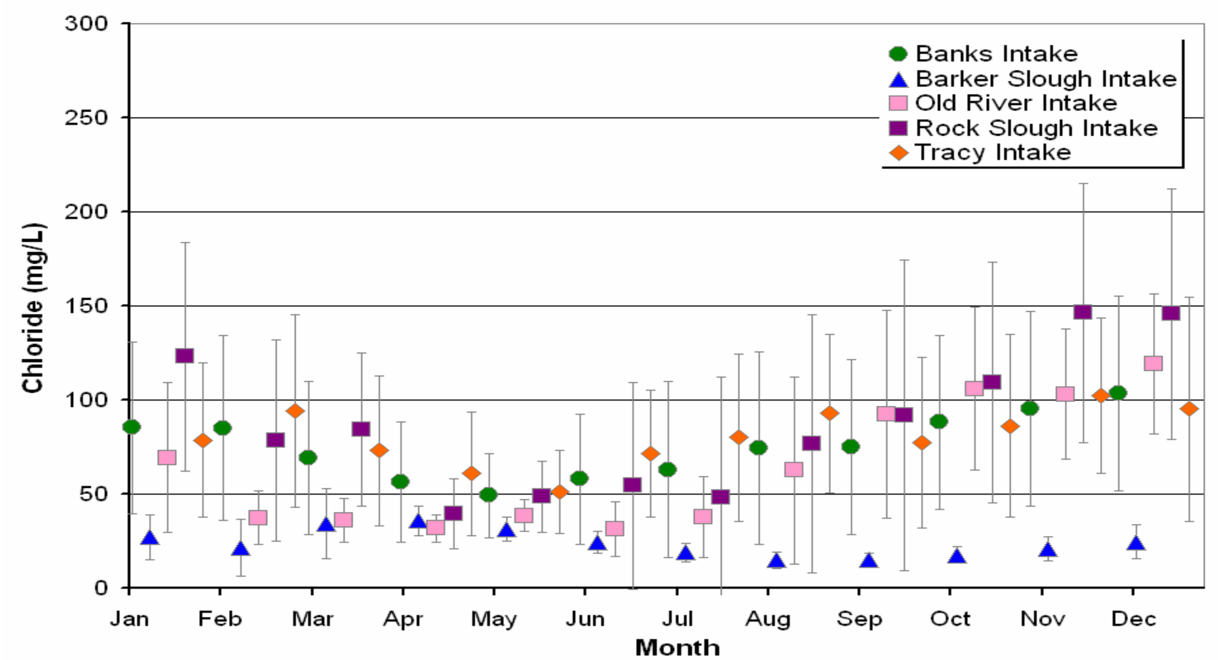


**Figure 2-15. Monthly average and standard deviation of chloride concentrations at Delta Intakes[12] (calendar year 1990-2004)**

[12] For ease of comparison, daily data from Old River Intake were filtered to show only samples that were collected on the same date as at nearby Rock Slough Intake.

## 2.5 Organic Carbon

### 2.5.1 Background

Drinking water agencies are primarily concerned with organic carbon compounds in source water due to the potential formation of THMs and haloacetic acids (HAAs) resulting from disinfection with chlorine. Organic carbon occurs in both dissolved and particulate forms and is most commonly measured and reported as either dissolved organic carbon (DOC) and/or TOC, which includes both dissolved and particulate species. A plot of the DOC/TOC ratio versus TOC measured at Banks Intake is shown in Figure 2-16 and indicates the fraction of the TOC attributed to dissolved carbon species (i.e., DOC). As shown in the plot, at high TOC concentrations (greater than 4 mg/L) the DOC/TOC ratio is often close to 1.0, indicating that much of the TOC is dissolved. For TOC concentrations below 4 mg/L, however, the DOC/TOC ratio varies more significantly and a larger proportion of organic carbon is particulate. TOC remains an important measurement, as it is used to regulate drinking water treatment plants. The ROD target is 3 mg/L of TOC at Delta intakes.

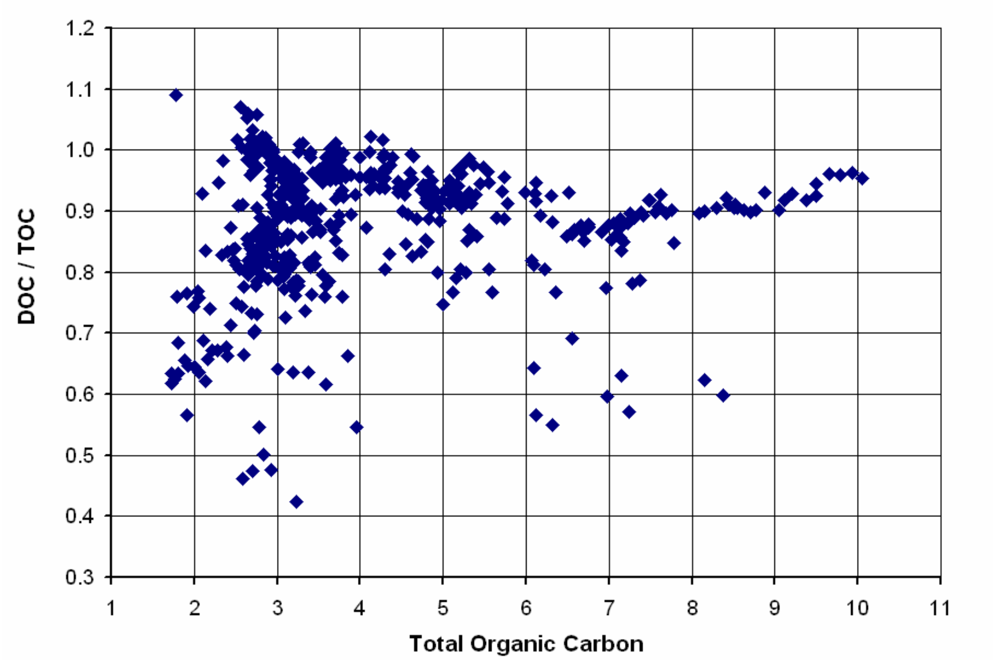


**Figure 2-16. DOC/TOC Ratio at Banks Intake based on real time data from October 2003-March 2005 [Plot was generated by CCWD]**

### 2.5.2 Dissolved Organic Carbon

DOC rather than TOC was examined for this assessment because DOC data are considered to be more accurate and representative than TOC data in the Delta. Auto-sampling for TOC can be inaccurate because particulate matter can settle while samples are being analyzed and/or get lodged in the small needle used during aspiration of the sample. Also wet-oxidation and combustion, the two analytical methods used, show greater variation in the results for TOC than for DOC.

DOC time series plots for the Sacramento River at Hood and San Joaquin River at Vernalis are presented in Figures 2-17 and 2-18, respectively. The DOC average, median, and ROD TOC target of 3 mg/L at Delta Intakes are shown, as well as shading to indicate hydrologic year type for the rivers. Data are available at the MWQI stations from 1998 to 2004 for the Sacramento River at Hood, and from 1990 to 2004 for the San Joaquin River. The average DOC concentrations over this time period for the Sacramento and the San Joaquin Rivers are 2 mg/L and 3.6 mg/L and median concentrations are 1.7 and 3.1 mg/L, respectively. For both rivers, organic carbon concentrations are highest during the wet weather season and lowest during the drier summer months.

Further information on organic carbon trends in the Delta tributaries is provided in a United States Geological Survey (USGS) report that assessed long-term organic carbon trends in the Sacramento River at Freeport and San Joaquin River at Vernalis between 1980 and 2000. The majority of upstream sites indicated no organic carbon trends, however, decreasing organic carbon trends were observed over the 20 year time period within the lower reaches of both rivers at Sacramento River at Freeport and San Joaquin River at Vernalis[13].

Though tributary inflows from the Sacramento and San Joaquin Rivers can contribute high DOC loads, Delta islands and the Delta ecosystem contribute DOC loads as well. Time series DOC concentrations for four Delta Intakes from 1990 to 2004 are presented in Figure 2-19. DOC concentrations at the South Delta Intakes commonly vary between 2-10 mg/L, with the highest concentrations at Banks and Tracy Intakes. Concentrations at Barker Slough Intake are often higher than the South Delta Intakes and vary between 3 and 20 mg/L.

The DOC monthly average and standard deviation at Delta Intakes for years 1990 to 2004 is presented in Figure 2-20. The highest DOC concentrations at the South Delta Intakes are in mid to late winter, with the lowest concentrations typically in the late summer and fall. DOC concentrations at Barker Slough Intake are usually greater than the South Delta Intakes, particularly in January, February, and March. In general, the ROD TOC target is frequently exceeded at all intakes (based on DOC concentrations which are usually about 90 percent of the TOC concentrations in the Delta), except during the summer and early fall when DOC concentrations are at their lowest.

To observe the frequency in which both organic carbon and bromide exceed both numeric ROD targets of 3 mg/L and 50 µg/L at Delta intakes, DOC and bromide are plotted in Figure 2-21 for grab samples obtained on the same day. For the South Delta Intakes, both ROD targets are simultaneously exceeded for the majority of the samples. At Barker Slough Intake, the TOC target is frequently exceeded, but the bromide concentrations are close to the ROD target.

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[13] United States Geological Survey. 2003. Organic Carbon Trends, Loads, and Yields to Sacramento-San Joaquin Delta, California Water Years 1980 to 2000.

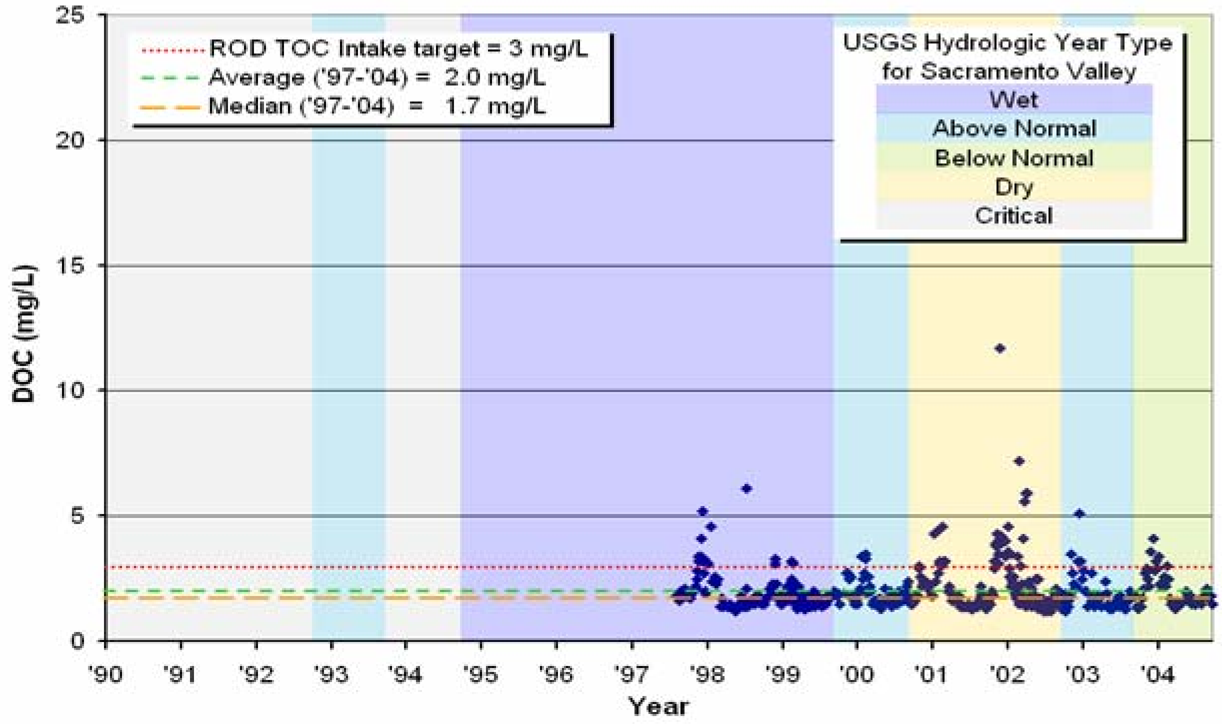



**Figure 2-17. Sacramento River at Hood DOC Concentrations and hydrologic year type [Data obtained from MWQI]**

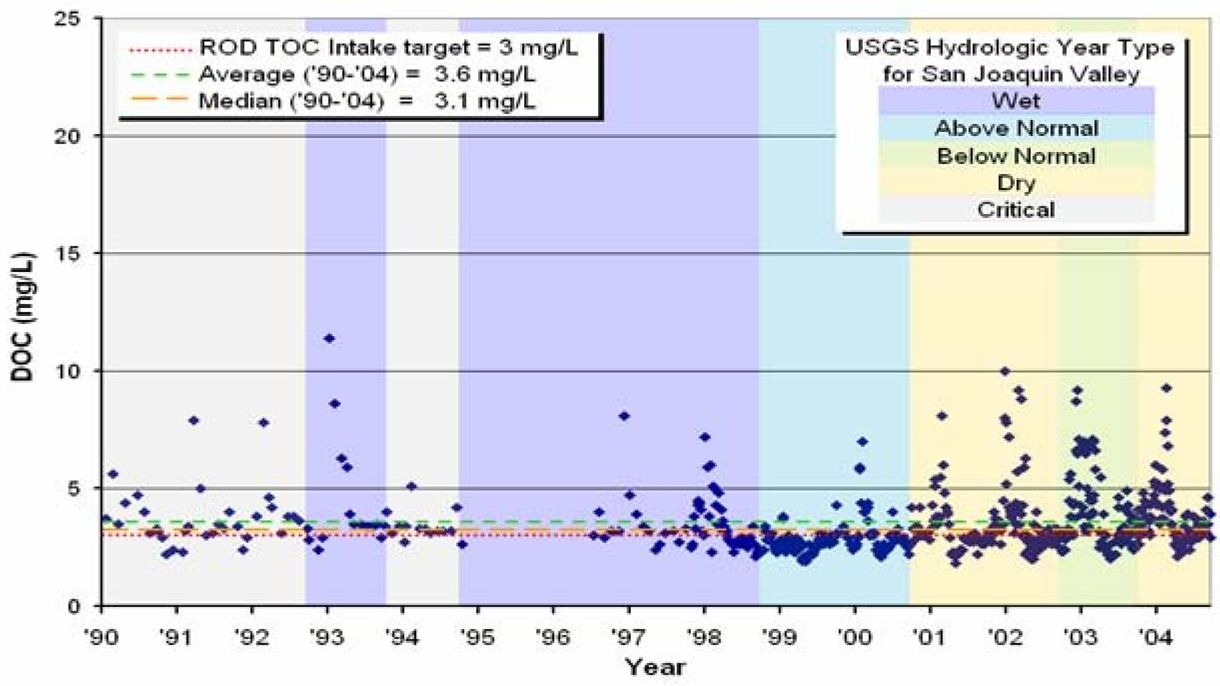



**Figure 2-18. San Joaquin River at Vernalis DOC concentrations and hydrologic year type [Data obtained from MWQI]**

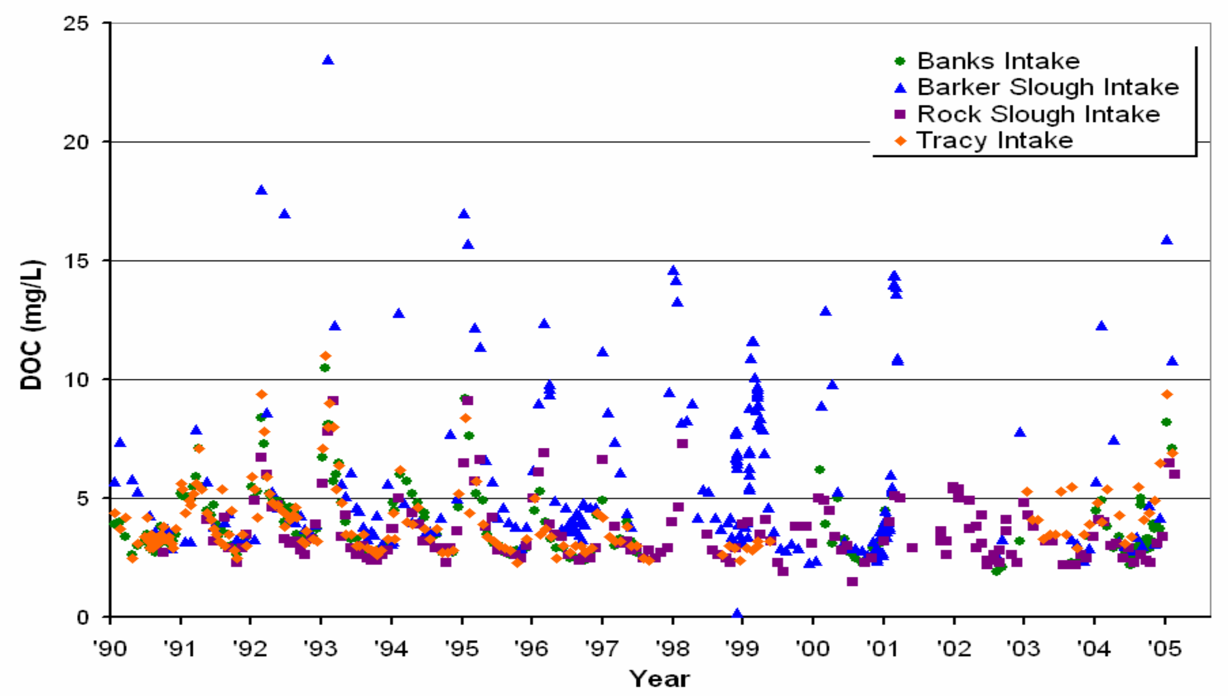



**Figure 2-19. DOC at Delta Intakes (calendar year 1990-2004)**
**[All data obtained from MWQI except Tracy (2003-2005) from USBR]**

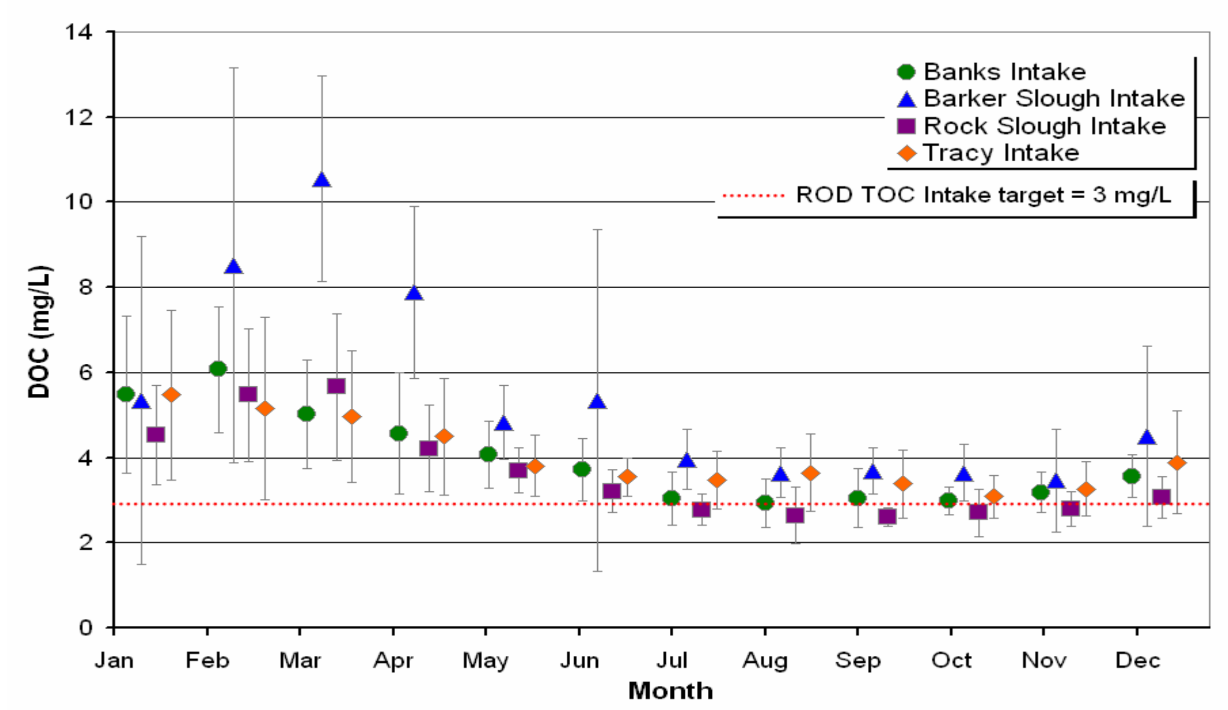



**Figure 2-20. Monthly average and standard deviation of DOC concentrations at Delta Intakes (calendar year 1990-2004)**

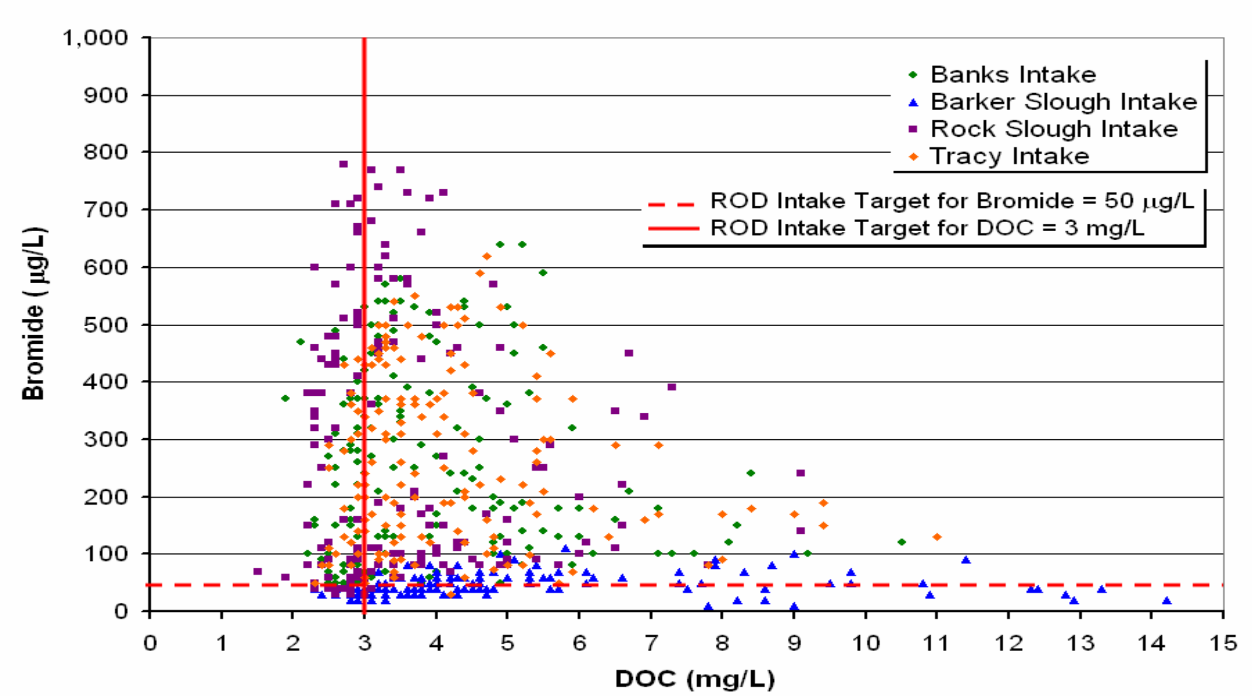



**Figure 2-21. Bromide versus DOC concentration at Delta Intakes[14]**
**[All data obtained from MWQI except Tracy from USBR]**

## 2.6 Nutrients

### 2.6.1 Background

Nutrients, primarily nitrogen and phosphorus species, are naturally present in Delta waters and are critical for maintaining primary growth in the Delta. Excess amounts of nitrogen and phosphorus compounds, often contributed by anthropogenic sources, can enhance algae growth which in turn can reduce dissolved oxygen. This can result in elevated organic carbon and/or algae toxins, which can cause taste and odor problems for drinking water.

Much of the water quality data utilized thus far for the Sacramento and San Joaquin Rivers was collected at MWQI stations; nutrient concentration data from these stations is quite limited as nutrient sampling began only a few years ago. Other data sources were utilized (USGS, SWRCB, DWR, City of Stockton) to assess nutrient concentrations at similar locations (Sacramento River near Freeport and San Joaquin River near Vernalis). These same locations were used in the USGS report which assessed nutrient concentrations in the Delta tributaries[15]. Data for the Delta Intakes was limited and again obtained from the MWQI database because it provides the most comprehensive data for the Delta Intakes.

[14] Six samples at Barker Slough Intake exceeded 15 mg/L DOC (but not 50 µg/L bromide) and are not shown on the graph.

[15] United States Geological Survey. 2003. Organic Carbon Trends, Loads, and Yields to Sacramento-San Joaquin Delta, California Water Years 1980 to 2000.

### 2.6.2 Nitrogen

At sampling locations within the Delta, nitrogen is commonly measured as $NO_2$, $NO_3$, the sum of $NO_2$ and $NO_3$, and total Kjeldahl Nitrogen (TKN), which is the sum of ammonia and organic nitrogen. The sum of dissolved nitrate and nitrite ($NO_3$+$NO_2$) was used because it is the most frequent nitrogen measurement among all the selected sites. Measurements for $NO_3$+$NO_2$ do not include organic nitrogen and ammonia, which can represent significant fractions (30-95 percent) of the total nitrogen present. Dissolved $NO_2$+$NO_3$ concentrations measured at Sacramento River at Freeport and San Joaquin Rivers from 1990 to 2005 are presented in Figure 2-22. Over the length of the data record, $NO_2$+$NO_3$ in the Sacramento River at Freeport typically varies between 0.05 and 0.6 mg/L whereas $NO_2$+$NO_3$ in the San Joaquin River varies in a higher range between 0.25 and 4.5 mg/L. There appears to be a seasonal pattern at both sites, where $NO_2$+$NO_3$ concentrations tended to peak in the late fall and winter and drop to the lowest levels during the late spring and early summer. In the report mentioned previously looking at historic organic carbon trends, the USGS noted a significant increasing trend in dissolved $NO_2$+$NO_3$ in the San Joaquin River near Vernalis between 1980 and 2000[16].

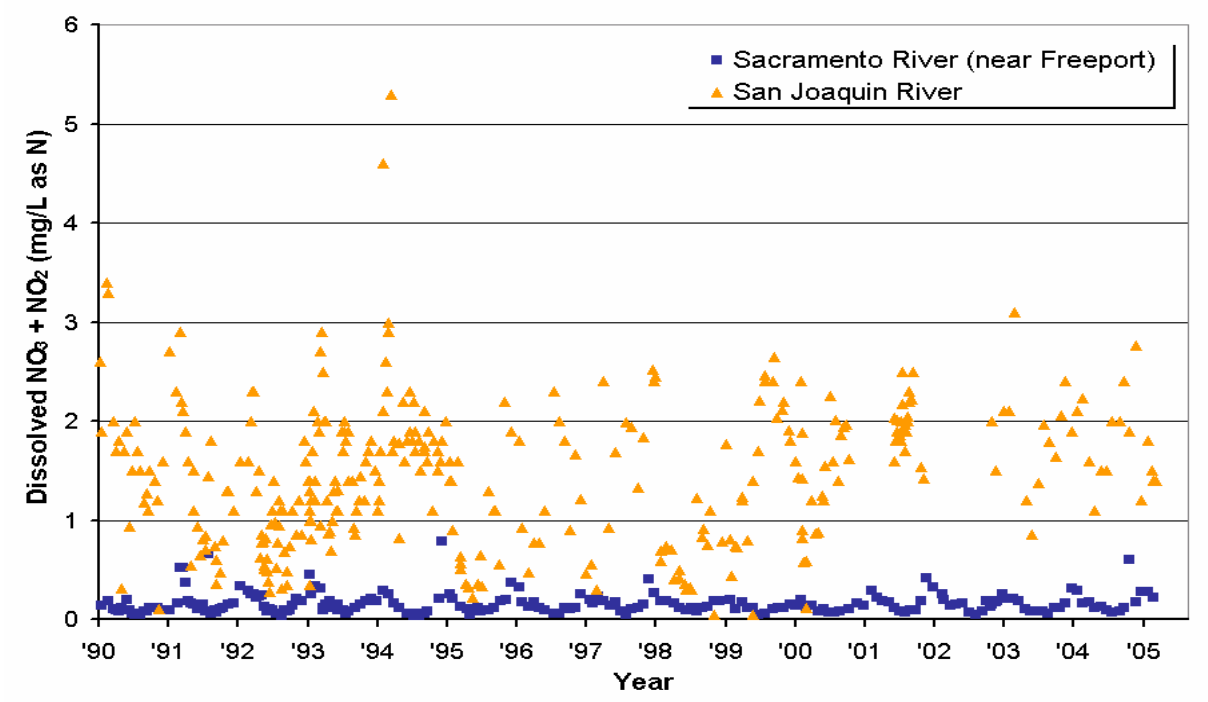



**Figure 2-22**. **Dissolved $NO_3$+$NO_2$ in Sacramento at Freeport and San Joaquin Rivers [Sacramento River data from MWQI (2002-2005) and BDAT (1990-2002). San Joaquin data from MWQI (2002-2005), BDAT (2000-2002) and USGS (1990-2000)]**

$NO_2$+$NO_3$ measured at Delta intakes from 1995 to 2005 are shown in Figure 2-23. Seasonal trends may be present with peaks appearing during winter months; however, data are too limited to draw any real conclusions.

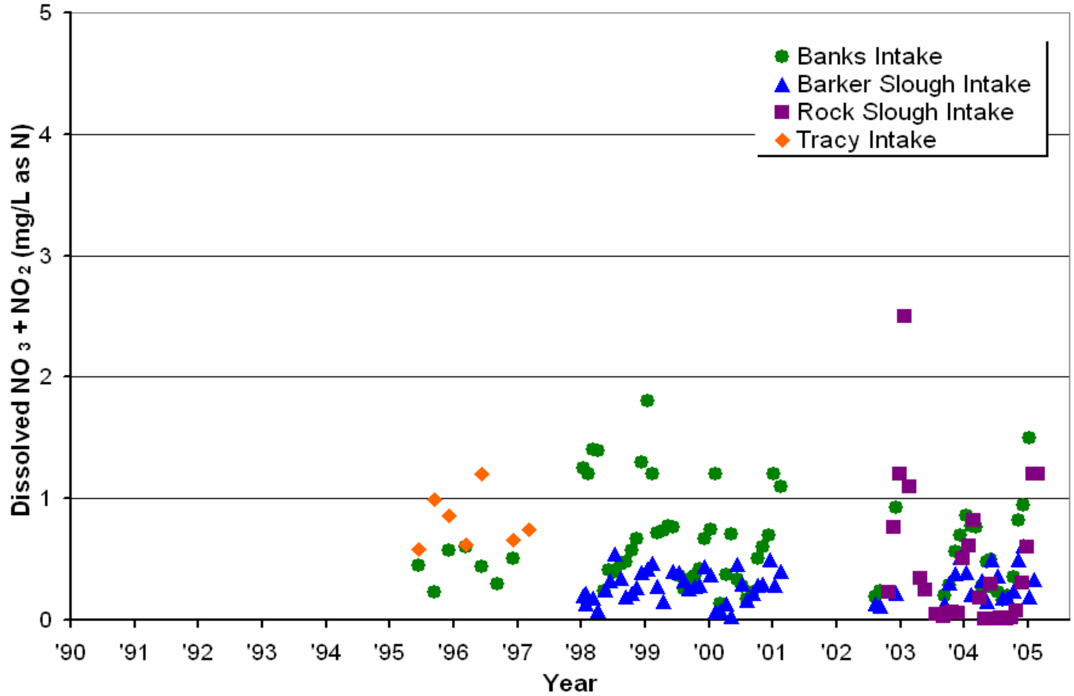



**Figure 2-23. Dissolved $NO_3$+$NO_2$ Delta Intakes [Data obtained from MWQI]**

### 2.6.3 Phosphorus

Similar to nitrogen, phosphorus exists in various forms in Delta waters but is often measured as total phosphorus (TP). TP measured in the Sacramento River at Freeport and San Joaquin River at Vernalis between 1990 and 2005 is shown in Figure 2-24. TP typically varies between 0.05 to 0.4 mg/L in the Sacramento River and 0.05 to 1.0 mg/L in the San Joaquin River. Seasonal patterns are discernable, with higher concentrations in the summer and mid-winter and lowest concentrations in the spring. Long term TP trends were assessed by the USGS at the two locations between 1980 and 2000, but no significant trends were detected[16].

[16] United States Geological Survey. 2003. Organic Carbon Trends, Loads, and Yields to Sacramento-San Joaquin Delta, California Water Years 1980 to 2000.

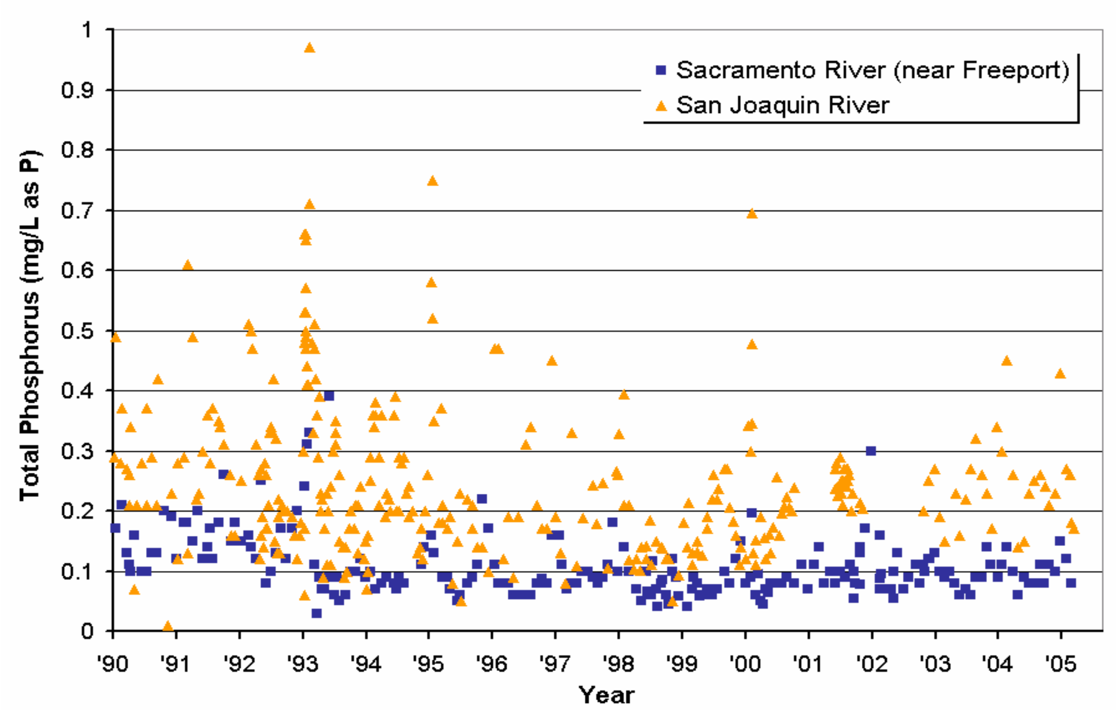



**Figure 2-24. Total Phosphorus in Sacramento River at Freeport and San Joaquin River at Vernalis [Sacramento River data from MWQI (2002-2005) and BDAT (1990-2002). San Joaquin data from MWQI (2002-2005), BDAT (2000-2002) and USGS (1990-2000)]**

Total phosphorus data from Delta intakes are more limited than nitrogen, and data are only available for Barker Slough and Rock Slough Intakes, as seen in Figure 2-25. TP measured at Barker Slough Intake typically varies between 0.05 and 0.45 mg/L, while TP at Rock Slough Intake varies between 0.03 and 0.15 mg/L. No Seasonal trends are discernable at either site.

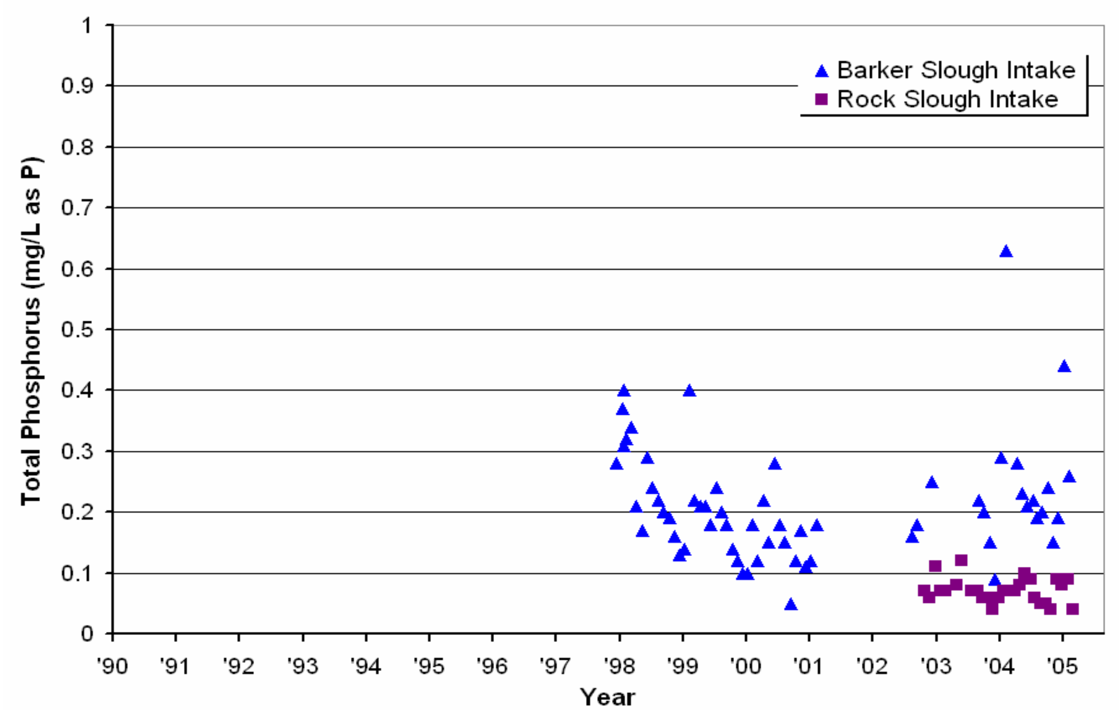



**Figure 2-25. Total Phosphorus at Barker Slough and Rock Slough [Data obtained from MWQI]**

### 2.6.4 Real Time Data versus Monthly Grab Samples

One limitation of assessing water quality conditions is that a monthly grab sample is not necessarily representative of constituent concentrations throughout the day and/or month for locations with high daily variability or short episodic events. The WQP has invested in high-frequency monitoring equipment at key Delta locations in order to better understand this limitation and to improve our understanding of daily variations and significant episodic water quality changes. Recent data monitoring at higher frequencies demonstrates the significant constituent variation during days and months. Figure 2-26 presents data from August 1, 2004 to September 30, 2004 and shows how monthly grab samples do not capture daily variability. For example, during this sampling period TOC concentrations ranged from 2.4 mg/L to 1.8 mg/L, in a matter of a few days and EC started at 140 µs/cm to rise to 190 µs/cm and drop back down to 140 µs/cm. It is easy to see how the timing of grab samples influences the result, and may not capture this type of variation.

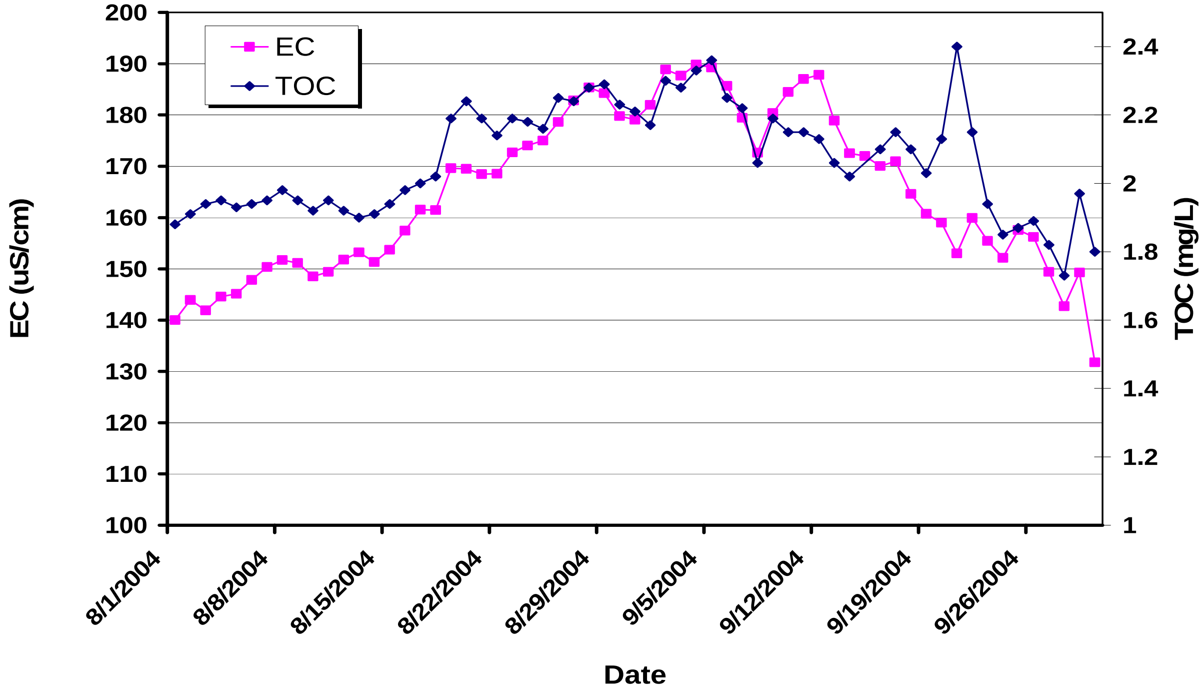



**Figure 2-26. Daily EC and TOC measurements from Sacramento River at Hood**

### 2.6.5 Delta Water Quality Modeling

DSM2 and CALSIM II, developed by DWR, are currently the more commonly used assessment tools for applications for water management and planning purposes. DSM2 is primarily a hydrodynamic and salinity model (or conservative constituent model) and is used in conjunction with CALSIM II to simulate SWP and CVP operations. DSM2 can determine the percentage of water and conservative constituents originating from primary water sources in the Delta, commonly referred to as "fingerprinting." Transport of conservative tracer constituents (e.g., TDS) is first simulated to determine volume contributions from various sources; this is called a Volume Fingerprint. These volume contributions can then be utilized to estimate concentrations of any other conservative constituent if concentrations are known in the source waters; this is called a Constituent Fingerprint. More information regarding this technique and general background can be found in the DWR 2002 Annual Progress Report to the SWRCB, Chapter 14.

An example of a recent volumetric, EC, and DOC "fingerprinting" at Clifton Court Forebay is shown in Figure 2-27. This fingerprinting indicates that Sacramento River may contribute the highest volume of water at different times of the year but does not necessarily contribute the highest organic carbon and salinity loads at Clifton Court Forebay. It also shows how volume of water and constituent load contributed from the different sources vary throughout the year at Clifton Court Forebay. Further examples of DSM2 simulation, conducted by CCWD, compare volume and EC at a number of locations from 1977 to 1991 and are provided in Appendix B, Figures B-9 to B-23.

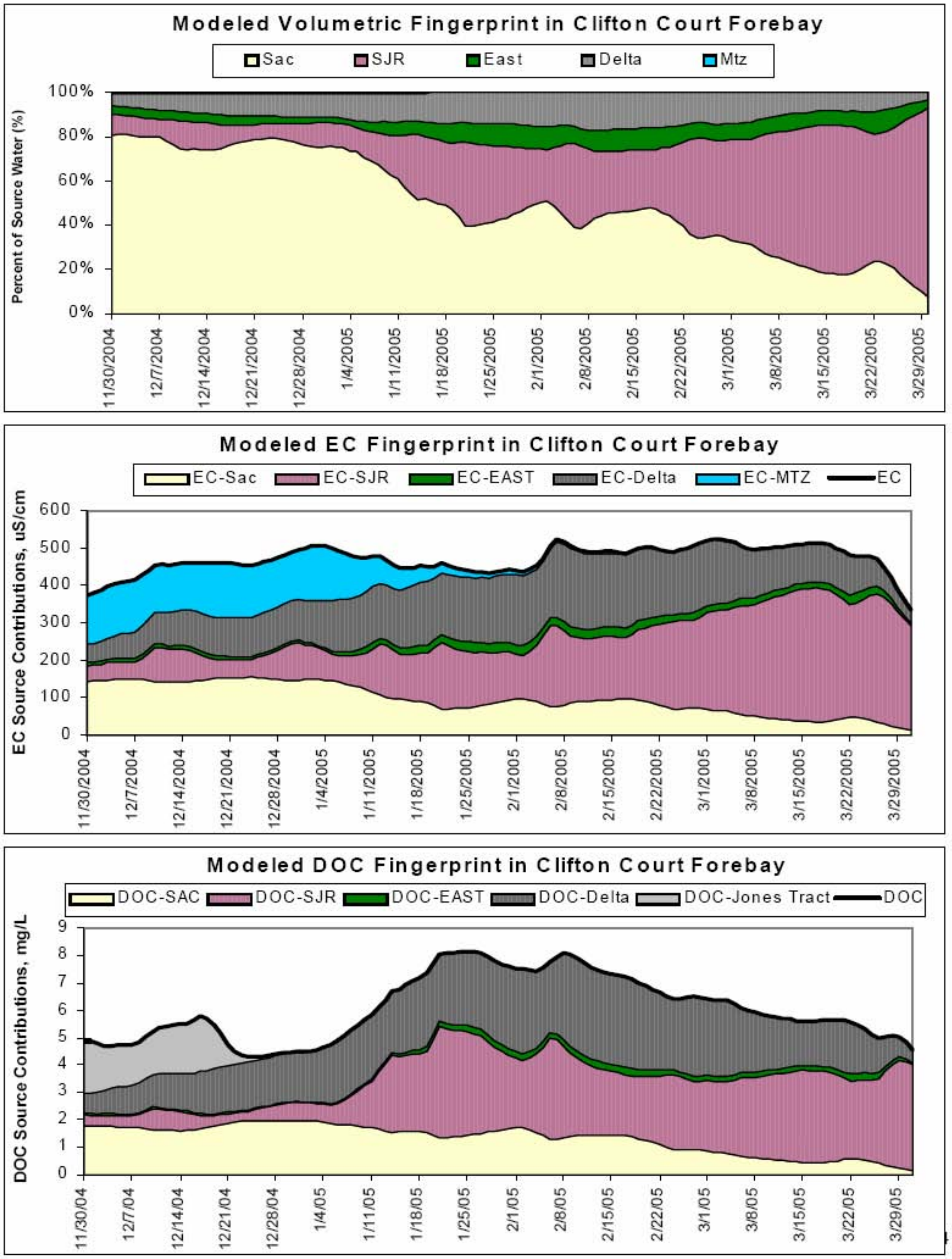



**Figure 2-27. Volume, EC, and DOC fingerprint for Clifton Court Forebay (Nov 2004-Mar 2005) [From DWR's Real Time Data Forecasting Weekly Report Volume 2, Issue 16]**

Other newer multi-dimensional models used at limited locations in the Delta have been developed, including Trim 3D/UnTrim Model (used by USGS and Stanford University), RMA-2/RMA-10 (developed by Resource Management Associates), and the Semi-Implicit-3D Model (SI-3D) (developed by USGS). Using such models for general water management and analyses planning in the Delta is not currently practiced[17]. To support the use of existing models and development of future models sufficient constituent monitoring is necessary. Projects such as the high-frequency monitoring stations on both the Sacramento River at Hood, San Joaquin River at Vernalis, and at Banks Intake, funded by the WQP, support these data needs. Further development of the models is necessary to understand natural events and operation impacts to the Delta and potential changes to the Delta, to fully evaluate Delta water quality, and to observe water quality improvements as a result of WQP and CBDA activities and funded projects in the future.

## 2.7 Conclusions

### 2.7.1 Water Quality Observations

For the Sacramento and San Joaquin Rivers, seasonal patterns were apparent for salinity, organic carbon, nitrate and nitrite, and phosphorous. Salinity concentrations in the San Joaquin River also demonstrate a relationship to flow, with lower concentrations in high flow water years, as shown in Figure 2-8. Seasonal patterns are apparent for salinity and organic carbon for all the Delta Intakes. For the South Delta Intakes (as defined for this report), EC, bromide, and chloride concentrations peak during early fall and winter and are lowest during April, May, and June. No patterns in concentration are evident at the intakes with hydrologic years.

In general, the bromide concentrations at the South Delta Intakes always exceed the ROD intake target of 50 µg/L. In contrast, bromide at the Barker Slough Intake only exceeds the ROD bromide target during April, May, and June. DOC concentrations consistently exceed the ROD target of 3 mg/L TOC at the South Delta during January, February, March, and April. DOC concentrations at the Barker Slough Intake consistently exceed the ROD target for TOC throughout the year with significantly higher concentrations than the South Delta Intakes, particularly in February, March, and April.

Pumping rates vary seasonally, with the highest pumping rates often occurring during times when the water is of relatively lower quality. During the fall, salinity concentrations and pumping rates for Banks and Tracy are the highest, but organic carbon concentrations are relatively low. In general, pumping rates at Barker Slough are highest when both organic carbon and salinity are the lowest.

As mentioned previously in this report, work by the USGS has shown decreasing trends in organic carbon concentrations for the Sacramento and the San Joaquin Rivers and increasing nutrient concentrations for the San Joaquin River. Longer-term, consistent data (i.e., 10 to 20 years) will be needed to perform more trend analyses in the future.

[17] California Department of Water Resources. February 2005. Flooded Islands Feasibility Study Baseline Report.

### 2.7.2 Data and Information Gaps

Throughout this evaluation of existing water quality, a number of data and information gaps were identified, including period of record, monitoring frequency, method consistency, and tools to adequately analyze the cause and effect relationships on Delta water quality.

*Data Completeness*

There are a number of existing monitoring locations operated by DWR that provide valuable Intake data, yet monitoring frequency and period of record is limited for many constituents, particularly for nutrients and pathogens. For most intakes, organic carbon and bromide are only monitored once a month, and for nutrients, the data are either very limited or incomplete. Intake data for Tracy had to be obtained from two records, MWQI and USBR, for a more complete historical data. Long periods of time where data are not available are frequent among all locations.

For the Sacramento and San Joaquin Rivers, bromide and organic carbon are monitored more frequently than once a month, but the monitoring method and sample timing is inconsistent. Complete records with greater than monthly frequency for all constituents of concern are needed to adequately monitor water quality in the Delta. Long-term trends in Delta water quality are often masked by year-to-year variability and the complexity of systems. For example, salinity concentrations at Delta Intakes are governed by recirculation and drainage of the Delta, the amount of salt water intrusion in the Delta, and water management actions like reservoir releases, barrier operations, Delta Cross Channel operations, and pumping at Tracy and Banks. Long-term records are needed to analyze these trends and determine their underlying influences.

*Consistency in Analytical Methods*

Organic carbon measurement (both TOC and DOC) in the Delta and its tributaries has been conducted with inconsistent methods, with no apparent trends in this inconsistency. Analytical measurements for nutrients are also inconsistent throughout all locations. Consistent methods are needed throughout and need to be continued to establish a historical record so that data can be compared at multiple locations. The high frequency monitoring stations funded by the WQP on the San Joaquin River at Vernalis, the Sacramento River at Hood, and Banks Intake add significant value to existing monitoring and modeling efforts and will improve the water quality data available for future assessments, especially where consistent, long-term, higher-frequency data are currently limited.

*Coordination of Monitoring*

The constituents discussed in this section are not of unique concern to drinking water. There are a number of monitoring programs throughout the Bay-Delta system, conducted for a variety of purposes, and many of them monitor these constituents. Rather than initiating new data monitoring, the WQP could encourage coordination of specific monitoring by outlining their water quality objectives and management questions, and comparing them with those of existing programs. Objectives and management questions would help identify priority locations, monitoring frequency and constituents of concern. The WQP could coordinate with, or even augment, existing programs and projects to obtain important monitoring data.

Development of objectives and management questions should include a focus on understanding the linkages of sources, fate, and transport of constituents of concern. Through the establishment of these linkages, further linkages to the methods of control, including those developed with WQP funding, can be better understood and further acted upon. The geographic scope of this effort should include the watersheds to the Bay-Delta system.

*Assessment Tools*

A number of tools, such as those developed by DWR, model existing data to better understand the linkage between tributary water quality and water quality at the intakes. Refinements to and new development of such tools is needed to fully understand the water quality relationships in the Delta.

# SECTION 3

# OVERVIEW AND ASSESSMENT OF PROJECTS SUPPORTING THE WQP

A total of 74 projects have been funded by the WQP and other CALFED programs (i.e., Ecosystem Restoration, Watershed, and Conveyance Programs) to improve drinking water quality. The 74 projects included in the WQP database and discussed in this assessment are a subset of the more than 227 projects and $195 million dollars invested in CALFED programs to improve water quality. The 74 projects were reviewed relative to four types of interim performance measures to provide the basis, both quantitative and qualitative, for this initial assessment. As noted in Section 1, the interim performance measures range from simple program administrative measures to progress toward ROD commitments, water quality targets, and treatment technologies. Formal performance measures for the WQP, which are still under development, will help to frame more focused program assessments in the future.

## 3.1 Background

Project information was collected through surveys and interviews of project managers and from a review of project contracts and reports. The information has been housed in a WQP project database.

### 3.1.1 Survey

As described in Section 1, a survey was sent to project managers. Background questions were included on the survey to gather information on project descriptions, objectives, locations, constituents studied, deliverables, start and end dates, contact information, amount funded, and amount of matched funding. Status questions were asked to determine percent of project completion, percent of money spent, changes to project objectives, goals achieved through the project, action areas covered, performance measures, future steps, load reductions, communication of results, public outreach, and advancement of regional efforts. Surveys were distributed to a total of 74 projects. Of the surveys sent out, 49 surveys (65 percent) were returned with project manager responses. Project managers were initially asked to return surveys within two weeks, but responses were relatively limited, so the deadline was extended to two months which slightly improved the response.

### 3.1.2 Project Database

A project database was developed and populated to track and monitor the progress and status of projects funded during 2000-2004 to improve drinking water quality. Of the 74 total projects, 63 were funded by the WQP. The remaining 11 projects were funded by other CALFED programs (i.e., Ecosystem Restoration Program [7 projects], Watershed Program [3 projects], and Conveyance Program [1 project]), but provided important benefits for drinking water quality. The USBR Recirculation project was not included in the administrative measures, but has been included within the WQP project database for tracking.

A copy of the database is provided with this report, and will be added to the CALFED WQP website. The database categorizes project information by summary, objectives, reporting, performance, and next steps. Projects can be searched by project title, recipient type, organization, grant program, project description key words, and constituents, pollutants and water quality data collected. The project database identifies the project managers that returned surveys to provide additional information for this assessment. The project database has been used to support the quantitative assessment of project funding and can also serve as an effective communication tool to track project progress and information in the future. Highlighted projects and examples of information contained in the database are provided in Appendix D.

### 3.1.3 Project Manager Interviews

Nine interviews were also conducted with selected project managers and/or agencies to get more detailed information from a broad representation of projects by region, action area, and different topics the projects addressed. Many agencies were responsible for more than one project, so typical interviews focused on a number of projects. The target questions for these interviews are provided in Appendix C and interview summaries are provided in Appendix D. The objective of these interviews was to obtain information on how these projects would improve Delta water quality, feedback on the accomplishments of the WQP, and suggestions for improvement of the WQP. Much of the information obtained was used to further understand how projects addressed the ROD commitments. Interviews were also conducted with the Environmental Justice and Tribal coordinators to obtain feedback on where the water quality program could further coordinate their objectives to include Tribal and Environmental Justice issues and priorities.

## 3.2 Simple Administrative Measures

Simple administrative measures focused primarily on funding statistics among several categories indicative of the various WQP objectives. It should be noted that there are some gaps in the funding data because information was not available for every project, but the evaluation does provide a reasonably comprehensive overview. The funding statistics are presented from two perspectives: 1) the number of projects funded and 2) the amount of funding provided. Projects were generally separated between WQP-funded efforts and projects funded by other CALFED programs.

### 3.2.1 Project Completion

As of June, 2005, approximately 26 of the projects funded by the WQP will be complete, six will be greater than 50 percent complete, and 31 will be less than 50 percent complete (Figure 3-1). According to the survey responses, start dates for many projects were delayed, primarily due to contracting issues. As of May 2005, four projects from the 2003 project solicitation are still in the contracting process.

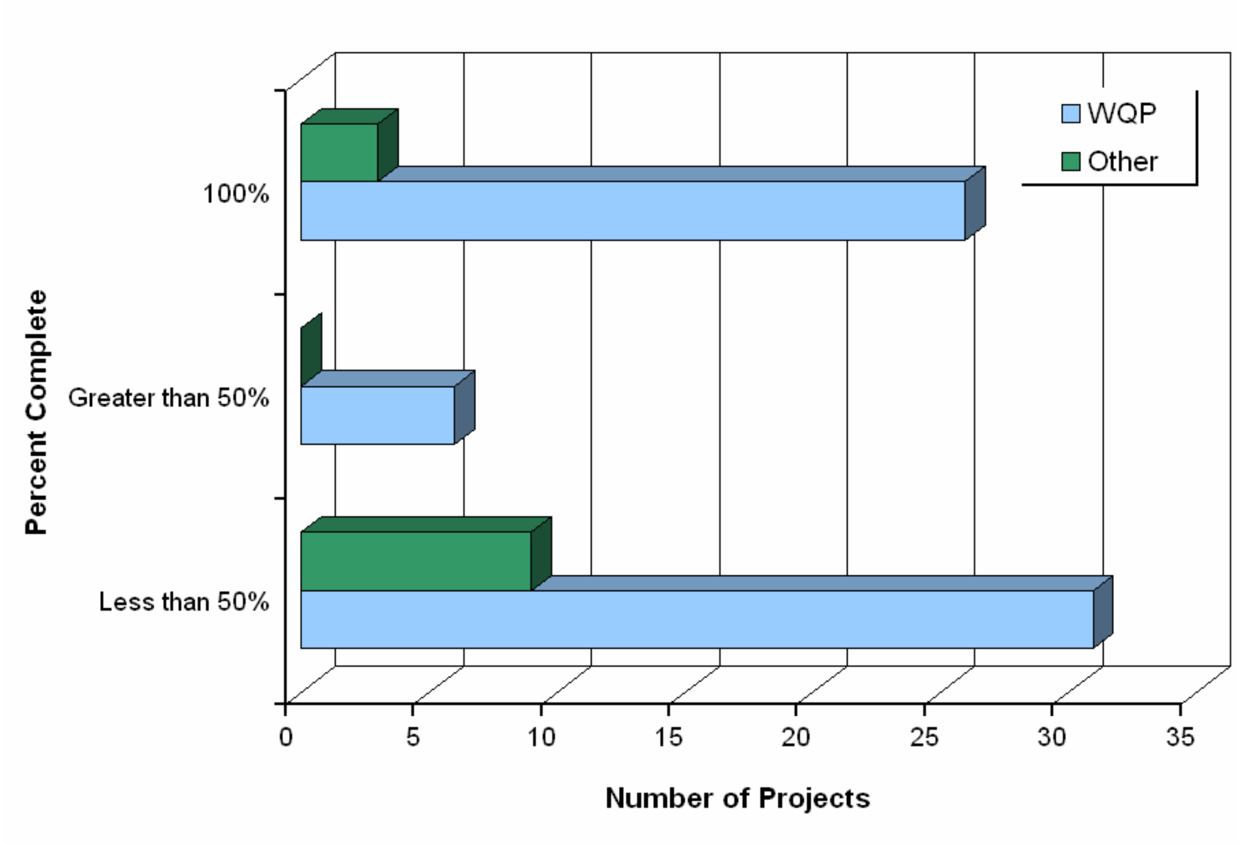



**Figure 3-1. Number of projects completed (June 2005)[1]**

### 3.2.2 Recipient Type

The percentage of projects funded by type of recipient organization is shown in Figure 3-2. The recipient types identified are federal, state, and county government, special district, non-governmental organization (NGO), education and private institutions. Of the 63 projects that received WQP funding, the majority were awarded to special districts. Of the 11 projects funded by other CALFED programs, the majority were awarded to federal organizations, such as the USGS. Both the WQP and other CALFED programs funded a relatively small number of projects managed by education institutions and NGOs.

[1] "Other" in the legend refers to projects funded by CALFED programs other than the Water Quality Program. This nomenclature is used throughout this section.

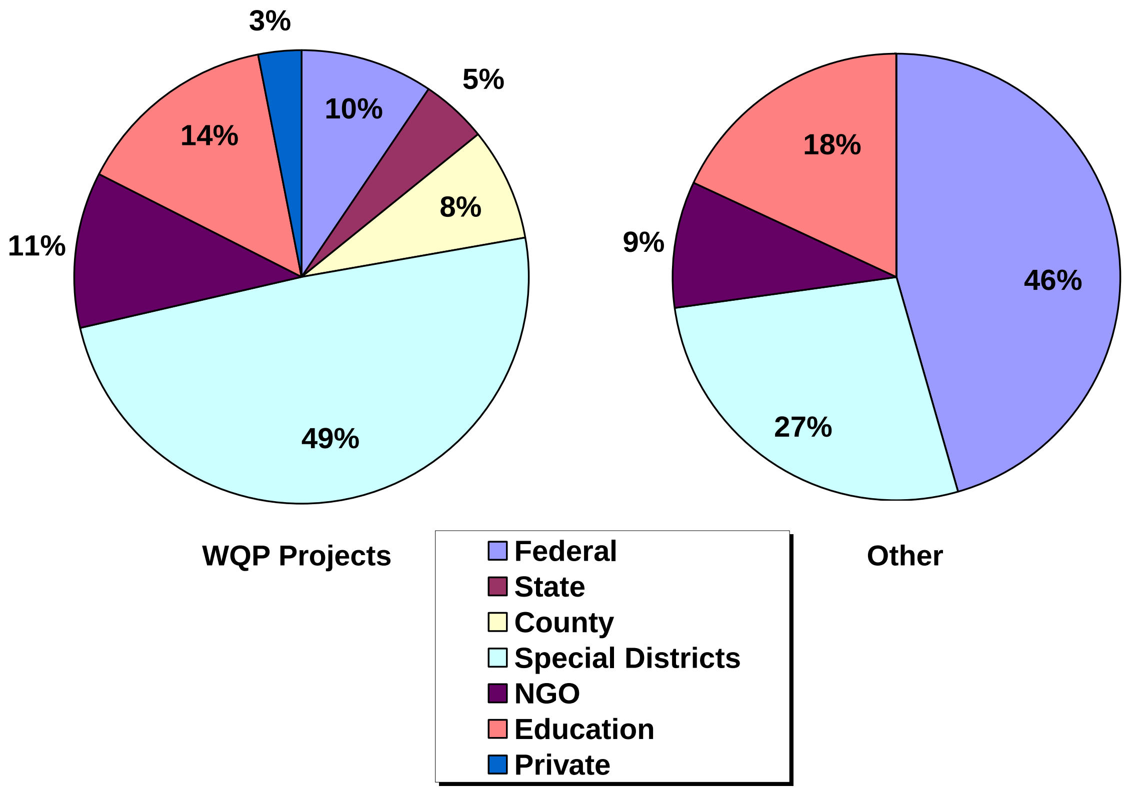



**Figure 3-2. Percentage of projects by recipient type**

### 3.2.3 Action Areas and Degree of Implementation

Accomplishments to improve water quality and activities of the WQP were grouped into five broad categories, or action areas, as defined through the strategic planning process of the WQP and summarized below.

- **Source Improvement.** All actions to improve water quality upstream of drinking water intakes, including Delta water quality, imported water quality, and local source water quality. Source improvement projects focus on reducing levels of drinking water constituents of concern in the Delta and its tributaries. These actions include point and non-point source controls, as well as actions to reduce constituents of concern in conveyance, operations, storage, and water exchanges.

- **Science and Improved Understanding (Monitoring and Assessment).** Actions to gather water quality data and evaluate trends and impacts, including the development of program performance measures.

- **Treatment Technology.** Actions to explore/test the use of advanced water treatment methods at drinking water treatment plants.

- **Regional Planning.** Development of regional drinking water quality management plans, which identify and prioritize the specific state, regional, and local actions needed to achieve ELPH.

- **Institutional/Program Management.** DWS support, coordination with other CALFED Programs, and other actions necessary for program implementation, such as strategic and financial planning and refining the definition of ELPH.

Projects were further divided into categories to describe the level of implementation, or sequential progression of activities toward implementation (i.e., whether the projects addressed research and monitoring, research toward implementation, implementation, or institutional/other).

- **Research/Monitoring.** These projects provide research and monitoring of key constituents of concern and other related issues. This category further develops understanding and knowledge of existing Delta water quality. Examples are projects that support increased data collection or provide detailed investigations to address relevant research questions.

- **Research Toward Implementation.** These projects provide research/monitoring and planning in support of subsequent implementation. These types of projects build on knowledge and understanding to determine the best treatment or management practices to improve Delta water quality. Some of these projects may require research and monitoring before recommendations can be made. Examples are projects that research best management practices (BMP) or draft implementation plans for selected BMPs.

- **Implementation.** These projects design and build infrastructure to improve Delta water quality. Examples are projects that implement BMPs (e.g., fencing), treatment technologies, or drainage system improvements.

- **Institutional/Other.** These projects include Regional Planning and efforts that contribute to defining ELPH and the strategic development of the WQP, support the DWS, and provide public outreach.

Each project was categorized by action area and implementation degree, based on characterization by WQP and Brown and Caldwell staff (Figure 3-3). It is interesting to note that project managers, in response to the survey, also categorized their projects into action areas, with markedly different results. Given that many projects address multiple action areas, however, this is not a surprising result. As shown, the majority of projects were funded in the Source Improvement action area for both the WQP and the other CALFED programs and the majority of these projects were in the first two stages, moving toward implementation. The action area with the second greatest number of projects was Science and Improved Understanding, where projects were primarily in the first stage: research and monitoring. The remaining WQP-funded projects (17 percent) were distributed among Regional Planning, Treatment Technology, and Institutional/Program Management.

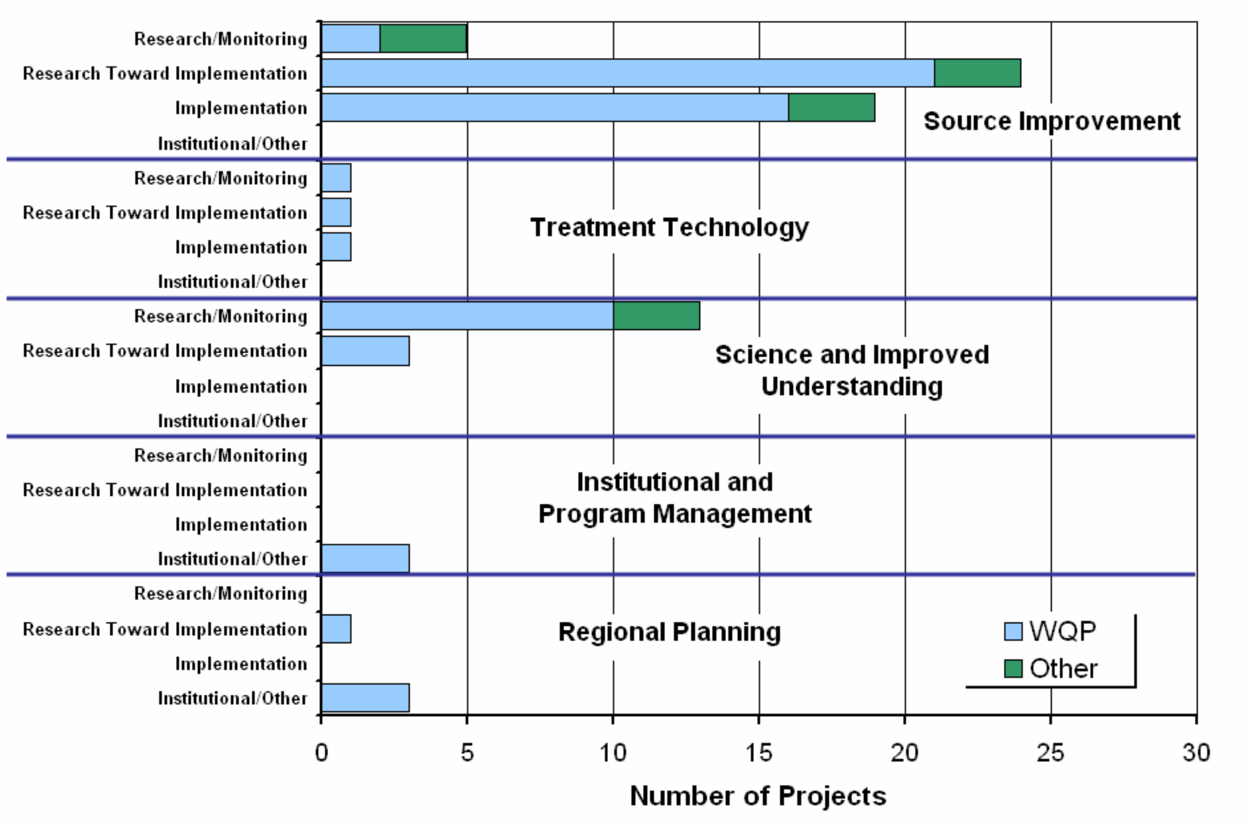


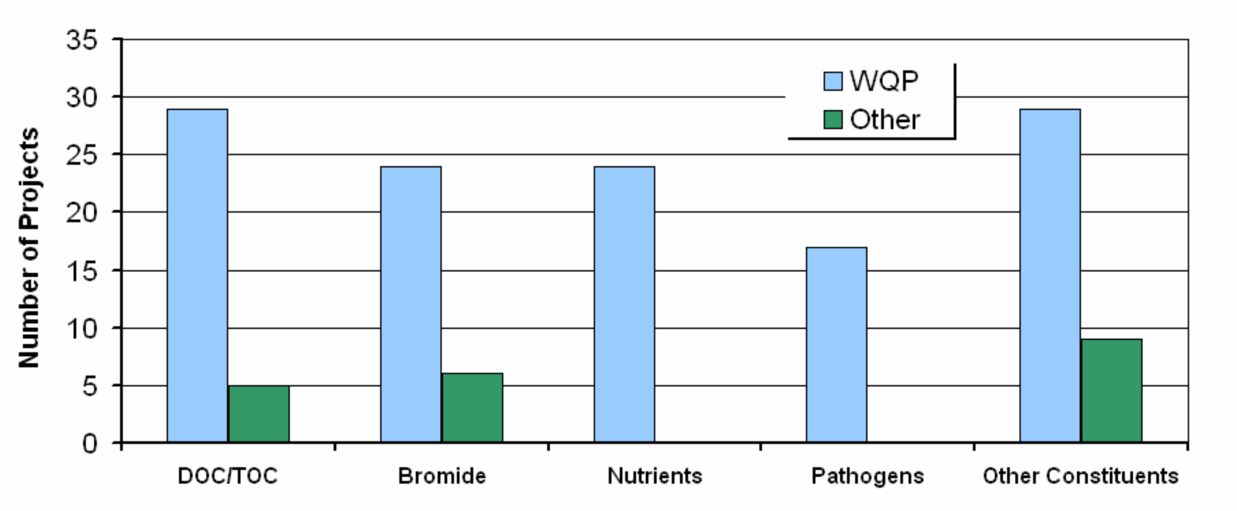

**Figure 3-3. Number of projects by degree of implementation and action area**

### 3.2.4 Constituents

Projects to improve drinking water quality focused on five major categories of constituents of concern to the WQP, as listed below.

- Organic carbon
- Bromide/salinity
- Nutrients
- Pathogens
- Other

The "other" category includes a wide variety of constituents including selenium, metals, total dissolved solids, turbidity, sediments, pesticides, fertilizers, dissolved oxygen, and metals. The majority of projects address more than one constituent, and thus, some projects are double-counted in the following graph (Figure 3-4).




Note: The majority of the projects are counted multiple times because they study multiple constituents.

**Figure 3-4. Number of projects addressing each constituent**

### 3.2.5 Regions

The CALFED solution area has been divided into five regions: the Delta, the San Joaquin Valley, the Sacramento Valley, the (San Francisco) Bay Area, and Southern California. Each region has its own unique characteristics, issues, and priorities, which are described on the CALFED website (http://calwater.ca.gov/Regions/Regions.shtml).

State-wide or multiple region projects received the most WQP funding (about $23 million). Thirty-four percent of the WQP-funded projects ($15 million) are in the San Joaquin Valley, and 25 percent ($18 million) are in the Delta. The remaining projects are relatively evenly divided among the Sacramento, Bay Area, and Southern California regions. Their distribution is shown in Figure 3-5.

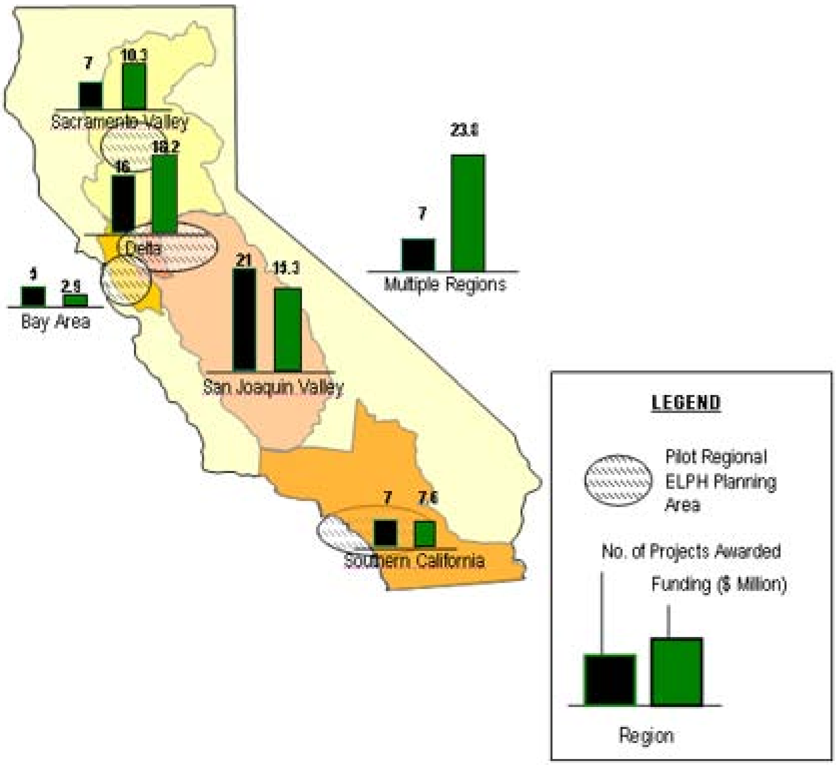
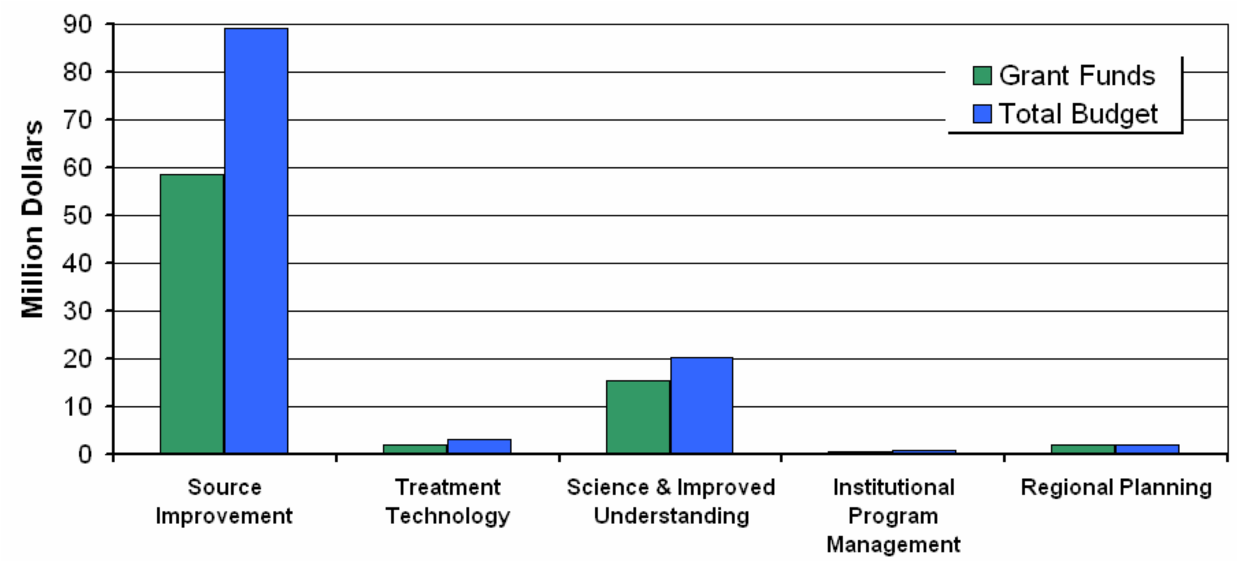



**Figure 3-5. Geographical Distribution of WQP Projects**

### 3.2.6 Funding

$78 million dollars in grant funding has been awarded in support of the WQP in Years 1-4 (and in pre-ROD actions). More than $37 million has been obtained in matching funds (47 percent), for a total budget of $115 million. The matching fund amount may actually be higher because information on matching funds was limited. One of the largest WQP allocations was a $20 million Proposition 13 grant to fund the "Water Quality Exchange Partnership Program," led by the MWDSC in conjunction with several other regions. The 11 projects funded through other CALFED programs provided approximately $17 million in additional grant funds toward improving water quality.

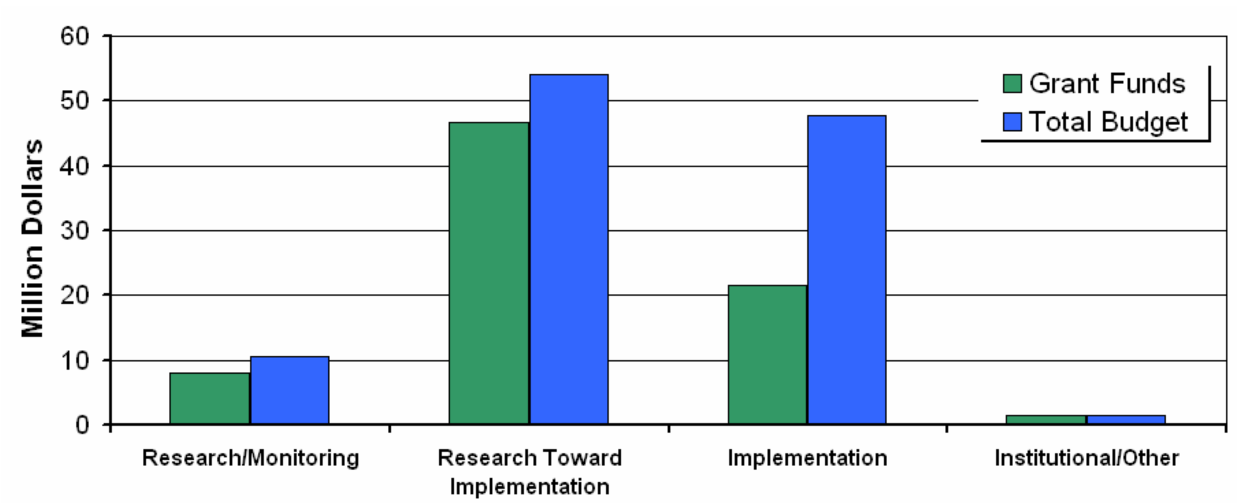
When categorized by action area, the majority of the grant funds were directed towards Source Improvement, followed by Science and Improved Understanding (Figure 3-6). The other action areas totaled together received less than $5 million in grant funding.




Note: To avoid double counting, projects were placed in one action area.

**Figure 3-6. Funding by action areas (WQP only)**

When categorized by Degree of Implementation, the majority of grant funds have been allocated to projects that provide Research toward Implementation (Figure 3-7), followed by Implementation projects.




Note: Incomplete information on total budget for 5 projects.

**Figure 3-7. Funding by degree of implementation (WQP only)**

## 3.3 Progress toward ROD Commitments

While this section assesses progress toward ROD commitments, it is important to also recognize that certain ROD commitments cover actions that specifically contribute to water quality targets and treatment technologies. The remaining ROD commitments have a role in contributing to the achievement of ELPH. The ROD commitments are thus organized by these more specific performance measures and evaluations of overall progress towards water quality targets and towards treatment technologies are included.

During the initial stages of the WQP, ROD commitments were used to guide grant funding. Each of the ten ROD commitments has been addressed by WQP-funded projects and/or by implementing agency actions to some degree. Many of the ROD commitments do not provide specific language on measures or endpoints, so it is difficult to determine whether endpoints have been reached. For each ROD commitment, a summary of the issues identified in the ROD, an assessment of overall progress, and example projects are presented below. A few projects (three WQP-funded projects, with $1.7 million in funding) did not directly address any of the ROD commitments, but did support the ELPH target and are discussed at the end of this section.

### 3.3.1 ROD Commitments Supporting Progress toward Water Quality Targets

There are three ROD commitments and one complementary action which include activities that directly support the reduction of bromide, organic carbon, and other constituents of concern in the Delta. As discussed in Section 2, it is too early to see actual improvements in Delta water quality, and these projects are essentially either establishing institutional frameworks, demonstrating control measures, or just beginning to implement small-scale improvements. This assessment does not delve into the issue of whether water quality projects actually result in water quality improvements (versus other benefits), which will be important for the WQP to track and understand in the future.

The ROD commitment to "Implement source controls in the Delta and its Tributaries" has received 38 percent of WQP funding, from funding of monitoring equipment, research into the fate and transport of priority constituents, and technical studies to support regulatory protections, to on-the-ground source improvement projects. The ROD commitment to "Address drainage problems in the San Joaquin Valley to improve downstream water quality" has received 7 percent of WQP funding. Along with "Study recirculation of export water to reduce salinity and improve dissolved oxygen in the San Joaquin River" these efforts over the last four years have led to tremendous strides in institutional development, motivated by the adoption of the Salinity and Boron TMDL for the Lower San Joaquin River. The ROD complementary action to "Develop and implement within two years a plan to meet all existing water quality standards and objectives for which the State and Federal water projects have responsibility" has not received WQP funding (it is not an action supported by projects), yet federal authorization directs this activity to be completed by November 2005.

All together, ROD commitments supporting progress toward water quality targets represent the largest number of projects and funding by the WQP. They also represent the largest amount of work envisioned for the WQP within the ROD, so the fact that none of these commitments are complete is both a reflection of the early stage of the program and the reduced level of funding, as compared to initial ROD estimates. It is also important to put water quality targets in perspective within the ELPH solution, and as that solution evolves, the scope of source improvement may also evolve. To date, the WQP has recognized that some degree of source improvement will be included in the ELPH solution and have thus made investments. It will grow increasingly critical to understand both the potential and actual value of these types of investments and their role in the ELPH.

#### 3.3.1.1 Implement source controls in the Delta and its Tributaries

The goal of this commitment is to develop a comprehensive source water protection program, which includes identification and implementation of appropriate pollutant control measures, focused regulatory and/or incentive programs targeting pollutants of concern, development of a comprehensive monitoring and assessment program, and infrastructure improvements to separate drinking water intakes from irremediable sources of pollutants. One specific goal of this element is to support the Central Valley Regional Water Quality Control Board (CVRWQCB) in establishing a state drinking water policy for the Delta by the end of 2004 and to begin implementation of appropriate source control measures by 2006.

**Overall assessment.** Developing and implementing source controls to address drinking water quality issues throughout the Delta and upstream tributaries is one of the broadest, most challenging ROD commitments for the WQP. The bulk of WQP funding to date addresses source control with a total of 33 projects and $30 million, yet the WQP does not have an overall strategy or established priorities to guide these investments. Several important projects have been implemented which should inform the WQP strategy, such as the construction of high-frequency monitoring stations at critical locations in the Delta. The Central Valley Drinking Water Policy project's monitoring database, conceptual models, and resulting policy direction will help to provide a comprehensive approach and priorities for source control actions in the future. Regional ELPH planning will also help to define future needs and priorities for source water protection. Funding to support "comprehensive monitoring and assessment," however, has been lacking, and monitoring/assessment results of small-scale projects have no larger framework for evaluation of incremental contributions.

Many of the source control projects to date have also been in the research or planning phases and are now in the process of shifting toward more on-the-ground implementation actions to improve drinking water quality. As a result, water quality improvements may not be evident for a number of years. Progress on this ROD commitment is in the early stages, but with a comprehensive program to guide more implementation projects in the future, results should become more evident.

**Example Projects:**

- ***Vernalis Real-Time Monitoring Station and Real-time Continuous Monitoring of Bromide and Nutrients at H.O. Banks Pumping Plant.*** The California Department of Water Resources (DWR) was funded $615,000 to construct a monitoring station to measure water quality constituents and flow on a real-time basis. Additional funding of $274,556 was provided to Santa Clara Valley Water District to improve real-time monitoring capabilities of bromide and organic carbon at Banks and Vernalis. These projects were completed in May 2005, and data is being made available through the California Data Exchange Center.

- ***Watershed Monitoring and Technical Studies to Support Development of Central Valley Drinking Water Policy.*** CUWA was awarded $970,000 to conduct the technical studies needed to assist the CVRWQCB with development of a drinking water policy for the Central Valley, which they recently received at the time of this report (end date of WQP funding January 2008). Additional funding for this effort has been provided by U.S. EPA, the CALFED WQP, CUWA, Sacramento Regional County Sanitation District, and the Sacramento River Watershed

Program. The Central Valley Drinking Water Policy Work Group (Work Group) was formed to oversee the technical studies. The Work Group consists of a number of the CALFED implementing agencies, WQP staff, and staff from several stakeholder organizations. Work completed with other funds, prior to receiving grant funding, includes an assessment of the water quality constituents to be included in the policy development, an assessment of data availability, development of a water quality data base, and initiation of conceptual model development for key constituent groups. The constituents that are to be included in the conceptual modeling effort include dissolved minerals (total dissolved solids and chloride), nutrients (nitrogen and phosphorus), organic carbon, bromide, and pathogens and indicator organisms. The next steps will be to assess monitoring needs and to partner with other monitoring programs to fill the data gaps. The conceptual models will then be updated and an analysis of the sources and loads of drinking water constituents will be conducted. Finally, control strategies will be evaluated. Upon completion of the technical studies, the CVRWQCB will prepare a Basin Plan amendment. The Basin Plan Amendment may include numeric or narrative water quality objectives for some of the drinking water constituents.

- ***Evaluating the Drinking Water Impact of Wetland Derived Organic Carbon.*** This project is particularly important to further understand the impact that different wetland management practices have on the quantity and quality of organic carbon contributed from wetlands when they are drained. Lawrence Berkeley National Laboratory was funded $465,750 to conduct this research. This project will identify management practices and provide valuable information on organic carbon sources and help identify more problematic organic carbon sources. This project directly addresses one of the water quality concerns identified in the water quality evaluation – seasonal variation in carbon. This project is still in its beginning stages and will be completed in June 2007.

- ***The Water You Play in is the Water You Drink.*** This project focused on addressing non-point source pollution in the Delta contributed by recreation practices. $982,000 was allocated to Contra Costa County to develop and implement an education program to inform boaters how to appropriately dispose of bilge waste and promote better fueling practices. This project is expected to make important contributions in an area that has previously received little attention and funding. The program includes informational material for boaters and marinas and outreach to inform users that the Delta is not only a place for recreation but also their drinking water. While monitoring for pathogens was conducted, per the project agreement, there was concern of how meaningful the data would be given the sampling and analysis difficulties and the challenges presented by the complexity of the Delta system. Contra Costa County plans to contribute $120,000 a year to continue and maintain the education program and facilities set up through this project, but these funds are only for a portion of the Delta and boater recreation also occurs in other areas throughout the Delta. This project is over 50 percent complete.

#### 3.3.1.2 - Address drainage problems in the San Joaquin Valley to improve downstream water quality

The goal of this ROD commitment is to implement recommendations from the San Joaquin Valley Drainage Program. Actions include identifying and supporting innovative drainage management programs, developing and supporting voluntary land retirement programs for drainage impaired land, and developing a TMDL for salinity in the lower San Joaquin River.

**Overall assessment.** A tremendous amount of work has been done to understand drainage problems in the San Joaquin Valley. The challenge is to address the problems in a way that yields multiple benefits – resolving other environmental water quality problems, increasing water supply reliability, and providing water quality improvements. The presumption of this assessment is that there will be some improvement in drinking water quality through resolution of these problems, such as a reduction in the historical build up of salt in the San Joaquin Valley that recycles through the Delta and a reduction in other constituents of concern (such as organic carbon and nutrients) that are elevated in drainage water.

Ten projects in the WQP have been funded with a total of $4.4 million to address salinity and nutrients from agricultural drainage and dairy farming. The projects that have been funded to date provide an initial start, but considerably more work will be required to fully address this ROD commitment, as the costs exceed $100 million. Some of the funded projects have effectively demonstrated technologies that could be expanded for larger-scale application throughout the Valley, but others are still in process. In 2004, the CVRWQCB adopted a salinity and boron total maximum daily load (TMDL) for the lower San Joaquin River.

This is a simple assessment of this ROD commitment, which is more complex than described. The WQP has made significant progress with the TMDL commitment, and some progress has been made institutionally as a result. This is a commitment where significant progress could be made with additional funding resources.

**Example Projects:**

- ***Dairy Nutrient Management.*** East Stanislaus Conservation District was awarded $271,930 of Proposition 13 funding to address challenges of disposing dairy wastes by providing engineering and training assistance to dairy operators. The goal of this project was to secure voluntary implementation of non-point source management measures to improve ground and surface water quality. This project is to be completed in March 2006.

- ***Full Scale Demonstration of Agricultural Drainage-Water Recycling Process Using Membrane Technology.*** The ERP and the WQP funded $319,993 to Water Tech partners to conduct a project in the San Joaquin Valley region which addresses water quality improvement concerns for both programs. The objective of this project is to demonstrate removal of selenium, boron, and other salts using nanofiltration to pre-settle out the salts at a treatment plant designed for agricultural runoff to improve water quality. This project was completed in 2004.

- ***Regulatory and Institutional.*** In addition to the CALFED-funded projects, development of regulatory and institutional frameworks has provided a strong basis to address agricultural drainage problems. The Salt and Boron TMDL and Basin Plan Amendment for the San Joaquin River at Vernalis, which include a real-time salinity management approach, were adopted in September, 2004. Salinity objectives for the San Joaquin River upstream of Vernalis are in process. TMDLs are also underway for other constituents of concern on the San Joaquin River (i.e., dissolved oxygen and organophosphate pesticides). A San Joaquin River Water Quality

Management Group, consisting of local stakeholders, was formed in late 2004 and is working cooperatively to develop a plan to meet salinity and dissolved oxygen requirements on the river.

#### 3.3.1.3 Study recirculation of export water to reduce salinity and improve dissolved oxygen in the San Joaquin River

The goal of this element is to investigate the potential to enhance flows in the San Joaquin River by exporting water from the Delta and conveying it through existing channels to the San Joaquin River to reduce salinity and improve dissolved oxygen in the lower San Joaquin River. This ROD commitment is implemented through the CALFED Conveyance Program.

**Overall assessment.** A short pilot study of recirculation was conducted in the Fall of 2004, and did show a water quality improvement at Vernalis. Recent federal legislation authorizes a feasibility study of this project. This action is being considered as a part of the solution to the San Joaquin Valley drainage problem.

#### 3.3.1.4 Develop and implement within two years a plan to meet all existing water quality standards and objectives for which the State and Federal water projects have responsibility (Complementary Action)

**Overall assessment.** No projects were directly funded through the WQP for this ROD commitment, but the DWR and the USBR are working towards this commitment.

### 3.3.2 ROD Commitment Supporting Progress toward Treatment Technologies – Invest in treatment technology demonstration projects

There is only one ROD commitment addressing treatment technology, "Invest in treatment technology demonstration projects." This ROD commitment identified the need for investigations in treatment technology for desalination of agricultural drainage for source water improvement, and UV disinfection technologies. The source water improvement aspect of this ROD commitment is addressed under the San Joaquin drainage ROD commitment (3.3.1.2), so that this discussion focuses on drinking water treatment technology.

**Overall assessment.** This ROD commitment has essentially been fulfilled. Four projects have been funded to investigate drinking water treatment technology for a total of about $1.9 million, including two projects to investigate UV disinfection and one that applied pH suppression to reduce bromate formation during ozonation. The ability of ion exchange resins to remove organic carbon was also assessed. The commitment to address desalination of agricultural drainage was addressed by a full-scale demonstration of agricultural drainage-water recycling, as described above. The real issue relative to treatment technology is whether enough has been done in treatment to inform ELPH or to make progress towards it. As the WQP and the ELPH strategy evolves, it may be determined that more demonstration projects are warranted or that treatment technologies are a high priority. The WQP should maintain that treatment will be some part of the solution, just as it currently assumes that source improvement is part of the solution.

**Example Projects:**

- ***NBA Ion Exchange for Organic Carbon Removal.*** Solano County Water Agency was awarded $495,000 to evaluate ion exchange resins as an advanced pretreatment process to remove organic carbon from North Bay Aqueduct water, which may substantially reduce disinfection by-product (DBP) formation. This completed project demonstrated successful removal of organic carbon from NBA water using MIEX®, a commercial resin developed for organic carbon removal. This project is complete and has proved useful to the City of Vallejo, which is implementing this technology at their Green Valley treatment plant. In addition, Contra Costa Water District will also be using MIEX® for pre-treatment in their pilot scale experiments investigating UV light disinfection practices (see next project).

- ***UV Light and Multiple Disinfectants.*** Contra Costa Water District was funded $715,000 to conduct research to assist drinking water treatment facilities to determine ways to modify and extend the performance of existing treatment facilities. The goal of this research is to help treatment facilities meet increasingly stringent regulations that are difficult to meet with the Delta source water quality. The pilot plants that are currently being set up will further research the potential use of MIEX® for organic carbon removal at drinking water treatment plants that use Delta water. MIEX® results will be compared to the results obtained in the previously described project on ion exchange. Pilot plant research is scheduled to start in the summer of 2005. Three locations have been chosen for the pilot plant work, EBMUD, Santa Clara Valley Water District, and Contra Costa Water District. While this project is just beginning, pilot plant evaluations will provide important relevant information to drinking water utilities that use Delta water by continuing the research on MIEX® and integrating disinfection processes.

- ***Integrating UV Light to Achieve Multiple Treatment Objectives***. Another UV light disinfection project that is in its finishing stages was funded $610,000 to MWD. This project expands on the other UV research work by integrating UV light with oxidants commonly used at drinking water treatment plants for disinfection - chlorine, ozone, and chlorine dioxide.

- ***Bromate Control with Carbon Dioxide Addition.*** Alameda County Water District was funded $100,000 to evaluate the design and economic feasibility of carbon dioxide to suppress pH therefore minimizing bromate formation. Results were presented at the Fall 2004 CALFED Science Conference, and demonstrated that successful bromate formation reduction by suppressing the pH with carbon dioxide was a more feasible option than using other more hazardous chemicals to lower the pH during treatment.

### 3.3.3 Remaining ROD Commitments - Supporting Progress toward ELPH

The remaining ROD commitments, along with projects that do not specifically support ROD commitments (regional ELPH plans and public outreach), support the WQP's progress toward achieving ELPH. These ROD commitments investigate alternative ways to improve water quality, such as conveyance improvements, blending and exchange opportunities, and infrastructure improvements.

The ROD commitment to "Support the ongoing efforts of the Delta Drinking Water Council or its successor" has largely been fulfilled through the WQP's convening of regular meetings to present program activities and solicit comments. The ROD commitments to "Control runoff into the California Aqueduct and other similar conveyances" and "Address water quality problems at the North Bay Aqueduct" have received 24 percent of WQP funding, with a large portion of that addressing a ROD commitment that was originally part of the Conveyance Program (the Rock Slough/Old River projects). The two remaining Complementary actions "Establish a Bay Area Blending/Exchange project" and "Facilitate water quality exchanges and similar programs" have received 27 percent of WQP funding, and both are exploring regional opportunities, aside from source and treatment measures, for drinking water quality improvement. Other projects have received 2 percent of WQP funding to develop pilot regional plans and expand public outreach efforts.

These projects represent the WQP's efforts to better understand the many other parts of an ELPH solution aside from water quality targets in the Delta and treatment technologies.

#### 3.3.3.1 Support the ongoing efforts of the Delta Drinking Water Council or its successor

The Delta Drinking Water Council was a subcommittee to the Federal Advisory Committee Act (FACA) chartered Bay-Delta Advisory Council. The Council provided a stakeholder forum for development of the CALFED programmatic documents, including the Water Quality Program Plan. The Delta Drinking Water Council has been replaced by the FACA-chartered Bay-Delta Public Advisory Committee's DWS. The DWS is comprised of stakeholders who serve in a public advisory capacity to review WQP actions and provide comments to the WQP. The ROD commitment includes a general objective for the DWS to develop recommendations for CALFED agencies in several areas to meet CALFED's goal of continuous improvement in Delta water quality for all uses, and specific objectives for initial and final assessments of WQP progress.

**Overall assessment.** The DWS, convened in February of 2002, has spent the past three years as the public involvement element of the WQP. A significant focus has been reviewing program targets (especially the ELPH target) and priorities and providing both comments and stakeholder-level information to the program. It is in this forum that drinking water issues, updates of WQP projects, strategic planning and performance issues are presented and fully discussed. For example, the question for the NWRI Workshop and questions for the Water Management Science Board were developed through the DWS. The DWS has also been actively engaged in providing review and comment on this initial assessment report. This is an ongoing ROD commitment that has been adequately addressed over the first four years.

**Example Project:**

- ***National Water Research Institute: CBDA Drinking Water Quality Program Workshops Grant.*** NWRI was funded $100,000 to assist the WQP in peer reviews of proposals and to conduct a Nominal Group Technique (NGT) Workshop to define what an ELPH means, particularly as related to the numerical targets for bromide and organic carbon. The "CALFED Bay-Delta Drinking Water Quality Workshop Report," was produced from the workshop. This was the only project funded within this ROD commitment.

#### 3.3.3.2 Control runoff into the California Aqueduct and other similar conveyances

The ROD identified the potential for water quality impairment in the California Aqueduct and other conveyance channels by soil erosion, agricultural and livestock runoff during storm water events, agricultural drains, and groundwater seepage. This commitment includes a comprehensive evaluation of necessary physical modifications and development and implementation of watershed programs to correct these problems. Projects to address the North Bay Aqueduct (NBA) are discussed under a separate ROD commitment. The ROD commitment addressing Contra Costa Water District facilities was originally in the Conveyance Program, but in 2004 was moved to the WQP.

**Overall assessment.** This ROD commitment calls for an evaluation of the California Aqueduct, which has been met through the Sanitary Survey process. This survey has not resulted in high priority water quality improvement projects. From the WQP, a total of eight projects and $17 million were funded to address conveyance water quality issues, primarily to Contra Costa Water District facilities. Studies investigating localized water quality impacts to the CCWD have resulted in projects to address those impacts. Another study was recently funded to better define problems along the South Bay Aqueduct and to develop a Watershed Management Plan. Efforts have been made on the California Aqueduct through seven funded projects, including two projects that address water quality degradation within storage reservoirs. Again, this ROD commitment is essentially fulfilled, but actions to improve conveyances for water quality improvement may be needed to achieve ELPH. Regional plans should clarify this point.

**Example Projects:**

- ***Little Panoche and Cantua Creek.*** The Westside Resource Conservation District was awarded $200,000 to conduct assessments of Little Panoche and Cantua Creek watersheds to identify and quantify significant sources of sediment and selenium, as well as erosion and transport mechanisms that affect land use in the Valley floor and water quality in the California Aqueduct. A list of recommended BMPs to reduce water quality impacts in the California Aqueduct was developed.

- ***Rock Slough and Old River Water Quality Actions/ Improvement Projects Phases I-III and Contra Costa Canal Encasement Project.*** These four projects with a total funding of almost $12 million addressed water quality degradation at the Contra Costa Water District intakes and in the Contra Costa Canal. The initial phases of the projects investigated ways of reducing impacts of local agricultural drainage on the water quality at the intakes and developing BMPs. The final project, awarded about $7 million and now underway, will encase 1900 meters of the canal to prevent groundwater seepage into the water supply.

#### 3.3.3.3 Address water quality problems at the North Bay Aqueduct

The goals of this ROD commitment are to investigate and develop BMPs to address poor water quality (i.e., high organic carbon) in the NBA and to study the feasibility of relocating the intake.

**Overall assessment.** Both aspects of this ROD commitment have been fulfilled. Two projects have been funded a total of $588,000 to improve water quality of the North Bay Aqueduct, as described below. Solano County Water Agency (SCWA) is moving forward to further assess results from the projects and to determine the most cost-effective options to implement. Continued support will be important as the SCWA moves forward with implementation.

**Example Projects**:

- ***North Bay Aqueduct Watershed Best Management Practices.*** SCWA was awarded $399,608 to investigate BMPs for the watershed and built fencing along the aqueduct to prevent cattle from trampling the banks of the aqueduct, to reduce the turbidity, TDS, pathogens, and DOC in the aqueduct. The fencing was completed prior to the wet-weather season, and work to quantify any reductions in pathogens, turbidity, TDS, and organic carbon continues. While quantifiable differences have not yet been documented for this project, it is the opinion of the project manager, that there is qualitative improvement in the water quality. The riparian zones will take a number of years to re-develop and assist in water quality improvement.

- ***North Bay Aqueduct Alternative Intake Study***. SCWA was funded $188,500 to investigate alternative sites for the NBA intake location. This project has been completed and has identified two viable alternative locations.

#### 3.3.3.4 Establish a Bay Area Blending / Exchange project (Complementary Action)

The focus of the "Bay Area Blending / Exchange Project" is to examine the feasibility of blending or exchanging source waters among Bay Area water utilities to achieve improvements in water quality. This ROD commitment has been completed and the effort is transitioning to a regional coalition.

The *Bay Area Water Quality and Water Supply Reliability Program* was the only project funded addressing this ROD commitment. The WQP has funded $1.3 million in this ongoing effort, which was greater than 50 percent complete at the time of this report. The goal of this project is to examine the feasibility of blending or exchanging source waters among Bay Area utilities to achieve improvements in water quality. By working cooperatively, Bay Area water providers could more reliably provide an overall higher quality of water for all users. Helping the water districts do a better job of articulating what benefits they want from storage, conveyance, and exchange and what benefits they want from treatment (i.e., pursuing ELPH strategies) would improve the ability to plan and implement future projects.

#### 3.3.3.5 Facilitate water quality exchanges and similar programs (Complementary Action)

The goal of the ROD commitment is to support efforts to make high quality Sierra Nevada water in the eastern San Joaquin Valley available to urban Southern California interests, as well as to improve agricultural water supply reliability.

*The Metropolitan Water District of Southern California (MWDSC) Water Quality Exchange Partnership Program* was the only project funded addressing this ROD commitment. MWDSC was allocated $20 million from Proposition 13 to evaluate the feasibility of water quality exchanges with San Joaquin Valley partners and to implement pilot projects. This project is in its beginning stages and will be completed in March 2009. MWDSC is working with the Friant Water Users Authority to identify pilot projects that can be implemented to improve both water supply reliability for Friant and water quality for MWDSC. MWDSC's work with the Kings River Water Association is currently on hold pending Kings' decision on whether to proceed with water quality exchange activities. Information regarding the potential benefits of water quality exchanges will become available as pilot projects are implemented.

#### 3.3.3.6 Other Projects

There are three WQP-funded projects which do not specifically support ROD commitments, but do support the WQP goals. These projects have received 2 percent of WQP funding to develop pilot regional plans and expand public outreach efforts.

Regional ELPH plans have emerged as a crucial tool for the WQP. The plans seek to gather local information, facilitate regional coordination, and identify the slate of local, regional, and state actions needed to achieve ELPH.

**Examples**

- ***Sacramento Valley Regional Water Quality Management.*** Three groups were awarded funding (up to $250,000) to develop pilot regional ELPH plans. Glenn County was awarded $249,330, to advance the efforts of four counties (Tehama, Glenn, Butte, and Colusa) toward regional collaboration through a project approach centered on the development of Four County goals, objectives, and an organizational structure that will carry this group into the future. Associated technical efforts will support the development of a regional drinking water quality management strategy.

- ***Drinking Water Education Program.*** This project was funded $443,394 to develop a web based document titled "Where Your Drinking Water Comes From," a documentary on the public perception of drinking water quality, and a series of radio spots. This project was just recently initiated.

## 3.4 Concerns from WQP Project Managers

Project managers were asked for feedback on interactions with CBDA, accomplishments of the WQP, problems encountered with their projects, and suggestions for improving the WQP and its funding program. Some of the common themes voiced by project managers are summarized below. Related recommendations for improvement are discussed in Section 4.

### 3.4.1 Program Funding

Many of the stakeholders interviewed for this assessment expressed strong concern that CALFED is "behind on WQP funding targets" and that the WQP effort "does not match other CALFED program efforts." In addition, some suggested that a consistent, dedicated source of funding for the WQP is critical to future success. Another concern has been the "piecemeal" nature of the funding, coming from various grant programs, which has made it more difficult to implement a cohesive, comprehensive strategy. A review of funding information for Years 1-4, presented in the Years 5-8 Program Plan, indicates that the WQP has been largely under-funded. Current funds total only about 30 percent of the $311 million ROD estimate for Years 1-4. The WQP is also under-funded relative to many other CALFED programs, having received less than 5 percent of total CALFED funding to date. Another concern, which was voiced by a number of stakeholders during the assessment process, is that the WQP has also been under-staffed during the first four years of the program. These chronic shortages in funding and staff have hampered the ability of the WQP to effectively address program goals and objectives, particularly in staying on schedule to meet ROD commitments and other objectives of the adaptively managed program.

### 3.4.2 Contracting Delays

It was evident from the numerous survey and interview responses that contracting has presented significant barriers to project success. Many contracts took over a year after grants were awarded, delaying project initiation. Project managers noted that delayed contracts caused a number of specific problems. Delays were identified as a particular concern for projects conducted at universities and/or federal agencies, where there is a need to hire students/staff and provide training to execute the work, which cannot be done without access to funding. The delay in contracting also affected agency's ability to retain local match money as budget cycles were exceeded. Partnering with other organizations was also challenging when project managers were without definitive, reliable start dates. In one example, contracting delays were so severe that the source of the grant funding disappeared. In January 2002, Metropolitan Water District of Southern California was awarded a CALFED DWQP grant for $973,311 for *Assessing the Occurrence and Sources of Microbial Contamination in the Sacramento-San Joaquin Delta Region.* The contracting process took more than one and one-half years, and by the time the contracts were near completion, the State general fund monies at DWR had expired, so the project was cancelled.

### 3.4.2 Shortened Project Schedules

By the time contracting issues finally resolve, time remaining to execute the project was considerably shorter than planned on by project managers. As a result, a number of project managers felt that the quality of the project and the expected gains of the project were compromised. One example is the project *The Water You Play in is the Water you Drink*, which was awarded funding based on a two-year effort but now has only one boating season for education and outreach. The project managers are concerned that behavior cannot be effectively modified in one boating season and expected results from the original two-year efforts will no longer be realized. Other examples are monitoring efforts, where shortened project schedules mean missing the window of opportunity for wet-weather or dry-weather sampling or insufficient time to collect representative samples.

### 3.4.3 Inflexible Deliverables and Scopes

A number of project managers expressed concerns regarding the inflexibility of project deliverables. By the time contracts were executed, deliverable deadlines were too close and the process to modify deliverables is overly cumbersome, particularly after all the time spent on contracting. Project managers also expressed concern about the difficulty in changing project scopes of work and deliverables in order to adapt projects based on recent experience/project results or to better address overall objectives. Often project managers felt that the scope of work needed to be more of an iterative process, with the option of putting more money into a task that was determined to have a great deal of potential for success rather than having to continue work in a task that was no longer valuable.

### 3.4.4 CBDA Goals and Mission

There is a general sense of disconnect between project managers and the overall goals of the CALFED program. A number of project managers were not at all aware of the goals and mission of CALFED or the WQP. A few project managers were not sure how their projects fit into the program as a whole. However, project managers were interested in changing this and suggested many ways that could help them improve their knowledge and communication with the WQP (see Section 4 for recommendations).

In the future, it will be important for the WQP to continue to connect with smaller, disadvantaged communities, especially through regional plan implementation. It would also be valuable to understand how existing projects are addressing the needs of disadvantaged communities. Of the CALFED program elements, Tribal and Environmental Justice Coordinators feel that the WQP is the most important program element to their stakeholders.

### 3.4.5 Knowledge Sharing and Coordination

There was a request by some project managers for access to more science to evaluate their projects. Some of the project managers identified more technical assistance and feedback that would further assist their projects. In addition, a recommendation that was made several times was to continue to fund further phases of projects and track what projects have been funded so that there are not overlapping projects or gaps in knowledge.

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# SECTION 4

# CONCLUSIONS AND RECOMMENDATIONS

This assessment fulfills the ROD requirement that the "[Delta Drinking Water] Council [or its successor] will complete an initial assessment of progress toward meeting CALFED water quality targets and alternative treatment technologies by the end of 2003." For the purposes of this initial assessment, Brown and Caldwell and WQP staff have interpreted "progress toward meeting CALFED water quality targets" as progress toward numeric targets for source water quality and the target of ELPH. Progress toward "alternative treatment technologies" has been assessed on the basis of investments in alternative or creative conventional technologies.

At the time the ROD was developed, the focus was on a balance between meeting numeric and narrative source water targets and investing in treatment technologies. Over time, ELPH has been defined to include a broader array of components and the WQP has begun the transition to a performance-based program. This assessment attempts to evaluate progress throughout this broader array of ELPH components, as a function of progress on several individual ROD commitments and within the context of the original direction for this assessment. Because the WQP is still in its early stages it is challenging to quantify progress toward meeting CALFED drinking water quality targets.

To date, a relatively small number of projects have been implemented, and most of them have been research rather than implementation efforts. They provide the necessary preconditions for water quality improvements, but quantification of overall accomplishments is difficult. This initial assessment has focused on factors that can be evaluated at this time, primarily early project results and WQP investments in ongoing projects, as compared to existing performance measures or indicators. Project tracking and communication of project results to date were also assessed. The preliminary assessment of existing Delta water quality summarized in Section 2 has helped to identify some of the remaining questions and data needs for future work. Finally, based on the assessment a number of recommendations are being made to the WQP.

The ROD also calls for a final assessment of the program in 2007. Based on the delays in implementing the program as originally envisioned, the complicated nature of water quality in the Delta, and the shifting program focus on performance, serious consideration should be given to a longer time frame for producing a meaningful assessment of the WQP.

## 4.1 Assessment Measures

Measuring performance and using performance to drive implementation is a major emphasis of the CALFED program, as seen in the ROD. The WQP has not yet developed comprehensive performance measures, although it is making progress on data assembly and conceptual model development. Brown and Caldwell and WQP staff utilized four measures to assess progress: simple administrative measures, progress towards ROD commitments, progress towards water quality targets, and progress towards treatment technologies.

### 4.2 Conclusions and Recommendations

Based on the assessments, it became clear that there are several overarching conclusions that can be drawn regarding program progress to date, as well as specific recommendations.

Recommendations were developed to suggest areas where improvements are needed to increase effectiveness of the WQP. These recommendations for improvements are based on observations made by Brown and Caldwell during the WQP assessment process and are provided to the DWS for their information. Observations have been drawn from several sources, including project surveys, project manager interviews, the project database, members of the Technical Advisory Group for this assessment effort, DWS members, and WQP staff.

#### 4.2.1 Comprehensive Understanding of Drinking Water Quality

*Conclusion:*
The WQP is making serious progress towards gaining an understanding of drinking water quality, through the funding of continuous water quality monitoring stations at key locations in the Delta and at Delta drinking water intakes, the development of high-priority constituent conceptual models by the Central Valley Drinking Water Policy project, and through a few key research studies. The WQP also brought the project managers of many of these studies together at the 2004 CALFED Science Conference to share their experiences and results.

The lack of funding and resources for comprehensive monitoring and assessment has prevented the collection of long-term monitoring data needed to evaluate the fate and transport of priority constituents from the watershed through the treatment plant. This lack of dedicated resources to support monitoring and assessment is not isolated to the CALFED WQP (or to CALFED), but perhaps is more crucial to its success as a performance-based program. The WQP has identified tools to improve its understanding: assembling information from Total Maximum Daily Load programs and funded studies, coordinating on the development of conceptual models as a first step in performance measures, investing in the construction of high frequency monitoring stations at key points in the Delta, and collecting local information through the development of regional ELPH plans.

*Recommendation:*
It is critical to the success of the WQP, especially given its shift in focus towards performance and in the overall CALFED emphasis on performance, that it develop a comprehensive understanding of drinking water quality.

- Continue to support and coordinate with the Central Valley Drinking Water Policy project. This project is the single most important project for the goal of linking source water protection with treated water quality. The WQP should also partner with this project to identify monitoring and assessment needs.

- Shift the focus of the WQP from ROD commitments toward development and implementation of regional ELPH plans. Regional plans will provide critical information to the WQP, both on drinking water quality needs and the treated water side of drinking water quality information.

- Make the development of performance measures a high priority for the near future. Use these measures to integrate across other CALFED Programs that improve water quality, especially those with potentially conflicting goals.

- Understand the role that environmental justice and tribal interests play in drinking water quality within the CALFED solution area, and within the ELPH construct.

### 4.2.2 Realistic Schedules and Expectations

*Conclusion:*
In its first four years, the WQP awarded approximately $78 million in project funds and leveraged an additional $37 million in matching funds. Translating those awards into contracts and project implementation has taken approximately one to two years, and in some cases much longer. Since 2000, when the first contracts were initiated, 26 of the WQP funded projects have been completed or are scheduled for completion by June 2005. Many of the remaining 37 WQP funded projects, which are scheduled for completion in 2006-2008, are not far enough along to produce results, and four are still in the contracting phase. The majority of these projects are focused on research, planning, and demonstration – all phases leading up 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.

The ROD calls for an evaluation of WQP progress at four and seven years (2004, 2007). The ROD also estimated spending $311 million in the first four years of the program. Although this assessment is an assessment of the first four years, it is not necessarily an assessment of the first four years as envisioned by the ROD. Also, the ROD calls for an assessment of "water quality targets," yet water quality trends are generally assessed in much longer time-frames (i.e., 10 to 20 years or more), especially for water quality in the highly variable, complex Delta.

*Recommendation:*
The WQP needs to develop realistic schedules and expectations as to the outcomes of the program, both at a project level and at a program level. Future grant-funded projects will perform better with realistic expectations of the funding schedule. Future water quality assessments will be more meaningful when done at critical points in the life of the program. Assessments should recognize the longer time-frame of water quality changes.

- Shift focus to on-the-ground improvement projects where possible, especially where projects have laid the groundwork through research, planning and demonstration phases. To date, about 27 percent of the projects funded by the WQP focused on actual implementation.

- Prioritize efforts based on a reduced level of funding, as evidenced in the first four years. When awarding grant funding, prepare more focused solicitation packages centered on the highest priorities.

- Use scarce funds most effectively by prioritizing projects, so that funding goes first to projects that will contribute substantially to water quality improvements.

- Develop performance measures to better track the contributions of individual projects, to determine both their potential and their eventual role in progress towards the water quality targets and treatment technology. Performance measures should track contributions to implementation of regional ELPH plans.

- Develop a clear scope and schedule for the uncompleted ROD commitments, as well as a description of how they contribute to WQP goals.

### 4.2.3 Coordination between Projects and Program

*Conclusion:*
In the first four years of the WQP there has been a disconnect between the goals of the program and the distribution of funds for WQP projects. Managers of projects funded through the WQP are not always aware of the source of their funding, or the purpose of that funding. Grant funds used to support the WQP are usually distributed through its implementing agencies, which has become one source of this disconnect, as implementing agencies focus on their individual responsibilities and priorities. Implementing agencies are not always allocated the resources to truly manage the contracted funds, and this lack of resources results in a low prioritization for communication of WQP goals, for tracking relevant progress of funded projects, and communicating results to the WQP. The current grant funding process also results in some confusion between project management at implementing agencies and overall program management, an additional source of the disconnect.

In 2004, several project managers were given their first opportunity to communicate their progress at the CALFED Science Conference, in a consolidated session on drinking water quality. In early 2005, the Central Valley Drinking Water Policy project brought together researchers working on various aspects of organic carbon. Both forums were well received by project managers and researchers and resulted in requests for similar opportunities in the future.

*Recommendation:*
The WQP needs to improve coordination between projects and the overall program. This should occur between implementing agencies, between projects, and between the program and projects. Greater coordination among projects would help to reduce overlap and/or gaps and enable greater collaboration and improved results. Improved communication, as described above, will help to facilitate coordination, but it would be valuable for the WQP.

- Include appropriate staff resources in grant funding processes. Work within grant funding processes to focus funding, communicate program priorities and context, and improve coordination between program and project managers.

- Facilitate knowledge sharing, integrate project results into a broader WQP framework, and regularly update the Strategic Plan to enhance the overall effectiveness of the WQP.

- Provide additional communication forums. A broader array of active communication forums would greatly enhance sharing of project results. It would also help the program identify and encourage important linkages among projects and stakeholders. Some suggested forums include the following.

  - *Website.* The WQP website could more effectively provide current information on program priorities and strategy, existing project contributions, ongoing project status, need for potential future projects, funding, and overall WQP progress. Pages centered on topics, such as regional planning or Delta drinking water treatment, could also be developed.

  - *Brown bag series.* More frequent informal discussions (e.g., brown bag series) would be a relatively simple, effective way to help support ongoing communication among the scientific community.

  - *Topic-specific workshops or conferences***.** Periodic focused conferences or workshops on various topics (e.g., organic carbon, salinity, tools to assess Delta water quality, and specific source improvement programs) would help facilitate communication of lessons learned and successes among project managers, stakeholders, CALFED programs and others. Greater emphasis on drinking water quality at the annual CALFED Science Conference would also be of value and interest.

### 4.2.4 Central Valley Drinking Water Policy

*Conclusion:*
One of the most important projects in the WQP is the Central Valley Drinking Water Policy development project. This project is investigating the connection between source water quality and treated water quality and developing conceptual models critical to development of program performance measures. It is also a good example of coordination between implementing agencies and stakeholders and of leveraging projects for multiple benefits. Furthermore, the development of conceptual models is facilitating integration between CALFED programs, based on constituents of common interest.

The ROD commits to adoption of a Policy by 2004. Given the program realities, as discussed previously, it will take longer than this initial expectation. The Central Valley Regional Water Quality Control Board adopted a resolution supporting the development of the Policy in July 2004. With funding from a number of sources, the technical studies are underway – beginning with the creation of a monitoring database. A more realistic deadline for completion of the technical studies is 2008 with adoption of a policy by the Regional Board in 2009 or 2010.

*Recommendation:*
The WQP should continue its support of and coordination with the Central Valley Drinking Water Policy development project, including funding of the project through the basin planning phases.

### 4.2.5 The Role of CALFED in Treatment Technology

*Conclusion:*
The "equivalent level of public health protection" target embraces an improvement of drinking water quality through a cost-effective balance of source improvement, treatment improvement, and improvement through actions between source and treatment. The ROD committed to an initial investment in demonstrations of advanced treatment technology. This commitment, as described in the ROD, has been fulfilled. Four demonstration projects have shown promising results. It is unclear, however, how this translates into progress towards the ELPH target. Investments have focused on large utilities, advanced treatment technologies, and demonstration phases, with a goal of technology transferability.

*Recommendation:*
The WQP needs to reevaluate its role in treatment technology. One of its implementing agencies, the Department of Health Services, has a significant role in drinking water treatment, through application of regulations and funding of treatment plant improvements. The reevaluation should consider several issues, including the scale of involvement (demonstration versus full-scale), the transferability of technologies between plants, the focus of studies (advanced versus conventional treatment processes), and the different challenges facing different sized utilities. The reevaluation should also use regional ELPH plans and stakeholder forums to inform these issues.

### 4.2.6 Tools Linking Source and Treated Drinking Water Quality

*Conclusion:*
The WQP has been appropriately shifting its focus from fulfilling ROD commitments to considering its role in a more comprehensive results-based strategy, through its focus on achieving ELPH. The Central Valley Drinking Water Policy project, discussed in 4.2.4, is an important part of this shift. Another important tool is regional ELPH planning, which gathers local and regional drinking water quality data, strategy, and priorities to inform statewide strategy and priorities. This trend has been observed through the ROD, the recent California Water Plan, and, appropriately, within the WQP funding of three pilot plans in 2004 and longer-term support of the Bay Area Water Quality and Water Supply Reliability Project. As the WQP has recognized, it is timely now to shift focus towards regional planning, to build on the developing knowledge base and provide a broader framework for water quality improvements within the ELPH construct.

*Recommendation:*
The WQP should retain a high priority for the development of tools linking source and treated drinking water quality.

- Fund the development of regional ELPH plans, with the WQP serving to facilitate and coordinate these plans, as well as to develop an overall synthesis of the plans. Use the regional ELPH plans to inform priorities and goals, and to identify the capabilities of various improvement measures.

- Support and use conceptual models developed by the Central Valley Drinking Water Policy to identify linkages between source and treated drinking water quality for high priority constituents of concern, and to identify priorities for improvements.

- Develop performance measures which recognize and strengthen linkages between source and treated drinking water quality and use them to track progress and inform WQP management.

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## SECTION 5

## REFERENCES


CALFED Bay-Delta Program. July 2000. Final Programmatic Environmental Impact Statement/ Environmental Impact Report, Water Quality Program Plan Technical Appendix.

CALFED Bay-Delta Program. August 2000. Programmatic Record of Decision.

CALFED Bay-Delta Program. December 2002. Drinking Water Quality Program, Program Assessment and Work Plan.

California Department of Water Resources. Chronological Reconstructed Sacramento and San Joaquin Valley, Water Year Hydrologic Classification Indices: (*http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST*).

California Department of Water Resources. June 2002. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh.

California Department of Water Resources. July 2003. The Municipal Water Quality Investigations Program, Summary and Findings from Data Collected August 1998 through September 2001.

California Department of Water Resources. October 2004. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh.

California Department of Water Resources. February 2005. Flooded Islands Feasibility Study Baseline Report.

California Department of Water Resources, Bulletin 160-05, Review Draft, April 2005.

California Regional Water Quality Control Board, Central Valley Region. September 1998. Water Quality Control Plan for the Sacramento and San Joaquin River Basins.

California Urban Water Agencies. June 1998. Bay-Delta Water Quality Evaluation Draft Final Report.

California Urban Water Agencies. December 2001. California Urban Water Agencies Expert Panel Letter Report.

Central Valley Drinking Water Policy Workgroup. March 2005. Constituent Prioritization Summary Technical Memorandum from Karen Larsen.

National Oceanic and Atmospheric Administration. Our Restless Tides:A Brief Explanation of the Basic Astronomical Factors which Produce Tides and Tidal Currents. http://140.90.121.76/restles1.html. February 1998.

National Water Research Institute. July 2003. CALFED Bay-Delta Drinking Water Quality Workshop Report.

Snoeyink and Jenkins. 1980. Water Chemistry

State Water Resources Control Board. November 1999. Final Environmental Impact Report for Implementation of the 1995 Bay/Delta Water Quality Control Plan.

State Water Resources Control Board. December 1999, revised March 2000. Water Right Decision 1641 (D-1641).

Woodard, Richard. September 2000. Sources and Magnitudes of Water Quality Constituents of Concern in Drinking Water Supplies taken From the Sacramento-San Joaquin Delta. Prepared for the CALFED Bay-Delta Program.

SB 1155. California Senate Bill 1155.

HR 2828. United States House Resources Committee Bill 2828.

United States Geological Survey. 2003. Organic Carbon Trends, Loads, and Yields to Sacramento-San Joaquin Delta, California Water Years 1980 to 2000.

Water Quality Program - CALFED Bay-Delta Program. December 1999. Drinking Water Quality Operations Studies for the Water Management Strategy Comprehensive Evaluation.

Water Quality Program - CALFED Bay-Delta Program. August 2001. Drinking Water Quality Program Memorandum of Understanding.

Water Quality Program - CALFED Bay-Delta Program. December 2002. CALFED Drinking Water Quality Conceptual Framework.

Water Quality Program - CALFED Bay-Delta Program. August 2003. Drinking Water Quality Program Multi-Year Program Plan (Years 4-7).

Water Quality Program - CALFED Bay-Delta Program. July 2004. Drinking Water Quality Program Multi-Year Program Plan (Years 5-8).