Appendices-Municipal Water Quality Investigations Program 2009-10 Workplan

5/12/09
Final

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Appendix 1—Specific Tasks to be Implemented Using SWPCA Funds

Table 1 Program Element Costs FY 2009-10 (SWPCA Funds)

No.	Program Element	Title	SWPCA Funding Labor PY's	Labor Hours	Labor Cost	Contract/ Other Costs	Supplies/ Equip Costs	Other Costs	Total Costs
5	**Water Quality Assessment**								
	Collection of Grab Samples								
	Biennial Report	Student Assistant 1	0.5	600	$9,007				$9,007
6.1	**Real Time Water Quality Monitoring**								
	MWQI Real Time WQ Stations	Student Assistant 2	1	1201	$14,412				$14,412
	O&M WQ HQ								
	Gianelli WQ Monitoring Station								
6.2	**Real Time Forecasting**								
	Bay-Delta Modeling								
	OCO Modeling								
6.3	**Real Time Data Dissemination**								
	RTDF Data Dissemination and Reporting								
	Administration & Database Activities	Data Management Consultant	1	1000	$62,400				$62,400
	Long-term trends analysis/reporting								
7	**Special Studies**								
7.1	Urban Sources and Loads								
7.2	NDMA Study								
7.3	South Delta EC Study								
7.4	O'Neill Forebay Water Circulation Study								
7.5	Update of Water Quality Compendium	Student Assistant 1	0.5	601	$9,008				$9,008
7.6	Organic Carbon Boundary Study								
7.7	Spectrofluorometry Study	Academic Consultant	1	100	$6,000				$6,000
7.8	Dual Conveyance Study								
8	**Emergency Response**								
10	**Program Management**	SWP Contractor Consultant	1		$55,000			$3,000	$58,000
	Funds not assigned to specific Program Elem.							$41,173	$41,173
Total			5	3502	$155,827			$44,173	$200,000

Contracts required for FY 2009-10:

1. Consultant to assist with development of RTDF-CP data management for up to **$62,400**.
2. Consultant to administer SWPCA managed fund and serve as a liaison between MWQI and SWP Contractors-**$55,000**.
3. CSUS Hornet Foundation for student assistants-**$32,427**
4. Academic Consultant for up to **$6,000**.

Task List using SWPCA Funds:

- Program Element 5: Water Quality Assessment
  a) Continue to employ a student assistant for miscellaneous tasks. Annual cost for a student will be approximately **$9,007**. This expense is covered under a renewed contract between the SWPCA and the CSUS Hornet Foundation.

- Program Element 6.1: Real Time Water Quality Monitoring
  a) Continue to employ a student assistant for miscellaneous tasks. Annual cost for a student will be approximately **$14,412**. This expense is covered under a renewed contract between the SWPCA and the CSUS Hornet Foundation.

- Program Element 6.3: Real Time Data Dissemination
  a) Continue to employ a consultant to improve the RTDF-CP database capabilities and move the weekly MWQI water quality report to a daily product. Assist field staff with remote data relay issues and assist with all areas of data management including the Water Data Library. Consultant's salary will be **$62,400** through a contract between the SWPCA and the consultant.

- Program Element 7.5: Special Studies-Update of Water Quality Compendium
  a) Continue to employ a student assistant to assist with various tasks under this program element. Annual cost for a student will be approximately **$9,008**. This expense is covered under a renewed contract between the SWPCA and the CSUS Hornet Foundation.

- Program Element 7.7: Special Studies-Spectrofluorometry Study
  a) Consultant for special assignments such as assistance with spectrofluorometry studies and manuscript preparation of urban vs. agricultural nutrient loads in the Delta. Consultant's salary will be **$6,000** through a contract between the SWPCA and the consultant.

- Program Element 10: Program Management
  a) Costs for semi-annual MWQI offsite meetings. Costs may include rental fees for a facility, AV equipment and technical assistance, refreshments, deposit for reserving dates and other miscellaneous meeting package elements. Estimated cost for offsite meeting is **$3,000**.

  b) SWPCA-MWQI Consultant to provide technical and managerial expertise on program tasks associated with the MWQI program. Consultant serves as a member of the MWQI-TAC, administers the SWPCA fund, and serves as a liaison between SWPCA and MWQI. Consultant's salary is **$55,000**.

Appendix 2--MWQI and Real Time Data and Forecasting Comprehensive Program--Overview and Evolution

MWQI Program Background

In the early 1960's, the U.S. Public Health Service published drinking water criteria that consisted of only a few water quality parameters. These criteria remained largely unchanged for years, as the conventional wisdom of the day held that treatment of surface waters by filtration, and natural filtering of ground water by soils, along with disinfection, rendered these supplies safe for drinking. In the 1970's, improvements in scientific measurement techniques led to discovery of trihalomethanes (THMs) in U.S. drinking waters. Subsequent investigation indicated a possible link with increased incidence of cancer among exposed populations. With the creation of the U.S. EPA a process was set in motion that resulted in a new federal regulation in the early 1980's controlling THMs in drinking water.

In anticipation of the new regulation, DWR undertook a three-month investigation of organic carbon and bromide sources in Delta drinking water supplies. This study resulted in a preliminary finding that discharges from wastewater treatment plants and drainage from land surfaces contained elevated concentrations of organic carbon precursors of THMs, and that bromide was present in the system in concentrations sufficient to create bromine-containing THMs in treated drinking water. This finding led to the formation of a panel of recognized independent water quality and health scientists who were asked to evaluate information and make recommendations for further action as needed.

The panel report, published in 1981, found that most Delta water quality data then in existence was produced in support of ecological, rather than human health, concerns. The panel recommended institution of a program of monitoring for constituents of human health significance, namely THM precursors, sodium, and synthetic organic pollutants such as pesticides. In 1982, DWR implemented the Interagency Delta Health Monitoring Program (IDHAMP) in satisfaction of the panel's recommendations. The IDHAMP was created as an interagency effort, and its successor remains so today. Participants have included the U.S. Bureau of Reclamation, City of Stockton, City of Sacramento, Contra Costa Water District, and California Department of Health Services, along with SWC agencies that purvey drinking water.

Early information from the IDHAMP indicated drainage from Delta island peat soils is rich in organic carbon, therefore a separate study, the Delta Island Drainage Investigation (DIDI) was subsequently instituted. The DIDI was established to develop detailed information on the nature of this carbon source and to identify potential means of mitigating its impact on Delta drinking water supplies.

Meanwhile, advancements in analytical methodology continued, and as these were applied to environmental analysis, new water quality concerns emerged. Among these were the presence of DDT and PCB in fish and sediments of the Delta and its watersheds, selenium pollution in the San Joaquin River watershed, arsenic in the watersheds of the Delta and SWP, pesticide pollution by molinate and thiobencarb (rice herbicides) and insecticides such as diazinon, and waterborne pathogenic protozoa (*Giardia, Cryptosporidium*) that resist disinfection. Advancements in the analytical sciences have also led to discovery of previously unidentified disinfection by-products in drinking water supplies. Scientific data on all these and other potential water quality challenges were collected through the IDHAMP Program.

As scientific discoveries were made, there was a greater appreciation of the need for water quality information upon which to base management decisions affecting Delta water supplies. Accordingly, in 1985, the SWC requested DWR to propose a broad-based program that would provide information on known and emerging threats to drinking water quality. In 1986, DWR responded by implementing the Municipal Water Quality Investigations (MWQI) Program, that unified the IDHAMP and DIDI programs. The MWQI Program was founded on the principle that water quality concerns will continue to evolve as scientific understanding progresses, and that the program must be flexible and pro-active in order to address the new water quality challenges that will continually arise.

In search of practical means of eliminating or mitigating sources of undesirable constituents, the MWQI Program has supported numerous scientific investigations into underlying mechanisms of pollution. Years of monitoring effort have established a high quality, long-term base of data documenting the drinking water quality status of the Delta, and the phenomena that cause changes in Delta water quality. Data from the program have been, and continue to be used, extensively in water quality and water supply studies and planning. The continually evolving integration of MWQI's data with forecasting and information dissemination tools have made possible a future in which we will be able to not only better understand the consequences of changes that occur in the Delta and SWP, but also to anticipate, communicate and, in some measure, control water quality conditions. It is toward this future that the MWQI program is focused.

The Real Time Data Forecasting Comprehensive Program Background

Past MWQI water quality assessments centered on periodic collection of discrete ("grab") samples followed by their laboratory analysis and retrospective data interpretation. The early years of the program were primarily devoted to surveying the status of THM precursors and other water quality constituents and identifying their sources. Information derived from this work was used for water supply planning. Today, new technology allows remote, near continuous, monitoring of water quality parameters such as organic carbon and bromide, along with instantaneous remote acquisition of the data. With these advances, the MWQI Program and the SWC realized that the tools were available to coordinate real time data acquisition and water quality forecasting to provide water agencies and municipal operators with the information to make operational decisions based on imminent changes in water quality. What was lacking was a coordinated mechanism to realize this capability. On June 7 and 8, 2006, representatives from SWC agencies who are participants of the MWQI Program, DWR management and staff, and select outside agencies, met to discuss the concept of a Real Time Data and Forecasting Comprehensive Program (RTDF-CP). The meeting focused on identifying the required program elements, possible collaboration and the resource sharing opportunities that would allow the RTDF-CP to become reality. It was determined that if MWQI and the SWC were to effectively harness the tools to improve the efficiency of water project operations, while protecting and improving drinking water quality, then the RTDF-CP must address the following considerations:

- The Delta and SWP must be more thoroughly instrumented to assure that real time water quality data are available at all critical locations.
- A forecasting system must be created that was capable of producing water quality simulations and providing early warning and notification on a daily production basis using the existing SWP water quality forecasting model. Primarily, this would entail developing the software mechanisms for efficiently channeling the necessary input data to the model, and producing a report output suitable for use by water managers.
- Improvement in the Coordination among various DWR and SWC organizations to enable smooth information flow and timely, appropriate action.

To address these needs the RTDF-CP was developed by the MWQI Program. A five-year strategic plan was developed to guide the RTDF-CP (see Appendix 4 for a copy of the 5 year strategic plan). The objectives of the 5-year strategic plan include:

- Create a cooperative organizational structure and identify the coordination and funding required for the RTDF-CP
- Develop and refine a SWP Early Warning System for water quality concerns to include:
    - Water quality monitoring and emerging concerns,
    - Water quality forecasting,
    - Water quality information management and data dissemination,
    - Scientific support studies, and
    - Emergency Response.

As envisioned, water quality sensors in the tributaries to the Delta (mainly Sacramento and San Joaquin rivers) would provide early warning of elevated concentrations of organic carbon, bromide, turbidity, algal growths, and other water quality constituents of concern to drinking water purveyors. Movement and concentrations of these constituents would be predicted using computer forecasting tools, and their actual movements tracked through other monitoring stations in the Delta. Water operations managers could be made aware of the conditions and could make operations decisions designed to mitigate water quality problems while maintaining water deliveries. Agencies using the Delta as a source of drinking water would be notified and status of the situation communicated on an ongoing basis. If elevated concentrations of constituents entered the SWP system, they could be tracked using computer forecasting and remote sensing tools, and drinking water agencies along the system could be notified when the material was expected to appear at their turnouts, and in what concentrations. Drinking water purveyors could alert water treatment plant managers who, in turn, would prepare for chemical addition or other process changes as warranted. Drinking water agencies would provide continuing feedback to SWP operators and water quality managers to enable the full consequences of operations decisions to be understood, and this information would be acted upon to improve the early warning and operational control processes.

The geographic scope of the MWQI Program has historically been confined to the Delta. However, the scope of real time monitoring and forecasting effort must, by necessity, encompass the watersheds of the Delta, the SWP, and portions of the federal Central Valley Project that are interconnected to the Delta and SWP. Implementing many of the RTDF-CP goals required coordination with staff outside of the MWQI unit. Within DWR, several units have expertise and responsibilities that are necessary to operate an extensive real time early warning and response system, including: Division of Environmental Services (MWQI Program, Environmental Real Time Monitoring and Support), Division of Operations and Maintenance (Office of Water Quality, Operations Control Office, SWP Field Divisions), Bay Delta

Office (Delta Modeling Section), and Division of Planning and Local Assistance (District Offices). Therefore, in 2006, the SWC began working with the Department to create additional positions needed to ensure that the goals of the RTDF-CP are accomplished. In FY 2007/08 seven new positions were created within the Department and were filled by February 2008. The FY 2008/09 work plan represented the first year where all RTDF-CP positions were filled and priority tasks associated with the RTDF-CP could be fully addressed. Currently, oversight is being provided by an RTDF Steering Committee with participation from each involved contractor of the SWP. It also includes DWR staff members from the various component divisions.

A major, but necessary, challenge has been to develop mechanisms to integrate and coordinate among DWR programs and other agencies to achieve effective communications, standardized information formats, provide funding, and periodically review and update programs to meet current needs. The DWR Office of Water Quality was established in recognition of the need for greater linkage among existing DWR water quality programs. Expansion of the Real time Data and Forecasting program illustrates the need and provides a mechanism to realize this coordination and integration. However, if a robust real time water quality data and forecasting capability is to be realized, it will require longer-term management commitment and funding from DWR and the SWC. Eventually the RTDF CP will need to reside organizationally where the integration of functions and resources can be best realized.

Today the MWQI Program, the RTDF-CP entails the following elements:

1. Coordination and collaboration between DWR monitoring and forecasting groups.
2. Real time data acquisition for the Delta and SWP through remote, high-frequency monitoring.
3. Enhancement of forecasting and fingerprinting of drinking water quality through use of computer models.
4. Centralized information management and dissemination.
5. Scientific support studies.
6. Emergency response preparedness as related to drinking water quality.
7. Coordination and collaboration within DWR and with outside agencies to enhance real time monitoring activities.

Besides the water quality monitoring, forecasting and data dissemination that makes up the "nuts and bolts" behind a real time early warning system, scientific special studies and emergency response elements are also necessary for an early warning system. In the case of special studies, the information collected is an integral part of the real time data collection and forecasting. Special studies are conducted to investigate the origins, fate and transport, and in some cases, loads of current and emerging contaminants of concern. Such studies help to determine where new instruments should be located. Special studies may also investigate seasonal patterns and trends of constituents or examine circulation patterns of contaminants. These studies can also be used to refine modeling assumptions. Special studies can also assess the impacts of increasing urbanization on levels of water quality constituents of concern. In addition, ensuring that Departmental emergency response mechanisms include consideration of drinking water constituents is vital to an early warning system. A mechanism that can quickly notify water purveyors and operators of emergency spills and analytes that aren't modeled or analyzed in real time will always be necessary.

Real Time Monitoring

Real time monitoring or in situ monitoring is defined as high frequency or continuous measurement of water quality and flow by remote equipment installed in locations within the Delta, its tributaries, and the SWP. Communication equipment transmits the resulting data to headquarters to be used shortly after measurements are made. Real time monitoring is comprised of two parts; a) field operations which ensure the operation and maintenance of all automated sampling equipment, timely transmission of real-time data to users and implementation and documentation of QA/QC of this data, and b) the synthesis of real time data from a variety of federal, State and local agency water quality monitoring programs, rapid data quality control, analysis, and dissemination of results. These results are currently provided as part of the RTDF CP via weekly electronic reports.

Real time results are used to: a) inform operational decisions affecting the Delta and SWP, b) support development of water quality forecasting tools for better managing of SWP water supplies, and c) for water quality and water supply planning studies. In addition to DWR and the SWC, this information is used by many federal, state, and local agencies, and the public.

Today, real time equipment is installed and maintained by MWQI at four critical Delta locations (Hood, Vernalis, Banks PP and Jones PP). Remote sensing technology allows real time operational decisions to be made that take into account water quality considerations. As water management has become vastly more complex, due to increasing environmental restrictions on water operations, it has become necessary to manage the Delta and SWP to increasingly finer degrees. This new water quality sensing technology offers a tool for better and quicker "tuning" of water operations.

Within the RTDF-CP, real time monitoring activities receive technical advice and guidance from the RTDF Steering Committee, a group of technical experts composed of staff from participating agencies. The RTDF Steering Committee serves as a subcommittee of the MWQI TAC, to which the Steering Committee reports.

Current objectives for the Real time Monitoring Program include:

- determining baseline concentrations of organic carbon, anions, nutrients and other drinking water quality constituents in Delta and SWP waters.
- determining loads, timing, and quality of carbon, nutrients, anions (i.e. chloride and bromide) entering the Delta from the Sacramento and San Joaquin Rivers, as well as in-Delta sources.
- identifying and quantifying water quality changes caused by land use changes from urbanization and population growth in the Delta and its watersheds, and by actions proposed or taken by CALFED or other entities that affect the Delta environment.
- providing water quality data relevant to SWP contractors and other users of Delta water supplies in a timely manner for decision making.
- providing water quality forecasts that assist SWP and other utilities in advanced planning efforts to optimize management of their water supplies while meeting increasingly stringent drinking water regulations.

Water Quality Forecasting

High frequency real time water quality data from multiple remote locations also provides the needed information base to develop and populate computer tools for fingerprinting and forecasting drinking water quality conditions in the Delta and SWP. Although water quality monitoring enables an understanding of current and past water quality conditions, it is generally inadequate to forecast and assess the water quality effects of future, or proposed, changes in the Delta and SWP. To enable future conditions to be forecasted and analyzed, this component of the RTDF-CP uses monitoring data in conjunction with mathematical modeling techniques to develop and refine computer simulation tools. The geographic domain of DWR's Delta Simulation Model (DSM2) has been extended to include the newly developed DSM2-Aqueduct extension model. This new model includes the California and South Bay Aqueducts. A third model includes the Delta Mendota Canal. With these tools, water quality consequences of Delta and SWP-Central Valley Project operations can be forecasted, with the objective of incorporating this information into water operations decisions for the export facilities as well as downstream purveyor's facilities.

To achieve the tasks associated with modeling and forecasting requires the continued collaboration between the various DWR groups responsible for real time data collection and forecasting. These groups include the MWQI Program, O & M's OCO and the Bay Delta Office's Delta Modeling Section.

Objectives of this enhanced effort are to better tailor water quality monitoring to modeling needs and to maximize the use of modeling results by water quality managers.

RTDF Information Management and Dissemination

This component of the RTDF-CP integrates and delivers results of the real time monitoring, fingerprinting and forecasting elements of the forecasting aspect of the RTDF-CP. This is generally accomplished through the weekly water quality reports distributed via an E-mail subscription list to staff of agencies participating in the MWQI Program and to other interested parties. Both current and archived reports are available on the MWQI website. However, as additional needs arise that require real time data and forecasting tools, this information will also be disseminated to stakeholders through e-mail, reports, and meetings. The goals of this program element are:

- to continue to provide real time water quality data and forecasting information to stakeholders and utilities for source water management decisions,
- to continue to review and refine format of real time information based on stakeholder and utility needs,
- to continue to develop a program for acquisition, storage, assessment, and transfer of water quality data and processed information in a near-real time mode,
- to provide continuous, real time postings of relevant autoanalyzer, operations, hydrologic data, and water quality forecasts to stakeholders and utilities via the Internet in a "user friendly" format, and
- to continue updating and enhancing the MWQI Program website.

Within this component, there are information management and data dissemination tasks associated with grab sample data and with real time data. Grab sample data is stored in the California Water Data Library (WDL) which encompasses DWR programs beyond MWQI. Real time data from MWQI's real time monitoring stations are stored on a MWQI server and posted on DWR's California Data Exchange Center (CDEC) and the MWQI web site.

The database management associated with this component has gone through several evolutionary steps. Initially the data management system ("RTDF2") was used to generate weekly reports. Data was retrieved by MWQI staff from the California Data Exchange Center (CDEC). MWQI staff then reviewed the data for accuracy, and summarized the data in graphical and text forms in the weekly reports. In FY 2007/08, the RTDF2 data management system was replaced by RTDF3, consisting of a database platform that automatically received data from real time stations and/or CDEC as necessary. The final phase of data management evolution under this program element (RTDF4) will link the database with the Internet using a web-based interface. RTDF4 will establish an "on demand" capacity for users to query RTDF data such as TOC, DOC, EC, precipitation, hydrology, anion, and operations data.

Due to the great difficulty of trying to correct problems while the database is in use, it is important for the databases to be well designed from the outset, as opposed to being configured after deployment. It is anticipated that a Database Working Group, composed of DWR staff and Contractor representatives of the MWQI Committee, will need to be formed to oversee technical aspects of data dissemination tool development, especially with respect to RTDF 4. This group will report to the RTDF Steering Committee. This subcommittee will be expected to provide advice and recommendations on the appearance, format, and function of web pages, reports and related media that provide access to the information produced through the project.

Appendix 3--Science Support (Special Studies)

Background

The many natural and anthropogenic processes that affect drinking water quality in the Delta, its tributaries, and the State Water Project remain poorly understood. To further improve DWR's ability to measure and forecast drinking water quality of water delivered to its customers, MWQI engages in special studies that focus on specific aspects of source waters, contaminant loading, measurement methods and instrumentation, and climate and hydrology. Results of these studies inform subsequent cycles of the MWQI work plan by improving the RTDF and discrete sampling programs.

Generally strawman proposals of special studies are submitted to the Special Studies subcommittee for discussion and prioritization. Strawman proposals are evaluated on technical merit, how well they met the needs of the MWQI mission, and funding available to conduct the study.

To keep the workplan concise, only short summary descriptions are provided in the 2009-10 workplan. This appendix contains the full project proposals for the special studies that appear in the workplan. In some cases the proposal that appears in the workplan did not require further elaboration in this appendix. In other cases, for some projects, project proposals for both the 2008-09 and 2009-10 workplans are presented. In those cases, projects started in FY 2008-09 have evolved as more information has become available. To show the changes in the project, both the 2008-09 original proposal and the updated 2009-2010 proposal are reproduced in this appendix.

2009-10 Workplan Proposal for Urban Sources and Loads Investigation--Lead Investigator: Rachel Pisor

Background/Introduction

As urbanization in the Delta increases, so does the potential for impacts to drinking water quality. MWQI began to investigate the effects of urban runoff with a study of the Steelhead Creek watershed. Results from that study showed that urban runoff can have significant impacts to drinking water quality and demonstrated how important tracking this issue is as the Delta continues to urbanize. To further understand these effects, MWQI reviewed several areas of concern for further investigation. Under consideration were northern and southern Sacramento, Stockton, Brentwood, Lathrop and Mountain House.

A northern Sacramento area study would revisit the Steelhead Creek study to assess changes in land use and water quality. Since the completion of that study, there has been a major collapse in the housing market; therefore, any further changes in land use and water quality are unlikely. In southern Sacramento, Morrison Creek flows to the Sacramento, Mokelumne, and Cosumnes Rivers. During storm events, water backs up into Beach Lake, preventing accurate calculations of the volume and quality of water that flows to the Sacramento, therefore, making this site infeasible.

There is much interest in focusing on the San Joaquin River watershed especially considering the current pumping restrictions. In Stockton, numerous creeks and sloughs drain into the San Joaquin River; however, they are geographically widespread, making this site logistically infeasible. Additionally, some of the sloughs drain both agriculture and urban land, making it impossible to differentiate between urban and agricultural runoff. Finally, not all Stockton runoffs flow to the San Joaquin River. Therefore, smaller municipalities of Brentwood, Mountain House and Lathrop were considered.

Brentwood's runoff flows northerly to Big Break and out to San Pablo Bay and does not influence drinking water quality. Mountain House was considered and was logistically sound, but due to current pumping schedules, runoff from Mountain House would flow more directly to the Central Valley Project through the Delta Mendota Canal than to the State Water Project. Lathrop was determined to be the best choice for this study because its location is logistically the most feasible, and Lathrop has the potential to directly impact the State Water Project's drinking water quality.

Lathrop is a small municipality that was rapidly urbanizing prior to the housing market collapse. Being able to assess its impacts on drinking water quality now will give us the opportunity to revisit later and assess the changes in land use and water quality. Also because Lathrop is a small municipality, it is covered under the Phase II General NPDES Permit and is, therefore, not required to monitor its stormwater runoff. In order to manage drinking water throughout the Delta effectively, it is necessary to know what contributions small growing municipalities make to drinking water quality.

Objectives

This study will assess the effects of urban stormwater runoff from Lathrop on the San Joaquin River Watershed with special attention paid to first flush storm water events. Because the population of Lathrop is small, this study may serve as a baseline of water quality conditions and land use patterns. As development continues to grow, we will be able to see at what population size urbanization results in significant effects on drinking water quality. This may be useful in policy decisions regarding monitoring of stormwater and mitigation of negative impacts on drinking water quality for urban runoff.

Study Design

Sampling will start at the first storm event of the 2009-2010 wet season, and will continue for at least 2 years. Grab samples will be collected from the rivers, and composite samples collected by autosamplers will be collected from the city's stormwater pumping plants.

River samples will be collected on the San Joaquin River south of Lathrop at Mossdale, north of Lathrop at Brandt Bridge, and at Lathrop just downstream of the confluence of the San Joaquin and Old River. Grab samples will also be collected at the head of Old River. Grab samples from the rivers will be collected via boat or van and the timing of collection will be determined by the tide. The order in which the river stations will be sampled will depend on what stage in the tidal cycle the river is in at that time, such as flood or ebb, and samples will be collected within a timely manner to ensure all river station samples are collected at the same stage. For example, when the storm event occurs, if the tidal stage is flood, the Brandt Bridge station would be sampled first, and the Mossdale station would be sampled last, but all stations would be sampled during the flood tide. Because storm events can occur during any stage in the tidal cycle, samples taken during separate storm events may not be comparable since samples taken at both flood and ebb tides are not comparable. Therefore, the focus of the analysis will be on what percent of the total load Lathrop contributes to the San Joaquin River.

Autosamplers will be used to collect samples from Lathrop's 8 pumping plants that discharge to the San Joaquin River. These stations are M1, M2, M3, M5, M6, KV, River and Stone Bridge pumping plants. These stations automatically pump discharge into the river once a pre-determined volume is reached in their stilling well. Figure 1 identifies both the cities' discharge stations and the river sites that will be sampled.

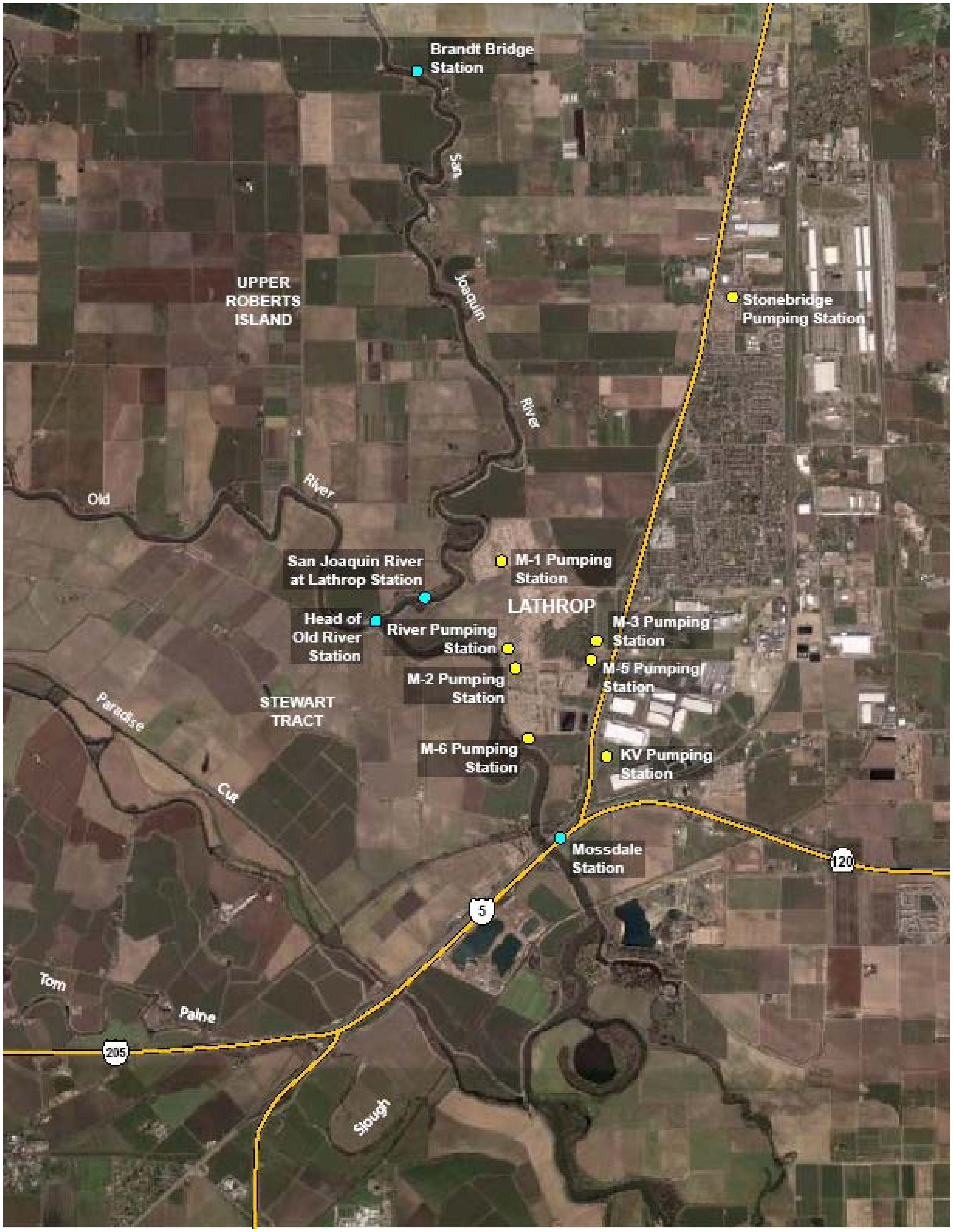


Figure 1. Location of sampling stations for urban runoff study. City discharge pump stations are in yellow. River sampling stations are in blue.

Sample analytes will include minerals (Calcium, Magnesium, Sodium, Potassium, Alkalinity, Sulfate, Chloride, Boron), metals (Aluminum, Antimony, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Mercury, Nickel, Manganese, Molybdenum, Selenium, Silver, Thallium, Zinc), nutrients (Nitrate+Nitrite, Ammonia, Organic Nitrogen and Ammonia, dissolved orthophosphate), pesticides (chlorpyrifos, diazinon, malathion, atrazine, simazine, cyanazine, prometryn), total and dissolved organic carbon, bromide, bacteria (total and fecal coliforms), turbidity, total dissolved and suspended solids, UVA_{254} and total trihalomethane formation potential.

A GIS analysis will assess the land use patterns in the study area. This analysis will be valuable in a future correlation between change in land use patterns and water quality.

Deliverables

Deliverables	Participants	Estimated Completion Date
Storm event sampling at 12 sites in the Lathrop study area	MWQI Staff MWQI Field Group	September 2011
Analysis of samples as indicated above by DWR	Bryte Laboratory	October 2011
Final Report	MWQI Staff	April 2012

Budget

See 2009/10 Workplan

2008-09 Workplan Proposal for Urban Sources and Loads Investigation--Lead Investigator: Rachel Pisor

Background/Introduction

As Delta watersheds continue to urbanize, the impacts to drinking water quality from urban runoff is of concern. MWQI has already conducted one intensive urban loading study of the Natomas East Main Drainage Canal (NEMDC) watershed. The study found that, on a daily basis, NEMDC contributed up to 93 percent of the organic carbon load in the Sacramento River at Hood during the wet season. On a monthly basis, NEMDC contributed up to 8.2 percent of the organic carbon load, up to 19 percent of the nitrate plus nitrite load, and up to 14 percent of the orthophosphate load at Hood. These numbers emphasize the level of impacts that urban drainage can have on drinking water quality and the importance of tracking urban loading as the Delta continues to urbanize.

Objectives

The purpose of this study is to investigate where MWQI should focus its efforts for another urban load study in the FY 2009/10. Possible areas of investigation include:

a) examining the impacts from a Southern Sacramento urban watershed (ie. Morrisson Creek).

b) conducting a follow-up study to the previous NEMDC study, with the purpose of determining whether any water quality changes have occurred in the 4 years that have passed between studies and filling in data gaps associated with the first NEMDC study.

c) examining Stockton urban impacts to the San Joaquin River (identifying suitable sample areas).

d) evaluating the effectiveness of mandated in-place Best Management Practices (BMPs) from stormwater permits as they relate to drinking water constituents of concern.

e) quantifying urban runoff from Brentwood and/or Lathrop as their vicinity to the Banks Pumping Plant would have the immediate impact on water quality, and because of their size, no stormwater monitoring has been conducted by the cities.

During this fiscal year, staff will examine the feasibility of the above options (and any others that are uncovered). The goal of this research is to provide the background information required to begin the field work or design of the project. Research conducted will determine the ideal location, feasibility and logistics.

Deliverables

Deliverables	Associated Tasks	Participants	Estimated Completion Date
Conduct background research and investig study locations, feasibility and logistics.	A,	**MWQI Program**	June 2009

2008/09 Budget

Labor Costs: Labor hours: 1595.5 Labor Cost: $118,128 Other Costs: 0 Total Cost: $118,128

2008-09 Workplan proposal for Sources, Fate, and Transport of Nitrosamines and their Precursors in the Sacramento-San Joaquin Delta and the State Water Project-- Lead Investigator: Carol DiGiorgio and MWDSC

Note there are no changes between the 2008/09 study design and the 2009/10 study design

Background/Introduction

Nitrosamines are highly carcinogenic compounds with cancer potentials much higher than that of trihalomethanes (THMs). Historically, nitrosamine concerns have centered on food products. More recently, interest has focused on drinking water—especially effluent-impacted supplies, as surface waters used for drinking water that are downstream of wastewater treatment plants (WWTPs) may contain the carcinogenic compounds themselves, or the precursors necessary to form nitrosamines. Depending on the level of nitrification and/or the use of advanced physical/chemical treatment at a WWTP, the discharge can be a major source of nitrosamines and/or their precursors. Treated wastewater used for groundwater recharge has been shown to contain N-nitrosodimethylamine (NDMA) at elevated levels (cited in Mitch and others, 2003). In an effluent-dominated river in Colorado, elevated levels of nitrosamines (i.e., NDMA and N-nitrosomorpholine [NMOR]) and nitrosamine precursors have been detected (Krasner and others, 2005). There is also evidence that some nitrogenous pesticides may react with chlorine or chloramines to form nitrosamines (for example, diuron) (Chen and Young, 2007). In addition, certain nitrosamines (e.g., NDMA) can be a chloramination by-product created during the drinking water disinfection process. If certain organic nitrogen precursors are present, drinking water facilities that have switched from chlorine to chloramines, to reduce THM formation in their distribution system, may find themselves in the untenable position of having reduced THMs only to have created more toxic nitrosamines.

Because it was first detected in drinking water wells, much of the attention has been directed at NDMA. However, as more information has become available, the California Department of Public Health has set notification levels of 10 ng/L each for NDMA, N-nitrosodiethylamine (NDEA), and N-nitroso-di-n-propylamine (NDPA), with a Public Health Goal for NDMA of 3 ng/L (http://www.cdph.ca.gov/certlic/drinkingwater/Pages/NDMAhistory.aspx, accessed 12/29/07). The EPA's Unregulated Contaminant Monitoring Rule 2 (UCMR2) has also listed 6 nitrosamines, NDEA, NDMA, NDPA, N-nitroso-di-n-butylamine (NDBA), N-nitroso-methylethylamine (NMEA), and N-nitroso-pyrrolidine (NPYR), as contaminants to be monitored during 2008-2010 to support the Agency's determination of whether to regulate these contaminants in the interest of protecting public health (http://www.epa.gov/safewater/ucmr/ucmr2/basicinformation.html#list, accessed 12/29/07). Early indications suggest that nitrosamines will become the next set of contaminants regulated in treated drinking water by the EPA (Bruce Macler, EPA Region 9, Pers. Comm., Oct. 2007).

The largest municipal discharger to the Delta is the Sacramento Regional WWTP, with an average annual dry weather flow of 160 MGD. Depending on its treatment practices, Sacramento Regional WWTP may be a source to the Sacramento River of both nitrosamines and nitrosamine precursors. With the plant's discharge site located a few miles upstream of a potential peripheral canal location at Hood, understanding what concentrations of nitrosamines and/or nitrosamine precursors are present at this site is critical. The next largest WWTP discharge in the Delta is located in Stockton. Although discharge from this facility (36.7 MGD average annual dry weather flow) would not affect the water quality of a peripheral canal structure, water quality at the Banks Pumping Plant could be affected. Therefore, regardless of whether a dual conveyance, a through Delta conveyance or a peripheral canal is ultimately decided upon, understanding water quality contributions from both of these WWTPs to nitrosamines and nitrosamine precursors are important to the drinking water community that receives its water from the SWP.

The potential of agricultural inputs of nitrosamine precursors (e.g., from diuron) also needs to be examined. The Delta receives pesticide and herbicide inputs from the Sacramento and San Joaquin River's watersheds, as well as supporting an average annual farming industry of over $2.1 billion within the Delta itself (http://www.delta.ca.gov/pdf/Sacto-SanJoaqin_fact.pdf, accessed 12/29/07). Moreover, diuron is the third most heavily used herbicide in California.

Objectives

Because of their extreme toxicity, their likely potential to become regulated in the future, and the fact that no assessment of the occurrence of nitrosamines or the nitrosamine formation potential of Delta waters has ever been undertaken, MWQI proposes a cost share special study with Metropolitan Water District of Southern California that would 1) identify and quantify some of the potential sources of nitrosamines and their precursors at a number of key points in the Delta (i.e., sample upstream and downstream of potential point sources), and 2) examine the fate and transport of nitrosamines (which can undergo photolysis depending on the depth of the photic zone) and their precursors (which can be biodegraded to some extent in a river) in the Delta. The study proposed would be a 2-year study, so that trends and seasonal patterns could be assessed. Because this is a cost share study, no large expenditures are anticipated for this study.

Study Design

To accomplish the project objectives, MWQI would sample quarterly, for 2 years, beginning in July 2008, from 7 sites (i.e., total of 8 sampling events). The sites sampled would be:

1. West Sacramento Drinking Water Intake: This sampling site would serve as the sampling point upstream of Sacramento Regional WWTP. Samples collected at this point would also capture most of the agricultural drainage impacts from the Sacramento River watershed.
2. Sacramento River at Hood: This sampling site would serve as the sampling point downstream of Sacramento Regional WWTP and is also one of the potential sites of a peripheral canal.
3. San Joaquin River at Mossdale: This sampling site would serve as the sampling point upstream of Stockton's WWTP.
4. San Joaquin River at Holt: This sampling site would serve as the sampling point downstream of Stockton's WWTP.
5. San Joaquin River at Vernalis: This sampling site would capture most of the agricultural drainage impacts from the San Joaquin river watershed.
6. Banks Pumping Plant: This sampling site integrates all of the Delta and riverine influences to the headworks of the SWP's California Aqueduct.
7. Twitchell Island ag drain: This sampling site would represent the in-Delta agricultural drainage inputs from a high-carbon peat island.

Three of these sites are already part of MWQI's discrete sampling program.

Along with standard field measurements, samples would be analyzed by Bryte Laboratory for total organic carbon, dissolved organic carbon, diuron, TKN, ammonia, nitrates + nitrites, total phosphate, UVA-254, THMFP, and HAAFP. A subset of each sample would be split and sent to Metropolitan Water District of Southern California (MWDSC)'s chemistry laboratory, where samples would be analyzed for eight nitrosamines (all nitrosamines with notification levels and all those listed in the UCMR2, as well as NMOR and N-nitrosopiperidine [NPIP]) and nitrosamine formation potential testing. If time and funding permit, MWDSC would also analyze for the anticonvulsants primidone and carbamazepine, as well as caffeine, as conservative tracers of WWTP influences. This will help determine whether the sources of the nitrosamine precursors are from treated wastewater or other sources.

Deliverables

Deliverables	Participants	Estimated Completion Date
Quarterly sampling at 7 sites in the Sacramento-San Joaquin Delta	MWQI staff MWQI Field Group	July 2010
Analysis of all samples as indicated above by both DWR and MWDSC	Bryte Laboratory MWDSC Laboratory	August 2010
Final Report	MWQI staff MWDSC staff	December 2010
Paper for Publication	MWQI staff MWDSC staff	Submitted March 2011

Literature Cited

Chen, W.-H., and T.M. Young. 2007. Potential transformation by-product and associated risk of diuron in the disinfection process. Presented at the 233rd American Chemical Society national meeting, Chicago, Ill.

Krasner, S.W., P. Westerhoff, B. Chen, G. Amy, and S. Nam. 2005. Contribution of wastewater to DBP formation: case study of an effluent-impacted river. In the proceedings of the 2005 American Water Works Association (AWWA) Water Quality Technology Conference. Denver, Colo.: AWWA.

Mitch, W. A., J. O. Sharp, R. Rhodes Trussell, R. L. Valentine, L. Alvarez-Cohen, and D. L. Sedlak. 2003. N-Nitrosodimethylamine (NDMA) as a drinking water contaminant: a review. Environmental Engineering Science (20)5: 389-404.

Budget.

DWR MWQI and MWDSC have agreed to a cost-sharing arrangement for this study.

2008/09 Labor Costs: Labor hours: 1144 Labor Cost: $ 91,347 Other Costs: $429.00 Total Cost: $91,776

2008-09 Workplan Proposal for Feasibility of Estimating Mass Loads of TDS, Organic Carbon, and Nutrients Discharged from a South Delta Agricultural Island--Lead Investigator: Carol DiGiorgio

See 2009/10 workplan for modifications to this proposal

Background/Introduction

DWR's Delta Island Consumptive Use Model (DICU) estimates agricultural diversions and return volumes and assigns these volumes and water quality concentrations to nodes in DWR's Delta Simulation Model (DSM2). In estimating the water quality of the agricultural drainage, DICU relies on earlier work conducted by Marvin Jung. Using data collected from Delta island drainage channels approximately 20 years ago, Jung divided the Delta into 3 subregions. In each subregion, a monthly median EC and DOC value was calculated. These 36 data values (3 regions x 12 months), accessed in a lookup table by DICU, are assumed by DICU to represent the monthly water quality discharged from all agricultural islands in each given region. While this approach is fairly robust, MWQI's recently completed Staten Island study found, in some months, that DICU underestimates Staten Island DOC loads by as much as 2 orders of magnitude. In south Delta channels, measured EC can be much higher than that assumed in agriculture drainage by DICU in its lookup table. This situation seems most pronounced when San Joaquin River inflow is low. During periods of low flow in the South Delta, there is less circulation of channel water and agriculture drainage can become a more significant contributor of channel water quality. The Delta Modeling Section reports that DSM2 simulations of EC in the south Delta channels during low flow periods are consistently lower than field-measured EC. Measured EC in Old River at Tracy Road, for example, can be as much as three times higher than DSM2 simulated values. This suggests that our understanding of the timing and quality of South Delta agricultural discharges needs improvement. With the completion of the Staten Island study, there has been some discussion between MWQI and the Delta Modeling Section of applying the information gained to refine DICU's water quality estimates from drainage from Delta peat islands. A better understanding of the quantity and quality of South Delta agricultural discharges would benefit Delta modeling efforts in general, and improve DWR's ability to predict water quality at the Banks pumping plant and other municipal intakes.

Objectives

Unlike Staten Island, where access onto the island was secured by the Nature Conservancy, there is no guarantee that DWR would be allowed to conduct a study on either Union Island or Fabian Tract (the

Delta Modeling Section has indicated that these are 2 areas of interest). The purpose of this study is to determine if any landowners in these areas would allow access onto their property for flowmeter installation and weekly sampling. If an appropriate landowner could not be located, then it is likely that MWQI could not move forward with this study. If cooperative landowners can be identified, MWQI could work with the Delta Modeling Section to determine if the pump locations would satisfy modeling needs. If this is the case, it is anticipated that MWQI would begin the installation of flowmeters in the spring of 2009 with the study to run for 2 years, to capture seasonal variability.

Study Design

This study could only be conducted if a cooperative landowner could be located. The monitoring site would need access to power and drainage water would have to have the potential to influence water quality in the South Delta. It is anticipated that the sampling design would be similar to the one followed for Staten Island. If all criteria could be met, MWQI could begin the installation of flowmeters in the spring of 2009. In addition to flow, it is anticipated that the analytes measured would be TDS, organic carbon, and nutrients, along with standard field measurements of EC, turbidity, DO and temperature. Flow and concentration data would allow loading calculations and give accurate measurements of seasonal discharges.

Deliverables

Deliverables	Task	Participants	Estimated Completion Date
Determine if there are willing landowners for a study. If so confirm with Bay-Delta modelers on site appropriateness	A,B	**MWQI**	October 2008
If an appropriate site is located, install flowmeters	C	**MWQI Field Group**	January 2009
Begin flow measurements and weekly sample collection. Sampling to begin approximately 3/09.	D	**MWQI staff MWQI/Field Group**	March 2011

2008/09 Budget

MWQI labor is already covered within the MWQI budget. It is anticipated that the flowmeter equipment that was used on Staten Island would be reused if a study could be conducted in the South Delta.

Labor Costs: Labor hours: 966 Labor Cost: $ 73,729 Other Costs: 0 Total Cost: $ 73,729

2008-09 Workplan proposal for Investigation of O'Neill Forebay water circulation-- Lead Investigator: Ron Melcer

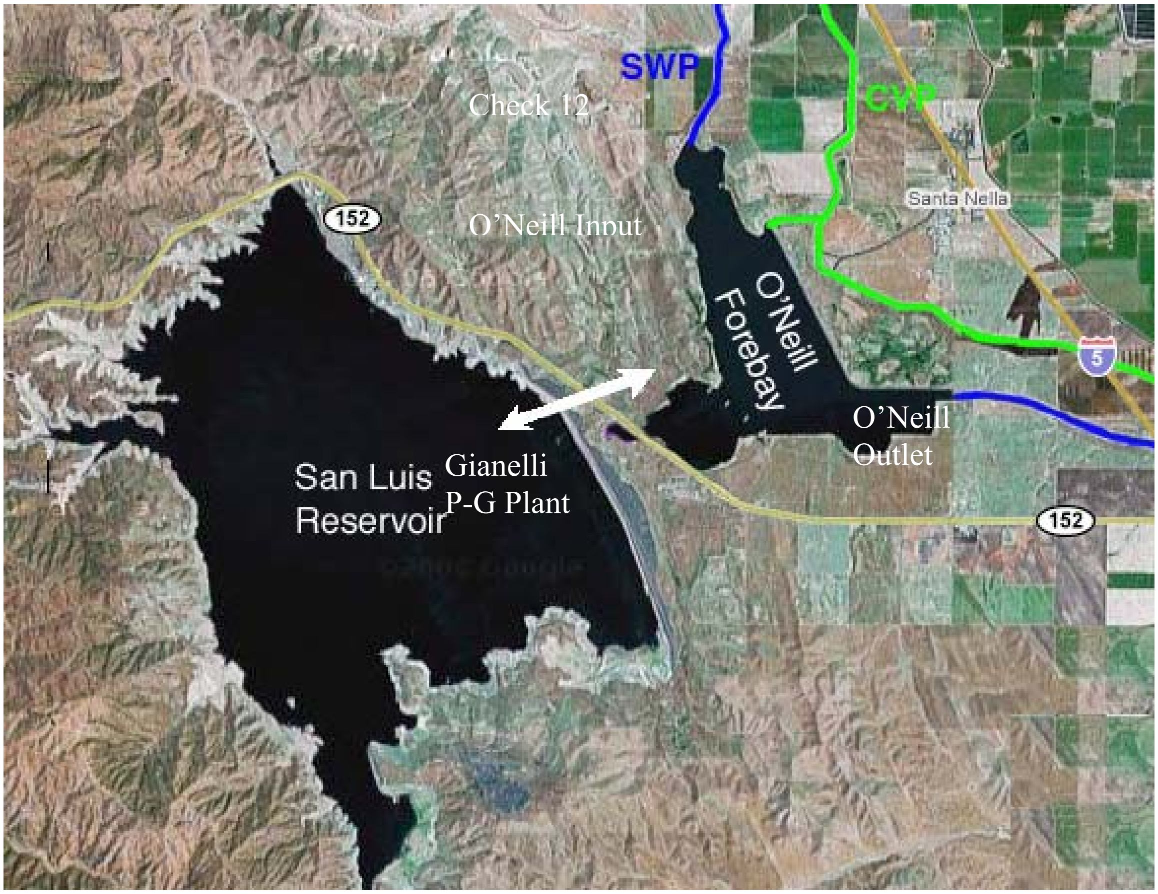
See 2009/10 workplan for modifications to this proposal.

Background/Introduction

Water from the State Water Project (SWP) and federal Central Valley Project (CVP) are pumped into O'Neill Forebay at the foot of Sisk Dam and San Luis Reservoir (Figure 2). The SWP and CVP waters are generally of differing water quality, containing different concentrations of bromide and other dissolved salts, organic carbon, and other constituents of concern. Water from the SWP enters O'Neill at its north end, at SWP Check 12. Water from the CVP enters O'Neill on the east side, at CVP O'Neill Intake. Depending on flow and pumping conditions at Gianelli Pumping-Generating Plant, the two waters may be transported south into the joint-use aqueduct at O'Neill outlet, or flow through a channel on the west side to Gianelli and thence into San Luis Reservoir. Observations suggest that the waters do not appreciably mix in O'Neill and, specifically, that CVP water tends to hug the east shore of O'Neill and travel directly to O'Neill Outlet.

Objectives

The behavior of water flows in O' Neill forebay has important implications for water quality modeling and forecasting. The objectives of this study are to: (i) better understand water flow patterns in O'Neill Forebay under a range of conditions, (ii) support more accurate numerical modeling of the O'Neill Forebay region of the DSM2 Aqueduct Extension model, and (iii) improve forecasting of water quality characteristics in subsequent parts of the State Water Project.

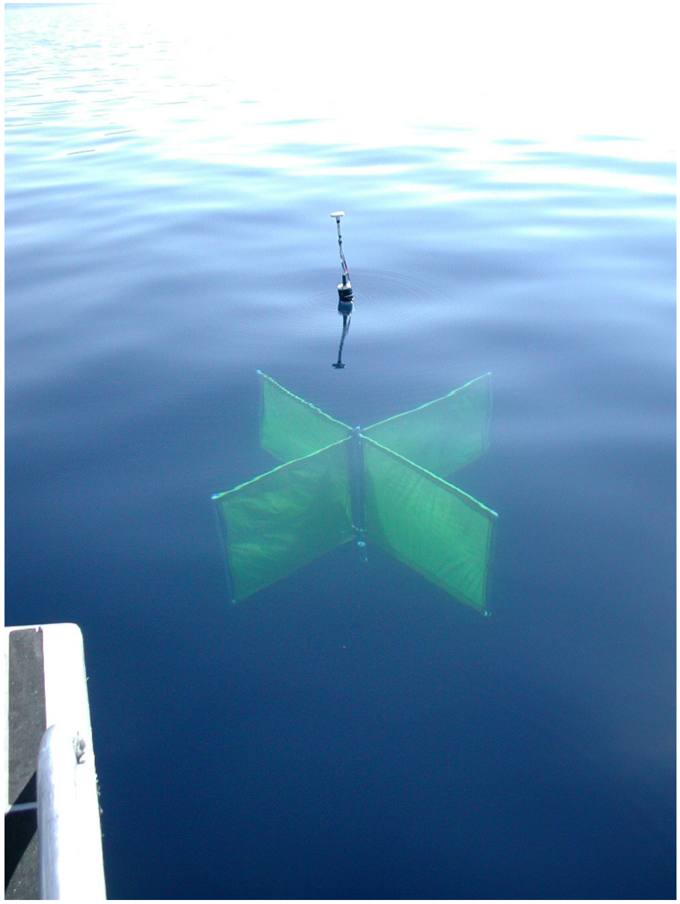


CVP water enters at O'Neill Input. The waters may not mix on their way to O'Neill Outlet.

Figure 2. Movement of SWP water into O'Neill Forebay

Study Design

Passively-drifting drogues are a proven tool in lake and ocean circulation studies (e.g., Austin and Atkinson 2004; Figure 3). A submerged "kite" moves with the water at a chosen depth, carrying a surface sensor along with it. In this application, the surface buoy would contain a small, battery-powered GPS receiver and logger. The logger would periodically record the drogue's location for later recovery and downloading.



Buoy is attached to drogue by short stainless steel cable. Each yellow panel is 1 m square. Drifters used in this study may be much smaller. (example picture taken on Lake Tahoe, CA-NV).

Figure 3. Example of a drifter surface buoy with a GPS location logger

Deliverables

Deliverables	Participants	Estimated Completion Date
Purchase miniature logging GPS receivers materials to construct drifters.	**MWQI Program**	Sept 2008
Assemble and test drifters	**MWQI Program**	Oct 2008
Field studies at O'Neill Forebay	**MWQI Program**	Dependent on pumping. Nov 2008 - May 2009, with potential sampling in July 09 based on Wanger effects on summer pumping.
Data Analysis and preparation of report	**MWQI Program**	Dec 2008 – June 2009
Preparation of peer-reviewed manuscript for publication	**MWQI Program**	May 2009 – July 2009

Literature Cited

Austin, Jay and Sten Atkinson. 2004. The design and testing of small, low-cost GPS-tracked surface drifters. Estuaries and Coasts 27(6): 1026-1029.

2008/09 Budget

Labor Costs: Labor hours: 1559.5 Labor Cost: $125,509 Other Costs: $10,000 Total Cost: $135,509

2009-10 Workplan Proposal for DSM2 Boundary Improvement & Model Recalibration Study for Dissolved Organic Carbon--Lead Investigator: Joe Christen

Background/Introduction

During the MWQI/RTDF comprehensive program meeting on September 30, 2008 to discuss future water quality monitoring sites the Delta Modeling Section presented three locations of interest for purposes of separating out river based carbon from island based carbon. The locations identified were Cache Slough (for Yolo Bypass inflow), the Mokelumne-Cosumnes Rivers (East Side Streams), and Suisun Marsh. These locations are DSM2 boundaries and as such data from these locations would be used to generate boundary conditions for simulations of DOC and UVA in the Delta. Additionally, to help to improve calibration of the model, more data from sites in the Delta are needed.

A review by MWQI staff of the available data and the current methodology for generating boundary conditions confirmed the need for data representative of water quality at the boundary locations. MWQI staff evaluated candidate locations for discreet sampling and proposed a sampling program to address these data gaps. This sampling study is within the MWQI program objectives and within the RTDF-CP's stated objective of providing support to DWR modeling efforts (MWQI 2008).

Objectives

This study is a discreet water quality sampling plan aimed at providing the Bay-Delta Modeling Section with representative water quality data for dissolved organic carbon (DOC) concentrations and ultra-violet absorbance at 254nm (UVA) from the Sacramento-San Joaquin Delta for Delta Simulation Model 2 (DSM2) simulations. Currently the DSM2 assumed boundary conditions for the East Side Steams and the Yolo Bypass inflow are not developed from representative data. Additionally, there are few Delta locations for which there are available data for calibrating DSM2 for carbon simulations, therefore stations that would address this data gap were also included in this study.

Study Design

To address boundary condition data gaps and additional data requirements for model calibration, discreet sampling will be conducted biweekly for one year at six locations. The DSM2 boundary locations will be sampled biweekly on a low tide when possible. Sampling on a low tide increases the chance of capturing the water quality of the source water inflow. The three interior Delta stations used for model calibration are not sampled on a tidal schedule. The geographic data for all stations are listed in Table 2, and shown graphically in Figure 4. Emphasis was given to the collection of organic carbon and UVA data. Samples will also be analyzed for a suite of other parameters including bromide, conductivity, total dissolved solids, and nutrients.

Table 2 Station Locations of Boundary and Calibration Sites

Data Use	Area	Station	Latitude	Longitude
Boundary Condition	Yolo Bypass	Shag Sl at Liberty Island Br	38.3065	-121.6928
		Cache Sl at Liberty Is Ferry	38.2384	-121.6856
	East Side Streams	Mokelumne R at Wimpy's	38.2286	-121.4909
		Calaveras R at Brookside Rd	37.9756	-121.3466
Calibration	Interior Delta	Old River at Tracy Blvd	37.8048	-121.4497
		Old River at Fink Rd	37.8103	-121.5422
		Grant Line Canal Tracy Blvd	37.8203	-121.4478

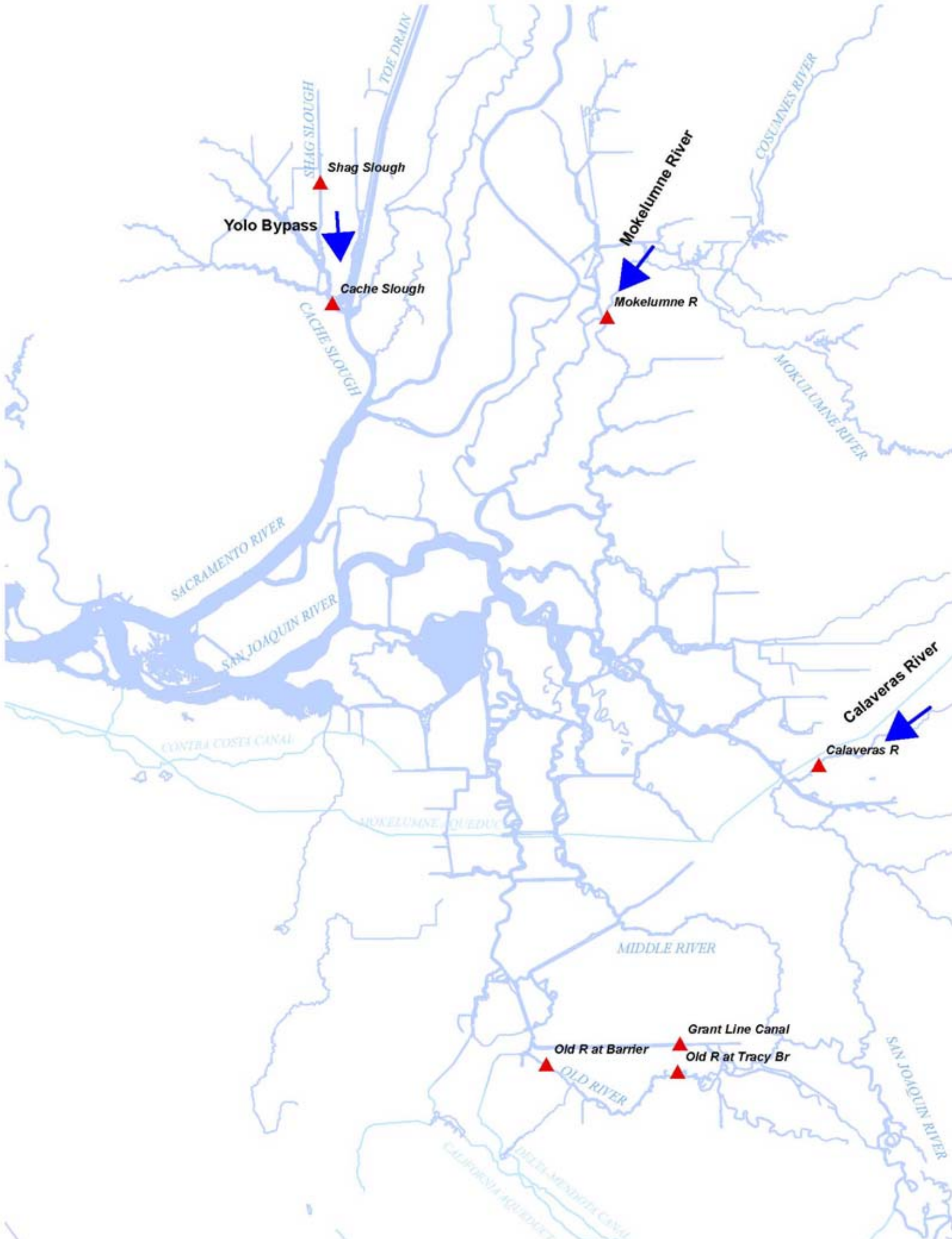


Figure 4. Map of Sampling Stations and DSM2 Boundary Inflows

Sample sites were based on discussions with DWR modelers. To provide representative data for the boundary conditions MWQI selected three main locations for discreet sampling at the DSM2 boundaries. Shag Slough was selected to represent Yolo Bypass inflow. The Mokelumne River 4.6 river miles downstream of the confluence with the Cosumnes River was selected to represent both the Mokelumne and Cosumnes Rivers. A station on the Calaveras River 1.4 river miles upstream of the confluence with the San Joaquin River was included in order to have data for all the East Side Streams (Calaveras, Cosumnes, Mokelumne Rivers)(Anderson 2005). A secondary event sampling station in addition to the main three boundary stations was selected on Cache slough downstream of the Yolo Bypass. The Cache Slough station will only be sampled when flows from the Sacramento River top the Fremont weir. The Suisun Marsh inflow was excluded from this study due to complications and expenses in accessing a suitable site.

In the course of evaluating the appropriateness of sampling locations the Modeling Group also identified three interior Delta locations from which carbon data would be useful for calibrating the DSM2; Old River at Tracy Boulevard, Old River at the temporary barrier near Fink Road, and Grant Line Canal at Tracy Boulevard (Suits Pers Comm). These three interior Delta "calibration" stations are readily accessible with the MWQI Field Unit's current water sampling vehicles and equipment.

An in-depth analysis of the boundary condition data gaps are given below.

Current Model Results and Assumptions

Currently there is not enough data available from the Yolo Bypass and East Side Streams boundaries to capture the seasonal or flow-related variation in carbon concentrations. The current DSM2 boundary conditions for DOC in the East Side streams and the Yolo Bypass are generated from data for the American and Sacramento Rivers (Pandey 2001, Suits 2002). The generated "assumed" boundary conditions underestimate carbon concentrations when compared to actual location appropriate data and are most likely a source of error in modeled runs.

Figures 5 and 6 below graph results from the DSM2 DOC source fingerprinting and measured DOC values. There are areas of a pronounced underestimation of DOC in the winters of water years 2007 and 2008.

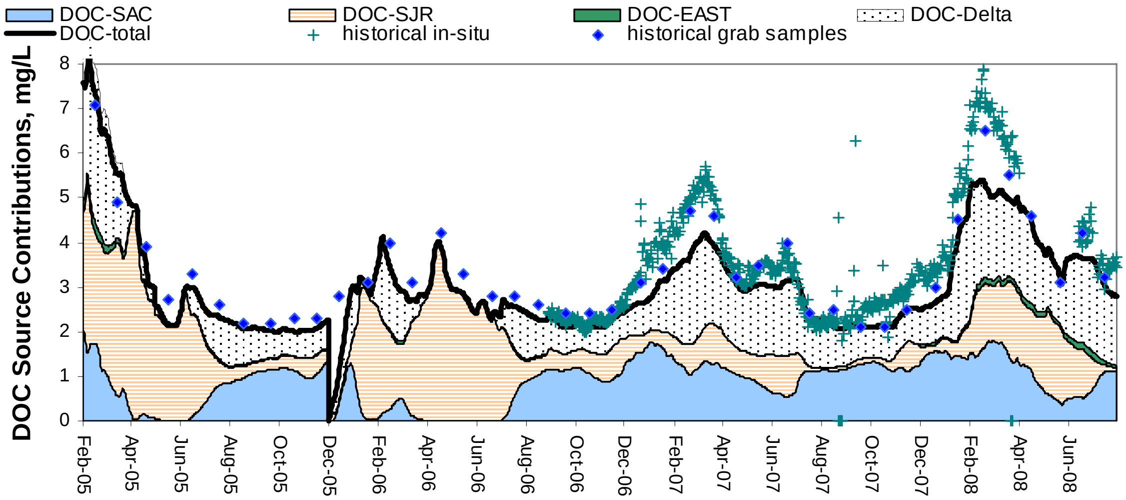


Figure 5. DSM2 results of DOC concentrations at the Banks P.P. and sampled values.

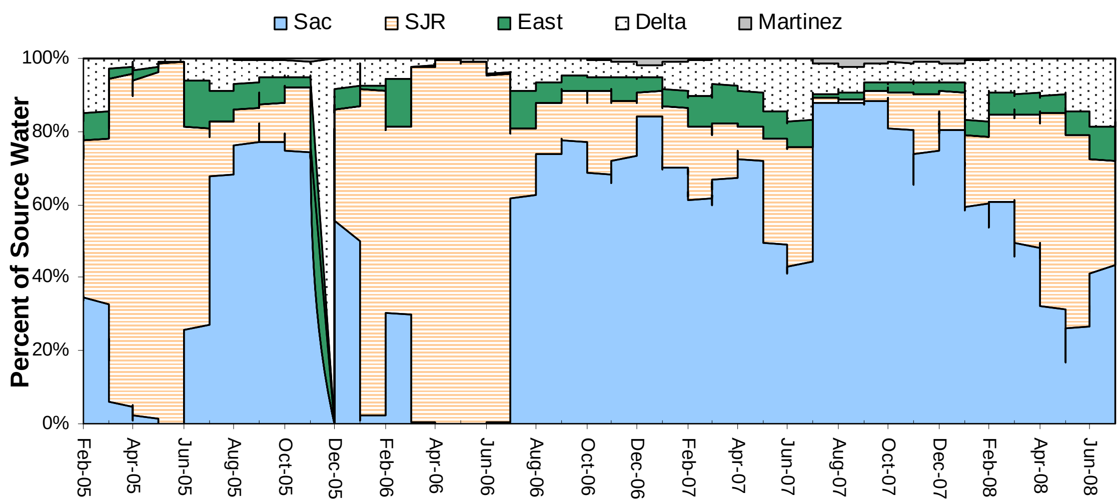


Figure 6. Modeled % volumetric contributions to water at the Banks P.P.

Assumed values and available data

Yolo Bypass

During low flow (<50 cfs) the dissolved organic carbon concentrations of the Yolo Bypass were assumed to be equivalent to the DICU model's low-DOC agriculture drain condition (0 mg/L< DOC <6 mg/L) (Suits 2002). During high flow the Yolo Bypass DOC concentrations were assumed to be equivalent to the Sacramento River (Suits 2002). A comparison of historical data for two Yolo Bypass locations (Shag Slough at the Liberty Island Bridge and the Yolo Bypass Toe Drain at the Lisbon Gauge) to the Sacramento River at Hood shows that DOC concentrations in the Yolo Bypass are consistently greater than the concentrations in the Sacramento River (Figure 7). Table 3 is the descriptive statistics for the DOC data sets, carbon values are in mg/L.

Table 3. Summary Statistics of DOC in Sacramento River and Yolo Bypass Locations

Station	n	Mean	Median	Min	Max
Sacramento R	722	2	1.8	1	5.6
Shag Slough	16	4.5	4	3	7.4
Toe Drain	4	5.2	5.7	2.8	6.8

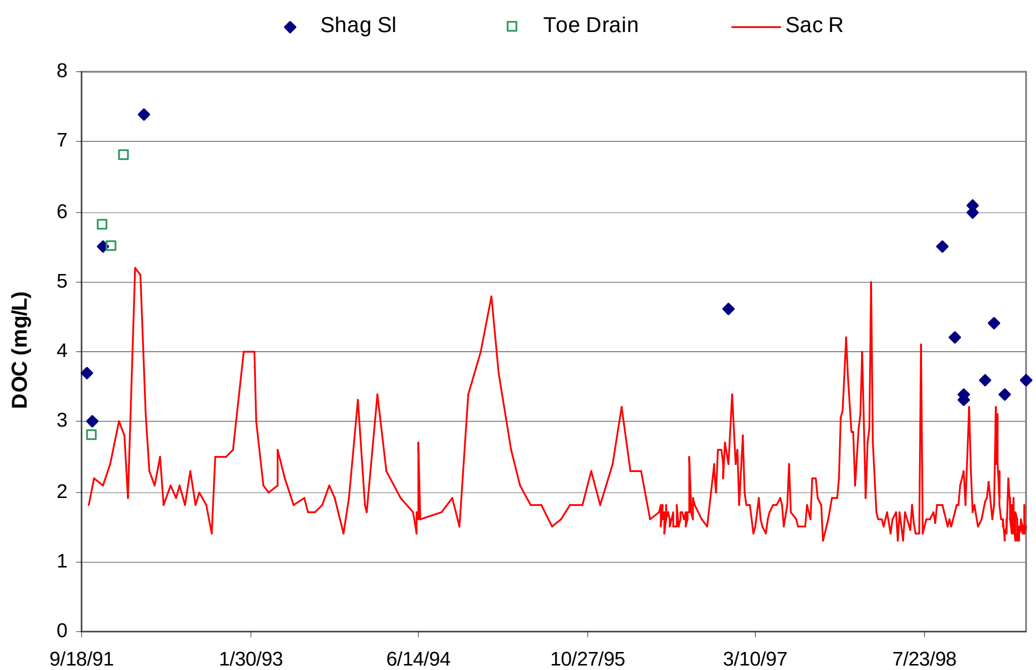


Figure 7. DOC in the Yolo Bypass and the Sacramento River

Below (Figure 8) is a box plot comparison of the DOC concentrations for Shag Slough, the Toe Drain, and the Sacramento River. Data from the Yolo Bypass stations are only available in the months between October and January. So a separate box representing Sacramento River DOC concentrations only in the months of October through January is presented in order to eliminate skewness due to season when comparing between stations.

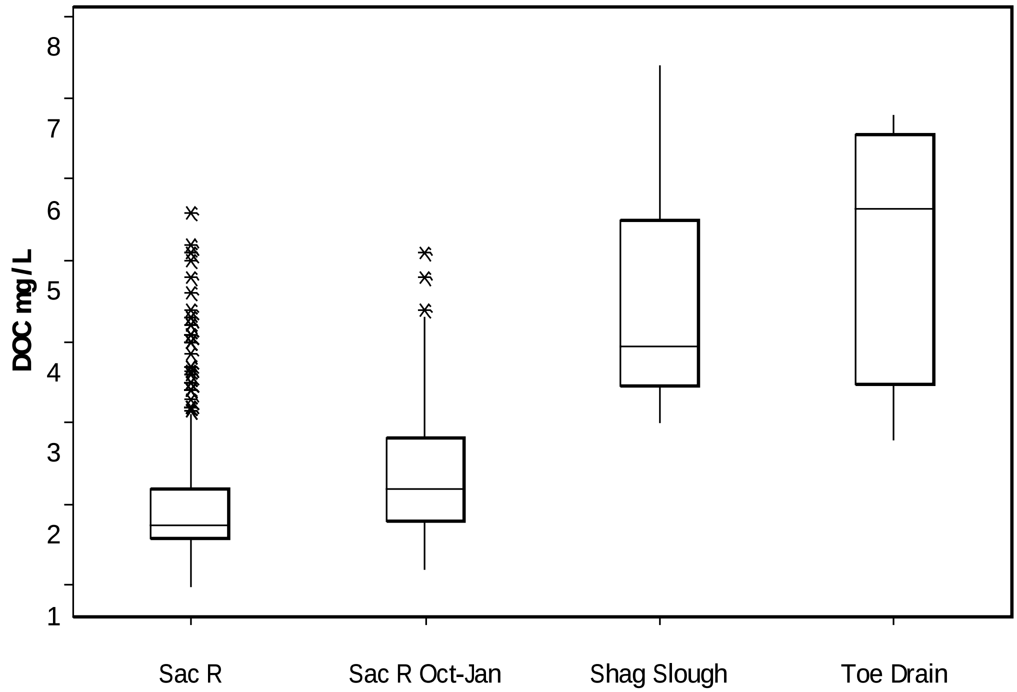


Figure 8. DOC concentrations

East Side Streams

A. Mokelumne and Cosumnes Rivers

Water quality data for the American River at the water treatment plant intake has been used as the boundary condition for the Mokelumne and Cosumnes Rivers. There are sparse data available however for total organic carbon concentrations in the Mokelumne at New Hope Road (SAC002) and the Cosumnes at Twin Cities Road (SAC001) from the Central Valley Regional Water Quality Control Board (CVRWQB) San Joaquin River Sub-basin monitoring program (Graham 2007). The current assumption for DOC in the Mokelumne is that there are two alternate values; a high DOC of 3.95 mg/L or a low DOC of 1.74 mg/L. The two value scheme was developed from American River data which did not show a flow related pattern. A flow related pattern may be more appropriate for the East Side Streams or a revised DOC value for the high DOC condition. Plots of TOC data for SAC001, SAC002, and the American River show more variability in TOC within the Mokelumne and Cosumnes than the American (Figure 9 {does not include a data point at 20 mg/L} and Figure 10).

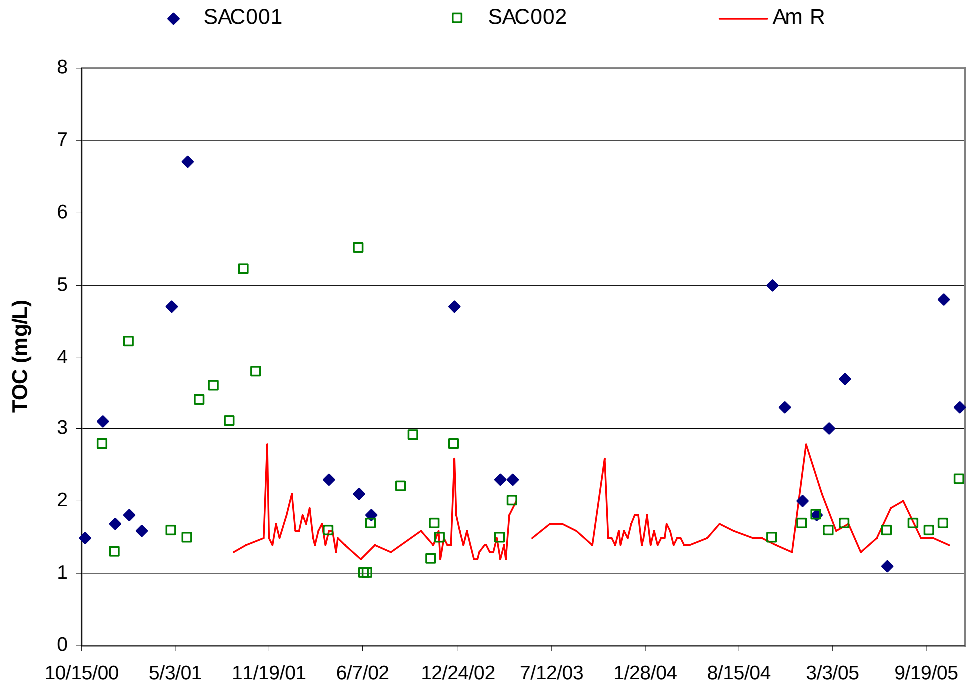


Figure 9. TOC in the Cosumnes (SAC001), Mokelumne (SAC002), and the American R at the WTP intake

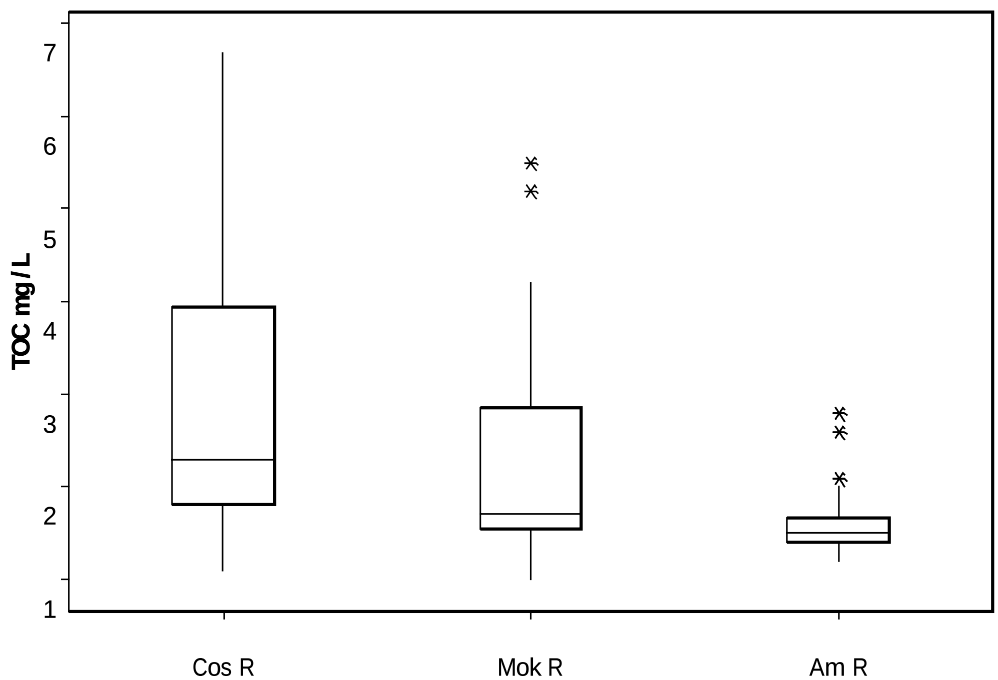


Figure 10. TOC in the Cosumnes, Mokelumne, and American Rivers

Mann-Whitney comparisons find the medians of both the Cosumnes and Mokelumne Rivers to be statistically significant from the median of the American River data (Table 3).

Table 4. Summary Statistics. TOC values in mg/L

Station	n	Mean	Median	Min	Max
SAC001	23	3.7	2.3	1.1	20
SAC002	33	2.3	1.7	1	5.5
American R	151	1.8	1.5	1.2	2.8

B. Calaveras River

Three data points for organic carbon concentrations are available from the CVRWQB sub-basin monitoring program for the Calaveras River (Graham 2007). The samples were taken from the Calaveras River near Hwy 88 thirteen miles upstream of the confluence with the San Joaquin River. Results for total organic carbon concentrations in the Calaveras and American River during the same period are plotted in Figure 11.

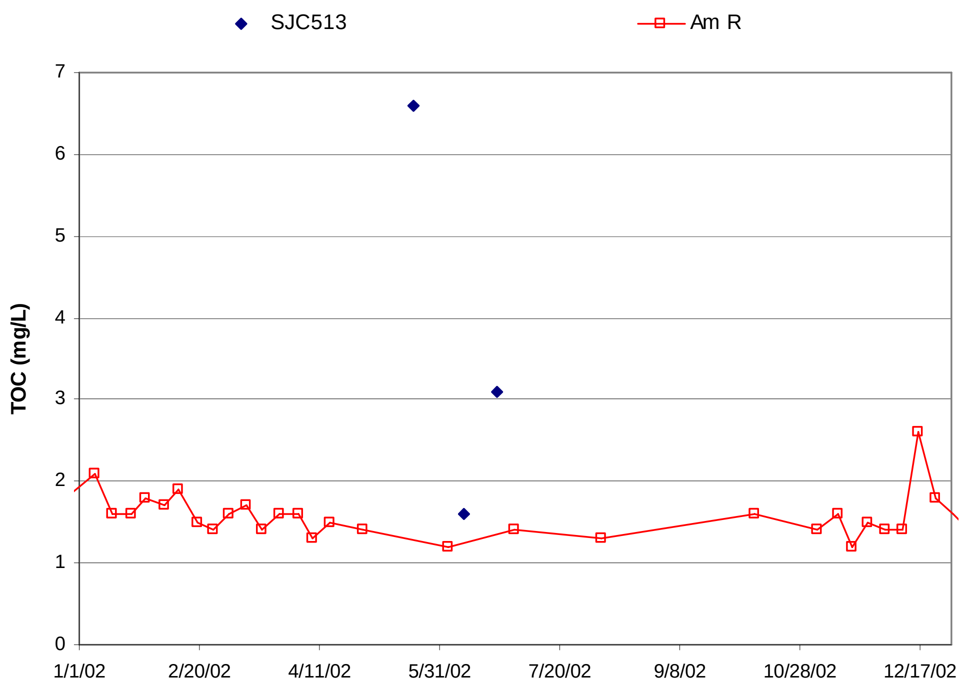


Figure 11. TOC in Calaveras (SJC513) and American Rivers

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Deliverables

Deliverables	**Participants**	**Estimated Start Date**	**Estimated Completion Date**
Collect organic carbon data and provide results to Bay Delta modelers.	**MWQI**	November 2008	December 2009 with potential extension to be determined based on discussion with modelers
Final Report	**MWQI**	October 2009	June 2010

Budget

See 2009/10 Workplan

2009-10 Workplan Proposal for Spectrofluorometer Investigation--Lead Investigator: Ted Swift

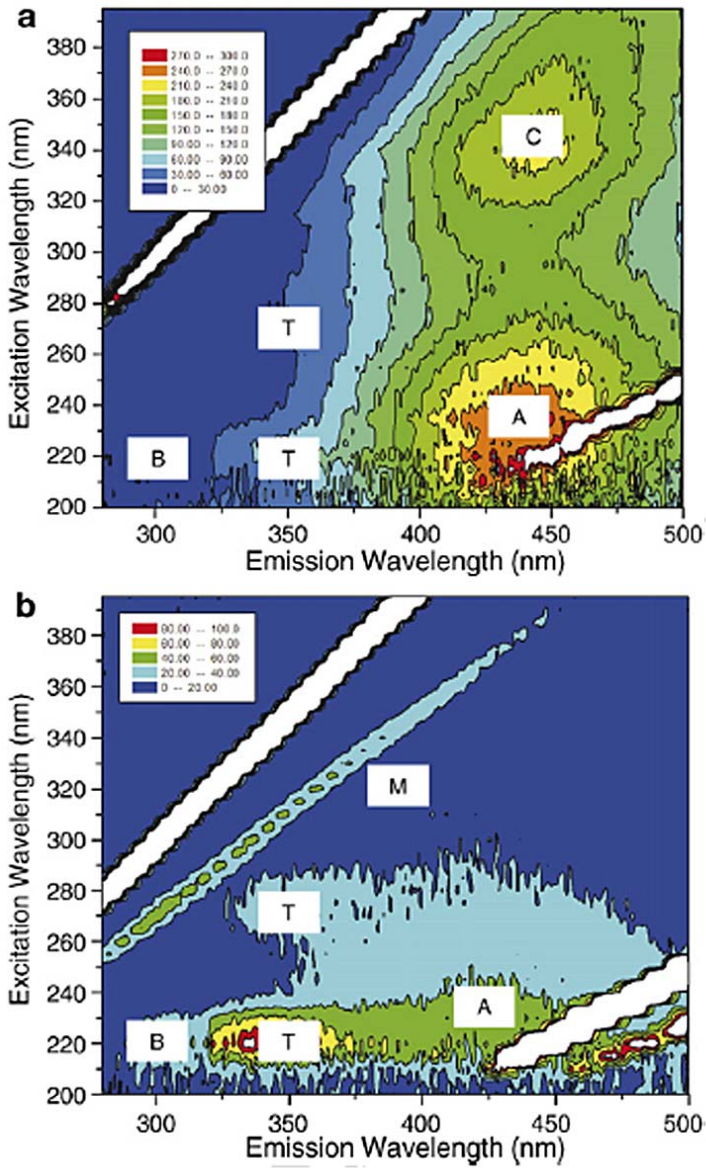
Background/Introduction

Natural water sources contain a complex variety of dissolved and particulate organic materials, or natural organic matter (NOM). In the Sacramento-San Joaquin River Delta, sources include tributary river flows from distinct watersheds, in-Delta algae and submerged vegetation growth and decay, and organic-rich peat soils. NOM concentrations and characteristics in source waters ultimately bound for municipal drinking water use is of great interest to water contractors and water treatment operators because of the disinfection byproducts (DBPs) resulting from water treatment. Regulatory agencies such as the US EPA have put in place regulations on the concentrations of DBPs allowable in finished drinking water. Thus, it is of great interest to (a) understand the sources, chemical reactivity, and seasonal variations of NOM in Delta source waters and (b) identify cost-effective ways of producing the most useful water quality information with the least effort and cost.

NOM can be evaluated through several surrogate measurements such as total organic carbon (TOC), dissolved organic carbon (DOC), absorbance spectroscopy (e.g., UVA254) and spectrofluorescence methods. For example, MWQI operates TOC/DOC analyzers at the two main tributary points (the Sacramento River at Hood and the San Joaquin River at Vernalis) and two export facilities (Banks Pumping Plant on the State Water Project and Jones Pumping Plant on the federal Central Valley Project). UVA254 is used by DWR O&M as a DOC surrogate at several points throughout the SWP. These have all proven to be quite useful in accurately measuring TOC or DOC as a bulk measurement. However, without other concurrent and relatively laborious analyses, such as trihalomethane formation potential (THMFP) or pigment analysis, these bulk measurements do not provide much insight into the sources, concentrations, and potential reactivity of NOM in a given water sample.

Fluorescence occurs when a loosely held electron within an atom or molecule is excited to a higher energy level (electron orbit) by absorption of energy, e.g, a photon of light, and subsequently releases energy as light as it drops to a lower energy level. Some energy is lost prior to emission, so the energy of the emitted photon is lower than the excitation energy. Stated another way, the wavelength of the excitation light is shorter than the emission wavelength. The wavelength at which excitation and emission occur is specific to the molecule involved. Those compounds that absorb light (often pigments) are called chromophores and those that both absorb and re-emit light energy are called fluorophores. Aromatic organic compounds provide particularly good subjects for fluorescence analysis due to the electron structure of the carbon ring (Hudson *et al*., 2007).

A fluorometer is an instrument that excites the sample at one wavelength and measures the resultant fluorescence at a longer wavelength to measure a given suspended material, such as chlorophyll contained in algal cells. A spectrofluorometer extends that principle by exciting the sample across a rapidly-scanned range of ultraviolet-to-visible light wavelengths, while simultaneously measuring light emission across another band of wavelengths. The result is an *excitation-emission matrix* (EEM), such as Figure12, where excitation wavelength is on one axis, emission wavelength is the second, and fluorescence intensity forms a third axis. Each matrix consists of hundreds of excitation-emission measurements of a single water sample. Water constituents of concern, such as DOC and algae, along with other characteristics that may be distinctive of each source water, can be resolved from features in the EEM (Yan, 2000). For example, pigments within living algae produce distinctive features characteristic of the algal family. Spectrofluorescence has also been used to distinguish wastewaters from pristine waters (e.g., Baker *et al.* 2004b, Hudson *et al.,* 2007).



Typical fluorescence EEMS showing the position of the principal fluorophores in optical space: (a) River Tyne, England (b) coastal North Sea. Note that the fluorescence intensity scale is different for (a, 0-300) and (b, 0-100). C=terrestrial humic/fulvic-like peak; M=marine humic/fulvic-like peak; A=humic-like peak; T=tryptophan-like, protein-like peak; B=tyrosine-like, protein-like peak. Fluorophores C and M are often referred to as H, humic/fulvic-like peak for comparison. The diagonal linear features are Rayleigh Tyndall and Raman scattering of water, respectively (Spencer et al., 2007..

Figure 12. Typical fluorescence EEMs observed in a study by Spencer et al., 2007

In 2007, the DWR QA/QC group acquired a high-performance FluoroMax 4 spectrofluorometer to, among other things, investigate the usefulness of spectrofluorometric analysis to Delta and Delta source waters. An extensive and growing literature (e.g., references in Hudson *et al.* 2007), strongly suggest that this approach may provide a rapid method or methods of accurately quantifying multiple constituents of concern in a single measurement.

Objectives

This study will evaluate the usefulness of spectrofluorometry as a method of rapidly quantifying constituents of concern (COCs) such as DOC, algae and organic carbon, and as a method of fingerprinting source waters as they pass through the Delta. This study will examine the feasibility of configuring a spectrofluorometer instrument to operate unattended in real-time monitoring stations. It will also seek to identify distinctive characteristics of Delta source waters to provide a water "fingerprint" that would be used to, among other things, validate Delta water models.

Study Design

Field grab samples will be collected approximately monthly for two years at sites in the Delta study area and Delta source waters. Sites will be selected to reflect the individual tributary source waters, seasonal variations, and the likely sources of organic carbon in each source water. Sampling stations will include

- West Sacramento Drinking Water Intake. Samples from this site would represent the Sacramento River upstream of Sacramento Regional Wastewater Treatment Plant (WWTP). Samples here would also include most of the agricultural drainage impacts from the Sacramento River watershed.
- Sacramento River at Hood. Samples from this site would represent water downstream of Sacramento Regional WWTP
- Sacramento Water Intake on the American River.
- San Joaquin River at Vernalis. Samples from this site would capture the San Joaquin River as it enters the Delta. It would include most of the agricultural drainage impacts from the San Joaquin river watershed.
- Banks Pumping Plant. Samples from this site would represent water as it leaves the Delta at the beginning of the State Water Project's California Aqueduct.
- Other source waters further upstream of the Delta, such as the Colusa Basin Drain, tributaries to the Sacramento River, the Mokulumne and Cosumnes Rivers, and tributaries to the San Joaquin River.

Samples will be analyzed as soon as possible after collection to minimize changes. However, Yan *et al.* (2000) found in a study of sample stability that a sample that had been stored in a sealed dark-glass container for 43 days had, within experimental error, same structure and intensity originally measured for those samples within 24 h of collection.

Laboratory preparations of specific "end member" waters will include dissolved organic carbon from known Delta peat soil, pure cultured algae, and cultured algae that has been allowed to senesce.

In coordination with the MWQI standard field sampling program, samples will be analyzed by Bryte Laboratory for total organic carbon, dissolved organic carbon, pH, UVA-254, THMFP, and HAAFP.

The resulting data will be analyzed to identify distinctive features in the EEMs that are highly correlated with characteristics such as DOC and TOC concentration, THMFP, and algal biomass. Analytical tools will include multiple regression, parallel factor analysis, and principle component analysis.

Deliverables

Milestones / Deliverables	Participants	Estimated Start Date	Estimated Completion Date
Approximately monthly sampling at sites in the Delta study area	MWQI Staff MWQI Field Unit	July 2009	June 2011
Spectrofluometric analysis of raw and filtered water samples	MWQI Staff	July 2009	June 2011
Analysis of samples by DWR Bryte Laboratory	Bryte Laboratory	July 2009	June 2011
Interim report	MWQI Staff		July 2010
Final Report	MWQI Staff		October 2011

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Budget
See 2009/10 Workplan

Appendix 4-MWQI 5 Year Strategic Plan

During 2006-07, the five-year strategic plan for the MWQI Program was updated and approved and adopted by the MWQI Technical Advisory Committee. This strategic plan will serve as the basis for the MWQI Program for completing development of program work plans for 2008-2009, and subsequent years. The plan that was approved is reproduced below.

MWQI Mission Statement

The mission of the MWQI Program is to collect and disseminate timely information to enable drinking water supplies taken from the Sacramento-San Joaquin Delta to be economically treated to produce safe and palatable drinking water. Information produced through this program will be used for:

1. Identifying and evaluating sources of drinking water contaminants.
2. Assisting MWQI Program participants in achieving their water quality objectives, meeting regulatory requirements, and planning for the future.
3. Supporting Delta and SWP water supply operations and assessing the water quality consequences of these operations.
4. Augmenting, in a cost-effective manner, the efforts of State and federal agencies mandated to monitor, protect, and improve drinking water.
5. Assessing impacts of actions by the California Bay Delta Authority and other entities on Delta and SWP drinking water quality.
6. Participating in public regulatory and funding processes to disseminate drinking water quality information and to assist in efforts to protect and improve drinking water sources.

Objectives for The Five-Year Plan

Organizational Structure, Coordination and Funding

- Develop an organizational structure that ensures staffing requirements for the MWQI Program are met on a timely basis through the retention of highly qualified personnel that have the expertise to meet MWQI Program objectives.
- Develop and implement the Real Time Data and Forecasting-Comprehensive Program (RTDF-CP) which will encompass tasks identified by the State Water Contractors, MWQI staff, other DWR units, outside agencies as high priority and achievable through cooperative effort.
- Work with the State Water Contractors to identify tasks that can most efficiently be performed through cooperative agreement, and participate in cooperative implementation of such tasks. These tasks will be described in detail and planned for on an annual basis in the RTDF-CP strategic plan.
- Work with the State Water Contractors to identify funding needs that will enable the MWQI Program to be adequately implemented, and to participate in acquiring, allocating, and accounting for, funds to accomplish needed work both directly, and through cooperative agreement.

- Coordinate MWQI Program activities with those of other DWR units under the RTDF-CP to enhance productivity, minimize duplication and overlap, and ensure effective coordination and communication among these units to enable joint implementation of water quality assessment and forecasting activities affecting the Delta and SWP as a whole.

Development and REfinement of a SWP "Early Warning System" for WAter Quality Concerns

- In conjunction with the Division of Operations and Maintenance and as one of the primary objectives of the RTDF-CP, develop and refine a "SWP Water Quality Early Warning" system that will alert MWQI Program participants of likely drinking water quality problems in a timely manner to enable preventative or corrective actions to be taken to avoid consumer impacts.
- Develop efficient communications among DWR units and MWQI Program participants to ensure early warning information is transmitted, received, and acted upon as appropriate.
- Tasks identified under the "Water Quality Monitoring", "Information Management and Dissemination", "Water Quality Forecasting", "Scientific Support" and "Emergency Response" program elements support the development of this early warning system.

Water Quality Monitoring and Emerging concerns

- Monitor water quality parameters relevant to drinking water at key locations in the Sacramento-San Joaquin Delta through periodic collection of discrete samples and their analysis by field and laboratory instruments, according to accepted methods.
- Maintain existing *in-situ* multi-parameter water quality monitoring stations on the Sacramento River at Hood, H.O. Banks Delta Pumping Plant Headworks, and San Joaquin River near Vernalis.
- As part of RTDF-CP work cooperatively with the State Water Contractors, other DWR units, and other agencies, to identify additional key locations in the Delta, its tributaries, and the State Water Project where additional *in-situ* water quality assessment equipment is needed. Work cooperatively with others to acquire needed permits, plan for and perform construction, acquire monitoring and communications equipment, bring new stations into operation, and assure the quality of data produced.
- Perform water quality assessments and evaluations to identify drinking water quality consequences of physical or operational changes in the Delta, its watersheds, and the State Water Project.
- With participation of the State Water Contractors, other MWQI Program participants, and DWR modelers, produce annual re-evaluations of the discrete and *in-situ* monitoring programs to identify and recommend needed changes to eliminate critical data gaps, provide valid data for the DSM2 model, improve program efficiency and minimize monitoring costs.
- Ensure timely and appropriate quality assurance/quality control of water quality and related information produced by the MWQI program. Take timely and effective action to identify and correct QA/QC problems. Include equipment/instrument maintenance and calibration as part of the annual QA/QC process.
- As part of the RTDF-CP work with other DWR units towards standardization of QA/QC procedures, especially for new stations.

- Continue to explore new and improved technologies for acquiring real time water quality data. Utilize new technology where possible to minimize monitoring costs and data gaps and to move towards standardization of monitoring methodology.
- Plan for emerging constituents of concern such as "Taste and Odor" issues that have been increasing with time. Respond to these emerging concerns in a timely manner as part of the RTDF-CP.
- As part of the RTDF-CP develop a comprehensive program of monitoring, early warning, and management for algal growths in the Delta and SWP having the potential for causing taste and odor in treated drinking water taken through the SWP. Governance of this program will be through a steering committee composed of DWR staff from relevant organizational units, and State Water Contractor representatives of affected agencies.

Information Management and Dissemination

- Provide timely analysis, interpretation, and dissemination of monitoring information to MWQI program participants and other identified stakeholders on key constituents of concern. Analyze and present monitoring results to program participants and in public proceedings.
- Continue to develop and refine capability for MWQI Program participants to rapidly acquire real time and other drinking water quality data and supporting information through the internet in user-friendly formats.
- Produce annual data and/or interpretative reports documenting program findings, as shall be determined by the MWQI Committee.
- Continue production of weekly water quality reports, with continuing improvements, as may be directed by the MWQI Committee.
- Provide technical assistance to MWQI Program participants in acquiring needed water quality data and supporting information.
- Research and develop new and innovative means of communicating MWQI Program work products to program participants and other interested parties.
- Encourage and promote actions by regulatory agencies necessary to ensure a high-quality and reliable water supply by disseminating information derived from the MWQI Program.
- Advocate drinking water quality protection by tracking new projects in the Central Valley, including operational planning activities, by alerting MWQI Program participants to projects having the potential to affect the quality of drinking water supplies taken through the Delta, reviewing and commenting on environmental documents, and participating in pubic hearings and workshops.
- Maintain awareness of findings from international, national, and regional research activities that have a bearing on the ability to meet future drinking water regulations, factor these findings into analyses of Delta water quality conditions and facilities options as appropriate, and communicate these findings to MWQI Program participants.

Water Quality Forecasting

- Complete development of, and implement, extension of the DSM2 Delta model to include the State Water Project.
- Produce timely water quality forecasts for SWP Contractors. MWQI Program staff will support DWR modeling efforts by providing water quality expertise needed to improve Delta models,

coordinating closely with modelers to collect data to support model development, and to improve the ability to interpret and apply model outputs.

- Pending full implementation of the extended DSM2 model, evaluate other existing models for the potential of providing interim water quality forecasts to SWP Contractors.

Scientific Support Studies

- In cooperation with MWQI Program participants and as part of the RTDF-CP, identify the need for, and implement, detailed studies to examine specific phenomena that affect, or may in the future affect, Delta drinking water quality. These studies may be generally classified as follows:
    - Detailed evaluations of problem areas or conditions identified as a result of monitoring activities.
    - Evaluations of drinking water quality consequences of proposed physical or operational modifications in the Delta and its tributaries, its inflows, internal flow patterns, or outflows.
    - Prediction of the drinking water quality consequences of population growth patterns.
    - Detailed evaluations of natural processes that have the potential to affect the quality of Delta drinking water sources.
    - Detailed evaluations of point and non-point pollutant discharges to the Delta (including tributaries to the Delta).

  Studies will be selected for implementation based on their significance to the quality of drinking water supplies taken through the Delta, and likelihood of being able to apply the information to attain higher quality of Delta drinking water sources. Outside expertise will be enlisted where necessary and feasible to conduct or collaborate on scientific studies.

Emergency Response

- Identify, to the extent possible, ahead of time specific concerns regarding these events and what constituents would need to be assessed.
- Develop scenarios for different emergency events using models to determine which areas in the Delta pose most significant DWQ issues
- Develop emergency response plans ahead of time (follow SIMS template), identifying funding and staffing needs, all participating groups and their roles
- Work with other DWR units (i.e. Div of Flood Management) to develop emergency response plans
- Encourage DWR Executive to treat these events similar to flood events
- Perform water quality assessments and evaluations in response to emergency situations, such as Delta levee breaks, supplying timely water quality information to emergency decision makers and public health authorities.
- During emergency circumstances, work cooperatively with emergency managers and rapidly communicate results of emergency water quality assessments the MWQI Program may be tasked to perform.