State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Planning and Local Assistance

2006 SUPPLEMENTAL REPORT
TO 2004 DRAFT STATE FEASIBILITY STUDY
IN-DELTA STORAGE PROJECT

May 2006

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Foreword

The ***2006 Draft Supplemental Report to 2004 Draft State Feasibility Study – In-Delta Storage Program*** was prepared in response to comments received during the public review of the initial 2004 draft State feasibility study. The 2005 report also incorporates new information gathered by the Department of Water Resources (DWR) during the response to the June 2004 Middle River levee breach and flooding of Jones Tract.

During preparation of the supplemental report, other events were occurring in the Delta that will affect water project operations. These include a decline in the abundance of pelagic organisms and increased focus on seismic instability and global climate change and their potential effects. In response to the pelagic organism decline, DWR has modified its approach to a long-planned project, the South Delta Improvement Program. DWR seeks to proceed with the construction of operable gates in some Delta channels, while postponing operational decisions until the reasons for the pelagic organism decline are better understood.

There is mounting concern that the current physical configuration of the Delta will become increasingly difficult to maintain. Recent analysis conducted by DWR suggests that a major earthquake on one of the faults near the Delta could cause many Delta islands to fail, having major and long-lasting effects. The increasing body of knowledge regarding global climate change suggests that, in the future, the Delta will need to withstand both increased sea level and stronger storm flood events.

Several efforts are under way to increase our understanding of Delta risks and develop options to cope with these risks including the Delta Risk Management Strategy, AB 1200 response, and the Delta Vision Process. The Delta Risk Management Strategy is a multi-agency effort let by DWR in cooperation with the Department of Fish and Game (DFG) and the U.S. Army Corps of Engineers. This effort will identify the various hazards to each island, examine potential impacts to beneficiaries, and recommend alternative risk management strategies. A related effort is the response to AB 1200 (Chapter 573, Statutes of 2005), which directed DWR and DFG to evaluate potential impacts to the Delta from subsidence, earthquakes, floods, and climate change, and evaluate options for the Delta's future. Finally, the Resources Agency and the Business, Transportation, and Housing Agency are leading a new collaborative effort to develop a realistic shared vision of the Delta's future given the threats that it faces.

By 2008, these Delta efforts will be completed and feasibility analysis of other CALFED storage projects will be available to compare to the results of this In-Delta feasibility study. At that time it will be appropriate to consider whether to proceed with In-Delta storage.

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1. Summary

This Supplemental Report was prepared in response to comments received during the public review of the 2004 *Draft In-Delta Storage Program State Feasibility Study*. The report describes new studies on a broad array of issues, including water supply and quality, project design, risk analysis, environmental evaluations, and construction costs. New information gathered by DWR during the response to the June 2004 Middle River levee breach and flooding of Jones Tract is incorporated in these studies. As with previous studies, DWR conducted these investigations as a neutral technical evaluator of the costs, benefits, impacts, and uncertainties associated with a publicly owned In-Delta Storage Project.

This report reaffirms many of the conclusions stated in the 2004 *Draft In-Delta Storage Program State Feasibility Study.* The supplemental work described in this report has primarily served to reduce the uncertainty associated with previous findings. This report includes revised project cost estimates, refined project operations, revised risk analysis, and additional information on specific technical issues, such as the impact to project operations from organic carbon absorbed in water stored on Delta islands with peat soils.

1.1 Conclusions

Water Supply Operations and Water Quality

- The total average annual water supply benefits provided by the project are estimated to be about 107,000 acre-feet initially and improve to about 120,000 acre-feet after a few years of project operations. This increase would result from a gradual decrease in carbon loading rates for water stored on the Delta islands, allowing more flexible project operations.
- The water supply, Environmental Water Account (EWA), Ecosystem Restoration Program, and water quality benefits under each operational scenario investigated and summarized in this report can occur simultaneously.
- Tank experiments conducted as part of this investigation demonstrated initial organic carbon loading rates similar to those observed in the Jones Tract flood. In the tank experiments, organic carbon loading rates decreased over a two year period by 68 percent.
- The simulated operations conducted for this report comply with short-term annual water quality regulations and agreements.
- Water quality modeling conducted for this study does not account for the potential effects of the cessation of agricultural drainage from the project islands on the water quality of the Delta channels. With a conversion from agriculture to project uses, past agricultural drainage patterns from the project islands would be replace by project operations. More detailed water quality modeling that accounts for this change could reduce the water quality release requirements in the simulated project operations and result in improved estimates of project water supply benefits.
- Water quality data collected during the Jones Tract flood suggest that dissolved oxygen (DO) and temperature of water stored on Delta islands may vary significantly with time of day. This may require further refinement in operations and implementation rules to assure that water discharged from the islands meets

fishery requirements. While further analysis may result in a daily operations plan that can accommodate the projected changes in DO and temperature without affecting project performance, these constraints could reduce estimates of project water supply benefits.

- The State Court of Appeals has set aside SWRCB D1643 and the water right permits issued to Delta Wetlands. That not withstanding, this report has used the PDA's, SWRCB D1643, and the WQMP to fully describe and analyze the project as the reasonable and best available definition of likely permit condition.

Engineering Considerations

- **Project Cost:** Using new information on foundation soils and riprap slope protection, the Draft 2004 State Feasibility Study estimated project cost of $774 million is increased to $789 million.
- **Seepage to Adjacent Islands:** Seepage conditions were observed at McDonald Island during the Jones Tract flood. This information confirms that the seepage modeling assessment conducted for In-Delta Storage project operations provides a reasonable estimate of seepage to adjacent islands. Accordingly, the proposed seepage control measures are confirmed to be adequate to protect neighboring land owners.
- **Stability of Embankments:** The use of soil cement for slope protection on the reservoir side of the project embankments for protection against wind and wave action is not a suitable solution. Riprap slope protection is recommended.
- **Risk Analysis:** The risk analysis was updated to consider additional infrastructure (East Bay MUD Mokelumne Aqueducts, Burlington Northern Santa Fe Railway, PG&E gas lines and Kinder Morgan pipelines) and recent Jones Tract Flood information. The results are similar to the original risk analysis. Embankment improvements included in the In-Delta Storage project would reduce the failure probability and the economic losses by factors of 6 to 10 in comparison to the existing conditions.
- **Technical Feasibility:** DWR reaffirms its prior finding that the In-Delta Storage project is technically feasible. DWR is satisfied that it can safely design, construct and operate an In-Delta Storage Project (as disclosed in this and other DWR reports).

Environmental Evaluations

- The California Environmental Quality Act (CEQA) requires a subsequent environmental impact report (EIR) because of needed changes to the original Delta Wetlands proposal. Any such additional environmental review will make extensive use of work already done by Delta Wetlands and DWR as part of this feasibility study.
- Two years of extensive surveys found no giant garter snakes on the Webb tract and Bacon Island.
- Potential giant garter snake habitat on these islands is decreased by 50 percent from the 2002 habitat estimates reported in the 2004 Environmental Evaluations for the Draft 2004 State Feasibility Report.

Economic Evaluations

- Work is ongoing through the CALFED Surface Storage Program Common Assumptions effort to better quantify the economic value of water supply benefits that could be produced by the In-Delta Storage project and other CALFED surface storage proposals. The existing economic analysis does not fully quantify all of the potential project benefits and, therefore, cannot be compared directly to project costs.

1.2 Recommendations

The Department of Water Resources, acting as the State implementing agency for the CALFED Bay-Delta Program surface storage projects, has refined the In-Delta Storage project proposal and developed a substantial body of information to facilitate its evaluation and consideration. Additional work to add to the existing body of information and further reduce uncertainty regarding the In-Delta Storage project proposal would require significant new investment in field testing, data collection and modeling to better understand the effects of DOC, DO, temperature, and taste and odor on project operations and potential water supply benefits.

DWR believes that sufficient technical information is now available for potential project participants to evaluate their interest in the In-Delta Storage Project. To date, DWR has not received any expression of interest from potential project participants willing to use water developed by the project and share in project costs. DWR acknowledges that some potential project participants may be reluctant to express an interest in any CALFED surface storage proposal until equivalent, comparable information is available for other CALFED surface storage proposals.

DWR recommends that further detailed study of the In-Delta Storage project be suspended until adequate technical information is available for other CALFED surface storage projects. DWR further recommends that limited economic study and operations modeling of the In-Delta Storage project proposal continue through the CALFED Surface Storage Program Common Assumptions effort. This information will allow DWR and potential project participants to continue to compare the In-Delta Storage project proposal to other CALFED surface storage proposals as work on those proposals advances.

1.3 Next Steps

If a future decision is made to continue work on the In-Delta Storage Project, the following next steps are recommended:

- Conceptual models for water quality effects should be advanced to help define benefits, costs and risks, and identify needed modifications in operations, facilities, monitoring, contingency plans or water rights.
- Significant investment in field testing, data collection and modeling is needed to reduce uncertainty associated with project operations, water supply and quality benefits, and the effects of dissolved organic carbon, dissolved oxygen and taste and odor on project water supply and quality. Future operations studies must be presented with greater assurances that reported benefits will be obtained by project participants.

- Other factors affecting water system operations in the Delta, such as potential landscape changes and pelagic fish and ecosystem concerns, will need to be incorporated into project evaluations.
- Better quantification of the economic benefits of the project proposal is needed. DWR continues to advance its economic analysis of these benefits through the Common Assumptions effort with State, Federal and local stakeholders.
- Early and frequent communications and participation with Delta stakeholders should be undertaken to provide assurances that any project design and operations plan will protect lives, property, business, infrastructure, and other social and economic interests in the Delta.
- Maintain an open dialogue with local, state and federal interests and define specific project formulations that best describe their interests.
- Address future authorization for federal participation.
- Reinitiate the CEQA process and include analysis of refined of the operational plans to resolve water quality issues.
- Complete a final subsequent EIR.

2. Supplemental Study Scope

2.1 Introduction

This Supplemental Report includes technical investigations conducted by DWR since July 2004 in response to public comments received through the 2004 Draft State Feasibility Study public review. It also reports on completion of studies prompted by new events such as the Jones Tract flooding. The review began in February 2004 when the Draft State Feasibility Study was completed. The Summary and the supporting technical reports were made available to the public on the CALFED Web site for 45 days. The project team held public workshops in Walnut Grove and Sacramento to present information and answer questions. Other briefings were provided as requested.

This Supplemental Report presents information on additional studies for water supply operations and water quality analysis with new field information (Chapter 3), project design modifications and updated costs (Chapter 4), updated risk analysis to include additional infrastructure and data from the recent Jones Tract levee breach (Chapter 5), future California Environmental Quality Act (CEQA) work requirements and results of giant garter snake surveys (Chapter 6), and legal implications of recent court decisions (Chapter 7). Chapter 7 also includes a status report of the economic analysis. The conclusions, recommendations, and next steps are detailed in Chapter 8 and are summarized in Chapter 1.

2.1.1 Project Study Background

In July 1987, Delta Wetlands proposed a project to store water on Webb Tract and Bacon Island and develop habitat on Holland Tract and Bouldin Island. The State Water Resources Control Board (SWRCB) issued the project a water rights permit in February 2001, subject to a variety of agreements and state and federal requirements. SWRCB approved water quality certification under the Clean Water Act Section 401 on September 20, 2001. The Section 404 Application to the U.S. Army Corps of Engineers (USACOE) was approved in 2002.

The August 2000 CALFED Bay-Delta Program Record of Decision (ROD) outlined a broad framework of actions to restore ecological health and improve water management for beneficial uses of the San Francisco Bay/Sacramento - San Joaquin Delta. Among a variety of other integrated actions, the ROD directed the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation) to evaluate five surface storage proposals, including the In-Delta Storage Project, and to report on their ability to contribute to Bay-Delta solutions.

In 2001, DWR and the California Bay-Delta Authority (CBDA), with technical assistance from Reclamation, began evaluating the Delta Wetlands Project and other in-Delta storage options. This evaluation was completed in May 2002 and concluded that the project concepts proposed by Delta Wetlands were generally well planned. However, design modifications and further evaluations were needed before considering public ownership of the project.

The In-Delta Storage Project, described in the 2004 Draft State Feasibility Study, would store about 217,000 acre-feet of water in the south Delta for a wide array of water supply, water quality and ecosystem benefits. The project would include two storage islands, Webb Tract and Bacon Island, and two habitat islands, Holland Tract and Bouldin Island, shown in Figure 2.1. The project is similar to that proposed by Delta Wetlands more than a decade ago, but would also include a new embankment design, consolidated inlet and outlet structures, new project operations, and revised habitat management plans. In addition to the water supply benefits, the project could provide operational flexibility, water quality improvements, wildlife and habitat improvements, seismic stability for Delta levees, recreation, flood damage reduction, and reduced levee-maintenance expenses.

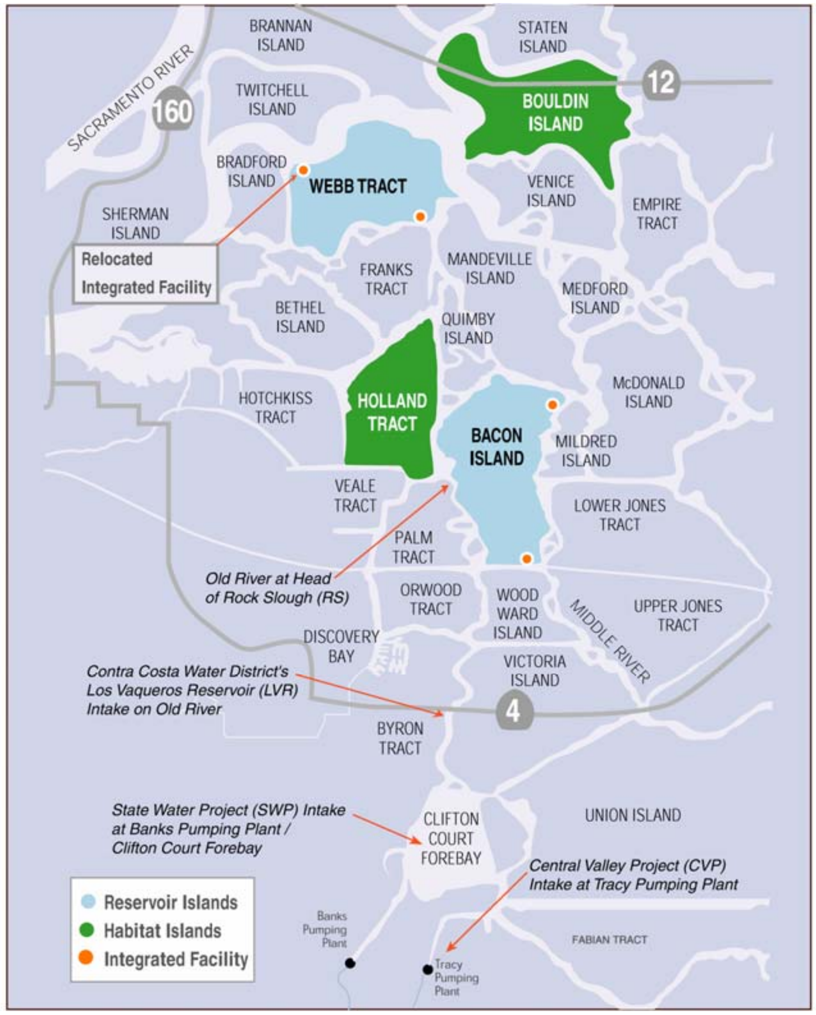

Figure 2.1 – Proposed In-Delta Storage Project

In June 2002, based on initial work completed by DWR and Reclamation, the Bay-Delta Public Advisory Committee recommended that the CALFED implementing agencies complete additional evaluations and address several issues before considering implementation of the In-Delta Storage Project. The 2004 Draft State Feasibility Study reports the findings of this additional work. The work done for this Supplemental Report resulted, in large part, from the public comments about the 2004 Draft State Feasibility Study.

2.2 Public Review and Concerns

A 30-day public review was started on February 5, 2004, and after a request from the California Urban Water Agencies, extended to 45 days, ending on March 20. Comment letters are available at the following CALFED Web site:

http://www.calwater.ca.gov/Programs/Storage/InDeltaStorageReports_2003/InDeltaFeasibilityStudies_Jan2004.shtml

The DWR organized public comments into topics such as: water quality (30), economics (20), operations (15), engineering (12), agricultural (8), risk analysis (4), navigation (1), recreation (1) and miscellaneous (10). The number in parentheses indicates the total number of comments received in that category. The main issues and concerns were:

- Water quality and operations modeling does not meet all State Water Resources Control Board water rights permit conditions as stated under the Water Quality Management Plan (WQMP) and Protest Dismissal Agreement (PDA) requirements. As a result, it overstates project water supply benefits estimates. Two main areas of concern are organic carbon affecting urban drinking water supplies and dissolved oxygen and temperature in adjacent channels close to the proposed outlets affecting fisheries habitat in the Delta.
- Concerns about the project's cost-effectiveness, such as questions if the project can realize many of the project benefits simultaneously. It needs economic evaluation methodology and assumptions peer review to help quantify all potential project benefits and assess the project's value.
- Project design concerns related to stability of embankments, slope protection and location of inlet and outlet facilities.
- Risk analysis omitted the East Bay Municipal Utility District Mokelumne Aqueducts, PG&E gas pipelines, Kinder Morgan pipelines, Burlington Northern and Santa Fe Railroad Co. railroad lines, and the Stockton Deepwater Ship Channel.
- Local concerns include seepage to adjacent islands, land use changes resulting in loss of agricultural lands, recreation, and mitigation for environmental impacts.

Some also supported project development. Specific comments indicating this support were:

- Continue investigations, including economic and environmental reviews.
- IDSP is a positive component of a balanced program for enhancing Delta habitat and water management flexibility.
- The project will create wetland habitat, improve water supplies, strengthen Delta levees, create jobs and generate sales tax revenue.
- The project supports ecosystem restoration and habitat benefits.
- The project provides an environmentally friendly way of developing a new source of water for California.

2.3 Supplemental Report Scope

The purpose of this Supplemental Report is to provide information on further analysis of issues raised during the 2004 Draft State Feasibility Study public review, report on the Middle River levee breach resulting in 2004 Jones Tract Flooding and to define the scope of the future EIR/EIS work that would be necessary if the project is pursued. The analyses presented in this report deal with:

- Water supply and water quality
  - Representation of operational scenarios for simultaneous realization of benefits
  - Operational scenarios consistent with the Surface Storage's Common Assumptions effort
  - Diversity and quantification of benefits
  - Incorporation of operational procedures to meet the SWRCB water quality requirements
  - Organic carbon analysis using field studies information
  - Inclusion of Dr. Ramesh Reddy's 2005 review of DWR's organic carbon tank experiments.
- Project design
  - Verification of the 2004 Draft State Feasibility Study on seepage to adjacent islands through use of data collected during the Jones Tract Flood Groundwater Monitoring Program and validity of the URS Corporation Seepage Model application to seepage studies for Webb Tract and Bacon Island
  - Durability of the soil cement for reservoir slope protection from wind-driven wave action and erosion
  - Integrated Facility relocation on Webb Tract to deal with water circulation in the reservoir and EBMUD concerns of the Mokelumne River confluence
- Risk analysis
  - Inclusion of EBMUD Mokelumne Aqueducts, Burlington Northern Santa Fe Railroad, PG&E gas lines and Kinder Morgan pipelines, which were not covered in the original risk analysis
  - Inclusion of Jones Tract levee breach information on damages
- Environmental evaluations
  - Future CEQA analysis
  - Giant garter snake surveys
- Legal and economics
  - Recent court decisions
  - Effects of court decision on State Board water rights permit
  - Legal consequences of raising IDSP embankments higher than the Delta levee existing embankments height
  - Improvements in economic analysis procedures and updating economic models
- Conclusions, recommendations and next steps
  - Conclusions
  - Recommendations
  - Work priorities and future actions

3. Water Supply Reliability and Water Quality Assessments

3.1 Introduction

The water supply reliability studies presented in this chapter focus on three aspects of supply:

1) representation of operational scenarios for simultaneous realization of benefits
2) diversity and quantification of benefits
3) effects of various dissolved organic carbon (DOC) growth rate assumptions on project water supply benefits

Project operations were simulated using DWR's California Simulation Model CalSim II. Scenarios so far demonstrate benefits for the State Water Project, Central Valley Project, Environmental Water Account, Ecosystem Restoration Project, and to help meet Delta water quality requirements. Water released from in-Delta storage could also serve broad public benefits in several ways. More specific descriptions of these public objectives and benefits could be explored with other state and federal resource agencies in future work.

This report contains additional CalSim II and DSM2 analysis concerning organic carbon using the latest available field information from tank experiments and Jones Tract flood water quality monitoring. In this section, changes in Delta salinity due to the In-Delta Storage Project's revised operations are reported. Salinity, in particular bromide, a constituent of seawater, affects urban water agencies' ability to meet U.S. Environmental Protection Agency's safe drinking water regulations. Other water quality and groundwater seepage information from the Jones Tract flood and adjacent islands monitoring is also included.

The Protest Dismissal Agreements (PDAs) executed by Delta Wetlands Properties with California Urban Water Agencies (CUWA), CCWD, and East Bay Municipal Utility District (EBMUD) include a Water Quality Management Plan (WQMP) which prevents the release of water that will degrade the water quality and beneficial uses of Delta water. The State Water Resources Control Board Water Rights Decision 1643 (SWRCB D1643) incorporates the terms and conditions of these PDAs. Water supply reliability and water quality studies included in this report incorporate most of the restrictions of the Water Quality Management Plan (WQMP). However, more long-term scientific research to estimate the effect of restrictions on project water supply benefits will be necessary to further reduce the uncertainty related to estimates of project benefits. These restrictions include provisions that curtail or stop water releases due to:

- Expected exceedance of TOC standards at urban diversions;
- DO concentrations in some areas of the reservoirs may fall below 6 mg/l and may also vary significantly during time of the day; and,
- Delta Smelt fall mid-water trawl index falling below values identified in the USFWS Biological Opinion.

Impact of these restrictions has been evaluated to some extent in previous studies. Lack of funding, staffing, time and data for analytical tools limits more studies in these areas. It is not possible to predict with 100 percent certainty how these restrictions will affect operations even with detailed scientific research. Some of the conditions of the WQMP rely upon discretionary actions such as discussions of a Water Quality Management and Action Board, and annual pre-project operations modeling. These conditions are impossible or extremely difficult to incorporate into modeling simulations in planning studies.

The State Court of Appeals has set aside SWRCB D1643 and the water right permits issued to Delta Wetlands. That not withstanding, this report has used the PDA's, SWRCB D1643, and the WQMP to fully describe and analyze the project as the reasonable and best available definition of likely permit condition.

3.2 Operational Strategy

The In-Delta Storage Project's (IDSP) strategic location in the Delta could provide enhanced operational flexibility of the Central Valley Project (CVP) and State Water Project (SWP) in responding to short-term operational needs for water quality and fisheries benefits. This added flexibility combined with water supply benefits and more immediate response would result in greater environmental protection and more reliable water supplies.

These uses were considered in developing scenarios for IDSP:

- Meeting SWP and CVP water demands
- Recharging groundwater banks south of the Delta to enhance conjunctive management operations. Surplus water north of the Delta may be used to recharge groundwater for use during dry periods.
- Meeting Central Valley Project Improvement Act Level 4 Refuge demands to benefit fish, wildlife and associated habitats in the Central Valley
- Providing water needed to support the Environmental Water Account (EWA) and enhancing EWA's ability to respond to fisheries needs
- Providing spring pulse flows as proposed in the Ecosystem Restoration Program (ERP)
- Helping reduce salinity intrusion by making releases of fresh water into the Delta.

One of the concerns raised during the public review was that all project benefits may not be realized simultaneously. To help respond to this concern and reduce this uncertainty, operational scenarios in the Supplemental Report were developed in a stepwise progression starting with meeting SWP and CVP demands as the highest priority and then adding other uses from one study to another level of study with the stated benefits. Also, the water quality analysis followed a two-step analysis. First, the water quality simulation (Scenario 4) for salinity improvements in water quality during August, September and October was run without DOC constraints to determine salinity reduction benefits as a result of water releases in these three months. In a second step, the DOC growth rate constraints were applied and the magnitude of violations was reduced through circulation of fresh water through proposed reservoirs and actual water supply benefits of the water quality scenario under DOC constraints was determined. Benefits (expressed in terms of water quantity) under each scenario are additive and can be realized simultaneously. Additional information on circulation strategy for water quality improvements and DOC growth rates is given in Sections 3.6.3 and 3.6.4.

3.3 Operational Scenarios

The scenario development for the Supplemental Report was changed from the scenarios used in the 2004 Draft State Feasibility Study. As mentioned above, the scenarios build upon each other by adding potential beneficiaries one at a time. In response to a suggestion made during the public review to provide additional releases to improve Delta salinity, Scenario 4 was added. In addition, a series of scenarios that include a range of dissolved organic carbon (DOC) growth rates was added. The range was developed to help understand the sensitivity of project operations, project water supply benefits and export water quality to DOC loading rates.

The Base and Scenario 1 through 4 CalSim simulations did not include a DOC operational constraint and thus a DOC growth rate was not applied to CalSim in these simulations. These scenarios represent the benefits that would result if there are no DOC constraints. Scenario series 4a and 4b used DOC growth rates to constrain operations. The difference between these series is that the Scenario 4b simulations include fresh water circulation operations that aim to reduce the magnitude of water quality violations. The CalSim 4a and 4b simulations considered three different DOC growth conditions based upon Reddy's 2005 analysis of DWR's 2002-2004 mesocosm experiments (DWR requested review by Dr. K. R. Reddy, Chair, Soil and Water Science Department, University of Florida as presented in a report titled "Review of Delta Wetlands Water Quality: Release and Generation of Dissolved Organic Carbon from Flooded Peatlands", March 2005) . Each of the three DOC growth conditions assume seasonally varying growth rates and represent growth conditions expected during the initial, intermediate and longer-term phases of island operations. Two additional studies considered a DOC growth condition assuming a constant growth rate for March to October and a zero growth rate for November to February, one study without and one with circulation.

Table 3.1 presents a summary of the CalSim II simulations that were run for the Supplemental Report. In addition to Table 3.1, a brief description of each scenario is provided below.

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Table 3.1 – Summary of CalSim II Simulations

Scenario	CalSim II Operational Constraints	DSM2 DOC Growth Rate	Fresh Water Circulation Rate
Base	D1641	n/a	n/a
1	D1641, WQMP	n/a	n/a
2	D1641, WQMP, EWA	n/a	n/a
3	D1641, WQMP, EWA, ERP	n/a	n/a
4	D1641, WQMP, EWA, ERP, additional water quality releases	n/a (Longer-term in DSM2 only)	n/a
4a1	D1641, WQMP, EWA, ERP, additional water quality releases, DSM2 derived DOC constraint	Initial	n/a
4a2	Same as 4a1 above	Intermediate	n/a
4a3	Same as 4a1 above	Longer-term	n/a
4a4	Same as 4a1 above	Constant (Mar to Oct)	n/a
4b1	D1641, WQMP, EWA, ERP, additional water quality releases, DSM2 derived DOC constraint, circulation operation	Initial	500 cfs per island
4b2	Same as 4b1 above	Intermediate	500 cfs per island
4b3	Same as 4b1 above	Longer-term	200 cfs per island
4b4	Same as 4b1 above	Constant (Mar to Oct)	500 cfs per island

In-Delta Storage Scenarios

Base: Future No-Action Condition

The Future No-Action Condition includes the 1) 400 cubic feet per second DMC/CA Intertie, 2) SDIP (including increasing permitted Banks Pumping Plant capacity to 8,500 cubic-feet per second), and 3) proposed Integrated Operations. The Base study is identical to the base study described in the document Interim Update of the California Bay-Delta Authority Surface Storage Investigations, Interim Common Model Package, Modeling Protocol and Assumptions (January 11, 2005).

Scenario 1: Water Supply

The objective of this scenario is to help meet the future demands of CVP/SWP water contractors when supplies are short. The project also provides water for additional refuge and recharge for South-of-the-Delta groundwater banking operations (only recharge operations were simulated). Further analysis would be necessary to confirm the viability of the groundwater banking operations.

Scenario 2: Water Supply and EWA

In addition to meeting the future demands of CVP/SWP water contractors, this scenario increases flexibility by using a dedicated 500 cubic feet per second of Banks Pumping Plant capacity from July through September for the EWA supply.

Scenario 3: Water Supply, EWA and ERP

In addition to meeting the future demands of CVP/SWP water contractors and dedicating a portion of Banks Pumping Plant capacity for the EWA (as in Scenario 2), this scenario provides water for the ERP goals in the Delta. The ERP Delta outflow targets are 20,000, 30,000 and 40,000 cubic feet per second for an additional 10 days in March and 10 days in April/May for Dry, Below Normal and Above Normal water year types, respectively.

Scenario 4: Water Supply, EWA, ERP and Water Quality

In addition to meeting water supply, EWA and ERP objectives (as in Scenario 3) this scenario improves Delta water quality during August, September and October with an augmented 1,500 cubic feet per second Delta outflow. This augmented flow is not used for exports at Banks and Tracy or as a replacement for SWP/CVP Delta outflow obligations.

Changes from the January 2005 Interim Update of the California Bay-Delta Authority Surface Storage Investigations simulations include: 1) South-of-the-Delta groundwater operations were changed to be more consistent with the North of the Delta Offstream Storage Investigation simulations, 2) Scenario 4 includes ERP and 3) Scenario 4 water quality releases for augmented Delta outflow occur during August, September and October (rather than July, August and September).

3.4 DOC Growth Rate Review and Modeling

3.4.1 DOC Growth Rate Review

The DOC growth rates used in the modeling were based on studies conducted by DWR over the past five years. They involve monitoring DOC releases into the water column in tanks at DWR's Bryte laboratory. The 2004 Draft State Feasibility Study details the studies. Information from the first two years of the studies was based on soils collected from Twitchell Island. To represent the soil characteristics of flooded DW reservoirs and on the basis of CALFED Science Panel Review in 2002, a new set of tank experiments with soils from Bacon Island was initiated. Based on the 2002 and 2003 DOC data (the first two years of this experiment), the DOC average annual growth rate of 0.47 $g/m^2/day$ with seasonal variations was used in the modeling for the 2004 Draft State Feasibility Study. A second review of the water quality studies by the CALFED Science Panel Review in 2003 recommended a more process-based analysis of the system using more detailed conceptual models. To get information regarding contribution of DOC from the peat soils, the panel also recommended measurement of diffusive fluxes of DOC from reservoir soils using either intact soil cores or in situ mesocosms.

In 2004, the DWR requested K. R. Reddy to conduct an independent review of the tank study DOC growth rates, including the recent organic carbon monitoring data from Jones Tract Flooding. Reddy's independent review (K. R. Reddy, Review of Delta Wetlands

Water Quality: Release and Generation of Dissolved Organic Carbon from Flooded Peatlands, 2005) concluded that:

- Average DOC flux rate was 0.6 g/m2/day in 2002, decreased to 0.4 g/m2/day in 2003, and 0.15 g/m2/day in 2004. When compared to 2002 data, flux rates decreased by approximately 40% in 2003 and by 70% in 2004. These results suggest that an initial "tea bag" effect continues for at least two years.
- Flooding of Jones Tract agricultural lands resulted in a substantial release of DOC and TOC into the water column. During the first 48 days of flooding, DOC and TOC flux rates were 0.48 g/m2/day, a rate similar to those observed in 2002 mesocosm experiments.
- A field study is more appropriate to determine more realistic DOC/TOC loading rates. Mesocosm experiments provided the first approximation of the DOC loading rates, but the rates may be lower under field conditions. Mesocosms functioned more as static systems and lack hydrodynamic events that would occur under field conditions.
- Additional information is necessary to determine the longer-term flux of DOC and TOC release potential from peat soils to the overlying water column.

The Jones Tract first 48 days carbon loading data are similar to the first year tank experiment data. As Reddy concluded, the Jones Tract data probably represents the initial flushing of carbon from carbon sources on the island and not a longer term rate. However, there may be differences in the evaluated conditions for the IDSP and the Jones Tract flood, which include the rate and nature of water diversion and the state of the islands when they fill. Reddy's review also suggested limited grab-sample temperature data from tank experiments are available to evaluate seasonal effects on TOC/DOC growth rates. However, using continuous air temperature data at the Bryte laboratory, a general trend of the influence of temperature on DOC growth rates in the tanks is evident.

3.4.2 DOC Growth Rates for Modeling

To estimate the sensitivity of the In-Delta Storage Project water supply benefits to DOC loading or growth rates, CalSim II was used to simulate reservoir operations while meeting most requirements under the SWRCB May 1995 Water Quality Control Plan (WQCP), Water Right Decision 1641, Water Right Decision 1643, and CUWA Water Quality Management Plan (WQMP) established for the Delta Wetlands Project. DSM2 was used for modeling of water quality parameters. As stated in Section 3.1, some provisions of the WQMP and biological opinions were not incorporated into the model.

Four loading rates were modeled. Three represented each year of data collected from the tanks on a monthly basis. An additional rate of 0.47 g/m2/day with a 0 g/m2/day rate from November to February was modeled. This latter loading rate closely resembles the loading rates observed at the Jones Tract flooding event during the first 48 days of flooding and is in the same range as the 2002 tank experiments.

The three monthly-varying loading rates used to represent each year of data collected from the tanks may represent initial (from 2002 data), intermediate (from 2003 data) and longer term (from 2004 data) carbon loading rates. Reddy's report concluded that over the three years of the study there was a declining carbon loading trend in the tank data, similar to the repetitive use of a tea bag. Reddy's analysis provided monthly data from mesocosms for short and tall tanks. Loading rates for each month the data existed were used from the tank studies by averaging the data from the short and tall tanks. Table 3.2 shows these averaged loading rates under the heading Tank Data. For months when data was not available from the tank studies (DOC in the tank experiment during these months was not monitored), loading rates were derived by using proportionate reductions from 2002 to 2004 as suggested by Reddy. Table 3.2 shows the method used to derive loading rates. There are some large variations in the month to month tank experiment rates, which may reflect limitations in the applicability of the tank data to large scale reservoir islands, possibly due to varying temperatures. However, the intent of modeling these rates was to get an understanding of the sensitivity of project water supply benefits to loading rates, not to provide a definitive estimate of water supply benefits or to predict specific loading rates. A statistical analysis of this methodology was not performed or implied, as this analysis is based on grab sample data (not continuously recorded data).

There are limits when using loading rates derived from tank studies, and further water quality work is needed to better analyze the impact of organic carbon restrictions on the project. Some of the limitations, identified by the CALFED Science Panel, Reddy, the project team and stakeholders are:

- Lack of data limits monthly interpretation of loading rate
- Focus is primarily on the soil to water carbon loading
- Lack of water temperature considerations which directly affects solubility rates of peat soils in water
- Using the same annual pattern of loading rates across longer term modeling periods
- Uncertainty concerning whether soils used in the tanks represent the variability of soils on the reservoir islands
- Water quality modeling conducted for this study does not account for the potential effects of the cessation of agricultural drainage from Bacon Island and Webb Tract on the water quality of the Delta channels. With a conversion from agricultural to project uses, past agricultural drainage patterns from the project islands would be replaced by project operations. More detailed water quality modeling that accounts for this change could reduce the water quality release requirements in the simulated project operations and result in improved estimates of project water supply benefits.

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Table 3.2 – DOC Growth Rates Used in CalSim II and DSM2 Modeling Studies

	Tank Data			Loading Rate Derivation				DOC Growth Rate Used in Modeling		
Month	**2002**	**2003**	**2004**	**03 DOC Rate as % of 02**	**03 Avg DOC Rate as %of 02**	**04 DOC Rate as % of 03**	**04 Avg DOC Rate as % of 03**	**2002**	**2003**	**2004**
Jan	nc	0.250	0.153	–		0.611		**0.320**	0.250	0.153
Feb	nc	0.250	0.153	–		0.611		**0.320**	0.250	0.153
Mar	0.437	0.396	0.152	0.906		0.382		0.437	0.396	0.152
Apr	0.437	0.396	0.152	0.906		0.382		0.437	0.396	0.152
May	0.597	0.615	0.167	1.031		0.271		0.597	0.615	0.167
June	0.597	0.615	0.167	1.031		0.271		0.597	0.615	0.167
July	0.927	0.259	nc	0.279		–		0.927	0.259	**0.109**
Aug	0.489	0.259	nc	0.530		–		0.489	0.259	**0.109**
Sep	0.489	nc	nc	–		–		0.489	**0.259**	**0.109**
Oct	nc	nc	nc	–		–		**0.239**	**0.187**	**0.079**
Nov	nc	0.115	nc	–		–		**0.147**	0.115	**0.048**
Dec	nc	0.115	nc	–		–		**0.147**	0.115	**0.048**
Annual Average				–	0.780	–	0.421	0.429	0.309	0.120

nc – data not collected in these months

Table 3.2 Notes

The tank data represents an average of the DOC growth rates from the shallow and deep tanks. All DOC growth rates for months for which data were not available was estimated by using percentage reductions derived from the 2002 to 2004 tank studies using the procedure summarized below.

1. September 2003 growth rate is using the same rate as August 2003, since September 2002 rate is the same as the August 2002 rate.
2. The October 2003 growth rate was taken as the average of September 2003 (estimated) and November 2003 (observed) growth rates
3. The DOC growth rate for January-February and October-December 2002 was calculated based on January-February and October-December 2003 rate (observed or estimated) divided by the average percentage decrease from 2002 to 2003.
4. DOC growth rate for July-December 2004 was calculated based on July-December 2003 rate (observed or estimated) divided by the average percentage decrease from 2003 to 2004.

3.5 Water Supply Evaluations

The water supply reliability studies presented in this chapter focus on three aspects of supply:
1) representation of scenarios for simultaneous realization of benefits
2) diversity and quantification of benefits
3) effects of various DOC growth-rate assumptions on project water supply benefits

Table 3.3 gives a summary of IDSP reservoir operations showing annual average diversions, releases and end–of-September carryover storage.

Table 3.3 – Summary of In-Delta Storage Project Reservoir Operations

Scenario[1]	Webb & Bacon Reservoir Diversions (TAF)	Webb & Bacon Reservoir Releases (TAF)	Reservoir Storage Carryover (TAF)		
			Webb Tract	Bacon Island	**Total**
Base Future No-Action	-	-	-	-	-
Scenario 1 Water Supply	124	125	19	26	45
Scenario 2 Water Supply/EWA	132	132	14	21	35
Scenario 3 Water Supply/EWA/ERP	121	120	13	22	35
Scenario 4 Water Supply/EWA/ERP/ Water Quality	134	132	3	7	10
Scenario 4a1	108	108	23	44	67
Scenario 4a2	118	117	23	44	67
Scenario 4a3	132	133	5	20	25
Scenario 4a4	117	117	17	37	54
Scenario 4b1 (with Circulation)	113	112	19	38	57
Scenario 4b2 (with Circulation)	124	122	13	33	46
Scenario 4b3 (with Circulation)	133	133	4	15	19
Scenario 4b4 (with Circulation)	120	119	13	32	45

1 – See Section 3.3 for Scenario descriptions

3.5.1 Sample Operational Scenario Results

The four sample operational scenarios build upon each other by adding potential beneficiaries one at a time. An analysis of Scenarios 1, 2, 3 and 4 indicates that water supply, Environmental Water Account, Ecosystem Restoration Program and water quality benefits (expressed in terms of water quantity) under each scenario are additive and can be realized simultaneously. Table 3.4 shows the dry period and long-term average annual results for the base and Scenarios 1, 2, 3 and 4 and reflect that for each scenario, an increase to one beneficiary may cause a decrease to another. This is most obvious when comparing Scenarios 3 and 4. Making water available in Scenario 4 for releases for water quality improvement resulted in long-term reductions in groundwater banking, EWA and CVPIA level 4 refuge supplies.

The CalSim simulations for the base and Scenarios 1 through 4 did not include a DOC operational constraint.

Table 3.4 – Potential Project Benefits from Sample Operational Scenarios

Benefit Category	**Base** Future No-Action		**Scenario 1** Water Supply		**Scenario 2** Water Supply/ EWA		**Scenario 3** Water Supply/ EWA / ERP		**Scenario 4** Water Supply/ EWA / ERP / Water Quality	
	(TAF)		Annual Improvement (TAF)							
	Dry Period	Long-term	Dry Period	Long-term	Dry Period	Long-term	Dry Period	Long-term	Dry Period	Long-term
SWP/CVP Deliveries	2493	4619	46	65	42	60	32	39	25	40
Groundwater Banking	11	24	16	22	15	20	16	21	10	14
EWA	-	-	-	-	0	19	0	20	0	11
ERP	-	-	-	-	-	-	0	19	0	19
CVPIA Level 4 Refuge Supply	-	-	3	6	1	5	1	5	0	3
Releases for Water Quality Improvement	-	-	-	-	-	-	-	-	4	29
Total Water Quantity Benefits	**2504**	**4643**	**65**	**93**	**58**	**104**	**49**	**104**	**39**	**116**

3.5.2 Organic Carbon Simulation Results

As indicated in Table 3.1, eight CalSim II simulations (4a1-4a4 and 4b1-4b4) were modeled based on Scenario 4 to include a DOC operational constraint and a range of varying DOC growth rates. The Scenario 4b simulations include a circulation operation that aims to reduce the magnitude of water quality violations, whereas the Scenario 4a simulations do not. Any exceedance of water quality criteria in the Water Quality Control Plan or the Water Quality Management Plan, whether small or large, was counted as a violation towards the percentage of number of violations presented in the Water Quality Evaluations Section 3.6.

These simulations provided a bookend approach to estimate project water supply benefits under high and low carbon loading rate assumptions. In addition, further analysis was done to determine the impact on project water supply benefits using average, rather than monthly varying, DOC growth rates. The analysis included two additional CalSim simulations. One simulation, Scenario 4a4, assumes a loading rate of 0.47 g/m2/day (each month's loading rate equals 0.47 g/m2/day) except November to February when the loading rate is zero. The second simulation, Scenario 4b4, assumes same loading rates as in Study 4a4 but includes circulation operations. These loading rates closely resemble the first 48 days average loading rate found during the Jones Tract flooding event.

Table 3.4 compares long-term average annual water supply, EWA, ERP and water quality benefits (expressed in terms of water quantity) under Scenarios 4, 4a and 4b. Using DSM2, water quality impacts were evaluated and are discussed in Section 3.6.

The results in Table 3.5 below show that potential project water supply benefits, hereafter also referred to as project yield, varies from 107,000 acre-feet, assuming initial carbon loading rates, to 120,000 acre-feet, assuming longer-term carbon loading rates. The results for the initial and intermediate DOC growth rate simulations (4a1, 4a2, 4b1 and 4b2) indicate a slight decrease in project yield from Scenario 4. Conversely, the results for the longer-term DOC growth rate simulations (4a3 and 4b3) indicate a slight increase in project yield from Scenario 4. This anomaly is explained in detail below.

Table 3.5 – Potential Project Benefits under Scenarios 4, 4a and 4b

Scenario[1]		**Benefit (Yield) Category**						
		SWP/CVP Deliveries	Ground-water Banking	EWA	ERP	CVPIA Level 4 Refuge Supply	Releases for Water Quality Improvement	**Total Water Quantity Benefits (TAF)**
Base Future No-Action		4619	24	-	-	-	-	**4643**
Scenario 4 Water Supply / EWA / ERP/ Water Quality	Annual Improvement	40	14	11	19	3	29	**116**
Scenario 4a1		40	21	6	15	2	23	**107**
Scenario 4a2		37	21	7	16	2	27	**110**
Scenario 4a3		39	17	10	17	3	34	**120**
Scenario 4a4		37	21	7	16	2	27	**110**
Scenario 4b1 (with Circulation)		38	22	6	15	2	24	**107**
Scenario 4b2 (with Circulation)		36	21	7	15	2	30	**111**
Scenario 4b3 (with Circulation)		40	15	10	16	3	36	**120**
Scenario 4b4 (with Circulation)		40	21	7	16	2	27	**113**

1 – See Section 3.3 for Scenario descriptions

Unexpectedly, water quality constraints on releases for exports may not necessarily reduce project yield at the lower DOC growth rates of Scenarios 4a3 and 4b3. Table 3.4 shows that Scenario 4, with no DOC constraints on island operations, produces 116,000 acre-feet in total long-term average annual water quantity benefits, while Scenario 4a3 and Scenario 4b3, with DOC constraints, produce 120,000 acre-feet in total benefits.

The reason for achieving higher benefits with lower DOC growth rate constraints in Scenarios 4a3 and 4b3 is that with change in timing of IDSP releases, possibility exists for more effective use of San Luis Reservoir storage. The interim use of San Luis storage prior to delivery to groundwater recharge later on when aqueduct capacity is available, could result in higher recharge.

All scenarios identified Groundwater Recharge as a potential beneficiary of the IDSP. The simulations offered IDSP water to recharge only in years that SWP or CVP did not need it -- typically in above-normal or wet years. Often, conveyance capacity was unavailable in these years to move water directly through Banks Pumping Plant and the California Aqueduct to recharge. From May through December, if Banks Pumping Plant capacity was available and aqueduct capacity was not, simulations allowed IDSP to store water in San Luis Reservoir for later withdrawal for recharge. The window of opportunity to move water to San Luis was limited, and benefits to recharge through this transfer was relatively small.
To overcome the small recharge benefits, San Luis storage was made available for recharge on the assumption that San Luis would be refilled by IDSP at a later date. This paper transfer occurs on September 1. It was only allowed when SWP San Luis storage is 120,000 acre-feet greater than the San Luis Reservoir rule-curve. The amount of the paper transfer was dependent on IDSP storage and SWP San Luis storage. Higher IDSP storage on September 1 would likely lead to a higher paper transfer to San Luis. With the DOC constraints slowing island releases to all beneficiaries, IDSP has an annual average of 21,000 acre-feet more in storage on September 1 in Scenario 4a3 than in Scenario 4. Some of this extra storage is intended for SWP and CVP contractors, however about 12,000 acre-feet on average would be available for San Luis storage. This was water that, if not for the DOC constraints, would have been discharged in August to fill the recharge San Luis account or improve water quality.

This does not guarantee that water from IDSP will be moved to San Luis to make up for any recharge debt. In fact, IDSP water promised to recharge through the paper transfer on September 1 would often be released to improve Delta water quality through September and October. At the same time, recharge would make withdrawals from its San Luis account between September and December when aqueduct capacity is available. The result, as compared to Scenario 4, is higher KC deliveries, higher water quality releases, and lower carryover storage in San Luis and Oroville. As such, Scenario 4a3 takes greater risk with carryover storage than Scenario 4. The marginally higher risk leads to marginally higher benefits. Of course, San Luis and Oroville carryover in both Scenario 4 and 4a3 are higher than in the Base Scenario. None of the benefits computed with respect to the base are the result of operating reservoirs to a higher level of risk.

3.5.3 Qualification of Project Yield Results

During the public review, DWR received comments that the modeled storage release operations, which affect total organic carbon (TOC) at urban intakes, did not follow the Water Quality Management Plan (WQMP) release criteria. Section E of the WQMP, Screening Procedures and Operational Constraints to Prevent Short-Term Impacts, establishes the process by which the project operates. Briefly, the process is:

- Predictive modeling is performed before and during project diversions and discharges to determine if operations are likely to exceed one or more of the screening criteria (TOC loading, Disinfection Byproducts (DBP) formation, salinity impacts).

- If modeling predicts operations could cause exceedance of the screening criteria, more studies are conducted to determine if drinking water quality protection principles would be threatened at an urban water treatment plant (TOC loading and DBP formation standards).
- If the further study indicates that operations may threaten water protection principles at an urban water treatment plant, a determination is made whether the threat would be offset by a water quality or water supply benefit. If the treatment plant agrees that the threat is offset, the project can proceed with the operation.
- If the project operations threaten a drinking water quality protection principle without offsetting benefits and the treatment plant owner does not waive the right to protection, project operations will be reduced, rescheduled or otherwise constrained to prevent the impact.
- If an urban water treatment plant operator presents a complaint that a violation of principles or criteria has, or is likely, to occur, and the Water Quality Management and Action Board (WQMAB) finds the complaint has merit to warrant an investigation, the WQMAB will proceed with an investigation. Until the matter is resolved by the WQMAB, project operations will follow the schedule presented in Section E, Table 1 of the WQMP (ramping down provisions) or an Emergency Operating Plan approved by the WQMAB.
- If the WQMAB finds that the monitoring, modeling, and/or operational constraints fail to prevent a violation of water quality principles or criteria, the WQMAB will require the operator to initiate emergency operations or take remedial actions to correct the problems.

The TOC standard can be relaxed or waived in these provisions based upon actions by the WQMAB or water treatment plant owners. It is not possible to develop predictive modeling for all likely conditions allowed by Section E for project operations requiring discretionary WQMAB decisions. For feasibility study purposes, the use of the CalSim II model and its 73-year hydrology provides an adequate estimate of project yield. For the scenarios modeled, it was assumed that TOC is equal to DOC. In the case of DOC, a simple operating constraint was included: Discharge until the WQMP TOC standard was exceeded; then, cease discharge until the DOC plume dissipates and urban export concentrations fall below the WQMP TOC standard. The WQMP short-term TOC screening criteria, to be calculated as 14-day averages, are:

- Project operations that cause an increase in TOC of more than 1.0 mg/L at the urban intakes; or
- Project operations that cause TOC concentrations at the urban intakes to exceed 4.0 mg/L; and
- Project operations that cause TOC concentrations at a water treatment plant to exceed 4.0 mg/L

The CalSim II Daily Operations Model (DOM) tracks the IDSP DOC impacts at urban intakes using regression equations that relate Delta inflow, exports, and IDSP discharge to a Delta Simulation Model 2 (DSM2) volumetric fingerprint analysis at Tracy Pumping

Plant, Banks Pumping Plant, and the Contra Costa Water District's Los Vaqueros and Rock Slough intakes. For detailed discussion of the regression analysis, please refer to Chapter 9 of the 2004 *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh*. No analysis of IDSP DOC impacts at water treatment plants was included in the studies; therefore, it was conservatively assumed that exceeding 4 mg/L at the urban intakes would cause DOC concentrations to exceed 4 mg/L at the treatment plant.

DWR's modeling for TOC at the urban intakes was performed so that reservoir releases ceased instead of ramping down when the 14-day average TOC concentration at the urban intakes exceeded the 1 mg/l standard, as specified in Attachment 2 of the WQMP. Two potential yield estimates may result from these modeling assumptions. First, because the modeling performed does not ramp down to maintain operations, some reservoir release opportunities may be lost when the 1 mg/l standard is reached. If this is true, the results may underestimate the yield. The second result is that the results may overestimate yield because the project operates at full-throttle until the 1mg/l standard is reached. After exceeding the standard, the model stops project releases. Because there is a lag time between the discharge of water from the island reservoirs and its arrival at the urban intakes, the WQMP could continue to be exceeded after releases are stopped. Stated another way, reservoir releases could have been ramped down so that the criteria were not exceeded. There seems to be more uncertainty in the project yield under higher (initial) DOC growth rates. The lower (longer-term) growth rates have much less uncertainty with respect to avoiding short-term (14-day weighted average) impacts and generating yields above 100,000 acre-feet.

DWR received comments that maintaining about four feet of water depth on the reservoir islands could be advantageous to project water quality operations by limiting TOC loading. Maintaining four feet of water depth would limit establishment of plants and drying of the reservoirs bottoms, both of which may increase TOC production rates. Maintaining about four feet of water on each reservoir island would require about 20,000 acre-feet of water on each reservoir island. The current CalSim simulations use a minimum storage of 1,000 acre-feet per reservoir in calculating water supply benefits. It may be possible and beneficial in managing water quality on the reservoir islands to use existing 250 cubic feet per second Delta Wetlands Properties water rights and the 20,000 acre-feet annual reservoir topping allowed under SWRCB D1643 to develop an operations plan to maintain water coverage on the reservoir islands.

A test case study (using Study 4b4) was run with 10,000 acre-feet of minimum storage maintained in each reservoir, which would provide about two feet of water depth on each island. Under the test case, the average annual yield changed by 2,000 acre-feet. To achieve a depth of four feet of water depth at each island, the average annual yield change would increase.

Additionally, it should be noted that topography will be extensively modified during construction which will help reduce the amount of reservoir bottom that will be exposed during low reservoir volumes. The volume of overburden excavations for Webb Tract and Bacon Island amount to 86.5 million cubic yards, with 33.3 million cubic yards used as borrow materials for strengthening the island-sides of the levees. After this excavation takes place, leveling of the reservoir bottoms will be performed.

3.5.4 No Increase in Permitted Banks Pumping Capacity to 8,500 cfs

As mentioned in Section 3.3, the Base and IDSP operational scenarios were modeled assuming the South Delta Improvements Program (SDIP) proposed change in permitted pumping capacity is in effect. Using the existing pumps at Banks Pumping Plant, the SDIP would increase the maximum rate at which the State Water Project is permitted to pump water from the Sacramento-San Joaquin Delta from 6,680 to 8,500 cubic-feet per second. However, in this Supplemental Study, two additional IDSP scenarios; the Base and Scenario 4b3 have been modeled under existing permitted pumping capacity (6,680 cubic-feet per second) at Banks Pumping Plant.

Table 3.6 presents the modeling results for the Base and Scenario 4b3 under 8,500 and 6,680 cubic-feet per second Banks pumping capacity. The results indicate that not increasing Banks pumping capacity to 8,500 cubic-feet per second reduces total Delta exports by 16 TAF. The In-Delta Storage Project average annual yield reduces from 120 to 107 TAF in Scenario 4b3 (which includes DOC constraints and circulation). This reduction in south of Delta deliveries of 13 TAF is primarily attributed to the following:

- SWP/CVP delivery benefit is reduced by 10 TAF since opportunities for pumping surplus water are reduced
- EWA benefit of 10 TAF is lost. In Scenario 4b3 with 8,500 cubic-feet per second Banks pumping capacity, 500 cubic-feet per second is dedicated for use by the EWA for delivery to San Luis Reservoir in July, August and September. In Scenario 4b3 with 6,680 cubic-feet per second Banks pumping capacity, the dedicated EWA pumping capacity is not available, resulting in a loss of the entire EWA benefit. This loss can be recovered if the state is allowed to increase existing Banks permitted pumping capacity by 500 cfs for the EWA use in July, August and September. This option has not been modeled.
- Releases for water quality improvement are increased by 8 TAF, because with reduced Delta export capacity more IDSP water is available to release for water quality improvement.

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Table 3.6 – Comparison of Long-Term Average Annual Potential Project Benefits with 8,500 and 6,680 cfs Banks Pumping Capacity

Benefit Category	**8,500 Base** with 8,500 cfs Banks P.P. Capacity	**Scenario 4b3** with 8,500 cfs Banks P.P. Capacity	**6,680 Base** with 6,680 cfs Banks P.P. Capacity	**Scenario 4b3** with 6,680 cfs Banks P.P. Capacity
	Base Quantity (TAF)	Annual Improvement (TAF)	Base Quantity (TAF)	Annual Improvement (TAF)
SWP/CVP Deliveries	4619	40	4512	30
Groundwater Banking	24	15	15	18
EWA	-	10	-	0
ERP	-	16	-	13
CVPIA Level 4 Refuge Supply	-	3	-	2
Releases for Water Quality Improvement	-	36	-	44
Total Water Quantity Benefits	**4643**	**120**	**4527**	**107**

3.6 Water Quality Evaluations

3.6.1 DSM2 Simulations

A series of DSM2 16-year planning studies (water years 1975 – 1991) were run in two DSM2 modules known as HYDRO and QUAL based on the latest proposed operations for the IDSP islands: Webb Tract and Bacon Island.

This report focuses on the analysis of the Chloride and DOC associated with a series of modeled CalSim operations of the two project islands. Chloride concentrations were calculated based on modeled electrical conductivity (EC) results. Further details on this conversion procedure can be found in Section 7.1 of the Water Quality Report. The analysis of other disinfection by-products is presented in the Water Quality Report of the 2005 Supplemental Report. The Delta inflows, exports, and island operations used in these studies were provided from the DOM. A summary of the DSM2 simulations conducted for this Supplemental Report is listed in Table 3.6. DSM2 simulations were not conducted for Scenarios 1, 2 or 3.

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Table 3.7 – Summary of DSM2 Simulations

Scenario	CalSim II Operational Constraints	DSM2 DOC Growth Rate	Maximum Circulation
Base	D1641	n/a	n/a
4	D1641, WQMP, EWA, ERP, additional water quality releases	Longer-term	n/a
4a1	D1641, WQMP, EWA, ERP, additional water quality releases, DSM2 derived DOC constraint	Initial	n/a
4a2	Same as 4a1 above	Intermediate	n/a
4a3	Same as 4a1 above	Longer-term	n/a
4a4	Same as 4a1 above	Constant (Mar to Oct)	n/a
4b1	D1641, WQMP, EWA, ERP, additional water quality releases, DSM2 derived DOC constraint, circulation operation	Initial	500 cfs per island
4b2	Same as 4b1 above	Intermediate	500 cfs per island
4b3	Same as 4b1 above	Longer-term	200 cfs per island
4b4	Same as 4b1 above	Constant (Mar to Oct)	500 cfs per island

3.6.2 Representation of Project Islands in DSM2

The principal difference between the base and other scenarios was two new IDSP island reservoirs: Bacon Island and Webb Tract. In the alternative scenarios, both of these islands were modeled as isolated reservoirs. The DSM2 representation of the project islands is described in greater detail in the Water Quality Report, Section 5.1 of the 2005 Supplemental Report. Though the DSM2 configuration of the islands is the same in all of the alternative scenarios, the operational constraints applied in CalSim and adding the islands to the statewide water projects result in different flows and operations for not only the project islands, but for the entire system. The key processes unique to the project islands, as modeled in DSM2, can be divided into hydrodynamic and water quality processes. Some of these are physical processes, caused by water being stored on a peat-soil-rich island. Other processes are related to operating the IDSP islands, that is, the diversion and release schedules. A model of some of these processes is shown in Figure 3.1.

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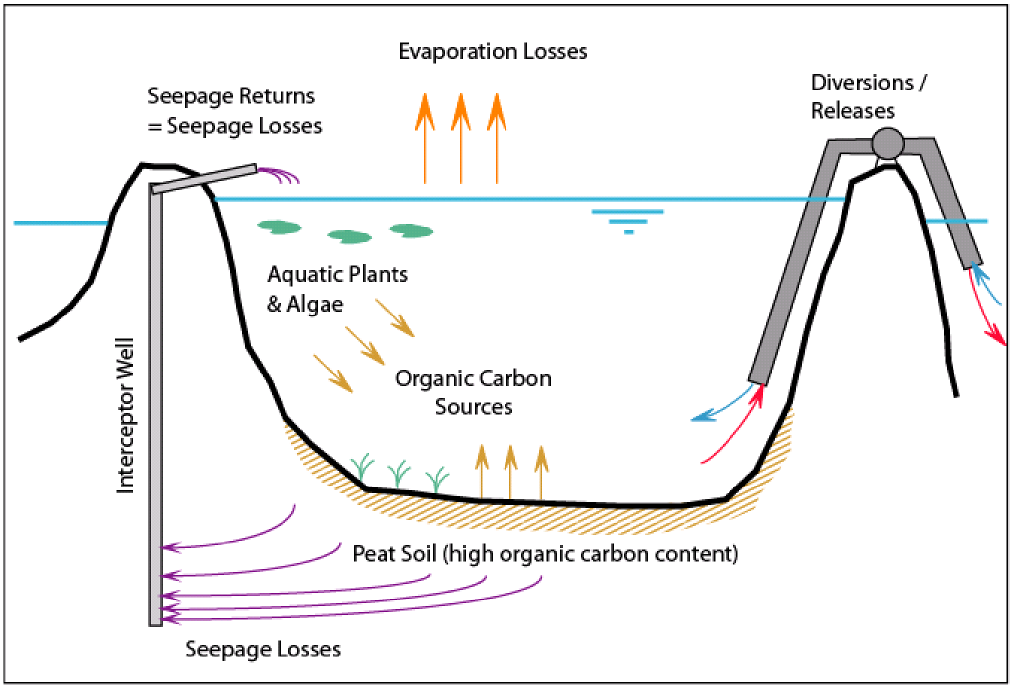
Figure 3.1 – Conceptual Model of DSM2 Project Island



3.6.3 Operation Strategies

Volumetric Based Fingerprint Constraints

CalSim introduced dissolved organic carbon (DOC) constraints on island discharge in scenarios 4a and 4b, as discussed in Section 3.5.2. These constraints are formulated through a flow-based regression relating project island operations and Delta operations to the amount of project island water reaching the urban intakes. Project island water reaching the urban intakes was determined using a DSM2 volumetric fingerprint. Volume fingerprinting is a DSM2 modeling approach used to determine the relative contributions of water sources to the volume at any specified location. Volume fingerprinting can be used to estimate concentrations of any conservative constituent without rerunning DSM2. This methodology can answer questions such as "What percentage of the dissolved organic carbon at Banks Pumping Plant originated from IDSP reservoirs?" By knowing how much water at the urban intakes will come from the project islands under various operations, CalSim was able to halt or limit project island releases when the effect of the releases on organic carbon concentrations at the urban intakes would approach or exceed DOC water quality standards. Since Scenario 4 did not make use of these DOC constraints, CalSim would continue to release water from the project islands regardless of the organic carbon concentrations at the urban intakes.

Circulation

The primary difference in the 4b scenarios from the 4 and 4a scenarios is the use of a circulation operation to dilute DOC concentrations on project islands. Each island has two integrated facilities. Circulation operations take advantage of this by diverting water through one facility while simultaneously releasing water on the same day through the other facility. This creates a circulation or exchange of water on the project islands. The net difference in flow rates will determine if project islands are storing or releasing water. For this particular operation, CalSim limited the circulation to 500 cubic feet per second for scenarios 4b1 and 4b2 and to 200 cubic feet per second for Scenario 4b3. Since Scenario 4b3 uses a lower DOC growth rate, a lower circulation operation could achieve similar water quality improvements on the project islands. Similar to standard release operations, releases made under a circulation operation are subject to all Delta water quality standards. Figure 3.2 shows examples of the relative flow patterns for the north and south integrated facilities on Bacon Island for diversion only, release only, and circulation operations.

Figure 3.2 – Examples of Diversion Only, Release Only, & Circulation Operations

3.6.4 Project Island Dissolved Organic Carbon (DOC)

Located in the Central Delta, Bacon Island and Webb Tract are made up of thick peat soil – a significant source of organic carbon. Water stored on these islands will, over time, increase in DOC concentration due to the leaching and microbial decay of the underlying peat soil.

In DSM2-QUAL, the DOC concentration inside either island is a function of the initial DOC concentration of diversion, organic carbon mass made from algae and wetlands plants, and adding organic carbon mass from leaching and microbial decay of the peat soils. DSM2-QUAL using a DOC growth algorithm accounts for the increase in DOC concentration associated with storing water on the islands. Complete mixing is assumed.

Four organic carbon growth rates as described in Section 3.3 were modeled. For the purpose of this study, each of the growth rates (initial, intermediate and longer-term) was applied over an entire 16-year simulation. Table 3.7 shows the monthly varying organic carbon growth rates, the years for which the data were based, and the scenarios that made use of these rates.

Table 3.8 – Project Island Organic Carbon Growth Rates (gC/m2/day)

Island	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Initial Growth Rate – 2002 Data (Scenarios 4a1 and 4b1)												
Bacon Island	**0.24**	**0.15**	**0.15**	**0.32**	**0.32**	**0.44**	**0.44**	**0.60**	**0.60**	**0.93**	**0.49**	**0.49**
Webb Tract	**0.24**	**0.15**	**0.15**	**0.32**	**0.32**	**0.44**	**0.44**	**0.60**	**0.60**	**0.93**	**0.49**	**0.49**
Intermediate Growth Rate – 2003 Data (Scenarios 4a2 and 4b2)												
Bacon Island	**0.19**	**0.12**	**0.12**	**0.25**	**0.25**	**0.40**	**0.40**	**0.62**	**0.62**	**0.26**	**0.26**	**0.26**
Webb Tract	**0.19**	**0.12**	**0.12**	**0.25**	**0.25**	**0.40**	**0.40**	**0.62**	**0.62**	**0.26**	**0.26**	**0.26**
Longer-Term Growth Rate – 2004 Data (Scenarios 4, 4a3, and 4b3)												
Bacon Island	**0.08**	**0.05**	**0.05**	**0.15**	**0.15**	**0.15**	**0.15**	**0.17**	**0.17**	**0.11**	**0.11**	**0.11**
Webb Tract	**0.08**	**0.05**	**0.05**	**0.15**	**0.15**	**0.15**	**0.15**	**0.17**	**0.17**	**0.11**	**0.11**	**0.11**
Constant Growth Rate – Average of Mar – Oct 2002 Data (Scenarios 4a4 and 4b4)												
Bacon Island	**0.47**	**0**	**0**	**0**	**0**	**0.47**	**0.47**	**0.47**	**0.47**	**0.47**	**0.47**	**0.47**
Webb Tract	**0.47**	**0**	**0**	**0**	**0**	**0.47**	**0.47**	**0.47**	**0.47**	**0.47**	**0.47**	**0.47**

3.6.5 Water Quality Analysis Results

DSM2-QUAL electrical conductivity (EC) was used and dissolved organic carbon (DOC) results to evaluate the response of several different operations of the IDSP islands on the water quality at four urban intakes. They are CCWD's intake at Rock Slough (RS), CCWD's Los Vaqueros Reservoir (LVR) intake on the Old River, the SWP Banks Pumping Plant (Clifton Court Forebay), and the CVP's Tracy Pumping Plant. DOC and EC were used to calculate the total trihalomethane (TTHM) and bromate disinfection by-product formation potentials. Results of these two constituents were not included here. However, you can find them in the Water Quality Report of the 2005 Supplemental Report.

Chloride at Urban Intakes

The WQMP stated that the project operations should be limited so that the daily average chloride concentrations in the proposed project alternatives at any of the urban intakes not exceed 225 mg/L nor increase the salinity more than 10 mg/L from the base. Table 3.8 shows the daily average change in chloride concentrations. Results indicate that for short-term annual operations, 75 percent of the time there is no significant increase in chloride concentrations. Overall, 90 percent of the time the maximum increase in chloride concentration is about 6 mg/L.

It also shows the change in chloride concentrations associated with the 10th, 25th, 50th, 75th, and 90th percentiles. A percentile is the quantity at which the percentage of values is equal to or less than the value shown. That is the value associated with a 90th percentile is greater than 90% of the values in the period of record of the simulation, or in other words, only 10% of the values are greater than the values shown for the 90th percentile.

Table 3.9 shows the number of days and frequency (percentage of time) that the WQMP change in chloride constraint was exceeded. The results indicate that the change in chloride constraint was exceeded less than 8%, 4%, 3% and 2% of the time at RS, LVR, SWP and CVP intakes, respectively. Any exceedance of water quality criteria stated in the WQCP or the WQMP, whether it is small fraction or whole number, is considered a violation and counts towards the percentage of number of violations presented in Table 3.9.

Long-Term Chloride Mass Loading at Urban Intakes

In addition to daily average chloride constraints, the WQMP specified that the IDSP should "acquire offsets or otherwise mitigate 150% of the net increase in TOC, TDS, bromide, and chloride loading greater than 5% in the urban diversions due to Project operations" as part of its mitigation of long-term water quality impacts. The WQMP did not clearly define long-term water quality impacts. It was assumed that the intent of the WQMP mitigation of long-term impacts applied to the modeling screening work, so a three-year running average of daily average chloride mass loading were calculated to evaluate the long-term change in chloride loading at the urban intakes. Figure 3.3 shows the chloride mass loading at each of the urban intakes.

As specified above, the WQMP requires mitigation when the results show chloride mass loading increases above the 5% line. These increases do not imply reduced project yield. The WQMP does not clearly state the nature of the mitigation. However, during discussions with Treatment Plant operators and CCWD, they said they may have to spend extra money on treatment. Mitigation can be in the form of payment for treatment. If a treatment plant owner does not waive the right, after studying the impact of this long-term chloride mass loading, the owner of a drinking water supply system would be paid. It is also possible violations could be eliminated by refining modeling operations, improvements in modeling techniques, changes in Artificial Neural Network (ANN: CalSim uses this ANN as a tool to estimate Delta salinity impacts based on historical flow and salinity relationships due to its decisions) and scientific research.

DOC at Urban Intakes

According to the WQMP, when the modeled base case DOC is less than 3 mg/L or greater than 4 mg/L, the maximum increase in DOC at any urban intake is 1 mg/L. When the base case DOC is between 3 mg/L and 4 mg/L, the 14-day average DOC at any urban intake can not exceed 4 mg/L. Not included in the model were other DOC provisions of the WQMP, such as ramping down water releases when the 1 mg/l increase at the pumps is anticipated.

Table 3.10 shows the 16-year minimum, average and maximum change (scenario – base) in 14-day average DOC. The WQMP DOC constraint listed above varies between 0 and 1 mg/L, thus the percentile results can only be used to estimate the magnitude of the change in DOC due to operating the project, but not the frequency that the WQMP DOC constraint is exceeded.

Figure 3.4 shows the change in 14-day average DOC at the urban intakes. It compares the increase in 14-day average DOC allowed by the standard with the increase in 14-day average DOC resulting from the IDSP scenarios. The results indicate that on the average for circulation Study 4b3 (Column 4 in Table 3.10), the DOC Standard of 1mg/l is exceeded by 0.1 mg/l for Rock Slough and by 0.3 mg/l for SWP.

Table 3.11 shows the number of days and frequency the WQMP DOC constraint is exceeded. Based on the longer-term organic carbon growth rate, the water quality modeling studies indicate that the 1mg/l restriction on increase in organic carbon is exceeded up to a maximum of 10 percent of the time. There is flexibility with respect to the amount of short-term project releases and further refinement of operations may help in reducing the frequency of 10 percent exceedance.

Long-Term DOC Mass Loading at Urban Intakes

In addition to 14-day average organic carbon constraints, the WQMP specified that the IDSP should “acquire offsets or otherwise mitigate 150% of the net increase in TOC, TDS, bromide, and chloride loading greater than 5% in the urban diversions due to Project operations” as part of its mitigation of long-term water quality impacts. A three-year running average DOC mass loading was calculated to evaluate the longer-term change in DOC loading at the urban intakes. Figure 3.5 shows the long-term DOC mass loading at each of the urban intakes. Table 3.12 shows a summary of percent change in three-year running average of long-term DOC mass loading.

3.6.6 Dissolved Oxygen and Temperature Concerns

The dissolved oxygen (DO) modeling studies conducted for the 2004 Draft State Feasibility Study was based on the U.S. Geological Survey (USGS) DO monitoring of flooded islands and previous Reclamation DO studies. Based on information from the USGS and Reclamation studies, DO in the reservoirs was assumed to remain at or above the WQMP criterion of 6 mg/l. The WQMP prevents the proposed In-Delta Storage Project from discharging water if DO in the reservoirs is less than 6 mg/L. However, as presented in Figures 3.6 to 3.9, new Jones Tract flood monitoring data from June-November 2005 indicates values 1 meter below the surface did go lower than 6 mg/l. There is some potential that DO in the project storage islands may sometimes be lower than 6 mg/l.

At all four sites, DO concentrations increased during daylight. At stations UJI and UJM the difference in DO between early morning and afternoon is about 5 mg/L. The variation and higher concentrations of DO were probably due to daytime photosynthetic production. DO declines after dark were probably due to respiration from both photosynthetic and heterotrophic (non-photosynthetic) organisms. A review of the data at four stations shows that Station UJI (Figure 3.7) had DO lower than 6 mg/L in August and part of September. The second Station UJM had 6 hours of daily data in July lower than 6 mg/L. The two other stations, LJM and LJI, were frequently above 6 mg/L in all months. It is not known why Station UJI was so different than others. It is possible that site conditions at UJI Station may have caused much lower DO values than others.

Jones Tract provides a significant quantity of data (96 data points per day) concerning what may happen during initial flooding of a Delta island. However, the differences in the initial flooding between Jones Tract and the IDSP islands suggest that using the Jones Tract information to evaluate the initial DO effects on IDSP reservoirs has limitations. Some of the differences include the amount of vegetation present on initial flooding, soil types, presence of chemicals and pesticides, farm buildings and farm animal establishments, and the rate at which the particular island fills. Another important consideration is the flexibility that the IDSP provides. In particular, IDSP reservoirs can curtail releases during certain hours of the day when DO is below 6 mg/l, rather than making releases as a continuous 24-hour operation.

Further work is needed to estimate DO concentrations and variability within the reservoirs. Modeling DO concentrations within an island reservoir system will be complicated. However, such an analysis may be beneficial to determine the risk of reservoir DO falling below allowable levels. Similarly, the analysis may indicate the need to modify operations, facilities, and monitoring, or the need to adjust water rights or develop contingency plans. Reddy's report also points towards an inverse DO – TOC relationship, which also may be useful to explore.

No new temperature studies were done for the Draft Supplemental Report. Additional work is needed to include temperature considerations in modeling DOC and DO. Temperature plays an important role in the solubility of substances in water. A more dynamic approach in which DOC growth rates and DO concentrations are related to temperature would produce more realistic simulations of carbon and DO effects caused by the reservoir islands.

3.6.7 Taste and Odor

The production of methylisoborneol (MIB) during Jones Tract flooding may have increased taste and odor problems in water at SWP Banks facilities. Taste and odor problems related to Jones Tract flooding received a great deal of media coverage and suggest that the potential for IDSP reservoirs to produce similar problems. While the Jones Tract flood occurred under conditions that are different than IDSP, taste and odor effects relating to the operation of IDSP should be evaluated.

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Table 3.9 – Summary of DSM2 Urban Intake Change in Chloride (mg/L)

Urban Intake	Scenario	Min	Ave	Max	Percentiles				
					10th	25th	50th	75th	90th
RS	**4**	-64.2	0.3	90.8	-5.9	-0.9	0.1	1.7	6.2
	4a1	-47.1	0.5	89.5	-5.5	-1.0	0	1.5	5.7
	4a2	-56.1	0	91.5	-5.7	-1.3	0	1.4	5.8
	4a3	-65.3	-0.3	94.5	-6.1	-1.1	0.1	1.4	4.8
	4a4	-56.1	0.1	91.5	-5.4	-1.2	0.1	1.6	5.7
	4b1	-46.6	0.1	81.9	-5.4	-1.2	0.2	1.5	5.5
	4b2	-51.1	-0.2	84.1	-6.8	-1.0	0.2	1.4	4.6
	4b3	-62.5	-0.4	87.8	-7.3	-1.2	0.1	1.4	4.8
	4b4	-48.7	-0.2	84.9	-6.4	-1.5	0.2	1.4	4.8
LVR	**4**	-49.9	0.2	71.5	-5.0	-0.9	0.1	1.3	4.9
	4a1	-34.7	0.2	67.9	-4.9	-1.0	0	1.2	4.3
	4a2	-48.7	-0.2	73.2	-5.1	-1.3	0	1.1	4.7
	4a3	-52.0	-0.4	74.6	-5.3	-1.0	0	1.1	3.8
	4a4	-48.7	-0.1	73.2	-4.9	-1.2	0	1.2	4.4
	4b1	-36.8	-0.1	65.8	-4.6	-1.2	0	1.2	4.7
	4b2	-46.2	-0.3	68.0	-5.5	-1.1	0	1.2	4.1
	4b3	-50.2	-0.4	70.3	-6.0	-1.1	0	1.3	4.4
	4b4	-41.6	-0.3	69.1	-5.4	-1.4	0	1.1	4.1
SWP	**4**	-37.3	0.1	54.9	-3.8	-0.7	0	1.0	3.8
	4a1	-25.5	0	52.4	-4.0	-0.9	0	0.7	3.1
	4a2	-34.2	-0.3	56.3	-4.3	-1.1	0	0.7	3.1
	4a3	-40.1	-0.4	57.3	-4.4	-0.9	0	0.7	2.9
	4a4	-34.3	-0.2	56.3	-4.1	-0.9	0	0.9	3.3
	4b1	-36.9	-0.3	49.7	-3.9	-1.0	0	0.9	3.1
	4b2	-41.6	-0.3	51.4	-4.8	-1.0	0	0.8	2.8
	4b3	-39.1	-0.3	53.1	-5.0	-0.9	0	0.9	3.3
	4b4	-40.6	-0.4	52.5	-4.2	-1.2	0	0.8	2.8
CVP	**4**	-25.0	0.2	41.1	-2.9	-0.6	0	0.9	3.2
	4a1	-25.6	0	41.2	-3.1	-0.9	0	0.7	2.7
	4a2	-29.8	-0.2	44.3	-3.5	-0.9	0	0.7	3.0
	4a3	-39.8	-0.3	44.4	-3.3	-0.7	0	0.7	2.5
	4a4	-28.1	-0.1	44.3	-3.5	-0.8	0	0.8	2.9
	4b1	-28.3	-0.1	37.9	-3.0	-0.9	0	0.8	2.8
	4b2	-31.0	-0.2	40.0	-3.6	-0.8	0	0.7	2.5
	4b3	-38.0	-0.2	43.4	-3.6	-0.7	0	0.8	2.8
	4b4	-29.4	-0.3	41.1	-3.3	-1.0	0	0.7	2.3

Table 3.10 – No. of Days and Frequency the WQMP Chloride Constraint is Exceeded

Urban Intake	Scenario	# Days > Standard	% Days > Standard
RS	4	426	7.3
	4a1	379	6.5
	4a2	389	6.7
	4a3	437	7.5
	4a4	387	6.6
	4b1	402	6.9
	4b2	413	7.1
	4b3	347	5.9
	4b4	315	5.4
LVR	4	220	3.8
	4a1	213	3.6
	4a2	196	3.4
	4a3	204	3.5
	4a4	184	3.1
	4b1	222	3.8
	4b2	229	3.9
	4b3	191	3.3
	4b4	186	3.2
SWP	4	145	2.5
	4a1	135	2.3
	4a2	147	2.5
	4a3	150	2.6
	4a4	148	2.5
	4b1	159	2.7
	4b2	157	2.7
	4b3	135	2.3
	4b4	134	2.3
CVP	4	90	1.5
	4a1	102	1.7
	4a2	101	1.7
	4a3	96	1.6
	4a4	102	1.7
	4b1	107	1.8
	4b2	105	1.8
	4b3	88	1.5
	4b4	93	1.5

Table 3.11 – Summary of DSM2 Urban Intake Change in DOC (mg/L)

Urban Intake	Scenario	Min	Ave	Max	Percentiles				
					10th	25th	50th	75th	90th
RS	4	-0.5	0.1	3.4	0	0	0	0	0.1
	4a1	-0.5	0.3	6.9	0	0	0	0.3	1.0
	4a2	-0.5	0.2	4.3	0	0	0	0.2	0.7
	4a3	-0.5	0.1	1.8	0	0	0	0	0.3
	4a4	-0.5	0.2	4.4	0	0	0	0.2	0.7
	4b1	-0.4	0.4	2.0	0.1	0.2	0.4	0.6	0.8
	4b2	-0.4	0.3	1.6	0	0.2	0.3	0.5	0.6
	4b3	-0.5	0.1	1.1	0	0.1	0.1	0.2	0.3
	4b4	-0.5	0.3	1.5	0	0.1	0.3	0.5	0.7
LVR	4	-0.6	0.1	3.4	0	0	0	0	0.2
	4a1	-0.6	0.5	8.8	0	0	0	0.5	1.8
	4a2	-0.6	0.3	7.3	0	0	0	0.4	1.2
	4a3	-0.6	0.1	2.2	0	0	0	0.1	0.4
	4a4	-0.6	0.3	7.7	0	0	0	0.4	1.2
	4b1	-0.5	0.7	4.3	0.1	0.3	0.6	0.9	1.5
	4b2	-0.6	0.5	2.3	0	0.2	0.4	0.7	1.1
	4b3	-0.6	0.2	1.5	0	0.1	0.2	0.3	0.5
	4b4	-0.6	0.5	2.3	0	0.1	0.4	0.8	1.2
SWP	4	-0.4	0.1	3.6	0	0	0	0	0.2
	4a1	-0.3	0.7	9.3	0	0	0	0.7	2.3
	4a2	-0.3	0.4	5.7	0	0	0	0.4	1.4
	4a3	-0.4	0.1	2.4	0	0	0	0.1	0.5
	4a4	-0.3	0.4	6.3	0	0	0	0.4	1.4
	4b1	-0.3	0.8	6.5	0.1	0.3	0.7	1.2	1.6
	4b2	-0.3	0.6	2.7	0	0.3	0.5	0.9	1.3
	4b3	-0.3	0.3	1.6	0	0.1	0.2	0.4	0.6
	4b4	-0.3	0.6	3.1	0	0.1	0.5	0.9	1.3
CVP	4	-0.3	0.1	2.8	0	0	0	0	0.1
	4a1	-0.2	0.5	9.0	0	0	0	0.4	1.6
	4a2	-0.2	0.3	6.9	0	0	0	0.3	1.0
	4a3	-0.3	0.1	1.9	0	0	0	0	0.4
	4a4	-0.3	0.3	7.3	0	0	0	0.3	1.1
	4b1	-0.1	0.6	4.6	0	0.2	0.5	0.9	1.5
	4b2	-0.1	0.5	2.3	0	0.2	0.4	0.7	1.2
	4b3	-0.1	0.2	1.4	0	0.1	0.2	0.3	0.5
	4b4	-0.1	0.5	2.7	0	0.1	0.4	0.8	1.3

Table 3.12 – No. of Days and Frequency the WQMP DOC Constraint is Exceeded

Urban Intake	Scenario	# Days > Standard	% Days > Standard
RS	4	173	3.0
	4a1	663	11.3
	4a2	448	7.7
	4a3	103	1.8
	4a4	477	8.2
	4b1	621	10.6
	4b2	359	6.1
	4b3	107	1.8
	4b4	350	6.0
LVR	4	281	4.8
	4a1	1,174	20.1
	4a2	877	15.0
	4a3	233	4.0
	4a4	873	14.9
	4b1	1,961	33.6
	4b2	1,396	23.9
	4b3	496	8.5
	4b4	1372	23.5
SWP	4	311	5.3
	4a1	1,347	23.0
	4a2	978	16.7
	4a3	312	5.3
	4a4	986	16.9
	4b1	2,457	42.0
	4b2	1,809	31.0
	4b3	576	9.9
	4b4	1879	32.2
CVP	4	208	3.6
	4a1	1,058	18.1
	4a2	771	13.2
	4a3	208	3.6
	4a4	776	13.3
	4b1	1,813	31.0
	4b2	1,360	23.3
	4b3	384	6.6
	4b4	1417	24.2

Table 3.13 – Summary of Percent Change in 3-Year Running Average of Long-Term DOC Mass Loading

Urban Intake	Scenario	Min	Ave	Max	Percentiles				
					10th	25th	50th	75th	90th
RS	4	-0.8	3.2	10.1	0.0	0.2	2.1	6.2	7.2
	4a1	-0.6	5.7	19.0	0.0	0.5	5.1	7.5	15.8
	4a2	-0.5	3.3	9.0	0.0	0.7	2.5	5.6	7.7
	4a3	-0.6	2.6	7.7	0.0	0.3	1.0	4.7	6.2
	4a4	-1.8	3.1	8.6	0.0	0.8	2.4	5.3	7.1
	4b1	3.7	10.9	15.5	7.2	9.1	11.3	13.4	14.1
	4b2	3.2	10.5	14.8	7.0	8.1	10.9	13.0	13.5
	4b3	1.4	4.7	7.4	2.2	3.1	5.4	5.9	6.1
	4b4	2.7	9.0	13.5	5.8	7.0	9.8	10.4	11.2
LVR	4	0.3	4.9	9.9	1.4	3.4	4.7	7.0	7.9
	4a1	0.3	11.6	22.6	5.6	9.5	11.3	15.2	17.3
	4a2	0.3	9.2	15.4	4.8	7.5	9.3	12.0	13.6
	4a3	0.3	4.0	8.1	1.6	2.6	4.0	5.4	6.4
	4a4	0.3	9.1	15.2	5.4	7.4	9.3	11.8	13.2
	4b1	8.6	17.1	25.2	10.6	13.1	17.1	21.7	23.0
	4b2	6.7	13.1	18.9	8.4	10.6	13.6	16.0	17.3
	4b3	3.3	6.0	8.2	4.5	5.2	6.1	7.1	7.4
	4b4	6.5	12.7	18.0	8.0	10.2	13.1	15.5	16.9
SWP	4	-1.5	6.0	13.1	0.3	4.1	6.7	8.1	9.1
	4a1	0.2	17.0	32.9	11.2	11.2	15.9	24.0	28.7
	4a2	0.2	12.0	23.3	7.1	7.1	12.2	17.4	19.3
	4a3	-2.7	6.3	14.4	0.2	4.2	6.9	8.7	10.4
	4a4	0.2	12.2	23.0	1.7	7.3	12.5	17.6	19.5
	4b1	9.7	19.2	27.4	12.0	16.8	19.3	23.1	24.7
	4b2	7.3	14.5	22.6	9.4	12.2	14.6	17.6	18.9
	4b3	2.5	7.8	13.9	4.3	6.4	7.6	9.7	10.6
	4b4	7.8	14.5	22.1	9.3	12.4	14.2	17.5	18.8
CVP	4	-0.2	3.1	5.9	0.9	2.4	3.2	4.3	4.9
	4a1	0	12.9	23.6	6.5	9.2	12.5	17.3	21.3
	4a2	0.5	8.9	15.1	4.5	6.3	9.2	12.3	13.7
	4a3	0.3	3.6	7.2	1.1	2.6	3.6	4.7	5.8
	4a4	0.5	9.1	15.3	4.7	6.2	9.3	12.6	13.9
	4b1	7.2	14.9	21.5	8.5	12.0	15.4	18.1	19.6
	4b2	5.0	11.0	15.5	6.7	9.0	11.8	13.0	13.8
	4b3	2.4	5.0	6.9	3.5	4.3	5.2	5.7	6.1
	4b4	5.7	11.5	17.0	6.7	9.1	12.0	13.6	14.6

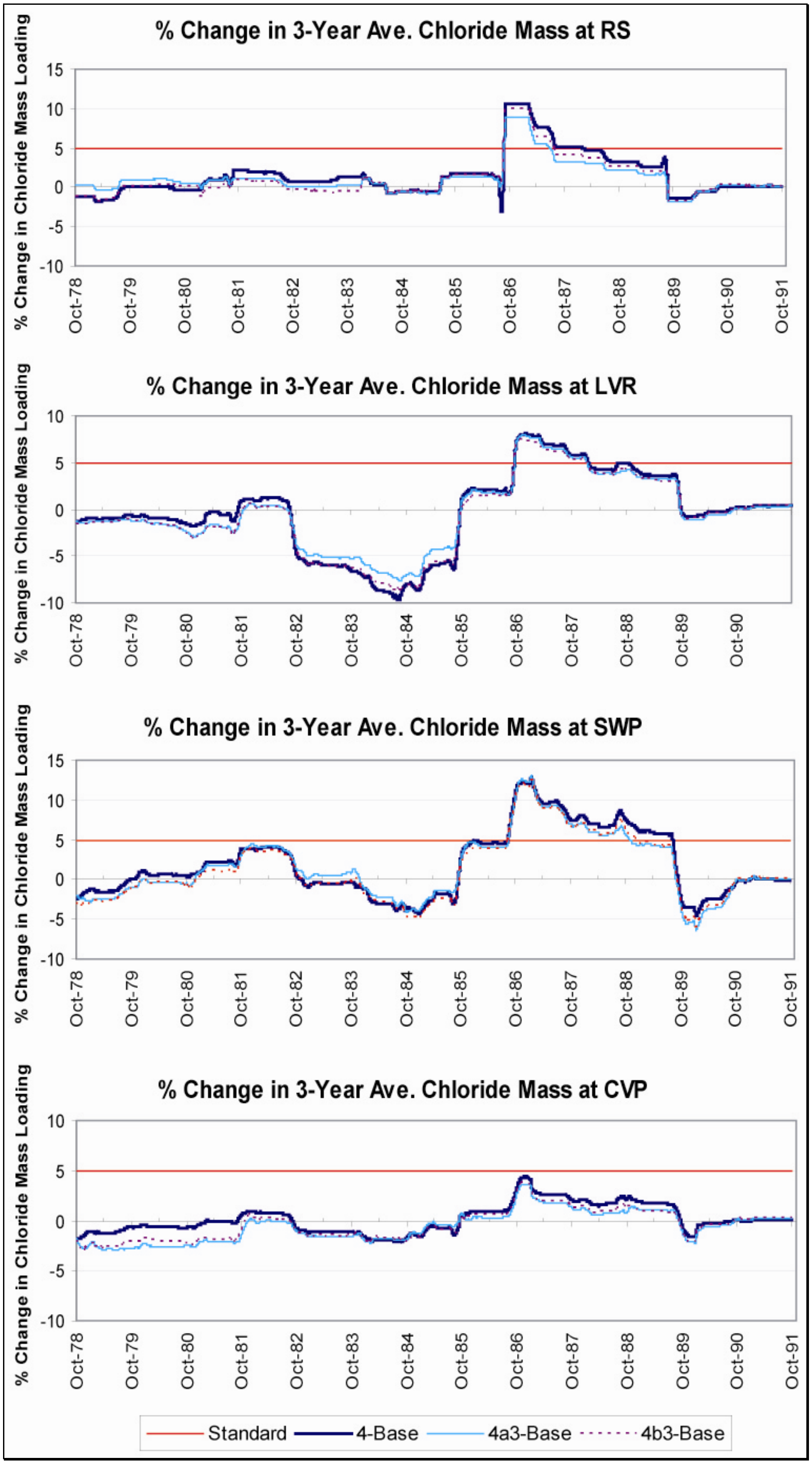

Figure 3.3 – Percent change in 3-Year Average Chloride Mass at Urban Intakes

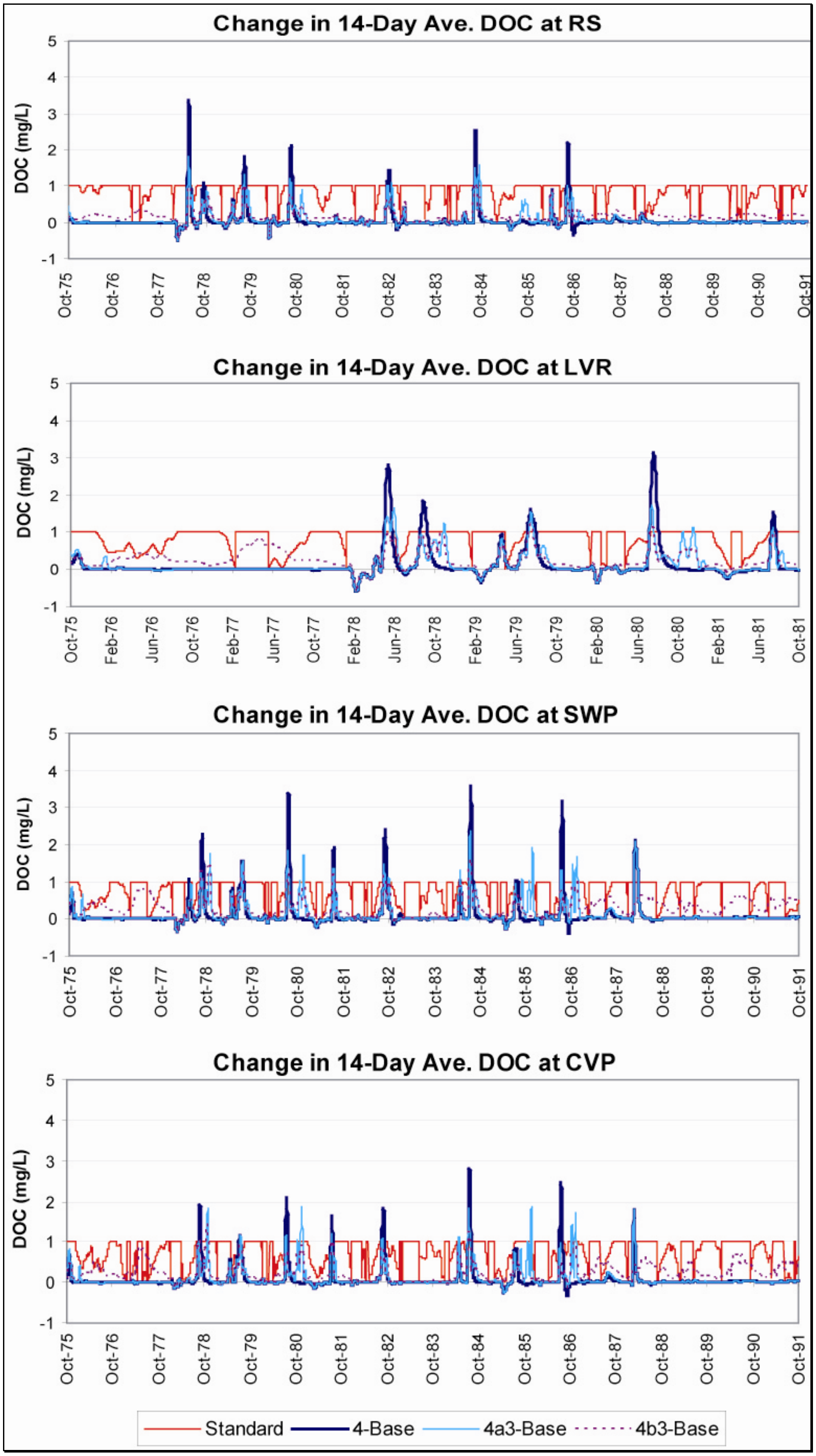

Figure 3.4 – Change in 14-Day Average DOC at Urban Intakes

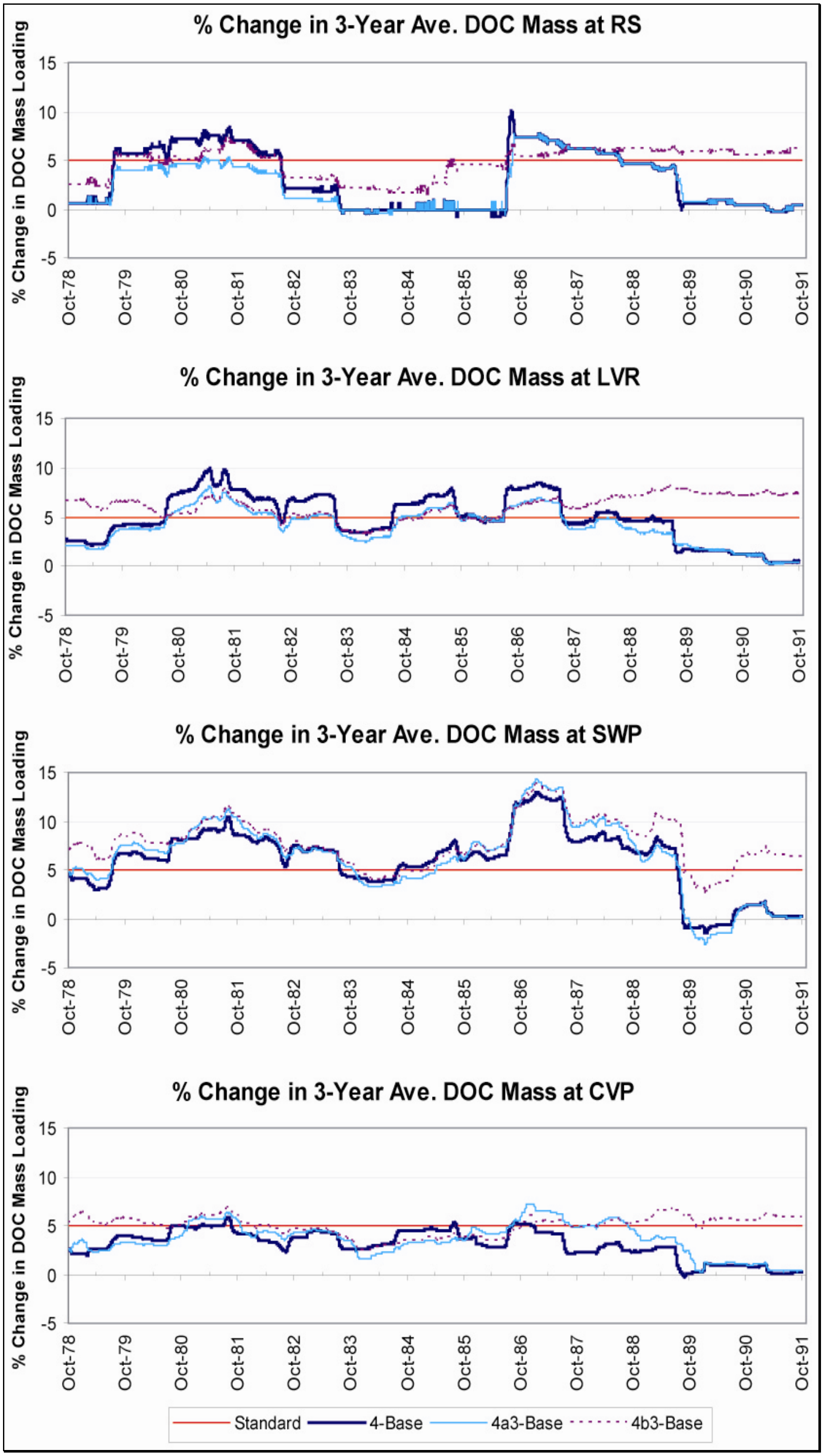

Figure 3.5 – Percent change in 3-Year Average DOC Mass at Urban Intakes

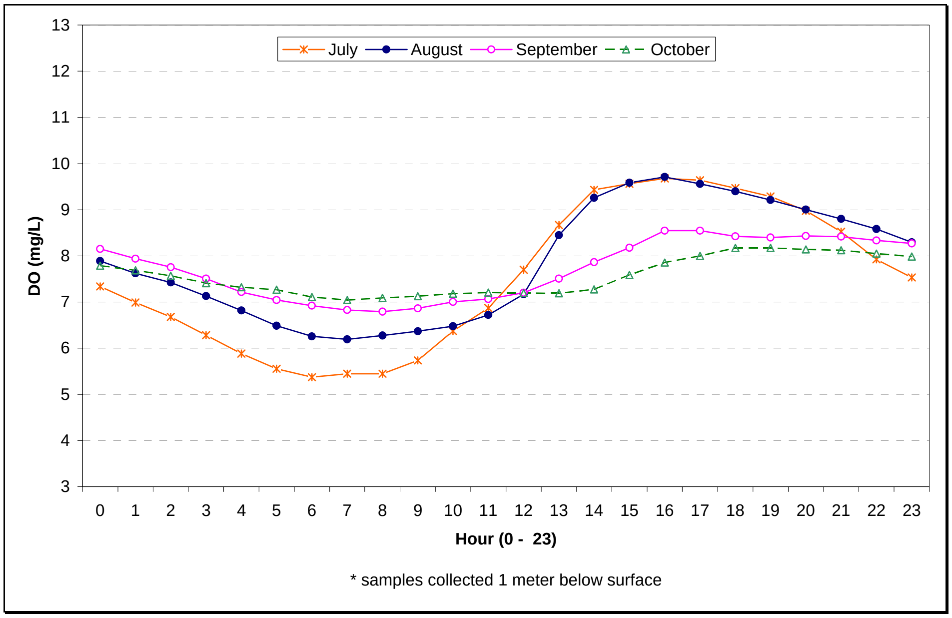

Figure 3.6 – Typical Daily DO Pattern at UJM

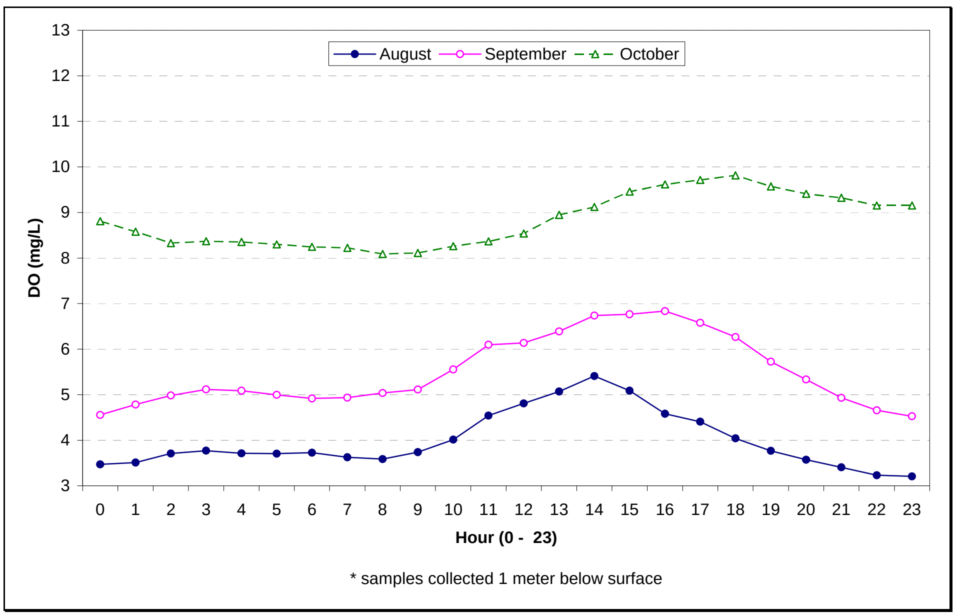

Figure 3.7 – Typical Daily DO Pattern at UJI

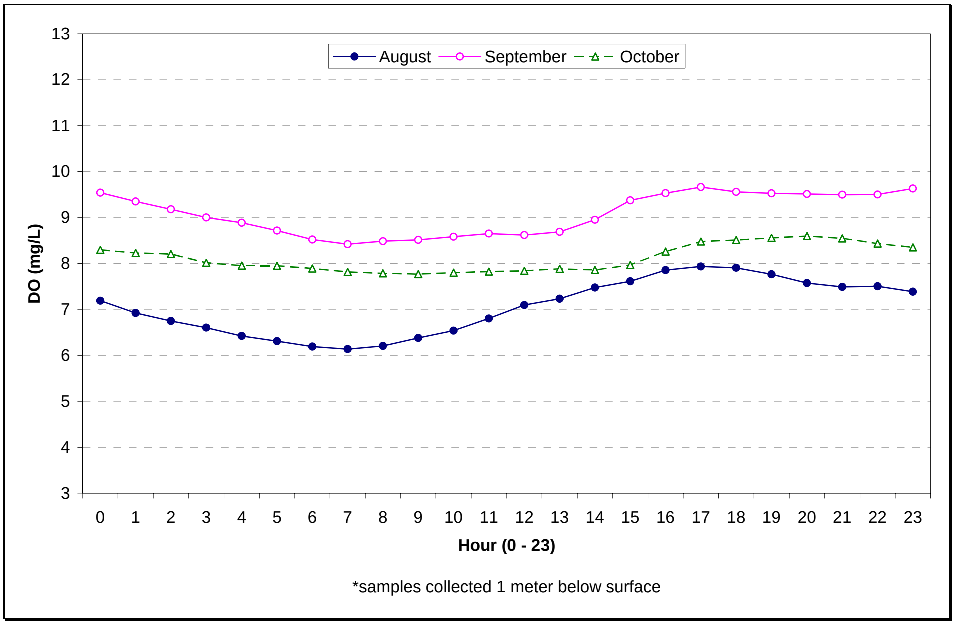

Figure 3.8 – Typical Daily DO Pattern at LJM

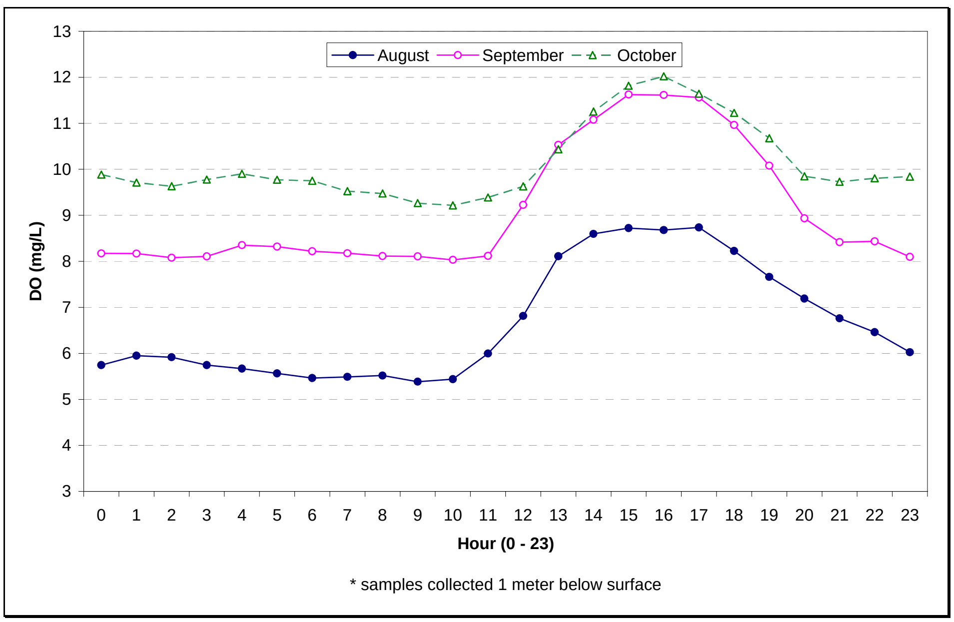

Figure 3.9 – Typical Daily DO Pattern at LJI

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4. Project Design Modifications

4.1 Introduction

In response to public comments received during the 2004 Draft State Feasibility Study public review, Department of Water Resources (DWR) has conducted a variety of technical analyses to address project design issues.

The project design issues addressed in this chapter include:

- Section 4.2 – Project design as proposed in the feasibility study
- Section 4.3 – Integrated Facility relocation on Webb Tract to deal with water circulation in the reservoir and East Bay Municipal Utility District (EBMUD) concerns of the Integrated Facility location in relation to the confluence of the Mokelumne and San Joaquin rivers
- Section 4.4 – Durability of using soil cement for reservoir slope protection to guard against wind-driven wave action and erosion, validation study of the feasibility study seepage analysis, and addressing other EBMUD concerns
- Section 4.5 – Revised project capital cost estimate based on proposed project design changes

4.2 Proposed Project Design

As described in the 2004 Draft State Feasibility Study, the proposed In–Delta Storage Project would provide capacity to store approximately 217,000 acre-feet of water in the south Delta for many water supply, water quality and ecosystem benefits. The project would include two storage islands (Webb Tract and Bacon Island) and two habitat islands (Holland Tract and Bouldin Island), similar to that proposed by Delta Wetlands more than a decade ago. However, it would also include a new embankment design, seepage control, piping protection and erosion control, and consolidated inlet and outlet structures.

Location of storage and habitat islands and inlet/outlet control structures (labeled as integrated facilities) in the Delta is shown in Figure 4.1.

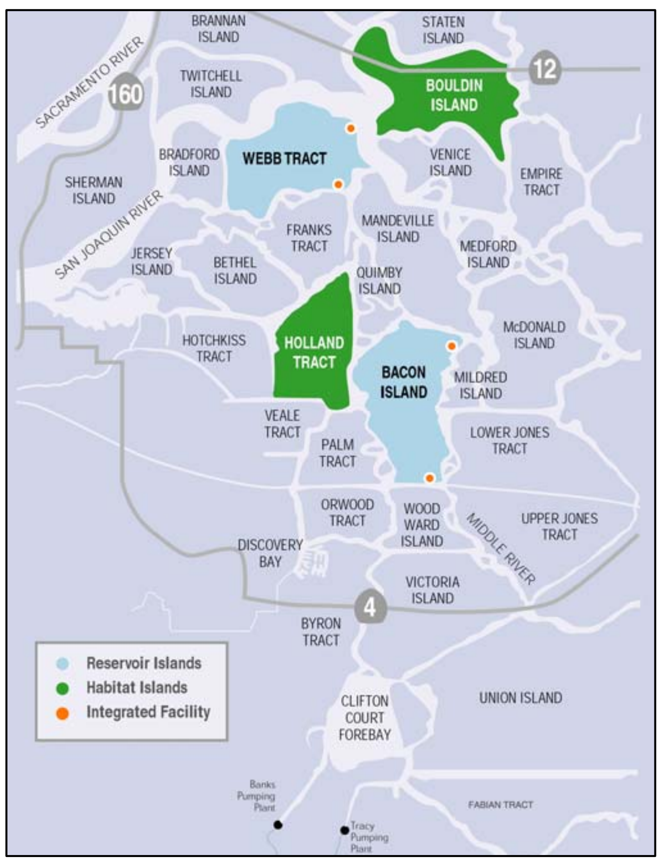

Figure 4.1 – Project Location

4.2.1 Embankment Design

The recommended embankment configuration in the feasibility study includes a combination of two embankment options to meet recommended factors of safety: (1) rock berm, and (2) bench options (Figure 4.2). The bench option would be used in areas where the slough is deep, the slough-side embankment slope is too steep to place rock adequately, or where placed rock may block a portion of channel and affect navigation (about 4 percent of each island's perimeter).

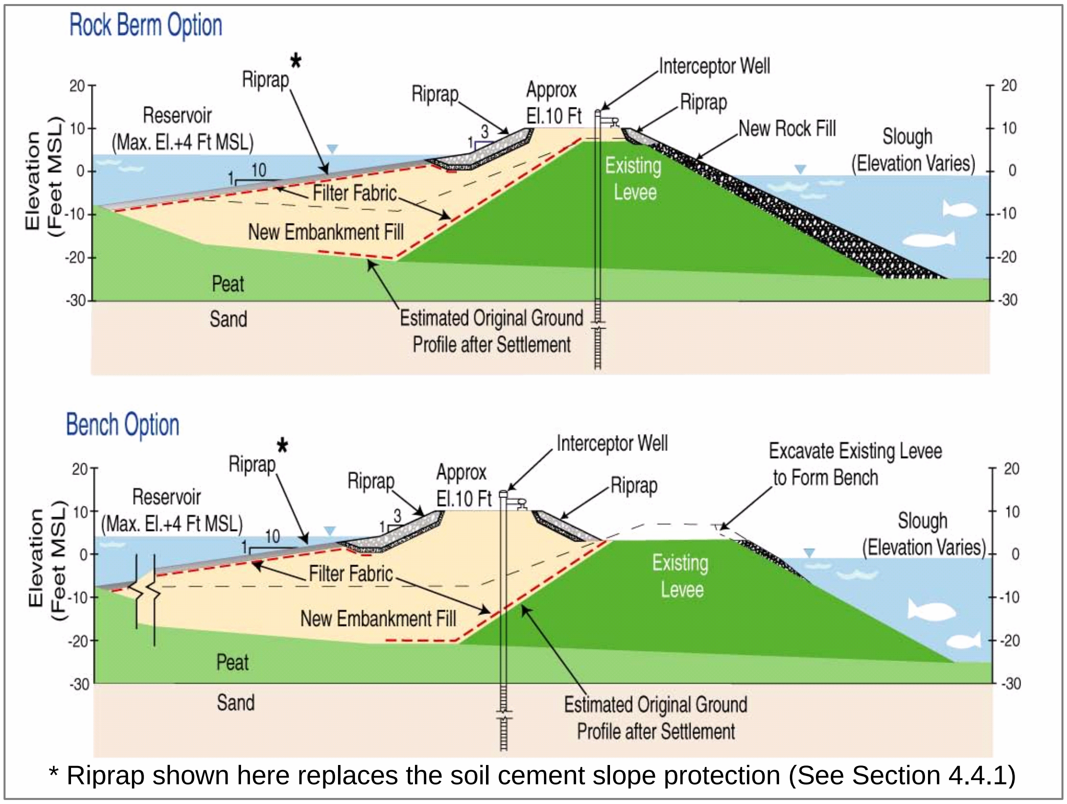

Figure 4.2 – Rock Berm and Bench Embankment Option Configurations

4.2.2 Seepage Control

To prevent crop damage and increased pumping costs on adjacent islands, seepage control measures are designed to prevent seepage rates onto adjacent islands beyond their current rates. The feasibility study recommended using interceptor wells with pumps along the reservoir island embankments to control seepage on neighboring islands.

4.2.3 Piping Protection and Erosion Control

A geotextile filter fabric measure was selected as a preferred solution to lessen the chance for piping (water flow through cracks in the embankments caused by foundation settlement). The Independent Board of Consultants recommended some level of inboard side erosion protection over areas of vulnerability to wind and wave action. Prevailing winds will be the key forces driving inboard wave erosion potential. Based on a cost comparison to riprap, soil cement with Bentonite mix was proposed on the shallow sloped reservoir-side north and west facing slopes for protection against wind and wave action.

4.2.4 Integrated Inlet and Outlet Facilities

The 2004 Draft State Feasibility Study proposed four integrated facilities, two on Webb Tract and two on Bacon Island. The integrated facilities are consolidated control structures that combine all operational components and would be used to control the diversion and release of water onto and off the reservoir islands. The operational components of each facility primarily include a fish screen, a transition pool, three inlet/outlet structures, a midbay, a pumping plant and associated conduits, a bypass channel, and engineered embankments. Figure 4.3 is a conceptual 3-dimensional illustration of a typical integrated facility.

Figure 4.3 – Typical Integrated Facility

4.3 Structural Relocations

As proposed in the 2004 Draft State Feasibility Study, the integrated facilities would be near the northeast and southeast corners of each island. These locations were selected based on permit restrictions, site topography and geology, channel depth and alignment of the channel reach, impact of the quality of released water on other Delta intakes, and location in relation to environmentally sensitive areas.

This evaluation focuses on relocating the northeastern Webb Tract integrated facility to the northwestern portion of the island, as shown in Figure 4.4. There are several reasons to consider this relocation. First, the current locations of the Webb Tract integrated facilities may not fully meet the objective of the proposed circulation operation. Circulation of water through the island has been evaluated as a means to dilute the reservoir island water, which has higher

Figure 4.4 – Relocated Integrated Facility

concentrations of dissolved organic carbon (DOC), with better quality (lower DOC) channel water. A typical circulation operation would divert water onto the reservoir island through one facility while releasing water from the island through the other facility, mixing the two sources of water. Locating the integrated facilities near the northeast and southeast corners of Webb Tract, as proposed in the 2004 Draft State Feasibility Study, does not appear to create the most effective flow path to circulate water. Locating the facilities on opposite corners of the island (one facility near the northwestern corner and one near the southeastern corner) provides a much longer flow path across the island, increasing the effectiveness of the circulation.

Second, relocating the northeastern Webb Tract integrated facility to the northwestern portion of the island may also help improve Delta water quality with regard to pushing X2 position downstream.

Although this relocation moves the northeastern integrated facility away from the confluence of the Mokelumne and San Joaquin rivers, there may still be impacts to the Mokelumne River fishery. The island operations would still follow the Webb Tract operational constraints outlined in an EBMUD protest dismissal agreement.

4.3.1 Geotechnical Explorations

As part of this feasibility study, DWR asked URS Corporation (URS) to perform supplemental geotechnical explorations to evaluate the foundation at the site of the relocated integrated facility at the northwest corner of Webb Tract. URS drilled and sampled one foundation exploration boring (DH-1) for the proposed integrated facility. The data were used to perform hydraulic and structural engineering analyses and design of the proposed integrated facility.

The original scope of work included drilling two soil borings (DH-1 and DH-2) 100 feet below the ground surface on Webb Tract to obtain soil samples. The drilling locations correspond to the integrated facility's fish screen structure (DH-1) and the pump station structure (DH-2). However, access to DH-2 was not achievable during the winter weather at the project site; therefore, only Boring DH-1 was completed. The data collected from Boring DH-1 were used for the engineering design of both the fish screen structure and the pumping plant.

To evaluate the engineering properties of the foundation soils, laboratory testing included triaxial compression, unconfined compression, moisture content and dry density, Atterberg limits, sieve analysis, and sieve-wash analysis.

The subsurface at Boring DH-1 generally consists of a layer of very soft, low to high plasticity, highly compressible, black organic silt with organic debris and peat to a depth of about 18 feet. The black organic silt and peat layer is underlain by alternating layers of gray and brown, silty sand (SM and SP-SM), clayey and sandy silt (ML), and silty clay (CL) to the bottom of the boring. The sandy soils are loose to medium dense between about 18 feet and 29 feet below the ground surface; below 29 feet, the sandy soils are medium dense to dense. The consistency of the clayey and silty soils ranges from stiff to hard.

More information on these geotechnical explorations can be found in the URS Draft Report, *Proposed Integrated Facility at Webb Tract Supplemental Geotechnical Exploration, April 2005*.

4.3.2 Engineering Analyses and Design

Hydraulic engineering analysis and design were performed on the relocated integrated facility at the northwest corner of Webb Tract. The design methodology, procedures and assumptions used in this analysis are identical with those used in the feasibility study for the other integrated facilities. The purpose of the hydraulic design was to determine finished elevations of all structural components of the relocated integrated facility. The results of the hydraulic design, along with the data collected in the supplemental geotechnical exploration, were used to perform structural engineering analysis and design of the relocated facility, as discussed below.

URS performed supplemental structural engineering design and analysis of the relocated integrated facility's structural components, including inlet/outlet structures, pumping stations, sheet pile walls, and structural components of the fish screens. URS then prepared a report on the structural feasibility of the proposed facilities; URS Draft Report, *In-Delta Storage Program Integrated Facilities Supplemental Structural Engineering Design and Analysis, April 2005*. DWR used the design information to estimate quantities and costs of the proposed integrated facility.

The design criteria for the relocated integrated facility bypass channel walls (permanent sheet pile walls that separate the transition pool from the bypass channel) changed in comparison to the criteria used in the previous designs of the other four integrated facilities. First, the maximum head differential the sheet pile walls would be subjected to was overestimated in the previous designs and has since been updated. Second, the peat soil has been replaced with mineral soil, enhancing the stability of the cantilevered sheet pile walls. The relocated integrated facility design has incorporated these updated criteria. To ensure consistency in the designs and cost-estimating methods, the previously designed facilities have been reevaluated based on the updated criteria. The results indicate a significant reduction in the bending moment imposed on the sheet pile walls in comparison to the previous design. This reduction translates into a higher sheet pile wall tip (or bottom) elevation, which significantly reduces the cost of the sheet pile walls. A cost savings of about 6 percent is realized for the integrated facility structures. Table 4.1 shows the change in cost for each integrated facility.

It appears that the overall construction cost of the integrated facilities would not be significantly affected by removal of the peat. However, removing the peat significantly improves the seismic performance of the integrated facilities by limiting maximum lateral seismic displacements of structures to 1 inch. Also, removing the peat would substantially reduce settlement of the integrated facility embankments.

Further design may consider the use of batter piles to resist lateral loads. In addition, further studies may indicate that precast concrete construction for such elements as the box culvert structures may be more economical than cast-in-place construction.

4.4 Embankment Stability and Related Issues

This section addresses the durability of using soil cement for reservoir slope protection to guard against wind-driven wave action and erosion, the validity of the feasibility study seepage analysis, and related concerns raised by EBMUD.

4.4.1 Slope Protection

As indicated in Section 4.2.3, the 2004 Draft State Feasibility Study recommended soil cement with Bentonite mix to be used on the shallow (10:1) sloped reservoir-side north and west facing slopes for protection against wind and wave action. This recommendation was based on a cost comparison of soil cement to riprap and recent (2002) slope protection provided for Clifton Court Forebay using soil cement. Using soil cement reduced the island embankment (rock-berm option) construction costs (based on using riprap) by $9,772,000 for Webb Tract and $9,250,000 for Bacon Island, for a total cost reduction of $19,022,000. More details on the original recommendation can be found in the 2004 Draft State Feasibility Study, Engineering Summary Report, Section 8.2.4.

Concerns were raised during the 2004 Draft State Feasibility Study public review regarding the use of soil cement for slope protection on the reservoir side of the project embankments. The integrity of the soil cement slope protection was questioned in regard to potential embankment settlement and seepage issues.

In response to the concerns raised, DWR's Division of Safety of Dams (DSOD) performed a feasibility level review on the adequacy of using soil cement for slope protection on the reservoir side of the project embankments. DSOD found:

> "Although soil cement has many beneficial uses, our experience with its use as slope protection where the slope is exposed to wave action or current flows has not been favorable.
>
> At Clifton Court Forebay, we found the soil cement slope protection to be problematic in terms of maintenance and operation. Periodic inspection reports beginning one year after completion of construction of the dam (April 1970), have noted continuing deterioration and on-going repairs of the soil cement revetment. Much of the failure was in the form of cracked and broken slabs washing out, undercutting and gouging of the sub-layers, and general deterioration and disintegration of the revetment.
>
> Soil cement is a rigid mass system which requires a relatively static environment and stable foundation. The Delta islands are known to have high settlement characteristics. This combined with exposure to dynamic wave action could cause the soil cement slope protection to have a service life much shorter than the Project's design life. Soil cement is relatively impervious and prone to cracking. Rapid drawdown during reservoir operations or wave action could cause buildup of excess hydrostatic pressure behind the blanket and cause failure. It also requires a mix design having specific soil properties. Available materials in the Delta generally consist of very fine grained soils and organics, which normally do not meet specifications for soil cement.

> We have found the use of properly designed and constructed riprap for slope protection in the Sacramento-San Joaquin Delta environment has proven most effective in terms of cost, service and maintenance."

Based on these findings, the In-Delta Storage Project cost estimates have been updated to reflect the use of riprap for slope protection on the reservoir side of the project embankments. The updated cost estimates will reflect the cost estimates reported in the *Earthwork Construction Cost Estimate report, URS June 2003*. The URS cost estimates include riprap protection on the north and west facing 10:1 reservoir side slopes.

4.4.2 Seepage to Adjacent Islands

As described below, piezometers were installed and data was collected at various locations as part of the Jones Tract Flood Groundwater Monitoring Program. A seepage calibration study was performed using data collected from the Empire Cut levee at McDonald Island, where seepage was observed in the island interior (adjacent to Lower Jones Tract) as a result of the Jones Tract flood event. The purpose of the seepage calibration study was to validate the seepage analysis findings on seepage to adjacent islands as presented in the 2004 State Feasibility Study.

Piezometer Installation Report, Reclamation District 2030, McDonald Island, San Joaquin County, CA., Lowney Associates, July 15, 2004

This report presents the results of piezometer installations in the McDonald Island levee and levee berm embankment and foundation soils along Empire Cut. The piezometers are on the south side of McDonald Island, across Empire Cut from the recently flooded Lower Jones Tract. The piezometers allow for observation of ground water levels and changes associated with Lower Jones Tract flooding and the planned removal of the flood waters by pumping.

Topographic maps of the McDonald Island levee (adjacent to Empire Cut) were obtained from Kjeldsen, Sinnock & Neudeck Inc., consulting engineers and land surveyors, and DWR district engineers for McDonald Island.

Groundwater Monitoring, Jones Tract Flood, Hultgren-Tillis Engineers, April 15, 2005

Hultgren-Tillis Engineers monitored groundwater levels in six piezometers at or near Upper and Lower Jones Tracts during and after pumping operations. One piezometer was on Upper Jones Tract (UJ-21), two were on Woodward Island (WO-26 and WO-27) and two were on Palm Tract (PA-29 and PA-30). These five piezometers were drilled and installed as part of the Delta Wetlands project. The new piezometer is on Bacon Island (BA-35).

Piezometers UJ-21, BA-35, WO-26 and WO-27 are within the levee crest. Piezometer WO-27 is about mid-slope of the landside levee face and WO-26 is near the landside levee toe. The piezometers on Palm Tract are far removed from Jones Tract and were monitored to collect data on background water levels that would not be affected by the dewatering of Jones Tract.

Jones Tract flooding raised the groundwater levels within the footprint of Upper and Lower Jones Tract to near mean tide elevation. The groundwater data presented in the report shows that the groundwater levels were raised 1.5 to 2 feet in the sand layer at two piezometers on Woodward Island and Bacon Island (both nominally 300 meters from Jones Tract). No impact was observed in piezometers located nominally 1,000 meters (WO-27) or at 3.7 to 5 kilometers (background piezometers on Palm Tract).

In-Delta Storage Program Seepage Calibration Study, URS Draft Technical Memorandum, May 5, 2005

The proposed reservoirs at Webb Tract and Bacon Island are expected to have the potential for changing seepage within neighboring islands where the slough widths are relatively narrow. Changes in seepage and measures to mitigate those changes have been previously estimated (URS, 2003a). During the Jones Tract flooding, resulting seepage was observed in adjacent islands, and four piezometers installed at McDonald Island on a portion of the Empire Cut levee for the purpose of monitoring seepage during pumping of Lower and Upper Jones Tract, provided the information for verification of the URS seepage study results.

The objective of this study was to calibrate seepage models developed for the In-Delta Storage Program (URS, 2003a) by modeling seepage at McDonald Island during flooding of Lower Jones Tract and comparing them with the observed conditions. In addition to calibrating the seepage models, laboratory test data for samples of the sand layer underlying the peat obtained at Webb Tract and Bacon Island during previous investigations were reviewed with respect to the variability in permeability that might be anticipated along the perimeter of the embankments.

The seepage model estimated the Phreatic surfaces and total head contours (in feet of water). The model indicated that flooding of Lower Jones Tract would result in a 7.7-foot increase in head under the interior toe of the McDonald Island levee and flooding of a 300- to 400-foot-wide zone adjacent to the levee toe. The total head estimated by the seepage model, which was developed in a manner similar to the models used for the In-Delta Storage Program, was within 6 inches of the total head observed in the field during the Jones Tract groundwater monitoring. Therefore, we conclude that the seepage calibration study validates the approach used in the In-Delta Storage Program seepage models and that those models provide a reasonable estimate of the average seepage for the proposed Webb Tract and Bacon Island reservoirs.

Seepage will vary at any section along the reservoir embankments based on many factors including:

- thickness of the peat and sand layers
- variations of soil type in the levee, peat, and sand layers
- phreatic surface within the neighboring islands
- distance of the neighboring island from the embankments

Laboratory data reviewed for the sand layer at Bacon Island and Webb Tract indicate there are likely to be areas where the permeability of the sand layer can be anticipated to be similar to that found at the McDonald Island levee near Empire Cut. However, the locations of the borings for the data available were primarily in the island interior and the areas of the sand layer under the Webb Tract and Bacon Island levees, which may have higher permeability, are unknown.

4.4.3 East Bay Municipal Utility District Concerns

During the feasibility study phase of the In-Delta Storage Project, EBMUD raised concerns related to stability of the project embankments. In particular, EBMUD was concerned that levee failure or seepage on Bacon Island caused by the Delta Wetlands Project (particularly along Santa Fe Cut) could wash out Woodward Island's protective levees, or cause seepage to undermine the same levees, damaging or destroying EBMUD's Mokelumne Aqueducts. Other concerns addressed here are related to the proposed circulation operations and their impact on total diversions as well as concerns regarding the location of the northeastern Webb Tract integrated facility and its potential diversion effects on the Mokelumne River fishery.

The proposed seepage plan in the Protest Dismissal Agreement has been altered because adjoining islands mentioned in the agreement have refused to provide access and cooperation and have suggested legal action to attain this access. The new seepage plan recommends solution of seepage and erosion problems with local measures on the Delta Wetlands owned islands.

A study was conducted to calibrate seepage models developed for the In-Delta Storage Program by modeling seepage at McDonald Island during flooding of Lower Jones Tract and comparing them with the observed conditions. The seepage calibration study validates the approach used in the In-Delta Storage Program seepage models and concludes that those models provide a reasonable estimate of the average seepage for the proposed Webb Tract and Bacon Island reservoirs. For more details on this study see Section 4.4.2.

The risk analysis has been updated to include certain infrastructure not included in the original risk analysis. This includes probabilities and consequences of embankment failure related to the EBMUD Mokelumne Aqueducts and other infrastructure. Chapter 5, Risk Analysis Update gives more information. Complete details of the risk analysis update can be found in the URS Draft report, In-Delta Storage Program Risk Analysis, April 25, 2005.

In the revised project design, the northeastern Webb Tract integrated facility has been relocated away from the confluence of the Mokelumne and San Joaquin rivers to the northwestern corner of Webb Tract. This will improve the effectiveness of the proposed circulation operation. Proposed circulation operations will make use of the Delta Wetlands permit to circulate water. Water will be drawn from the southern Webb Tract integrated facility most of the time and water will be released from the northwestern facility. This should minimize any impacts to the Mokelumne River fishery. Circulation of water will not adversely affect seepage to adjacent islands because circulation flows are diverted and released during the same day, causing no net increase in storage beyond normal reservoir operations.

4.5 Revised Project Cost Estimate

The project capital cost analysis performed for the January 2004 Draft State Feasibility Study focused both on identifying suitable construction methods as well as developing feasibility level cost estimates. The total capital cost of the project, including construction, engineering, legal, administration, permitting, land acquisition, relocations, and allowance for contingencies was estimated to be about $774 million.

The project capital cost analysis has been revised as part of this supplemental study to reflect the proposed project design modifications. These modifications include relocating the northeast integrated facility on Webb Tract to the northwest corner of the island and replacing the soil cement with riprap for slope protection on the reservoir side of the project embankments. Other modifications include updating the foundation pile requirements at all integrated facility locations based on peat soil replacement with mineral soils and updating the bypass channel sheet pile wall requirements as discussed in Section 4.3.2.

The revised total capital cost of the project is estimated to be about $789 million. For comparison, the revised construction cost estimate (April 2005) is shown along with the original construction cost estimate (June 2003) in Table 4.1. The construction cost estimate summarized in Table 4.1 is for the rock-berm embankment option. The June 2003 cost estimate is based on using 12 inches of soil cement protection on the north and west facing 10:1 reservoir-side slopes and the May 2005 cost estimate is based on using riprap protection on the north and west facing 10:1 reservoir-side slopes. The integrated facility structures' cost estimates have been updated to include corrected information on foundation pile and sheet pile requirements.

Table 4.1 shows that the change in reservoir-side slope protection from soil cement to riprap will increase costs by about $19 million. Revised structural designs indicate the combined cost of all four integrated facility structures will lessen by about $9 million. An overall increase in project cost with contingencies will be about $15 million. So the 2004 Draft State Feasibility Study estimated project cost of $774 million will increase to $789 million.

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Table 4.1 – Revised Total Capital Cost of the In-Delta Storage Project

Item	February 2004 Amount		May 2005 Amount	
1. Island Embankments [1]				
Webb Tract	$ 87,428,000		*$ 97,200,000*	
Bacon Island	$ 90,067,000		*$ 99,318,000*	
2. Seepage Control System	$ 12,200,040		$ 12,200,040	
3. Instrumentation	$ 3,000,000		$ 3,000,000	
4. Mobilization for Embankment Construction [2]	$ 14,986,000	**$ 207,682,000**	$ 14,986,000	**$ 226,705,000**
5. Integrated Facility Embankments [3]				
Webb Tract @ SJR (Relocated to Northwest Corner)	n/a		*$ 18,774,350*	
Webb Tract @ San Joaquin River	$ 19,585,500		n/a (Replaced with Relocated Facility)	
Webb Tract @ False River	$ 17,357,300		$ 17,357,300	
Bacon Island @ Middle River	$ 18,974,950		$ 18,974,950	
Bacon Island @ Santa Fe Cut	$ 15,250,150	**$ 71,168,000**	$ 15,250,150	**$ 70,357,000**
6. Integrated Facility Structures [3]				
Webb Tract @ SJR (Relocated to Northwest Corner)	n/a		*$ 34,878,812*	
Webb Tract @ San Joaquin River	$ 36,830,697		n/a (Replaced with Relocated Facility)	
Webb Tract @ False River	$ 35,002,266		*$ 33,019,519*	
Bacon Island @ Middle River	$ 36,694,504		*$ 34,477,035*	
Bacon Island @ Santa Fe Cut	$ 38,415,855	**$ 146,944,000**	*$ 36,000,755*	**$ 138,377,000**
7. Miscellaneous				
Land Acquisition	$ 60,000,000		$ 60,000,000	
Mitigation	$ 34,450,000		$ 34,450,000	
Demolition & Hazardous Materials Clean Up	$ 8,000,000		$ 8,000,000	
PG&E Pipeline & Electrical Relocation	$ 15,000,000		$ 15,000,000	
Permits	$ 300,000	**$ 117,750,000**	$ 300,000	**$ 117,750,000**
SUBTOTAL		**$ 543,544,000**		**$ 553,189,000**
Contingency for Island Embankment Earthwork (25%)		**$ 44,374,000**		**$ 49,130,000**
Contingency for Facilities Earthwork (25%)		**$ 17,792,000**		**$ 17,590,000**
Contingency for Facility Structures and Others (20%) [4]		**$ 31,014,000.0**		**$ 29,301,000.0**
Contingency for Miscellaneous (15%) [5]		**$ 8,618,000**		**$ 8,618,000**
Subtotal with Contingencies		**$ 645,342,000**		**$ 657,828,000**
Costs for Eng Design, Const Mgmt, Admin & Legal [6]		**$ 129,069,000**		**$ 131,566,000**
TOTAL COST		**$ 774,411,000**		**$ 789,394,000**
Annual Operation & Maintenance Costs [7]		$ 5,873,000		$ 5,873,000

1 June 2003 costs are based on using 12-inches of Soil Cement for 10:1 reservoir side slope protection and May 2005 costs are based on using Riprap
2 Includes mobilization for island embankments, seepage control and instrumentation
3 Costs include mobilization at each facility
4 "Others" include Seepage Control System and Instrumentation and does not include mobilization costs
5 Excludes Land Acquisition and Permits Costs
6 This cost is 20% of Subtotal with Contingencies
7 A description and breakdown of the Annual O&M Costs are provided in the 2004 Engineering Summary Report

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5. Risk Analysis Update

5.1 Introduction

The original risk analysis presented in the 2004 Draft State Feasibility Study omitted certain infrastructure that could be affected by the project in the event of a project embankment failure. As part of this supplemental study, the risk analysis has been updated to include the infrastructure not covered in original risk analysis. In addition, the risk analysis has been updated to include new information available as a result of the June 3, 2004, Middle River levee breach at Upper Jones Tract in the Sacramento-San Joaquin Delta.

5.1.1 Inclusion of Infrastructure Not Covered in Original Risk Analysis

The updated risk analysis includes the EBMUD Mokelumne Aqueducts, PG&E gas pipelines, Burlington Northern Santa Fe (BNSF) railroad lines, Kinder Morgan pipelines, and the Stockton Deepwater Ship Channel and Bradford Island. Damage to these facilities and resulting direct economic losses were estimated as a result of an embankment breach at Bacon Island. The damage and economic loss estimates are based on information obtained direct from EBMUD, PG&E, BNSF and Kinder Morgan representatives. Figure 5.1 shows the main infrastructure that was considered in the risk analysis.

5.1.2 Inclusion of Jones Tract Levee Breach Information

One concern is flooding of a neighboring island caused by a breach of the project embankment that, in turn, triggers a breach of the levee on the neighboring island. On June 3, 2004, a levee breach occurred on Upper Jones Tract. It flooded Upper and Lower Jones Tracts, and caused substantial damage and economic losses. The risk analysis in this study incorporates this type of a failure scenario, so the information obtained from the June 3, 2004, event was used to validate, and revise if necessary, the assumptions made in estimating economic losses from any future flooding of the Jones Tract islands, as well as other neighboring islands in the study area. The updated analysis considered levee breach and scour hole dimensions; cost of levee repairs; cost to restore the Jones Tract Islands to suitable farming conditions; flood damages on Jones Tract Islands including damage to infrastructure; and impacts to state and federal project water supplies and Delta water quality.

5.2 Updated Evaluation of Consequences of Failure

The consequences of failure of the project embankments include emergency response; embankment repair; damage to equipment; effects on fish, water quality and supply, gas pipelines, railroads, aqueducts, and other infrastructure; and loss of life. The consequences of flooding of neighboring islands include emergency response; damage to levees, buildings and infrastructure; and impacts to agricultural resources, natural habitats, water quality and supply, and infrastructure.

This report discusses only the updated consequences of failure of the project embankments based on including certain infrastructure and Jones Tract levee breach information. The updated consequences of failure that were evaluated for both inward and outward breach scenarios include emergency response; embankment repair; and impacts to gas pipelines and railroads. These are discussed in Sections 5.2.1 and 5.2.2, respectively. The updated consequences of flooding of neighboring islands include emergency response; and damage to levees, buildings and infrastructure. These are discussed in Section 5.2.3.

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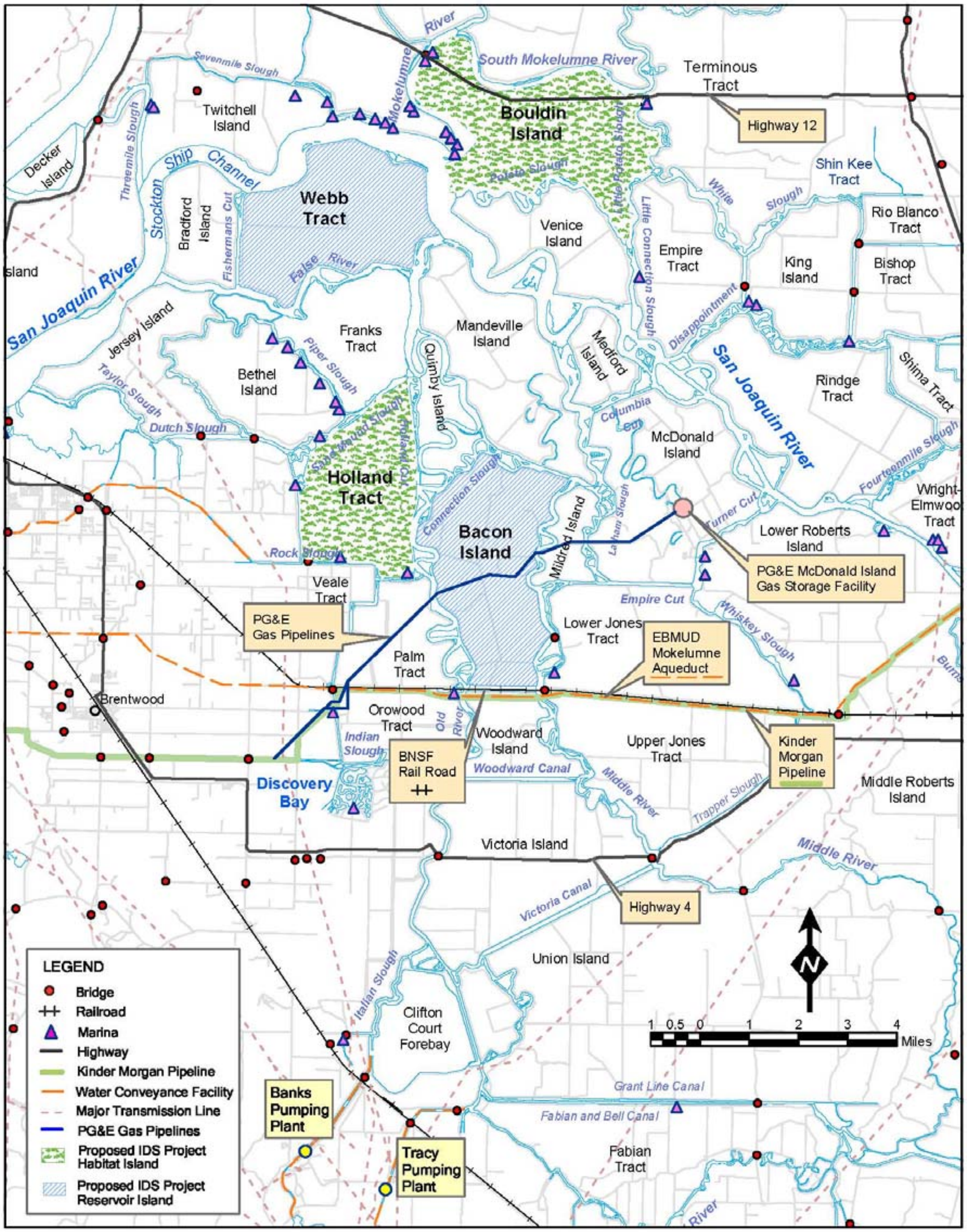

Figure 5.1 – Existing Main Infrastructure

5.2.1 Updated Consequences of Inward Breach of Project Embankment

The updated consequences of failure that were evaluated for an inward breach scenario are discussed in this section.

Emergency Response

The data from the Jones Tract failure of June 3, 2004, was used to estimate the emergency response cost after a breach of the project embankment without a failure of a neighboring island. The emergency response cost for the Jones Tract flood (excluding the cost of pumping out water from the Jones Tracts) was about $25 million. This response required large-scale actions to protect the entire perimeter of Upper and Lower Jones Tracts. If only the project embankment were to breach, the emergency response cost would be much less and was assumed to be $2.5 million.

Embankment Repair

The Jones Tract failure of June 3, 2004, provided real data on levee breach repair cost during an emergency. Construction of the closure of the breach in a reservoir embankment would be similar to that used to close the breach in the Jones Tract levee. Essentially, initial closure is achieved by placing rock materials through water. A 2-foot-thick riprap layer would be placed on the slough-side of the embankment. A layer of bedding material would underlie the riprap layer. Soil materials would be used in the remainder of the embankment (reservoir side). The cost of this repair work for the Jones Tract levee failure was about $10.3 million for a 400-foot-wide breach. To close a 1,000-foot-wide breach assumed for the risk analysis, the repair cost would be roughly $25.8 million.

After the breach has been closed, construction to re-establish the embankment slopes in the interior (reservoir side) of the island can proceed. The costs to re-establish the interior embankments are estimated to be an additional $2 million for the Rock Berm embankment option and $2.5 million for the Bench option. Therefore, the total repair cost would be about $28 million for either option.

Impact to PG&E Gas Pipelines

Two PG&E gas pipelines cross Bacon Island at the juncture of Mildred Island on the eastern side of Bacon Island. Only the northern pipeline is active, while the southern pipeline is maintained as a possible backup. The northern pipeline also crosses Bacon Island at the western end of Palm Tract.

The probability and consequences of a failure of the PG&E gas pipelines crossing Bacon Island were estimated as if a failure were to occur due to an inward breach of the project embankment at Bacon Island. It is recognized that the pipeline would be under hydrostatic loading from the reservoir, which would need to be addressed during final design. Consequences of a failure of PG&E gas pipelines under normal operation (without a breach of the project embankment) were not included in the risk analysis. For example, if the PG&E pipeline were to fail under normal operation, the cost of repair could be higher because it would be under several feet of water. This incremental cost was not considered in this risk analysis because it is not related to the risk of a failure of the project embankment, and therefore should be considered part of normal operating costs.

An inward breach at the locations mentioned above could scour the bottom of Bacon Island and cause a failure of the gas pipelines. Past levee failures under flood conditions appear to have caused large scours (up to about 1,700 feet long, 600 feet wide and 50 feet deep). Because the gas pipelines would be within such a zone of impact, it was assumed that the gas pipelines would fail if an inward breach were to occur within 600 feet along the embankment on either side of the pipeline crossing.

On the Mildred Island side, the probability of failure of each pipeline was assessed by considering the proportion of the embankment length over which a breach could occur and impact the pipeline. The assessed failure probabilities, given an inward breach on Bacon Island embankment, were 6% and 2%, respectively, for the northern and southern gas pipelines. On the Palm Tract side, the assessed probability of pipeline failure was 2%.

The cost of repairing the pipelines, downtime of the northern pipeline during which gas service would be interrupted, and the loss of revenue during downtime were estimated based on information obtained from PG&E. The unit cost of pipeline repair was assumed to be $3,500 per lineal foot. The repair length of the northern/southern pipeline perpendicular to the project embankment was assumed to be 1,700 feet, which is the estimated length of land scour after an inward breach. The repair length of the northern pipeline parallel to the project embankment was assumed to be 600 feet, which is the width of the estimated land scour. The expected loss of direct revenue to PG&E in case of pipeline failure was estimated to be $2.8 million based on the information provided by PG&E.

Impact to BNSF Railroad

The Burlington Northern and Santa Fe Railroad Co. (BNSF) railroad between Bacon Island and Woodward Island is supported on a trestle bridge founded on piles. There is also an earth embankment beneath the railroad tracks; however, it does not provide structural support to the railroad tracks.

An inward breach at the southern edge of the embankment on Bacon Island would draw water from the slough into the reservoir. This could erode the soils from the railroad embankment. However, the probability of a failure of the bridge was assessed to be negligible.

The hydraulic analysis estimated that, in the case of an inward breach in the Bacon Island embankment north of Woodward Island, the peak water velocity at the railroad embankment would be about 9 feet per second. The probability of failure of the railroad embankment under this scenario was estimated to be 50%. It was assumed that the embankment would be repaired if it failed and the associated cost was estimated to be $5 million.

5.2.2 Updated Consequences of Outward Breach of Project Embankment

The updated consequences of failure that were evaluated for an outward breach scenario are discussed in this section.

Emergency Response

Making assumptions similar to those for an inward breach scenario, the emergency response cost in case of an outward breach of the project embankment (but no failure of neighboring island levee) was estimated to be $2.5 million.

Embankment Repair

Making assumptions similar to those for an inward breach scenario, the embankment repair cost was estimated to be $28 million.

Impact to Mokelumne Aqueducts, Kinder Morgan Pipeline and BNSF Railroad

An outward breach along the southern edge of the embankment on Bacon Island could cause water flowing at high velocities into the slough towards the Mokelumne Aqueducts, Kinder Morgan pipeline, and BNSF railroad and create a potential for failure of one or more of these three facilities. Three different scenarios of affecting these resources from an outward breach on Bacon Island were analyzed:

(1) the breach occurs on the portion of the embankment in front of Woodward Island
(2) the breach occurs on the southeastern edge of the embankment in front of Upper Jones Tract
(3) the breach occurs on the southwestern edge in front of Orwood Tract.

The probability and consequences of failure under each scenario were assessed separately.

Scenario 1: Breach in Front of Woodward Island

Under this scenario, an outward breach must cause overtopping or washing out of the BNSF railroad embankment and cause a failure of the levee on Woodward Island before the Mokelumne Aqueducts or the Kinder Morgan pipeline could be affected (see locations of pipelines on Figure 3). Although the peak water velocity (about 14 feet per second) at the BNSF railroad embankment could wash away a portion of the embankment, the probability of failure of the railroad bridge and tracks under this scenario was assessed to be negligible since the embankment does not provide structural support to the railroad bridge and tracks. Nonetheless, it was assumed that the railroad embankment would be repaired at an estimated repair cost of $5 million.

Considering a peak water velocity (about 11 feet per second) occurring at the Woodward Island levee and the probability that flood-fighting measures to protect Woodward Island would be unsuccessful, the probability that the Woodward Island levee would fail given an outward breach at this location was calculated to be 68%. If the Woodward Island levee were to fail, this would cause a large scour inside Woodward Island, likely causing the Mokelumne Aqueducts to fail. The probability of failure of the Mokelumne Aqueducts under this scenario was assessed to be 80%. The repair cost for the three pipelines was estimated to be $36.7 million and the total cost of pumping the make-up water during the service interruption was estimated to be about $6.4 million.

Information on the potential repair cost and revenue loss due to failure of the Kinder Morgan pipeline was unavailable from Kinder Morgan. However, information provided by DWR indicates that the Kinder Moran pipeline is a buried steel 10-inch diameter pipeline. The installed cost for such a pipeline is estimated at $200 per lineal foot, which was used to estimate the cost to repair the pipeline that crosses Woodward Island. Based on an assumed 600-foot-long section of pipe that may be damaged due to a scour hole caused by a breach, the repair cost is estimated to be $120,000. Information is unavailable on potential revenue loss and, therefore, this cost could not be assessed for this draft of the risk analysis. Furthermore, based on the available information, it appears that the product flowing through the pipeline could result in environmental clean-up efforts and associated costs if the pipeline were to rupture. The potential for revenue loss and environmental clean-up cost information is being sought and could be included in an updated draft.

Scenario 2: Breach on the Southeastern Edge of Embankment in front of Upper Jones Tract

Under this scenario, an outward breach could cause a failure of the Mokelumne Aqueducts, Kinder Morgan pipeline, BNSF railroad, or the levee on Upper Jones Tract.

Comparing the estimated depth of scour in the slough (Middle River) at the Mokelumne Aqueducts under this breach scenario with the depth and structural support of the pipelines, it was assumed that the scour might expose the pipes, but the piles would maintain their structural integrity. Therefore, the probability of a failure of any of the aqueducts due to scour was judged to be negligible. Based on the data from the June 3, 2004, Jones Tract flooding event, the scour dimensions were estimated to be 300 feet by 200 feet by 50 feet (length by width by depth) and the cost of scour backfill was estimated to be $1 million.

It was assumed that the Kinder Morgan pipeline would be placed in a trench with gravel bedding where it crosses the slough at Middle River. The repair cost was assumed to be $180,000.

Based on the depth of scour at the BNSF railroad bridge abutment at the edge of Upper Jones Tract and because the bridge is supported on deep piles, the probability that the bridge itself would fail from the scour impact was assessed to be negligible. However, the scour was assumed to cause a failure of the railroad embankment beyond the bridge abutment and displacement of railroad tracks. This railroad failure mode and abutment scour is consistent with what occurred when Lower Jones Tract flooded after the June 3, 2004, levee breach. Consistent with the June 3, 2004, Jones Tract failure, the cost of railroad repairs was estimated to be $8 million and the loss of revenue due railroad service interruption was estimated to be $15 million.

Based on a peak water velocity at the levee on Upper Jones Tract of 9 feet per second, the corresponding probability of failure of this levee was calculated to be 50%. The costs of a failure of the levee on Upper Jones Tract are estimated in Section 5.2.3 below.

Scenario 3: Breach on the Southwestern Edge of Embankment in front of Orwood Tract

Under this scenario, an outward breach could impact the railroad bridge embankment, the Mokelumne Aqueducts, Kinder Morgan pipeline, BNSF railroad, and the levee on Orwood Tract.

The depth of scour in the slough at the Mokelumne Aqueducts under this breach scenario was estimated to be 9 feet. As noted above, the probability of failure of the Mokelumne Aqueducts due to scour in the slough was assessed to be negligible and the cost of scour backfill around the aqueducts was estimated to be $1 million.

The peak velocity at the levee on Orwood Tract was estimated to be about 8 feet per second. The corresponding probability of failure of this levee was calculated to be 25%. If Orwood Tract flooded, the impact on the Mokelumne Aqueducts was assumed similar to that for Woodward Island under Scenario 1. The cost impacts of a failure of the levee on Orwood Tract are estimated in Section 5.2.3 below.

The repair cost of the Kinder Morgan pipeline where it crosses the slough at Old River was assumed to be $180,000, the same as the repair cost for the Middle River crossing.

The depth of scour at the railroad bridge abutment on the west side of Old River was estimated to be about 22 feet. As discussed under Scenario 2, such scour was assumed to result in a failure of the railroad embankment and displacement of railroad tracks and the estimated costs of railroad repairs and consequent loss of revenue were $8 million and $15 million, respectively.

Stockton Ship Channel and Bradford Island

The Stockton Deepwater Ship Channel (within the San Joaquin River) passes around the north side of Webb Tract. The river channel is about half-mile wide where it is adjacent to Webb Tract. If an outward breach were to occur in the reservoir embankment at Webb Tract, soils would be transported to the San Joaquin River. However, due to the width of the river, it is considered unlikely that a breach in the northern reservoir embankment at Webb Tract would have a significant impact on the ship channel.

An outward breach on the western Webb Tract embankment could cause a failure of the Bradford Island levee and flooding of this island. The resulting economic losses associated with flooding Bradford Island were estimated in the original risk analysis and have been updated (see Table 15, In-Delta Storage Program Risk Analysis, URS Draft Report) based on Jones Tract flood information.

5.2.3 Updated Consequences of Flooding of Neighboring Islands

In the event of an outward breach on the reservoir-island embankment caused by operational loading, the levee on the island adjoining the breach may also fail. Such a failure could occur due to the impact of waves generated from the reservoir island breach. The probability of failure of the levee depends on the width of the slough separating the two islands and on the success of any flood-fighting measures. The greater the width of the slough separating the two islands, the less severe the threat to the integrity of the neighboring island levee would be and the lower the probability of a levee breach on the neighboring island.

The risk of loss of life from the flooding of a neighboring island was considered to be insignificant. There should be sufficient warning time to any individuals inside the neighboring island after a breach of the reservoir island and they should be able to evacuate. The Jones Tract failure of June 3, 2004, did not cause loss of life.

Emergency Response

The emergency response costs and costs of repairing or replacing damaged levees, buildings, and infrastructure were estimated.

It was assumed that the emergency response cost per square foot of a flooded island after the flooding of a neighboring island would be similar to that experienced during the June 3, 2004, Jones Tract flood which was estimated to be $31 million (including the cost of pumping water out) or $2,560 per acre. For each neighboring island, this unit cost was multiplied by the area of the island to estimate the emergency response cost for that island.

Repair of Levee Breach

The cost of a levee breach repair was assumed to be $28 million based on the data compiled for the Jones Tract breach closure (see Section 5.2.1).

Repair of Buildings

Based on the data on building repairs on Upper Jones and Lower Jones Tracts after the flood, the average repair cost per building was estimated to be $360,000 per building. This unit cost was multiplied by the estimated number of buildings on each neighboring island to estimate the total building repair cost for the island if it were flooded.

Repair of Infrastructure

Repair of roads, bridges and railroads was included in the original risk analysis. For the railroad, the project team used the data provided by BNSF regarding railroad repair cost and loss of revenue after the Jones Tract flooding. The estimated railroad repair cost was $8 million and the estimated loss of revenue was about $15 million.

Impact to Infrastructure

Flooding of Upper or Lower Jones Tract was assumed to damage the BNSF railroad embankment and tracks. Based on the Jones Tract breach, the estimated costs of railroad repairs and consequent loss of revenue were $8 million and $15 million, respectively.

The probability of failure of the Mokelumne Aqueducts due to flooding of Upper or Lower Jones Tract was assumed to be negligible. However, data from the Jones Tract flooding showed that the pipeline coating was damaged. The EBMUD cost of coating (rust-proofing) the pipelines and related cleanup was estimated to be $10.6 million. The same cost impact to the Mokelumne Aqueducts was assumed for any future flooding of the Jones Tracts.

There was no reported damage to the Kinder Morgan pipeline during the Jones Tract levee failure. Therefore, the probability of damage of the Kinder Morgan pipeline due to flooding of Upper or Lower Jones Tract was assumed to be negligible.

Flooding of Woodward Island would cause a large scour hole that would likely impact the Mokelumne Aqueducts. As discussed in Section 5.2.2 the probability of failure of the aqueducts was assessed to be 80%; the repair cost was estimated to be $36.7 million; and the cost of making up lost water supply was estimated to be $6.4 million. Likewise, flooding of Woodward Island would cause a large scour hole that would likely impact the Kinder Morgan pipeline. As discussed in Section 5.2.2 the repair cost was estimated to be $120,000.

It was assumed that flooding of Orwood Tract would also cause similar impacts to the Mokelumne Aqueducts and the Kinder Morgan pipeline.

5.3 Summary of Results

Comparison of Failure Risks of Existing Levee and Re-Engineered Project

Table 5.1 shows a comparison of the failure probabilities and risks under the “no-action” alternative (i.e., existing levee) and the two re-engineered alternatives at Webb Tract and Bacon Island.

Table 5.1 – Comparison of Risks under Project Alternatives and Existing Levees

Reservoir Island	Annual Failure Probability			Expected Dollar Risk During 50 Years ($000) (probability weighted dollar risk)				Expected Number of Fatalities During 50 Years		
						Existing Levee				
	Rock Berm	Bench	Existing Levee	Rock Berm	Bench	Excluding loss of resources on the Project Island	Including loss of resources on the Project Island	Rock Berm	Bench	Existing Levee
Webb Tract	0.0107	0.0113	0.1120	18,625 (2,085)	19,613 (2,972)	170,352 (13,152)	299,452 (131,175)	0.0026	0.0064	insigni-ficant
Bacon Island	0.0109	0.0116	0.0820	18,962 (2,112)	20,196 (3,059)	119,005 (7,231)	342,909 (176,650)	0.0025	0.0073	insigni-ficant

Note: Numbers in brackets ( ) are from the June 2003 Draft Risk Analysis and are provided for reference only.

In calculating the expected dollar risk for the In-Delta Storage Project (IDSP) alternatives, the economic losses from the flooding of the project island were not included because, for the IDSP, the loss of current resources would not be related to the risk of failure of the project embankment. For a consistent risk comparison, the loss of current resources should not be considered for the “no-action” alternative (existing levee) as well. However, for a stand-alone (i.e., non-comparative) evaluation of the risk of the existing levee, this loss may be included. Table 5.1 shows the expected dollar risk of the existing levee failure under both scenarios.

The expected dollar loss including the loss of current resources on the project island under existing conditions is large because multiple levee failures could occur during a period of 50 years under existing conditions. It is assumed that after a levee failure that causes flooding of a project island, the levee would be repaired and the island would be redeveloped to its current land uses.

Referring to Table 5.1, the annual failure probability for the existing levee is higher than for the re-engineered alternatives by factors of 7 to 10. Similarly, the expected dollar risk, excluding the loss of current resources on the project island, is also higher for the existing levee than for the re-engineered alternatives by factors of 6 to 9. The reason that the risk is substantially lower for the re-engineered alternatives is that the project embankment under either alternative would be designed and constructed in accordance with current standards and hence the probability of failure would be much lower for the embankment than for the existing levee.

A comparison of the two re-engineered alternatives shows that the probability of failure and the expected dollar risk are about the same for the two alternatives at both project islands (see Table 5.1). The fatality risk under both alternatives is relatively low at each project island, although it is lower for the Rock Berm alternative than for the Bench alternative. For example, the expected number of fatalities over a 50-year period under the Rock Berm alternative is about 0.0025 at either project island. This means that the likelihood of one fatality under the Rock Berm alternative over 50 years is 1 in 400. The expected number of fatalities over a 50-year period for the Rock Berm alternative is lower than for the Bench alternative by a factor of about 2.5 to 3, at both Webb Tract and Bacon Island. This is because the probability of embankment failure for the Rock Berm alternative is lower under seismic loading.

Table 5.2 shows the contributions of the three loading events to the overall failure probability and risk for each project alternative at the two candidate project islands. For the two re-engineered alternatives, operational loading contributes about 1% to the failure probability and expected dollar risk because the failure probability for the re-engineered alternatives under operational loading is small. Flooding and seismic loading events contribute about 40% and 60%, respectively, to the failure probability and expected dollar risk for the re-engineered alternatives. The probability of failure under flooding is mostly due to overtopping, while the contribution of piping/internal erosion to the probability of failure is minor. With regard to the expected number of fatalities for the re-engineered alternatives, almost all of the contribution is from seismic loading. Flooding does not contribute to the fatality risk, because only an inward breach is possible under flooding and the fatality risk under an inward breach is negligible.

For the existing levees at the proposed project islands, both flooding and operational loading have major contributions to the failure probability and expected dollar risk, while seismic loading has a smaller contribution because the overall probability of failure of the existing levees is higher under flooding and operational loading than under seismic loading. With the low crest elevation of the existing levees, a 100-year flood is likely to cause overtopping.

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Table 5.2 – Risk Contributions of Loading Events

Reservoir Island	% Contribution to Annual Failure Probability			% Contribution to Expected Dollar Risk During 50 Years ($000)				% Contribution to Expected Number of Fatalities During 50 Years		
						Existing Levee				
	Rock Berm	Bench	Existing Levee	Rock Berm Altern-ative	Bench Altern-ative	Excluding loss of resources on the Project Island	Including loss of resources on the Project Island	Rock Berm	Bench	Existing Levee
Webb Tract										
Flooding	42%	39%	48% (62)	40%	38%	41% (21)	44%	0%	0%	
Seismic	57%	60%	7% (9)	59%	61%	8% (4)	8%	98%	99%	N/A
Operational	1%	1%	45% (29)	1%	1%	51% (75)	48%	2%	1%	
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Bacon Island										
Flooding	41%	38%	65% (74)	39%	37%	58% (38)	63%	0%	0%	
Seismic	58%	61%	10% (12)	60%	62%	12% (7)	11%	98%	99%	N/A
Operational	1%	1%	24% (14)	1%	1%	30% (55)	26%	2%	1%	
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	

Note: Numbers in parentheses ( ) are from the June 2003 Draft Risk Analysis and are provided for reference only.

5.4 Risk Analysis Conclusions

Without the project, the existing levee on a project island could fail first in a flood, which would reduce the likelihood of a levee failure on a neighboring island. With the project embankment, the probability of a failure of the project island embankment would be substantially reduced. This, in turn, may increase the probability that a levee on a neighboring island would fail first. However, because the perimeter of a project island embankment is only a fraction of the total perimeter of levees on all neighboring islands, the potential increase in the probability of a levee failure on a neighboring island is likely to be relatively small. Additional engineering investigations could be performed to quantify the associated probabilities.

The overall In-Delta Storage Project risk is calculated as the product of the probability and cost of project failure. Although the probability of a failure for the project embankments is low (about 1% chance in any given year), the cost of a failure, should one occur, would be relatively high (anywhere from $30 million to $140 million depending on the failure scenario). The expected (probability-weighted) cost of failure over the life of the project would be about $20 million. The annual failure probability and the expected dollar risk during the 50-year project life are about 6 to10 times greater under existing conditions than for the proposed project. In other words, the In-Delta Storage Project reduces the failure probability and the economic losses by factors of 6 to 10.

6. Environmental Evaluations

6.1 Introduction

Past evaluations conducted for the State Feasibility Report updated and supplemented resource information. Recent environmental evaluations examined work needed for future CEQA compliance. Additionally, giant garter snake studies were completed. A report providing a perspective regarding how the Delta landscape is changing and a plan to investigate fishery declines in the Delta were released.

6.2 Future CEQA Analyses

Work needed to comply with the CEQA was evaluated using an Initial Study format. Past environmental documents and analyses were reviewed and areas where the proposed IDSP differs from the Delta Wetlands project identified. Based on the preliminary Initial Study, there are enough substantial differences between the Delta Wetlands project and the IDSP to require a subsequent EIR.

Following guidance in the "Guide to Regulatory Compliance for Implementing CALFED Actions", the CALFED "Environmental Consequences-Mitigation Strategies Checklist" was completed in the evaluations. Impacts, mitigation strategies and information contained in the CALFED Programmatic EIS/R were considered during preparation of the Initial Study.

Table 6.1 lists the resource areas additional environmental analyses are required. Resource areas are organized as presented in the CALFED Environmental Consequences-Mitigation Strategies Checklist. The reasons additional environmental analyses are required include:

- Resource area not previously covered – past environmental analysis not performed.
- Different project operation/facilities – the IDSP has consolidated points of diversion and includes circulation of water in the reservoirs to help meet Delta Wetland water right permit conditions.
- Levee work requires more construction work and embankment materials – IDSP includes strengthening of levees requiring more construction and substantial quantities of rock and fill materials to be imported onto the islands.
- New recreation plan needed – IDSP will include public recreation facilities; a detailed recreation plan for IDSP needs to be developed to analyze environmental impacts in various resource areas.
- CALFED commitment – in the CALFED Record of Decision, commitments were made by the CALFED agencies, including commitments regarding environmental justice, Indian Trust assets and agricultural lands. DWR, as a CALFED agency, will include these considerations in the EIR.
- State ownership/participation – the IDSP may be owned by the state or operated with state participation. State involvement may require a different approach or treatment of certain resource areas than a privately owned facility.

Table 6.1 – Additional Work Required for CEQA Compliance

Resource Area	Additional work required	Reason
Water Supply and Water Management	Yes	Different project operation/facilities.
Bay-Delta Hydrodynamics and Riverine Hydraulics	Yes	Different project operation/facilities.
Water Quality	Yes	Different project operation/facilities.
Groundwater Resources	No	Not a water supply issue in the project area; seepage is covered under flood control. If groundwater recharge is included as a purpose of water use upon delivery to a service area, groundwater impacts will be evaluated in the analyses of service area impacts.
Geology and Soils	No	Impacts relating to geology and soils were covered in the DW EIS/R in other resource areas: water quality, agricultural land use and flood control. For consistency, further IDSP environmental work should maintain the past treatment of impact analyses and treat geology and soil impacts within the other resource areas.
Noise	Yes	Not previously covered. Levee work requires more construction work and embankment materials. Different project operation/facilities.
Transportation	Yes	Levee work requires more construction work and embankment materials. New recreation plan needed.
Air Quality	Yes	Levee work requires more construction work and embankment materials. New recreation plan needed.
Fisheries and Aquatic Ecosystems	Yes	Different project operation/facilities. Levee work requires more construction work and embankment materials.
Vegetation and Wildlife	Yes	Different project operation/facilities. Levee work requires more construction work and embankment materials. New recreation plan needed. Habitat Restoration Plan for habitat islands needs to be updated and revised.
Agricultural Land and Water Use	Yes	CALFED commitment.
Urban Land Use	No	IDSP will not directly affect urban land use. Indirect and growth inducing impacts related to urban land use will be included in water service area impact analysis.
Utilities and Public Services	Yes	New recreation plan needed. State ownership/participation.
Recreation Resources	Yes	New recreation plan needed. State ownership/participation.
Flood Control	Yes	Levee work requires more construction work and embankment materials.

Cultural Resources	Yes	Required under existing draft Historic Properties Management Plan (HPMP). Different project facilities/new recreation plan may require additional Advisory Council on Historic Preservation (ACHP) National Historic Preservation Act (NPHA) Section 106 consultation.
Public Health and Environmental Hazards	Yes	Different project operation/facilities. Levee work requires more construction work and embankment materials. New recreation plan needed. Habitat Restoration Plan for habitat islands needs to be updated and revised.
Visual Resources	Yes	New recreation plan needed. Levee work requires more construction work and embankment materials. Different project operation/facilities.
Environmental Justice	Yes	CALFED commitment. State ownership/participation
Indian Trust Assets	Yes	CALFED commitment. Not previously covered.
Service Area Impacts and Growth Inducing Impacts	Yes	DWs EIR/S covered service areas generally; IDSP will be more specific as to where and how water will be used. Service area environmental consequences, including growth inducing impacts, will be evaluated.

6.3 Giant Garter Snake Surveys

Surveys and habitat evaluation for giant garter snakes on the project reservoir islands have been completed. In the two years of extensive surveys, no giant garter snakes were caught or observed, and all identifiable snakes were either Pacific gopher snakes or western yellow-bellied racers.

Potential giant garter snake habitat on the reservoir islands was re-evaluated based on field surveys performed in 2003. Potential habitat estimates were reduced from the 2002 habitat estimates reported in the 2004 Environmental Evaluations for the 2004 Draft State Feasibility Study. The 2002 estimates and 2003 revisions are shown in Tables 6.2 and 6.3.

Table 6.2 – Potential GGS Habitat on Bacon Island

	2002				**2003**			
	Hectares	Acres	Kilo-meters	Miles	Hectares	Acres	Kilo-meters	Miles
High	34	85	14	9	7	16	2	1
Moderate	44	110	49	31	28	70	20	13
Low	39	96	90	56	56	137	121	75
Upland	179	443	-	-	88	217	-	-
Total	**297**	**734**	**153**	**95**	**178**	**440**	**144**	**89**

Table 6.3 – Potential GGS Habitat on Webb Tract

	2002				2003			
	Hectares	Acres	Kilo-meters	Miles	Hectares	Acres	Kilo-meters	Miles
High	44	108	20	12	22	54	7	5
Moderate	40	98	42	26	24	59	19	12
Low	21	52	49	31	36	89	74	46
Lakes	35	87	6	4	34	84	5	3
Upland	245	609			91	226		
Total	**384**	**949**	**118**	**73**	**207**	**511**	**106**	**66**

The survey and habitat evaluation methods and results are described in the following reports:

- Giant Garter Snake Surveys for the In-Delta Storage Program, Year-end and Summary Report, 2004
- Giant Garter Snake Habitat Evaluations on Bacon Island and Webb Tract in 2003
- Giant Garter Snake Surveys on Bacon Island and Webb Tract in 2003.

6.4 Related Work

Jeffery Mount and Robert Twiss, members of the ISB Levee Fact-Finding Team, issued a report in December 2004 titled "Subsidence, Sea Level Rise, Seismicity in the Sacramento-San Joaquin Delta: Report to the Levee Integrity Subcommittee of the California Bay-Delta Authority Independent Science Board." This report noted that subsidence in the Delta is changing the Delta landscape. Floods and earthquakes are capable of causing rapid changes in the Delta landscape and, when considered with ongoing subsidence, there will be "a tendency for increases in and impacts of island flooding, with escalating costs for repair and increasing threat to CALFED programs." The report notes that there is no overarching policy of the California Bay-Delta Authority that "addresses the consequences of, and potential responses to, gradual or abrupt landscape change in the Delta". The full report is at:

http://www.science.calwater.ca.gov/pdf/isb/ISB_subcom_levee_report_120104.pdf

This report provides a perspective on how the Delta landscape may change. While not eliminating the threat of gradual or abrupt landscape change throughout the Delta, IDSP would cause a change in land use that would stop subsidence, strengthen the levees and reduce the need for levee repair at the two reservoir islands. The habitat islands would be managed to reduce or eliminate subsidence and levee failure repair would be funded by the project.

In October 2005, the Delta Smelt Action Plan was released. Monitoring by the Interagency Ecological Program (IEP), an estuary monitoring and research program conducted by six federal and three state agencies, has identified declines in numerous pelagic fish in the Delta. The abundance indices from 2002 to 2004 include record lows for delta smelt and young striped bass, and near-record lows for longfin smelt and threadfin shad. In addition to the changes in fish populations, IEP monitoring also found declining levels of zooplankton, such as copepods. The Delta Smelt Action Plan, developed by DWR and DFG, describes the IEP's current activities and planned actions. Although the plan is specific to delta smelt, state and federal agencies recognize that a better strategy is a multispecies approach to species protection through habitat conservation. In general, actions that benefit delta smelt will likely benefit other pelagic organisms and possibly the entire estuarine system. The full plan can be reviewed at:

http://www.publicaffairs.water.ca.gov/newsreleases/2005/10-20-05deltasmelt.cfm

The effects of these fishery and ecosystem problems to IDSP will need to be determined with State and federal fishery agencies.

7. Economics

7.1 Economic Analysis

No new economic analysis of the project was completed during the supplemental phase of the study. The Surface Storage Program common assumptions process is developing common guidelines for comparison of all five storage projects. One part of this process is related to updating the economic models and benefits evaluation procedures. With past economic information available for SWP and Central Valley Project (CVP) water supplies, it is relatively easy to assess economic benefits of water supply. However, value of environmental restoration and water quality improvements is difficult to assess.

A description of tasks for the Common Assumptions Economics Workgroup is given below. The first two tasks are continuations of current work and have the highest priority, though much of the work on updates to the Least-Cost Planning Simulation Model (LCPSIM) and the Central Valley Production Model (CVPM) will be accomplished by the start of next fiscal year – those items will shift over to ongoing assistance to study teams.

1. Continue review and upgrade to existing tools to be used for Economic Analysis, and coordinate/assist in their use: LCPSIM, CVPM and Long-term California Agricultural Model (CALAG) Development. Coordinate cost estimation procedures and guidelines across study teams.
2. Review relevant water quality benefit studies and develop recommended guidelines.
3. Develop recommended guidelines for estimating other benefit categories.
    a. Ecosystem restoration benefits
    b. Flood control
    c. Hydropower
    d. Recreation
4. Develop estimates of the amount and value of water transfers and incorporate water conservation assumptions, costs and potentials into the analysis of storage benefits.
5. Prepare guidelines for benefit-cost analysis.

The Common Assumptions work for the Plan Formulation analysis is planned for completion by the end of 2005. A detailed economic analysis of the IDSP will be rerun with updated economic models in response to the comments made on economic analysis during the public review process.

8. Conclusions and Recommendations

8.1 General

During four years of In-Delta Storage studies, DWR has developed significant new information related to project design, water supply and water quality operations, and environmental considerations. This supplemental study has attempted to further reduce uncertainty regarding these issues and resolve concerns expressed by reviewers, including the Science Panel, water users, and state and federal agencies.

8.2. Conclusions

8.2.1 Water Supply Operations and Water Quality

- Enhanced simulations of operations that account for organic carbon constraints were completed for this supplemental study. These simulations demonstrate average annual project yields of 107,000 acre-feet (under the initial carbon loading rate assumption) to 120,000 acre-feet (under the long-term carbon loading rate assumption). In comparison, simulations of operations for the 2004 Draft State Feasibility Study (that did not account for organic carbon constraints) demonstrated an average annual project yield of 136,000 acre-feet. It should also be noted that other non-yield benefits to the project, such as water management flexibility, have not been quantified.
- A critical analysis of four operational scenarios indicates that water supply, the Environmental Water Account (EWA), the Ecosystem Restoration Program (ERP), and water quality benefits under each scenario expressed in terms of water quantity are additive and the benefits under each scenario can be realized simultaneously. (See Section 3.2, *Operational Strategy*)
- Tank experiments conducted as part of this investigation indicate initial year flooding of the reservoirs will cause high organic carbon loading rates similar to that observed during the Jones Tract flood. However, the organic carbon loading rate will likely decline over several years toward a lower longer-term loading rate. In the tank experiments, organic carbon loading rates decreased over a two year period by 68 percent.
- Water supply reliability and water quality studies included in this report incorporate most of the restrictions in the Water Quality Management Plan (WQMP). (The WQMP, which prevents the release of water that will degrade the water quality and beneficial uses of Delta water, is included in the Protest Dismissal Agreements (PDAs) executed by Delta Wetlands Properties with CUWA, CCWD, and EBMUD. The SWRCB Water Rights Decision 1643 incorporates the terms and conditions of the PDAs). More long-term scientific research, including model development, field testing and data collection, will be necessary to better estimate the effects of these regulations on water supply benefits. (See Section 3.1, *Introduction*).
- Water quality modeling conducted for this study does not account for the potential effects of the cessation of agricultural drainage from the project islands (Bacon Island and Webb Tract) on the water quality of the Delta channels. With a conversion from agriculture to project uses, past agricultural drainage patterns from the project islands would be replaced by project operations. More detailed water quality modeling that accounts for this change could reduce the water

quality release requirements in the simulated project operations and result in improved estimates of project water supply benefits.

- Water quality data collected during the Jones Tract flood suggest that dissolved oxygen (DO) and temperature of water stored on Delta islands may vary significantly with time of day. This may require further refinement in operations and implementation rules to assure that water discharged from the islands meets fishery requirements. Modeling DO concentrations within an island reservoir system will be complicated. However, such an analysis may be beneficial to determine the risk of reservoir DO falling below allowable levels. Dr. Reddy's report also points towards an inverse DO – TOC relationship, which also may be useful to explore.
- No new temperature studies were done for the Draft Supplemental Report. Work is needed to include temperature considerations in modeling DOC and DO. Temperature plays an important role in the solubility of substances in water. A more dynamic approach in which DOC growth rates and DO concentrations are related to temperature would produce more realistic simulations of carbon and DO effects caused by the reservoir islands. While further analysis may result in a daily operations plan that can accommodate the projected changes in DO and temperature without affecting project performance, these constraints could affect estimated project yield. Similarly, the analysis may indicate the need to modify operations, facilities, and monitoring, or the need to adjust water rights or develop contingency plans.
- The State Court of Appeals has set aside SWRCB D1643 and the water right permits issued to Delta Wetlands. That not withstanding, this report has used the PDA's, SWRCB D1643, and the WQMP to fully describe and analyze the project as the reasonable and best available definition of likely permit condition.

8.2.2 Engineering Considerations

- **Project Cost:** Using new information on foundation soils from 2004 drilling, estimated costs of all four Integrated Facility structures are reduced by about $9 million. The change in slope treatment from soil cement to riprap will increase costs by about $19 million. An overall increase in project cost with contingencies will be about $15 million. Therefore, the 2004 Draft State Feasibility Study estimated project cost of $774 million is increased to $789 million.
- **Seepage to Adjacent Islands:** The 2004 Draft State Feasibility Study estimated seepage to adjacent islands resulting from water being stored on Webb Tract and Bacon Island. A seepage calibration study, which modeled seepage conditions at McDonald Island during the Jones Tract flood and compared them with observed conditions, validates the approach used in the In-Delta Storage Program seepage models and concludes that those models provide a reasonable estimate of the average seepage conditions for the proposed Webb Tract and Bacon Island reservoirs. Accordingly, the proposed seepage control measures are adequate to protect neighboring land owners.
- **Stability of Embankments:** The use of soil cement for slope protection on the reservoir side of the project embankments for protection against wind and wave action is not a suitable solution. Riprap slope protection is recommended. Soil cement is a rigid mass system which requires a relatively static environment and stable foundation, and the Delta islands are known to have high settlement

characteristics. This combined with exposure to dynamic wave action could cause the soil cement slope protection to have a service life much shorter than the Project's design life. Soil cement is relatively impervious and prone to cracking. Rapid drawdown during reservoir operations or wave action could cause failure.

- **Risk Analysis:** Results of the updated risk analysis including additional infrastructure (EBMUD Mokelumne Aqueducts, BNSF railroad, PG&E gas lines and Kinder Morgan pipelines) and recent Jones Tract flood information show that the overall expected probability of project failure risk is similar to the original risk analysis. The annual failure probability and the expected dollar risk during the 50-year project life are about 6 to10 times greater under existing conditions than for the proposed project. In other words, because of embankment improvements, the In-Delta Storage Project reduces the failure probability and the economic losses by factors of 6 to 10 in comparison to existing conditions.
- **Technical Feasibility:** DWR reaffirms its prior finding that the In-Delta Storage project is technically feasible. DWR is satisfied that it can safely design, construct and operate an In-Delta Storage Project (as disclosed in this and other DWR reports).

8.2.3 Environmental Evaluations

- Work needed to comply with the CEQA was evaluated using an Initial Study format. Past environmental documents and analyses were reviewed and areas where the proposed IDSP differs from the Delta Wetlands project identified. Based on the preliminary Initial Study, there are enough substantial differences between the Delta Wetlands project and the IDSP to require a subsequent EIR. Any such additional environmental review should make extensive use of work already done by Delta Wetlands and DWR.
- Potential giant garter snake habitat on the reservoir islands was re-evaluated based on field surveys performed in 2003. Two years of extensive surveys found no giant garter snakes on the Webb tract and Bacon Island. Section 6.3, Giant Garter Snake Surveys, details the results of the work performed for this project. Potential giant garter snake habitat on Webb tract and Bacon Island is decreased by 50 percent from the 2002 habitat estimates reported in the 2004 Environmental Evaluations for the 2004 Draft State Feasibility Report.

8.2.4 Economic Evaluations

- No new economic analysis of the project was completed during the supplemental phase of the study. Work is ongoing through the CALFED Surface Storage Program Common Assumptions effort to better quantify the economic value of water supply benefits that could be produced by the In-Delta Storage project and other CALFED surface storage proposals. One part of this process is related to updating the economic models and benefits evaluation procedures. With past economic information available for SWP and Central Valley Project (CVP) water supplies, it is relatively easy to assess economic benefits of water supply. However, value of environmental restoration and water quality improvements is difficult to assess. The existing economic analysis does not fully quantify all of the potential project benefits and, therefore, cannot be compared directly to project costs.

8.3 Recommendations

The Department of Water Resources, acting as the State implementing agency for the CALFED Bay-Delta Program surface storage projects, has refined the In-Delta Storage project proposal and developed a substantial body of information to facilitate its evaluation and consideration. Additional work to add to the existing body of information and further reduce uncertainty regarding the In-Delta Storage project proposal would require significant new investment in field testing, data collection and modeling to better understand the effects of DOC, DO, temperature, and taste and odor on project operations and potential water supply benefits.

DWR believes that sufficient technical information is now available for potential project participants to evaluate their interest in the In-Delta Storage Project. To date, DWR has not received any expression of interest from potential project participants willing to use water developed by the project and share in project costs. DWR acknowledges that some potential project participants may be reluctant to express an interest in any CALFED surface storage proposal until equivalent, comparable information is available for other CALFED surface storage proposals.

DWR recommends that further detailed study of the In-Delta Storage project be suspended until adequate technical information is available for other CALFED surface storage projects. DWR further recommends that limited economic study and operations modeling of the In-Delta Storage project proposal continue through the CALFED Surface Storage Program Common Assumptions effort. This information will allow DWR and potential project participants to continue to compare the In-Delta Storage project proposal to other CALFED surface storage proposals as work on those proposals advances.

8.4 Next Steps

If a future decision is made to continue work on the In-Delta Storage Project, the following next steps are recommended:

- Conceptual models for water quality effects should be advanced to evaluate the entire conceptual model and refine project operations. Refined operations will help define benefits, costs and risks, and identify needed modifications in facilities, monitoring, contingency plans or water rights.
- Significant investment in field testing, data collection and modeling is needed to reduce uncertainty associated with project operations, water supply and quality benefits, and the effects of dissolved organic carbon, dissolved oxygen, temperature and taste and odor on project water supply and quality. Future operations studies must be refined by incorporating the findings from new field testing and data collection and presented with greater assurances that reported benefits will be obtained by project participants.
- A factor affecting water system operations in the Delta is the potential landscape change in the Delta. This needs to be incorporated into future project evaluations. The ISB Levee Fact-Finding Team issued a December 2004 report that noted floods and earthquakes are capable of causing rapid changes in the Delta landscape. When considered with ongoing subsidence, there will be “a tendency for increases in and impacts of island flooding, with escalating costs for repair and increasing threat to CALFED programs.” IDSP would cause a change

in land use that would stop subsidence, strengthen the levees and reduce the need for levee repair at the two reservoir islands. The two habitat islands would be managed to reduce or eliminate subsidence and levee failure repair would be funded by the project.

- Another factor affecting water system operations in the Delta, and for IDSP specifically, which must be incorporated into future project evaluations is the pelagic fish decline and associated ecosystem concerns in the Delta. Monitoring by the Interagency Ecological Program (IEP) show the abundance indices from 2002 to 2004 include record lows for delta smelt and young striped bass, and near-record lows for longfin smelt and threadfin shad. Because IDSP operations are tied to the delta smelt fall mid-water trawl index (as outlined in the USFWS Biological Opinion), delta smelt recovery is essential for successful operations of IDSP.
- Better quantification of the economic benefits of the project proposal is needed. As stated above, while it is relatively easy to assess economic benefits of water supply, the values of environmental restoration and water quality improvements are more difficult to assess. The existing economic analysis does not fully quantify all of the potential project benefits and, therefore, cannot be compared directly to project costs. DWR should continue to advance its economic analysis of these benefits through the Common Assumptions effort with State, Federal and local stakeholders.
- Early and frequent communications and participation with Delta stakeholders should be undertaken to provide assurances that any project design and operations plan will protect lives, property, business, infrastructure, and other social and economic interests in the Delta. Local concerns include seepage to adjacent islands, land use changes resulting in loss of agricultural lands, recreation impacts, and mitigation for environmental impacts.
- Maintain an open dialogue with local, state and federal interests and define specific project formulations that best describe their interests.
- Address future authorization for federal participation. Currently, IDSP does not have federal feasibility authority.
- Reinitiate the CEQA process and include analysis of refined of the operational plans to resolve water quality issues. Any such additional environmental review will make extensive use of work already done by Delta Wetlands and DWR.
- Complete a final subsequent EIR.