Appendix F

Wet Year/Groundwater Storage Conceptual Alternative—Programmatic Evaluation

Technical Memorandum

Freeport Regional Water Authority

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Introduction

This document evaluates the range of technical, environmental, and institutional effects associated with utilizing a Wet Year/Groundwater Storage Conceptual Alternative to minimize dry year diversions of surface water from the Freeport Intake for the Freeport Regional Water Authority (FRWA). This effort was initiated by FRWA in response to comments during the scoping process for the Freeport Regional Water Project (FRWP) EIR/EIS, as well as a logical extension of some programmatic exploration of wet year diversions and groundwater storage elements of previous EIR/EIS processes within which EBMUD has investigated export of its entitled surface water to meet dry year demands. The primary purpose of this exercise is to explore the hypothesis that a modified FRWP that includes wet year diversions and groundwater storage would result in reductions to the effects anticipated downstream of Freeport. This document will bracket the potential effects of this concept, in order to evaluate this alternative at a programmatic level in the FRWA environmental document. The following parameters are the primary indicators used to evaluate potential effects:

- Tracy pumping;
- North of Delta Central Valley (CVP) Project storage;
- Oroville Reservoir storage;
- CVP and State Water Project deliveries; and
- Delta salinity (as measured by the position of the X2 location in kilometers).

These parameters provide a separate measure of a project's effect on the Bay-Delta environment or on the water storage and conveyance system of the CVP and the SWP and the respective customers of each. This document identifies four potential scenarios that reasonably test the hypothesis that a modified alternative would result in significant downstream benefits that might justify the additional financial investment in additional storage and conveyance (over and above the Base Project).

The Base Project would divert surface water from the Sacramento River at Freeport, California, and convey the surface water to the proposed SCWA water treatment facility in Sacramento County, and to EBMUD at the Folsom South Canal (FSC). The Base Project would deliver water to EBMUD during dry years and to SCWA during all years, though SCWA would receive more water during wet years than dry years. The intent of this evaluation is to investigate how a change in the planned FRWA yearly diversions from the Freeport Intake, primarily during wet years, instead of diverting water primarily during dry years, would affect project parameters such as cost, schedule, downstream delta outflow, water quality, and downstream deliveries, groundwater level fluctuations and other environmental measures. The stored water or natural groundwater would be delivered to FRWA for use by EBMUD and SCWA primarily during dry years, reducing the FRWA dependence on dry year diversions. The impact of this operational approach would be to increase natural flows to the Delta during dry years, potentially increasing water availability and improving water quality, while potentially providing benefits to the Sacramento groundwater basin(s).

The Base Project and Wet Year/Groundwater Storage Alternative are intended, within the context of the Water Forum, to meet the long-term surface and groundwater needs in Sacramento County's Zone 40 and EBMUD's dry year (drought-related) needs through the long-standing contract for water from the American River. One of the key project objectives for evaluating the feasibility of each candidate scenario is that the scenario cannot delay project implementation, since this project is a critical water supply source for both SCWA and EBMUD.

This document does not evaluate other types of storage, such as construction of a reservoir, construction of storage facilities near EBMUD's service area, or modification of the surface water diversion point to facilitate storage elsewhere. These projects are identified as alternatives in the EIR document, and the impacts of those are summarized there. This document also does not evaluate the storage of Mokelumne River water in upcountry groundwater basins such as the Galt Basin. The institutional constraints analyzed for storing Sacramento River water in the Galt Basin (resulting in at least a 10-year delay in project implementation, making the alternative infeasible as a stand alone project) would be similar for storing Mokelumne River water in the Galt Basin for subsequent delivery back to EBMUD.

This document also does not evaluate the technical and operational issues of exchange and recovery of American River water in the North Basin for EBMUD use in dry years, although the institutional analysis herein does address this potential alternative and finds it infeasible for full scale implementation in the short-term. The Sacramento Groundwater Authority (SGA), which governs the North Basin, does not establish groundwater baseline usages or enforceable banking provisions, and allocation of groundwater to non-SGA signatories could not be reliably accomplished at this time (would have to be acceptable to all 15 signatories). These factors would not necessarily limit EBMUD or SCWA's participation in the water bank, but would constrain FRWA from relying exclusively on banking in the North Area to meet total project needs for either EBMUD or SCWA.

The analysis of potential effects on the downstream Delta environment was evaluated in two steps. The first evaluated modifications to the EBMUD diversion schedule. Since EBMUD wet year diversions appeared to provide measurable benefits, the second step incorporated modifications to the SCWA and EBMUD diversion schedules. This stepwise analysis was performed to analyze the impacts of changing the EBMUD diversions on the SCWA ability to acquire "Other" or "Excess" water from the FRWA intake (in other words, to ensure that changing the timing of diversions would not adversely affect the availability of surface water to EBMUD and SCWA and detract from the project purpose).

This document evaluates the change in the EBMUD diversion schedule from a predominantly dry year[1] diversion to a predominantly wet year[2] diversion (Scenarios 1 and 2), and determines the potential benefits and impacts associated with implementation of this change in the Freeport project. Scenario 3 was developed to evaluate the overall effects of changing both the SCWA and EBMUD diversion schedules to emphasize wet year diversions. Scenario 4 was developed to evaluate the change in effects of the Freeport Project if SCWA only were to change its diversions to predominantly wet year diversions with injection and storage in the Central Basin.

Document Organization

This document is organized as follows:

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[1] Dry year is defined by a rating of 4 or 5 in the Sacramento River 40-30-30 index.
[2] Wet year is defined by a rating of 1 or 2 in the Sacramento River 40-30-30 index.

- Scenario 2 – Wet Year Groundwater Storage for EBMUD (Percolation/In-Lieu in Galt Basin)
- Scenario 3 - Wet Year Groundwater Storage for EBMUD and SCWA (Percolation/In-Lieu in Galt Basin and Conjunctive Use in Central Basin)
- Scenario 4 - Wet Year Groundwater Storage for SCWA (Conjunctive Use in Central Basin)

Groundwater Basins for Potential Storage and Recovery

There are three groundwater basins in Sacramento County being considered within the context of the Water Forum for the long-term storage of surface water identified in this alternative: the North, Central, and Galt Basins. A brief description of the available information for each basin is summarized below. Each may represent a technically effective mechanism to store treated surface water locally during wet years. A map of each basin is presented in Figure 1. For the purposes of this Technical Memorandum, the groundwater basins limits are as defined by the Water Forum in its 2001 Annual Report. Table 1 quantifies the sustainable yield, capacity, and key features of each basin. Note: compare to the annual injection and withdrawals we are proposing for EBMUD and SCWA.

Table 1: Summary of Groundwater Basin Characteristics

Basin	Sustainable Yield[1] (AFY)	Volume[2] (AF)
North Basin	131,000	1,500,000[3]
Central Basin	273,000	4,816,000
Galt Basin	115,000	6,000,000

1: Based on information in the Water Forum Agreement, 2001
2: Based on DWR Bulletin 118 estimates. Note that the Water Forum defines the groundwater basins limits within Sacramento County, but the basins extend outside of Sacramento County in the DWR definition.
3: Estimated by MWH in the ARBCA Evaluation as "Available Storage". Total Basin Volume would be much larger. Taking into account the physical characteristics of the basin and potential contamination, the available "exercisable" storage is 0.5 Million AF. Current groundwater demand among SGA members in the basin is about 100,000 AF/year.

Additional technical information about each basin and the rationale for identifying the Scenarios identified in the following section is summarized in the appendix.

Figure 1: Map of Sacramento County Basins

Scenario Identification

Each Scenario identified in this document builds upon the Base Project, which is the preferred alternative of the EIR/EIS. This project would deliver water from Freeport during all years to SCWA, and during dry years to EBMUD. This project includes all of the facilities required to deliver the surface water, including a Sacramento River intake, conveyance facilities to the SCWA treatment plant and Folsom South Canal, and EBMUD treatment facilities.

For the development of each Scenario, it was desired to utilize the same water diversion capacity of 185 MGD from the Freeport intake but modify diversions and identify the facilities to utilize the water under the new schedule. In each Scenario, it was assumed that only 90% of the water stored in the groundwater basin can be extracted. This difference accounts for the technical constraints that some of the water recharged (injected and percolated) cannot be recovered and is no longer available for extraction. Artificial recharge can result in decreased natural recharge or increased basin outflow.

In addition, this constraint relative to EBMUD has additional importance. Since EBMUD is not a local purveyor, EBMUD can only extract the same volume of surface water, minus losses, in order to reduce the chances of injury to other groundwater users in the Basin. Water Code 1220 also prohibits the export of groundwater from the combined Sacramento and Delta-Central Sierra Basins, as defined by DWR

Bulletin 160-74, unless the pumping complies with a groundwater management plan adopted by the County, or portion of the County, that overlies the groundwater basin. The boundaries of these protected basins include Sacramento County (including North, Central and Galt areas). Thus, pursuant to the Water Code, unless there is a voter-approved AB 3030 plan, which provides for the export of groundwater (there is not), EBMUD would be limited to using only an equivalent amount of surface water that was stored in the groundwater basin, minus losses.

Four potential Wet Year/Groundwater Storage Scenarios were identified in this document. Each Scenario is summarized below.

Scenario 1 – Wet Year Groundwater Storage for EBMUD (Injection in Central Basin)

The workplan identified the concept of surface water recharge from the Freeport intake in all three groundwater basins. For the development of this document, the initial thrust for scenario identification was to limit any modifications only to the EBMUD portion of the surface water diversions, and determine their impact on the availability of surface water supplies to SCWA. This hypothesis was based on the belief that modifications to the EBMUD diversion schedule may negatively affect the ability of SCWA to obtain "Excess" or "Other" water from the Freeport Intake. Thus, it was decided to model modifications to the EBMUD diversions and opportunities for recharge first, then to model the combined modifications to EBMUD and SCWA diversions to ensure adequate water availability.

This scenario would utilize the same facilities as identified in the Base Project, but add additional infrastructure to store surface water from Freeport in the Central Basin. SCWA would divert, treat, and store surface water from Freeport in the same manner as the Base Project. EBMUD would divert surface water from Freeport during wet and above normal years, and not divert during dry, below normal or normal years. This EBMUD diversion would be conveyed to the SCWA Water Treatment plant and treated to a level sufficient for injection into the Central Basin. The injection would be accomplished with a series of injection wells in the eastern part of Zone 40, generally between the Folsom South Canal and Bradshaw Road. During dry or critical years, water would be extracted from wells down gradient (south and west) of the injection wells, and conveyed to EBMUD through the Folsom South Canal, which would ultimately deliver water to the Mokelumne Aqueduct, similar to the Base Project.

Scenario 2 – Wet Year Groundwater Storage for EBMUD (Percolation/In-Lieu in Galt Basin)

Scenario 2 contemplates the diversion of EBMUD water in wet and above normal years from the Sacramento River at Freeport and the diversion of SCWA water at Freeport under its Base Project diversion schedule. The SCWA water would be treated and distributed as contemplated within the Base Project. The EBMUD water would be pumped directly to the FSC and conveyed through the FSC to the Galt Area for in lieu and direct recharge. The water would be pumped from the FSC through a distribution system and 80% of the water would be used on farms throughout the Omochumne-Hartnell Irrigation District, Clay ID and Galt ID. The balance (20%) would be recharged through in percolation ponds along the Cosumnes River. During dry years, the stored and in-lieu water would be extracted from the groundwater basin from wells near the farms and percolation ponds receiving the wet/above normal year surface water. The high quality, extracted surface water is conveyed through the FSC to the Mokelumne Aqueducts with the treatment and conveyance facilities of the Base Project.

Scenario 3 – Wet Year Groundwater Storage for EBMUD and SCWA (Percolation/In-Lieu in Galt Basin and Injection in Central Basin)

Scenario 3 builds upon Scenario 2, and includes the diversion of both EBMUD and SCWA water in wet and above normal years from the Sacramento River at Freeport. The SCWA water would be treated at the SCWA WTP and distributed throughout its service area in Zone 40 to demand points and injection wells near existing and planned extraction wells. During dry years, below normal, and normal years, SCWA demands in Zone 40 would be met through the increased use of groundwater and stored surface water and reduced use of surface water diverted at Freeport. EBMUD water would be conveyed as described for Scenario 2 to the FSC for conveyance to the Galt Area for in lieu recharge and percolation. Subsequent extraction would be managed as proposed for Scenario 2 as well.

Scenario 4 – Wet Year Groundwater Storage for SCWA (Injection in Central Basin)

Scenario 4 is the same as Scenario 3, except that it removes the Wet Year/Groundwater Storage facilities for EBMUD, and changes the EBMUD diversion schedule to match the Base Project. All SCWA deliveries and operations would remain the same as Scenario 3.

Evaluation of Alternative Conceptual Scenarios

This section will focus on the technical, environmental, and institutional issues associated with the development of Scenarios 1-4. If there are specific negative effects that constitute an insurmountable fatal flow, they are identified as such. The benefits of each Scenario will be quantified to the extent known. The specific issues evaluated in this section include:

- Availability of water for extraction/extracted water quality
- Impacts to groundwater basin
- Impacts to downstream water users
- Environmental issues
- Institutional issues
- Program timing

Each of these issues is further discussed in this section.

AVAILABILITY OF WATER FOR EXTRACTION/ EXTRACTED WATER QUALITY

Both the Base Project and all of the scenarios identified in this document make water available during dry years. One potential advantage of utilizing a predominantly wet year diversion schedule is the immediate ability of the SCWA or EBMUD to extract water from the ground, and thereby the reduced dependence on when monthly flows are available at the Freeport Intake. However, CVP releases could be scheduled based on a known diversion pattern to accommodate EBMUD water supply needs. Scenarios 3 and 4 would result in the most water available for extraction, since a large portion of water used by SCWA would be stored in the groundwater basin prior to use. However, water stored in the groundwater basin may not be resident where it is recharged. IGSM modeling showed that storage of water in the quantities required to eliminate dry year diversions results in water migrating outside of the area where it is applied. To minimize this effect, injection wells would need to be widely distributed throughout Zone 40.

Scenario 1 has the least groundwater available for extraction, since IGSM modeling showed that water does not remain resident in the injection field in the Central Basin. Scenario 2 appears to have adequate levels of water availability.

There is no feasible method FRWA can utilize to implement a long-term water supply storage project and ensure that the water recharged is the water extracted. The scenarios, as currently modeled, show that some water recharged into the basin may have to be stored in the ground for over twenty years before extraction. The long duration between recharge and extraction limits opportunities to locate pockets of recharge water that FRWA can manage and/or operate. Furthermore, the quantity of water required for recharge is large, and the water does not necessarily remain resident in the basin. Losses must also be accounted for. Additionally, there are other pumpers utilizing the same basin who could pump the recharged water. It is likely that the groundwater pumped will be of a poorer quality than the surface water added to the groundwater basin, though the water quality in the Central and Galt Basins is generally of good quality. No uniform expectation of extracted water quality can be identified at this time for any of the Scenarios.

IMPACTS TO GROUNDWATER BASINS

The operation of Scenario 1 seriously affects pumpers near extraction wells, and draws down groundwater levels throughout most the Central Basin. Injection results in surcharging, and raises the water table near the injection site by approximately 50 feet after one year of injection. Extraction during a dry year typically lowers the water table by approximately 55 feet. Multiple years of extraction in sequence lowers the water table well below baseline levels, due to the lack of residency of the injected water. Water injected into the groundwater basin and stored for many years tends to flow out of the injected area. During a seven year drought at the end of the IGSM model simulation, the water table is drawn down by over 70 feet. The impact to the Groundwater Basin is a fatal flaw for this Scenario.

Scenario 2 IGSM modeling results showed widespread raising of the water table in the Galt Basin by between 0-10 feet, but localized drawdowns in the vicinities of the extraction wells, especially during dry years. The extent of drawdown varies based on the number of extraction wells, but can range from 20-30 feet during multiple sequential dry years if using 5-15 extraction wells.

The operation of Scenarios 3 and 4 will result in significant rising of groundwater elevations during most wet years in the Central Basin (when using 1990 groundwater demands in the basin), due to the introduction of additional surface water supplies exceeding average demands. During extended dry years when using the 1990 condition, the water table remains above the baseline. Modeling of Scenario 3 for the 1990 condition also shows significant increases of the water table throughout the basin, and the elimination of depressions in the groundwater table. If basin demands were modeled based on the projected 2030 buildout condition, it is expected that a flat to slight increase in the water table would be seen in the Central Basin. However, during periods of extended dry years, it is expected that some drawdown of the water table would occur. Modeling at the 2030 condition was not immediately available, since those demand conditions have not been finalized. Central Basin groundwater demands in the year 2030 are expected to be between 90,000 – 100,000 AFY, not including demands associated with remediation of the Aerojet and Kiefer sites.

IMPACTS TO OTHER DOWNSTREAM SURFACE WATER USERS

Table 2 presents the modeling results for each of the Scenarios, the Base Project, and the No Action Alternative. All of the data is presented in relation to the No Action Alternative, which helps to measure table the net impacts of each Scenario to the condition where no project is constructed.

In terms of the net changes to the availability of water to downstream water users, and the overall system storage in the CVP and SWP systems, the four scenarios evaluated in this document do not vary considerably from each other, the Base Project, or from the No Action Alternative. This is, in part, due to the magnitude of water utilized in each alternative compared to the magnitude of water available in the CVP and SWP. A more detailed description of each difference is further described below.

While the effects on Tracy Pumping of the Base Project are small (less than 0.3 % in all years and 0.7% in dry years), the Wet Year Diversion and Groundwater Storage Scenarios appear to further reduce these effects to near the No Action Alternative.

The North of Delta CVP Storage simulations show that modifications to the EBMUD diversions improve this parameter more than modifications to SCWA diversions. Scenario 4 showed virtually no change (0.3%) in North of Delta CVP storage from the Base project. Similarly, modifications to EBMUD diversions appear to improve September storage quantities in the Oroville Reservoir more than modifications to SCWA diversions. Modifying both diversions as in Scenario 3 brought these storage values very close to the No Action Alternative.

CVP Deliveries to users North of the Delta are largely unaffected by any of the Scenarios or the Base Project. A long-term average decrease compared with the No Action Alternative of 7 TAF/yr was witnessed for the Base Project during dry years, but no differences of more than 2 TAF/yr was observed for either all years or the dry years for any of the Scenarios. Deliveries to South of the Delta Users showed that the Scenarios varied only slightly from each other, with values similar to the No Action Alternative identified for Scenario 3, and slight modifications from the No Action alternative for Scenarios 1, 2, and 4. SWP Total Deliveries reflected similar results to the CVP deliveries to South of the Delta users.

The maximum and minimum change to the X2 position over the course of the entire simulation period was identical to the No Action Alternative for all diversion scenarios. Some monthly variations of up to 0.43 km and -1.25 km were shown for Scenarios 1 & 2, but these were compensated for by other counter modifications during other months.

In conclusion, the effects of Wet Year diversion and groundwater storage scenarios on the Delta and its users are very small (long-term 0.1 to 0.5% enhancement effect compared with the Base Project, depending upon the parameter and the scenario; 0.3 to 2.4% enhancement effect during the dry period examined). The parameter affected the greatest was average Oroville Storage during the dry period examined, especially when utilitizing Scenario 3. In general, the Scenarios that divert more water during wet years show slight increases in water storage or water availability compared to the Base Project, and bring the overall project closer to the No Action alternative. The positive effects of wet year diversion and groundwater storage relative to the Base Project are quite limited relative to the extensive facilities and costs required to implement such alternative projects.

Table 2: Comparison of Downstream Delta Effects of Wet Year/Groundwater Storage, Base Project, and No Action Scenarios

Criterion	No Action Alternative[7]		Average Values by Diversion Scenario (Difference between No Action Alternative and Scenarios expressed as a percentage)																
			Base Project				EBMUD only (Scenarios 1 & 2)				EBMUD and SCWA (Scenario 3)				SCWA Only (Scenario 4)			
Water Year	All Years[a]	Dry Period[1]	All Years		Dry Period[1]		All Years		Dry Period[1]		All Years		Dry Period [1]		All Years		Dry Period [1]	
Tracy Pumping (TAF/yr)[2]	2,256	1,662	2,249	-0.3%	1,651	-0.7%	2,253	-0.2%	1,654	-0.5%	2,255	-0.1%	1,662	0.0%	2,251	-0.2%	1,655	-0.4%
North of Delta CVP Storage (TAF)[3]	4,547	2,554	4,523	-0.5%	2,511	-1.7%	4,537	-0.2%	2,524	-1.2%	4,539	-0.2%	2,559	0.2%	4,526	-0.5%	2,530	-0.9%
Oroville Storage (TAF)[4]	2,072	1,506	2,053	-0.9%	1,469	-2.5%	2,062	-0.5%	1,480	-1.7%	2,063	-0.4%	1,505	-0.1%	2,058	-0.7%	1,480	-1.7%
CVP Total Deliveries – North (TAF/yr)[5]	2,199	1,959	2,199	0.0%	1,952	-0.3%	2,200	0.0%	1,956	-0.1%	2,200	0.1%	1,958	0.0%	2,199	0.0%	1,957	-0.1%
CVP Total Deliveries – South (TAF/yr)[5]	2,554	1,695	2,548	-0.2%	1,683	-0.7%	2,553	0.0%	1,689	-0.3%	2,554	0.0%	1,695	0.0%	2,549	-0.2%	1,686	-0.5%
SWP Total Deliveries (TAF/yr)[5]	2,980	1,946	2,973	-0.2%	1,917	-1.5%	2,975	-0.2%	1,927	-1.0%	2,978	-0.1%	1,950	0.2%	2,976	-0.1%	1,932	-0.7%
Maximum and minimum change in X2 position (km)[6]	89.7 km – Oct 1932		89.7 km (0%) – Oct 1932				89.7 km (0%) – Oct 1932				89.7 km (0%) – Oct 1932				89.7 km (0%) – Oct 1932			
	42.0 km – Apr 1983		42.0 km (0%) – Apr 1983				42.0 km (0%) – Apr 1983				42.0 km (0%) – Apr 1983				42.0 km (0%) – Apr 1983			

Notes:
a. Modeled period was the historical runoff from WY 1922-1994. Average value during that period listed.
1: Dry period values reported are for WY 1928-1924. Average value during that period listed.
2: Tracy Pumping is measured at the Tracy Pumping Plant.
3: Based on the sum of storage within the Trinity, Shasta, and Folsom Reservoirs during September.
4: Average September Oroville storage during the 73-year simulation.
5: Total Deliveries during water year (October – September)
6: X2 is measured as the distance away from the Golden Gate Bridge. It was not assumed to be accurate to a level of detail less than 0.5 km. The values presented here are the maximum and minimum distances for the duration of the simulation.
7: Percentage differences are reflected as the difference between the Scenario and the No Action Alternative
Source data provided by CH2M Hill, 2002 and 2003. All modeling is based on the 2001 hydrology

Abbreviations:
TAF: Thousand Acre-feet
M&I: Refers to Municipal and Industrial deliveries of CVP water
Ag: Refers to Agricultural deliveries of CVP water
WY: Water year

ENVIRONMENTAL ISSUES

One of the major environmental issues in the Central or Galt Basin is the ephemeral nature of Cosumnes River flows. Cosumnes River is the primary river draining the local watersheds, and has historically provided habitat and passage for salmon. The upper aquifer was historically connected to the Cosumnes River, and helped provide perennial flows to the reach roughly located between Highway 99 and approximately the FSC. However, a variety of issues has recently resulted in a 15-mile gap between the downstream reaches of the River and the spawning areas in the upper reaches. The Consumes River division of The Nature Conservancy is attempting to purchase water supplies from others to provide water to the Cosumnes River during the fall salmon run to wet the channel, and provide passage. Projects that further this goal would provide an environmental benefit to the local habitat.

Attempts were made to model the impact of the projects on Cosumnes River flows. However, the IGSM model does not necessarily have the level of precision required to predict changes in stream flow, but is better suited to compare changes in the depth to the local groundwater aquifer due to a change in project conditions. IGSM modeling showed that both Scenarios 1 and 2 do not affect the ability to the Cosumnes River to provide fish passage. The local aquifer is still disconnected from the river streambed. Scenarios 3 and 4 would result in benefits to the local water table elevation near the Cosumnes River, but no determination could be made if these benefits would be significant enough to provide passage in the 15-mile gap at the 2020 level of development.

In summary, there are no major environmental issues independent of those addressed in the other sections. These issues, which are potentially associated with groundwater levels and downstream water user effects, are addressed in the other sections.

INSTITUTIONAL ISSUES

This institutional analysis addresses the feasibility of the Wet Year Diversion and the Groundwater Storage aspects of the alternative Scenarios. First, relative to wet year diversions, the EBMUD Wet Year diversion is not yet feasible without an amendment of EBMUD's contract with the Bureau of Reclamation. This is considered feasible, but would affect the timing of implementation of the project, and could result in delays to delivery of surface water to FRWA by 2008, a key project objective. Second, the focus of this Institutional Analysis on the groundwater storage component. EBMUD has attempted to implement similar projects in the past, and lessons learned from those efforts have been applied to potential projects in the Sacramento County area. A review of the institutional analysis revealed several institutional issues that would need to be answered prior to implementation of any Wet Year Groundwater Storage Alternative. These issues include:

- Is there a legislative or legal framework for groundwater storage and recovery of stored groundwater?
- Can a groundwater bank be implemented?
- What is the level of control of groundwater overpumping by overlying agencies and pumpers?
- Does EBMUD have the authority to export banked water out of Sacramento County?
- Is there a strong local authority with clear boundaries and sufficient powers to partner with FRWA?
- Does local/regional consensus exist for implementation of a groundwater storage project?
- What is the ability to assure protection of existing groundwater users?

A discussion of these questions is contained in Table 3. This institutional analysis table contrasts the feasibility of the Base Project with a possible groundwater storage project in the North, Central and Galt Basins with an eye towards the scenarios identified.

Table 3: Institutional Analysis – Degree of Feasibility for FRWA Base Project and Alternative Concepts for Groundwater Storage

		FRWA Project w/ Wet Year Diversions from Sac River and Groundwater Storage for Deliveries in Dry Years		
Issue	Base Project	North Area Banking	Central Area Injection/Extraction	Galt Area In Lieu Recharge/Percolation and Extraction
1) Legislative/Legal Framework for Groundwater Storage and Recovery of Stored Groundwater	**N/A** - Zone 40 Master Plan contemplates no artificial recharge. Only in-lieu banking consistent with the CSCGF.	**YES** - Appendix 66 of State Water Code Allows it in Sacramento County	**YES** - Appendix 66 of Water Code Allows it in Sacramento County	**YES** - Appendix 66 of State Water Code Allows it in Sac County
2) Implementability of a Groundwater Bank	**YES** – Zone 40 Master Plan contemplates in-lieu recharge consistent with Water Forum Solution	**YES** – Pilot water banking projects demonstrate feasibility of establishing long-term project	**YES** – Conjunctive Use of GW Basin in Zone 40 Contemplated in Water Forum Solution; Banking and Exchange (B/E) not explicitly stated; CSCGF is vehicle to address B/E in Central Basin	**Not Yet Clear** – JPA formed, but not bank. Pilot projects needed. Will take 3 years to determine.
3) Control of Groundwater Overpumping by Overlying Agencies and Pumpers	**YES (incomplete)** – SCWA has legal authority to establish regulatory controls over pumping in all basins, including Zone 40 area, and is exercising that authority through the Water Forum.	**YES (partial)** – Although basin not adjudicated, Sacramento Groundwater Authority (SGA) has some authority, but expressly provided that it will control only with economic incentives.	**YES (incomplete)** – Although basin not adjudicated, SCWA has clear authority in Zone 40, and is exercising that authority through the Water Forum. EBMUD's stored water could be protected if there were an allocation of groundwater storage to existing users and a mechanism for enforcing those limitations (not yet in place).	**YES (incomplete)** – Groundwater Management Plan established at a preliminary level. Full Basin Management Plan not yet in place. SCWA has authority but not delegated that authority.
4) Ability to Export Stored Groundwater out of Sac County to EBMUD	N/A	**Not Yet Clear** – AB 3030 Plan not yet in place, but SB 1938 plan projected by end of year, 2003. No known political obstacles. Pilot to export not yet done. Lack of actual groundwater export and use of water trading may improve feasibility. Two to five years to establish necessary additional framework.	**NO** – No AB 3030 Plan in place. Political support for exports uncertain. Central Groundwater Forum started. County Ordinance passed in 2000, Title 3, Chapter 3.40.090 authorizes Director of Water Resources to issue permit to export groundwater and surface water. Probably will take 5 to 10 years to establish necessary framework to implement groundwater export.	**NO** – Groundwater Management Plan established at preliminary level, but no AB 3030 specific authority for exports. Collaborative stakeholder process not yet begun to extent contemplated in Water Forum. Probably will take 5 to 10 years to establish necessary framework to implement groundwater export.
5) Presence of Strong Local Authority with Clear Boundaries and Sufficient Powers to Partner	N/A	**Not Likely –** Can partner but does not yet have enforceable program acceptable internally to SGA to make partnering likely. Can occur in future, but will take approximately 1.5 years or more.	**Partial YES** – SCWA is strong local authority, has established service area. Has powers to partner. Deferring to CSCGF process for comprehensive plan for governance. FRWA not yet a formal stakeholder.	**Not Yet Clear** – JPA formed. Partially staffed. Clear boundaries. No collaborative process yet started.
6) Local/Regional Consensus that GW Storage Project is Desirable	**YES** – Consistent with Water Forum solution	**YES –** The North Basin already has a banking program underway.	**NO** – Not yet explored within County. Due to large number of farmers and other institutions affected, probably will take 1 to 2 years to determine with full time vetting; governance establishment through the Water Forum CSCGF will take an additional 2 to 5 years.	**NO** – Preliminary exploration in 1998. Not yet explored within community. Due to large number of farmers within 3 districts, probably 1 to 2 years with full time vetting. Collaborative stakeholder process still needed.
7) Ability to Avoid Potential Injury to Existing GW Users	**YES** – Zone 40 Master Plan developed to accomplish this objective	**Not Clear** – Basin is relatively small (131,000 AF yield, 500,000 AF bankable volume); may not be sufficient to support entire FRWA project w/o impacts.	**Not Clear –** Basin may be large enough to bank SCWA water during wet year diversions, but detailed modeling needed to verify. Basin not large enough to bank both agencies water through injection and extraction without large water level fluctuations (50 feet or more).	**Not Clear –** Basin may be large enough to bank EBMUD water during wet year diversions, but detailed modeling needed to verify.

PROGRAM TIMING

Relative to timing for project implementation, an assessment of the status of the North Area Groundwater Bank is instructive relative to the progress needed in the Central and Galt Areas to create a Feasible Alternative to carry into development and detailed, project specific environmental (CEQA/NEPA) review, as shown in Table 4.

Table 4: Comparison of Status of Groundwater Storage in North Area with Central and Galt Areas

	North Area	Central Area	Galt Area
Organizational Infrastructure	Formed SGA to manage Basin; formed RWA to provide regional forum for project development. Have full time Executive Director and Consultants providing support.	SCWA is in place, but not organized for banking yet. SCWA is participating in CSCGF process to develop a basin management plan.	JPA of Omochumne-Hartnell, Galt ID and Clay ID; no full time staff or consultants working for JPA. WFA contemplates a Galt Basin management plan, but it has not yet begun.
Delivery Infrastructure	Pipeline in place to deliver American River water for injection.	None. Base project would provide delivery pipelines and treatment to enable banking.	None. Base project would provide delivery pipelines to enable banking
Pilot Projects	Completed two pilot projects; SAFCA with USBR and Storage for the Environmental Water Account	None. Some feasibility investigations done.	None
Funding Status	Raised $2 Million; Obtained $22.5M construction grant for facilities	None for groundwater bank.	None

The stakeholders have taken three to four years to develop the institutional basis for the North Area groundwater storage program. One of those years was not fully productive due to the loss of an Executive Director and a delay in filling the position. It is estimated that it will take the North area another five years to establish a long-term program that could accommodate outside participants. For the Central Area, because the Water Forum has just begun the collaborative process through the Central Sacramento County Groundwater Forum it is estimated that it will take 1 and ½ years to reach the end of the negotiation phase, and another seven years to have an established plan and long-term program for a total of 8 and ½ years. For the Galt Area, it is estimated that is would take about five years within a process like the Groundwater Forum Process to progress to where the North Area was when they formed the organizational infrastructure and began to implement the banking program, and another five years to get to an established plan and long-term program, for a total of ten years.

Once a plan and program are in place, a project could be developed and a public/environmental documentation process, such as the one FRWA is currently engaged in, could begin. To meet the project objectives of delivering water supplies to SCWA and EBMUD by 2008, the wet year/groundwater storage alternative cannot be implemented in place of the Base Project. Rather, implementing the Base Project enables the future implementation of such a plan.

References

1. American River Basin Cooperating Agencies/Sacramento North Area Groundwater Management Authority, Montgomery Watson Harza, 2000.

2. CH2M Hill, CALSIM modeling data supplied via email during 2002 and 2003.
3. CH2M Hill, personal communication with Rob Tull and Randy Ritzema, 2002 and 2003.
4. County of Sacramento, Groundwater Modeling Results for Proposed Banking Program, December 1998.
5. County of Sacramento, County of Sacramento Discussion Paper for EBMUD – Sacramento Joint Water Supply Project, Conjunctive Use Program Scenarios – Draft, July 1998.
6. Department of Water Resources, DWR Bulletin 118,
7. East Bay Municipal Utilities District, EBMUD Supplemental Water Supply Project, Draft REIS/SEIS, December 2000.
8. Florin Resources Conservation District c/o Saracino Kirby, Preliminary Groundwater Evaluation, October 2000.
9. Kleinfelder, Preliminary Groundwater Recharge Feasibility Study Expanded Zone 40, Sacramento, California, April 2000.
10. Montgomery Watson Harza, Sunrise Douglas Community Plan/Sunridge Specific Plan, June 2000.
11. Nature Conservancy, Cosumnes River Low Flow Analysis: Michigan Bar to McConnell, October 2000.
12. Personal Communication between Ed Winkler, GM of SGA and Gary Darling, Water Supply Improvements Division Manager, EBMUD, November 2002
13. Personal communication with Steve Setoodeh, Department of Health Services, September 2002.
14. Personal communication with Mike Eaton, Nature Conservancy, October 2002.
15. Pajaro Valley Water Management Agency, Revised Basin Management Plan, 2002.
16. Regional Water Quality Control Board, Basin Plan, The Water Quality Control Plan for the California Regional Water Quality Control Board – Central Valley Region, The Sacramento River Basin and the San Joaquin River Basin, 4^{th} edition, 1998.
17. Sacramento Groundwater Authority c/o Montgomery Watson Harza, Banking and Exchange Pilot Program, July 2002
18. Sacramento County Water Agency c/o Luhdorff and Scalamini Consulting Engineers, Groundwater Injection Feasibility Study, June 1998.
19. Water Forum Agreement – Sections 1-5 and Appendices, Water Forum, 2000
20. Water Forum 2001 Annual Report, Water Forum, 2001.
21. WRIME, IGSM modeling data supplied via email during 2002 and 2003.
22. WRIME, personal communication with Ali Thagavi and Chris Smith, 2002 and 2003.

Acronym List

Acronym	Name
AF	Acre Feet
CALSIM	Surface Water Operational Model
CEQA	California Environmental Quality Act
CSCGF	Central Sacramento County Groundwater Forum
CVP	Central Valley Project
DHS	Department of Health Services
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utilities District
FRWA	Freeport Regional Water Authority
FRWP	Freeport Regional Water Project
FSC	Folsom South Canal
IGSM	Integrated Groundwater/Surface Water Model
JPA	Joint Powers Authority
M & I	Municipal and Industrial
MAF	Millions of Acre Feet
NEPA	National Environmental Protection Act
OHWD	Omochumne-Hartnell Water District
RWA	Regional Water Authority
RWQCB	Regional Water Quality Control Board
SCWA	Sacramento County Water Authority
SGA	Sacramento Groundwater Authority
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	Thousands of Acre Feet

Appendix

This appendix provides documentation supporting the technical memorandum. This appendix is intended to provide additional details about the technical memorandum, but not to duplicate or replace that document.

Potential Recharge and Banking Locations

Sacramento County has three major groundwater basins, commonly referred to as the North, Central, and Galt Basins. This section identifies major characteristics of each basin, and identifies the logic justifying the selection of the Scenarios.

North Basin

Within Sacramento County, the North Basin is generally bounded by the American River to the South, and the Sierra Nevada Foothills to the East, the Sacramento River to the North, and the county line to the North. The DWR characterizes the groundwater quality as marginal in some portions of this basin. Generally in the southern part of the basin, the groundwater is generally of good quality, with moderate mineral content and low disinfection by-product concentrations (DWR, September 2001), though some areas have elevated levels of minerals.

The North Basin has three major known groundwater contamination sites: the McClellan Air Force Base, the United Pacific Roseville Rail Yard, and the Aerojet Superfund site. The Aerojet site is located in the Central Basin, but its contamination plume extends into the North Basin.

Historical extractions from this basin have greatly exceeded natural and artificial recharge. DWR estimated the natural recharge to be 83,800 AFY, and artificial recharge of 29,800 AFY. Annual extraction was estimated to be 399,000 AFY for urban and agricultural uses (DWR, September 2001). The Water Forum has estimated the sustainable yield of this of the North Basin to be 131,000 AFY. The North Basin has existing groundwater banking programs in place with the Placer County Water Agency and two local water districts. The quantity of water banked in the North Basin through this artificial recharge totals 29,800 AFY (DWR, September 2001). The bank appears to have sufficient capacity to meet some of FRWA needs. However, on an annual basis, the Sacramento Groundwater Authority (SGA) has indicated it could sell available water supplies to FRWA during a typical year (Personal Communication, EBMUD, November 2002). During a dry year, the peak demands of SCWA and EBMUD are 80,000 AFY and 55,000 AFY, respectively.

The Sacramento Groundwater Authority (SGA) is a joint powers authority created to manage and protect the North Basin, and is comprised of sixteen public and private water agencies, including the City of Sacramento, and the Sacramento County Water Agency.

The most likely mechanism to feasibly deliver water to the North Basin would be to divert CVP water and Excess water at Folsom Dam into the Cooperative Transmission pipeline in wet years for banking in wet years. In dry years, the SGA would need to forego their surface water diversions and rely on groundwater. The foregone surface water would then be diverted at Freeport by FRWA. SGA would change a handling charge for diverting, banking, and shifting to groundwater use. This also would require amendments to the EBMUD and SCWA CVP contracts with USBR, which would delay project implementation. Water trading was also not considered with the Placer County Water Agency or another

American River diverter at this time due to the significant institutional hurdles that would need to be overcome compared to the Base Project.

As a result, project ideas were limited to water diverted at the Freeport Intake.

Even if the institutional issues could be overcome by using existing facilities to divert and transport American River water from Folsom to the North Basin, other legal and institutional issues would have to be overcome, as follows:

- The focus of the institution responsible for groundwater management and developing a banking project, the SGA, has been on developing a bank to primarily meet the needs of the purveyors north of the American River. The SGA has implemented some preliminary pilot programs but has yet to grapple with fundamental institutional issues that must be resolved before implementing a long-term groundwater banking program. For instance, before an effective long-term program can be established, a baseline pumping allowance must be established for each of the agencies within the basin relying on groundwater. Moreover, a mechanism must be developed to enforce the baseline pumping allowance. It is not reasonable to believe that an allocation of groundwater storage would be made to an outside agency, such as EBMUD, until the needs of the local agencies have been met and those agencies have a means of protecting their respective rights to the groundwater and surface water stored in the groundwater basin.
- There are at least 15 separate agencies that are members of the SGA. Any long-term groundwater banking program will require the cooperation and acceptance of all SGA members, particularly if any FRWA alternative were to use existing facilities. The SGA expressly specifies that local control of groundwater resources will remain in the hands of the local agencies, and control of pumping will be exercised through economic incentives and disincentives. FRWA cannot yet rely on the as yet not established incentives and disincentives and a unanimous vote of 15 independent agencies as a mechanism to ensure that water banked in the North Basin could be extracted and exported. FRWA is not part of the SGA, and there are significant institutional obstacles to implementation of a reliable water supply project dependent on banking and exchange with the north area. SGA has also not yet set a baseline for groundwater pumping for its member agencies in the North Basin.
- SGA has implemented two pilot banking projects. As a result of those pilot projects, it is evident that the individual decision making authority by each of the SGA members is critical. Every agency wants to be free to make independent business and policy decisions. Developing a legal framework that both preserves local autonomy as well as provides an enforceable structure for regulating and managing the groundwater basin will continue to take several years to establish. The legal framework for managing groundwater must also be consistent with the express language of the SGA Joint Power Agreement that "prohibits the SGA from restricting or otherwise limiting the extraction of groundwater within the boundaries of the Authority except by means of economic incentives and disincentives."
- Until the SGA comes up with an enforceable groundwater banking program that is acceptable internally to the SGA members, it is not likely that an outside agency would be able to partner with them. The institutional issues required to develop a project would delay project implementation. It is especially true that a groundwater project of the magnitude of what FRWA requires for its entire yield would be difficult, if not impossible, to accommodate in the North Basin, currently.

Therefore, until the SGA develops an enforceable groundwater banking program that FRWA can rely upon to assure its water deliveries, partnering with SGA to develop a groundwater banking program for the entire project yield in the North Basin is not feasible at this time (see Issue No. 5 in Table 3).

CENTRAL BASIN

The Central Basin Area spans from American River to the North, the Sierra Nevada Foothills to the East, Cosumnes River to the South and the Sacramento River to the West. Groundwater is typically a calcium magnesium bicarbonate or magnesium calcium bicarbonate groundwater. TDS ranges from 24 – 581 mg/L, with an average of 221 mg/L (Montgomery Watson, 1993).

There are seven major known groundwater contamination sites in the Central Basin Area. They include three Superfund sites: Aerojet, Mather Field and the Sacramento Army Depot. The other sites include the Kiefer Boulevard Landfill, an abandoned PG&E site in Old Sacramento, and the Southern Pacific and Union Pacific Rail Yards near downtown Sacramento.

Central Basin inflows historically total approximately 257,000 AFY. Extraction rates have been estimated to be approximately 230,000 AFY for urban and agricultural uses. The Water Forum has estimated the Central Basin annual sustainable yield to be 273,000 AFY.

The Central Sacramento County Groundwater Forum (CSCGF) was created as an extension of the Water Forum, DWR, and the California Center for Public Dispute Resolution. This forum was assembled to develop a groundwater management plan to protect available groundwater supplies and quality (Water Forum, 2002). Most recent estimates by the Central Sacramento County Groundwater Forum for completion of the Negotiation Phase, including deciding on an Action Plan for Implementation, is June 2004 (Memorandum from Jim McCormick and Larry Norton to the Central Sacramento County Groundwater Forum, Subject: Road Map for Negotiation Phase, October 25, 2002).

Groundwater levels have declined in portions of the basin, potentially impacting river and stream flows. It is expected that pumping will steadily increase in the future. Potential litigation could force basin adjudication.

There are no known artificial banking programs in the Central Basin. The Basin is not generally considered to be in an overdraft condition, but portions of the Basin (Elk Grove area) have significant cones of depression in the groundwater table.

The establishment of a groundwater management plan for the Central Basin was recently begun under the CSCGF process. The collaborative stakeholder process is quite extensive and will take several years to develop its ultimate product of a “solution package and implementation plan” (from the negotiation phase, presently underway), a basin management plan, and a framework for governance. One of the FRWA member agencies, SCWA, which could lend its authority to the governance structure has deferred to this process and is in fact financially supporting it.

In summary, there were no fatal flaws identified associated with the establishment of a groundwater recharge program in the Central Basin. However, attempts were made to locate an EBMUD banking program outside of the Zone 40 buildout area. SCWA banking programs would be located within the Zone 40 buildout area, since a portion of their wells and infrastructure are in place.

GALT BASIN

The Galt Basin Area lies to the South of the Central Basin, and generally extends from the Cosumnes River south to the County line. The basin itself extends into San Joaquin County to the south and Amador County to the east. Available information about the Galt Basin is limited. Groundwater level trends since the 1980s have shown declines followed by recoveries in groundwater levels. The eastern portion of the basin has maintained consistently higher groundwater levels than the western portion of the basin. TDS levels in the twenty water supply wells ranged from 140 – 438 mg/L, with an average of 218 mg/L (DWR, May 2002). There appear to be no known major contamination sites.

Basin inflows have historically exceeded extraction rates. There is a large cone of depression in the northern part of the basin. Natural and applied water recharge rates have totaled approximately 269,000 AFY. Urban and agricultural extractions have totaled approximately 129,000 AFY. The remainder indicates the quantity of subsurface outflows. The sustainable yield of the Galt Basin has been estimated to be 115,000 AFY.

There are thirteen separate water agencies actively involved in utilizing groundwater in the Galt Basin. The Sacramento Metropolitan Water Authority filed a notice of intent to adopt an AB 3030 plan for the Omochumne – Hartnell, Galt ID, Clay WD and the City of Galt in 1994. These agencies subsequently drafted a joint powers agreement (not including the City) to work cooperatively on water resources issues. A formal AB 3030 Plan was never prepared, however. During 2002, these agencies decided to create the Southeast Sacramento County Agricultural Water Authority, and formally organize their activities. This Authority has the ability to manage water resources within the three agencies service areas, but not throughout the basin. The ability of the Authority to implement a groundwater banking project is unknown, due to their very recent creation; and the lack of a collaborative stakeholder process, as proscribed in the Water Forum Agreement, has limited the potential implementation of a banking and exchange program. This process would have to be undertaken in order to clearly define the parameters within which such a program could be developed. A similar parallel process to the CSCGF for the Galt Basin is also contemplated under the Water Forum Agreement but has not yet begun.

In summary, land use in the Galt Basin points to recharge of surface water through in-lieu applications, due to the large use of groundwater by farmers. It was believed that reducing groundwater pumping would more widely distribute water within the groundwater basin as compared to injecting surface water, which could mound if over applied. In addition, attempts were made to benefit Cosumnes River flows and the local aquifers, and improve water availability in that area, some percolation basins will be located within the Cosumnes River floodplain area. This area has the highest percolation rates in the Galt Basin.

Regulation of Groundwater Storage and Recovery

Three regulatory agencies will need to be consulted in order to fully evaluate this conceptual alternative. They are the Regional Water Quality Control Board (RWQCB), the State Water Resources Control Board (SWRCB), and the Department of Health Services (DHS). The State Resources Agency (including Department of Water Resources – DWR) is also an important source of information. The agency roles, responsibilities, and potential involvement are further described below. Permits will also be required from various other jurisdictions or agencies, depending on what concept is ultimately implemented.

REGIONAL WATER QUALITY CONTROL BOARD (RWQCB)

The RWQCB (Central Valley Region) is responsible for the preparation and adoption of Water Quality Control Plans (Basin Plans), enforcement of the Clean Water Act and the California Water Code. The Basin Plans designate beneficial uses for the waters within the basin, their water quality objectives, and identify strategies to attain these objectives. All groundwaters in Sacramento County are considered to be suitable for a municipal or domestic water supply, agricultural supply, industrial service supply, and industrial process supply.

Each Basin Plan in Sacramento County incorporated the maximum contaminant level water quality objectives as defined in Title 22 of the California Code of Regulations. These objectives include limiting coliform concentrations to below 2.2 MPN/100 ml, and waters free from taste or odor producing substances, and radioactivity. The RWQCB also has a non-degradation policy, such that any new supply of water recharged into the basin must not degrade the existing groundwater basin.

Any project proposing to store surface waters in the groundwater basins will be required to obtain a permit from the RWQCB for the design, operation, and construction of all groundwater injection, recharge and extraction facilities, as specified in WC 13260.

STATE WATER RESOURCES CONTROL BOARD (SWRCB)

The SWRCB has jurisdiction over the Regional Boards. In addition, the SWRCB has jurisdiction over the surface water rights that would be an essential element of the proposed groundwater storage conceptual alternative. The SWRCB would be responsible for approving any changes in places of use, purposes of use, or points of diversion that would be required to implement the conceptual plan. These issues are explored in the institutional feasibility analysis of this memorandum.

DWR (STATE RESOURCES AGENCY)

The State Resources Agency includes the Department of Fish and Game, Coastal Conservancy and other resource-oriented departments, including the Department of Water Resources (DWR). DWR prepares the State Water Plan (Bulletin 160), manages and operates the State Water Project, and assists in monitoring the state's water resources and protects, restores, and enhances the natural and human environments. In relation to groundwater, the DWR prepares the Bulletin 118 report, which defines the existing conditions of each basin.

The DWR monitors groundwater levels in approximately 2,000 wells in central California. This tracking has shown that groundwater levels in the North Basin are steadily decreasing. Water levels in the Galt Basin have largely recovered to their 1980 levels, and there is no consistent pattern in the Central Basin, though some decreases have been measured, and the Elk Grove area has experienced significant groundwater level declines. The DWR is studying several areas in the lower Sacramento Valley where conjunctive use operations may be possible. At this point in our investigation, it appears that the State Resources Agency is an interested party, but not a permitting agency with respect to water transfer, exchange, or conveyance, with the exception of construction permits such as Streambed Alteration Agreements with the Department of Fish and Game.

DEPARTMENT OF HEALTH SERVICES (DHS)

The DHS regulates the operation of potable and recycled water systems: issues operating permits for these facilities; reviews plans and specifications for new facilities; enforces existing laws and regulations, including the Safe Drinking Water Act; and reviews water quality monitoring results. Furthermore, the DHS also conducts source water assessments, and evaluates projects utilizing injection and extraction into potable groundwater basins.

For any groundwater storage concept, the DHS would be heavily involved in the conceptual design and planning of all water treatment facilities. The DHS would primarily defer to other regulators for all non-treatment related issues, except those related to the impact of long-term storage of treated surface waters in the groundwater basin. These issues include the following (Setoodeh, 2002):

- "Bubble" formation – how close does the injected water "bubble" come to influencing the surface, and where does it migrate?
- Would the extracted water be retreated?
- What is the proximity of the stored water to known contamination sites?
- The impact of long-term storage on existing groundwaters, e.g. presence of THMs.

These issues would need to be resolved with DHS prior to the approval to operate any of these conceptual alternatives. The DHS would also need to approve the design of any treatment facilities. Water quality requirements for injected and extracted water would be likely be addressed by a combination of the DHS and Regional Water Quality Control Board.

OTHER AGENCY JURISDICTION

At this time, there are no other agencies with known jurisdiction or permitting authority over a wet year/groundwater storage project over and above those associated with the Base Project. However, this assumption would have to be further investigated if the wet year/groundwater storage alternative were to be considered at a project level in the CEQA process.

Scenario Evaluation

The Scenarios were selected based on the potential feasibility of the project, and the previous discussion about locations for groundwater recharge. The scenarios that were believed to represent a potentially technical feasible solution, absent of any institutional issues, were:

- Scenario 1: Wet Year Groundwater Storage for EBMUD (Injection in Central Basin)
- Scenario 2: Wet Year Groundwater Storage for EBMUD (Percolation/In-Lieu in Galt Basin)
- Scenario 3: Wet Year Groundwater Storage for EBMUD and SCWA (Percolation/In-Lieu in Galt Basin, and Injection in Central Basin)
- Scenario 4: Wet Year Groundwater Storage for SCWA (Injection in Central Basin)

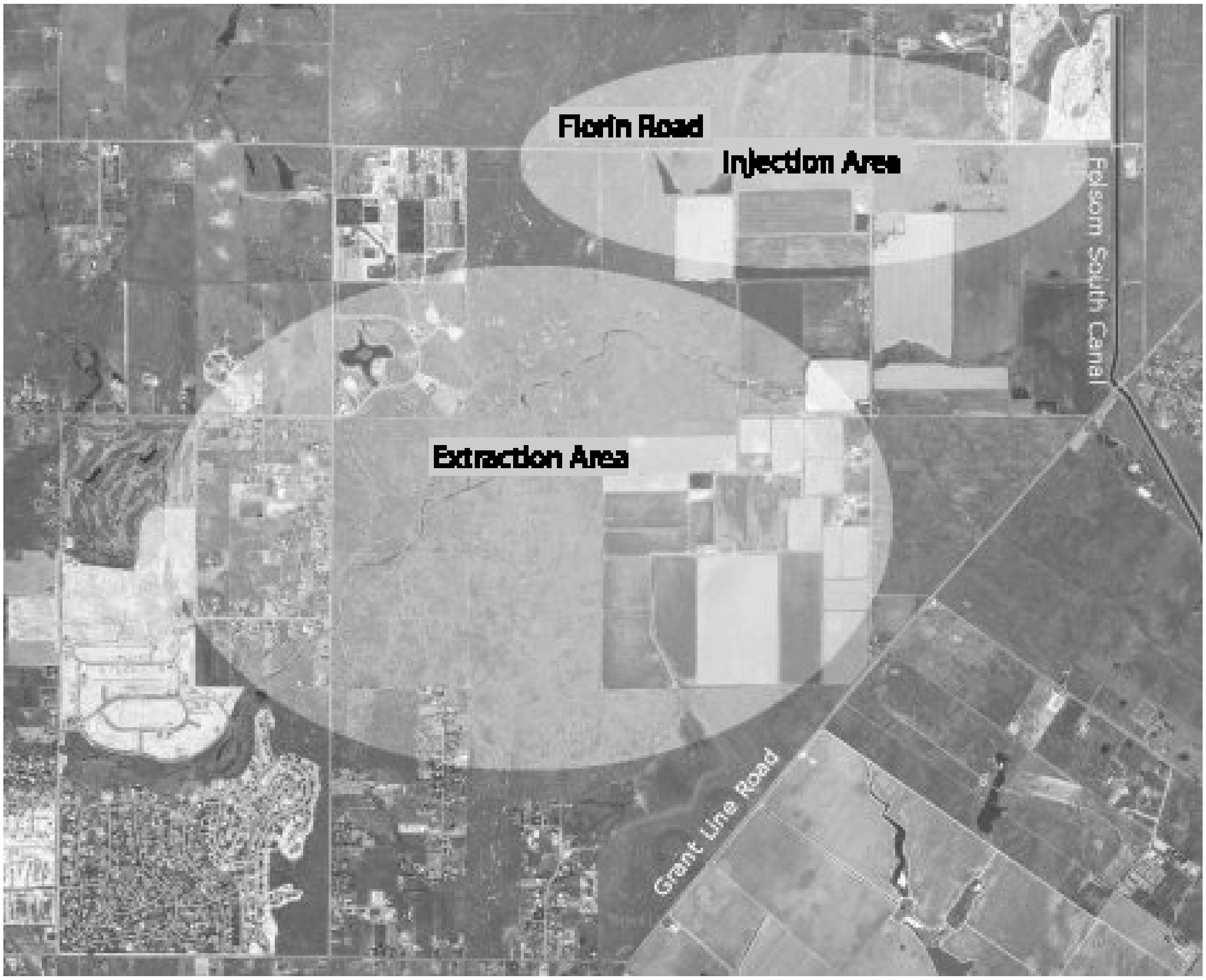
Each of these scenarios is discussed below.

SCENARIO 1 – WET YEAR GROUNDWATER STORAGE FOR EBMUD (INJECTION IN CENTRAL BASIN)

This scenario would modify the EBMUD diversion schedule so that surface water would be diverted from the Freeport intake during wet years at a constant rate of 4,500 AF/month. No modifications were made to SCWA's diversion schedule, which were assumed to remain the same as the Base Project. Treatment is required prior to injection of surface water to prevent degradation of groundwater quality, to reduce the turbidity of the surface water, minimize aquifer clogging, and maximize the injection capacity of each injection well. Treatment would occur at either the proposed SCWA treatment plant or a new satellite treatment plant.

Filtered water would be injected into the Central Basin. These injection wells would be located in an area generally bounded by Bradshaw Road to the west, Florin Road to the north, the FSC to the east, and Gerber Road to the South. A map of the proposed injection and extraction areas is shown as Figure A2. This location was selected because it is currently a largely undeveloped area with fewer extraction wells, available land for locating wells, pipelines and treatment facilities, and would not affect the planned SCWA conjunctive use operations. Each injection well was assumed to have an injection capacity of 1,000 gpm. Based on 24-hour, seven days per week diversions at a constant rate, a total of 36 injection wells are required to meet capacity requirements, including two additional wells for redundancy, reliability, and operational flexibility considerations. It was assumed that the Base Project facilities would be backbone of an injection operation, and injection wells would be located within 1,000 feet of the pipeline alignment. Wells would be spaced a minimum of 2,000 feet apart from each other. Screens would be located to pump out of the lower aquifer. Specific locations for the injections wells were not identified as a part of this effort, though it was assumed that new wells would need to be drilled for this scenario either on existing farm land or farm roads.

Figure A2: Map of Scenario 1 Injection and Extraction Well Areas



Extraction wells would be located to the south and west of the injection wells, downgradient from the location of the injection wells. Aquifer storage and recovery wells were not utilized due to the significant migration of water within the Central Basin over the periods of groundwater storage. The extraction wells would each have an extraction capacity of up to 2,000 gpm. In order to minimize the potential for excessive mounding or drawdown associated with injection or extraction, it was assumed that each injection and extraction well would be spaced a minimum of 2,000 feet away from any other injection or extraction well. To provide the equivalent of 55,000 AFY to the FSC, nineteen extraction wells are required, including two additional wells for reliability and redundancy. Though it is desired for the extraction wells to capture water injected into the ground, it is believed that water extracted from groundwater wells would be a combination of groundwater and injected surface water, once adequate surface water supplies were banked in the groundwater basin. Screens would be located to extract water from the lower aquifer. It was assumed that 90% of water banked in the ground could be extracted, and 10% would be left in the groundwater basin to account for losses. Monitoring wells may be required to determine the residency of injected surface water, and to allow for groundwater sampling. Extraction wells were assumed to extract water at a pressure meeting the FRWA pipeline pressure for deliveries to the FSC.

A new collection system would be required to convey extracted water from the extraction wells to the FSC. It was estimated that approximately 33 miles of pipeline would be required to convey water to and from the injection and extraction wells. Of this length, it was assumed that there was 1,000 feet of 16-inch ductile iron pipe for every injection and extraction well. A conveyance system from each extraction well back to the FRWA facilities (or FSC, whichever is closer) would also be required. No injection or extraction wells were specifically located for this effort. It was not known whether existing farm wells or new wells would be utilized for this effort, though it was assumed that new wells would be drilled.

The overall amount of water diverted by EBMUD is the same in the Base Project and Scenario 1, though it is assumed that only 90% of the water injected can be extracted. This would result in approximately 160 TAF less of overall deliveries to EBMUD during the period of the CALSIM simulation. The constraint that EBMUD only extract stored surface water (and not native groundwater) is important for the following reasons:

- This constraint minimizes the chances of injury to other groundwater users in the Basin that are considered an important condition that would be placed on a project of this type.
- Water Code 1220 prohibits the export of groundwater from the combined Sacramento and Delta-Central Sierra Basins, as defined by DWR Bulletin 160-74, unless the pumping is in compliance with a groundwater management plan adopted by the County, or portion of the County, that overlies the groundwater basin. The boundaries of these protected basins include Sacramento County (including North, Central and Galt areas). Thus, pursuant to the Water Code, unless there is a voter-approved AB 3030 plan, which provides for the export of groundwater (there is not), EBMUD would be limited to using only a quantity of water equal to the volume surface water that was stored in the groundwater basin, minus losses and any agreed upon leave.

In order to keep the overall diversions for Scenario 1 the same as those developed for the Base Project, some dry year diversions were required during the 1928 – 1934 drought period to prevent overdraft of the groundwater basin. The total extractions would not, at any time, exceed the amount of water banked, minus any agreed upon leave for losses. The quantity of dry year diversions during this time period was 150.8 TAF.

Surface Water Operational (CALSIM) Modeling: CALSIM is a generalized multi-year water resources simulation model for evaluating operational alternatives of large, complex river basins, such as the Sacramento River. The results of the CALSIM modeling help predict the impact of the proposed Scenarios on available water supplies, water quality, and storage volumes, among other items.

CALSIM modeling of Scenario 1 was performed utilizing the EBMUD diversion schedule as a fixed input. The results of this modeling effort (CH2M Hill, 2002) showed the following:

- There was available water to supply EBMUD during the modified diversion schedule;
- Total available CVP storage increased by an average of 1.1% during dry years as compared to the Base Project;
- There was no change in SCWA "Other" or "Excess" water diversions as a result of the change in the EBMUD diversion schedule, as compared to the Base Project; and
- No change to Delta's X2 position (location of the salt water/fresh water interface in the Delta) was observed, as compared to the Base Project.

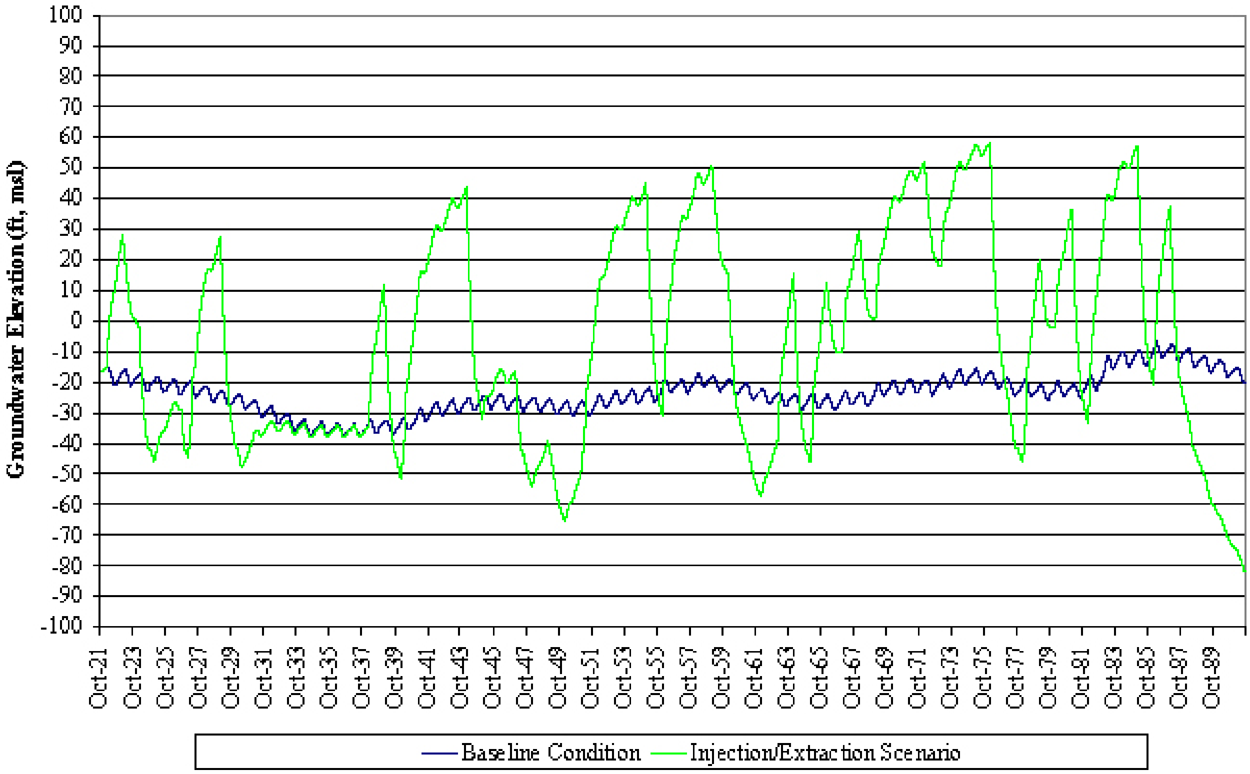
The net effect on CVP operations of modifying EBMUD diversions from dry years to wet years is small to negligible. However, EBMUD dry year diversions account for approximately 1% of the overall CVP diversions during a typical dry year in which EBMUD diverted, so these results are not unexpected. The net impacts of the change in diversion was most evident during the later years of a multi-year drought, when storage levels in Oroville Dam and elsewhere are at their lowest point. This would constitute the condition of maximum benefit associated with a shift in diversion pattern. However, such benefits would only be available if available groundwater had already been banked and remained in storage. As multiple dry years were modeled in the simulation, the 1928 through 1934 drought identified that in the third and subsequent years of a drought, with groundwater storage depleted to background levels, dry year diversions were required to meet the project purpose of dry year deliveries to EBMUD, and therefore, the range of project impacts still included occasional dry year diversions.

Groundwater Operational (IGSM) Modeling: Preliminary IGSM modeling showed that implementation of Scenario 1 heavily influences local groundwater table elevations. Figure A3 shows a hydrograph for a node located near the injection/extraction site. Injection affects groundwater levels by up to 50 feet in one year in the area immediately adjacent to the injection well, with a similar extent of drawdown at extraction wells during periods of extraction. During the simulation, the difference between maximum and minimum groundwater elevation varied by as much as 120 feet in the immediate area of the injection and extraction wells. Changes in groundwater elevation were observed throughout the Central Basin, with the northern portion of the basin generally receiving increased groundwater elevations, with the southern portion of the basin generally having slightly reduced groundwater elevations. The injection appeared to not affect the ability of the Cosumnes River to connect to the upper aquifer, but the level of accuracy of the model limits detailed conclusions about this issue. During a drought period following long periods of injection, groundwater levels decreased below the Base Project levels, resulting in drawdowns of up to 50 feet. It is believed that this drawdown is a result of the lack of residency of the surface water injected into the aquifer. In essence, water is being injected on the "shoulder" of the groundwater basin, and the amount of time between injection and extraction allows water to migrate to areas with lower groundwater elevations, or to local creeks.

The results of the simulation show that the implementation of Scenario 1 either has to be spaced over a much wider area than outlined in this scenario, in order to minimize the local impacts of injection and extraction, or the quantity of water injected and extracted needs to be significantly reduced to better manage the groundwater basin. In addition, a significant quantity of groundwater volume would need to be identified to use for long-term storage.

A static analysis of the supply and demand requirements for this scenario showed that up to 500,000 AF of groundwater storage during peak storage years would be optimal in the simulation to ensure continued operation and minimize dry year diversions for just the EBMUD component of the project. However, the simulation shows that the peak storage volume takes many years to reach, and assumes that the water is not lost over time. The result of this scenario is that the simulation predicts up to 180,000 AF of surface water remaining in the groundwater bank, and an additional 165,000 AF assumed to be lost to the environment. To minimize dry year diversions, therefore, there would be a need to increase the volume of water lost to the environment to account for the IGSM modeling results.

Figure A3: Groundwater Hydrographs for Node near Injection/Extraction Area)



Incremental Capital Cost Evaluation: Since no injection wells or extraction wells were specifically located, the cost for this scenario is based on a number of assumptions. These assumptions are identified below.

- Injection wells would be located 1,000 feet to the north and south of the Gerber Road Pipeline alignment. Turnouts for each well would be located 1,000 feet apart from each other, with one turnout connecting to an injection well to the north and the next to an injection well to the south. Each turnout would be sized with 12-inch pipe;
- Extraction wells were assumed to require an additional 1,000 feet of 16-inch pipe, plus an additional 1,000 feet of transmission pipeline. The assumed size of the transmission pipeline is 48-inches;
- The cost for each pipeline is $8 per inch-diameter per lineal foot; and
- Each injection and extraction well was assumed to cost $500,000 each.

Based on these cost assumptions, a cost estimate for Scenario 1 is presented in Table A1. This cost estimate is developed only to a conceptual level, which typically correlates to a -30%/+50% level of accuracy. The cost for Scenario 1 would be in addition to the $690 million cost estimated for the Base Project.

Table A1: Scenario 1 Conceptual Incremental Capital Cost (2002 Dollars)

Project Elements	Unit Price	Units	Quantity	Cost
Filtration Treatment (40 MGD capacity)	$6,000,000	LS	1	$6,000,000
Injection Wells	$500,000	EA	36	$18,000,000
Transmission pipeline for Extracted water (48-inch)	$384	LF	30,000	$12,000,000
Lateral from Extraction Wells to Transmission Pipeline (16-inch)	$108	LF	72,000	$7,800,000
Extraction Wells	$500,000	EA	19	$9,500,000
Lateral from Extraction Wells to Transmission Pipeline (16-inch)	$108	LF	72,000	$7,800,000
Pipeline Appurtenances (Fittings, line valves, air valves, etc)	10%	%		$2,800,000
Subtotal				**$63,900,000**
Construction Contingency (30%)	30%	%		$19,200,000
Total Construction Cost				**$83,100,000**
Engineering, Legal, Admin, Permits, Right of Way (25 %)	25%	%		$20,800,000
Overall Total				**$103,900,000**

Notes:
1. Assumes that the injection wells would be spaced 1,000 feet to the north and south of the proposed FRWA transmission pipelines.
2. Costs are rounded to two significant figures.
3. Extraction wells would be spaced 1,000 feet from a 48-inch collection pipeline, and be parallel to each other a minimum of 2.000 feet apart.
4. Assumes a unit cost for pipelines of $8 per inch diameter per foot.
5. Well facilities were not located. This estimate should serve only as a guide until facilities are located.

SCENARIO 2 – WET YEAR GROUNDWATER STORAGE FOR EBMUD (PERCOLATION/IN-LIEU IN GALT BASIN)

This scenario would divert surface water intended for EBMUD from the Freeport intake during wet years for use in the Galt Basin. No modifications were made to SCWA's diversion schedule, which were assumed to remain the same as the Base Project. The surface water would be stored in the Galt Basin. Uses would include agricultural irrigation and percolation into the groundwater basin. It was assumed that 80% of the surface water would be diverted on a monthly schedule correlating to when farmers required water. It was assumed that 90% of the water injected could be recovered in order to account for losses. No diversions would occur during dry or normal years, and the overall amount of water diverted during the 70-year simulation period remains the same. Table A2 shows the monthly distribution of agricultural demands used to estimate monthly deliveries.

Table A2: Monthly Distribution of Agricultural Demands for Scenario 2

Month/Project Component	Delivery Distribution by Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
In-lieu recharge (TAF)	0.03	0.03	1.76	4.24	7.19	6.33	6.82	6.13	5.25	3.25	1.69	0.02	42.8
Percolation (TAF)	0.00	0.00	0.00	1.78	1.78	1.78	1.78	1.78	1.78	0.00	0.00	0.00	10.7
Total Monthly Diversions (TAF)	**0.03**	**0.03**	**1.76**	**6.03**	**8.97**	**8.12**	**8.61**	**7.91**	**7.04**	**3.25**	**1.69**	**0.02**	**53.5**

The annual diversion schedule for Scenario 2 is the same as for Scenario 1, but the monthly distribution varies based on the agricultural demand for water and the percolation ability of the basin. Eighty percent of the water recharged in Scenario 2 would be recharged in-lieu through delivery to farmers within the Galt Basin, while 20% of the water would be recharged in groundwater basins. Water availability at the Freeport Intake is typically highest during the winter and early spring months, but this alternative would take water predominantly during the spring, summer, and fall months.

In order to keep the overall diversions for Scenario 2 the same as those developed for the Base Project, some dry year diversions were required during the 1928 – 1934 drought period to prevent overdraft of the groundwater basin, as in Scenario 1. The total extractions would not, at any time, exceed the amount of water banked, minus any agreed upon leave for losses. The quantity of dry year diversions during this time period was 150.8 TAF.

It was expected that raw surface water could be delivered without pretreatment, since it would be used solely for agricultural irrigation or percolation. If treatment were required, suitable location(s) would need to be identified. How both uses are utilized is described below.

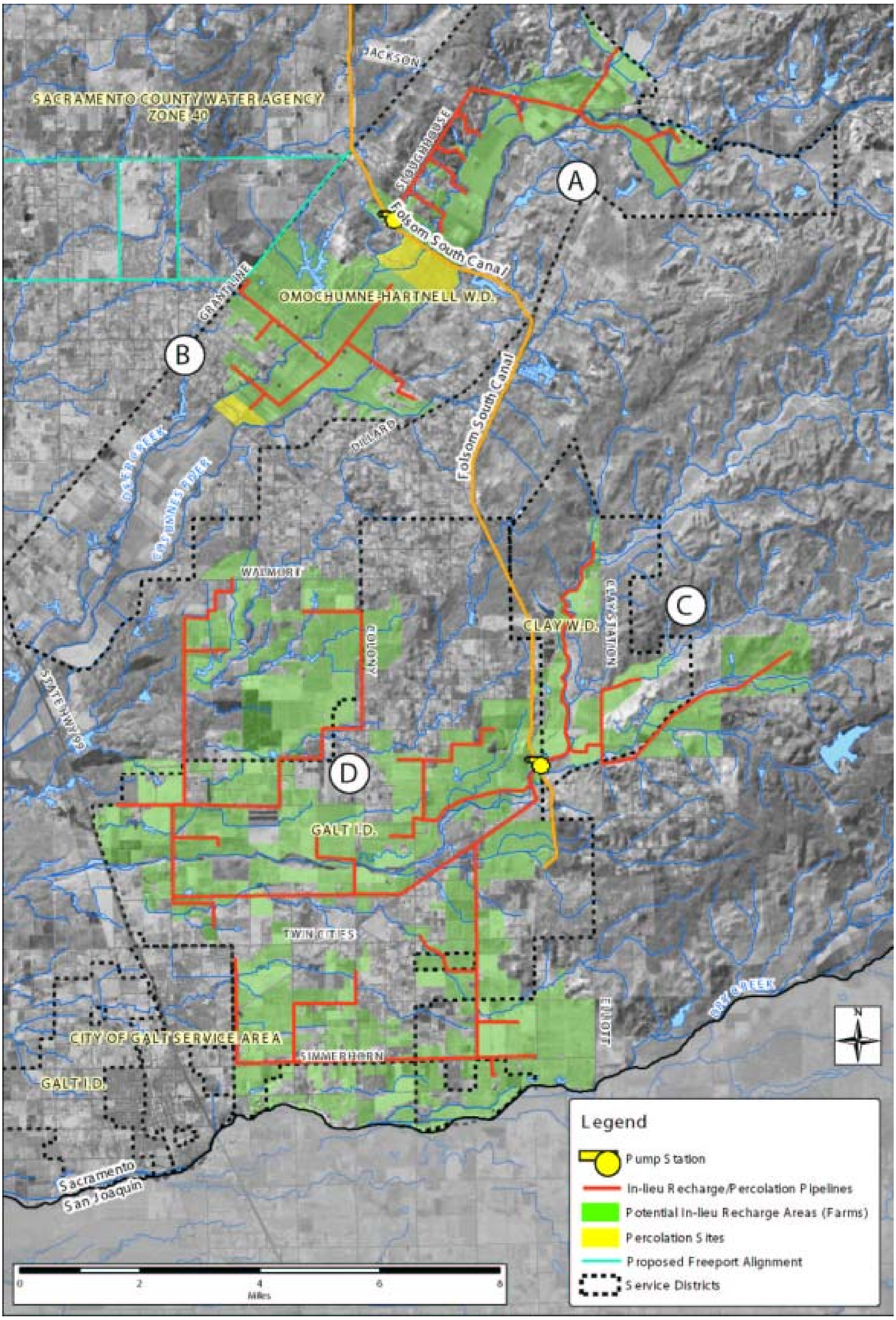
In-Lieu Recharge

The Zone 40 Master Planning effort is developing estimates for unit average water use for farmland within the entire Sacramento basin. These water use factors vary depending on the type of crop and the location of the farm, but typically range between 2.5 acre-feet per acre per year (ft/yr) and 3.5 ft/yr. Though no farm specific data was analyzed, a conceptual planning level water use factor of 3.0 ft/yr was assumed for all in-lieu recharge sites.

Based on this rate, efforts were made to locate at least 15,000 acres of irrigated farmland. Aerial photos, GIS data, irrigation intensity and the proximity to existing facilities were all reviewed in this analysis to identify potentially feasible sites for in-lieu recharge. Over 50,000 acres of potential farmland was identified in areas potentially feasible for an in-lieu recharge project. The total area presented in the following alignments total approximately 32,000 acres. It was desired to spread out the location of in-lieu recharge areas to maximize the amount of available groundwater volume that would be utilized for storage, and minimize the local impacts of the project. Figure A4 shows a map of the proposed in-lieu recharge area.

The farms selected as candidates for in-lieu recharge are located predominantly in the Omochumnee – Hartnell Water District (OHWD), Galt Irrigation District, Clay Water District and areas immediately surrounding those Districts. These areas would receive raw surface water pumped from the FSC for irrigation. Water would be extracted from selected farms receiving surface water for irrigation from either existing on-site wells, or new wells constructed on the farm site. A map of these areas and conceptual distribution systems for each area is shown in Figure A4. Maps of each alignment and a description of that alignment are discussed below.

Figure A4: Map of Scenario 2 – In-Lieu Recharge and Percolation Sites



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Alignment A would receive surface water either through directly pumping out of the FSC, or construction of an extension of the proposed FRWA alignment to Sloughhouse Road. The main distribution pipeline would travel northeast on Sloughhouse road and east on Jackson Highway, connecting approximately 4,000 acres of farmland within the OHWD. There are some farm lands just outside of the OHWD that could also be connected to the pipeline, but the added infrastructure requirements to connect these lands seemed cost-prohibitive. Efforts were made to locate pipelines along roads to minimize right of way issues.

Alignment B would divert from surface water from the proposed FRWA pipeline on Grant Line Road for delivery to approximately 6,000 acres of farmland and 600 acres of percolation basins. It is believed that no additional pumping would be required, provided there is adequate pressure at Grant Line Road to deliver water to the farm sites. This alignment would require construction on farm roads or within farm sites, since there appear to be few to no roads in this area except Grant Line Road and Wilton Road. There is one crossing of the Cosumnes River to connect additional farmland on the South side of the River. Alignment B could also be extended onto Dillard Road to connect a fish hatchery to surface water. The fish hatchery is believed to be one of the largest groundwater pumpers in the Central Basin.

Alignments C and D would pump surface water from the FSC to farmers in Clay, Galt ID and environs. The pump station would be located just north of Twin Cities Road, and the alignments would extend east and west from the pump station discharge between Highway 99 and the foothills. Approximately 25,000 acres of farmland were identified in the areas that are potentially suitable for irrigation, and up to 60 miles of pipeline could be constructed to connect each farm to the distribution system. Significant efforts would be required to determine the best irrigation sites, and minimize the overall facility requirements. Long stretches of the alignments travel along either farm roads, levees, or existing farmlands, due to the lack of suitable roads in some areas. There are numerous creek crossings as well. The areas served by these alignments are typically more intensive to the west near Highway 99, with largely pasture lands for grazing in the eastern portion of the alignment.

Alignments B and D seemed to present the most likely opportunities to connect the most acreage while minimizing infrastructure costs. Significant work would be required to optimize the location and operation of these distribution systems, including determining farm-specific water needs, procuring right of way, managing delivery schedules, and determining required delivery pressures. These alignments also have farms within existing water districts, which could make export of groundwater more suitable in the long-term. Preliminary discussions with local entities such as the Nature Conservancy in the Cosumnes River preserve have indicated their willingness to locate extraction wells and recharge facilities on their property. They also suggested that locating in-lieu recharge sites in the area directly across Highway 99 between Twin Cities and the Elk Grove Urban Services Boundary also held opportunities for high-intensity irrigation/recharge, but those opportunities were not explored due to the abundance of farm land closer to project facilities. If these farm lands are determined to not be suitable for recharge, opportunities for other in-lieu recharge sites are prevalent in other areas of the Galt Basin.

Providing storage would allow the distribution system to operate as a gravity system, instead of providing pressure solely through pumping. Opportunities to add system storage to the distribution system to provide system storage could be incorporated into Alignments B and C, since they are nearby areas of higher elevation. Storage in Alignment C would provide storage to Alignment D as well.

Opportunities to minimize the infrastructure cost for the distribution system, including pumping requirements, pipeline diameters, and real estate costs, can be incorporated into the design. These opportunities include scheduling water deliveries to farmers to minimize peaking, requiring existing wells to be used as an on-site backup if adequate supplies are not available, and requesting easements from farmers receiving water for distribution pipelines. These opportunities will be further explored during design development.

Percolation Basins

The remaining 20% of the available surface water diversions would be diverted to percolation basins for recharge. Percolation would occur between April – October. It is desired to recharge primarily during dry weather months, when permeability is highest and the soil is less saturated. Water would be delivered to the percolation basins at a constant monthly rate during that period. It is intended to percolate raw water into the basin with no additional treatment. Some of the water intended for percolation will evaporate due to evapotranspiration.

There is no obvious natural depression suitable for a percolation basin that is either unoccupied or not already considered to be a pond or stream. It was expected that between 300 – 500 acres of percolation area is required to percolate 10,700 AFY. Based on the area requirement, it is likely that a percolation basin would need to be created out of flat or slightly contoured areas. Thus, significant excavation will be required to manufacture a percolation basin. For this analysis, areas near proposed pipeline alignments and with a high permeability were identified as candidates for locating a percolation basin. Alternates not considered in this analysis include utilizing existing ponds on Cosumnes River tributaries, or augmenting Cosumnes River flows. These issues will need to be further explored in order to determine the feasibility of implementing either alternate. However, it is expected that amending existing water bodies with waters not specific to that watershed are critical issues for regulators, and limit the feasibility of a project.

The area within the Cosumnes River floodplain generally had the highest percolation ability of any soils within the Central or Galt basins. Much of the floodplain had a "B" rating overall for permeability, based on the Natural Resources Conservation Service Soil Survey Geographic Database soil data. For this analysis, it was assumed that the soil permeability was 0.3 ft/day. Many of these areas are already farmed, and were also identified as potential in-lieu recharge sites. Two areas that are not irrigated but have a high permeability are located adjacent to areas served by Alignment B. These areas are shaded in yellow on Figure A4. Thus, a minimum area of 300 acres for percolation is required, though more may be required if percolation rates are less than expected. These areas have a direct interface with the Cosumnes River, which could accelerate the movement of water to and from the percolation basin.

Extraction wells would ring the percolation basin to maximize extraction. It is believed that at least five extraction wells would ring each percolation basin. These wells would penetrate only to the upper aquifer, where the surface water is to be percolated. Likely, the water extracted from the basin much of the water percolated into the basin and not extracted for many years would be lost to the environment, and that the water extracted would be a mixture of surface water and groundwater.

Surface Water Operational (CALSIM) Modeling: CALSIM modeling of Scenario 2 was not expected to vary significantly from Scenario 1, since only the monthly distribution of diversions within a given year changed compared to Scenario 1. Thus, it was expected that the same results will be seen from CALSIM modeling of Scenario 2, and a separate CALSIM modeling run was not completed. The results of that CALSIM modeling run are repeated here.

- There was available water to supply EBMUD during the modified diversion schedule, except for the 150.8 TAF of dry year diversions during the 1928-1934 drought period.;

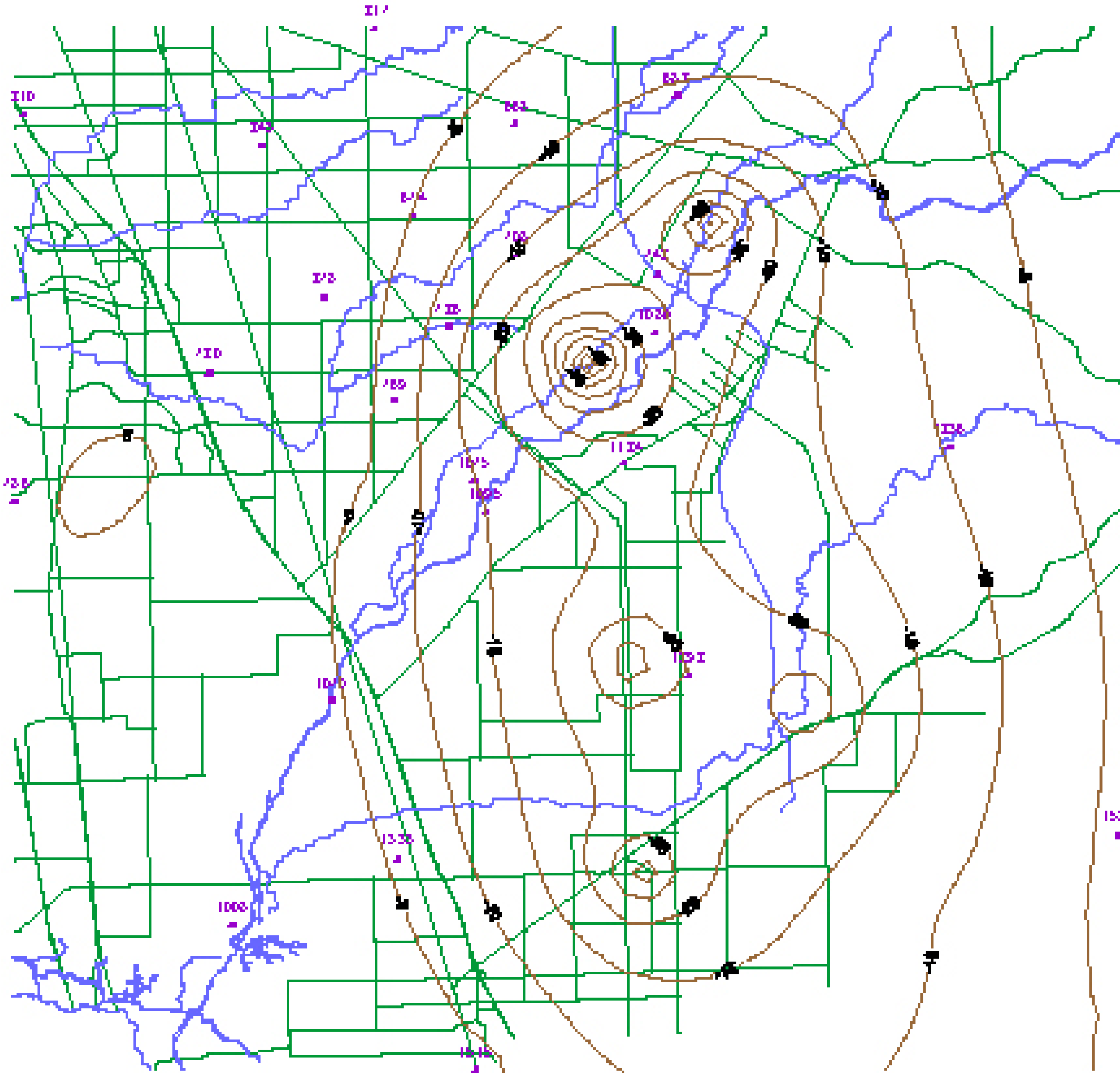
- Total available North of Delta CVP storage was 10 TAF less than the No Action Alternative during all years, and 30 TAF less during dry years.
- Oroville storage decreased by 10 TAF from the No Action Alternative during all years, and 26 TAF during dry years.
- Both North and South CVP total deliveries were similar to the No Action Alternative.
- SWP total deliveries were 5 TAF less than the No Action Alternative during all years, 19 TAF less during dry years.
- There was no change in SCWA "Other Water" or "Excess Water" diversions as a result of the change in the EBMUD diversion schedule, as compared to the Base Project.
- No change to Delta's maximum or minimum X2 position was observed, as compared to the Base Project.
- No change to Delta salinity is anticipated based on predicted Delta flows as compared to the Base Project.

Similar to Scenario 1, during the drought of 1928 through 1934, not enough water had been banked to provide water to EBMUD during this entire time period. During the third and subsequent years of a drought, with groundwater storage depleted to background levels, dry year diversions were required to meet the project purpose of dry year deliveries to EBMUD, and therefore, the range of project impacts still included occasional dry year diversions.

IGSM Modeling: Scenario 2 IGSM modeling results showed widespread raising of the water table by between 0-10 feet, but localized drawdowns in the vicinities of the extraction wells, especially during dry years. The extent of drawdown varies based on the number of extraction wells, but can range between 20-30 feet if using 5-15 extraction wells. Figure A5 shows a contour map of groundwater elevations for layer two of the groundwater basin when using five extraction wells. This change would affect the ability of wells to pump from their existing screened depths, and result in increased power charges for pumping. Following multiple sequential dry years, maximum drawdown is typically achieved.

The wider area of application of surface water greatly distributes the injected water, reducing the changes to groundwater elevations during application and extraction compared to Scenario 1. However, the extraction of groundwater still results in localized depressions around the extraction wells. One way to help resolve this issue is to utilize more extraction wells pumping at lower rates. Existing farm wells could also be converted for this purpose, provided that the farmers agree to use their wells for this use.

Figure A5: Scenario 2 – September 1991 Groundwater Difference Contours



Cost: Optimization of the Scenario 2 distribution system alignment was not performed. Over 50,000 acres of potential sites for in-lieu recharge were identified, but the best sites for recharge are currently unknown. The types of crops, irrigation methods, desire to receive surface water, and other site specific issues will assist in determining the most suitable alignments. It is expected that a combination of the reaches will be utilized that allow for system storage, reliable deliveries and opportunities to expand the distribution system.

The cost estimate presented for this option is based solely on the expected unit price for delivering water to 20,000 acres of land, based on the location and lengths of Alignments A through D. Pipeline diameters were estimated based on the quantity of land served by that pipeline. It is expected that the final cost for this alternative would be determined during the development of additional design details. Other cost assumptions are identified below.

- Pipelines capital cost is $8 per inch diameter per lineal foot;
- The diameter of the pipelines will vary in size from 12-inches to 36-inches;
- Water deliveries would be scheduled to reduce pumping requirements;
- Surface water would be delivered to all customers at a minimum pressure of 60 psi.

Based on these cost assumptions, a cost estimate for Scenario 2 is presented in Table A3. This cost estimate is developed only to a conceptual level, which typically correlates to a -30%/+50% level of accuracy. The costs for Scenario 2 are in addition to the cost for the Base Project facilities, which is currently estimated to be $690 million.

Table A3: Scenario 2 Conceptual Cost Estimate

Project Elements	Unit Price	Units	Quantity	Cost
Percolation Basin	$4,000,000	LS	1	$4,000,000
Distribution Pipelines	$160	LF	258,720	$41,000,000
Pump Stations	$2,500,000	LF	2	$5,000,000
Extraction Wells	$500,000	EA	20	$10,000,000
Pipeline Appurtenances (Fittings, line valves, turnouts, air valves, etc)	10%	%		$4,100,000
Subtotal				$**64,100,000**
Construction Contingency (30%)	30%	%		$19,000,000
Total Construction Cost				**$83,000,000**
Engineering, Legal, Admin, Permits, Right of Way (25 %)	25%	%		$21,000,000
Overall Total				**$104,000,000**

Notes:
1. Costs are rounded to two significant figures.
2. Pump Station and Percolation Basin cost estimates based on comparably sized facilities identified in the Revised BMP.
3. Distribution pipelines assume an average pipeline diameter of 20-inches.
4. Extraction wells would be located on farms receiving surface water.
5. Assumes a unit cost for pipelines of $8 per inch diameter per foot.

SCENARIO 3 – WET YEAR GROUNDWATER STORAGE FOR EBMUD AND SCWA (PERCOLATION/IN-LIEU IN GALT BASIN AND INJECTION IN CENTRAL BASIN)

Scenario 3 builds on Scenario 2 by adding a wet weather diversion component for water diverted from Freeport for use by SCWA in Zone 40. The SCWA water would be treated at the SCWA WTP and distributed throughout its service area in Zone 40 to demand points and to injection wells near the existing and planned extraction wells. During dry years, below normal, and normal years, demands in Zone 40 would be met through increased use of groundwater, stored surface water and reduced use of surface water diverted at Freeport. EBMUD water would be conveyed as described for Scenario 2 to the FSC for conveyance to the Galt Area for in lieu recharge and percolation. Subsequent extraction would be managed as proposed for Scenario 2 as well.

Zone 40/41 Deliveries

The major difference between Scenario 3 and Scenario 2 is the increase of wet weather diversions for SCWA from Freeport. These diversions increase during wet and normal years, and are decreased during dry and critical years. This schedule was developed to maximize the ability of FRWA to divert surface water when water is available, and reduce the downstream impacts to Delta Water Users in dry years. Major tenets of this change are:

- No FRWA CVP Diversions during Critical Years;

- No Other Water Diversions during Critical Years; and
- The amount of Other Water and Excess Water diverted during normal or wet years would increase to offset the reduction in CVP deliveries during critical years;

These assumptions were selected solely for their ability to model the outer envelope of water diversion schedules from the FRWA intake, and not for their suitability or feasibility. It was believed that this diversion basis reflected the "best-case" scenario for reducing the impacts of the Base Project on downstream water users.

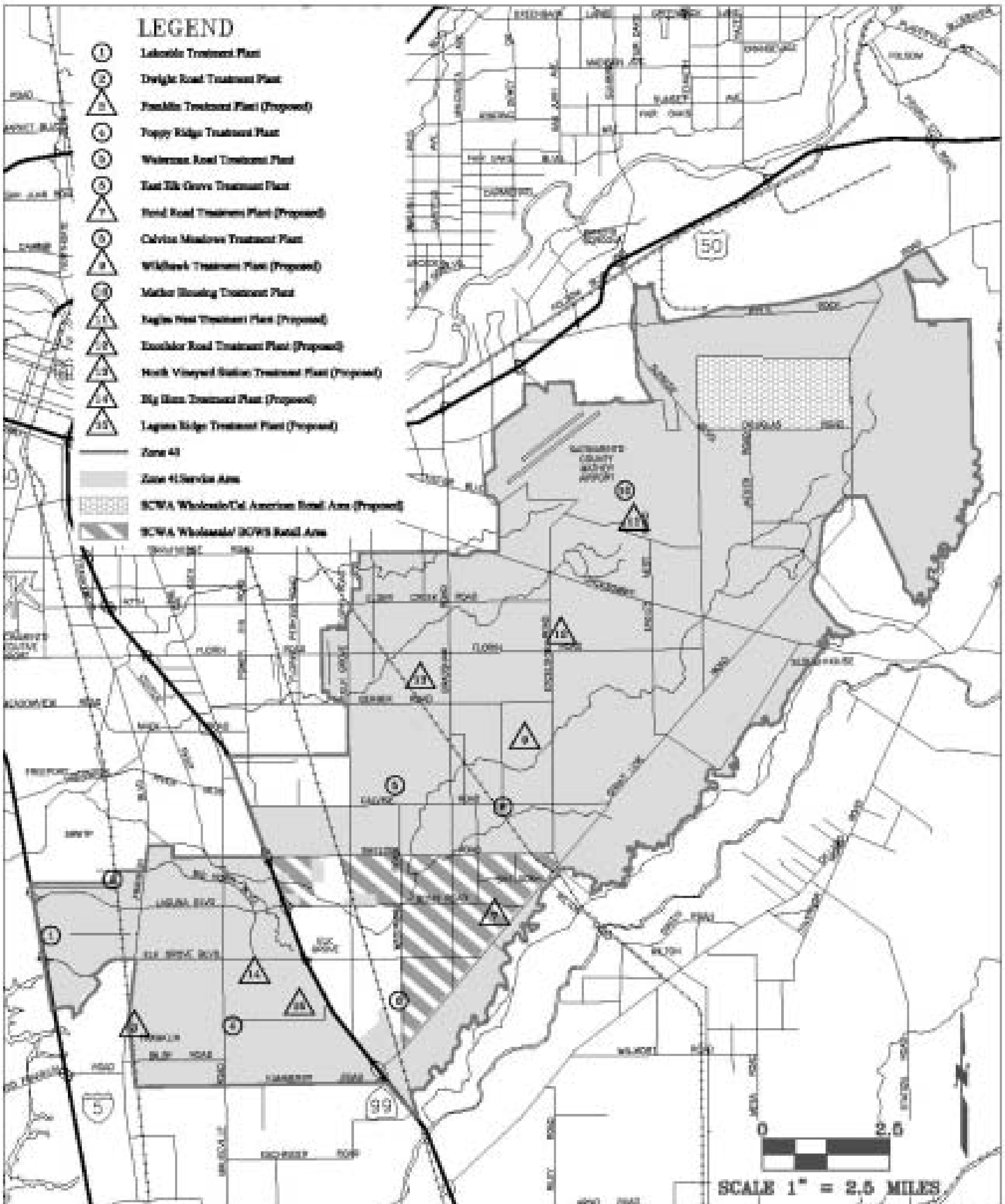
The Scenario 2 facilities would remain the same as described in that section. The new facilities identified in Scenario 3 are described below:

Water diverted at Freeport for use by SCWA would be conveyed through the FRWA diversion facilities to a new surface water treatment plant. This plant is expected to be located near the intersection of Bradshaw and Florin Roads, and would treat all surface water prior to either injection or delivery. Treated surface water was proposed to be injected at 15 sites between Interstate 5 and Mather Air Force Base, as shown on Figure A6. Water would be delivered to each site through either the existing distribution system, planned improvements to the distribution system, or new transmission lines through existing infrastructure. The amount, frequency, and operational strategy for the groundwater injection was not developed as a part of this project, but for the purposes of this analysis, it was assumed that any water injected would be injected in equal quantities at each of the 15 sites. The extracted treated surface water was assumed to be treated at either a new groundwater treatment plant (eight) located adjacent to the injection/extraction well, or at an existing groundwater treatment plant (seven).

The facilities required to locate the pipelines to and from each site were not developed as a part of this analysis. It was considered that the utilization of existing facilities would be maximized to the extent possible, and significant modeling and research would be required to identify the most suitable locations for conveyance facilities or pipeline upsizing.

The overall amount of water diverted by EBMUD and SCWA in Scenario 3 is the same in the Base Project, though it is assumed that only 90% of the water percolated by EBMUD can be extracted. This accounting for losses was not continued over into the SCWA conjunctive use in the Central basin, since SCWA helps manage the basin, and the water not recovered by these extraction wells would likely be pumped out by another well within the SCWA service area.

Figure A6: Map of Existing and Planned Groundwater Treatment Facilities



Existing and Planned Groundwater Treatment Facilities

October 28, 2002

Surface Water Operational (CALSIM) Modeling: CALSIM modeling of Scenario 3 was completed. The results of the modeling effort generally showed slightly smaller reductions in the amount of storage and deliveries, compared to the Base Project. The details of the modeling effort were:

- There was available water from the groundwater bank to supply EBMUD and SCWA during the modified diversion schedule, except for the 150.8 TAF of dry year diversions required during the 1928-1934 drought period;
- Total available North of Delta CVP storage decreased by 8 TAF from the No Action Alternative during all years, and increased by 5 TAF during the 1928-1934 drought. This increase is likely due to the elimination of SCWA CVP during this dry period.
- The amount of SCWA Excess and Other Water increased during wet years to offset a reduction in CVP water deliveries.
- Oroville Storage decreased by 9 TAF and 1 TAF during all years and the dry period examined, respectively.
- Both North and South CVP total deliveries were similar to the No Action Alternative.
- SWP total deliveries were virtually unchanged from the No Action Alternative.
- There was no change to Delta's X2 position, as compared to the Base Project.
- No change to Delta salinity is anticipated based on predicted Delta flows as compared to the Base Project.

Similar to Scenarios 1 and 2, during the drought of 1928 through 1934, not enough water had been banked to provide water to EBMUD during this entire time period. Dry year diversions continued for SCWA according to the assumptions identified. During the third and subsequent years of a drought, with groundwater storage depleted to background levels, dry year diversions were required to meet the project purpose of dry year deliveries to EBMUD, and therefore, the range of project impacts still included occasional dry year diversions.

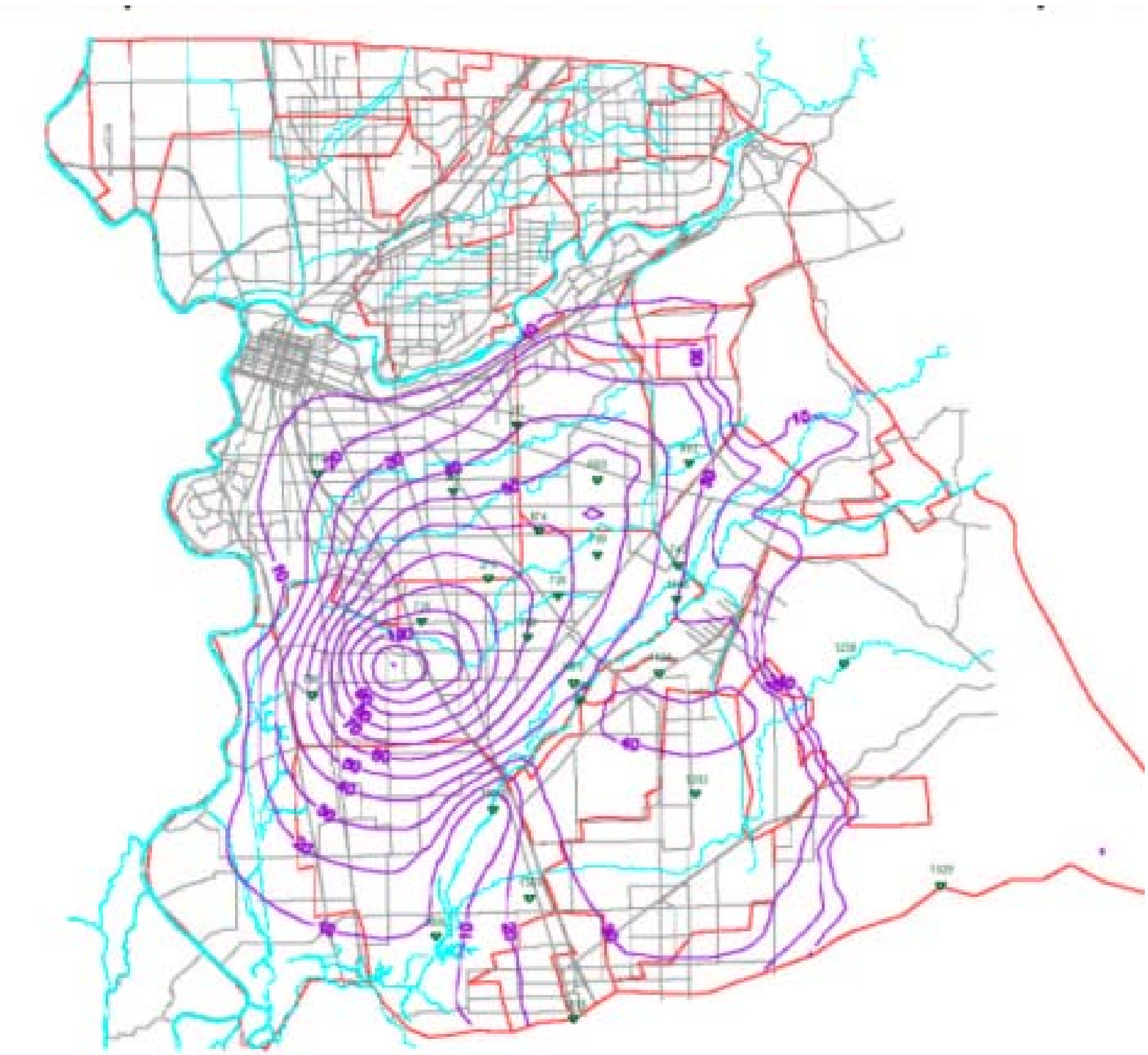
Groundwater Operational (IGSM) Modeling: IGSM modeling was completed in a manner similar to Scenarios 1 & 2, which utilize the 1990 condition. The introduction of annual surface water deliveries in excess of the historical demands resulted in widespread elevation increases of the water table. These increases were distributed throughout the Central and Galt Basin, but did not inundate any of the nodes identified in the model. Future analyses will identify the impact of this project at the 2020 level of development.

IGSM modeling of Scenario 3 was prepared based on the 1990 baseline water demands in the Central Basin. The use of this historical data results in annual surface water deliveries to the Central Basin that exceed the quantity pumped from the groundwater basin by approximately 40,000 AFY. Consequently, the IGSM model assumes that this additional surface water is injected into the groundwater basin. The annual injection of a large volume of water results in the filling of groundwater depressions in the Elk Grove area and areas of the Galt Basin, and widespread increases of up to 90 feet in the groundwater table. Figure A7 shows a sample hydrograph from this simulation. Most areas of the Central and Galt Basin within the proposed project area will have groundwater elevations increased by at least 20 feet. Groundwater also percolates into Layers 2 & 3, the deeper subsurface strata, resulting in groundwater levels increasing in those Layers by similar amounts.

It is important to note that the IGSM model assumes that based on historical water demands, annual Zone 40 groundwater pumping averaged approximately 38,000 AFY between 1922 – 1994. The SCWA has estimated that the long-term annual Zone 40 average demands between 1995 – 2064 are approximately

108,000 AFY, while others have estimated between 90,000 – 100,000 without pumping from the Aerojet and Kiefer sites. Modeling at the 2030 condition was not immediately available, since those demand conditions have not been finalized. It is expected that these data files will be available following the completion of the Zone 40 Master Plan. For a more accurate representation of the impacts to the groundwater basin, additional modeling using the 2030 condition is required.

Figure A7: Scenario 3 Groundwater Contour Map – Difference between Scenario 3 and No Action Alternative



The net result of this groundwater modeling effort shows that if this Scenario had been operational between 1922 – 1994 with the same level of demand, groundwater elevations in the Central and Galt Basin would be significantly higher than if the Scenario had not been in place. No conclusions about the groundwater impacts can be drawn from these results at this time for future demands.

Incremental Capital Cost Evaluation: The costs identified in Table A4 for Scenario 3 are in addition to the costs required to implement Scenario 2 ($104,000,000), as well as the costs to implement the Base Project ($690 million). Components of Scenario 3 that are not included in this evaluation are costs that are already included in the Base Project, such as the surface water treatment plant, and the conveyance facilities to and from the treatment plant. However, the costs for the additional conveyance facilities to and from the injection/extraction wells, the injection/extraction wells, and the groundwater treatment facilities are included in this evaluation.

The cost estimate for Scenario 3 is based on a number of assumptions, including:

- Pipelines capital cost is $10 per inch diameter per lineal foot. Note that these costs are slightly higher than the other Scenarios, since construction is typically occurring within existing city street right of ways.
- It was assumed that there would be one main transmission pipeline from the proposed treatment plant site, extending south on Bradshaw and east on Elk Grove Boulevard to the Site #1. This pipeline would average 42-inches in diameter. Another 24-inch pipeline would extend east and north to Mather AFB to Sites #10 – 12; and
- Similar sized treatment plants and injection wells would be located at each site. Each site would have the ability to inject, extract, and treat approximately 600 AF/month, or approximately 6.5 MGD.

It is expected that the final cost for this alternative would be determined during the development of additional design details. Based on these cost assumptions, a cost estimate for Scenario 3 is presented in Table A4. This cost estimate is developed only to a conceptual level, which typically correlates to a level of accuracy equivalent to -30%/+50%.

Table A4: Scenario 3 Conceptual Cost Estimate

Project Elements	Unit Price	Units	Quantity	Cost
Conveyance Facilities				
42-inch transmission pipeline	$420	LF	32,000	$13,000,000
24-inch transmission pipeline	$240	LF	15,000	$3,600,000
18-inch to/from transmission pipeline	$180	LF	11,000	$2,000,000
Groundwater Treatment Plant – new (including pumping)	$3,000,000	EA	15	$45,000,000
Upgrades to Existing Groundwater Treatment Plant				
Injection/Extraction Wells	$500,000	EA	15	$7,500,000
Pipeline Appurtenances (Fittings, line valves, turnouts, etc)	10%	%		$1,900,000
Subtotal				$**9,400,000**
Construction Contingency (30%)	30%	%		$22,000,000
Total Construction Cost				**$95,000,000**
Engineering, Legal, Admin, Permits, Right of Way (25%)	25%	%		$24,000,000
Scenario 3 only facilities				**$119,000,000**
Scenario 2 Facilities				**$104,000,000**
Overall Scenario 3 Total				**$223,000,000**

Notes:
1. Costs are rounded to two significant figures.
2. 24-inch assumed to travel along Florin Road from Bradshaw Road to Eagles Nest Road, then North on Eagles Nest Road to Site 10.
3. 42-inch assumed to travel along Bradshaw Road from Florin Road to Elk Grove Boulevard, then West on Elk Grove Boulevard to Site #1.
4. Each 18-inch pipeline to/from groundwater treatment plant was assumed to be 750 feet long.
5. No costs for special construction are included e.g. freeway crossings, creek crossings, microtunneling).

SCENARIO 4 – WET YEAR GROUNDWATER STORAGE FOR SCWA (INJECTION IN CENTRAL BASIN)

Scenario 4 is the same as Scenario 3, except that it removes the Wet Year/Groundwater Storage facilities for EBMUD, and changes the EBMUD diversion schedule to match the Base Project. All SCWA deliveries and operations would remain the same as Scenario 3.

Surface Water Operational (CALSIM) Modeling: CALSIM modeling of Scenario 4 was completed. The results of the modeling effort generally showed similar results as Scenario 2, with minor variations in the amount of North of Delta CVP storage, CVP Total Deliveries – South and SWP Total Deliveries. The details of the modeling effort were:

- There was available water to supply SCWA during the modified diversion schedule;
- Total available North of Delta CVP storage decreased by 21 TAF from the No Action Alternative during all years, 24 TAF during dry years.
- Oroville storage decreased by 14 TAF from the No Action Alternative during all years, and 26 TAF during dry years.
- Both North and South CVP total deliveries were similar to the No Action Alternative during all years, but South CVP total deliveries decreased by 9 TAF during dry years.
- SWP total deliveries were 4 TAF and 14 TAF during all and dry years, respectively, compared to the No Action Alternative.
- There was no change to Delta's maximum or minimum X2 position, as compared to the No Action Alternative.
- No change to Delta salinity is anticipated based on predicted Delta flows as compared to the Base Project.

Groundwater Operational (IGSM) Modeling: IGSM modeling of Scenario 4 was not completed, and the information presented in this summary was estimated based on the results of Scenario 3.

Groundwater level estimates were prepared based on the 1990 baseline water demands in the Central Basin. The use of this data results in annual surface water deliveries to the Central Basin that exceed the quantity pumped from the groundwater basin by approximately 40,000 AFY. Consequently, the model would inject this additional surface water into the groundwater basin. The annual injection of a large volume of water results in the filling of groundwater depressions in the Elk Grove area and areas of the Galt Basin, and widespread increases of the groundwater table.

It is important to note that the IGSM model assumes that based on historical water demands, annual Zone 40 groundwater pumping averaged approximately 38,000 AFY between 1922 – 1994. The SCWA has estimated that the long-term annual Zone 40 average demands between 1995 – 2064 are approximately 108,000 AFY, while others have estimated between 90,000 – 100,000 without pumping from the Aerojet and Kiefer sites. Modeling at the 2030 condition was not immediately available, since those demand conditions have not been finalized. It is expected that these data files will be available following the completion of the Zone 40 Master Plan. For a more accurate representation of the impacts to the groundwater basin, additional modeling using the 2030 condition is required.

Incremental Capital Cost Evaluation: The cost for Scenario 4 is the same as identified in A6, except the EBMUD groundwater recharge facilities are removed. The costs for Scenario 4 are identified in Table A5.

Table A5: Scenario 4 Conceptual Cost Estimate

Project Elements	Unit Price	Units	Quantity	Cost
Conveyance Facilities				
42-inch transmission pipeline	$420	LF	32,000	$13,000,000
24-inch transmission pipeline	$240	LF	15,000	$3,600,000
18-inch to/from transmission pipeline	$180	LF	11,000	$2,000,000
Groundwater Treatment Plant – new (including pumping)	$3,000,000	EA	15	$45,000,000
Upgrades to Existing Groundwater Treatment Plant				
Injection/Extraction Wells	$500,000	EA	15	$7,500,000
Pipeline Appurtenances (Fittings, line valves, turnouts, etc)	10%	%		$1,900,000
Subtotal				$**9,400,000**
Construction Contingency (30%)	30%	%		$22,000,000
Total Construction Cost				**$95,000,000**
Engineering, Legal, Admin, Permits, Right of Way (25%)	25%	%		$24,000,000
Scenario 4 only facilities				**$119,000,000**

Notes:
1. Costs are rounded to two significant figures.
2. 24-inch assumed to travel along Florin Road from Bradshaw Road to Eagles Nest Road, then North on Eagles Nest Road to Site 10.
3. 42-inch assumed to travel along Bradshaw Road from Florin Road to Elk Grove Boulevard, then West on Elk Grove Boulevard to Site #1.
4. Each 18-inch pipeline to/from groundwater treatment plant was assumed to be 750 feet long.
5. No costs for special construction are included (e.g., freeway crossings, creek crossings, microtunneling).