Chapter 9

Year 2010 Salt Management Studies and Screening

Chapter 9

Year 2010 Salt Management Studies and Screening

9.1 Introduction

This chapter presents the results of screening-level salt balance studies based on individual and composite salt management strategies described in Chapter 8. Multiple studies were initially developed and evaluated but only those that would successfully meet projected supply and demand conditions (i.e., provide a sustainable water supply) are reported herein. The studies were additionally constrained by having to use only existing or already planned Zone 7 facilities. In many cases the size of study components was determined based on these latter constraints and/or as needed to achieve a zero (neutral) salt balance under projected year 2010 demand, operational, and land use conditions.

The salt balance studies presented in this chapter were conducted using projected 2010 demands (derived from the April 1997 Sustainable Water Supply Report) and land use characteristics, and hydrology from 1922 through 1996 (which includes normal, wet, dry, and drought years). For each study a 75-year simulation using 1922 through 1996 hydrology was conducted to ensure that the study was a viable operations plan that could provide a sustainable water supply. As discussed in Section 5.2, the calculations were based on steady state 1974 through 1998 hydrology since these provide a better indicator of potential long-term loading conditions than calculations based on any given annual hydrologic conditions.

Strategy specific facility and operational constraints were input into a version of the Zone 7 salt balance model (presented in Chapter 5) modified to reflect year 2010 conditions. The modified model was used to evaluate how alternative salt management studies would affect the year 2010 salt balance. These screening level studies focused on projects and basin management measures directly affecting year 2010 salt loading to the Main Basin. Measures other than these may be needed to reduce salt loading to the creeks, which flow out of the valley and do not impact the main basin, but can potentially impact water quality in the Niles Cone.

Calculations were performed for each study to determine the estimated net salt loading to the Main Basin, the estimated net annual increase in TDS of the groundwater, the projected TDS in the overall groundwater basin after 10 years of implementation, the TDS of Zone 7 treated water deliveries, and the incremental operational costs (based on Chapter 8 unit costs) of implementing each strategy.

Originally, approximately 15 basic salt management studies were evaluated, all of which included an assumed 6 TAF/year of RO recycled water injection and recharge via Chain of Lakes Lake I. Several iterations of some of the basic studies were subsequently developed and evaluated based on optimizing the initial results, recommendations from Zone 7 advisory groups, and public concerns about RO recycled water injection.

Long-term averages for each water inflow and outflow component were calculated along with the main basin water and salt balances. Results in this chapter for each study evaluated are presented in individual tables similar in format to the 2010 steady-state salt balance results included in Chapter 5 (Table 5.3). The salt source (water supply) and salt export (water demand) components of these tables were defined in Chapter 5. Most of the assumptions inherent in generating the salt balance results presented in Chapter 5 also apply to these studies. These assumptions are summarized in sections 9.2 and 9.3. For a more comprehensive presentation of the details behind these year 2010 screening level salt balance studies refer to Reference M.

The individual study results are briefly described (Section 9.4) and then compared (Section 9.5) relative to their impacts on salt loading, groundwater quality, delivered water quality, and on water rates (i.e., costs). The concept of and examples of composite studies is then presented. A feasibility screening is then performed (Section 9.6) to identify the most promising studies to carry forward for more detailed analysis and modeling (Chapter 10).

9.2 Definitions and Assumptions

The key results of the year 2010 screening level studies have been summarized in two tables. Table 9.1 presents a summary of the water quality and O&M cost results of the studies. Table 9.2 presents a preliminary cost estimate associated with each of the salt balance studies. The following is a brief explanation of the components found in tables 9.1 and 9.2.

Vadose zone salt attenuation credit assumes that a given percent of salt applied for irrigation purposes is permanently retained by the soil and does not migrate vertically to impact the groundwater. Studies 3, 4, and 12 assume vadose zone attenuation at rates of 15% and 30%, which are based on the available literature. Vadose zone attenuation is incorporated by reducing the salt load mass resulting from urban and agricultural irrigation by the corresponding percentage.

Demineralized municipal pumpage assumes that groundwater of 450 mg/L or 1,000 mg/L TDS will be pumped and demineralized at the wellhead to 100 mg/L TDS. There is assumed to be a 10% loss to brine, so the pumpage required was increased by 10%.

TABLE 9.1

SUMMARY OF SALT BALANCE STUDIES AT 2010 CONDITIONS

		LONG TERM AVERAGE									
STUDY NO.	NAME	VADOSE ZONE ATTENUATION CREDIT	DEMINERALIZED MUNICIPAL PUMPAGE TAF	SALT MGT. CONJ. USE GW PUMPAGE TAF	TOTAL ZONE 7 GW PUMPAGE TAF	NET SALT LOADING TONS/YR	NET INCREASE IN TDS mg/l/year	PROJECTED GW TDS AFTER 10 YEARS	TDS OF ZONE 7 DELIVERIES mg/l	INCREMENTAL OPERATIONAL COST PER YEAR	INCREMENTAL OPERATIONAL COST PER ACRE-FOOT OF TW DELIVERY
								CURRENT 450			
1	Status Quo 6 TAF RO RW INJECTION (1)	NONE	NONE	NONE	12	**3100**	**10**	**550**	**300**	**$0**	**$0**
1A	Status Quo NO RO RW INJECTION	NONE	NONE	NONE	7.5	**5400**	**18**	**630**	**275**	**$0**	**$0**
1B	Status Quo 3640 AF RO RW INJECTED PLUS 20% MORE GW PUMPED FOR AG	NONE	NONE	NONE	10.4	**5000**	**17**	**620**	**270**	**$0**	**$0**
2	DELTA FIX 100mg/l SBA water quality	NONE	NONE	NONE	12	**0**	**0**	**450**	**180**	**$0**	**$0**
3	15% ATTENUATION	15%	NONE	NONE	12	**2000**	**7**	**520**	**300**	**$0**	**$0**
4	30% ATTENUATION	30%	NONE	NONE	12	**1000**	**3**	**480**	**300**	**$0**	**$0**
5	INCREASED GW PUMPING FOR CONJUNCTIVE USE	NONE	NONE	16	28	**800**	**3**	**480**	**360**	**$760,000**	**$10**
6		NONE	NONE	22	34	**0**	**0**	**450**	**390**	**$1,100,000**	**$20**
7	DEMINERALIZE ZONE 7 GW PUMPAGE	NONE	13	NONE	12	**1700**	**6**	**510**	**210**	**$5,473,000**	**$100**
8	DEMINERALIZE ZONE 7, CWS & PLEASANTON GW PUMPAGE	NONE	20	NONE	12	**900**	**3**	**480**	**210**	**$8,420,000**	**$160**
9	COMPOSITE OF CONJUNCTIVE USE & DEMINERALIZATION OF GW PUMPAGE	NONE	19	7	19	**100**	**0**	**450**	**212**	**$8,333,000**	**$160**
10		NONE	10	16	28	**-100**	**0**	**450**	**250**	**$4,968,000**	**$90**
11		NONE	5 (Demin 1000 mg/l GW pumpage to 100 mg/l)	5	17	**-2200**	**-7**	**380**	**270**	**$2,351,000**	**$40**
11A		NONE	1.5 (Demin 1000 mg/l GW pumpage to 100 mg/l)	10	22	**0**	**0**	**450**	**320**	**$1,091,500**	**$20**
11B		NONE	3 (Demin 1000 mg/l GW pumpage to 100 mg/l)	3	15	**0**	**0**	**450**	**277**	**$1,383,000**	**$30**
12	COMPOSITE OF ATTENUATION, CONJUNCTIVE USE & GW DEMINERALIZATION	15%	1.5 (Demin 1000 mg/l GW pumpage to 100 mg/l)	10	22	**-1200**	**-4**	**410**	**320**	**$1,077,500**	**$20**
13	ZONE 7 GW (1000TDS) PUMPAGE TO ARROYO MOCHO (EXPORT) WHEN GW STORAGE IS ABOVE 200 TAF	NONE	NONE	AVERAGE 3.6 TAF SEASONAL GW EXPORT	15.6	**0**	**0**	**450**	**300**	**$404,000**	**$8**
13A	ZONE 7 GW (1000TDS) PUMPAGE TO ARROYO MOCHO (EXPORT) WHEN GW STORAGE IS ABOVE 200 TAF	NONE	NONE	AVERAGE 1.5 TAF SEASONAL GW EXPORT	13.5	**1730**	**6**	**510**	**300**	**$169,000**	**$0**
14	COMPOSITE OF RO RW, ASR CONJUNCTIVE USE & DEMINERALIZATION OF GW PUMPAGE **ASR RO RW PUMPAGE FOR AG USE**	NONE	4.6 (Demin 1000 mg/l GW pumpage to 100 mg/l)	4	14.3	**0**	**0**	**450**	**250**	**$2,096,600**	**$40**
14A	COMPOSITE OF RO RW ASR CONJUNCTIVE USE & DEMINERALIZATION OF GW PUMPAGE **ASR RO RW PUMPAGE FOR URBAN IRRI.**	NONE	3.8 (Demin 1000 mg/l GW pumpage to 100 mg/l)	4	14.3	**0**	**0**	**450**	**255**	**$1,759,800**	**$30**
15	COMPOSITE OF CONJUNCTIVE USE & DEMINERALIZATION OF GW PUMPAGE **NO RECYCLED WATER INJECTION**	NONE	5 (Demin 1000 mg/l GW pumpage to 100 mg/l)	8.5	16	**0**	**0**	**450**	**270**	**$2,607,000**	**$50**

Assumptions:

1. *All studies iIncludes 6 TAF/YEAR of RO recycled water (RW) injection except Study 1a & 15 have no RO RW water injection and studies 14 & 14a have 3640 af of demineralized RW injection.*
2. *All studies do not include salt loading due to future development outside the main basin or new recycled water irrigation water use.*
3. *Incremental operational cost is based upon total treated water deliveries (45,100 AF Zone 7 plus 7,214 AF GPQ pumpage) .*

03-Jul-02

TABLE 9.2

PRELIMINARY COST ESTIMATE FOR SALT BALANCE STUDIES AT 2010 CONDITIONS

		ANNUAL INCREMENTAL OPERATIONAL COSTS							ANNUAL INCREMENTAL CAPITAL COSTS					ANNUAL CAPITAL AND OPERATIONAL		
STUDY NO.	NAME	GW PUMPING COST	SW TREATMENT PLANT COST	GW Demin cost	BRINE DISPOSAL COST	TOTAL PER YEAR	COST/ AF	COST/ TON OF SALT MITIGATION	GW WELLS	TREATMENT PLANT EXPANSION	GW Demin PLANT	ADDITIONAL SBA CAPACITY	TOTAL PER YEAR	TOTAL COST/YEAR	COST/ AF	COST/ TON OF SALT MITIGATION
1	Status Quo 6 TAF RO RW INJECTION (1)	$0	$0	$0	$0	**$0**	**$0**	**$0**	$0	$0	$0	$0	**$0**	**$0**	**$0**	**$0**
1A	Status Quo NO RO RW INJECTION	$0	$0	$0	$0	**$0**	**$0**	**$0**	$0	$0	$0	$0	**$0**	**$0**	**$0**	**$0**
1B	Status Quo 3640 AF RO RW INJECTED PLUS 20% MORE GW PUMPED FOR AG	$0	$0	$0	$0	**$0**	**$0**	**$0**	$0	$0	$0	$0	**$0**	**$0**	**$0**	**$0**
2	DELTA FIX 100mg/l SBA water quality	$0	$0	$0	$0	**$0**	**$0**	**$0**	$0	$0	$0	$0	**$0**	**$0**	**$0**	**$0**
3	15% ATTENUATION	$0	$0	$0	$0	**$0**	**$0**	**$0**	$0	$0	$0	$0	**$0**	**$0**	**$0**	**$0**
4	30% ATTENUATION	$0	$0	$0	$0	**$0**	**$0**	**$0**	$0	$0	$0	$0	**$0**	**$0**	**$0**	**$0**
5	INCREASED GW PUMPING FOR CONJUNCTIVE USE	$960,000	($200,000)	$0	$0	**$760,000**	**$10**	**$300**	$0	$0	$0	$0	**$0**	**$760,000**	**$10**	**$300**
6		$1,320,000	($220,000)	$0	$0	**$1,100,000**	**$20**	**$400**	$1,344,000	$0	$0	$0	**$1,344,000**	**$2,444,000**	**$50**	**$800**
7	DEMINERALIZE ZONE 7 GW PUMPAGE	$78,000	$0	$5,200,000	$195,000	**$5,473,000**	**$100**	**$3,900**	$0	$0	$1,495,000	$0	**$1,495,000**	**$6,968,000**	**$130**	**$5,000**
8	DEMINERALIZE ZONE 7, CWS & PLEASANTON GW PUMPAGE	$120,000	$0	$8,000,000	$300,000	**$8,420,000**	**$160**	**$3,800**	$0	$0	$2,300,000	$0	**$2,300,000**	**$10,720,000**	**$200**	**$4,900**
9	COMPOSITE OF CONJUNCTIVE USE & DEMINERALIZATION OF GW PUMPAGE	$534,000	($86,000)	$7,600,000	$285,000	**$8,333,000**	**$160**	**$2,800**	$0	$0	$2,185,000	$0	**$2,185,000**	**$10,518,000**	**$200**	**$3,500**
10		$1,020,000	($202,000)	$4,000,000	$150,000	**$4,968,000**	**$90**	**$1,600**	$0	$0	$1,150,000	$0	**$1,150,000**	**$6,118,000**	**$120**	**$1,900**
11		$330,000	($54,000)	$2,000,000	$75,000	**$2,351,000**	**$40**	**$400**	$0	$0	$575,000	$0	**$575,000**	**$2,926,000**	**$60**	**$600**
11A		$609,000	($140,000)	$600,000	$22,500	**$1,091,500**	**$20**	**$400**	$0	$0	$172,500	$0	**$172,500**	**$1,264,000**	**$20**	**$400**
11B		$198,000	($60,000)	$1,200,000	$45,000	**$1,383,000**	**$30**	**$400**	$0	$0	$345,000	$0	**$345,000**	**$1,728,000**	**$30**	**$600**
12	COMPOSITE OF ATTENUATION, CONJUNCTIVE USE & GW DEMINERALIZATION	$609,000	($154,000)	$600,000	$22,500	**$1,077,500**	**$20**	**$300**	$0	$0	$172,500	$0	**$172,500**	**$1,250,000**	**$20**	**$300**
13	ZONE 7 GW (1000TDS) PUMPAGE TO ARROYO MOCHO (EXPORT) WHEN GW STORAGE IS ABOVE 200 TAF	$144,000	$8,000	SWP VARIABLE $252,000 CHARGE FOR WATER REPLACEMENT	$0	**$404,000**	**$8**	**$130**	$250,000	$40,000	$0	$0	**$290,000**	**$694,000**	**$10**	**$200**
13A	ZONE 7 GW (1000TDS) PUMPAGE TO ARROYO MOCHO (EXPORT) WHEN GW STORAGE IS ABOVE 200 TAF	$60,000	$4,000	$105,000	$0	**$169,000**	**$0**	**$123**	$100,000	$20,000	$0	$0	**$120,000**	**$289,000**	**$10**	**$200**
										STUDY 13A COST DOES NOT INCLUDE ANY FIXED COST TO BUY ANY ADDITIONAL ENTITLEMENT						
14	COMPOSITE OF RO RW, ASR CONJUNCTIVE USE & DEMINERALIZATION OF GW PUMPAGE **ASR RO RW PUMPAGE FOR AG USE**	$267,600	($80,000)	$1,840,000	$69,000	**$2,096,600**	**$40**	**$700**	$0	$0	$529,000	$0	**$529,000**	**$2,625,600**	**$50**	**$800**
14A	COMPOSITE OF RO RW ASR CONJUNCTIVE USE & DEMINERALIZATION OF GW PUMPAGE **ASR RO RW PUMPAGE FOR URBAN IRRI.**	$262,800	($80,000)	$1,520,000	$57,000	**$1,759,800**	**$30**	**$600**	$0	$0	$437,000	$0	**$437,000**	**$2,196,800**	**$40**	**$700**
15	COMPOSITE OF CONJUNCTIVE USE & DEMINERALIZATION OF GW PUMPAGE **NO RECYCLED WATER INJECTION**	$540,000	($8,000)	$2,000,000	$75,000	**$2,607,000**	**$50**	**$800**	$0	$0	$575,000	$0	**$575,000**	**$3,182,000**	**$60**	**$1,000**

OPERATIONAL COSTS / ACRE-FOOT						CAPITAL COSTS / ACRE-FOOT			
GW PUMPING COST TO SYSTEM $/AF	SW TREATMENT PLANT COST	GW Demin COST	BRINE DISPOSAL COST	GW PUMPING COST TO WASTE $/AF	SWP ENTITLEMENT VARIABLE CHARGES	GW WELLS	TREATMENT PLANT EXPANSION	GW Demin PLANT	ADDITIONAL SBA CAPACITY
60	20	400	150	40	70	**50**	**100**	**115**	**25**

03-Jul-02

Salt management conjunctive use is the combination of pumping additional groundwater for delivered water supply and the complementary recharge to replace the groundwater with lower TDS (250 mg/L) surface water. Values listed under conjunctive use are in addition to the average annual projected year 2010 baseline pumpage and recharge of 12,000 AF.

Total Zone 7 pumpage is the sum of Zone 7 municipal pumpage, pumpage for blending with injected recycled water, and conjunctive use pumpage.

Net salt loading values are the expected salt loading to the main basin under a given salt management study and are rounded to the nearest 100 tons/year. The negative salt loading values in studies 10 and 12 indicate that, on average, more salt will be removed from the basin each year than would be applied.

Net increase in TDS converts the net salt loading in the basin to a corresponding increase in TDS of the groundwater. Implicit in this conversion are the assumptions that all salts have been uniformly mixed with groundwater.

Projected groundwater TDS after 10 years assumes that the current groundwater contains 450 mg/L TDS and computes the expected TDS after 10 years based on the previously described calculations. Implicit in this calculation is the assumption that the upper and lower aquifers are mixed.

TDS of Zone 7 deliveries are calculated assuming constant surface water (250 mg/L) and groundwater (450 mg/L) TDS concentrations. It should be noted that actual SBA concentrations vary from 100 to over 700 mg/L and the actual extracted groundwater TDS values also can vary, as described in Chapter 5.

Preliminary planning level cost estimates for these salt balance studies at 2010 conditions are summarized in Table 9.2. Costs are broken down into operational costs and capital costs. The unit costs for each component are itemized in the sub-tables at the bottom of Table 9.2 and in Table 9.3 below. The unit O&M cost information is a summary of information and assumptions presented in more detail in Section 8.14.

Annual incremental operational costs shown in Table 9.2 are conceptual planning level costs for unit operations and maintenance only. These costs include $60/AF for municipal groundwater pumping, $20/AF marginal cost to treat the water at one of the treatment plants, $400/AF for wellhead demineralization, $150/AF of brine disposed from associated wellhead demineralization, $40/AF for groundwater pumping to waste, and $70AF SWP entitlement variable charges for replacement water.

Table 9.3
Summary of Assumed Costs for
2010 Salt Balance Studies

Operational Expenses	Cost
GW demineralization	$400/AF
Brine disposal via LAVWMA	$150/AF
Groundwater pumpage power	$60/AF
Surface Water Treatment	$20/AF
SMP conjunctive use	$40/AF
SWP entitlement variable charges	$70/AF
Capital Expenses	
ASR Wells	$50/af/yr
Treatment plant expansion	$100/af/yr
Groundwater Demineralization plant	$115/af/yr
Additional SBA capacity	$25/af/yr

Annual incremental capital costs assume amortization at 7% interest over 30 years. Negative numbers represent avoided costs due to another aspect of the project (e.g., stream recharge and extraction versus treatment and delivery). Annual incremental capital costs included in the studies are reported per year and include $50/AF for new wells, $100/AF for treatment plant expansion, $115/AF for a wellhead demineralization facility, and $25/AF for additional SBA capacity. In contrast to the unit O&M costs, these capital costs are normalized per acre-foot of treated water delivered by Zone 7 during 2010 (i.e., 45 TAF).

The sum of the **Annual Capital and Operational** costs is tabulated on the right side of Table 9.2 and is also included as the final two columns in Table 9.1. Those costs have been computed in two ways, including the **total cost per year** and the **cost per acre-foot of treated water delivery** (45 TAF Zone 7 delivery plus 7.2 TAF groundwater pumping quota (GPQ)).

9.3 Assumptions Common to Year 2010 Salt Balance Studies

The following is a list of the assumptions that were used to generate the results for Study 1, which is considered the baseline case and is based on Zone 7's historic operational basin management strategy. Note that although the studies include facilities in addition to those presently (1998) available, the majority of the studies involve use of the facilities scheduled for construction as part of the expansion program (i.e., no new costs are incurred solely for salt management). All of the noted assumptions are also valid for the other studies unless noted otherwise in the description of the individual studies.

Demand and Supply—Zone 7 demand is based on sustained water supply. The hydrologic study period used for local supply is 75 years (1922 through 1996). The demand for SWP is assumed to be 4.1 MAF. The existing Zone 7 SWP entitlement is 46 TAF. An additional 15 TAF is assumed to be available by 2010. The Zone 7 treated demand for 2010 is 45,100 AF and untreated demand is 8,700 AF/year.

Water Quality—SBA water TDS was assumed at 250 mg/L, ASR pumpage TDS at 250 mg/L, and groundwater TDS at 450 mg/L. Annual average delivered water quality is calculated using these consistent concentration values proportioned to the blend of surface and groundwater delivered each year.

RO Recycled Water—RO recycled water (or other low TDS water) injection or recharge is assumed to be 6 TAF per year. This is 2,300 AF more than the amount potentially available through the Livermore and DSRSD projects. The Livermore and DSRSD projects would produce 840 AF/Y and 2,800 AF/Y, respectively. It was assumed that these projects would be expanded and the remaining 2,300 AF/Y recharged in the future Chain-of-Lakes. This was a significant component of the original studies since the assumed injection of 100 mg/L TDS water and extraction of 450 mg/L groundwater elsewhere would represent 2,300 tons per year of salt removal from the basin in 2010.

All the fifteen studies except 1A, 1B, 14, 14A and 15 include 6TAF of RO recycled water injection. Studies 1B, 14 and 14a include only 3,640 AF of RO recycled water recharge. Studies 1A and 15 do not include any RO recycled water recharge.

Wells—These studies assume that there will be some groundwater pumpage required to meet peak demands. The required groundwater pumpage is the sum of pumpage for daily peaking and seasonal peaking. It was assumed that if ASR is successful, Zone 7 could use ASR wells to inject low TDS surface water into the basin and pump it out to meet peak demands. The studies assumed injection capacity of ASR wells to be approximately 8,300 AF/year by year 2010. If ASR wells were not to be used (due to well clogging problems), increased wellhead demineralization could be used to maintain delivered water TDS and the Chain of Lakes could be used for surface water recharge.

Storage—It was assumed that when groundwater storage at the beginning of the water year is over 240 TAF Zone 7 will pump groundwater for deliveries and surface water supplies will carry over for the following year. It was assumed that Zone 7 will be allowed to carry over 10 TAF of local storage from one year to the next. Lake Del Valle supplies include the local water used as direct inflow and local water used after short-term storage in the lake. It does not include the local water released from the lake for recharge to satisfy prior rights on the Arroyo Valle.

Recharge—The artificial stream capacity includes existing Arroyo Mocho recharge capacity, existing Arroyo Valle recharge capacity, and the recharge capacity of Lake I in the Chain of Lakes. The existing Arroyo Mocho recharge capacity is about 19 cfs from April through September and 14 cfs from October through March. The existing recharge capacity on the Arroyo Valle is approximately 3 cfs. It was assumed that the stream capacity from June through August will be unusable due to the SBA capacity limit. Therefore, stream capacity is used for only nine months of the year. Delivery into Lake I is assumed to be 30 cfs for six months of the year plus 2,300 AF/Y of RO recycled water. It is anticipated that Zone 7 would make recharge releases between October and June down the Arroyo Mocho at a rate at 50-60 cfs. Of this, 20-25 cfs would recharge in the Arroyo Mocho and 30-35 cfs would be diverted for storage and recharge in the Chain of Lakes.

9.4 Individual Salt Balance Study Results

The following is a brief description of the 15 screening level salt management studies. The resultant main basin water and salt balances for each study are summarized on one page each in tables 9.4 through 9.17. The complete 75-year tabular and graphical results for each study are presented in Reference M. Note that all of the assumptions described in section 9.2 and 9.3 above apply to all 15 individual studies. Assumptions unique to each study are cited therein.

Study 1 reflects the historic operational practice of Zone 7 and is considered the baseline case. Study 1 does not include any salt management measures other than the assumed 6 TAF of RO recycled water injection common to studies 1-13.

Available surface water is used to meet water demands with groundwater pumped primarily to meet peak demands and demands that exceed the surface water supply. The surface water supply is limited by the SWP yield for the year, Zone 7's water treatment plant capacity, the maximum instantaneous SBA flow rate, and the maximum monthly delivery from the SWP.

Study 1 (and all others except 3, 4, and 12) assumes that 100% of applied salts impact the groundwater. The main basin water and salt balance for 2010 steady state conditions is given in Table 9.4. Study 1 conditions result in a salt loading of 3,100 tons/year and delivered water quality of 300 mg/L (range 250 to 440 mg/L). Since this is the original

Table 9.4

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

WITH NO ATTENUATION OF SALTS IN APPLIED WATER AND NO CONJUNCTIVE USE PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT	SALT LOAD IN TONS PER
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l	LOAD IN TONS	1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,360	250	780	2,679	2,840	3,640
Groundwater, Extraction only wells	4,660	450	430	4,877	2,850	6,630
Groundwater, ASR wells	390	250	40	2,438	130	3,250
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,935		1,360		6,250	4,600
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	950	1,500	950	1,500	1,940	2,040
Total Natural Supply	23,765		13,840		13,820	1,000
ARTIFICIAL RECHARGE						
Stream recharge	2,750	250	2,750	250	930	340
Injection well recherge (ASR wells))	1,550	250	1,550	250	530	340
Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	34,065		24,140		16,100	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT	SALT REMOVED IN TONS PER
	ACRE-FEET	TDS IN mg/l	LOAD IN TONS	1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	1,550	250	530	340
Zone 7 municipal pumpage, Extraction only wells	6,110	450	3,740	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected recycled water, Extraction only wells	4,160	450	2,550	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	20,120		11,900	590
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	620	900	760	1,230
Total Demand	24,140		13,050	
WATER/SALT BALANCE	0		3,050	

baseline case study and no additional facilities are required other than those already assumed to be in place in the year 2010, there are no incremental costs associated with this study.

Study 1A and Study 1B are slight variations of Study 1. These studies were performed after the Zone 7 Board made the decision in September 1998 not to support RO recycled water injection into the main basin pending further public acceptability.

The only difference in Study 1A from Study 1 is that it has no injection of RO recycled water into the main basin. The main basin water and salt balance for 2010 steady state conditions is given in Table 9.4A. Study 1A conditions result in a salt loading of 5,400 tons/year and delivered water quality of 275 mg/L. Delivered water quality improves versus Study 1 because more surface water has to be delivered and Zone 7 groundwater pumpage is less than in Study 1. Groundwater basin salt loading increases to 5,400 tons/year from 3,100 tons/year for Study 1. Since this is also the baseline case and no additional facilities are required other than those already assumed to be in place in the year 2010, there are no incremental costs associated with this study. Study 1A defines the baseline for the salt management Study 15.

The only difference in Study 1B from Study 1 is that it has 3,640 AF/year injection of RO recycled water into the main basin instead of 6,000 AF/year. Also, all of RO recycled water injected (presumably during the wet weather season to provide additional peak wet weather disposal capacity) is assumed to be recovered by pumping at the same location during the irrigation season. The 3,640 AF represents the maximum annual combined production of the existing DSRSD and the Livermore RO facilities. The main basin water and salt balance for 2010 steady state conditions is given in Table 9.4B. Study 1B conditions result in a salt loading of 5,000 tons/year and delivered water quality of 270 mg/L. Delivered water quality improves versus Study 1 because more surface water is delivered and Zone 7 groundwater pumpage is less than in Study 1. Groundwater basin salt loading increases to 5,000 tons from 3,100 tons for Study 1. Since this is also the baseline case and no additional facilities are required other than those already assumed to be in place in the year 2010, there are no incremental costs associated with this study. Study 1B defines the baseline for the salt management studies 14 and 14A.

Study 2 is referred to as the "Delta Fix." This study evaluates the effect on salt loading to the main basin if a higher quality surface water supply were made available, for example, as part of the CalFed Option 3 dual conveyance system. SBA water quality is assumed to improve to 100 mg/L from 250 mg/L TDS. The direct cost for this improvement is assumed to not affect Zone 7 water rates.

As shown in Table 9.5, the Study 2 net salt loading to the main basin would be negligible without any other institutional changes. Delivered water quality would improve to approximately 180 mg/L TDS and the projected groundwater quality would stabilize at current levels (Table 9.1).

STUDY 1A

TABLE 9.4A

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

WITH NO ATTENUATION OF SALTS IN APPLIED WATER AND NO CONJUNCTIVE USE PUMPAGE FOR SALT MANAGEMENT
NO RECYCLED WATER INJECTION

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT	SALT LOAD IN TONS PER
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l	LOAD IN TONS	1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	9,440	250	880	2,682	3,210	3,650
Groundwater, Extraction only wells	3,370	450	310	4,892	2,060	6,650
Groundwater, ASR wells	600	250	60	2,500	200	3,330
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,935		1,360		5,900	4,340
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	980	1,500	980	1,500	2,000	2,040
Total Natural Supply	23,795		13,870		13,530	980
ARTIFICIAL RECHARGE						
Stream recharge	3,540	250	3,540	250	1,200	340
Injection well recherge (ASR wells))	2,390	250	2,390	250	810	340
Recycled water injection	0	100	0		0	0
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	29,725		19,800		15,540	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT	SALT REMOVED IN TONS PER
	ACRE-FEET	TDS IN mg/l	LOAD IN TONS	1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,390	250	810	340
Zone 7 municipal pumpage, Extraction only wells	5,110	450	3,130	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected recycled water, Extraction only wells	0	450	0	0
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	15,800		9,020	570
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	590	900	720	1,220
Total Demand	19,790		10,130	
WATER/SALT BALANCE	**10**		**5,410**	

STUDY 1B

Table 9.4B

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

WITH NO SALT MITIGATION, 3640 AF RECYCLED WATER INJECTION AND CWR WELLS PUMPING FOR AGRICULTURE DEMAND (120% of Recycled water)

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT LOAD	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l	IN TONS	
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	9,700	250	910	2,665	3,300	3,630
Groundwater, Zone 7 Extraction only wells (NO Demin)	950	450	90	4,750	580	6,440
Groundwater, Zone 7 Extraction only wells (Demin)	0	100	0		0	0
Groundwater, ASR wells	620	250	60	2,583	210	3,500
Groundwater, others (No Demin)	2,180	450	200	4,905	1,330	6,650
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,975		1,370		5,850	4,270
Agricultural Irrigation						
SBA water	870	250	220	989	300	1,360
CWR Project agricultural pumpage	870	160	220	633	190	860
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		610	1,240
Subsurface groundwater inflow	1,020	1,500	1,020	1,500	2,080	2,040
Total Natural Supply	23,875		13,920		13,460	970
ARTIFICIAL RECHARGE						
Stream recharge	4,780	250	4,780	250	1,620	340
Injection well recherge (ASR wells))	2,340	250	2,340	250	800	340
RO Recycled water injection	3,640	100	3,640	100	490	130
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	34,635		24,680		16,370	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT LOAD	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
	ACRE-FEET	TDS IN mg/l	IN TONS	
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,340	250	800	340
Zone 7 municipal pumpage, Extraction only wells	3,630	450	2,220	610
Zone 7 municipal pumpage to waste, brine	0	450	0	0
Zone 7 municipal pumpage to waste, Demin brine (from 1000 mg/l water)	0	1,000	0	0
Conjunctive use pumpage, Extraction only wells(Deep aquifer water)	0	450	0	0
Conjunctive use pumpage, Extraction only wells(1000 MG/L GW)	0	1,000	0	0
Pumpage for injected recycled water, Extraction only wells	0	450	0	0
Other municipal pumpage	8,300	450	5,080	610
Addtional DSRSD's pumpage for recycled injection	2,240	450	1,370	610
Total municipal pumpage	16,510		9,470	570
CWR Project agricultural pumpage	4,370	160	950	220
Agricultural pumpage (groundwater)	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	400	900	490	1,230
Total Demand	24,680		11,300	
WATER/SALT BALANCE	0		5,070	

06/28/02

STUDY 2

Table 9.5

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

WITH NO ATTENUATION OF SALTS IN APPLIED WATER AND NO CONJUNCTIVE USE PUMPAGE FOR SALT MANAGEMENT
WITH 100 TDS SBA WATER

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l		
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	100	1,240	100	170	140
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,260	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,360	100	780	1,072	1,140	1,460
Groundwater, Extraction only wells	4,660	450	430	4,877	2,850	6,630
Groundwater, ASR wells	390	100	40	975	50	1,250
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	500	40	5,063	280	7,000
Total Urban Irrigation	13,935		1,360		4,390	3,230
Agricultural Irrigation						
SBA water	1,740	100	440	395	240	550
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		360	730
Subsurface groundwater inflow	950	1,500	950	1,500	1,940	2,040
Total Natural Supply	23,765		13,840		11,360	820
ARTIFICIAL RECHARGE						
Stream recharge	2,750	100	2,750	100	370	130
Injection well recherge (ASR wells))	1,550	100	1,550	100	210	140
Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	34,065		24,140		12,760	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
	ACRE-FEET	TDS IN mg/l		
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	1,550	100	210	140
Zone 7 municipal pumpage, Extraction only wells	6,110	450	3,740	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected recycled water, Extraction only wells	4,160	450	2,550	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	20,120		11,580	580
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	620	900	760	1,230
Total Demand	24,140		12,730	

WATER/SALT BALANCE	0	30

Study 3 evaluates the effect of vadose zone salt attenuation and does not include any other salt management measures. It assumes 15% attenuation (permanent loss of mass) of salts in the vadose zone.

As shown in Table 9.6, a 15% attenuation in salt loading from the irrigation water applied would result in an overall 33% reduction in salt loading from Study 1 to approximately 2,000 tons/year. Delivered water quality would not be affected significantly and the ten-year projected groundwater quality would increase by approximately 70 mg/L TDS to 520 mg/L (Table 9.1).

Study 4 also evaluates the effect of vadose zone salt attenuation and does not include any other salt management measures. It assumes 30% attenuation (permanent loss of salt mass) in the vadose zone.

As shown in tables 9.1 and 9.7, Study 4 provides a 67% reduction in salt loading to approximately 1,000 tons/year. Delivered water quality would not be affected significantly and the ten-year projected groundwater quality would increase by about 30 mg/L TDS to 480 mg/L. It should be noted that the general staff, the technical advisory group, and the citizen's advisory group conclusions are that there is no significant actual long-term loss of salt in the vadose zone.

Study 5 evaluates the effect of instituting 16 TAF of conjunctive use. It assumes that 16 TAF additional groundwater pumpage for conjunctive use will be implemented using only already planned year 2010 (Study 1) facilities. This represents the maximum conjunctive use that can be implemented with those facilities.

As described in Chapter 8, when conjunctive use groundwater pumping is practiced, a given volume of groundwater (higher-TDS) is pumped for salt management and an equal volume of treated surface water (lower TDS) is recharged into the basin. The conjunctive use assumed in Study 5 would be implemented by using the maximum available stream recharge capacity (approximately 50 cfs on Arroyo Mocho for six months of the year) and by injecting the difference using available ASR wells capacity. As a result of the conjunctive use, approximately 52% of total Zone 7 demand would be met with groundwater.

As shown in tables 9.1 and 9.8, Study 5 would reduce salt loading in the main basin to approximately 800 tons/year but would also increase the Zone 7 delivered water TDS by 60 mg/L to 360 mg/L. The ten-year projected groundwater quality would increase by approximately 30 mg/L TDS to 480 mg/L. The incremental O&M costs would be equivalent to approximately $10/AF (i.e., when spread across/melded into the projected 45 TAF of Zone 7 treated water deliveries in 2010 plus the 7.2 TAF of groundwater pumping quota).

STUDY 3

Table 9.6

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

WITH 15% ATTENUATION OF SALTS IN APPLIED WATER AND NO CONJUNCTIVE USE PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,360	250	780	2,679	**2,420**	3,100
Groundwater, Extraction only wells	4,660	450	430	4,877	**2,420**	5,630
Groundwater, ASR wells	390	250	40	2,438	**110**	2,750
Domestic groundwater pumpage	120	450	70	771	**60**	860
LWRP reclaimed water irrigation	405	650	40	6,581	**300**	7,500
Total Urban Irrigation	13,935		1,360		5,310	3,900
Agricultural Irrigation						
SBA water	1,740	250	440	989	**500**	1,140
Groundwater	200	450	50	1,800	**100**	2,000
Total agricultural irrigation	1,940		490		600	1,220
Subsurface groundwater inflow	950	1,500	950	1,500	1,940	2,040
Total Natural Supply	23,765		13,840		12,770	920
ARTIFICIAL RECHARGE						
Stream recharge	2,750	250	2,750	250	930	340
Injection well recherge (ASR wells))	1,550	250	1,550	250	530	340
Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	34,065		24,140		15,050	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	1,550	250	530	340
Zone 7 municipal pumpage, Extraction only wells	6,110	450	3,740	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected recycled water, Extraction only wells	4,160	450	2,550	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	20,120		11,900	590
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	620	900	760	1,230
Total Demand	24,140		13,050	

WATER/SALT BALANCE	0		2,000	

Table 9.7

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

WITH 30% ATTENUATION OF SALTS IN APPLIED WATER AND NO CONJUNCTIVE USE PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,360	250	780	2,679	**1,990**	2,550
Groundwater, Extraction only wells	4,660	450	430	4,877	**2,000**	4,650
Groundwater, ASR wells	390	250	40	2,438	**90**	2,250
Domestic groundwater pumpage	120	450	70	771	**50**	710
LWRP reclaimed water irrigation	405	650	40	6,581	**250**	6,250
Total Urban Irrigation	13,935		1,360		4,380	3,220
Agricultural Irrigation						
SBA water	1,740	250	440	989	**410**	930
Groundwater	200	450	50	1,800	**90**	1,800
Total agricultural irrigation	1,940		490		500	1,020
Subsurface groundwater inflow	950	1,500	950	1,500	1,940	2,040
Total Natural Supply	23,765		13,840		11,740	850
ARTIFICIAL RECHARGE						
Stream recharge	2,750	250	2,750	250	930	340
Injection well recherge (ASR wells))	1,550	250	1,550	250	530	340
Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	34,065		24,140		14,020	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	1,550	250	530	340
Zone 7 municipal pumpage, Extraction only wells	6,110	450	3,740	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected recycled water, Extraction only wells	4,160	450	2,550	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	20,120		11,900	590
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	620	900	760	1,230
Total Demand	24,140		13,050	
WATER/SALT BALANCE	**0**		**970**	

Table 9.8

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

NO ATTENUATION OF SALTS IN APPLIED WATER AND 16 TAF AVERAGE CONJUNCTIVE USE PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l		
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	4,310	250	400	2,694	1,470	3,680
Groundwater, extraction only wells	8,440	450	780	4,869	5,160	6,620
Groundwater , ASR wells	660	250	60	2,750	220	3,670
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total urban irrigation	13,935		1,350		7,280	5,390
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1940		490		710	1,450
Subsurface groundwater inflow	1,150	1,500	1,150	1,500	2,350	2,040
Total Natural Supply	23,965		14,030		15,260	1,090
ARTIFICIAL RECHARGE						
Stream recharge	13,810	250	13,810	250	4,690	340
Injection well recherge, ASR wells	5,920	250	5,920	250	2,010	340
Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	49,695		39,760		22,780	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
	ACRE-FEET	TDS IN mg/l		
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,625	250	890	340
Zone 7 municipal pumpage, Extraction only wells	3,335	450	2,040	610
Conjunctive use pumpage, Extraction only wells	18,370	450	11,240	610
Pumpage for injected recycled water, Extraction only wells	3,600	450	2,200	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	36,230		21,450	590
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	150	900	180	1,200
Total Demand	39,780		22,020	
WATER/SALT BALANCE	(20)		760	

Study 6 evaluates the effect of instituting 22 TAF of conjunctive use. It assumes that 22 TAF of additional groundwater pumpage for conjunctive use will be implemented using existing facilities plus four more ASR wells (i.e., nine total ASR wells).

This volume of conjunctive use was selected because it balances the net salt loading. The conjunctive use assumed in Study 6 would be implemented by using the maximum available stream recharge capacity (approximately 50 cfs on the Arroyo Mocho plus the Chain of Lakes for six months of the year) and by injecting the difference with the nine ASR wells. As a result of the conjunctive use, approximately 74% of total Zone 7 demand would be met with groundwater (almost the reverse of base case Study 1).

As shown in tables 9.1 and 9.9, Study 6 would eliminate net salt loading in the main basin and stabilize the ten-year projected groundwater quality at current levels. Study 6 would also increase the Zone 7 delivered water TDS by 90 mg/L to 390 mg/L. Costs would increase by approximately $20/AF delivered.

Study 7 evaluates the effect of wellhead demineralization. It assumes Zone 7 groundwater pumpage would be demineralized from 450 mg/L TDS to 100 mg/L TDS. The demineralization facility would be sized at 13 TAF to account for the 12 TAF of pumpage estimated in Study 1, plus 1 TAF (~10%) of water expected to be lost as brine.

As shown in tables 9.1 and 9.10, Study 7 would reduce the year 2010 salt loading in the main basin by over half to approximately 1,700 tons/year, and would improve the Zone 7 delivered water quality by 90 mg/L to 210 mg/L. The ten-year projected groundwater quality would increase by 60 mg/L to approximately 510 mg/L. The cost increase associated with Study 7 would be approximately $100/AF.

Study 8 also evaluates the effect of wellhead demineralization. It assumes that all of the Zone 7, City of Pleasanton, and Cal Water groundwater pumpage would be demineralized from approximately 450 mg/L TDS to 100 mg/L TDS. A centralized reverse osmosis facility or multiple facilities would be sized at 20 TAF to account for all municipal pumpage and 10% brine loss.

As shown in tables 9.1 and 9.11, Study 8 would reduce the salt loading in the main basin to 900 tons/year and would improve the Zone 7 delivered water quality by approximately 90 mg/L to 210 mg/L. Pleasanton and Cal Water average delivered TDS levels would be even lower than noted above, because under Study 8 assumptions, they would be supplementing their Zone 7 purchases with their own 100 mg/L demineralized facilities' water. The cost increase would be in the range of $160/AF and would likely involve other non-Zone 7 demineralization facilities. The ten-year projected groundwater quality would increase by 30 mg/L to approximately 480 mg/L.

Study 9 is one of seven "composite" studies that evaluated the effect of increased conjunctive use plus wellhead demineralization. Each composite study was sized to

Table 9.9

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

NO ATTENUATION OF SALTS IN APPLIED WATER AND 22 TAF AVERAGE CONJUNCTIVE USE PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	2,900	250	270	2,685	990	3,670
Groundwater, extraction only wells	9,860	450	920	4,823	6,030	6,550
Groundwater , ASR wells	660	250	60	2,750	220	3,670
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total urban irrigation	13,945		1,360		7,670	5,640
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1940		490		710	1,450
Subsurface groundwater inflow	1,330	1,500	1,330	1,500	2,710	2,040
Total Natural Supply	24,155		14,220		16,010	1,130
ARTIFICIAL RECHARGE						
Stream recharge	14,120	250	14,120	250	4,800	340
Injection well recherge, ASR wells	10,930	250	10,930	250	3,720	340
Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	55,205		45,270		25,350	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,625	250	890	340
Zone 7 municipal pumpage, Extraction only wells	3,505	450	2,140	610
Conjunctive use pumpage, Extraction only wells	26,230	450	16,050	610
Pumpage for injected recycled water, Extraction only wells	1,200	450	730	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	41,860		24,890	590
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	20	900	20	1,000
Total Demand	45,280		25,300	

STUDY 7

Table 9.10

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

RO ALL ZONE 7 MUNICIPAL PUMPAGE AND NO CONJUNCTIVE USE GW PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,420	250	780	2,699	2,860	3,670
Groundwater, Zone 7 Extraction only wells	2,480	100	230	1,078	340	1,480
Groundwater, ASR wells	420	100	40	1,050	60	1,500
Groundwater, others (no Demin)	2,080	450	190	4,926	1,270	6,680
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,925		1,350		4,960	3,670
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	990	1,500	990	1,500	2,020	2,040
Total Natural Supply	23,795		13,870		12,610	910
ARTIFICIAL RECHARGE						
Stream recharge	3,460	250	3,460	250	1,180	340
Injection well recharge (ASR wells))	1,680	250	1,680	250	570	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	34,935		25,010		15,180	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	1,680	250	570	340
Zone 7 municipal pumpage, Extraction only wells	5,810	450	3,550	610
Zone 7 municipal pumpage to waste, brine	1,158	450	710	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected RO recycled water, Extraction only wells	4,080	450	2,500	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	21,028		12,410	590
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	570	900	700	1,230
Total Demand	24,998		13,500	
WATER/SALT BALANCE	1[illegible]		1,680	

Table 9.11
Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

RO ALL MUNICIPAL PUMPAGE (INCLUDING PLEASANTON & CWS) AND NO CONJUNCTIVE USE GW PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,490	250	790	2,687	2,890	3,660
Groundwater, Zone 7 Extraction only wells	2,400	100	220	1,091	330	1,500
Groundwater, ASR wells	440	100	40	1,100	60	1,500
Groundwater (pleasanton & cws)	1,650	100	150	1,100	220	1,470
Groundwater, others	430	450	40	4,838	260	6,500
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,935		1,350		4,190	3,100
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	1,010	1,500	1,010	1,500	2,060	2,040
Total Natural Supply	23,825		13,890		11,880	860
ARTIFICIAL RECHARGE						
Stream recharge	3,690	250	3,690	250	1,250	340
Injection well recherge (ASR wells))	1,750	250	1,750	250	590	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	35,265		25,330		14,540	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	1,750	250	590	340
Zone 7 municipal pumpage, Extraction only wells	5,710	450	3,490	610
Zone 7 municipal pumpage to waste, Demin brine	1,131	450	690	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected RO recycled water, Extraction only wells	3,840	450	2,350	610
Other municipal pumpage	8,957	450	5,480	610
Total municipal pumpage	21,388		12,600	590
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	530	900	650	1,230
Total Demand	25,318		13,640	
WATER/SALT BALANCE	**10**		**900**	

reduce the salt loading to zero (or lower) and to maintain delivered water quality below the current baseline level of 300 mg/L TDS. Study 9 assumes that all of the Zone 7 groundwater pumpage would be demineralized from approximately 450 mg/L TDS to 100 mg/L TDS. In addition, 7 TAF of conjunctive use would be implemented, the minimum necessary to meet the constraints specified above.

Under these assumptions, the baseline (Study 1) 12 TAF of Zone 7 pumpage would be demineralized with reverse osmosis, and an additional 7 TAF of lower aquifer (450 mg/L TDS) groundwater would be pumped, demineralized, and replaced by recharging the groundwater basin with surface water.

As shown in tables 9.1 and 9.12, Study 9 would reduce the salt loading in the main basin to 100 tons/year and stabilize the ten-year projected groundwater quality at the current level of 450 mg/L TDS. Study 9 would improve the Zone 7 delivered water quality by approximately 90 mg/L to 210 mg/L and the cost increase would be in the range of $160/AF.

Study 10 evaluates the effect of using maximum conjunctive use based on stream recharge capacity plus enough wellhead demineralization to eliminate net salt loading. It assumes that 10 TAF of the baseline Zone 7 groundwater pumpage would be demineralized from approximately 450 mg/L TDS to 100 mg/L TDS. In addition, 16 TAF of stream recharge and groundwater pumpage for conjunctive use would be implemented using existing facilities.

As shown in tables 9.1 and 9.13, Study 10 would eliminate the net salt loading in the main basin and result in a slight reduction in the total mass of salt loading to the main basin. The ten-year projected groundwater quality would stabilize at the current level of 450 mg/L TDS, and the Zone 7 delivered water quality would improve by approximately 50 mg/L to 250 mg/L. The cost increase would be in the range of $90/AF.

Study 11 evaluates the effect of conjunctive use plus demineralization of high TDS shallow groundwater. It assumes that 5 TAF of stream recharge and groundwater pumpage for conjunctive use would be implemented using existing facilities. The 5 TAF of conjunctive use pumpage would be demineralized from approximately 1,000 mg/L TDS to 100 mg/L TDS.

In all previously described studies using demineralization, it was assumed that lower aquifer water with approximately 450 mg/L TDS would be demineralized. A fundamental difference and premise of Study 11 is that the salts residing in the higher TDS upper aquifer would eventually migrate vertically and degrade the higher quality lower aquifer. By pumping and demineralizing the high TDS upper aquifer water that potential degradation may be avoided.

Table 9.12

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

RO ALL ZONE 7 MUNICIPAL PUMPAGE AND 7 TAF AVERAGE CONJUNCTIVE USE GW PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT	SALT LOAD IN TONS PER
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l	LOAD IN TONS	1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	7,010	250	650	2,696	2,380	3,660
Groundwater, Zone 7 Extraction only wells	3,640	100	340	1,071	490	1,440
Groundwater, ASR wells	670	100	60	1,117	90	1,500
Groundwater, others (No Demin)	2,080	450	190	4,926	1,270	6,680
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,925		1,350		4,660	3,450
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	1,020	1,500	1,020	1,500	2,080	2,040
Total Natural Supply	23,825		13,900		12,370	890
ARTIFICIAL RECHARGE						
Stream recharge	8,520	250	8,520	250	2,900	340
Injection well recherge (ASR wells))	2,680	250	2,680	250	910	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	41,025		31,100		17,000	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT	SALT REMOVED IN TONS PER
	ACRE-FEET	TDS IN mg/l	LOAD IN TONS	1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,680	250	910	340
Zone 7 municipal pumpage, Extraction only wells	3,480	450	2,130	610
Zone 7 municipal pumpage to waste, Demin brine	1,718	450	1,050	610
Conjunctive use pumpage, Extraction only wells	7,330	450	4,480	610
Pumpage for injected RO recycled water, Extraction only wells	3,680	450	2,250	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	27,188		15,900	580
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	500	900	610	1,220
Total Demand	31,088		16,900	

WATER/SALT BALANCE	**10**		**100**	

Table 9.13

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

RO 10 TAF OF ZONE 7 MUNICIPAL PUMPAGE AND 16 TAF AVERAGE CONJUNCTIVE USE GW PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	4,640	250	430	2,698	1,580	3,670
Groundwater, Zone 7 Extraction only wells (NO Demin)	3,520	450	330	4,800	2,150	6,520
Groundwater, Zone 7 Extraction only wells (Demin)	2,510	100	230	1,091	340	1,480
Groundwater, ASR wells	660	250	60	2,750	220	3,670
Groundwater, others (No Demin)	2,080	450	190	4,926	1,270	6,680
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,935		1,350		5,990	4,440
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	1,300	1,500	1,300	1,500	2,650	2,040
Total Natural Supply	24,115		14,180		14,270	1,010
ARTIFICIAL RECHARGE						
Stream recharge	13,230	250	13,230	250	4,500	340
Injection well recherge (ASR wells))	5,890	250	5,890	250	2,000	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	49,235		39,300		21,590	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,625	250	890	340
Zone 7 municipal pumpage, Extraction only wells	3,575	450	2,190	610
Zone 7 municipal pumpage to waste, Dmin brine	957	450	590	620
Conjunctive use pumpage, Extraction only wells	19,230	450	11,770	610
Pumpage for injected RO recycled water, Extraction only wells	1,200	450	730	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	35,887		21,250	590
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	20	900	20	1,000
Total Demand	39,307		21,660	
WATER/SALT BALANCE	(10)		(70)	

As shown in tables 9.1 and 9.14, Study 11 would eliminate the positive net salt loading in the main basin and result in a further reduction of 2,200 tons of salt per year in the main basin. The ten-year projected groundwater quality would improve from the current level of 450 mg/L TDS to 380 mg/L, and the Zone 7 delivered water quality would improve modestly by approximately 30 mg/L to 270 mg/L. The increase in cost would be approximately $40/AF. Study 11 may have an even greater positive impact on the salt balance in the main basin depending on the specific location chosen for the upper aquifer wells to be pumped. For example, available data indicates that the upper aquifer water may exceed 1,000 mg/L TDS in areas west of the Camp Parks well site.

Zone 7 groundwater model preliminary simulations (Chapter 10) indicated that the Study 11 assumed pumping of 5 TAF/year of shallow groundwater from the Camp Parks site would not be feasible. This finding led to developing studies 11A and 11B.

Studies 11A and 11B, variations of Study 11, evaluate the effect of conjunctive use plus demineralization of high TDS groundwater. Studies 11A and 11B assume that 10 TAF and 3 TAF, respectively, of stream recharge and groundwater pumpage for conjunctive use would be implemented using existing facilities. In addition, 1.5 and 3 TAF, respectively, of new shallow aquifer conjunctive use pumpage would be demineralized from 1,000 mg/L TDS to 100 mg/L TDS.

As shown in tables 9.1, 9.14A and 9.15, both studies 11A and 11B would eliminate the positive net salt loading in the main basin. The ten-year projected groundwater quality for both would stabilize at the current level of 450 mg/L TDS. However, Zone 7 delivered water quality would degrade slightly by 20 mg/L to 320mg/L in the case of study 11A but would improve modestly by approximately 20 mg/L to 280 mg/L in the case of Study 11B. The increase in cost would be approximately $20/AF for Study 11A and $30/AF in Study 11B. As noted above, studies 11A and 11B may have an even greater positive impact on the salt balance in the main basin depending on the specific location chosen for the upper aquifer wells to be pumped (e.g., Camp Parks well site).

Study 12 is the same as Study 11A (10 TAF conjunctive use and 1.5 TAF demineralization of upper aquifer water) except for the assumption of a 15% attenuation of salts in the vadose zone.

As shown in tables 9.1 and 9.16, Study 12 would eliminate the positive net salt loading in the main basin and would result in a reduction of 1,200 tons of salt per year in the main basin. The ten-year projected groundwater quality would improve from the current level of 450 mg/L TDS to 410 mg/L. Zone 7 delivered water quality (320 mg/L) and the resultant Zone 7 treated water rate increase ($20/AF) would be the same as shown in Study 11A. As noted above in Study 11A and Study 11B, Study 12 may also have an even greater positive impact on the salt balance in the main basin depending on the TDS of the specific upper aquifer wells to be pumped. Also, as noted earlier, the general conclusion on vadose attenuation is that salts are not permanently tied up in the vadose zone.

Table 9.14

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

RO 5 TAF OF ZONE 7 MUNICIPAL PUMPAGE AND 5 TAF AVERAGE CONJUNCTIVE USE GW PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l		
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	7,320	250	680	2,691	2,490	3,660
Groundwater, Zone 7 Extraction only wells (NO Demin)	2,090	450	190	4,950	1,280	6,740
Groundwater, Zone 7 Extraction only wells (Demin)	1,260	100	120	1,050	170	1,420
Groundwater, ASR wells	660	250	60	2,750	220	3,670
Groundwater, others (No Demin)	2,080	450	190	4,926	1,270	6,680
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,935		1,350		5,860	4,340
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	980	1,500	980	1,500	2,000	2,040
Total Natural Supply	23,795		13,860		13,490	970
ARTIFICIAL RECHARGE						
Stream recharge	6,520	250	6,520	250	2,220	340
Injection well recherge (ASR wells))	2,300	250	2,300	250	780	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	38,615		28,680		17,310	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
	ACRE-FEET	TDS IN mg/l		
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,625	250	890	340
Zone 7 municipal pumpage, Extraction only wells	3,745	450	2,290	610
Zone 7 municipal pumpage to waste, Demin brine	519	450	320	620
Conjunctive use pumpage, Extraction only wells	5,410	1,000	7,360	1,360
Pumpage for injected recycled water, Extraction only wells	4,160	450	2,550	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	24,759		18,490	750
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	530	900	650	1,230
Total Demand	28,689		19,530	
WATER/SALT BALANCE	(10)		(2,220)	

STUDY 11A

Table 9.14A

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

RO 1500 AF (FROM 1000 mg/l) OF ZONE 7 MUNICIPAL PUMPAGE AND 10 TAF AVERAGE CONJUNCTIVE USE GW PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	5,880	250	550	2,673	2,000	3,640
Groundwater, Zone 7 Extraction only wells (NO dmin)	4,410	450	410	4,840	2,700	6,590
Groundwater, Zone 7 Extraction only wells (demin)	380	100	40	950	50	1,250
Groundwater, ASR wells	660	250	60	2,750	220	3,670
Groundwater, others (No demin)	2,080	450	190	4,926	1,270	6,680
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,935		1,360		6,670	4,900
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	990	1,500	990	1,500	2,020	2,040
Total Natural Supply	23,805		13,880		14,320	1,030
ARTIFICIAL RECHARGE						
Stream recharge	11,230	250	11,230	250	3,820	340
Injection well recherge (ASR wells))	2,950	250	2,950	250	1,000	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	43,985		34,060		19,960	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,625	250	890	340
Zone 7 municipal pumpage, Extraction only wells	3,075	450	1,880	610
Zone 7 municipal pumpage to waste, demin brine	0	450	0	0
Zone 7 municipal pumpage to waste, demin brine (from 1000 mg/l water)	200	1,000	270	1,350
Conjunctive use pumpage, Extraction only wells(Deep aquifer water)	10,340	450	6,330	610
Conjunctive use pumpage, Extraction only wells(1000 MG/L GW)	1,500	1,000	2,040	1,360
Pumpage for injected RO recycled water, Extraction only wells	4,160	450	2,550	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	30,200		19,040	630
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	460	900	560	1,220
Total Demand	34,060		19,990	

WATER/SALT BALANCE	0	(30)

Table 9.15

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

RO 3000 AF (FROM 1000 mg/l) OF ZONE 7 MUNICIPAL PUMPAGE AND 3 TAF AVERAGE CONJUNCTIVE USE GW PUMPAGE FOR SALT MANAGEMENT

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	7,680	250	710	2,704	2,610	3,680
Groundwater, Zone 7 Extraction only wells (NO demin)	2,230	450	210	4,779	1,360	6,480
Groundwater, Zone 7 Extraction only wells (demin)	750	100	70	1,071	100	1,430
Groundwater, ASR wells	660	250	60	2,750	220	3,670
Groundwater, others (No demin)	2,080	450	190	4,926	1,270	6,680
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,925		1,350		5,990	4,440
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	970	1,500	970	1,500	1,980	2,040
Total Natural Supply	23,775		13,850		13,600	980
ARTIFICIAL RECHARGE						
Stream recharge	5,170	250	5,170	250	1,760	340
Injection well recherge (ASR wells))	2,050	250	2,050	250	700	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	36,995		27,070		16,880	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,625	250	890	340
Zone 7 municipal pumpage, Extraction only wells	4,105	450	2,510	610
Zone 7 municipal pumpage to waste, DEMIN brine	0	450	0	0
Zone 7 municipal pumpage to waste, DEMIN brine (from 1000 mg/l water)	300	1,000	410	1,370
Conjunctive use pumpage, Extraction only wells(Deep aquifer water)	630	450	390	620
Conjunctive use pumpage, Extraction only wells(1000 MG/L GW)	3,000	1,000	4,080	1,360
Pumpage for injected RO recycled water, Extraction only wells	4,160	450	2,550	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	23,120		15,910	690
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	540	900	660	1,220
Total Demand	27,060		16,960	

WATER/SALT BALANCE			
WATER/SALT BALANCE	10		(80)

STUDY 12

Table 9.16

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

RO 1500 AF (FROM 1000 mg/l) OF ZONE 7 MUNICIPAL PUMPAGE, 12 TAF AVERAGE CONJUNCTIVE USE GW PUMPAGE FOR SALT MANAGEMENT AND 15% ATTENUATION

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	5,880	250	550	2,673	**1,700**	3,090
Groundwater, Zone 7 Extraction only wells (NO de	4,410	450	410	4,840	**2,290**	5,590
Groundwater, Zone 7 Extraction only wells (demin	380	100	40	950	**40**	1,000
Groundwater, ASR wells	660	250	60	2,750	**190**	3,170
Groundwater, others (No demin)	2,080	450	190	4,926	**1,080**	5,680
Domestic groundwater pumpage	120	450	70	771	**60**	860
LWRP reclaimed water irrigation	405	650	40	6,581	**300**	7,500
Total Urban Irrigation	13,935		1,360		5,660	4,160
Agricultural Irrigation						
SBA water	1,740	250	440	989	**500**	1,140
Groundwater	200	450	50	1,800	**100**	2,000
Total agricultural irrigation	1,940		490		600	1,220
Subsurface groundwater inflow	990	1,500	990	1,500	2,020	2,040
Total Natural Supply	23,805		13,880		13,200	950
ARTIFICIAL RECHARGE						
Stream recharge	11,230	250	11,230	250	3,820	340
Injection well recherge (ASR wells))	2,950	250	2,950	250	1,000	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	43,985		34,060		18,840	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,625	250	890	340
Zone 7 municipal pumpage, Extraction only wells	3,075	450	1,880	610
Zone 7 municipal pumpage to waste, DEMIN brine	0	450	0	0
Zone 7 municipal pumpage to waste, DEMIN brine (from 1000 mg/l water)	200	1,000	270	1,350
Conjunctive use pumpage, Extraction only wells(Deep aquifer water)	10,340	450	6,330	610
Conjunctive use pumpage, Extraction only wells(1000 MG/L GW)	1,500	1,000	2,040	1,360
Pumpage for injected ROrecycled water, Extraction only wells	4,160	450	2,550	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	30,200		19,040	630
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	460	900	560	1,220
Total Demand	34,060		19,990	

WATER/SALT BALANCE	0	(1,150)

Study 13 evaluates the impacts of pumping high TDS groundwater to the creeks (seasonal groundwater export) during periods of high flow so as not to adversely affect downstream beneficial uses. It assumes that 3.6 TAF/year of 1,000 mg/L TDS groundwater would be pumped to the Arroyo Mocho during specified wet weather flow periods and as long as groundwater storage exceeded 200 TAF. Groundwater would be replaced by buying additional SWP entitlement water. The pumped groundwater is assumed to be released in areas where it would not recharge the main basin. This study assumes that prior agreement would be reached with ACWD describing how such pumping would be managed so as not to unacceptably impact their recharge operations.

As shown in tables 9.1 and 9.17, Study 13 would eliminate the net salt loading in the main basin and stabilize the projected ten-year groundwater quality at current levels. The TDS of Zone 7 delivered water would remain unchanged at 300 mg/L TDS and the resultant increase in cost would be approximately $8/AF. The costs do not include replacement water and possible mitigation costs for potential impacts to ACWD.

Zone 7 groundwater model preliminary simulations indicated that pumping 3.6 TAF/year shallow groundwater from the Camp parks site would not be feasible. This finding led to developing Study 13A.

Study 13A is a small variation of Study 13 that evaluates the impacts of reduced pumping of high TDS groundwater to the creeks (seasonal groundwater export) during periods of high flow so as not to adversely affect downstream beneficial uses.

The major difference between 13 and 13A is the amount of groundwater export. Study 13 would require 3.6 TAF/year groundwater export from both the Camp parks well site and from an additional line of wells along the Arroyo Mocho or in a future Bernal Property well field. It would eliminate the salt balance. Study 13A includes only the maximum feasible 1.5 TAF/year of groundwater export from the proposed Camp Parks well site.

As shown in tables 9.1 and 9.17a, Study 13A would reduce the net salt loading in the main basin to about 1,700 tons/year and the projected ten-year groundwater quality would increase by 60 mg/L to 510 mg/L. The TDS of Zone 7 delivered water would remain unchanged at 300 mg/L TDS and the resultant increase in cost would be less than $1/AF. The costs do not include replacement water and possible mitigation for potential impacts to ACWD.

Studies 14, 14A and 15 were performed after the September 1998 Zone 7 Board decision not to support RO recycled water injection into the groundwater basin. All the original studies included 6 TAF per year of RO recycled water injection. In studies 14 and 14A, RO recycled water injection was reduced to 3,640 AF/Y (the combined DSRSD and Livermore RO design capacities). The RO recycled water injected into the basin was assumed to be recovered from the injection location during the irrigation season by

Table 9.17

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

WITH 3,600 ACRE-FEET AVERAGE ANNUAL 1000 TDS GW PUMPAGE TO ARROYO MOCHO (WASTE)

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l		
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,580	250	800	2,681	2,920	3,650
Groundwater, Extraction only wells	4,340	450	400	4,883	2,660	6,650
Groundwater, ASR wells	490	250	50	2,450	170	3,400
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,935		1,360		6,180	4,540
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	1,060	1,500	1,060	1,500	2,160	2,040
Total Natural Supply	23,875		13,950		13,970	1,000
ARTIFICIAL RECHARGE						
Stream recharge	4,700	250	4,700	250	1,600	340
Injection well recherge (ASR wells))	1,950	250	1,950	250	660	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	36,525		26,600		17,050	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
	ACRE-FEET	TDS IN mg/l		
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	1,950	250	660	340
Zone 7 municipal pumpage, Extraction only wells	5,470	450	3,350	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected recycled water, Extraction only wells	3,520	450	2,150	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	19,240		11,240	580
ZONE 7 GW PUMPAGE TO ARROYO MOCHO	3,590	1,000	4,880	1,360
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	450	900	550	1,220
Total Demand	26,680		17,060	
WATER/SALT BALANCE	(80)		(10)	

Table 9.17A

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

WITH 1500 ACRE-FEET AVERAGE ANNUAL 1000 TDS GW PUMPAGE TO ARROYO MOCHO (WASTE)

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l		
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,450	250	790	2,674	2,870	3,630
Groundwater, Extraction only wells	4,530	450	420	4,854	2,770	6,600
Groundwater, ASR wells	440	250	40	2,750	150	3,750
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,945		1,360		6,220	4,570
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	990	1,500	990	1,500	2,020	2,040
Total Natural Supply	23,815		13,880		13,870	1,000
ARTIFICIAL RECHARGE						
Stream recharge	3,650	250	3,650	250	1,240	340
Injection well recherge (ASR wells))	1,750	250	1,750	250	590	340
RO Recycled water injection	6,000	100	6,000	100	820	140
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	35,215		25,280		16,520	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
	ACRE-FEET	TDS IN mg/l		
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	1,750	250	590	340
Zone 7 municipal pumpage, Extraction only wells	5,730	450	3,510	610
Conjunctive use pumpage, Extraction only wells	0	450	0	0
Pumpage for injected recycled water, Extraction only wells	4,000	450	2,450	610
Other municipal pumpage	8,300	450	5,080	610
Total municipal pumpage	19,780		11,630	590
ZONE 7 GW PUMPAGE TO ARROYO MOCHO	1,550	1,000	2,110	1,360
Agricultural pumpage	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	540	900	660	1,220
Total Demand	25,270		14,790	

WATER/SALT BALANCE	**10**	**1,730**

pumping 120% of the volume injected. As Study 1 was the baseline case for the original studies, Study 1B was performed to define the baseline for studies 14 and 14A. In Study 15, RO recycled water injection was totally eliminated. Study 1A was performed to define the baseline case for Study 15.

Studies 14 and 14A evaluate the effect of ASR RO recycled water and other conjunctive use plus demineralization of high TDS groundwater. These studies assume that 4 TAF of stream recharge and groundwater pumpage for conjunctive use will be implemented using existing facilities. About 4.6 and 3.8 TAF respectively of conjunctive use pumpage would be demineralized from approximately 1,000 mg/L TDS to 100 mg/L TDS.

In Study 14, the recovered RO recycled water pumpage would be delivered for agricultural irrigation use where most of it would be applied outside the main basin. In Study 14A, the recovered recycled water pumpage would be delivered for urban irrigation over the main basin. Since the low TDS injected and recovered RO recycled water would be delivered outside the main basin in Study 14, the salt removal benefit is less than in Study 14A and, therefore, Study 14 requires more wellhead demineralization than Study 14A to eliminate the salt loading. In these two studies, the majority of the salt removal is provided by wellhead demineralization. The RO recycled water ASR volume does increase the local water supply by offsetting summer treated water irrigation demands.

As shown in tables 9.1, 9.18 and 9.19, Studies 14 and 14A would eliminate the positive net salt loading in the main basin. The ten-year projected groundwater quality would stabilize at the current level of 450 mg/L TDS. Zone 7 delivered water quality would improve to about 250 and 255 mg/L, respectively. The increase in cost would be approximately $40/AF for Study 14 and $30/AF for Study 14A.

Study 15 evaluates the effect of conjunctive use plus demineralization of high TDS groundwater without any RO recycled water injection. Study 15 assumes that 8.5 TAF of stream recharge and groundwater pumpage for conjunctive use would be implemented using existing facilities. The 5 TAF of shallow aquifer conjunctive use pumpage included would be demineralized from approximately 1,000 mg/L TDS to 100 mg/L TDS.

As shown in tables 9.1 and 9.20, Study 15 would eliminate the positive net salt loading in the main basin. The ten-year projected groundwater quality would stabilize at the current level of 450 mg/L TDS. Zone 7 delivered water quality would be slightly better than the baseline case at 270 mg/L. The increase in cost would be approximately $50/AF.

9.5 Discussion of Results

The original baseline case Study 1 basin management study (that included 6 TAF of RO recycled water injection) was predicted to result in an average net salt loading to the main basin of approximately 3,100 tons/year, based on projected year 2010 conditions.

Table 9.18

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

4 TAF OF CONJUNCTIVE USE, 4.5 TAF OF SHALLOW RO, 3640 AF RECYCLED WATER INJECTION AND CWR WELLS PUMPING FOR AGRICULTURE DEMAND (120% of Recycled water)

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,730	250	820	2,662	2,970	3,620
Groundwater, Zone 7 Extraction only wells (NO demi	540	450	50	4,860	330	6,600
Groundwater, Zone 7 Extraction only wells (demin)	1,220	100	110	1,109	170	1,550
Groundwater, ASR wells	780	250	70	2,786	270	3,860
Groundwater, others (No demin)	2,180	450	200	4,905	1,330	6,650
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,975		1,360		5,500	4,040
Agricultural Irrigation						
SBA water	870	250	220	989	300	1,360
CWR Project agricultural pumpage	870	160	220	633	190	860
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		610	1,240
Subsurface groundwater inflow	1,080	1,500	1,080	1,500	2,200	2,040
Total Natural Supply	23,935		13,970		13,230	950
ARTIFICIAL RECHARGE						
Stream recharge	8,210	250	8,210	250	2,790	340
Injection well recherge (ASR wells))	2,950	250	2,950	250	1,000	340
RO Recycled water injection	3,640	100	3,640	100	490	130
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	38,735		28,770		17,510	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,950	250	1,000	340
Zone 7 municipal pumpage, Extraction only wells	2,040	450	1,250	610
Zone 7 municipal pumpage to waste, DEMIN brine	0	450	0	0
Zone 7 municipal pumpage to waste, DEMIN brine (from 1000 mg/l water)	465	1,000	630	1,350
Conjunctive use pumpage, Extraction only wells(Deep aquifer water)	20	450	10	500
Conjunctive use pumpage, Extraction only wells(1000 MG/L GW)	4,650	1,000	6,320	1,360
Pumpage for injected RO recycled water, Extraction only wells	0	450	0	0
Other municipal pumpage	8,300	450	5,080	610
Addtional DSRSD's pumpage for recycled injection	2,240	450	1,370	610
Total municipal pumpage	20,665		15,660	760
CWR Project agricultural pumpage	4,370	160	950	220
Agricultural pumpage (groundwater)	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	320	900	390	1,220
Total Demand	28,755		17,390	

WATER/SALT BALANCE	20		120	

Table 9.19

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

4 TAF OF CONJUNCTIVE USE, 3.8 TAF OF SHALLOW RO, 3640 AF RECYCLED WATER INJECTION AND CWR WELLS PUMPING FOR AGRICULTURE DEMAND (120% of Recycled water)

WATER SUPPLY COMPONENTS	APPLIED WATER		RECHARGE WATER		SALT LOAD	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
	ACRE-FEET	TDS IN mg/l	ACRE-FEET	TDS IN mg/l	IN TONS	
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	8,690	250	820	2,649	2,950	3,600
CWR Wells pumpage	4,370	160	410	1,705	950	2,320
Adjustment for CWR wells pumpage	(4,370)	325	(410)	3,464	(1,930)	4,710
Groundwater, Zone 7 Extraction only wells (NO dem	800	450	80	4,500	490	6,130
Groundwater, Zone 7 Extraction only wells (demin)	1,000	100	90	1,111	140	1,560
Groundwater, ASR wells	780	250	70	2,786	270	3,860
Groundwater, others (No demin)	2,180	450	200	4,905	1,330	6,650
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,975		1,370		4,630	3,380
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
CWR Project agricultural pumpage	0	160	0	ERR	0	0
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	1,080	1,500	1,080	1,500	2,200	2,040
Total Natural Supply	23,935		13,980		12,460	890
ARTIFICIAL RECHARGE						
Stream recharge	8,260	250	8,260	250	2,810	340
Injection well recherge (ASR wells))	2,970	250	2,970	250	1,010	340
RO Recycled water injection	3,640	100	3,640	100	490	130
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	38,805		28,850		16,770	

WATER DEMAND COMPONENTS	WATER REMOVED		SALT LOAD	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
	ACRE-FEET	TDS IN mg/l	IN TONS	
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	2,970	250	1,010	340
Zone 7 municipal pumpage, Extraction only wells	2,000	450	1,220	610
Zone 7 municipal pumpage to waste, DEMIN brine	0	450	0	0
Zone 7 municipal pumpage to waste, DEMIN brine (from 1000 mg/l water)	380	1,000	520	1,370
Conjunctive use pumpage, Extraction only wells(Deep aquifer water)	1,050	450	640	610
Conjunctive use pumpage, Extraction only wells(1000 MG/L GW)	3,800	1,000	5,170	1,360
Pumpage for injected recycled water, CWR wells for urban irrigation	4,370	160	950	220
Other municipal pumpage	8,300	450	5,080	610
Addtional DSRSD's pumpage for recycled injection	2,240	450	1,370	610
Total municipal pumpage	25,110		15,960	640
CWR Project agricultural pumpage	0	160	0	0
Agricultural pumpage (groundwater)	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	320	900	390	1,220
Total Demand	28,830		16,740	

WATER/SALT BALANCE	20		30	

Table 9.20

Main Basin Water Balance and Salt Balance
2010 Steady State Conditions

8.5 TAF OF CONJUNCTIVE USE, 5 TAF OF SHALLOW RO, NO RECYCLED WATER INJECTION

WATER SUPPLY COMPONENTS	APPLIED WATER ACRE-FEET	APPLIED WATER TDS IN mg/l	RECHARGE WATER ACRE-FEET	RECHARGE WATER TDS IN mg/l	SALT LOAD IN TONS	SALT LOAD IN TONS PER 1,000 ACRE-FEET OF RECHARGE
NATURAL						
Rainfall recharge water			4,100	0	0	
Arroyo Valle:						
Lake/imported water recharge	1,240	250	1,240	250	420	340
Natural recharge	1,830	440	1,830	440	1,090	600
Total Arroyo Valle	3,070		3,070		1,510	
Arroyo Mocho natural recharge	2,610	480	2,610	480	1,700	650
Arroyo las Positas natural recharge	1,260	1,000	1,260	1,000	1,710	1,360
Urban Irrigation						
SBA water	7,810	250	710	2,750	2,650	3,730
Groundwater, Zone 7 Extraction only wells (NO demi	1,280	450	150	3,840	780	5,200
Groundwater, Zone 7 Extraction only wells (demin)	1,260	100	120	1,050	170	1,420
Groundwater, ASR wells	980	250	100	2,450	330	3,300
Groundwater, others (No demin)	2,080	450	200	4,680	1,270	6,350
Domestic groundwater pumpage	120	450	70	771	70	1,000
LWRP reclaimed water irrigation	405	650	40	6,581	360	9,000
Total Urban Irrigation	13,935		1,390		5,630	4,050
Agricultural Irrigation						
SBA water	1,740	250	440	989	590	1,340
Groundwater	200	450	50	1,800	120	2,400
Total agricultural irrigation	1,940		490		710	1,450
Subsurface groundwater inflow	1,100	1,500	1,100	1,500	2,240	2,040
Total Natural Supply	23,915		14,020		13,500	960
ARTIFICIAL RECHARGE						
Stream recharge	4,810	250	4,810	250	1,640	340
Injection well recherge (ASR wells))	7,890	250	7,890	250	2,680	340
Recycled water irrigation	0	0	0		0	0
TOTAL SUPPLY	36,615		26,720		17,820	

WATER DEMAND COMPONENTS	WATER REMOVED ACRE-FEET	WATER REMOVED TDS IN mg/l	SALT LOAD IN TONS	SALT REMOVED IN TONS PER 1,000 ACRE-FEET OF EXPORT
Municipal Pumpage				
Zone 7 municipal pumpage, ASR pumpage	3,890	250	1,320	340
Zone 7 municipal pumpage, Extraction only wells	1,490	450	910	610
Zone 7 municipal pumpage to waste, RO brine	0	450	0	0
Zone 7 municipal pumpage to waste,demin brine (from 1000 mg/l water)	480	1,000	650	1,350
Conjunctive use pumpage, Extraction only wells(Deep aquifer water)	3,620	450	2,210	610
Conjunctive use pumpage, Extraction only wells(1000 MG/L GW)	5,000	1,000	6,800	1,360
Pumpage for injected RO recycled water, CWR wells for urban irrigation	0	160	0	0
Other municipal pumpage	8,300	450	5,080	610
Addtional DSRSD's pumpage for ROrecycled injection	0	450	0	0
Total municipal pumpage	22,780		16,970	740
CWR Project agricultural pumpage	0	160	0	0
Agricultural pumpage (groundwater)	200	450	120	600
Mining export	0	520	0	0
Mining offhaul	400	500	270	680
Pond evaporation	2,800	0	0	0
Subsurface groundwater outflow	440	900	540	1,230
Total Demand	26,620		17,900	

WATER/SALT BALANCE	**100**		**(80)**	

Groundwater quality would degrade by 10 mg/L/year to 550 mg/L after ten years and delivered water quality would be on average 300 mg/L. Under the Study 1A baseline case (with no RO recycled water injection), year 2010 net loading would increase to 5,400 tons/year. Groundwater quality would degrade by 18 mg/L/year to 630 mg/L after ten years and delivered water quality would be on average 275 mg/L.

Salt Loading to the main basin in eight of the fifteen basin management studies described above would be reduced to zero or less. These include Studies 2, 6, 9, 10, 11, 12, 14 and 15. The remaining studies would result in salt loading to the main basin varying between 100 and 2,000 tons/year. Studies 3, 4, and 12 include vadose zone attenuation assumptions. Based on the recommendations of the Zone 7 Technical Advisory Group and Citizen GMAC, minimal, if any, permanent attenuation of salts is believed to occur within the soil and gravel above the main basin. These studies were retained as a point of reference rather than feasible implementation options.

Groundwater Quality Impacts based on the projected salt loadings associated with each of the studies show that the projected net increases in groundwater TDS would vary from -4 mg/L/year in Study 12 to +18 mg/L/year in Study 1A. Given the multiple factors involved in predicting such basin-wide responses with a spreadsheet-based model, actual net increase in TDS may be less than the values projected in Table 9.1. The values equitably compare the relative magnitude of the effects of the various salt management options investigated with respect to long-term groundwater quality impacts. Under all conditions, TDS may continue to increase for a decade after the salt balance has been reduced to zero until a new steady-state equilibrium is reached.

The projected TDS in the groundwater after ten years of implementation of the salt management studies associated with studies 1 through 15 could vary by as much as +/-100 mg/L from the current level of 450 mg/L. It should be noted that these values were computed based on average hydrology and assumed hypothetical mixing of upper and lower aquifers, therefore, actual changes in loading and groundwater TDS at individual wells in a given year could vary significantly from these projections depending on the actual ten-year hydrology between 2000 and 2010. In either case, the basin is close to approaching the 500 mg/L TDS recommended secondary MCL standard and basin plan groundwater quality objective.

Delivered Water Quality Impacts under baseline Study 1 conditions (maximizing imported surface water deliveries) would result in a Zone 7 delivered water TDS of approximately 300 mg/L. The resultant TDS associated with other basin management studies varies from 180 mg/L for the Delta Fix to 390 mg/L for Study 5 (maximizing groundwater deliveries through conjunctive use). Other studies which would improve the delivered water quality compared to the current basin management practice are those that include demineralization as a component of the overall strategy. Studies which result in increased TDS in the delivered water are those based on implementation of conjunctive use as the primary mode of salt management.

Note that the delivered water TDS values cited are the overall average annual value from the 75-year simulations. Actual annual values under a given study will vary depending on the actual year hydrology and impacts on SBA water quality. Under Study 1 for example delivered water TDS would range from 250 to 440 mg/L (see detail tables for each study in Reference M (far right column) for the ranges of calculated TDS).

Costs—Incremental operational costs for the basin management studies described by studies 1 through 15 range from $0 to $160 per acre-foot of treated water delivered in 2010. The least expensive solution which yields a zero or negative salt loading to the main basin is the Delta Fix (Study 2) with assumed incremental costs of $0 per acre-foot of treated water delivered. It should be noted that the $17 billion delta fix will likely be paid in part by Zone 7 customers (probably via taxes) but not in Zone 7 water rates.

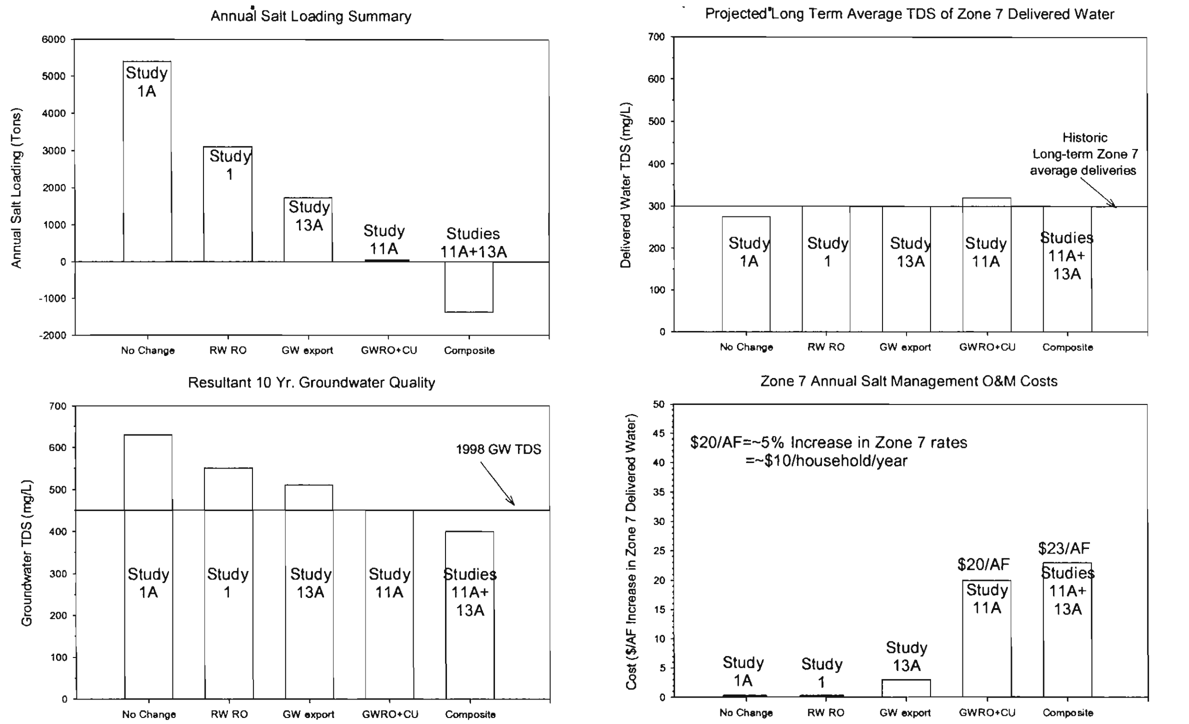
The next least-cost solutions yielding no net increase in salt loading are studies 6, 11 A&B, 14 and 15 with costs of $20, $20, $40 and $50 per acre-foot, respectively. Study 5, which still results in an estimated salt loading of 800 tons/year, has an incremental operational cost of only $10 per acre-foot of treated water delivered (but results in 360 mg/L TDS delivered water quality). Studies 7, 8, 9, and 10 have incremental operational costs of $110, $160, $160, and $100 per acre-foot of treated water delivered, respectively.

Composite Studies —A composite basin management study composed of a number of individual salt management studies may be best suited to balance the likely multiple requirements for an effective and acceptable overall salt management practice (i.e., balanced salt loading, low cost, decreased TDS of delivered water, etc.). Depending on the priorities of these requirements and public acceptance of individual strategies, the combination of studies implemented could vary from year to year.

To demonstrate the effectiveness of a potential composite salt management strategy, seasonal groundwater export (Study 13A) was paired first with Study 11A and then with Study 11B (wellhead demineralization) in figures 9.1 and 9.2, respectively. These four clustered bar graphs present the relative impacts on salt loading, groundwater quality, delivered water quality, and the cost of selected individual and composite strategies. Study 1A (left-most bar) is shown in each case as the "base case" for comparative purposes.

The effect of including RO recycled water injection (Study 1) is shown by the second bar from the left. The effect of adding seasonal groundwater export (under Study 1 base case conditions with RO recycled water injection) is shown in the third bar from the left. The effect of instituting high TDS groundwater demineralization (under Study 1 base case conditions) is shown by the fourth bar from the left. The fifth bar from the left shows the "composite" study (Study 13A plus 11A or B) cumulative results (under Study 1 base case conditions).

Figure 9.1
Individual and Composite Salt Management Studies at 2010 Condition
Option 1 - Maintain Historic Delivered Water Quality and Groundwater TDS



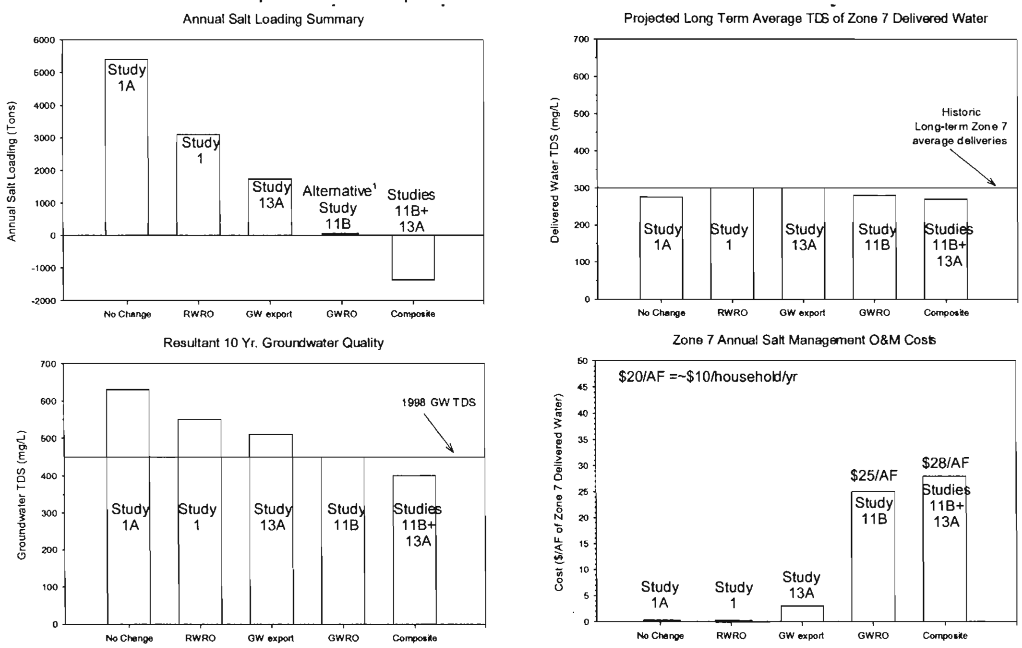
RWRO = 6 TAF of RO Recycled Water (RW) Injection
GW export = RWRO and 1.5 TAF groundwater (1000 mg/L) discharge to waste
GWRO + CU = RWRO and demineralization of 1.5 TAF groundwater (1000 mg/L) and 10 TAF conjunctive use (CU)
Composite = RWRO and GW export and GWRO + CU

f:\zn06\salt man alts sum.jnb

Figure 9.1 demonstrates that a composite salt management study composed of 1.5 TAF of groundwater export, 1.5 TAF of high TDS groundwater demineralization, and 10 TAF conjunctive use would result in a negative net salt loading (on average), an unchanged long-term average TDS of the delivered water, a modest decrease in the long-term TDS of the groundwater, and an incremental operational cost of approximately $23/AF of treated water deliveries.

Figure 9.2 below depicts a slightly more expensive composite strategy, but one that would improve both groundwater quality and delivered water quality. The major difference from Figure 9.1 is 3.0 TAF of high TDS groundwater demineralization (Study 11B) instead of 1.5 TAF in Study 11A. Such a composite salt management study would increase incremental operational costs by approximately $28/AF of treated water deliveries.

Figure 9.2
Individual and Composite Salt Management Studies at 2010 Condition
Option 2 - Improve Delivered and Groundwater TDS



RWRO = 6 TAF of RO Recycled Water (RW) Injection
GW export = RWRO and 1.5 TAF groundwater (1000 mg/L) discharge to waste
GWRO = RWRO and demineralization of 3 TAF groundwater (1000 mg/L)
Composite = RWRO, GW export, and GWRO

f:\zn06\salt man alts sum 2.jnb

[1] Alternative Strategy 11B is to RO enough groundwater to balance the salt loading (~3 TAF of 1000 mg/L groundwater)

9.6 Feasibility Screening of Year 2010 Studies

These screening level studies demonstrate that a salt management strategy can have both advantages and disadvantages associated with it. This is especially true given that a successful strategy will likely have to meet multiple, potentially competing goals, as discussed in Chapter 7. These could include, for example: net loading less than x tons/year, delivered water quality less than y mg/L, and incremental cost less than $z per acre-foot of treated water deliveries. Composite studies (such as studies 11-15) appear most capable of providing maximum flexibility in meeting multiple goals. They should also be more adaptable in addressing unpredictable annual variations in water supply and quality than approaches relying on a single strategy.

A feasibility screening of the salt management studies identified earlier in this chapter was conducted as summarized in Figure 9.3 to help narrow the focus of additional investigations. The feasibility screening was composed of five different screens including:

- Technical Feasibility
- Timing
- Economics
- Delivered water quality

Figure 9.3
Feasibility Screening of
Year 2010 Salt Management Studies

Study	Name	Screen #1	Feasible Studies	Screen #2	Feasible Studies	Screen #3	Feasible Studies	Screen #4	Feasible Studies	Screen #5	Feasible Studies
1/1B	Status Quo (with RO Recycled water injection)	Technical Feasibility	1/1B	Timing	1/1B	Economics	1/1B	Delivered Water quality	1/1B	Public or institutional acceptance	
1A	Status Quo (without RO Recycled water injection)		1A		1A		1A		1A		
2	Delta Fix		2								
3	15% Attenuation										
4	30% Attenuation										
5	16 TAF GW Pumpage for Conjunctive Use		5		5		5				
6	22 TAF GW pumpage for conjunctive use		6		6		6				
7	Demineralize Z7 GW Pumpage		7		7						
8	Demineralize all Pumpage		8		8						
9	Comp. CU & 19 TAF Demin		9		9						
10	Comp. CU & 10 TAF Demin		10		10						
11	Comp. CU & 5 TAF Demin										
11A	Comp. CU & 1.5 TAF Demin		11A		11A		11A				
11B	Comp. CU & 3 TAF Demin		11B		11B		11B		11B		
12	Comp. CU, Demin, & attenuation										
13	Seasonal groundwater export (3.6 TAF/ year)		13		13		13		13		
13A	Seasonal groundwater export (1.5 TAF/ year)		13A		13A		13A		13A		
14	Comp. CU & 4.5 TAF Demin		14		14		14		14		
14A	Comp. CU & 3.8 TAF Demin		14A		14A		14A		14A		
15	Comp. CU & 5 TAF Demin, no RO recycled water injection		15		15		15		15		15

Explanation of Screens

1 Is the implementation technically feasibly?
2 Is timing of alternative predictable?
3 Is resultant cost ($/AF) acceptable ?
4 Is the resultant predicted delivered WQ acceptable?
5 Could alternative be accepted and implemented near-term?

Description of Composite Studies

9. 19 TAF demineralized municipal pumpage, 7 TAF conjunctive use
10. 10 TAF demineralized municipal pumpage, 16 TAF conjunctive use
11. 5 TAF demineralized municipal pumpage (1000 mg/L), 5 TAF conjunctive use
12. Same as #11a, also includes 15% attenuation
14. CWR injection wells pumping for AG use (inject and recover mode)
14a. CWR injection wells pumping for urban irrigation use (inject and recover mode)
15. No recycled water injection, 5 TAF demineralized municipal pumpage
and 8.5 TAF conjunctive use pumpage

- Public and institutional acceptance

The feasibility screens were initially applied to the original studies (with RO recycled water injection). Study 11B passed all screens except for the public acceptance ability of the groundwater injection component of RO recycled water. If and when the public were to accept the injection of RO recycled water into the groundwater basin, Study 11B would be the highest ranked, least cost management strategy. Since none of these original studies passed all the screens, studies 14, 14a and 15 were developed and the feasibility screens were reapplied. Following is a discussion of each feasibility screen and the screening results.

The first screen, technical feasibility, eliminates studies that depend upon vadose zone attenuation or unattainable amounts of localized shallow groundwater pumping to remove salts. As noted earlier, the extent, if any, of attenuation of dissolved salts in the vadose zone is uncertain. Based on the best available evidence and guidance from the Zone 7 Groundwater Advisory Committee, it has been assumed that although there may be a time lag between salts applied over the main basin and impacts on the groundwater, all salts applied over the main basin will eventually migrate vertically to the aquifer. Based on this assumption, none of the studies including attenuation (3,4, or 12) would be acceptable.

Study 11 was found to be technically infeasible because it would not be possible to pump 5 TAF per year from the shallow aquifer at the Camp Parks well site, based on the preliminary groundwater model simulation for Study 11. The model predicted that only 1.5 TAF/year of sustained pumpage would be available from this site. It would require too many shallow well locations (which at this time is not believed physically feasible) to be able to sustain the required 5 TAF/year shallow groundwater pumpage.

The second screen shown in Figure 9.3 is timing. While highly desirable, Study 2, the Delta Fix, does not pass this screen since it cannot be predicted with any certainty what CalFed alternative may be implemented and when. While the Delta Fix cannot be relied on as the sole strategy (particularly in the near-term) to mitigate the current salt loading to the main basin, the implementation of other studies can be conducted in a manner to allow the Delta Fix to be added to the mix of available studies if and when a Delta Fix is realized.

The economics screen eliminates studies that are likely to be considered impractical because of high costs. Based on the planning level O&M costs in Table 9.1, none of the studies that rely on significant amounts (10 to 20 TAF) of typical production well (450 mg/L TDS) demineralization pass this screen. This rules out studies 7, 8, 9, or 10 where the operational costs range from approximately $100 to $160/AF of treated water delivered. The maximum incremental operational cost of the other studies investigated is $50/AF of treated water delivered.

The delivered water quality screen eliminates studies that may control salt loading but cause an unacceptable increase in the TDS of the Zone 7 delivered water. Studies that rely on conjunctive use as the primary mode of salt reduction (5, 6, and 11A) without significant wellhead demineralization to maintain delivered water TDS levels, fail to pass this screen.

The final screen eliminates studies that are unlikely to be deemed acceptable by the general public or involved public institutions and agencies. Studies 1 and 1B (Status Quo) did not pass because they did not eliminate the salt imbalance and the also included RO recycled water injection into the main basin, which was unacceptable to a portion of the public. Study 1A (Status Quo without RO recycled water injection) failed to pass this screen because groundwater basin quality degradation would continue at an even higher rate than under Study 1. As described in Chapters 7 and 8, the status quo is not compatible with the goal of maintaining sustainable groundwater quality. The status quo at some point could be in conflict with state and federal non-degradation requirements. From a public opinion perspective, allowing continued degradation may also not be considered responsible stewardship of the groundwater resource.

Studies 13 and 13A (seasonal groundwater export) do not, at this time, pass the acceptance screen because of the inter-agency coordination issues that need to be addressed regarding the export of additional salts through the Niles cone. It is possible that an agreement could be reached with ACWD with respect to seasonal groundwater export at some time in future. If and when this happens, implementation of seasonal groundwater export as one component in a composite study would be desirable.

Study 11B, a composite of conjunctive use (stream recharge and groundwater pumping) and 3 TAF of wellhead demineralization would eliminate the salt balance in 2010 and maintain delivered water quality. It would be economically reasonable compared to other salt neutral and delivered water quality neutral strategies. The main limitation of this study is that it includes 6 TAF/year of RO recycled water injection, which is unacceptable to the public at this time. Studies 14 and 14A which include groundwater injection, re-extraction, and delivery of RO recycled water for agricultural irrigation or urban irrigation, also did not pass this final screen for similar reasons.

Study 15, the only study that passed all the screens, is a composite of conjunctive use and 5 TAF of wellhead demineralization. Since the Camp Parks well site would not yield more than 1.5 TAF from the shallow aquifer, it would require multiple shallow groundwater pumping locations (or multiple demineralization facility sites). This study would eliminate the salt imbalance at a relatively low cost, improve or maintain delivered water quality, and is believed to be acceptable to public. To be successful it requires reaching agreement with LAVWMA/EBDA on brine export.

In summary, Studies 11B and 15 both appear promising. Study 11B is less expensive than 15 but it does not pass the public acceptability screen at this time because it includes RO recycled water injection. The seasonal groundwater export studies 13 and 13a would also be economically attractive as partial future solutions, assuming institutional arrangements with ACWD could be addressed in a mutually satisfactory manner.

Based on these Chapter 4 results, baseline studies 1A and 1 and corresponding salt neutral studies 11B and 15 were developed and evaluated in more detail using the Zone 7 groundwater and system operation numeric models. Results are presented in Chapter 10.