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10.2.5 Recycled Water Planning Investigation Report

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# **Recycled Water Planning Investigation Report**

Draft Final





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#### **Acronyms, Abbreviations, and Initialisms**

1,2-DCE 1,2 dichloroethylene

acre-ft/yr acre-feet per year

ADD average day demands

Basin Water Quality Control Plan for the Santa Ana River Watershed

Plan

CDFG California Department of Fish and Game
CDFM cumulative departure from the mean
CDPH California Department of Public Health

CEQA California Environmental Quality Act

CWA Clean Water Act

CWF Clean Water Factory

Decree Consent Decree

DBCP dibromochloropropane
DWP Drinking Water Program

DWR Department of Water Resources
EPA Environmental Protection Agency

ft/day feet per day

ft-msl feet mean sea level

GRRP groundwater recharge reuse project

IEUA Inland Empire Utilities Agency

IRWMP Integrated Regional Water Management Plan

MDD maximum day demandsMgd million gallons per dayMMD maximum month demandsOCWD Orange County Water District

PCE Perchloroethylene
PHD peak hour demands

RIX Rapid Infiltration and Extraction

RWQCB Regional Water Quality Control Board

SARI Santa Ana Regional Interceptor

SARWQCB Santa Ana Regional Water Quality Control Board

SAWPA Santa Ana Watershed Project Authority

SBBA San Bernardino Basin Area

SBCFCD San Bernardino County Flood Control District
SBMWD San Bernardino Municipal Water Department



### **Acronyms, Abbreviations, and Initialisms**

SBVMWD San Bernardino Valley Water Conservations District

SBWRP San Bernardino Water Reclamation Plant

SCS Soil Conservation Service

SWP State Water Project

SWRCB State Water Resources Control Board

TCE trichloroethylene

TDS total dissolved solids

USFWS US Fish and Wildlife Service

Valley San Bernardino Valley Municipal Water District

District

WEI Wildermuth Environmental, Inc.
WMWD Western Municipal Water District



The City of San Bernardino Municipal Water Department (SBMWD) relies completely on groundwater from the Bunker Hill Groundwater Basin (Bunker Hill Basin) to meet the water supply needs of its service area. Currently, the Bunker Hill Basin is in overdraft,¹ and projections show that the SBMWD and other water retailers in the area intend to increase production from the basin over time. The SBMWD has made significant investments in the Bunker Hill Basin with more than sixty production wells, four groundwater treatment plants, and over five-hundred-and-fifty miles of water supply pipelines, and has a clear interest in maintaining and improving this water supply.

Due to the extended drought in California, conveyance limitations in State Water Project (SWP) facilities, finite groundwater supplies, and compliance with SBX-7,² the SBMWD is faced with developing innovative solutions, independent of traditional imported water supplies, for its future water needs. To this end, the SBMWD has commissioned a recycled water planning investigation to determine the feasibility of using recycled water to augment its water supply.

The SBMWD owns and operates the San Bernardino Water Reclamation Plant (SBWRP). The SBMWD and the City of Colton are members of a Joint Powers Agency that owns and operates the Rapid Infiltration and Extraction (RIX) Facility. The SBWRP currently treats approximately 24 million gallons per day (mgd) of raw wastewater from the City of San Bernardino, the City of Loma Linda, and the East Valley Water District to secondary standards. Secondary-treated effluent from the SBWRP is conveyed to the RIX facility for tertiary treatment and discharge to the Santa Ana River. The City of Colton also conveys about 5.3 mgd of secondary-treated effluent to the RIX facility for tertiary treatment and discharge to the Santa Ana River. At present, RIX discharges approximately 36 mgd to the river.

Previous studies have shown that conventional direct use throughout the SBMWD service area is not economically feasible. As such, this investigation focused on developing concepts that emphasize indirect potable reuse (i.e. recharge) and limited direct use to "targets of opportunity" adjacent to and near the SBWRP. The SBMWD has named the project that will result from this investigation the Clean Water Factory (CWF). The CWF will treat effluent from the SBWRP to a quality approved for reuse and convey it to the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins for surface spreading, and to specific customers for direct use applications. Figure ES-1 shows the locations of the spreading basins, potential direct use sites, the SBWRP, and the proposed recycled water distribution pipelines. Recycled water spread at the recharge facilities will recharge the Bunker Hill Basin and, more specifically, the Bunker Hill A Management Zone, as described in the Water Quality Control Plan for the Santa Ana River Watershed (Basin Plan).

<sup>&</sup>lt;sup>2</sup> SBX-7 requires urban water retailers to reduce per capita water demands by 10 percent by 2015 and by 20 percent by 2020, with that reduction measured against a specified per capita baseline.



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<sup>&</sup>lt;sup>1</sup> A groundwater basin is in overdraft when production exceeds its safe yield.

To implement this recycled water reuse project, the SBMWD's discharge to the Santa Ana River at the RIX facility will be minimized. To that end, the SBMWD submitted a Petition for Change pursuant to Water Code Sections 461, 13500 et seq. and 13575 et seq. to reduce the discharge at the RIX facility to 11.9 mgd or about 13,300 acre-ft/yr. The Petition for Change was submitted to the State Water Resources Control Board on April 22, 2010, and a revised petition was submitted on June 7, 2010. This recycled water reuse strategy will reduce the demand for imported water in the San Bernardino area by the amount of SBMWD recycled water reuse.

There are institutional and regulatory challenges that must be overcome to implement this change in water use. These challenges include conformance with the Basin Plan and the draft regulations regarding planned recycled water recharge projects, conformance with water rights and related agreements, and potential environmental limitations in the Santa Ana River. With the exception of potential environmental limitations in the Santa Ana River, this feasibility investigation describes these challenges and potential solutions to some of them.

This report was designed to cover a broad range of subjects and to provide the SBMWD with information that they can use to assess the feasibility of recycled water reuse in their service area.

Section 3 describes the federal, state, and regional regulations with which the proposed project will need to comply and identifies the local water agencies that will benefit from or may be affected by the implementation of this reuse project.

Section 4 demonstrates that there is not enough water to meet projected water demands within the San Bernardino Valley Municipal Water District (Valley District) service area. The cumulative unmet replenishment obligation (CURO) through 2030 is projected to be about 236,000 acre-ft (See Table 4-5). This assumes aggressive recharge of Santa Ana River water. The CURO could be reduced by introducing recycled water from the CWF as a source water for recharge in the Bunker Hill Basin. This is discussed in Section 12.

Section 5 describes the wastewater collection systems that supply water to SBMWD treatment plants and provides future wastewater flow projections. The SBMWD projects that the SBWRP will produce about 28 mgd (30,800 acre-ft/yr) by 2015, 31 mgd (34,200 acre-ft/yr) by 2020, and 35 mgd (39,600 acre-ft/yr) by 2030.

Section 6 describes the current recycling criteria, as required by the RWQCB and the CDPH, for planned recycled water recharge and direct use applications. Section 6 shows that if recycled water is treated to advanced standards (i.e. reverse osmosis and advanced oxidation), less dilution is required for recycled water recharge.

Section 7 describes an array of treatment processes that could be used to produce recycled water that meets the regulatory requirements for recycled water reuse and characterizes the treatment alternatives formulated for the CWF. The primary treatment alternatives evaluated in this investigation were:



- Treatment Alternative B, which is similar to Orange County Water District's Groundwater Replenishment System, includes microfiltration (MF), reverse osmosis (RO), ultra violet disinfection (UV), and an advanced oxidation process (AOP) to treat secondary effluent to advanced standards. This treatment alternative features a second treatment train that filters and disinfects a side stream of effluent, making it available for direct use. Recycled water produced from the RO plus UV/AOP treatment process will be of Title 22 quality and conveyed solely for recharge. Recycled water produced from the tertiary treatment train will also be of Title 22 quality and, thereby, available for recharge or direct use.
- Treatment Alternative C includes a membrane bioreactor, RO, and UV/AOP to treat primary effluent to advanced standards. This treatment alternative features a second treatment train that filters and disinfects a side stream of secondary effluent, making it available for direct use. Recycled water produced from this alternative will be of Title 22 quality.
- Treatment Alternative D is similar to Treatment Alternative B, but it uses a proprietary treatment process that accepts primary effluent rather than traditional secondary effluent. This treatment alternative features a second treatment train that filters and disinfects a side stream of secondary effluent, making it available for direct use. Recycled water produced from this alternative will be of Title 22 quality.

Section 8 demonstrates that recycled water recharge is feasible using the Waterman Basins and the East Twin Creek Spreading Grounds and probably feasible if the recharge project is extended to the Devil Canyon area. Extending the recharge to the Devil Canyon area will provide recharge to SBMWD wells located in that area and provide additional recharge capacity if the recharge capacity of Waterman and East Twin Creek Spreading Grounds is less than determined herein. Section 8 also shows that the SBBA model, in its current form, should not be used for a formal Title 22 Engineering Report of the proposed recycled water recharge project. A new localized model should be developed and used for the formal Title 22 Engineering Report that will be required by the CDPH. The domain of this new localized model should be limited to the region around the recharge basins and downgradient areas of interest. Useful information from the SBBA model could be exploited for the new localized model.

Section 9 identifies about 3,100 acre-ft/yr of direct use demand at sites adjacent to the SBWRP and along the East Twin Creek flood control channel.

Section 10 describes the marketing of surplus SBMWD recycled water. Recycled water that is surplus to the SBMWD's indirect potable reuse and direct use efforts has value to other agencies that use or plan to use recycled water. Therefore, rather than discharging surplus recycled water to the Santa Ana River without benefit to the SBMWD, it will be marketed from the RIX facility to agencies within the Santa Ana River Watershed that need recycled water and will pay for it. Water purveyors in the Chino Basin area have specifically shown interest in this surplus recycled water. Assuming that a sales agreement and facilities were in



place to convey 10,000 acre-ft/yr of recycled water by 2015 and that the value of the recycled water was pegged to Metropolitan's untreated Tier 2 rate, the SBMWD could receive about \$4.1 million per year, and this revenue could escalate to about \$7.8 million per year by 2020, and about \$21 million per year by 2030.

Section 11 characterizes the project alternatives developed for this investigation and the facilities required to recharge up to 14,500 acre-ft/yr of advanced treated recycled water, to provide up to 3,100 acre-ft/yr of tertiary treated water for direct uses, and to sell up to 10,000 acre-ft/yr of tertiary treated recycled water outside of the SBMWD service area. At full project capacity, the CWF will produce about 2,800 acre-ft/yr of brine, which will be discharged to the Santa Ana Regional Interceptor.

Section 12 provides an assessment of the project alternatives and describes the costs associated with each alternative. Implementation of the CWF was assumed to occur in three phases. Phase I includes an advanced treatment system capable of producing 5 mgd and a tertiary treatment system capable of producing 3 mgd. Phase II increases the advanced treatment capacity of the CWF by an additional 5 mgd, and Phase III further increases the advanced treatment capacity by 4.2 mgd. The ultimate advanced treatment capacity is 14.2 mgd, and the ultimate tertiary treatment capacity for direct use is 3.0 mgd. Figure ES-2 shows projected wastewater collection and treatment and the recycled water fate with this proposed phasing.

Table ES-1 lists the alternatives carried through to Section 12 for detailed analysis and summarizes their yield, capital costs, operations and maintenance costs, gross total project costs, and expected cost offsets. These costs are presented as first costs (cost of construction), annual costs (amortized capital plus operations and maintenance), and unit costs (\$ per acre-ft). The only difference among the alternatives is the treatment technology used at the CWF.

The capital cost estimates for these alternatives are about \$176,000,000 for Alternative 1B (MF+RO+UV/AOP), \$291,000,000 for Alternative 1C (MBR+RO+UV/AOP), and \$198,000,000 for Alternative 1D ([IMANS] MF+RO+UV/AOP). The operations and maintenance costs for these alternatives are fairly close: \$10,400,000 per year for Alternative 1B, \$11,700,000 per year for Alternative 1C, and \$11,600,000 per year for Alternative 1D. The annual and unit water costs, respectively, are about \$21,800,000 per year and \$1,240 per acre-ft for Alternative 1B, \$30,600,000 per year and \$1,740 per acre-ft for Alternative 1C, and \$24,500,000 per year and \$1,390 per acre-ft for Alternative 1D. On a gross total project cost basis, Alternative 1B is the least cost alternative and achieves the goals of the project.

There are some cost offsets that need to be factored into the economic analysis. These offsets have been grouped into two categories: cost offsets A and cost offsets B. Cost offsets A include reduced operations and maintenance costs at the SBWRP and the RIX facilities due to the treatment of water at the CWF and cost savings from the avoided purchase of imported water from the Valley District. Annual operations and maintenance savings at full project capacity are \$3,500,000 per year for Alternative 1B, \$4,600,000 per year for Alternative 1C, and \$5,600,000 for Alternative 1D. The avoided imported water purchase savings at full capacity would be \$5,300,000, based on the avoided purchase of 17,600 acre-ft/yr at \$300 per



acre-ft. Although the \$300 per acre-ft water cost is greater than the current cost of imported water from Valley District, this is probably a low estimate, given the cost of Delta improvements that will be added to the rate and costs associated with the Valley District's purchase of additional supplemental water supplies to augment its existing Table A contract water. With these cost offsets factored in, the annual and unit water costs, respectively, are about \$13,000,000 per year and \$740 per acre-ft for Alternative 1B, \$20,700,000 per year and \$1,180 per acre-ft for Alternative 1C, and \$13,600,000 per year and \$770 per acre-ft for Alternative 1D. With these offsets, Alternative 1B is still the least cost alternative and achieves the goals of the project.

Cost offsets B include reduced future capital costs at the SBWRP facility due to the addition of treatment capacity that would have had to be constructed anyway to expand the treatment plant. Alternative 1B does not increase the capacity of the SBWRP. The avoided capital cost from the expansion of the SBWRP from Alternatives 1C and 1D is about \$63,700,000, which equates to an annual savings of about \$4,100,000. With cost offsets A and B factored in, the annual and unit water costs are about \$13,000,000 per year and \$740 per acre-ft for Alternative 1B, \$16,600,000 per year and \$940 per acre-ft for Alternative 1C, and \$9,500,000 per year and \$540 per acre-ft for Alternative 1D. With these offsets, Alternative 1D is the least cost alternative and achieves the goals of the project.

#### Section 12 concludes:

- With the proposed SBMWD recycled water recharge project, the CURO in the Valley
  District service area would drop substantially to 108,000 acre-ft, as shown in Table
  ES-2. The CURO would be further reduced by the proposed direct use of recycled
  water.
- If the future avoided cost from capacity expansion at the SBWRP is ignored, Alternative 1B is the lowest cost alternative with a full capacity capital cost of \$176,000,000, an annual cost of about \$13,000,000, and a unit cost of \$740 per acre-ft.
- If the future avoided cost from capacity expansion at the SBWRP is included in the economic assessment, Alternative 1D is the lowest cost alternative with a full capacity capital cost of \$134,300,000, an annual cost of about \$9,500,000 and a unit cost of \$540 per acre-ft.

At these unit costs, Alternatives 1B and 1D are economically feasible. These unit costs are comparable to or less than the cost of acquiring new imported water supplies. And, the water supply developed by these alternatives is more reliable than imported water. The project alternatives were analyzed assuming project financing with conventional municipal bonds, using an interest rate of 5 percent and 30-year term. The SBMWD may be able to secure lower interest financing and grants, which would lower the cost of the proposed recycled water project.

Section 12 also describes a set of variants that reduce the scope of the initial reuse scenario and, thereby, reduce the capital, annual, and unit costs. The variants include removing the Devil Canyon and Sweetwater Basins as a recharge site, removing the direct use distribution



pipeline and pump stations, reducing the number of direct use sites, and/or removing direct use altogether. Without the Devil Canyon and Sweetwater Basins, the full capacity capital cost would be reduced by about \$15,000,000, the annual cost would be reduced by about \$1,500,000, and the unit cost would be reduced by about \$90 per acre-ft. Depending on the amount of direct use, a single pipeline configuration would reduce the full capacity capital cost by \$11,000,000 to \$16,000,000, the annual cost by about \$800,000, and the unit cost by about \$50 per acre-ft.



Table ES-1
Project Alternatives' Capital and Operation & Maintenance Costs

	Heite	Pi	roject Alternative	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	14,500	14,500	14,500
Direct Use	acre-ft/yr	3,100	3,100	3,100
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs <sup>1, 2, 3</sup>		,555	,	,555
Recharge				
Total Cost	\$	\$148,000,000	\$263,000,000	\$170,000,000
Annual Cost	\$/yr	\$9,600,000	\$17,100,000	\$11,100,000
Unit Cost	\$/acre-ft	\$660	\$1,180	\$770
Direct Use	******	,	* ,	, .
Total Cost	\$	\$28,000,000	\$28,000,000	\$28,000,000
Annual Cost	\$/yr	\$1,800,000	\$1,800,000	\$1,800,000
Unit Cost	\$/acre-ft	\$580	\$580	\$580
Total Capital Cost	φ/ασισ π	φοσσ	φοσο	φοσσ
Total Cost	\$	\$176,000,000	\$291,000,000	\$198,000,000
Annual Cost	\$/yr	\$11,400,000	\$18,900,000	\$12,900,000
Unit Cost	\$/acre-ft	\$650	\$1,070	\$730 \$730
Operation & Maintenance Costs <sup>1, 2</sup>	φ/ασισ π	φοσσ	Ψ1,070	Ψίσο
Recharge				
Annual Cost	\$/yr	\$9,700,000	\$11,000,000	\$10,900,000
Unit Cost	\$/acre-ft	\$670	\$760	\$750
Direct Use	φ/ασισ π	φονο	Ψίου	ψίου
Annual Cost	\$/yr	\$720,000	\$720,000	\$720,000
Unit Cost	\$/acre-ft	\$230	\$230	\$230
Total O&M Cost	φ/ασισ π	Ψ200	Ψ200	Ψ200
Annual Cost	\$/yr	\$10,400,000	\$11,700,000	\$11,600,000
Unit Cost	\$/acre-ft	\$590	\$660	\$660
Gross Total Project Costs	φιασιστι	\$555	4000	\$555
Total Capital Cost	\$	\$176,000,000	\$291,000,000	\$198,000,000
Annual Cost	\$/yr	\$21,800,000	\$30,600,000	\$24,500,000
Unit Cost	\$/acre-ft	\$1,240	\$1,740	\$1,390
Cost Offsets - A	φιασιστι	<b>\$.,2.</b> 0	ψ.,,	ψ.,σσσ
Operation & Maintenance <sup>4</sup>	\$/yr	\$3,500,000	\$4,600,000	\$5,600,000
Imported Water Purchases <sup>5</sup>	\$/yr	\$5,300,000	\$5,300,000	\$5,300,000
Net Total Project Costs with Cost Offse		* - , ,	<b>4</b> - <b>7 7</b>	, , , , , , , , , , , , , , , , , , , ,
Total Cost	\$	\$176,000,000	\$291,000,000	\$198,000,000
Annual Cost	\$/yr	\$13,000,000	\$20,700,000	\$13,600,000
Unit Cost	\$/acre-ft	\$740	\$1,180	\$770
Cost Offsets - B				
Capital				
Total Cost <sup>6</sup>	\$	\$0	\$63,700,000	\$63,700,000
Annual Cost <sup>3</sup>	\$/yr	\$0	\$4,100,000	\$4,100,000
Net Total Project Costs with Cost Offse	-			
Total Cost	\$	\$176,000,000	\$227,300,000	\$134,300,000
Annual Cost	\$/yr	\$13,000,000	\$16,600,000	\$9,500,000
Unit Cost	\$/acre-ft	\$740	\$940	\$540
		* "-	+	Ť · · ·

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include (1) the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively; (2) an avoided distribution cost of \$175 per acre-ft related to not pumping, treating, and distributing well water to irrigation customers in the SBMWD's service area.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.



Table ES-2 Cumulative Unmet Replenishment Obligation of the Valley District with SBMWD Recycled Water Recharge – 2010 through 2030 (acre-ft/yr)

	Cumulative Unmet Replenishment Obligation <sup>7</sup>	0	0	0	0	0	0	0	0	0	0	0	0	440	4,585	12,435	23,989	37,297	52,359	69,175	87,746	108,070
	Actual Replenishment <sup>6</sup>	0	0	0	0	0	12,725	31,460	34,527	37,594	40,661	35,652	38,954	41,814	41,411	41,007	40,604	40,540	40,477	40,413	40,350	40,286
	Replenishment Credits at the end of the Year <sup>56</sup>	157,070	127,072	93,505	56,371	15,668	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
er Project Water	Available for Replenishment	50,516	49,117	47,717	46,318	44,918	43,519	43,339	43,160	42,980	42,801	42,621	42,218	41,814	41,411	41,007	40,604	40,540	40,477	40,413	40,350	40,286
Valley District Supply of State Water Project Water	Direct Deliveries⁴	10,924	12,323	13,723	15,122	16,522	17,921	18,101	18,280	18,460	18,639	18,819	19,222	19,626	20,029	20,433	20,836	20,900	20,963	21,027	21,090	21,154
Valley District §	Table A deliveries at 60% Reliability³	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440
	Replenishment Obligation <sup>2</sup>	26,430	29,998	33,566	37,134	40,703	28,393	31,460	34,527	37,594	40,661	35,652	38,954	42,255	45,556	48,857	52,158	53,848	55,539	57,230	58,920	60,611
	Excess Extractions from the SBBA	31,094	35,292	39,490	43,688	47,885	33,403	37,011	40,620	44,228	47,836	41,944	45,828	49,711	53,595	57,478	61,362	63,351	65,340	67,329	69,318	71,307
	Total Production Rights from the SBBA	232,100	232,100	232,100	232,100	232,100	249,100	249,100	249,100	249,100	249,100	258,600	258,600	258,600	258,600	258,600	258,600	258,600	258,600	258,600	258,600	258,600
SBBA Production Rights	SBBA Augmentation from SBMWD Recycled Water Recharge	0	0	0	0	0	5,000	5,000	5,000	5,000	5,000	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500
SBBA Produ	SBBA Augmentation from New Santa Ana River Water Right	0	0	0	0	0	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
	Safe Yield	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100
	Water Use from the SBBA <sup>1</sup>	263,194	267,392	271,590	275,788	279,985	282,503	286,111	289,720	293,328	296,936	300,544	304,428	308,311	312,195	316,078	319,962	321,951	323,940	325,929	327,918	329,907
	Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

1. SBBs supples include groundwater from the Bunker Hill and Lyrie Creek Basins and surface water from the Senta Ana River. Mill Oreek, and Lyrie Creek, and Lyrie Creek, and Lyrie Creek. The Plaintifs are assumed to pump at their aggregate rights so they do not have a replenishment objected herein are based on information provided by the individual retail water agencies in 2009 and do not incorporate the SB-7 requirement for a 10-percent reduction in potable per capital demand by 2015 and a 20-percent reduction by 2020.

<sup>2.</sup> The replenishment obligation is equal to the total volume of excess extractions from the SBBA minus the return flow (15%) from the extractions above the sale yield.

<sup>3.</sup> The Valley District's Table A allocation of State Water Project water 102,400 acre-ft/yr.

<sup>4.</sup> Direct Deliveries are the Valley District's obligations to individual agencies for consumptive use, including the Fontana Water Company, West Valley Water District, City of Redands, and Yucaipa Valley Water District.

<sup>5.</sup> Assumes that the Valley District has a credit of about 183,500 acre-ft at the end of 2009.

<sup>6.</sup> Assumes that the Valley District only replenishes the SBBA when the replenishment credits have expired.

<sup>7.</sup> The CURO describes the total amount of water that the Valley District must recharge to balance the storage of the SBBA.



Riverside Ave

117°20'0"W

Cajon Creek

San Bernardino

County

Riverside County

Miles

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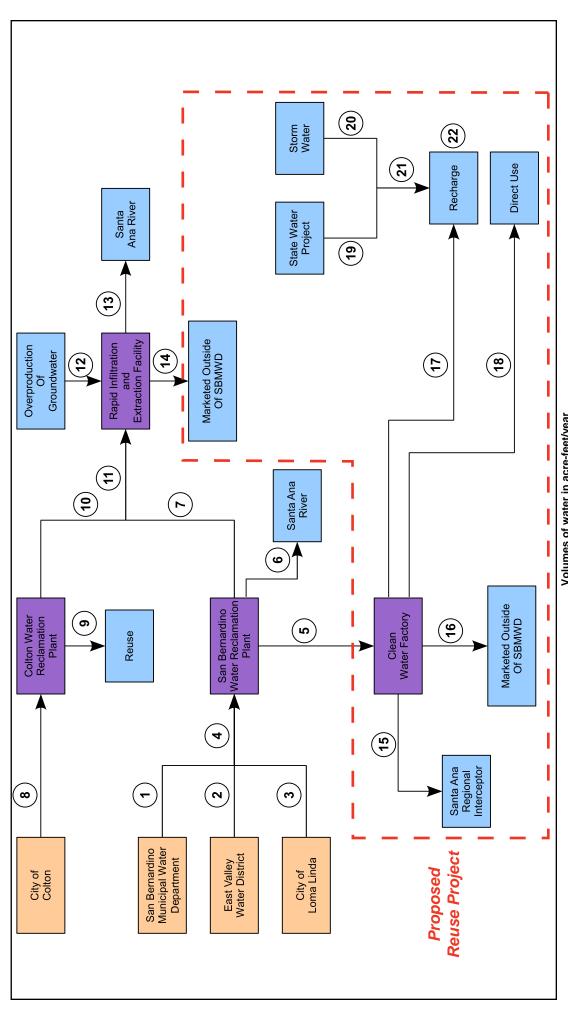


Produced for:

SBMWD Recycled Water Planning Investigation

Figure ES-1





Stream 1,2	-	2	3	4	5 63	၉၁	7	8	6	10	_	12	13	144	12 13 14 <sup>4</sup> 15 16 <sup>4</sup> 17 18 19 20 21 22	164	17	18	19	20	21	22
Year																						
2015	18,300	8,300 10,300 2,250 30,850 9,000	2,250	30,850	000'6	0	21,850	6,410	0	6,410	6,410 28,260 5,700 23,960 10,000	5,700	23,960	10,000	006	0	5,100 3,100 23,500 4,800 28,300 33,400	3,100	23,500	4,800	28,300	33,400
2020	20,500	20,500 11,000 2,620 34,120 14,900	2,620	34,120	14,900	0	19,220	6,840	0	6,840	6,840 26,060 5,200 21,260 10,000 1,800	5,200	21,260	10,000	1,800	0	10,300 3,100 23,500 4,800 28,300 38,600	3,100	23,500	4,800	28,300	38,600
2030	24,600	24,600 11,600 3,420 39,620 20,200	3,420	39,620	20,200	0	19,420	8,000	0	8,000	8,000 27,420 5,500 22,920 10,000 2,600	5,500	22,920	10,000		0 14,500 3,100 23,500 4,800 28,300 42,800	14,500	3,100	23,500	4,800	28,300	42,800

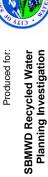
1 This schematic represents Project Alternative 1B. (see Section 11)

2 Assumes the CWF will be built using a phased approach. 3 SBWRP intermittently discharges to the Santa Ana River during large storm events.

4 Assumes that all marketed recycled water is conveyed from the RIX facility.











#### 1.1 Background

The City of San Bernardino Municipal Water Department (SBMWD) was established in 1905. Since then, it has grown to meet the needs of its service area, providing water supply, water reclamation, and geothermal heating supply services. The majority of the SBMWD service area overlays the Bunker Hill Groundwater Basin (Bunker Hill Basin), and the SBMWD relies completely on groundwater from the Bunker Hill Basin to the meet the water supply needs of its service area. The SBMWD has made significant investments in the Bunker Hill Basin with over sixty production wells, four groundwater treatment plants, and over five-hundred-and-fifty miles of water supply pipelines, and has a clear interest in maintaining and improving this water supply.

Due to the extended drought in California, conveyance limitations in State Water Project (SWP) facilities, finite groundwater supplies, and compliance with SBX-7,<sup>3</sup> the SBMWD is faced with developing innovative solutions, independent of traditional imported water supplies, for its future water needs. To this end, the SBMWD has commissioned a recycled water planning investigation to determine the feasibility of using recycled water to augment its water supply.

The SBMWD owns and operates the San Bernardino Water Reclamation Plant (SBWRP). The SBMWD and the City of Colton are members of a Joint Powers Agency that owns and operates the Rapid Infiltration and Extraction (RIX) Facility. The SBWRP currently treats approximately 24 million gallons per day (mgd) of raw wastewater from the City of San Bernardino, the City of Loma Linda, and the East Valley Water District to secondary standards. Secondary-treated effluent from the SBWRP is conveyed to the RIX facility for tertiary treatment and discharge to the Santa Ana River. The City of Colton also conveys

<sup>&</sup>lt;sup>5</sup> CCR, Title 22, Division 4, Chapter 3, Section 60301.230 defines disinfected tertiary treated recycled water as follows: "[...]a filtered and subsequently disinfected wastewater that meets the following criteria:



<sup>&</sup>lt;sup>3</sup> SBX-7 requires urban water retailers to reduce per capita water demands by 10 percent by 2015 and by 20 percent by 2020, with that reduction measured against a specified per capita baseline.

<sup>&</sup>lt;sup>4</sup> California Code of Regulation (CCR), Title 22, Division 4, Chapter 3 has two classifications of secondary treated recycled water: disinfected secondary-2.2 and disinfected secondary-23. Section 60301.220 of the CCR defines disinfected secondary-2.2 recycled water as "[...]recycled water that has been oxidized and disinfected so that the median concentration of total coliform bacteria in the disinfected effluent does not exceed a most probable number (MPN) of 2.2 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed, and the number of total coliform bacteria does not exceed an MPN of 23 per 100 milliliters in more than one sample in any 30 day period." Section 60301.220 of the CCR defines disinfected secondary-23 recycled water as "[...]recycled water that has been oxidized and disinfected so that the median concentration of total coliform bacteria in the disinfected effluent does not exceed a most probable number (MPN) of 23 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed, and the number of total coliform bacteria does not exceed an MPN of 240 per 100 milliliters in more than one sample in any 30 day period."

about 5.3 mgd of secondary-treated effluent to the RIX facility for tertiary treatment and discharge to the Santa Ana River. At present, RIX discharges approximately 36 mgd to the river.

## 1.2 SBMWD Objectives

Recent changes in the availability of State Water Project water have caused the SBMWD to rethink its water supply portfolio for the future. In January 2010, the DWR published the Draft State Water Project Delivery Reliability Report (DWR, 2009). This report updates the DWR's estimate of current (2009) and future (2029) SWP water delivery reliability. The report is produced every two years as part of a settlement agreement that was signed in 2003. The 2009 report shows that future SWP deliveries will be impacted by two significant factors: 1) a significant restriction on the SWP and Central Valley Project (CVP) Delta pumping, as required by the biological opinions issued by the U.S. Fish and Wildlife Service (December 2008) and the National Marine Fisheries Service (June 2009); and 2) climate change, which is altering hydrologic conditions in the state.

The 2009 Draft State Water Project Delivery Reliability Report represents the state of affairs if no Delta improvements are made. It shows the continued erosion of SWP water delivery reliability under the current method of moving water through the Delta. In the 2007 report, the average Table A delivery was about 63 percent for 2007 conditions and about 66 to 69 percent for 2027 conditions. In the 2009 report, the average Table A delivery is about 60 percent for 2009 conditions and about 60 percent for 2029 conditions. Most of the reduced reliability is caused by the export limitations that result from the two biological opinions—the first factor discussed above. The significance of the most recent projected delivery reliability is that there is a relative decrease in deliveries during wetter (higher allocation) years and a slight increase in deliveries during dry years. The projected future change in SWP delivery reliability is even more restrictive in wet years, indicating that, in the future, the SBMWD and other water retailers will receive less SWP water during wet periods than projected in the past. The eroding SWP reliability has major implications for the retail water agencies: retail agencies will need to expand conservation efforts, including recycled water reuse, to meet existing and

<sup>(</sup>b) The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed and the number of total coliform bacteria does not exceed an MPN of 23 per 100 milliliters in more than one sample in any 30 day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 milliliters".



<sup>(</sup>a) The filtered wastewater has been disinfected by either:

<sup>(1)</sup> A chlorine disinfection process following filtration that provides a CT (the product of total chlorine residual and modal contact time measured at the same point) value of not less than 450 milligram-minutes per liter at all times with a modal contact time of at least 90 minutes, based on peak dry weather design flow; or

<sup>(2)</sup> A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of the demonstration.

future water demands; and because the role of SWP water in salt management will be substantially diminished, new salt management strategies will need to be employed. It is unclear that the proposed improvements in the Delta will ever go forward and, if constructed, that SWP water delivery reliability will increase significantly. The SBMWD will need to find new water to provide for growth and to replace SWP water that has been lost to environmental issues in the Delta.

To meet this challenge, the SBMWD intends to maximize the reuse of recycled water treated at the SBWRP. This will be achieved by improving the treatment processes at the SBWRP to treat recycled water to tertiary levels and beyond. Most of this recycled water will be recharged at spreading basins that contribute to SBMWD wells, and some will be served to irrigation users. To the maximum extent possible, the SBMWD plans to use its recycled water to recharge the San Bernardino Basin Area (SBBA) and specifically the Bunker Hill Basin. Recycled water that is surplus to recharge and direct uses will either be sold to other water agencies or discharged to the Santa Ana River. To implement this recycled water reuse program, the SBMWD's discharge to the Santa Ana River at the RIX facility will be minimized. To that end, the SBMWD submitted a Petition for Change pursuant to Water Code Sections 461, 13500 et seq. and 13575 et seq. to reduce discharge at the RIX facility to 11.9 mgd or about 13,300 acre-ft/yr. The Petition for Change was submitted to the State Water Resources Control Board on April 22, 2010, and a revised petition was submitted on June 7, 2010. This recycled water reuse strategy will reduce the demand for imported water in the San Bernardino area by the amount of SBMWD recycled water reuse.

There are institutional and regulatory challenges that must be overcome to implement this change in water use. These challenges include conformance with the Basin Plan and the draft regulations regarding planned recycled water recharge projects, conformance with water rights and related agreements, and potential environmental limitations in the Santa Ana River.

The objective of this planning investigation was to develop projects that will reuse as much SBMWD recycled water as is economically and institutionally feasible, thereby increasing the City's water supply reliability and decreasing its demand for imported water.

## 1.3 Scope of Investigation

A prior Reclamation Feasibility Study, performed by Carollo (Carollo, 2005), found that the cost of treating and conveying recycled water to conventional direct reuse customers was too expensive. The Carollo investigation focused on the treatment and distribution costs associated with supplying recycled water for irrigation uses and limited groundwater recharge.

Since Carollo's investigation in 2004, the San Bernardino Valley Municipal Water District (Valley District) and the Western Municipal Water District (WMWD) have begun planning efforts for large-scale groundwater recharge projects as part of the Upper Santa Ana River Basin (USARB) Integrated Regional Water Management Plan (IRWMP). And, recently, the Valley District and the WMWD received a permit from the SWRCB to appropriate Santa Ana River water—most of which will be recharged in the SBBA. The Valley District and the WMWD intend to recharge imported SWP water and stormwater in several recharge basins



located within the SBMWD's service area. This new planned recharge could be used as a diluent supply to meet the blending requirements set in the CDPH Draft *Groundwater Recharge Reuse Regulations*. In addition to the planned recharge, the Valley District and the WMWD have commissioned a stormwater recharge enhancement study to identify opportunities throughout the SBBA to increase stormwater recharge. These projects, once implemented, will provide an additional diluent source to the basin.

In this investigation, a range of recycled water reuse alternatives were developed. These alternatives include various treatment technologies, conveyance schemes, and reuse. The hydrogeologic impacts and economic feasibility of these projects were evaluated. The SBMWD has named the project that will result from this investigation the Clean Water Factory (CWF). The CWF will treat effluent from the SBWRP to a quality approved for reuse and convey it to the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins for surface spreading, and to specific customers for direct use<sup>6</sup> applications. Figure 1-1 shows the locations of the spreading basins, potential direct use sites, the SBWRP, and the proposed recycled water distribution pipelines. Recycled water spread at the recharge facilities will recharge the Bunker Hill Basin and, more specifically, the Bunker Hill A Management Zone, as described in the Water Quality Control Plan for the Santa Ana River Watershed (Basin Plan). There are a large number of permutations of the proposed recycled water reuse project. The feasibility of a bounded group of treatment and reuse alternatives was explored. These alternatives are discussed later in this report.

On April 22, 2010, the SBMWD filed a Petition for Change, pursuant to Water Code Sections 461, 13500 et seq. and 13575 et seq., to reduce recycled water discharge from the RIX facility to the Santa Ana River. This petition requests permission to reduce the recycled water discharge at RIX from its current discharge of about 35.7 mgd (40,000 acre-ft/yr) to about 11.9 mgd (13,300 acre-ft/yr). At present, this would provide about 23.8 mgd (26,600 acre-ft/yr) of recycled water for reuse. By 2030, the volume of recycled water available for reuse could reach 30.6 mgd (34,300 acre-ft/yr). The recycled water project investigated herein would likely allocate recycled water reuse as follows: 14,500 acre-ft/yr for groundwater recharge to the Bunker Hill Basin, 3,100 acre-ft for direct use in the SBMWD service area, 10,000 acre-ft/yr for recycled water sales outside of the SBMWD service area, 13,300 acre-ft/yr for discharge to the Santa Ana River at RIX, and about 2,800 acre-ft/yr of brine disposal to the Santa Ana Regional Interceptor.

# 1.4 Investigation Area, Management Zones, and the San Bernardino Basin Area

The investigation area is the service area of the SBMWD. The SBMWD is located approximately 60 miles east of Los Angeles and approximately 110 miles north of San Diego and overlies portions of several groundwater basins, including the Bunker Hill, Lytle, Rialto,

<sup>&</sup>lt;sup>6</sup> These would primarily include irrigation uses but could include other non-potable uses.





and Colton Basins. Collectively, the Bunker Hill and Lytle Basins are known as the SBBA, a term coined in the Western San Bernardino Judgment.

The Santa Ana Regional Water Quality Board divided the groundwater resources of the Santa Ana Watershed into management zones<sup>7</sup> for water quality management, and these boundaries are slightly different for some groundwater basins. Figure 1-2 shows the location of the investigation area relative to the SBBA, and Figure 1-3 shows the investigation area relative to the Basin Plan management zones. The Bunker Hill Basin contains two management zones, Bunker Hill A and Bunker Hill B, and each has different water quality objectives for total dissolved solids (TDS) and nitrate.

The major spreading facilities in the investigation area include the Waterman Basins, the East Twin Creek Spreading Grounds, the Devil Canyon and Sweetwater Basins, and the Badger Basins. These facilities are located in the northern portion of the investigation area and upgradient of many SBMWD production wells. The SBWRP is adjacent to the Santa Ana River and located in the southern portion of the investigation area. These features are shown in Figure 1-3.

## 1.5 Report Organization

The objective of this report is to provide the SBMWD with information that they can use to assess the feasibility of recycled water reuse in their service area. As such, this report describes recycled water reuse alternatives, identifies the institutional and regulatory issues/challenges for each alternative, and evaluates their feasibility. This report is silent on implementation, as the SBMWD is independently developing an implementation plan. This report will be used as a basis for subsequent technical studies and environmental assessments. To accomplish these goals, the report was designed to cover a broad range of subjects and is divided into thirteen sections and three appendices, as follows:

Section 1 – Introduction: This section describes the project background, objective, and the scope of the investigation, and outlines the report.

Section 2 – Investigation Area: Section 2 describes investigation area characteristics that are pertinent to developing recycled water reuse projects. Moreover, this section briefly discusses the investigation area boundaries, geography and topography, geology and hydrogeology, hydrology, water quality, soil characteristics, land use and population projections, and the SBMWD's water demand plans.

Section 3 – Institutional and Regulatory Setting: Section 3 describes the federal, state, regional, and local agencies that will be involved or may be affected by the implementation of a reuse project, and the regulatory framework with which the proposed project alternatives will need to comply.



<sup>&</sup>lt;sup>7</sup> Board Resolution R8-2004-0001 (http://www.waterboards.ca.gov/santaana/board\_decisions/adopted\_orders/orders/2004/04\_001.pdf).

Section 4 – Current and Projected Water Supply Plans: Section 4 provides water demand and supply plans for the SBMWD and the surrounding water retail agencies and discusses how recycled water recharge can be used to augment water supplies from the Bunker Hill Basin.

Section 5 – Existing Recycled Water Management System: Section 5 describes the SBMWD's wastewater conveyance and treatment system.

Section 6 – Recycling Criteria: Section 6 describes the current recycling criteria, as required by the RWQCB and the CDPH, for planned recycled water recharge and direct use applications.

Section 7 – Treatment Alternatives: Section 7 describes an array of treatment processes that could be used to produce recycled water that meets the regulatory requirements for recycled water reuse. Section 7 also describes the comprehensive treatment alternatives formulated for the CWF.

Section 8 – Groundwater Recharge with Recycled Water. Section 8 describes the recycled water recharge opportunities at the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins; evaluates the facilities' recharge capacities for storm and supplemental water supplies; evaluates the conveyance facilities needed to move recycled water from the SBWRP to the recharge facilities; and describes the travel time and recycled water contribution at nearby wells related to the planned recharge of recycled water.

Section 9 – Direct Recycled Water Reuse Market Survey and Assessment: Section 9 describes the recycled water market for direct use within the SBMWD service area and evaluates the conveyance facilities needed to move recycled water from the SBWRP to selected direct use sites.

Section 10 – Marketing of Surplus Recycled Water. Section 10 describes the recycled water market outside of the SBMWD's service area and evaluates the conveyance facilities needed to move recycled water west from RIX to the Chino Basin.

Section 11 – Recycled Water Reuse Alternatives: Section 11 describes the proposed recycled water reuse alternatives for the CWF.

Section 12 – Assessment of the Recycled Water Reuse Alternatives: Section 12 provides a detailed feasibility assessment of the project alternatives. This assessment includes the operational and facility requirements for each alternative and associated cost opinions. This section also includes a description of the institutional and environmental issues related to implementing a project alternative.

Section 13 – References: Section 13 provides references for the data, computer codes, and modeling procedures used in this investigation.

Appendix A: Includes demand and supply plans for the retail water agencies that rely on the SBBA.

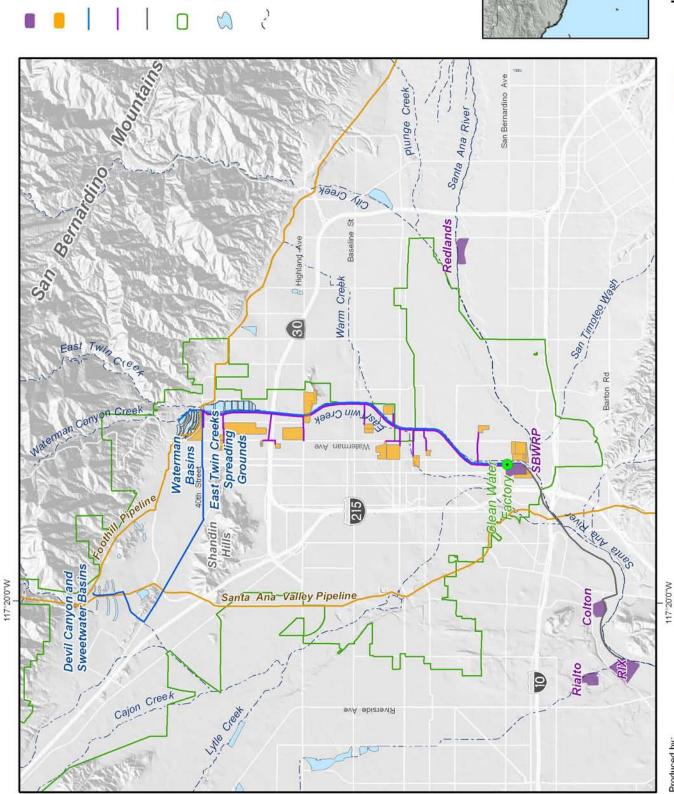
Appendix B: Includes Carollo's Final July 2010 Technical Memorandum No. 1, 2010 Recycled Water Feasibility Investigation, Recycled Water Alternatives Evaluation.



Appendix C: Includes projected time series plots of the recycled water contribution at wells downgradient of the recharge facilities.







Existing Pipeline from SBWRP to RIX

Proposed Direct Use Pipelines

Proposed Recharge Pipelines

Water Reclamation Facility

Potential Direct Use Sites

San Bernardino Municipal Water Department Service Area

San Bernardino County Flood Control District Recharge Facilities

Streams, Rivers, and Flood Control Channels

San Bernardino Riverside County County © San Orange County

Location of Clean Water Factory and Related Facilities

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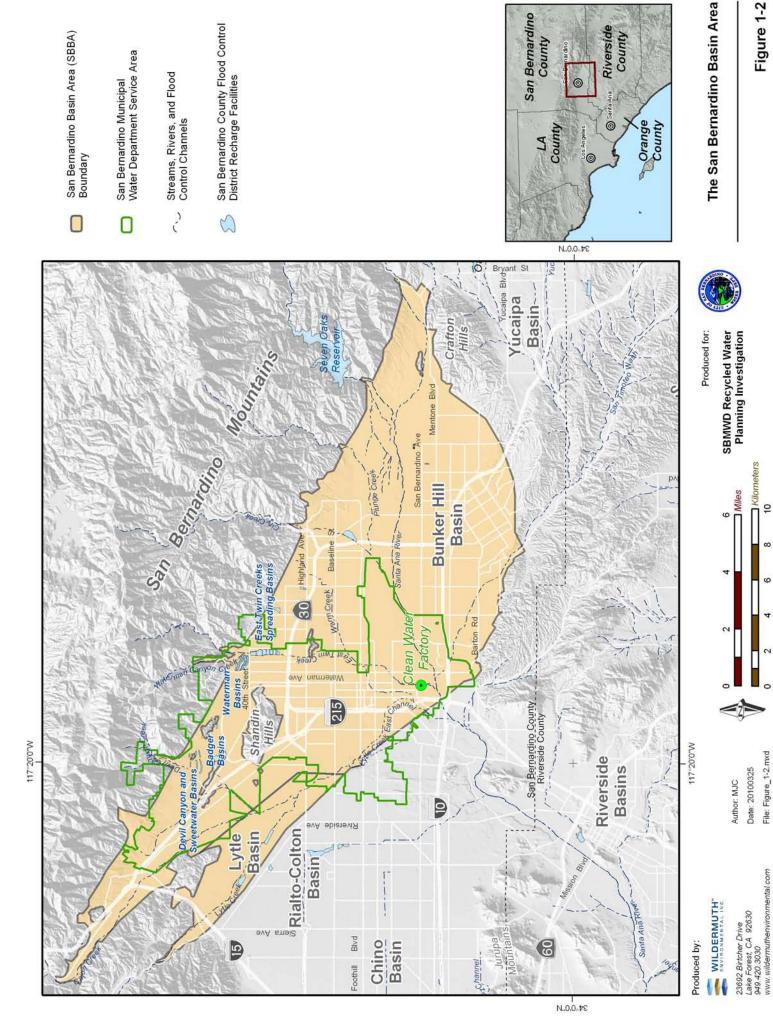
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Author: MJC

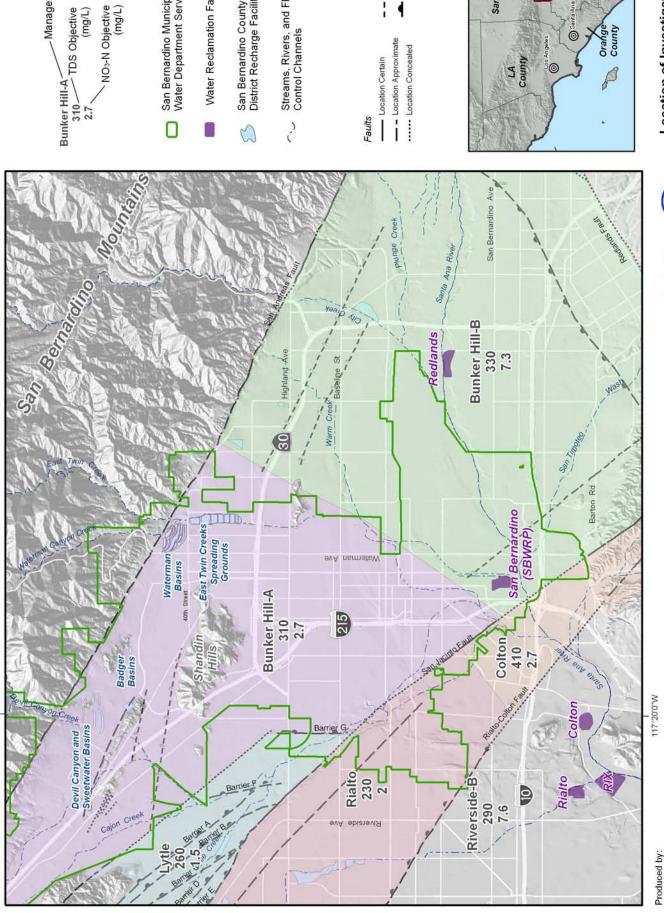
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Approximate Location of Groundwater Barrier - - -?- Location Uncertain

San Bernardino County Flood Control District Recharge Facilities

Streams, Rivers, and Flood Control Channels

San Bernardino Municipal Water Department Service Area

NO3-N Objective (mg/L)

Water Reclamation Facility

Management Zone

117°20'0"W

RWQCB Basin Plan Management Zones Location of Investigation Area and

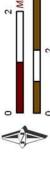
Riverside

County

San Bernardino County

County







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#### 2.1 Geography and Topography

The investigation area covers approximately 45 square miles within the SBBA, which is located in the southwest portion of San Bernardino County along the foothills of the San Bernardino Mountains. The main features of the investigation area are shown in Figure 2-1 and include artificial recharge sites in the north and the SBWRP in the south.

The investigation area overlies a sloping alluvial plain interrupted with bedrock outcrops and hills. The topographic elevation ranges from about 2,100 feet above mean sea level (ft-msl) at the foothills of the San Bernardino Mountains to about 1,000 ft-msl near the SBWRP. The Santa Ana River is the main trunk stream that drains the SBBA. Other major tributaries include Lytle Creek, Cajon Creek, East Twin Creek, Warm Creek, City Creek, Mill Creek, and San Timoteo Creek.

#### 2.2 Geology and Hydrogeology

The SBBA and the investigation area overlie part of a large, broad, alluvial-filled basin, located between the San Gabriel/San Bernardino Mountains to the north and the elevated Perris Block/San Jacinto Mountains to the south. Sediments eroded from igneous and metamorphic rocks within the surrounding mountains have filled this basin to provide reservoirs for groundwater.

Faults and consolidated bedrock form the boundaries and effective base of the groundwater reservoirs within the SBBA. The San Andres Fault is the northern boundary of the SBBA and separates the groundwater basin from the consolidated bedrock of the San Bernardino Mountains. To the south, the San Jacinto Fault cuts through the alluvium to form a major barrier to groundwater flow and, hence, separates the SBBA from the Rialto-Colton Groundwater Basin to the southwest. The Loma Linda Fault is a major internal groundwater barrier that strikes northwest across the SBBA and sub-divides the SBBA into the main Bunker Hill Basin and the smaller Lytle Creek Basin. Other internal faults within the SBBA vary in their effectiveness as barriers to groundwater flow. All of these faults, their effects on groundwater movement, and groundwater movement in general have been studied in detail by the USGS and DWR (Eckis, 1934; Gleason, 1947; Burnham & Dutcher, 1960; Dutcher & Garrett, 1963; Dutcher & Fenzel, 1972; Izbicki et al., 1998) and, more recently, by others (WEI, 2000; GSS and Stantec, 2009).

Predominant recharge to the SBBA groundwater basins is from the infiltration of stream flow out of the San Gabriel and San Bernardino Mountains, the artificial recharge of native and imported waters, and irrigation returns. In general, groundwater flow mimics surface drainage patterns: from the areas of recharge at the apexes of alluvial cones along the mountain fronts towards the area of discharge where groundwater leaks across the San Jacinto Fault in the vicinity of the Santa Ana River. Figure 2-1 shows groundwater elevation contours for Fall 2006, which depict this general groundwater flow pattern. Note that groundwater flow paths



(perpendicular to the contours) start in the various areas of recharge and converge upon the main area of natural discharge where the Santa Ana River crosses the San Jacinto Fault.

This "convergence zone" (commonly referred to as the Pressure Zone) is a historical area of flowing artesian wells and rising groundwater within streambeds. Dutcher & Garrett (1963) delineated the Pressure Zone as the "original limit of flowing wells." The Pressure Zone also coincides with the deepest (~1,500 ft) and most geologically stratified portion of the basin. Dutcher & Garrett (1963) developed a six-layer representation of the water-bearing and confining sedimentary units underlying this area, which has since served as the conceptual model of the Bunker Hill Basin (WEI, 2000; GSS and Stantec, 2009). Upgradient of the Pressure Zone in the forebay areas of the Bunker Hill Basin, the groundwater system is generally unconfined. Within the Pressure Zone, the groundwater system is generally confined—especially within the deeper layers of the aquifer system (Dutcher & Garrett, 1963).

The hydrogeologic characteristics of the Bunker Hill Basin are important in the context of the proposed recycled water use project because most of the recycled water will be recharged into the groundwater system for subsequent treatment, storage, recovery, and use as a potable supply. The hydrogeology, coupled with recharge and discharge stresses, will control the treatment and dilution of the recycled water in the aquifer system, the direction and speed of the transport of recycled water, how long the recycled water is stored prior to use, and the recycled water recharge impacts on groundwater levels and on the speed and direction of the groundwater contaminant plumes.

#### 2.3 Hydrology

The SBMWD is located in a region of both semi-arid and Mediterranean climates. The types of storms that affect the region are generally winter storms, local storms, and summer storms (Danskin, 2005). Figure 2-2 illustrates the annual precipitation time history and the cumulative departure from the mean (CDFM) precipitation at the San Bernardino Hospital precipitation station for the 1900 to 2008 period. The CDFM plot is useful in characterizing wet and dry climatic periods. Negatively sloped line segments indicate periods with below mean precipitation (dry periods), whereas positively sloped line segments indicate periods with above mean precipitation (wet periods). For example, in Figure 2-2, the period from 1935 to 1946 was a wet period, and the period from 1947 to 1977 was a dry period. Table 2-1 characterizes the dry and wet periods illustrated in Figure 2-2 along with similar assessments for precipitation stations in Ontario and Montclair. Review of the precipitation time series data indicates the following for the 1900 through 2008 period:

- The long-term annual precipitation for the San Bernardino Hospital station is 16.4 inches (1900 through 2008).
- The average annual precipitation over the valley floor for the ten-year period of 1999 through 2008 is about 12 to 27 percent below the long-term average precipitation.
- In comparison to the five dry periods identified in the 109-year precipitation time history, the 1999 through 2008 dry period, for two of the precipitation stations, is either the driest or second driest period of record.



• The fraction of dry precipitation years for the period of 1900 through 2008 is about 56 percent or almost six out of ten years. For the ten-year period of 1999 through 2008, the fraction of dry precipitation years is about 70 to 80 percent or seven to eight out of ten years.

The last ten years were drier than normal and may in fact be very dry when compared to the last 100 years. Dry years and, more specifically, dry periods contribute to lower than expected surface water discharge. Dry periods also contribute to lower than expected recharge from precipitation over the valley floor and surface water recharge in unlined channels and spreading basins, which contribute to lower groundwater levels. Groundwater production generally increases during dry periods as there is less surface water available for diversion.

The hydrologic characteristics of the Bunker Hill Basin are important in the context of the proposed recycled water reuse project because most of the recycled water will be recharged into the groundwater system at spreading basins that receive stormwater; thus, there is a potential conflict in the use of the same facilities. Stormwater is also a source of dilution, so the magnitude and occurrence of stormwater recharge may partially control the amount of recycled water that can be recharged.

#### 2.4 Water Quality Anomalies

Groundwater in the investigation area is generally of excellent mineral quality with total dissolved solids (TDS) averaging less than 350 milligrams per liter (mg/l) and nitrate as nitrogen concentrations averaging less the primary maximum contaminant level for drinking water. Figure 2-4a shows the maximum TDS concentration in local wells for the period of 2005 to 2009. Figure 2-4b shows the maximum nitrate as nitrogen concentration in local wells for the period of 2005 to 2009. Nevertheless, parts of the Bunker Hill Basin have been significantly impacted by the presence of contaminant plumes that contain volatile organic compounds, mainly trichloroethylene (TCE), perchloroethylene (PCE), and other chlorinated solvents (CDM, 2007). As shown in Figure 2-3, the basin contains five major groundwater contaminant plumes: the Muscoy and Newmark plumes near the Shandon Hills, which contain TCE and PCE; the Santa Fe plume, which contains PCE, TCE, and 1,2 dichloroethylene (1,2-DCE); the Norton Air Force Base plume, which contains TCE and PCE; and the Crafton-Redlands plume, which contains TCE, lower levels of PCE, and perchlorate. Dibromochloropropane (DBCP) has also been found in the vicinity of the Crafton-Redlands plume. The Santa Fe, Norton Air Force Base, and Crafton-Redlands plumes are located in the southern portion of the investigation area and downgradient from planned recycled water reuse areas. The Muscoy and Newmark plumes are adjacent to the recharge facilities that were evaluated in this investigation.

The addition of a new large slug of water could increase groundwater levels and subsequently mobilize contaminants in the vadose zone and alter the direction of contaminant plumes, the latter of which could be detrimental. A Consent Decree (Decree) among the US Environmental Protection Agency, the US Department of the Army, the City of San Bernardino, and the California Department of Toxic Substances Control settled a lawsuit filed



by the City of San Bernardino against the Department of Defense. The Decree, among other things, requires the City of San Bernardino to develop a groundwater management and permit program for an area that is a subset of the SBMWD service area (management area) to ensure the integrity and effectiveness of the interim remedial action implemented at the Newmark Groundwater Contamination Superfund Site. Accordingly, the City adopted a Municipal Ordinance on March 20 2006, Ordinance No. MC-1221, entitled "Spreading or Extraction within the Management Zone." On June 30, 2010, the City entered into the Institutional Controls Groundwater Management Program (ICGMP) Agreement with the Valley District, West Valley Water District, East Valley Water District, Riverside Highland Water Company, the City of Riverside, the City of Colton, and Western Municipal Water District. The ICGMP effectively replaced the provisions of the Municipal Ordinance adopted by the City and is the agreement by which the groundwater management and permit program is administered. The ICGMP regulates groundwater production and spreading within the management area.

Due to the proximity of planned recycled water recharge to the Muscoy and Newmark plumes, the Decree requires that potential impacts to the remediation be evaluated. The Newmark Groundwater Flow Model (developed by the SBMWD) and the San Bernardino Basin Groundwater Model (jointly owned by the SBMWD and the Valley District) are the most current models available for this area. The latter model was used along with planning data provided by the SBMWD and Valley District to prepare a reconnaissance-level assessment of the effects of the proposed recycled water recharge project. This assessment is discussed in Section 8.

#### 2.5 Soils and Infiltration Rates

The soils underlying and surrounding the recharge facilities were investigated for properties that control infiltration rates. These properties were assessed from the review of hydrologic soil type delineations by the Soil Conservation Service (SCS). The soil surveys for the investigation area are contained in *Soil Survey of San Bernardino County, Southwestern Part* (SCS, 1977). Figure 2-5 shows the spatial distribution of the hydrologic soil types and describes the SCS soil classifications as they relate to runoff potential. The artificial recharge sites evaluated in this investigation are located in soil Type A, meaning the top 5 feet of soil are estimated to have high infiltration rates even when thoroughly wetted. These facilities have been excavated to depths greater than 5 feet, so the SCS classification may not strictly apply. That said, other similar facilities located high on the alluvial fans of the San Bernardino and San Gabriel Mountains generally have sustainable infiltration rates between 1 to 2 feet per day, and those rates were assumed herein.

#### 2.6 Current and Future Land Uses

The 2005 General Plan for the City of San Bernardino shows five land use categories: commercial, industrial, public, open space, and residential. Public land uses include government facilities, parks, and flood protection. Open spaces encompass all undeveloped land use categories, including those zoned for commercial/industrial, residential, and public uses. For this investigation, commercial and industrial land uses were combined. Figure 2-6



shows current (2006) land uses in the City of San Bernardino. Ultimate land use descriptions for the investigation area were not available for incorporation in this investigation. The recharge facilities that would be used for the proposed recharge project are currently in public ownership, and no land use changes would be required. Improvements at the SBWRP would all be constructed on existing SBMWD property. The pipelines used to convey treated recycled water to the recharge sites and direct use sites will be located in public easements with only minor interference to private land.

#### 2.7 Current and Future Population Projections

Population projections were obtained for the City of San Bernardino, using tract-level census data from the Southern California Association of Governments. This data was developed for the 2004 Regional Transportation Plan. Based on a GIS analysis that compared the boundaries of the City of San Bernardino versus those of the SBMWD, it was determined that approximately eighty-seven percent of the City's population is served by the SBMWD. And, the population served by the SBMWD is expected to grow from about 176,000 in 2010 to nearly 187,000 in 2030, which corresponds to an average annual growth rate of approximately 0.3 percent over the next two decades. The change in population over the investigation period is expected to impact water use and wastewater generation.

#### 2.8 Current and Future Water Demands

The SBMWD delivers water to over 40,000 accounts within and outside of the City's limits, using 550 miles of water mains. The water demand of the SBMWD service area is projected to be approximately 54,800 acre-ft/yr in 2010 and is estimated to grow to over 77,000 acre-ft/yr by 2030. In the *San Bernardino Water Master Plan* (CDM, 2007), the ultimate water demand for the SBMWD service area is projected to reach about 79,000 acre-ft/yr; though, this 2007 projection is probably high given the recent passage of SB-7 in November 2009, which requires a reduction in per capita potable demand of 10 percent by 2015 and 20 percent by 2020. The projected water demands that were used in this investigation are discussed in Section 4, Water Demands and Supply Plan Projections.



Table 2-1
Annual Statistics of Long-Term Records at Precipitation Stations in / near the SBBA (inches)

Area	San Bernardino Hospital	Montclair/ Claremont	Ontario
Period of Record	1900 to 2008	1900 to 2008	1914 to 2008
Annual Average	16.36	17.78	15.38
Maximum	35.65	37.58	37.41
Minimum	5.95	5.39	3.84
Standard Deviation	6.83	7.66	7.05
Mean + 1 Standard Deviation	23.19	25.44	22.43
Coefficient of variation	42%	43%	46%

## Geology

117°20'0"W

Nater-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Plio-Pleistocene Sedimentary Rocks

Pre-Tertiary Igneous and Metamorphic Rocks

Location Certain

Location Approximate Location Concealed

Location Uncertain

Groundwater Barrier

## Other Features

San Bernardino Municipal Water Department Service Area

Fall 2006 Groundwater Elevation Contours (feet above mean sea-level)

Bunker Hill Pressure Zone

Water Reclamation Facility

San Bernardino County Flood Control District Recharge Facilities

Streams, Rivers, and Flood Control Channels

Precipitation Gauge Station



## and Groundwater Elevations Generalized Geology

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117°20'W

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Miles

SBMWD Recycled Water Planning Investigation

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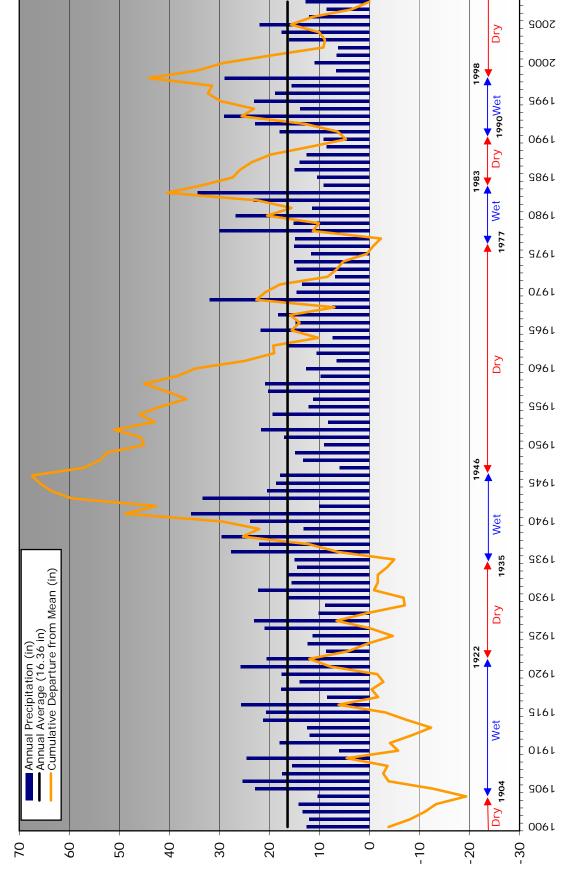
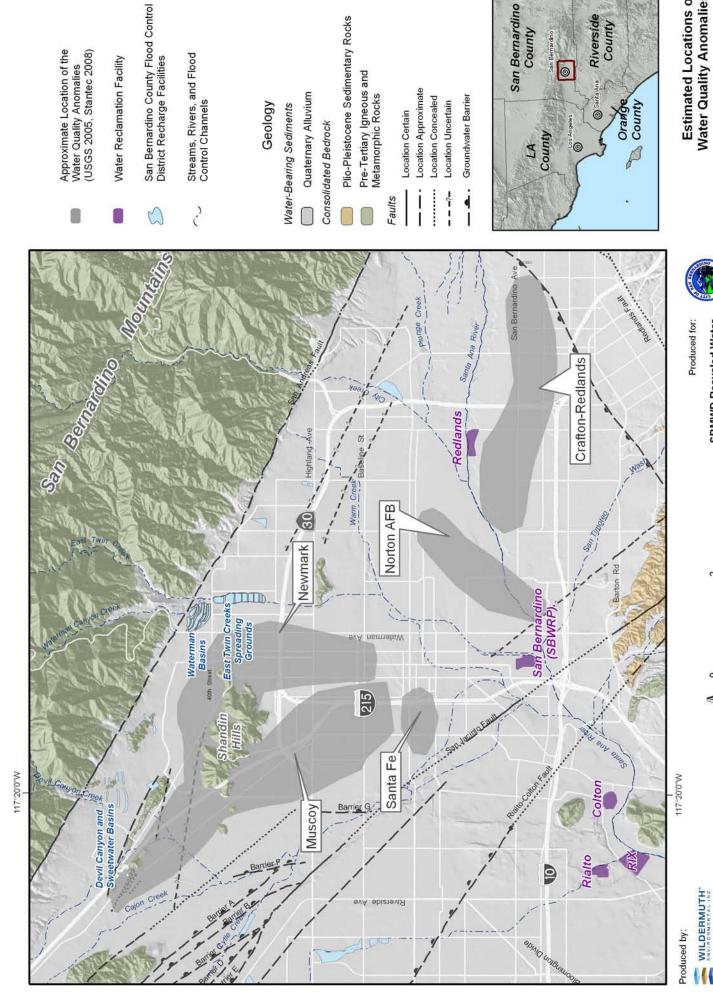


Figure 2-2 San Bernardino Hospital Gauge Annual Precipitation

Figure\_2-2.xls -- SB\_Hospital\_Chart-fig2-2 8/10/2010





**Estimated Locations of** Water Quality Anomalies

San Bernardino County

LA County

Location Approximate

Location Certain

Geology

Location Concealed

Location Uncertain

Groundwater Barrier

0

County Riverside

County County

Orange

SBMWD Recycled Water Planning Investigation





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Total Dissolved Solids (mg/L)

117°20'0"W

< 125

125 - 250

250 - 500

1,000 - 2,000 500 - 1,000

> 2,000

Secondary US EPA MCL = 500 mg/L

Water Reclamation Facility

San Bernardino County Flood Control District Recharge Facilities

Streams, Rivers, and Flood Control Channels (

Faults

Location Certain

- - Location Approximate

Approximate Location of Groundwater Barrier - - -?- Location Uncertain



Total Dissolved Solids in Groundwater Maximum Concentration 2005 - 2009

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Rialto

Riverside-B

9

117°20'0"W

Figure 2-4b

SBMWD Recycled Water Planning Investigation

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### San Bernardino Ave Baseline St 30 Grounds San Bernardino (SBWRP) Waterr Basins 9 Basins Sweetwater Ba Devil Canyo 215 San Bernardino County Riverside County 9

# Soil Conservation Service (SCS) Types

Low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

moderately coarse textures. These soils have moderately deep to deep, moderately well to Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of well drained soils with moderately fine to a moderate rate of water transmission. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer soils with moderately fine to fine texture. These that impedes downward movement of water, or soils have a slow rate of water transmission. O

surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the transmission. 

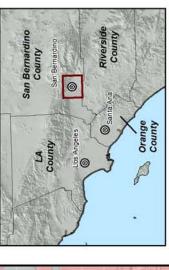
## Other Features

SBMIWD Service Area



Flood Control/Conservation Basins

Streams, Rivers, and Channels



## SCS Hydrologic Soil Types

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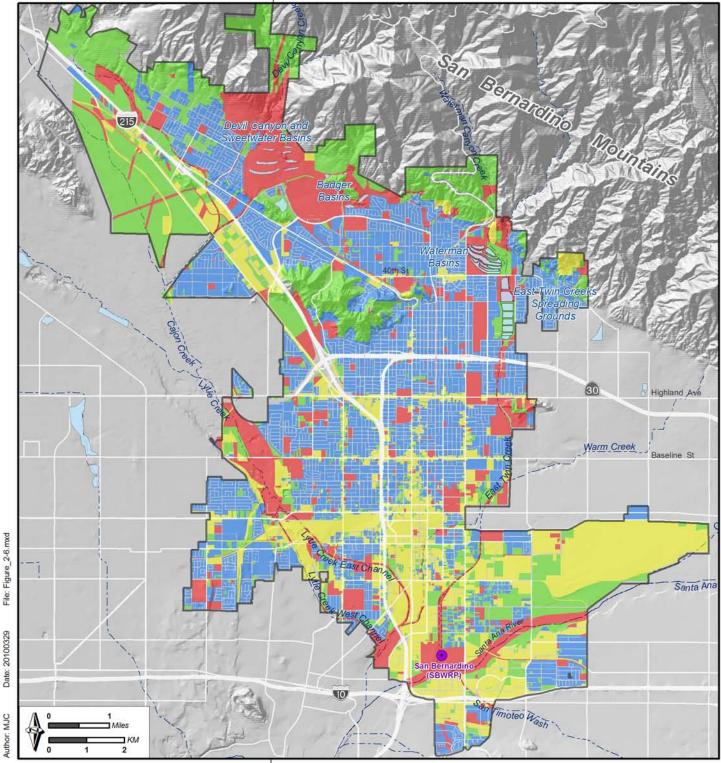
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SBMWD Recycled Water Planning Investigation

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#### 2006 Land Uses

Undeveloped

Commercial/Industrial

Public

Residential



Streams, Rivers, and Channels

Flood Control/Conservation Basins



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San Bernardino

County

Riverside

County

County

Orange County

⊚<sub>Santa</sub> A



#### **Section 3 - Institutional and Regulatory Setting**

#### 3.1 Existing Political Jurisdictions

The SBMWD operates under the jurisdiction of federal, state, and regional agencies. The roles of these agencies in managing the water resources of the investigation area are briefly discussed below.

#### 3.1.1 Federal Agencies

The Federal Government develops regulations and enforces laws to protect life and the natural resources of the United States. The two main federal agencies involved in the SBMWD's current and future operations are the Environmental Protection Agency (EPA) and the US Fish and Wildlife Service (USFWS).

#### 3.1.1.1 Environmental Protection Agency

The EPA is a federal agency whose primary mission is to protect human health and to safeguard the natural environment—air, water, and land—upon which life depends. The EPA is responsible for enforcing and assuring compliance with environmental regulations and may delegate this responsibility to state and tribal governments.

The principal authority for the EPA's water programs was established by the 1986 amendments to the Safe Drinking Water Act and the 1987 amendments to the Clean Water Act (CWA). The objective of the federal CWA is to "restore and maintain the chemical, physical and biological integrity of the Nation's waters," and to make US waters "fishable and swimmable." The CWA also sets specific requirements for states. For example, the CWA requires states (1) to adopt water quality standards, including standards for toxic substances, and (2) to have a continuing planning process that includes public hearings at least once every three years to review and, if necessary, revise the water quality standards.

The EPA is integral in shaping water quality policy in the investigation area. In 2004, it worked closely with the SBMWD to develop guidelines to manage and mitigate the Newmark and Muscoy contamination plumes. The Consent Decree obligates the SBMWD to operate and maintain a system of wells and treatment plants known as the Newmark Groundwater Contamination Superfund Site (Newmark Site). The Newmark Site specifically treats groundwater contaminated with trichloroethylene (TCE) and perchloroethylene (PCE). The SBMWD is required by the terms of the Consent Decree, entered on March 23, 2005, to enact institutional controls and implement a groundwater management and permit program.

The EPA also reviews and approves the discharge permit that governs the discharge of treated wastewater from the SBWRP to the Santa Ana River and discharge from the RIX facility to the Santa Ana River.



#### 3.1.1.2 US Fish and Wildlife Service

The USFWS is a bureau within the Department of the Interior. Its mission is to work with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. It assists in the development and application of an environmental stewardship ethic for our society, based on ecological principles, scientific knowledge of fish and wildlife, and a sense of moral responsibility. It enforces Federal wildlife laws, protects endangered species, manages migratory birds, restores nationally significant fisheries, conserves and restores wildlife habitat (e.g. wetlands), helps foreign governments with international conservation efforts, and distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies through a federal aid program.

The USFWS also reviews and comments on all environmental documents that are prepared for projects that apply for federal funding and that have the potential to impact federally listed endangered species.

#### 3.1.2 State Agencies

State agencies develop regulations and enforce both state and federal laws. The state agencies that are currently involved in SBMWD's operations, or would be involved after the implementation of recycled water reuse, are the State Water Resources Control Board (SWRCB), the Santa Ana Regional Water Quality Control Board (SARWQCB), the California Department of Public Health (CDPH), and the California Department of Fish and Game (CDFG).

#### 3.1.2.1 State Water Resources Control Board

The SWRCB was created by the State Legislature in 1967. The joint authority of water allocation and water quality protection enables the SWRCB to provide comprehensive protection for California's waters. The SWRCB allocates water rights, adjudicates water right disputes, develops statewide water protection plans, establishes water quality standards, and guides the nine Regional Water Quality Control Boards (RWQCBs) located in the major watersheds of the state.

The RWQCBs serve as the frontline for state and federal water pollution control efforts, and they develop and enforce water quality objectives and implementation plans that will best protect the state's waters, recognizing local differences in climate, topography, geology, and hydrology. In this project, the SWRCB will act primarily through the SARWQCB with the exception of the Petition for Change application to reduce the discharge of effluent from the RIX facility to the Santa Ana River.

The SWRCB offers financial assistance programs that provide loan and grant funding for the construction of municipal sewage and water recycling facilities, the remediation of underground storage tank releases, watershed protection projects, and nonpoint source



pollution control projects. And, the SWRCB administers the distribution of federal stimulus funds for California.

#### 3.1.2.2 Santa Ana Regional Water Quality Control Board

Geographically, the SARWQCB is the smallest of the nine RWQCBs. The region contains a wide variety of water resources, including mountain streams and lakes, coastal estuaries and beaches, effluent-dominated rivers, and intensively used and managed groundwater basins. The Santa Ana region upstream of Prado Dam is shown in Figure 3-1 along with the groundwater management zones, surface water bodies, and the locations of wastewater treatment plants that discharge to surface water. The SARWQCB manages a variety of programs to protect water quality and beneficial uses.

Currently, the SBWMD operates under four SARWQCB discharge orders:

- Order No. R8-2009-0004 (NPDES No. CAG648001) is a general WDR for discharges to surface waters of process wastewater associated with certain wellhead treatment systems.
- Order No. R8-2008-0007 (NPDES No. CA8000015) is a WDR for discharges to Lytle Creek, East Twin Creek, and Warm Creek channels from its Geothermal Facility.
- Order No. R8-2006-0052 (NPDES No. CA8000304) is a Waste Discharge and Producer/User Reclamation Requirements permit for discharges to the Santa Ana River from its RIX facility.
- Order No. R8-2005-0074 (NPDES No. CA0105392) is a WDR for discharges to the Santa Ana River from its SBWRP.

The SBMWD will require a permit from the SARWQCB to implement the proposed recycled water project. This permit will include requirements from the Department of Public Health and compliance with the Santa Ana Watershed Water Quality Control Plan (Basin Plan). These requirements are discussed in Section 6.

#### 3.1.2.3 California Department of Public Health

The CDPH is dedicated to optimizing the health and well-being of the people of California. The division of the CDPH most relevant to this investigation is the Division of Drinking Water and Environmental Management (DDWEM). Within the DDWEM, the Drinking Water Program (DWP) regulates public water systems. The primary goal of the DWP is to assure that all Californians are, to the extent possible, provided a reliable supply of safe drinking water. The DWP continues to subscribe to the basic principle that only the best quality sources of water reasonably available to a water utility should be used for drinking. Whenever possible, lower quality source waters should be used for non-potable uses, such as irrigation, recreation, or industrial uses, which pose lower health risks. The DWP consists of three branches: (1) the Northern California Field Operations Branch, (2) the Southern California Field Operations Branch. The field operation branches are responsible for the enforcement of the Federal and California Safe



Drinking Water Acts and the regulatory oversight of approximately 7,500 public water systems to assure the delivery of safe drinking water to all Californians. The Technical Programs Branch is responsible for maintaining the scientific expertise of the Drinking Water Program and for administering the Safe Drinking Water State Revolving Fund and the Small Water Systems Program. The Technical Programs Branch also develops water recycling criteria and regulations. On August 5, 2008, the CDPH released its latest *Draft Groundwater Recharge Reuse Regulations*, which describes the requirements for planned recycled water recharge. The CDPH also evaluates recycled water reuse projects and makes recommendations to the Regional Boards regarding implications, if any, to public health.

The CDPH's role in the proposed recycled water recharge project will be to review reports that pertain to the proposed project, conduct public hearings, and prepare findings of fact and direction to the SARWQCB regarding the contents of the permit issued to the SBMWD for recycled water reuse. This process is described further in Section 6.

#### 3.1.2.4 California Department of Fish and Game

The CDFG is responsible for the environmental review and permitting of the following programs: the California Endangered Species Act, the California Environmental Quality Act (CEQA), the Lake and Streambed Alteration Program, and the Timberland Conservation Program. The CDFG will review all projects that require a CEQA evaluation.

#### 3.1.3 Regional Water Agencies

There are five regional agencies involved in local water resources management in the Bunker Hill Basin and the investigation area: the Valley District, the San Bernardino Valley Water Conservation District (SBVWCD), the San Bernardino County Flood Control District (SBCFCD), the WMWD, and the Santa Ana Watershed Project Authority (SAWPA).

#### 3.1.3.1 San Bernardino Valley Municipal Water District

The Valley District was formed in 1954 and is responsible for long-range water supply planning, which includes groundwater and importing supplies within its boundaries. It fulfills its responsibilities in a variety of ways, including importing SWP water for direct delivery and groundwater recharge and coordinating water deliveries to retail agencies throughout its service area. The Valley District's service area overlies approximately 325 square miles and includes most of the San Bernardino Valley and a portion of the Yucaipa Valley (See Figure 3-2). The Valley District overlies the communities of San Bernardino, Colton, Loma Linda, Redlands, Rialto, Bloomington, Highland, East Highland, Mentone, Grand Terrace, and Yucaipa.

The Valley District's chief engineer is a member of the Santa Ana River Watermaster and the Western San Bernardino Watermaster. These watermasters were created as part of the settlements in the two water right adjudications that resolved water rights to the Santa Ana River and groundwater for a large area upstream of the Riverside Narrows, respectively.



The SBMWD and the Valley District will need to coordinate the operation of recharge facilities in the Bunker Hill Basin to ensure a balance of recharge and discharge in the groundwater basin and to ensure that enough dilution water is made available to maximize the recharge of recycled water. The Valley District has developed recharge plans for the future, and these plans were reviewed in this feasibility investigation. This review, which is discussed in Section 8, indicated that the SBMWD and the Valley District can both use the recharge facilities without significant interference and to the enhancement of the water resources of the Bunker Hill Basin.

#### 3.1.3.2 San Bernardino Valley Water Conservation District

The mission of the SBVWCD is to ensure that the recharge of the Bunker Hill Groundwater Basin is accomplished in an environmentally and economically responsible way, using local native surface water to the maximum extent practicable.

The SBVWCD and its predecessors have conducted groundwater recharge activities since 1912 or earlier in two areas that overlie the Bunker Hill Basin: at the upper end of the Santa Ana River wash area and on Mill Creek just upstream of its confluence with the Santa Ana River. Figure 3-2 shows the SBVWCD's facilities. The SBVWCD diverts surface water discharge, including stormwater runoff and base flow, from the Santa Ana River and Mill Creek and conveys that water to two separate recharge facilities where it infiltrates into the Bunker Hill Basin.

The SBVWCD is required to produce an annual engineering investigation and report on groundwater conditions so it can levy a groundwater charge. The SBVWCD's boundaries encompass about 78 square miles and include portions of the communities of San Bernardino, Loma Linda, Redlands, and Highland, as well as the unincorporated county area of Mentone and various county "islands" within the incorporated cities. The SBVWCD does not have a role in the proposed recycled water recharge project.

#### 3.1.3.3 San Bernardino County Flood Control District

The SBCFCD's functions include flood protection from major streams, flood control planning, storm drain management, debris removal programs, water conservation, right-of-way acquisitions, flood hazard investigations, and flood operations. The SBCFCD has numerous Master Plans of Drainage for various areas within the county and has developed an extensive system of flood control and water conservation facilities, including dams, conservation basins, debris basins, channels, and storm drains. Historically, these facilities have been used primarily to intercept and convey flood flows through and away from developed areas of the County. Secondary benefits of these facilities include water conservation and improved water quality. The SBCFCD service area is divided into 6 zones. Nearly all of the SBMWD's service area is located in Zone 2 of the SBCFCD service area except for a small portion east of the SBWRP, which is located in Zone 3.

The SBCFCD owns and operates the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins, among others, and has partnered with



the Valley District to use these facilities for the recharge of imported water. Similarly, these facilities could be used to recharge recycled water from the CWF. Section 8 of this report analyzes the amount of supplemental water that could be recharged at these facilities without interference to flood control function. Ultimately, an agreement between the SBCFCD and the SBMWD that defines the operational requirements will have to be developed and executed. The Chino Basin Watermaster and IEUA have such an agreement with SBCFCD to spread tertiary treated recycled water at recharge facilities in the Chino Basin area.

#### 3.1.3.4 Western Municipal Water District

The WMWD was formed by vote in 1954 to bring supplemental water to growing western Riverside County. At present, the WMWD serves roughly 24,000 retail and 8 wholesale customers with Colorado River water, SWP water, and groundwater. The WMWD's general manager is a member of the Santa Ana River Watermaster and the Western San Bernardino Watermaster. These watermasters were created as part of the settlements in the two water right adjudications that resolved water rights to the Santa Ana River and groundwater for a large area upstream of the Riverside Narrows. The WMWD does not currently have role in the proposed recycled water project. The implementation of the proposed recycled water recharge project will reduce the discharge of recycled water at the RIX facility and subsequently reduce the recharge of RIX effluent into the Riverside and Chino Groundwater Basins. Thus, there may be less groundwater available to retail water agencies that pump groundwater from these basins and an increase in demand for supplemental water from the WMWD.

#### 3.1.3.5 Santa Ana Watershed Project Authority

SAWPA was formed in 1968 as a planning agency and reformed in 1972 with a mission to plan and build facilities to protect the water quality of the Santa Ana River Watershed. SAWPA is a Joint Powers Authority, classified as a Special District (government agency) in which it carries out functions that are useful to its member agencies, including the Eastern Municipal Water District, the Inland Empire Utilities Agency (IEUA), the Orange County Water District (OCWD), the Valley District, and the WMWD.

SAWPA lead the design and construction of the eastern reaches of the Santa Ana Regional Interceptor (SARI) Line, shown in Figure 3-2. The SARI is a regional brine line that was designed to convey 30 mgd of non-reclaimable wastewater from the upper Santa Ana River Watershed for treatment at the Orange County Sanitation District and ultimately discharge to the ocean. The non-reclaimable wastewater consists of brines from groundwater desalters and small amounts of municipal and industrial wastewater. The SARI was built to reduce salt accumulation in the groundwater basins upstream of Prado Dam.

The SBMWD currently owns about 2.5 mgd of capacity in the SARI. The proposed recycled water recharge project will use this capacity in the SARI to dispose of brine created in the treatment process.



#### 3.2 Water Rights

Both surface water rights on the Santa Ana River and groundwater pumping rights in the upper Santa Ana River Watershed (i.e. above Prado Dam) have been the subject of a number of court judgments. These judgments provide the overall framework for the division of rights and responsibilities for water users in the upper Santa Ana River Watershed.

#### 3.2.1 Santa Ana River Water Rights (OCWD vs. City of Chino, et al., Case No. 117628)

In 1963, the OCWD began litigation to adjudicate water rights on the Santa Ana River. The lawsuit was filed against essentially all water users in the upper Santa Ana River Watershed. In the ensuing cross complaints, the adjudication of water rights was extended to substantially all water users downstream of Prado Dam. Eventually, over the course of the adjudication proceedings, the number of parties was reduced to four regional water agencies: the OCWD, the Chino Basin Municipal Water District, the WMWD, and the Valley District. These agencies developed a settlement that was approved by the Orange County Superior Court on April 17, 1969 (Orange County Judgment). The Orange County Judgment imposes a physical solution that requires parties in the upper Santa Ana River Watershed to deliver a minimum quantity of water to specific points on the River: Riverside Narrows and Prado Dam. This was the first comprehensive adjudication in Southern California in which the quality of water was taken into consideration in the quantification of water rights. A provision of the Orange County Judgment, related to conservation, establishes that once flow requirements are met, the upper area parties "[...] may engage in unlimited water conservation activities, including spreading, impounding, and other methods, in the area above Prado reservoir." The Orange County Judgment is administered by the five-member Santa Ana River Watermaster (one member each from the Valley District, the WMWD, and the IEUA, and two members from The Santa Ana River Watermaster reports to the court and the four the OCWD). representative agencies annually.

The Valley District's obligation for discharge at the Riverside Narrows reads as follows:

"5 (a) General Format. In general outline, SBVMWD (Valley Water District) shall be responsible of the delivery of an average annual amount of Base Flow at Riverside Narrows. CBMWD (IEUA) and WMWD shall jointly be responsible for an average annual amount of Base Flow at Prado."

"Base Flow" is a defined term in the Orange County Judgment and means the total surface flow passing a point of measurement (Riverside Narrows and Prado) that remains after the deduction of storm flow.<sup>10</sup>



<sup>&</sup>lt;sup>8</sup> OCWD vs. City of Chino et al., Orange County Superior Court Case 117628, Judgment, Paragraph 4, Declaration of Rights.

<sup>&</sup>lt;sup>9</sup> Ibid, Paragraph 5a.

<sup>&</sup>lt;sup>10</sup> Ibid, Paragraph 3 Definitions

- "5 (b) Obligation of SBVMWD. SBVMWD shall be responsible for an average annual Adjusted Base Flow of 15,250 acre feet at Riverside Narrows. A continuing account, as described in Appendix B, shall be maintained of the actual Base flow at Riverside Narrows, with all adjustments thereof and any cumulative debit or credit. Each year the obligations to provide Base flow shall be subject to the following:
  - (1) Minimum Annual Quantities. Without regard to any cumulative credits, or any adjustment for quality of the current Water Year under Paragraph (2) hereof, SBVMWD each year shall be responsible at Riverside Narrows for not less than 13, 240 acre feet of Base Flow plus one-third of any cumulative debit; provided, however, that for any year commencing on or after October 1, 1986, when there is no cumulative debit, or for any year prior to 1986 whenever the cumulative credit exceeds 10,000 acre feet, said minimum shall be 12,420 acreft.
  - (2) <u>Adjustments for Quality.</u> The amount of Base Flow at Riverside narrows received during any year shall be subject to adjustment based upon the weighted average annual TDS in such Base Flow, as follows:

If the Weighted Average TDS in Base Flow at Riverside Narrows is:	Then the Adjusted Base Flow shall be determined by the formula:
Greater than 700 ppm	Q – Q*(TDS- 700)*11/15 <b>,2</b> 50
600 ppm – 700 ppm	Q
Less than 600 ppm	Q + Q*(600- TDS)*11/15,250

#### Where Q = Base Flow actually received.

(3) <u>Periodic Reduction in Cumulative Debit.</u> At least once in any ten (10) consecutive years subsequent to 1976, SBVMWD shall provide sufficient quantities of Base Flow at Riverside narrows to discharge completely any cumulative debits. Any cumulative credits shall remain on the books of account until used to offset any subsequent debits, or until otherwise disposed of by SBVMWD."<sup>11</sup>

Table 3-1 contains a "continuous account" of the annual discharge at Riverside Narrows as reckoned by the Santa Ana River Watermaster and reported in the 39<sup>th</sup> Annual Report of the Santa Ana River Watermaster (Santa Ana River Watermaster, 2010). Of the 39 years for which Watermaster records are available, the following observations can be made:

• The TDS concentration exceeded 700 in only 8 of 39 years, and all of those occurrences were in the first 11 years.



<sup>&</sup>lt;sup>11</sup> Ibid, Paragraph 5b.

- There has been a credit in all but 1 of the 39 years, and the credits have reached 1,156,000 acre-ft.
- It will take about 400 years to expunge the cumulative credits at the Riverside Narrows, provided that the recycled water discharged to the Santa Ana River upstream of the Riverside Narrows were reduced such that the minimum discharge of 12,420 acre-ft/yr was maintained.

The proposed recycled water recharge project will reduce the effluent discharged from the RIX facility to the Santa Ana River to about 11.9 mgd or about 13,300 acre-ft/yr.<sup>12</sup>

The allocation of water rights, as described in the Orange County Judgment, was reaffirmed in a stipulation on May 2, 2007 and filed with the SWRCB in the water rights hearing process for Applications Nos. 31165, 31370, 31174, 31369, 31371, and 31372.

#### 3.2.2 Groundwater Pumping Rights in the Colton, Riverside, and San Bernardino Area (WMWD vs. ESBCWD, et al., Case No. 78426)

In parallel with developing the settlement for the Orange County Judgment, the upper area parties settled rights within the upper Santa Ana River Watershed (The Western San Bernardino Judgment) to determine (1) the safe yield of the SBBA, (2) the groundwater pumping rights of plaintiffs and non-plaintiffs in the SBBA, (3) replenishment obligations in the SBBA, and (4) groundwater pumping rights and replenishment obligations in the Colton and Riverside Basins. These determinations were made, in part, to ensure that the resources upstream of the Riverside Narrows would be sufficient to meet the flow obligations of the Orange County Judgment at the Riverside Narrows.

The Western San Bernardino Judgment is administered by the two-person Western-San Bernardino Watermaster—one person nominated each by the Valley District and the WMWD. The Valley District and the WMWD are responsible, on behalf of the numerous parties bound by the judgment, for implementing the requirements of the judgment. Moreover, the Valley District and the WMWD are responsible for replenishing the groundwater basins if extractions exceed the allowable production specified in the judgment. The Non-Plaintiffs have rights to produce 167,228 acre-feet (72.05 percent) in aggregate of the safe yield from the SBBA, and the Valley District is obligated to replenish for the over-production by the Non-Plaintiffs. The Plaintiffs, including the City of Riverside, the Riverside Highland Water Company, the Meeks & Daley Water Company, and the Regents of the University of California (Regents), have individually decreed rights, which, in aggregate, equal 64,872 acre-feet (27.95 percent) of the safe yield from the SBBA.

The Western San Bernardino Judgment allows for "new conservation," which is defined as any increase in replenishment from natural precipitation that results from the operation of



<sup>&</sup>lt;sup>12</sup> A literal reading of the revised Petition for Change suggests that the SBMWD will send about 11.9 mgd to RIX for treatment. With 20-percent overproduction, the resulting discharge at RIX will be about 14.3 mgd or about 16,000 acre-ft/yr.

works and facilities that did not exist in 1969. The Western San Bernardino Judgment specifies that the parties to the judgment have the right to participate in any new conservation projects, and provided that their appropriate shares of the costs are paid, their rights under the judgment will increase by their respective shares in new conservation (72.05 percent for the Valley District and 27.95 percent for the WMWD).

The proposed recycled water recharge project will recharge recycled water into the SBBA between Waterman Canyon and Devil Canyon, temporarily store that water in this area, and recover it with SBMWD wells. The specific intent of the project is to reduce the SBMWD's dependence on imported water, improve water supply reliability and maintain groundwater levels during drought and imported water shortfalls. The Western San Bernardino Judgment is silent on the storage of supplemental water in the SBBA by a non-party to the Judgment. The SBMWD has a right to recover all of the recycled water that it can safely recharge because this water is supplemental to SBBA. The SBMWD's discharge to the Santa Ana River is not included in the adjudicated safe yield of the SBBA; it is, in fact, foreign or imported water: "The fact that the foreign water is commingled with native supplies with a groundwater basin does not limit or abridge the rights of the importing part to recapture the water stored in the groundwater basin so as no injury results to existing vested rights" (Slater, 2005).

Paragraph VII of the Western San Bernardino Judgment requires the Valley District to keep in force an agreement with the SBMWD that requires the SBMWD to discharge 16,000 acreft/yr to the Santa Ana River to meet the Valley District's surface water discharge obligation at Riverside Narrows pursuant to the Orange County Judgment. In addition to the agreement with the SBMWD, the Valley District entered into an agreement with the City of Colton whereby the City of Colton would continue to discharge "at least 2,450 acre-feet of effluent each year in the manner presently being done for the use and benefit of the Valley [Water] District in meeting its obligation under any agreement with downstream interests." The proposed recycled water recharge project will result in at least 18,450 acre-ft/yr of discharge from the RIX facility and is therefore consistent with the provision of the Western San Bernardino Judgment and the agreement between the Valley District and the City of Colton.

#### 3.3 Existing Water Supply Framework

Water supplies and water supply planning are coordinated by the Valley District within its service area. The Valley District is an SWP contractor and imports SWP water into its service area for direct delivery to treatment plants and for replenishment. The Valley District's water supply planning includes importing supplemental water and managing the groundwater basins within its boundaries. The Valley District coordinates with retail water service providers and private water users.

#### 3.3.1 Retail Water Agencies

The major retail water service providers within the Valley District's service area that produce groundwater from the Bunker Hill Basin include the West Valley Water District, the City of Rialto, the City of Colton, the SBMWD, the East Valley Water District, the City of Loma



Linda, and the City of Redlands. The water and wastewater service areas and water supply plans of these agencies, with the exception of the SBMWD, are briefly discussed below.<sup>13</sup> The SBMWD's water demand and supply plans are discussed in Section 4. The locations of these retail water agencies relative to the investigation area are shown in Figure 3-3.

The proposed recycled water recharge project may impact some of these water service providers. The expected physical impacts will be small as the modeling work done as part of this investigation indicates that most of the recycled water will be recovered by SBMWD wells. There may be slight effects on groundwater levels and groundwater quality at non-SBMWD wells, caused by operating the Bunker Hill Basin at higher levels in the area between the Waterman and Devil Canyons.

#### 3.3.1.1 West Valley Water District

The West Valley Water District provides water service to more than 60,000 residents in the northern and southern portions of the City of Rialto and to a small portion of the City of Fontana, all located west of the investigation area. The total water demand in the West Valley Water District service area is about 31,400 acre-ft/yr in 2010 and is projected to increase to about 58,700 acre-ft/yr by 2030. The water supplies used to meet the District's 2030 demands (including volume and percent contribution) include groundwater from the Bunker Hill Basin—provided in part by the SBMWD through the Baseline Feeder—(20,000 acre-ft or 34 percent), the Lytle Basin (9,500 acre-ft or 16 percent), the Rialto-Colton Basin (8,000 acre-ft or 14 percent), the Riverside-North Basin (5,000 acre-ft or 9 percent), and the Chino Basin (1,000 acre-ft or 2 percent); surface water from Lytle Creek (5,500 acre-ft or 9 percent); imported SWP water (9,000 acre-ft or 15 percent); backwash water from the District's Oliver P. Roemer Treatment Facility (1,400 acre-ft); and recycled water from the Rialto Wastewater Treatment Plant (730 acre-ft or 1 percent). The West Valley Water District's water demand and supply projection for the 2010 through 2030 period is included in Appendix A.

Wastewater collection and treatment services for customers in the West Valley Water District service area are provided by the City of Rialto.

#### 3.3.1.2 City of Rialto

The City of Rialto, located to the west of the investigation area, provides water to about 12,000 domestic, commercial, institutional, and irrigation customers in the central portion of the Rialto city limits. Residents to the north and south of the city center receive water from the West Valley Water District. The total water demand in the Rialto service area is about 15,600 acre-ft/yr in 2010 and is projected to increase to about 16,200 acre-ft/yr by 2030. The water supplies used to meet Rialto's 2030 demands (including volume and percent



<sup>&</sup>lt;sup>13</sup> The water demands and supply plans reported herein are based on information provided by the individual retail water providers. All of the water demand projections reported herein are being revised as of this writing to incorporate the SB-7 requirement for a 10-percent reduction in potable per capita demand by 2015 and a 20-percent reduction by 2020.

contribution) include groundwater from the Bunker Hill Basin—provided in part by the SBMWD through the Baseline Feeder—(5,000 acre-ft or 32 percent), the Lytle Basin (3,600 acre-ft or 22 percent), the Rialto-Colton Basin (2,000 acre-ft or 12 percent), the Riverside-North Basin (1,000 acre-ft or 6 percent), and the Chino Basin (1,000 acre-ft or 6 percent); surface water from Lytle Creek (1,300 acre-ft or 8 percent); and recycled water from the City of Rialto's Wastewater Treatment Plant (2,300 acre-ft or 14 percent). The City of Rialto's water demand and supply projection for the 2010 through 2030 period is included in Appendix A.

In addition to providing water service, the city owns and operates a wastewater collection system and wastewater treatment plant with the capacity to treat up to 12 mgd of wastewater to tertiary standards. Currently, the plant discharges about 7.5 mgd of tertiary treated wastewater. About 0.75 mgd of that water is used for landscape irrigation, and the rest is discharged to the Santa Ana River.

#### 3.3.1.3 City of Colton

The City of Colton, located to the south of the investigation area, provides water to about 9,000 service connections within Colton city limits. The total water demand in the Colton service area is about 13,500 acre-ft/yr in 2010 and is projected to increase to about 17,400 acre-ft/yr by 2030. The water supplies used to meet Colton's 2030 demands (including volume and percent contribution) include groundwater from the Bunker Hill Basin (9,000 acre-ft or 52 percent), the Rialto-Colton Basin (5,300 acre-ft or 30 percent), and the Riverside-North Basin (3,100 acre-ft or 18 percent). The City of Colton's water demand and supply projection for the 2010 through 2030 period is included in Appendix A.

In addition to providing water service, the City of Colton owns and operates a wastewater collection system and wastewater treatment plant with the capacity to treat up to 10.4 mgd of wastewater to secondary standards. The Colton Water Reclamation Facility (CWRF) accepts domestic, commercial, and industrial wastewater generated within the Cities of Colton and Grand Terrace and some unincorporated areas of San Bernardino County. Currently, the CWRF treats about 5.6 mgd to secondary standards. Following treatment at the CWRF, effluent is conveyed to the RIX facility for tertiary treatment before it is discharged to the Santa Ana River. The City of Colton intends to meet some of the non-potable demands in the proposed Pellissier Ranch Development with recycled water in the future; the amount has not been quantified as of this writing.

#### 3.3.1.4 East Valley Water District

The East Valley Water District provides water to more than 70,000 residents in the City of Highland, located to the east of the investigation area. The total water demand in the East Valley Water District service area is about 31,400 acre-ft/yr in 2010 and is projected to increase to about 35,900 acre-ft/yr by 2030. The water supplies used to meet the District's 2030 demands (including volume and percent contribution) include groundwater from the Bunker Hill Basin (29,300 acre-ft or 82 percent) and surface water from the Santa Ana River



(6,600 acre-ft or 18 percent). The East Valley Water District's water demand and supply projection for the 2010 through 2030 period is included in Appendix A.

In addition to providing water service, the East Valley Water District maintains a wastewater collection system that conveys wastewater generated in its service area to the SBWRP where it is treated to secondary standards and subsequently conveyed to the RIX facility for tertiary treatment before it is discharged to the Santa Ana River. The District has no plans to build its own treatment plant.

## 3.3.1.5 City of Loma Linda

The City of Loma Linda, located to the southeast of the investigation area, provides water service to domestic, commercial, and landscape customers within Loma Linda city limits. The total water demand in the Loma Linda service area is about 6,400 acre-ft/yr in 2010 and is projected to increase to about 10,600 acre-ft/yr by 2030. The City of Loma Linda obtains 100 percent of its water supply from the Bunker Hill Basin. The city's water demand and supply projection for the 2010 through 2030 period is included in Appendix A.

In addition to providing water service, the city maintains a wastewater collection system that conveys wastewater generated in the Loma Linda service area to the SBWRP where it is treated to secondary standards and subsequently conveyed to the RIX facility for tertiary treatment before it is discharged to the Santa Ana River. The City of Loma has identified non-potable demands within its service area (about 1,000 acre-ft/yr) that could be met with recycled water. While the city does not have plans to build its own treatment plant or start a recycling program, it is exploring the possibility of purchasing recycled water from the City of Redlands.

## 3.3.1.6 City of Redlands

The City of Redlands, located to the southeast of the investigation area, provides water to 79,000 residents in Redlands, Mentone, parts of the Crafton Hills and San Timoteo Canyon, and a small part of San Bernardino County. The total water demand in the Redlands service area is about 42,300 acre-ft/yr in 2010 and is projected to increase to about 65,300 acre-ft/yr by 2030. The water supplies used to meet Redlands' 2030 demands (including volume and percent contribution) include groundwater from the Bunker Hill Basin (29,500 acre-ft or 45 percent) and the Yucaipa Basin (500 acre-ft or 1 percent), surface water from the Santa Ana River (16,000 acre-ft or 24 percent) and Mill Creek (10,500 acre-ft or 16 percent), imported SWP water (2,000 acre-ft or 4 percent), and recycled water from the City of Redlands Wastewater Treatment Facility (6,500 acre-ft or 10 percent). The City of Redlands' water demand and supply projection for the 2010 through 2030 period is included in Appendix A.

In addition to providing water service, the city owns and operates a wastewater collection system and a wastewater treatment plant. The treatment plant has the capacity to treat 9.5 mgd, of which 7.2 mgd is treated to tertiary standards and 3 mgd is treated to secondary standards. Currently, about 2.5 mgd of tertiary treated water is delivered for direct use to a



nearby power plant for cooling purposes. The remainder of the city's effluent is discharged to a series of percolation ponds that recharge the Bunker Hill Basin.

## 3.3.1.7 Other Private/Agricultural Water Users

There are numerous small mutual water companies that provide water to domestic and agricultural customers throughout the investigation area. The collective water demand of these private water companies is about 22,300 acre-ft/yr in 2010 and is projected to decrease to about 21,100 acre-ft/yr by 2030. These small water companies plan to rely exclusively on groundwater from the Bunker Hill Basin (14,700 acre-ft or 77 percent) and local surface water supplies from Mill Creek (4,300 acre-ft or 23 percent). The water demand and supply projection for the 2010 through 2030 period is included in Appendix A.

### 3.3.1.8 Plaintiffs of the Western San Bernardino Judgment

The four "Plaintiffs" of the Western San Bernardino Judgment—the City of Riverside, the Riverside-Highland Water Company, The Meeks and Daley Water Company, and the Regents of the University of California—have rights to pump groundwater from the SBBA, which includes the Bunker Hill and Lytle Creek Basins. Moreover, the Plaintiffs have a collective right in the SBBA of 64,800 acre-ft/yr and are projected to utilize their maximum water right every year between 2010 and 2030 to meet the demands of their service areas. Of this right, 62,300 acre-ft/yr (96 percent) is produced from the Bunker Hill Basin and 2,500 acre-ft/yr (4 percent) is produced from the Lytle Creek Basin. The Plaintiffs' water demand and supply projection for the 2010 through 2030 period is included in Appendix A.

# 3.4 Water Recycling Policy and Regulations

In California, any entity that recycles or has proposed to recycle water and/or that uses or has proposed to use recycled water must file a report with its RWQCB. The RWQCBs implement the provisions of the California Code of Regulations (CCR) Title 22, Division 4, Chapter 3 by issuing Water Recycling Requirements (WRRs) to the producer of recycled water, the user of recycled water, or both. WRRs are issued for a variety of uses, including, but not limited to, groundwater recharge (i.e. indirect potable reuse), landscape irrigation (i.e. direct use), and other non-potable uses. The RWQCB consults with the CDPH when issuing WRRs.

The proposed project includes indirect potable reuse and direct uses of recycled water.

# 3.4.1 State Water Resources Control Board Resolution 2009-0011 – Adoption of a Policy for Water Quality Control for Recycled Water

In 2009, the SWRCB adopted Resolution No. 2009-0011 – Adoption of a Policy for Water Quality Control for Recycled Water. The purpose of the Recycled Water Policy (Policy) is to increase the use of recycled water from municipal wastewater sources that meets the definition in Water Code Section 13050(n) in a manner that implements state and federal water quality



laws. When used in compliance with the Policy, Title 22, and all applicable state and federal water quality laws, the SWRCB finds that recycled water is safe for approved uses and strongly supports recycled water as a safe alternative to potable water for approved uses. The SWRCB sees increasing the acceptance and promoting the use of recycled water as a means to achieving sustainable local water supplies while reducing greenhouse gas emissions. The Policy is intended to encourage the beneficial use of, rather than the disposal of, recycled water.

#### 3.4.2 Santa Ana Regional Water Quality Control Plan (Basin Plan)

Under California Water Code Section 13240 et seq., each RWQCB must formulate and adopt a water quality control plan (Basin Plan) for all areas within their respective regions. Each Basin Plan must include:

- Beneficial uses, which are to be protected;
- Water quality objectives, which protect those uses; and
- An implementation plan to achieve those objectives.

Beneficial uses are the uses to which surface water and groundwater are being or may be put, including water contact recreation; municipal, agricultural, and industrial supply; and the preservation of fish and other aquatic wildlife.

Water Code Section 13050 defines water quality objectives as "the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area." At a minimum, an RWQCB must consider the following factors in establishing water quality objectives:

- (a) Past, present and probable future beneficial uses of water.
- Environmental characteristics of the hydrographic unit under (b) consideration, including the quality of the water available thereto.
- (c) Water quality conditions that could reasonably be achieved through coordinated control of all factors which affect water quality in the area.
- (d) Economic considerations.
- (e) The need for developing housing within the region.
- The need to develop and use recycled water. (Section 13241) (f)

In addition, the existing quality of water for which the objectives are being established must be considered. Both federal and state antidegradation policies require that existing high quality waters be protected unless lowering that quality:

- Is necessary to accommodate important economic or social development.
- Is consistent with the maximum benefit to the people of the state.
- Will not unreasonably affect actual or potential beneficial uses.



The implementation plan required in each Basin Plan includes the control of waste discharges by the RWQCB through waste discharge requirements and/or the prescription of waste discharge prohibitions. Implementation plans must also include recommendations for actions that are not under the RWQCB's statutory authority but can be undertaken by other public or private entities. Actions may include, but are not limited to, the construction and operation of desalters (well fields designed to intercept poor quality groundwater) and groundwater recharge programs.

The Water Code states that Basin Plans must be periodically reviewed and revised. The Federal Clean Water Act (CWA) specifies that water quality standards (beneficial uses and water quality objectives) must be reviewed at least once every three years. Basin Plan revisions may include changes to beneficial uses, water quality objectives, and implementation plans. However, state and federal policies and regulations place stringent limits on the RWQCB's discretion in making these changes:

- Beneficial Uses. For surface water, the CWA (Section 101 [a][2]) establishes the national "fishable/swimmable" goal, which states that, wherever attainable, water quality that "provides for recreation in and on the water" must be achieved. Where the RWQCB does not designate "fishable/swimmable" uses, a use attainability analysis must be performed to demonstrate that these uses are not attainable based on physical, chemical, biological, or economic factors (40 CFR 131.10[j]). These waters must be reviewed at least once every three years to determine whether conditions have changed such that "fishable/swimmable" uses should be designated. For surface waters, existing beneficial uses (as of 1975) may not be removed but must be maintained and protected (40CFR 131.10 [j][2]). The Water Code prohibits the removal of beneficial uses solely on economic grounds (Section 13241).
- Water Quality Objectives. The reduction of water quality (establishment of less stringent water quality objectives) requires a demonstration that the change is necessary to accommodate important economic or social development and is consistent with the maximum benefit to the people of the state and that actual and potential beneficial uses will not be unreasonably affected. If less stringent water quality objectives are proposed on the basis that prior technical errors or insufficient information led to the development of inappropriate water quality objectives, there must be a finding that the new objectives are theoretical rather than an actual reduction of water quality. Regardless, the level of water quality necessary to protect existing beneficial uses must be maintained.
- Implementation Plans. Changes to implementation plans are appropriate and necessary as conditions in a region change and as the understanding of water quality problems and issues improves. However, the intent of an implementation plan, to meet water quality objectives, must remain unchanged.

Figure 3-4 shows the water quality objectives for the management zones in the SBBA. As the figure shows, the proposed recycled water project will recharge recycled water into the Bunker Hill A Management Zone. The salt management plan is described in Section 5 of the Basin



Plan. The TDS and nitrate objectives of the Bunker Hill A Management Zone and the most recent ambient TDS and nitrate concentration estimates are listed below.

	Objective Concentration (mg/L)	Ambient Concentration (mg/L)	Assimilative Capacity
TDS	310	330	-20
Nitrate	2.7	4.0	-1.3

There is no assimilative capacity for TDS or nitrate because the current ambient TDS and nitrate concentrations exceed the objectives. Thus, the SARWQCB will require the TDS and nitrate concentrations in the recycled water recharged in Bunker Hill A to be less than or equal to the objectives. There are certain allowances for nitrate losses that occur during infiltration and transport through the soil column. The same limitation applies to recycled water used for irrigation uses. The SARWQCB will require the TDS and nitrate limits to be met either through dilution with new supplies, such as SWP water or new stormwater recharge, or by treatment that removes salt.

## 3.4.3 Regulations for Indirect Potable Reuse

Regulations for indirect potable reuse are specified in CCR Title 22, Division 4, Chapter 3, Article 5.1 – Groundwater Recharge. Using these regulations, the RWQCBs evaluate proposed recharge projects for compliance with applicable laws, regulations, and orders prior to issuing WRRs. Specifically, the RWQCBs need to ensure that proposed projects comply with the Basin Plan and meet the *Draft Groundwater Recharge Reuse Regulations* set by the CDPH. These regulations are described in detail in Section 6 – Recycling Criteria.

## 3.4.4 Regulations for Direct Use

Regulations for direct use are specified in CCR Title 22, Division 4, Chapter 3, Article 3 – Uses of Recycled Water. Regulations for sites receiving recycled water for direct use are specified in CCR Title 22, Division 4, Chapter 3, Article 4 – Use Area Requirements. Using these regulations, the RWQCBs evaluate proposed direct use projects for compliance prior to issuing WRRs. These regulations are described in detail in Section 6 – Recycling Criteria.

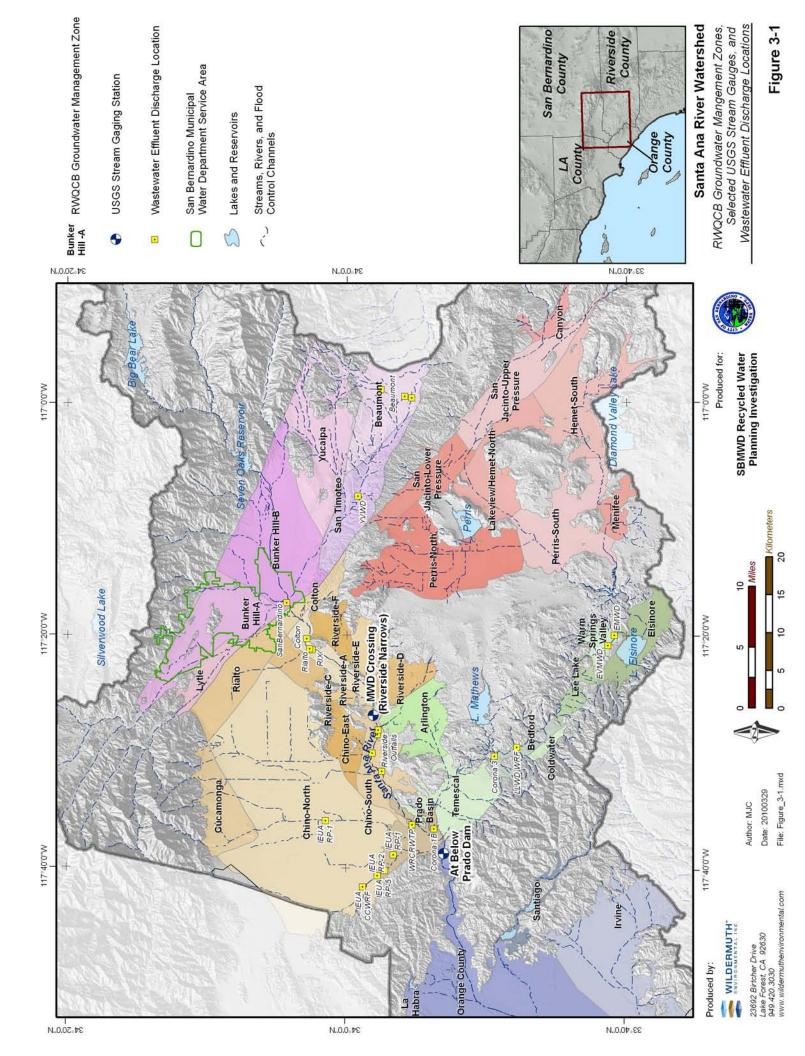


Table 3-1
Historical Findings of the Santa Ana River Watermaster<sup>1</sup>

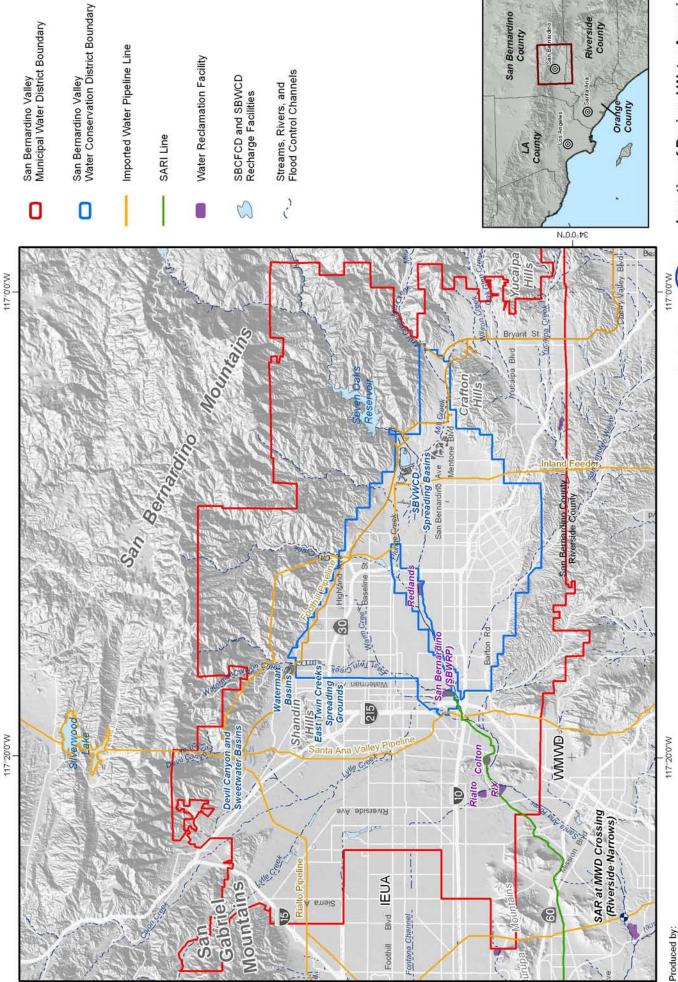
		Summary of F	indings at Rive	erside Narrows			Summa	ry of Findings	at Prado	
Year <sup>2</sup>	Total	Base	Weighted	Adjusted	Cumulative	Total	Base	Weighted	Adjusted	Cumulative
rear	Flow <sup>3</sup>	Flow 4	TDS <sup>5</sup>	Base Flow <sup>6</sup>	Credit <sup>7</sup>	Flow <sup>3</sup>	Flow <sup>4</sup>	TDS <sup>5</sup>	Base Flow <sup>6</sup>	Credit <sup>7</sup>
	acre-ft	acre-ft	mg/L	acre-ft	acre-ft	acre-ft	acre-ft	mg/L	acre-ft	acre-ft
1970 - 1971	24,112	17,061	704	17,012	1,762	51,864	38,402	727	38,402	(3,598)
1971 - 1972	22,253	16,157	712	16,017	2,529	51,743	40,416	707	40,416	(5,182)
1972 - 1973	32,571	17,105	700	17,105	4,384	77,484	48,999	638	51,531	4,349
1973 - 1974	24,494	16,203	700	16,203	5,337	62,511	43,106	633	45,513	7,862
1974 - 1975	19,644	15,445	731	15,100	5,187	61,855	50,176	694	51,263	17,125
1975 - 1976	26,540	17,263	723	16,977	6,914	59,209	45,627	635	48,098	23,223
1976 - 2009	23,978	18,581	722	18,286	9,950	62,953	48,387	660	50,000	31,223
1977 - 2009	181,760	22,360	726	21,941	16,641	252,850	58,501	383	73,955	63,178
1978 - 2009	47,298	26,590	707	26,456	27,847	134,506	71,863	580	79,049	100,227
1979 - 2009	253,817	25,549	676	25,549	38,146	527,760	82,509	351	106,505	164,732
1980 - 2009	34,278	19,764	715	19,550	42,446	117,888	74,875	728	74,875	205,652
1981 - 2009	82,708	32,778	678	32,778	59,974	143,367	81,548	584	89,431	253,083
1982 - 2009	279,645	57,128	610	57,128	101,852	426,750	111,692	411	138,591	353,036
1983 - 2009	82,745	56,948	647	56,948	143,550	177,606	109,231	627	115,876	431,514
1984 - 2009	78,771	69,772	633	69,772	198,072	162,912	125,023	617	133,670	523,184
1985 - 2009	99,258	68,220	624	68,220	251,042	197,373	127,215	567	141,315	622,499
1986 - 2009	77,752	59,808	649	59,808	295,600	143,191	119,848	622	127,638	708,137
1987 - 2009	79,706	55,324	620	55,324	335,674	166,818	124,104	582	136,308	802,445
1988 - 2009	62,376	52,259	607	52,259	372,683	152,743	119,572	583	131,230	891,675
1989 - 1990	58,159	53,199	590	53,583	411,016	143,463	119,149	611	127,986	977,661
1990 - 1991	73,790	45,041	616	45,041	440,807	186,426	111,151	514	128,379	1,064,040
1991 - 1992	71,427	40,306	620	40,306	465,863	189,677	106,948	499	124,862	1,146,902
1992 - 1993	267,043	41,434	634	41,434	492,047	566,630	128,067	368	163,499	1,268,401
1993 - 1994	45,006	31,278	677	31,278	508,075	152,808	111,186	611	119,432	1,345,833
1994 - 1995	243,411	45,562	646	45,562	538,387	422,816	123,468	415	152,792	1,458,387
1995 - 1996	81,786	54,548	625	54,548	577,685	190,553	131,861	514	152,299	1,568,686
1996 - 1997	104,518	62,618	624	62,618	625,053	198,459	136,676	514	157,861	1,684,547
1997 - 1998	213,033	65,013	601	65,013	674,816	456,316	154,021	392	193,553	1,836,100
1998 - 1999	76,294	73,094	603	73,094	732,660	182,310	158,637	581	174,369	1,968,469
1999 - 2000	75,572	63,499	602	63,499	780,909	188,538	148,269	527	169,644	2,096,113
2000 - 2001	75,331	61,872	603	61,872	827,531	208,535	153,914	525	176,360	2,230,473
2001 - 2002	59,434	58,705	606	58,705	870,986	156,596	145,981	587	159,728	2,348,201
2002 - 2003	88,502	57,747	617	57,747	913,483	245,947	146,113	463	174,970	2,482,058
2003 - 2004	75,799	54,788	634	54,788	953,021	201,967	143,510	508	166,472	2,606,777
2004 - 2005	355,503	65,760	616	65,760	1,003,531	637,568	154,307	348	199,570	2,766,713
2005 - 2006	111,113	67,161	608	67,161	1,055,442	246,101	147,736	517	170,266	2,898,541
2006 - 2007	56,022	56,123	635	56,123	1,096,315	153,823	129,830	604	140,216	3,002,288
2007 - 2008 <sup>8</sup>	74,554	46,776	674	46,776	1,127,841	194,309	116,483	495	136,382	3,100,835
2008 - 2009	67,567	43,902	663	43,902	1,156,493	161,026	102,711	527	117,519	3,178,543

- 1. Information in this table is from Table 1 of the 39th Annual Report of the Santa Ana River Watermaster dated April 30, 2010.
- 2. Water Year (October 1 to September 30).
- 3. As determined by the Watermaster, Total Flow based on Computed Inflow at either Prado or Riverside Narrows in any year may be exclusive of any Nontributary Flow, Exchange Water or other "water management" flows and, at Prado, may include discharges from Lake Elsinore or the San Jacinto Watershed that reach the Santa Ana River.
- 4. As determined by the Watermaster: (a) Base Flow at Prado in any year is exclusive of Storm Flow and may be exclusive of any Nontributary Flow, Exchange Water or other "water management" flows as well as any discharges from Lake Elsinore or the San Jacinto Watershed that reach the Santa Ana River; (b) Base Flow at Riverside Narrows in any year is exclusive of Storm Flow and may be exclusive of any Nontributary Flow, Exchange Water or other "water management" flows and, beginning in 1979-80, includes wastewater from Rubidoux CSD that is treated at the Riverside Regional WWTP.
- 5. For Base and Storm Flow at Prado and Base Flow only at Riverside Narrows.
- 6. The 1969 Orange County Judgment (Judgment) requires the Base Flow shall be subject to adjustment based on the TDS of the Base Flow and Storm Flow only.
- 7. As determined by the Watermaster, Cumulative Credit at Prado in any year may include credit for a portion of any water discharged from Lake Elsinore or the San Jacinto Watershed that reach the Santa Ana River. According to the Judgment, the "[Valley Water District] shall be responsible for an average annual Adjusted Base Flow of 15,250 acre-ft at the Riverside Narrows, the minimum required base flow is 12,420. Also according to the Judgment, the "[IEUA] and WMWD shall be responsible for an average annual Adjusted Base Flow of 42,000 acre-ft at Prado . . .". Because the cumulative credits exceed 30,000 acre-ft at Pardo, the minimum required base flow is 34,000.
- 8. The Base Flow amount for 2007-08 at Riverside Narrows was published as 47,760 acre-feet in the 2007-08 report. The correct amount is 46,776 acre-feet.









San Bernardino County Riverside · • County County

Location of Regional Water Agencies and Facilities

SBMWD Recycled Water Planning Investigation

Produced for:

WILDERMUTH-

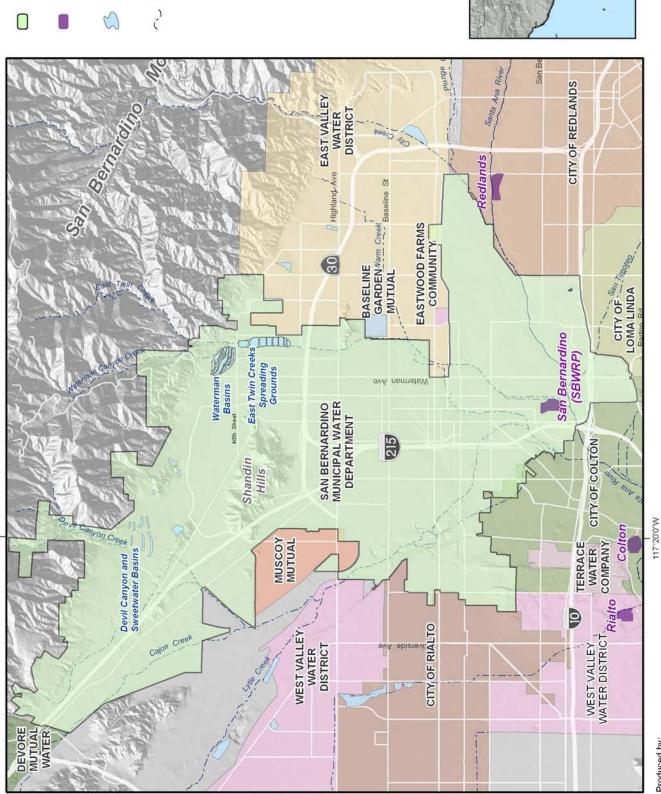
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San Bernardino County Flood Control District Recharge Facilities

Water Reclamation Facility

Water Service Area

117°20'0"W

Streams, Rivers, and Flood Control Channels

Location of Water Service Areas

Orange

San Bernardino

County

County

Riverside County

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Kilometers Miles

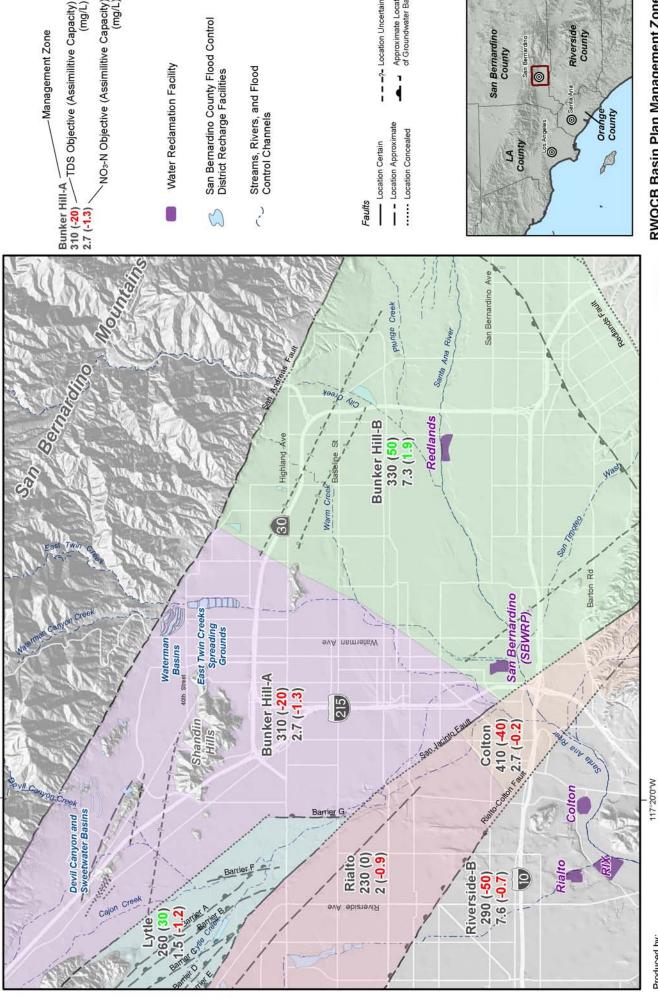
SBMWD Recycled Water Planning Investigation

Produced for:









Riverside San Bernardino County County County

Approximate Location of Groundwater Barrier

- - -?- Location Uncertain

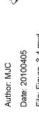
NO₃-N Objective (Assimilitive Capacity) (mg/L)

Management Zone

117°20'0"W

RWQCB Basin Plan Management Zone Locations and Water Quality Objectives





Produced for:



# **Section 4 - Water Demands and Supply Plan Projections**

## 4.1 SBMWD Water Supply Plans through 2030

The SBMWD provides water to more than 40,000 domestic, commercial, institutional, and irrigation customers throughout its 45 square mile service area, which includes some areas outside City of San Bernardino limits. The total water demand in the SBMWD service area is about 54,800 acre-ft/yr in 2010 and is projected to increase to about 77,000 acre-ft/yr by 2030. At present, the SBMWD relies solely on groundwater produced from the Bunker Hill Basin to meet the demands of its service area. According to the SBMWD's 2005 Urban Water Management Plan, the SBMWD intends to reactivate its tertiary treatment system (i.e. filtration and disinfection) at the SBWRP in 2015 to treat 0.75 mgd (840 acre-ft/yr) of wastewater to Title 22 standards for irrigation uses at the City of San Bernardino Municipal Golf Course and the California Department of Transportation.

## **4.1.1** Water Quality

The groundwater that the SBWMD extracts from the Bunker Hill Basin is of excellent mineral quality with TDS concentrations averaging less than 350 mg/L and nitrogen concentrations averaging less than 6.4 mg/L.

As discussed in Section 2, there are several water quality anomalies in the Bunker Hill Basin. The SBMWD operates four groundwater treatment plants to remediate the Muscoy and Newmark plumes and to produce groundwater for its potable distribution system. Groundwater treated at these facilities is of excellent quality and meets the public drinking water system requirements of the CDPH.

## **4.1.2** Cost of Water Supplies

The average cost to pump, treat, and distribute groundwater from the Bunker Hill Basin to customers in the SBMWD service area is approximately \$175 per acre-ft. This cost does not include the SBMWD's administrative and overhead costs or the cost to purchase and recharge imported water. The SBMWD purchases SWP water from the Valley District to recharge the Bunker Hill Basin in the northern part of its service area. The SBMWD is essentially using the groundwater basin to treat and convey SWP water to its wells. In the absence of this recharge, the SBMWD would not be able to reliably use some of its wells in the northern part of its service area.

The Valley District charges \$118 per acre-ft to deliver imported water to retailers in its service area. This fee covers the cost incurred by the Valley District to transport SWP from the Sacramento San Joaquin Delta to the Valley District service area; all other costs related to the

<sup>&</sup>lt;sup>14</sup> Note that in the SBMWD Water Master Plan Report (CDM, 2007), at build out, the ultimate water demand in the SBWMD's service area is estimated to be 79,200 acre-ft/yr; The 77,000 acre-ft/yr value was provided by SBMWD staff in 2010.



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Valley District's importation of SWP water are funded through property tax revenues. As part of the Cooperative Recharge Program, of which the SBMWD is a participant, the Valley District charges water retailers about \$75 per acre-ft for replenishment water.

The importation cost will increase in the future due to increases in the cost of power and new costs that will be incurred for the Delta fix.

#### 4.1.3 **Future SBMWD Water Supply Plan**

The SBMWD's water demand and supply plan for the 2010 through 2030 period is shown in Table 4-1. With or without the proposed recycled water project, the SBMWD plans to increase production from the SBBA, specifically from the Bunker Hill Basin, to meet future water demands in its service area. This will likely require an increase in the amount of SWP water recharged at the Waterman, Devil Canyon, and Sweetwater Basins.

#### 4.2 **Aggregate Water Supply Plans of Other Retail Agencies**

There are several retail water agencies and private water companies that rely on the SBBA to meet the water demand of their service areas. Table 4-2 summarizes the water demands of all retail water service providers that rely on the SBBA, including the Fontana Water Company, the West Valley Water District, the City of Rialto, the City of Colton, the City of San Bernardino (SBMWD), the East Valley Water District, the City of Loma Linda, the City of Redlands, the Plaintiffs of the Western San Bernardino Judgment (the City of Riverside, the Meeks & Daley Water Company, the Riverside Highland Water Company, and the University of California Regents), and other Private/Mutual Water Companies (Muscoy, Marygold, Terrace, and others). The total water demand of these agencies is about 324,000 acre-ft/yr for 2010 and is projected to increase to about 409,000 acre-ft/yr by 2030. Table 4-3 lists the various source waters used by the retail water service providers to meet their demands. The total water supply for the retail water service providers is about 348,000 acre-ft/yr in 2010 and is projected to increase to about 442,000 acre-ft/yr by 2030. The water demand and supply plans for each retail water service provider are included in Appendix A.

Table 4-4 shows the aggregated demand and supply plans. Total production from the SBBA is projected to increase from about 263,000 acre-ft/yr in 2010 to about 330,000 acre-ft/yr by 2030, an increase of 25 percent. The remaining 80,000 acre-ft/yr (19 percent) of the aggregate demand in 2030 is projected to be met by 47,000 acre-ft/yr (11 percent) of groundwater from surrounding basins, 16,000 acre-ft/yr (4 percent) of imported SWP water from the Valley District, and 17,000 acre-ft/yr (4 percent) of recycled water.

The projected groundwater production from the SBBA far exceeds its safe yield of 232,100 acre-ft/yr. By 2030, the demand on the SBBA will exceed the safe yield by about 98,000 acreft/yr. SWP water is currently the only supplemental source water used to replenish groundwater basins in the SBBA. The Valley District has proposed to convey surface water from the Seven Oaks Reservoir to augment the Bunker Hill Basin by about 10,800 acre-ft/yr (SBVMWD, 2007). That said, SWP water is the principal source used to enhance the yield of



the SBBA, and the ability to produce groundwater from the SBBA, specifically the Bunker Hill Basin, as projected herein, is directly linked to the reliability of SWP deliveries and other supplemental water.

#### 4.2.1 **SWP Delivery Reliability**

In January 2010, the DWR published the Draft State Water Project Delivery Reliability Report (DWR, 2009). This report updates the DWR's estimate of current (2009) and future (2029) SWP water delivery reliability. The report is produced every two years as part of a settlement agreement that was signed in 2003. The 2009 report shows that future SWP deliveries will be impacted by two significant factors: 1) a significant restriction on SWP and Central Valley Project (CVP) Delta pumping, as required by the biological opinions issued by the US Fish and Wildlife Service (December 2008) and the National Marine Fisheries Service (June 2009); and 2) climate change, which is altering hydrologic conditions in the state.

The report represents the state of affairs if no actions for improvement are taken. Moreover, it shows the continued erosion of SWP water delivery reliability under the current method of moving water through the Delta. In the 2007 report, the average Table A delivery is about 63 percent for 2007 conditions and about 66 to 69 percent for 2027 conditions. In the 2009 report, the average Table A delivery is about 60 percent for 2009 conditions and about 60 percent for 2029 conditions. Most of the reduced reliability is caused by export limitations that result from the two biological opinions—the first factor discussed above. Figure 4-1 shows the SWP delivery reliability from the 2005, 2007, and 2009 SWP Delivery Reliability Reports (DWR, 2005; 2008; & 2010 [respectively]). As the figure shows, the delivery probability curve for 2007 drops completely below the 2005 delivery probability curve, showing a drop in average current reliability from 72 percent to 63 percent; and the delivery probability curve for 2009 drops significantly below the 2007 delivery probability curve 68 percent of the time for higher allocations and climbs above the 2007 delivery probability curve 32 percent of the time, corresponding to lower allocations. The significance of the most recent projected delivery reliability is that there is a relative decrease in deliveries during wetter (higher allocation) years and a slight increase in deliveries during dry years. The Valley District will have less SWP water available to refill its storage assets and for groundwater replenishment during wet years and slightly more water to meet its firm demand (i.e. direct deliveries to water treatment plants) during dry years. Figure 4-2 compares the predicted reliability for 2025, 2027, and 2029. With the further erosion of SWP reliability projected in the Draft State Water Project Delivery Reliability Report (DWR, 2009), the availability of SWP water for replenishment is seemingly more limited in the current period than was thought just two years ago.



<sup>&</sup>lt;sup>15</sup> Figure 4-2 is not a straight apples to apples comparison due to changes in modeling capabilities and the assumptions associated with climate change in the out years. That said, the conclusion reached from examining the reliability projection is still valid.

#### 4.2.2 **Cumulative Unmet Replenishment Obligation for the SBBA**

The Valley District is responsible for maintaining storage levels in the SBBA. Each year, the Western San Bernardino Watermaster sums up all of the production from the SBBA. If the total aggregate production by the non-Plaintiffs is less than their allocated safe yield, a credit is given to the Valley Water District equal to the under production. Credits can be augmented for certain return flows and pre-delivered replenishment water. If the total aggregate production by the non-Plaintiffs is greater than their allocated safe yield, the Valley Water District incurs a replenishment obligation. Accumulated credits can be used to offset a replenishment obligation.

Table 4-5 is a simplified accounting of the projected replenishment obligation of the Valley Water District, based on the projected total water supply from the SBBA, exclusively using SWP water with 60-percent reliability for replenishment and the expected new Santa Ana River recharge pursuant to the new appropriative water right. 16 Per the 2009 Western San Bernardino Watermaster Annual Report, the Valley Water District has accumulated about 183,500 acre-ft of credit. Under these assumptions, the Valley Water District credits will be exhausted by 2015 and begin accruing a replenishment obligation in excess of its imported water supplies by 2019. By 2030, the Valley Water District will have a cumulative unmet replenishment obligation of about 236,000 acre-ft/yr and a yearly replenishment obligation of about 73,000 acre-ft/yr.

Solutions to meeting the Valley Water District's projected replenishment obligation could involve preemptive replenishment<sup>17</sup> with supplemental water from its SWP Table A contract, new stormwater recharge, the recharge of recycled water, and the acquisition of imported water other than their existing SWP Table A contract.



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<sup>&</sup>lt;sup>16</sup> The expected annual average diversion credited to the Valley Water District is about 12,000 acre-ft/yr with the difference allocated to the WMWD. No assumptions were made as to what the WMWD would do with its credit.

<sup>&</sup>lt;sup>17</sup> This would mean recharging supplemental water when available even though Valley Water District has credits or in the absence of a replenishment obligation—conjunctive use for short.

Water Demand and Water Supply Plan for the City of San Bernardino Municipal Water Department Service Area (acre-ft/yr) Table 4-1

		Demands				dnS	Supplies		
					Potable			Non-Potable	
Year	Potable <sup>1</sup>	Non Potable	Total Demand	Groundwater from the Bunker Hill Basin	Imported Water from the SWP	Total Potable Supply	Total Recycled Water Production <sup>2</sup>	Recycled Water Reuse at the SBWRP	Recycled Water Available for Reuse by the SBMWD <sup>3</sup>
2010	53,940	840	54,780	55,620	0	55,620	27,352	0	27,352
2011	55,360	840	56,200	57,040	0	56,704	28,045	0	28,045
2012	56,780	840	57,620	58,460	0	57,788	28,738	0	28,738
2013	58,199	840	59,039	59,879	0	58,871	29,431	0	29,431
2014	59,619	840	60,459	61,299	0	59,955	30,124	0	30,124
2015	61,039	840	61,879	61,039	0	61,039	30,817	840	29,977
2016	62,201	840	63,041	62,201	0	62,201	31,486	840	30,646
2017	63,363	840	64,203	63,363	0	63,363	32,154	840	31,314
2018	64,526	840	992,39	64,526	0	64,526	32,823	840	31,983
2019	65,688	840	66,528	65,688	0	65,688	33,491	840	32,651
2020	66,850	840	069,79	66,850	0	66,850	34,160	840	33,320
2021	68,013	840	68,853	68,013	0	68,013	34,652	840	33,812
2022	69,176	840	70,016	69,176	0	69,176	35,144	840	34,304
2023	70,338	840	71,178	70,338	0	70,338	35,635	840	34,795
2024	71,501	840	72,341	71,501	0	71,501	36,127	840	35,287
2025	72,664	840	73,504	72,664	0	72,664	36,619	840	35,779
2026	73,372	840	74,212	73,372	0	73,372	37,222	840	36,382
2027	74,080	840	74,920	74,080	0	74,080	37,825	840	36,985
2028	74,788	840	75,628	74,788	0	74,788	38,428	840	37,588
2029	75,496	840	76,336	75,496	0	75,496	39,031	840	38,191
2030	76,204	840	77,044	76,204	0	76,204	39,634	840	38,794

<sup>1.</sup> The potable demand projections are based on the 2005 UWMP and the 2007 IRWMP as revised by the SBMWD staff in 2010. These projections do not take into account the conservation measures (i.e. demand management measures) mandated in the 2010 Urban Water Management Planning Act.



<sup>2.</sup> The total recycled water production projections are based on 2010 discussions with SBMWD staff and are less than the numbers shown in the 2005 UWMP. These revisions were made to reflect the economic downtum that started in the 2010 Urban Water Management Planning Act.

<sup>3.</sup> These projections ignore the commitment to discharge 16,000 acre-ftyr contained in an agreement among the SBMWD and Valley Water District dated April 1969. This agreement is an obligation of the Valley Water District in the Orange County Judgment.



Table 4-2
Water Demand Summary for Agencies that Rely on the SBBA <sup>1</sup>
(acre-ft/yr)

		70	01	10	_	_	~	10	10		~	٥.	_	_	_	_	_	_	-+	•		_	
		Total Demand	323,642	331,205	338,767	346,330	353,893	353,775	358,455	363,134	367,813	372,492	377,171	381,431	385,690	389,950	394,210	398,469	400,674	402,879	402,084	407,289	409,494
		Total Non- Potable Demand	11,183	11,490	11,798	12,105	12,413	16,221	16,382	16,544	16,706	16,867	17,029	17,090	17,152	17,214	17,275	17,337	17,399	17,460	17,522	17,583	17,645
		City of Redlands	4,223	4,384	4,546	4,707	4,869	5,031	5,192	5,354	5,516	2,677	5,839	2,900	5,962	6,024	6,085	6,147	6,209	6,270	6,332	6,393	6,455
	Non-Potable Demands	City of San Bernardino (SBMWD)	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840
	Non-Pota	City of Rialto	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260
		West Valley Water District	1,360	1,506	1,652	1,798	1,944	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090
		Fontana Vater Company	2,500	2,500	2,500	2,500	2,500	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9	000'9
		Total Potable Demand	312,459	319,714	326,969	334,225	341,480	337,555	342,072	346,590	351,107	355,625	360,142	364,340	368,538	372,736	376,934	381,133	383,276	385,419	387,562	389,706	391,849
		Plaintiffs <sup>2</sup>	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800
(4016-1091)		Other Private / Mutual Water Companies	22,300	22,240	22,180	22,120	22,060	22,000	21,940	21,880	21,820	21,760	21,700	21,640	21,580	21,520	21,460	21,400	21,340	21,280	21,220	21,160	21,100
		City of Redlands	38,094	39,082	40,069	41,057	42,044	43,032	44,019	45,007	45,994	46,982	47,970	49,057	50,145	51,232	52,320	53,407	54,495	55,582	26,670	57,758	58,845
	sp	City of Loma Linda	6,445	6,653	6,861	7,068	7,276	7,484	7,692	7,899	8,107	8,315	8,523	8,730	8,938	9,146	9,353	9,561	692'6	9,977	10,184	10,392	10,600
	Potable Deman	East Valley Water District	31,400	31,960	32,520	33,080	33,640	34,200	34,540	34,880	35,220	35,560	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900
	Pc	City of San Bernardino (SBMWD)	55,620	57,040	58,460	59,879	61,299	61,039	62,201	63,363	64,526	65,688	66,850	68,013	69,176	70,338	71,501	72,664	73,372	74,080	74,788	75,496	76,204
		City of Colton	13,500	13,780	14,060	14,340	14,620	14,900	15,140	15,380	15,620	15,860	16,100	16,360	16,620	16,880	17,140	17,400	17,400	17,400	17,400	17,400	17,400
		City of Rialto	13,300	13,420	13,540	13,660	13,780	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900
		West Valley Water District	30,000	33,140	36,280	39,420	42,560	45,700	46,840	47,980	49,120	50,260	51,400	52,440	53,480	54,520	25,560	26,600	26,600	26,600	26,600	26,600	26,600
		Fontana Water Company	37,000	37,600	38,200	38,800	39,400	30,500	31,000	31,500	32,000	32,500	33,000	33,500	34,000	34,500	35,000	35,500	35,700	35,900	36,100	36,300	36,500
		Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
																							_

1. Data for this table was obtained from the Water Demand and Supply Plans from the San Bernardino Municipal Water Department Recycled Water Planning Investigation - Appendix A.

2. Plaintifies (the Western Judgment include the City of Riverside, the Meeks & Daley Water Company, the Riverside Highland Water Company, and the University of California Regents. The demands of the Plaintiffs represent their adjusted water right from the SBBA, not the company, the Riverside Highland Water Company, and the University of California Regents.

Table 4-3
Water Supply Summary for Agencies that Rely on the SBBA<sup>1</sup>
(acre-ftyr)

		Total	Supplies	347,654	355,909	364,165	372,421	380,677	377,753	383,100	388,448	393,796	399,144	404,491	409,243	413,994	418,745	423,497	428,248	431,056	433,864	436,672	439,480	442,288
			Total Non-Potable Supplies	35,195	36,195	37,196	38,196	39,197	40,198	41,028	41,858	42,688	43,519	44,349	44,902	45,456	46,009	46,562	47,116	47,781	48,445	49,110	49,774	50,439
		SWP Water	Backwash Water from WVWD's WFF	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360
Non-Potable Supplies			City of Redlands' WWTP	4,223	4,384	4,546	4,707	4,869	5,031	5,192	5,354	5,516	5,677	5,839	2,900	5,962	6,024	6,085	6,147	6,209	6,270	6,332	6,393	6,455
Non-Potab		l Water	City of San Bernardino RIX	27,352	28,045	28,738	29,431	30,124	29,977	30,646	31,314	31,983	32,651	33,320	33,812	34,304	34,795	35,287	35,779	36,382	36,985	37,588	38,191	38,794
		Recycled Water	City of San Bernardino SBWRP	0	0	0	0	0	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840	840
			City of Rialto's WWTP <sup>4</sup>	2,260	2,406	2,552	2,698	2,844	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990	2,990
			Total Potable Supplies	312,459	319,714	326,969	334,224	341,480	337,555	342,072	346,590	351,107	355,625	360,143	364,341	368,538	372,736	376,934	381,132	383,276	385,419	387,562	389,706	391,849
		Nater	City of Redlands	1,524	1,563	1,603	1,642	1,682	1,721	1,761	1,800	1,840	1,879	1,919	1,962	2,006	2,049	2,093	2,136	2,180	2,223	2,267	2,310	2,354
		Direct Use of SWP Water	West Valley Water District	1,500	2,640	3,780	4,920	6,060	7,200	7,240	7,280	7,320	7,360	7,400	7,440	7,480	7,520	7,560	7,600	7,600	7,600	7,600	7,600	7,600
		Direct	Fontana Water Company <sup>3</sup>	2,000	2,000	2,000	2,000	2,000	2,000	2,000	5,000	5,000	2,000	2,000	5,000	5,000	2,000	2,000	2,000	2,000	5,000	2,000	2,000	2,000
			City of Redlands	381	391	401	411	420	430	440	450	460	470	480	491	501	512	523	534	545	929	295	929	288
	. from	asins <sup>2</sup>	City of Colton	6,500	6,640	6,780	6,920	7,060	7,200	7,320	7,440	7,560	7,680	7,800	7,920	8,040	8,160	8,280	8,400	8,400	8,400	8,400	8,400	8,400
	Groundwater from	Surrounding Basins <sup>2</sup>	ley City of Rialto	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
		S	West Val Water Distric	000'6	9,500	10,000	10,500	11,000	11,500	12,000	12,500	13,000	13,500	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000
			ate Fontana Water Company	21,360	22,588	23,816	25,044	26,272	18,000	18,200	18,400	18,600	18,800	19,000	19,100	19,200	19,300	19,400	19,500	19,600	19,700	19,800	19,900	20,000
		34	Other Private / Mutual s Water Companies	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300
		Surface Water from Lytle Creek, Mill Creek, and Santa Ana River	City of Redlands	17,142	17,587	18,031	18,476	18,920	19,364	19,809	20,253	20,698	21,142	21,586	22,076	22,565	23,055	23,544	24,033	24,523	25,012	25,501	25,991	26,480
		Surface Water from Mill Creek, and San	East Valley Water District	4,710	4,794	5,854	6,059	6,162	6,264	6,327	6,389	6,451	6,514	9/5/9	6,576	6,576	9/5/9	6,576	9/5'9	9/2/9	9/5/9	6,576	9/5/9	9/5/9
		Surfac Sreek, Mill C	City of Rialto	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
olies		Lytle C	West Valley Water	2,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Potable Supplies			Fontana Water Company	4,500	4,500	4,500	4,500	4,500	4,500	4,600	4,700	4,800	4,900	2,000	5,200	5,400	2,600	5,800	000'9	9,000	9'000	9,000	9'000	9,000
			Plaintiffs	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
		r from asin	Other Private / Mutual Water Companies	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
	rea	Groundwater from the Lytle Basin	y City of Rialto	4,000	4,020	4,040	4,060	4,080	4,100	4,000	3,900	3,800	3,700	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
	San Bernardino Basin Area		West Valley Water District	8,000	8,300	8,600	8,900	9,200	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500
	San Bernard		Fontana Water Company	6,140	5,512	4,884	4,256	3,628	3,000	3,200	3,400	3,600	3,800	4,000	4,200	4,400	4,600	4,800	2,000	5,100	5,200	5,300	5,400	5,500
			Plaintiffs	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300	62,300
			Other Private / Mutual Water Companies	15,900	15,840	15,780	15,720	15,660	15,600	15,540	15,480	15,420	15,360	15,300	15,240	15,180	15,120	15,060	15,000	14,940	14,880	14,820	14,760	14,700
			City of Redlands	19,047	19,541	20,035	20,528	21,022	21,516	22,010	22,503	22,997	23,491	23,985	24,529	25,072	25,616	26,160	26,704	27,247	27,791	28,335	28,879	29,423
		from Basin	/ City of Loma Linda	6,445	6,653	6,861	7,068	7,276	7,484	7,692	7,900	8,107	8,315	8,523	8,731	8,938	9,146	9,353	9,561	692'6	9,977	10,184	10,392	10,600
		Groundwater from the Bunker Hill Basin	East Valley Water District	26,690	27,166	26,666	27,021	27,478	27,936	28,213	28,491	28,769	29,046	29,324	29,324	29,324	29,324	29,324	29,324	29,324	29,324	29,324	29,324	29,324
		the o	City of San Bernardino	55,620	57,040	58,460	59,879	61,299	61,039	62,201	63,363	64,526	65,688	66,850	68,013	69,176	70,338	71,501	72,664	73,372	74,080	74,788	75,496	76,204
			City of Colton	2,000	7,140	7,280	7,420	7,560	7,700	7,820	7,940	8,060	8,180	8,300	8,440	8,580	8,720	8,860	000'6	9,000	000'6	9,000	9,000	000'6
			City of Rialto	4,000	4,100	4,200	4,300	4,400	4,500	4,600	4,700	4,800	4,900	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	2,000
			West Valley Water District	000'9	7,200	8,400	9,600	10,800	12,000	12,600	13,200	13,800	14,400	15,000	16,000	17,000	18,000	19,000	20,000	20,000	20,000	20,000	20,000	20,000
			Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

1. Data for this table was obtained from the Water Demand and Suppy Plans from the San Bernardino Municipal Water Department Recycled Water Planning Investigation - Appendix A.

2. Surrounding groundwater basins include the Chino, Raito, Colton, Riverside North, and Yucapa Basins.

3. The Fontana Water Company has two sources of imported water: (1) from the Valley Water District and (2) from the WWDSC. These values represent the amount of imported water received from the Valley Water District.



WILDERMUTH"

Aggregate Water Demand and Supply Plan for Agencies that Rely on the SBBA (acre-ft/yr)

		Non-Potable	Surplus / Shortfall	24,012	24,705	25,398	26,091	26,784	23,977	24,646	25,314	25,983	26,651	27,320	27,812	28,304	28,795	29,287	29,779	30,382	30,985	31,588	32,191	32,794
		ž																						
		Potable	Surplus / Shortfall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Non-Potable		Recycled Water Available for Reuse <sup>4</sup>	35,195	36,195	37,196	38,196	39,197	40,198	41,028	41,858	42,688	43,519	44,349	44,902	45,456	46,009	46,562	47,116	47,781	48,445	49,110	49,774	50,439
			Total Potable Supply	312,459	319,714	326,969	334,224	341,480	337,555	342,072	346,590	351,107	355,625	360,143	364,341	368,538	372,736	376,934	381,132	383,276	385,419	387,562	389,706	391,849
			Direct Use of SWP Water	8,024	9,203	10,383	11,562	12,742	13,921	14,001	14,080	14,160	14,239	14,319	14,402	14,486	14,569	14,653	14,736	14,780	14,823	14,867	14,910	14,954
Supplies			Groundwater From Surrounding Basins	41,241	43,119	44,997	46,875	48,752	41,130	41,960	42,790	43,620	44,450	45,280	45,511	45,741	45,972	46,203	46,434	46,545	46,656	46,767	46,878	46,988
ns	Potable		Total Produced from the SBBA	263,194	267,392	271,590	275,788	279,985	282,503	286,111	289,720	293,328	296,936	300,544	304,428	308,311	312,195	316,078	319,962	321,951	323,940	325,929	327,918	329,907
		Basin Area	Surface Water <sup>3</sup>	37,452	37,981	39,485	40,135	40,682	41,229	41,835	42,442	43,049	43,655	44,262	44,952	45,641	46,330	47,020	47,709	48,199	48,688	49,177	49,667	50,156
		San Bernardino Basin Area	Groundwater from the Lytle Creek Basin	22,740	22,432	22,124	21,816	21,508	21,200	21,300	21,400	21,500	21,600	21,700	21,900	22,100	22,300	22,500	22,700	22,800	22,900	23,000	23,100	23,200
			Groundwater from the Bunker Hill Basin	203,002	206,979	209,981	213,837	217,796	220,074	222,976	225,877	228,779	231,680	234,582	237,576	240,570	243,565	246,559	249,553	250,952	252,352	253,752	255,151	256,551
			Total Demand	323,642	331,205	338,767	346,330	353,893	353,775	358,455	363,134	367,813	372,492	377,171	381,431	385,690	389,950	394,210	398,469	400,674	402,879	405,084	407,289	409,494
Demands			Non Potable <sup>2</sup>	11,183	11,490	11,798	12,105	12,413	16,221	16,382	16,544	16,706	16,867	17,029	17,090	17,152	17,214	17,275	17,337	17,399	17,460	17,522	17,583	17,645
			Potable	312,459	319,714	326,969	334,225	341,480	337,555	342,072	346,590	351,107	355,625	360,142	364,340	368,538	372,736	376,934	381,133	383,276	385,419	387,562	389,706	391,849
			Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

<sup>1.</sup> This table combines information from the San Bernardino Municipal Water Department Recycled Water Planning Investigation - Tables 4-2 and 4-3.

<sup>2.</sup> Represents non-potable demands that can be met with planned recycled water reuse.

<sup>3.</sup> Surface water supplies in the SBBA include Lytle Creek, Mill Creek, and the Santa Ana River.
4. Includes available recycled water from the City of San Bernardino's SBWRP and RIX facility, the City of Ralto's WWTP, and the City of Redlands' WWTP and backwash water from the WWWD's WFF.

Table 4-5 Cumulative Unmet Replenishment Obligation of the Valley District – 2010 through 2030 (acre-ft/yr)

		ve Unmer shment ation <sup>7</sup>	_	_										99	10 66 527	10 66 827	110 66 527 592	10 66 66 627 627 62 63	10 10 527 527 662 336 315	10 66 527 527 662 662 836 815	0 0 0 0 0 2,110 7,466 116,527 29,292 45,762 65,936 65,936 115,449	110 66 66 66 762 762 336 315 977	10 66 66 62 62 62 73 83 83 83 87
	į	Cumulative Unmer Replenishment Obligation <sup>7</sup>	0	0	0	0	0	0	0	0	0	2,110	7,466	16,527	29,292		45,762	45,762	45,762 65,936 89,815	45,762 65,936 89,815 115,449	45,7 65,8 89,8 115,	45,762 65,936 89,815 115,446 142,836	45,762 65,936 89,815 115,449 142,836 171,977 202,873
		Actual Replenishment <sup>6</sup>	0	0	0	0	0	16,975	35,710	38,777	41,844	42,801	42,621	42,218	41,814		41,411	41,411 41,007	41,411 41,007 40,604	41,411 41,007 40,604 40,540	41,411 41,007 40,604 40,540 40,477	41,411 41,007 40,604 40,540 40,477 40,413	41,411 41,007 40,604 40,540 40,477 40,413
	Replenishment	Credits at the end of the Year <sup>5,6</sup>	157,070	127,072	93,505	56,371	15,668	0	0	0	0	0	0	0	0	c	0	0 0	000	0 0 0	0000	00000	000000
	er Project Water	Available for Replenishment	50,516	49,117	47,717	46,318	44,918	43,519	43,339	43,160	42,980	42,801	42,621	42,218	41,814	41,411		41,007	41,007	41,007 40,604 40,540	41,007 40,604 40,540 40,477	41,007 40,604 40,540 40,477	41,007 40,604 40,540 40,477 40,413
	Valley District Supply of State Water Project Water	Direct Deliveries <sup>4</sup>	10,924	12,323	13,723	15,122	16,522	17,921	18,101	18,280	18,460	18,639	18,819	19,222	19,626	20,029		20,433	20,433	20,433	20,433 20,836 20,900 20,963	20,433 20,836 20,900 20,963 21,027	20,836 20,836 20,900 20,963 21,027 21,090
	valley District S	Table A deliveries at 60% Reliability³	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440		61,440	61,440	61,440 61,440 61,440	61,440 61,440 61,440 61,440	61,440 61,440 61,440 61,440	61,440 61,440 61,440 61,440 61,440
		Replenishment Obligation²	26,430	29,998	33,566	37,134	40,703	32,643	35,710	38,777	41,844	44,911	47,977	51,279	54,580	57,881	64.400	201,102	64,483	64,483 66,173	64,483 66,173 67,864	64,483 66,173 67,864 69,555	64,483 66,173 67,864 69,555 71,245
		Extractions from the SBBA	31,094	35,292	39,490	43,688	47,885	38,403	42,011	45,620	49,228	52,836	56,444	60,328	64,211	68,095	71.978		75,862	75,862	75,862 77,851 79,840	75,862 77,851 79,840 81,829	75,862 77,851 79,840 81,829 83,818
	nts	Total Production Rights from the SBBA	232,100	232,100	232,100	232,100	232,100	244,100	244,100	244,100	244,100	244,100	244,100	244,100	244,100	244,100	244,100		244,100	244,100	244,100 244,100 244,100	244,100 244,100 244,100	244,100 244,100 244,100 244,100 244,100
	SBBA Production Rights	SBBA Augmentation from New Santa Ana River Water Right	0	0	0	0	0	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000		12,000	12,000	12,000 12,000 12,000	12,000 12,000 12,000 12,000	12,000 12,000 12,000 12,000 12,000
į	ñ	Safe Yield	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100		232,100	232,100	232,100 232,100 232,100	232,100 232,100 232,100 232,100	232,100 232,100 232,100 232,100 232,100
		Water Use from the SBBA <sup>1</sup>	263,194	267,392	271,590	275,788	279,985	282,503	286,111	289,720	293,328	296,936	300,544	304,428	308,311	312,195	316,078		319,962	319,962 321,951	319,962 321,951 323,940	319,962 321,951 323,940 325,929	319,962 321,951 323,940 325,929 327,918
		Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		2025	2025	2025 2026 2027	2025 2026 2027 2028	2025 2026 2027 2028 2029

1. SBBA suppleis include groundwater from the Barker Hill and Lytle Creek Basins and surface water from the Santa Ana River, Mill Creek, and Lytle Creek, The Plaintiffs are assumed to pump at their aggregate rights so they do not have a replenishment obligation. The water demands reported herein are based on information provided by the includual retail water agencies in 2009 and do not incorporate the SB-7 requirement for a 10-percent reduction in potable per capita demand by 2015 and a 20-percent reduction by 2020.

4. Direct Deliveries are the Valley District's obligations to individual agencies for consumptive use, including the Fortana Water Company, West Valley Water District, City of Rediands, and Yucajpa Valley Water District.

7. The CURO describes the total amount of water that the Valley District must recharge to balance the storage of the SBBA.



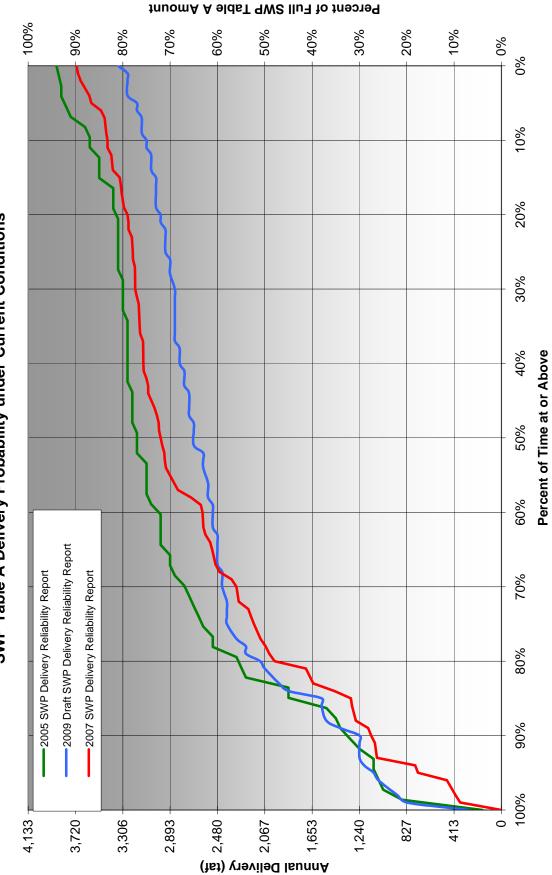
<sup>2.</sup> The replenishment obligation is equal to the total volume of excess extractions from the SBBA minus the return flow (15%) from the extractions above the sale yield.

<sup>3.</sup> The Valley District's Table A allocation of State Water Project water 102,400 acre-ft/yr.

<sup>5.</sup> Assumes that the Valley District has a credit of about 183,500 acre-ft at the end of 2009.

<sup>6.</sup> Assumes that the Valley District only replenishes the SBBA when the replenishment credits have expired.

Figure 4-1 SWP Table A Delivery Probability under Current Conditions





100% %06 80% %02 %09 20% 30% 20% 10% 40% %0 <sub>7</sub> %0 =2007 SWP Delivery Reliability Report, Lower Bound of 2027 Studies, Based on Four Climate Change Scenarios Averaged over Flow Target Scenarios -2007 SWP Delivery Reliability Report, Upper Bound of 2027 Studies, Based on Four Climate Change Scenarios Averaged over Flow Target Scenarios -2009 Draft SWP Delivery Reliability Report, 2029 Study 10% 20% SWP Table A Delivery Probability under Future Conditions 30% 40% Percent of Time at or Above 20% %09 -2005 SWP Delivery Reliability Report, 2025 Study %02 %06 100% 0 413 1,240 4,133 3,306 2,893 2,480 1,653 827 3,720 2,067 Annual Delivery (taf)

Figure 4-2

Percent of Full SWP Table A Amount



# **Section 5 – Existing Recycled Water Management Plan**

## **5.1** Wastewater Collection and Treatment Systems

The SBMWD owns and operates the SBWRP. The SBMWD and the City of Colton are members of a Joint Powers Agency that owns and operates the RIX Facility. Individual wastewater collections systems operated by the County of San Bernardino, the City of Loma Linda, and the EVWD discharge raw wastewater into the City of San Bernardino's wastewater collection system for treatment at the SBWRP and disposal to the Santa Ana River. The SBWRP also accepts domestic, commercial, and industrial wastewater generated in the SBWRP discharges secondary treated effluent to the RIX facility for further treatment and disposal to the Santa Ana River. Figure 5-1 shows the area tributary to each wastewater collection system and the locations of the treatment facilities.

The City of Colton operates a wastewater collection system and the Colton Water Reclamation Facility (CWRF). The CWRF discharges secondary treated effluent to the RIX facility for further treatment and disposal to the Santa Ana River. Currently, the CWRF treats about 5.3 mgd and is permitted to treat up to 10.4 mgd.

## **5.1.1** San Bernardino Water Reclamation Plant

Raw wastewater from the City's wastewater collection system is treated to a secondary level at the SBWRP in four separate stages: preliminary, primary, secondary, and solids handling. Figure 5-2 shows a partial flow schematic for the SBWRP, and Figure 5-3 shows an aerial photo of the plant. Following secondary treatment at the SBWRP, non-disinfected effluent is conveyed via a gravity pipeline to the RIX facility for further treatment and disposal. The SBMWD is permitted to discharge disinfected secondary treated effluent from the SBWRP directly to the Santa Ana River as long as at least a twenty-to-one dilution is maintained. The SBWRP is permitted to treat up to 33 mgd.

## **5.1.2** Rapid Infiltration Extraction Facility (RIX) in Colton

Secondary treated effluent from the SBWRP and the CWRF combine prior to entering the RIX facility. RIX treats the incoming effluent to a tertiary level to comply with Title 22, Division 4, of the CCR. Treatment at the RIX facility involves a soil aquifer treatment process, followed by ultraviolet (UV) disinfection prior to being discharged to the Santa Ana River. The major components of the RIX facility include a series of infiltration basins, an extraction well system, a fluidized bed sand filter, a cloth disk filter, and a monitoring well system. The filters were added to the RIX facility to increase filtration capacity.

The SARWQCB allows for the RIX facility to extract more groundwater at the RIX site than the amount of secondary effluent that is recharged: the RIX facility is permitted to treat up to 40 mgd of secondary effluent and discharge up to 64 mgd of tertiary treated recycled water.



## 5.2 Recycled Water Supply Projections

Water demand and supply projections were developed for this investigation based on information provided by the individual cities and water districts that rely on the SBBA as a water source. These projections, which are included in Appendix A, are the basis for the following wastewater and recycled water projections.

## **5.2.1** Projections by Wastewater Collection System

Table 5-1 shows the amount of raw wastewater that will be generated by the City of Colton, the SBWMD, the EVWD, and the City of Loma Linda through 2030. The amount of raw wastewater generated by the City of Colton's sphere of influence and collected by its wastewater collection system is approximately 5.3 mgd in 2010 and is projected to increase to about 7.1 mgd by 2030. The amount of raw wastewater generated by the SBMWD service area is approximately 14.4 mgd in 2010 and is projected to increase to about 22.0 mgd by 2030. The amount of raw wastewater generated by the EVWD service area and collected by its wastewater collection system is approximately 8.4 mgd in 2010 and is projected to increase to about 10.4 mgd by 2030. And, the amount of raw wastewater generated by the City of Loma Linda's sphere of influence and collected by its wastewater collection system is approximately 1.7 mgd in 2010 and is projected to increase to about 3.1 mgd by 2030.

## **5.2.2** Projections of Recycled Water at the SBWRP

Table 5-1 shows the amount of secondary treated recycled water that will be available for subsequent treatment and use or for discharge at the SBWRP. Currently, the SBWRP treats approximately 24.4 mgd; in 2030, it is projected to treat up to 35.4 mgd.

## **5.2.3** Projections of Recycled Water at the RIX Facility

Table 5-1 shows the amount of tertiary treated recycled water that will be available for use or discharge at the RIX facility. Currently, the RIX facility treats about 29.7 mgd; in 2030, it is projected to treat up to 42.5 mgd. Including extracted groundwater, which is expected to be about 20-percent of the incoming flow, the RIX facility will produce approximately 35.7 mgd in 2010 and about 51.0 mgd by 2030.

## **5.2.4** Current and Future Use of Recycled Water

Currently, effluent from the SBWRP and the RIX facility is discharged to the Santa Ana River, and the agencies that discharge to the SBWRP and CWRF do not have recycled water reuse programs in place; though, some intend to implement them in the future. Absent this project, the SBMWD had plans to reuse 840 acre-ft/yr (i.e. 0.75 mgd) from the SBWRP by 2015. The City of Loma Linda has identified non-potable demands that can be met with recycled water acquired from the City of Redlands. And, the City of Colton intends to meet non-potable demands in the Pellissier Ranch Development with recycled water in the future. The EVWD



does not anticipate recycled water reuse in its service area. The current and projected wastewater collection, treatment, and discharge of recycled water, in the absence of an expanded recycling program, is shown schematically in Figure 5-4.

# **5.3** Recycled Water Quality

Table 5-2 summarizes historical water quality at the SBWRP. Tables 5-3 and 5-4 summarize historical water quality at the RIX facility. At present, the effluent quality at the SBWRP and the RIX facility consistently complies with the existing discharge permits.





Table 5-1
Wastewater and Recycled Water Projections at the SBWRP and RIX Facility

		Waste	Wastewater Generated		Availak	Recycled Water Available for Use or Discharge	scharge	Recycled Wate Available for	Recycled Water with Extracted Groundwater Available for Use or Discharge from RIX	Groundwater je from RIX
Year	City of Colton	SBMWD <sup>1</sup>	EVWD 1	City of Loma Linda <sup>1</sup>	CWRF	SBWRP 2	RIX ³	Extracted Groundwater <sup>4</sup>	Available for Use or Discharge	Available for Use or Discharge
		m	mgd			pßm		pßm	pgm	(acre-ft/yr)
2010	5.3	14.4	8.4	1.7	5.3	24.4	29.7	5.9	35.7	39,950
2011	5.4	14.8	8.5	1.8	5.4	25.1	30.5	6.1	36.6	40,960
2012	5.5	15.2	8.7	1.8	5.5	25.8	31.2	6.2	37.5	41,974
2013	5.6	15.6	8.9	1.9	5.6	26.3	31.9	6.4	38.3	42,873
2014	5.6	16.0	9.0	1.9	5.6	26.9	32.6	6.5	39.1	43,772
2015	5.7	16.3	9.2	2.0	5.7	27.5	33.2	9.9	39.9	44,669
2016	5.8	16.7	9.3	2.1	5.8	28.1	33.9	8.9	40.6	45,515
2017	5.9	17.1	9.4	2.1	5.9	28.7	34.6	6.9	41.5	46,493
2018	0.9	17.5	9.6	2.2	0.9	29.3	35.2	7.0	42.3	47,348
2019	0.9	17.9	9.7	2.3	0.9	29.9	36.0	7.2	43.2	48,339
2020	6.1	18.3	9.6	2.3	6.1	30.5	36.6	7.3	43.9	49,204
2021	6.2	18.8	6.6	2.4	6.2	31.2	37.4	7.5	44.9	50,247
2022	6.3	19.1	6.6	2.5	6.3	31.6	37.9	7.6	45.5	50,909
2023	6.4	19.5	6.6	2.5	6.4	31.9	38.4	7.7	46.0	51,572
2024	6.5	19.8	6.6	2.6	6.5	32.3	38.9	7.8	46.6	52,236
2025	6.7	20.1	6.6	2.6	6.7	32.7	39.4	7.9	47.2	52,900
2026	6.8	20.3	6.6	2.7	6.8	32.9	39.7	7.9	47.6	53,366
2027	6.9	20.5	6.6	2.8	6.9	33.2	40.1	8.0	48.1	53,853
2028	7.0	21.0	10.1	2.9	7.0	34.0	41.0	8.2	49.1	55,044
2029	7.1	21.6	10.3	3.0	7.1	34.8	41.8	8.4	50.2	56,246
2030	7.1	22.0	10.4	3.1	7.1	35.4	42.5	8.5	51.0	57,165

<sup>1.</sup> Wastewater flows from the SBMWD, EVWD, and City of Loma Linda combine prior to being measured at the SBWRP. Therefore, the wastewater flow projections for the individual wastewater collection systems were based on the total water supplies for those service areas.



<sup>2.</sup> The SBWRP receives raw wastewater from the service areas of SBMWD, EVWD, and City of Loma Linda.

<sup>3.</sup> The RIX facility receives secondary treated effluent from the SBWRP and the CWRF. In May 2010, the SBMWD submitted a Wastewater Change Petition (WW0059) to the SWRCB to reduce the quantity of treated wastewater discharged to the Santa Ana River to 11.9 mgd or 13,322 acre-ft/year.

<sup>4.</sup> The extracted groundwater projections are based on a 20-percent overproduction rate.



Table 5-2
Effluent and Recycled Water Quality

Constituent	Primary Effluent at the SBWRP	Secondary Effluent at the SBWRP
	mg/L	mg/L
Total Suspended Solids (TSS) 1	06	2
Total Dissolved Solids (TDS) 1	260	510
Biochemical Oxygen Demand (BOD) <sup>1</sup>	200	16
Ammonia 1	30	2
Silica <sup>2, 3</sup>	27	27
TOC <sup>4</sup>	42	10-12

- 1. Data is based on 2009 historic averages.
- 2. Silica will limit the recovery of the reverse osmosis membrane process and is critical to determining the overall system recovery.
- 3. Silica is not typically analyzed in primary effluent but is expected to be similar to secondary effluent quality.
- 4. TOC data was not available. The values shown are based on data from the Orange County Sanitation District.

WILDERMUTH' ENVIRONMENTAL INC.

Table 5-3

		Maximum	38.4 36.9 48.5	7.4 7.3 8.4	838 810 880	1.0 0.4 3.1	ON ON 4	Q Q ∞	8.9 8.3 10.0	0.8 0.7 1.1
	Mississi		34.8 19.8 36.0	7.2 6.8 7.4	791 710 820	0.4 0.2 0.6	999	999	6.2 5.8 6.5	0.1 0.2 0.2
		Average	36.3 31.5 39.8	7.3 7.1 7.8	811 766 849	0.6 0.3 1.4	999	999	7.7 7.1 8.5	0.4 0.6 0.6
		June	35.9 25.5 48.5	7.3 7.2 7.4	833 800 850	0.9 0.3 2.7	9 9 r	999	7.8 6.9 8.8	0.5 0.6 0.6
		May	34.9 31.8 36.0	7.4 7.2 7.6	838 810 870	0.8	999	999	7.1 6.8 7.8	0.7 0.2 1.0
	5009	April	35.9 34.6 37.7	7.3 7.1 8.2	834 810 870	0.0 0.0 0.6	999	999	7.7 7.0 8.4	0 0 0.4 0.8 0.8
	20	March	38.4 36.9 40.0	7.2 7.1 7.6	818 790 850	0.3 0.3	999	999	8.0 7.7 8.3	0.3 0.2 4.
		February	37.3 33.7 39.7	7.2 6.8 8.0	807 710 840	1.0 0.4 3.1	O O 7	999	8 8 6 6 6 6	0.8 0.7 1.1
rge Data <sup>1</sup>		January	36.1 34.6 39.5	7.3 7.1 7.7	796 770 820	0.7 0.4 1.3	O O 0	999	8.9 8.1 10.0	0.5 0.8 0.8
RIX Discharge Data		December	35.7 29.0 37.5	7.3 7.2 8.3	791 750 830	0.7	Q Q &	222	8.8 9.6 9.6	0.4 0.0 0.6
		November	36.8 33.9 39.8	7.3 7.0 7.5	812 770 840	0.5 0.3 0.6	O O 4	222	8.8 8.2 8.9	0.2
	2008	October	34.8 19.8 39.8	7.3 7.1 7.4	815 750 880	0.7 0.2 1.9	Q Q 9	Q Q ∞	7.9 7.0 8.9	0.1
	20	September	36.0 33.0 42.1	7.3 7.0 7.5	800 750 840	0.6	2 2 2	222	6.6 5.9 7.9	0.3 0.3
		August	36.3 31.8 37.5	7.4 7.2 8.4	808 780 870	0.6 0.4 1.2	Q Q Q	O O 4	6.2 6.5 6.5	0.2 0.1 0.5
		July	36.9 33.9 39.4	7.4 7.3 7.4	806 740 830	0.7 0.4 1.3	999	999	6.2 6.5 6.5	0.2 0.1 0.5
			Average Minimum Maximum							
	o pi cel -	Sillo	pßw		umhos/cm	UTN	mg/L	mg/L	mg/L	mg/L
	, 100		Flow	Hd	EC	Turbidity <sup>2</sup>	BOD <sub>5</sub> <sup>2</sup>	TSS 2	Z N L	Ammonia <sup>2</sup>

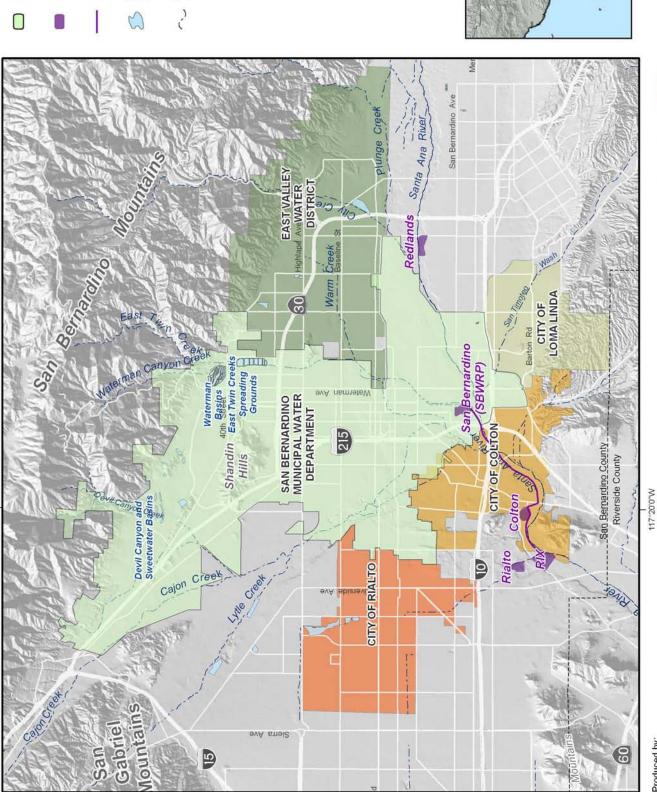
Data was obtained from the SBMWD.
 Data is from weekly sampling events.

Table 5-4
RIX Monthly Effluent Water Quality Data<sup>1</sup>

Constituent	Units	Average	Minimum	Maximum
Bicarbonate	mg/L	231	220	240
Calcium	mg/L	64	59	71
Carbonate	mg/L	ND	ND	ND
Chloride	mg/L	69	62	76
Carbon, Total Organic	mg/L	2.7	2.4	3.9
Dissolved Solids, Total	mg/L	489	420	560
Fluoride	mg/L	0.6	0.4	0.7
Manganese	mg/L	209	68	360
N.D.M.A.	mg/L	ND	ND	ND
Nitrogen, Ammonia Composite	mg/L	0.51	0.11	1.10
Nitrogen, Nitrate	mg/L	6.7	5.2	8.9
Nitrogen, Nitrite	mg/L	0.22	< 0.10	0.43
Nitrogen, Total Inorganic	mg/L	7.5	5.7	10.0
Sodium	mg/L	77	72	84
Sulfate	mg/L	78	70	87
Alkalinity, Total	mg/L	189	180	200
Hydroxide	mg/L	ND	ND	ND
Magnesium	mg/L	12	11	13
Potassium	mg/L	15	14	17
Total Suspended Solids	mg/L	ND	ND	ND
BOD	mg/L	< 5	ND	6
Hardness, Total	mg/L	209	190	230

<sup>1.</sup>Data was obtained from the SBMWD and is for the period on January 2007 to June 2009.





San Bernardino County Flood Control District Recharge Facilities

Streams, Rivers, and Flood Control Channels

Existing Pipeline from SBWRP to RIX

Water Reclamation Facilities

Wastewater Service Areas

117°20'0"W

Riverside County Orange County © San

San Bernardino County

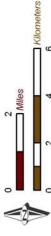
County

Location of Wastewater Service Areas

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SBMWD Recycled Water Planning Investigation

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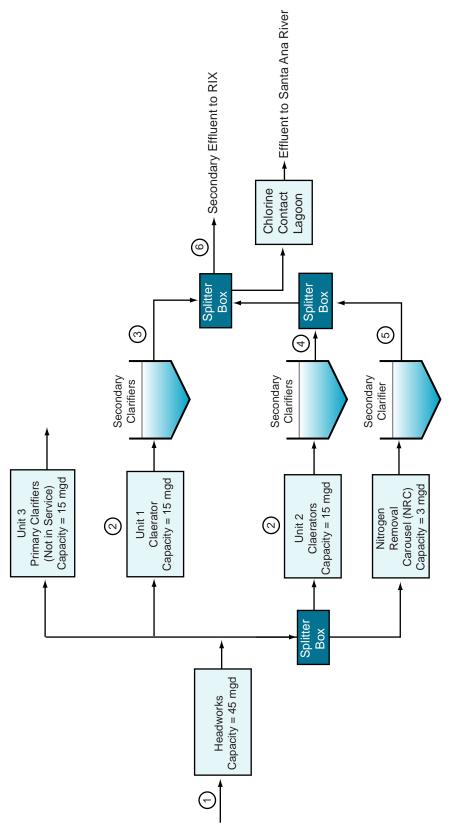




### **FACILITIES PFD EXISTING**

FIGURE 5-2

SAN BERNARDINO MUNICIPAL WATER DEPARTMENT



-	_		$\neg$	_	-	-	-	-	-	
9	Combined	Secondary	Effluent	25.1	17400	2	510	16	5.2	
5	NRC	Secondary	Effluent	2.8	1900	-	-	-	9.5	
4	Unit 2	Secondary	Effluent	12.2	8500	6			4.8	
8	Unit 1	Secondary	Effluent	10.1	0002	10	-	-	3.8	
2	Drimomi	Fffluent		25.1	17400	06	099	200	30	
1	+000	Influent		25.1	17400	280	260	330	30	
Stream Number		Description		Flow Rate (mgd)	Flow Rate (gpm)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Biochemical Oxygen Demand (mg/L)	Ammonia (mg/L)	







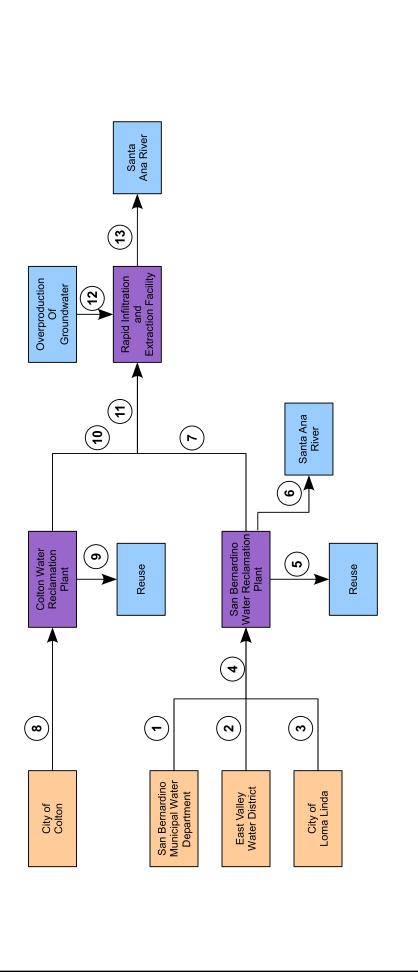
## EXISTING SITE LAYOUT

TE LAYOU









				Volume	es of wa	ater in a	Volumes of water in acre-feet/year	/year					
Stream 1	-	7	က	4	2	62	7	œ	6	10	1	12 13	13
Year													
2010	16,100	16,100 9,400 1,920 27,420	1,920	27,420	0	0	27,420	5,940	0	5,940	33,360 6,660	099'9	40,020
2015	18,300	18,300 10,300	2,250	30,850	840	0	30,010	6,410	0	6,410	6,410 36,420 7,440	7,440	43,860
2020	20,500	20,500 11,000	2,620	2,620 34,120	840	0	33,280	6,840	0	6,840	6,840 40,120 8,200	8,200	48,320
2030	24,600	11,600	3,420	24,600 11,600 3,420 39,620	840	0	0 38,780 8,000	8,000	0	8,000	8,000 46,780 9,530	9,530	56,310

1 This schematic represents the treatment facilities without the proposed reuse project. 2 SBWRP intermittently discharges to the Santa Ana River during large storm events.

SBMWD Recycled Water Planning Investigation



Produced for:

**Existing Wastewater Schematic** 





The Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), and the California Water Code (CWC) are the primary laws that protect water quality in California. Under the CWA, the EPA or an assigned state agency regulates the discharge of pollutants into waterways through the issuance of National Pollutant Discharge Elimination System (NPDES) permits. NPDES permits set limits on the amount of pollutants that can be discharged into the waters of the United States. The SDWA establishes contaminant limits in drinking water. The CDPH enforces drinking water standards in California and has established its own set of rules and water quality standards that are at least as restrictive as the SDWA and are often more restrictive. The CWC and the Porter-Cologne Act, a provision of the code, require the state to adopt water quality policies, plans, and objectives to protect the ground and surface waters of the state. The SWRCB and the nine RWQCBs meet this requirement by developing water quality control plans (i.e. Basin Plans) that establish water quality criteria in each region. The CDPH works with the RWQCBs to protect public health and safety through the California Code of Regulations (CCR) Title 22, Division 4, Chapter 3 by developing statewide regulations on the permitted uses of recycled water.

The recycling criteria described in the CCR set the water quality of, or levels of constituents in, recycled water and provide criteria for treatment processes, distribution, and use areas to assure the use of recycled water is safe from a public health standpoint. This section describes the recycling criteria expressed in the CCR and the Basin Plan and their relevance to the CWF.

### **6.1** Recycled Water Reuse

### **6.1.1** Groundwater Recharge – Spreading and Injection

Groundwater basins are naturally recharged by surface water that infiltrates beyond the root zone. Natural recharge can be enhanced by constructing spreading basins to divert and store stormwater for subsequent infiltration. Spreading basins can also be used to recharge supplemental source waters, such as recycled and imported waters. An alternative method to surface spreading is injection. Injection uses a well that has been completed into the vadose or saturated zone of an aquifer. Stormwater recharge through injection is usually done with drywells that are completed in the vadose zone. Supplemental water injection is usually done into the saturated zone and requires extensive treatment prior to injection: the level of treatment being a function of source water quality and receiving water quality.

Historically, surface spreading has been the more predominant method for groundwater recharge. Surface spreading has historically been done in the Santa Ana Watershed through improvements in natural channels, former quarry pits, stormwater retention facilities, and occasionally in off-channel facilities designed primarily for recharge. Injection has been used by some Southern California water agencies to protect fresh water supplies from seawater intrusion, to target recharge in specific areas to improve the balance of recharge and discharge, to store surplus water during the winter for subsequent withdrawal for summer peaking, and to accomplish recharge in areas where land is not available for spreading basins.



### **6.1.2** Direct Uses

Direct use refers to meeting non-potable demands with recycled water. These uses include irrigation, dust control, fire suppression, industrial process, and industrial cooling.

### **6.2** Regulatory Requirements

### **6.2.1 State Water Resources Control Board**

In February 2009, the SWRCB adopted the Recycled Water Policy to promote recycled water reuse throughout California and to provide direction to the RWQCBs on issuing recycled water permits. The Recycled Water Policy directly addresses constituents of emerging concern, compliance with the SWRCB's Anti-Degradation Policy, and salinity management.

In July 2009, the SWRCB adopted Order No. 2009-0006-DWQ – General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water (General Permit) to satisfy the requirements of CWC section 13552.5, which requires the SWRCB to adopt a General Permit for landscape irrigation uses of municipal recycled water. The General Permit is intended to streamline the permitting process for producers and distributors of municipal recycled water who intend to supply disinfected tertiary recycled water (or greater quality) for landscape irrigation uses. Irrigation projects must meet the following criteria to be eligible for the streamlined permitting process: "(1) [c]ompliance with the requirements for recycled water established in Title 22 of the [CCR] [...], (2) [a]pplication in amounts and at rates as needed for the landscape [...], (3) [c]ompliance with any applicable salt and nutrient management plan, (4) [a]ppropriate use of fertilizers that takes into account the nutrient levels in the recycled water [...]".

For the General Permit, the SWRCB acts as the "lead agency" under the CEQA and has prepared and certified a mitigated negative declaration, determining that the General Permit will have a less-than-significant effect on the environment.

### 6.2.2 Santa Ana River Regional Water Quality Control Board

The mission of the nine RWQCBs is to develop and enforce water quality objectives and implement plans that will best protect the state's water resources. The investigation area is located in the SARWQCB's jurisdiction.

In 2004, the SARWQCB implemented Resolution No. R8-2004-0001, amending the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) to incorporate an updated TDS and nitrogen management plan (SARWCB, 2004). This amendment included revised groundwater management zones, revised TDS and nitrate-nitrogen objectives, revised TDS and nitrogen wasteload allocations, revised reach designations, revised beneficial use designations for some surface water bodies, and revised TDS and nitrogen objectives for some surface water bodies.



### **6.2.2.1** Management Zone Water Quality Objectives

Every three years, the SARWQCB, recalculates the ambient water quality of each management zone to determine their current states and to assess the impacts that basin management activities are having on groundwater quality.

In the Bunker Hill A Management Zone, the water quality objectives for TDS and nitrate are 310 mg/L and 2.7 mg/L (NO<sub>3</sub>-N), respectively, and the most current (2006) estimates of ambient TDS and nitrogen concentrations are 330 mg/L and 4.0 mg/L, respectively (Wildermuth 2008). If the current quality of a management zone is the same as or poorer than the water quality objectives, assimilative capacity does not exist. If the current quality is better than the water quality objectives, assimilative capacity exists. In the latter case, the difference between the objective and current quality is the magnitude of assimilative capacity. Where assimilative capacity exists, the SARWQCB may, at its discretion, permit wastewater discharges at concentrations higher than the basin objective (SARWQCB, 2004). With TDS and nitrate concentrations that are 20 mg/L and 1.3 mg/L above the objectives, respectively, the Bunker Hill A Management Zone does not have assimilative capacity.

### 6.2.2.2 Santa Ana River Water Quality Objectives

The SBMWD is permitted to discharge secondary treated effluent from the SBWRP to Reach 5 of the Santa Ana River (SAR), which spans from the San Jacinto Fault in San Bernardino to the Seven Oaks Dam. The water quality objectives for Reach 5 are:

• TDS: 300 mg/L

• hardness: 190 mg/L

sodium: 30 mg/Lchloride: 20 mg/L

• total inorganic nitrogen: 5 mg/L

• sulfate: 60 mg/L

• chemical oxygen demand: 25 mg/l

The SBMWD is permitted to discharge tertiary treated effluent from the RIX facility to Reach 4 of the Santa Ana River, which spans from Mission Boulevard in Riverside to the San Jacinto Fault in San Bernardino. The water quality objectives for Reach 4 are:

TDS: 550 mg/L

• total inorganic nitrogen: 10 mg/L

chemical oxygen demand: 30 mg/L

### 6.2.2.3 Discharge and Reuse Permits

RWQCBs issue two main types of permits to agencies that operate WWTPs: Waste Discharge Requirements (WDR) and/or Water Recycling Requirements (WRR). WDRs are issued to regulate the discharge of wastes to waters of the state. WRRs regulate reuse and its potential impact to regional water quality by affecting the underlying groundwater basins.



The SBMWD currently operates under four SARWQCB orders (i.e. permits):

- Order No. R8-2009-0004 (NPDES No. CAG648001) is a general WDR for discharges to surface waters of process wastewater associated with certain wellhead treatment systems.
- Order No. R8-2008-0007 (NPDES No. CA8000015) is a WDR for discharges to Lytle Creek, East Twin Creek, and Warm Creek channels from its Geothermal Facility.
- Order No. R8-2006-0052 (NPDES No. CA8000304) is a Waste Discharge and Producer/User Reclamation Requirements permit for discharges to the SAR from its RIX facility.
- Order No. R8-2005-0074 (NPDES No. CA0105392) is a WDR for discharges to the SAR from its SBWRP.

In California, any entity that recycles or proposes to recycle water and uses or proposes to use recycled water must file a report with its local RWQCB. The RWQCBs implement the provisions of the CCR Title 22 regulations by issuing WRRs to recycled water producers, users, or both. WRRs are issued for a variety of uses, including, but not limited to, groundwater recharge, landscape irrigation (e.g. at schools, parks, golf courses, and freeways), and other non-potable uses.

Another type of recycling permit issued by the RWQCBs is a Master Recycling Requirements (MRR) permit. MRR permits allow agencies to distribute recycled water to various users without separate user recycling requirements from the RWQCB. According to CWC Division 7, Chapter 7, Article 4, an MRR permit, at a minimum, must include:

- "Waste discharge requirements, adopted pursuant to Article 4 (commencing with Section 13260) of Chapter 4;
- A requirement that the permittee comply with the uniform statewide reclamation criteria established pursuant to Section 13521. Permit conditions for a use of reclaimed water not addressed by the uniform statewide water reclamation criteria shall be considered on a case-by-case basis;
- A requirement that the permittee establish and enforce rules or regulations for reclaimed water users, governing the design and construction of reclaimed water use facilities and the use of reclaimed water, in accordance with the uniform statewide reclamation criteria established pursuant to Section 13521;
- A requirement that the permittee submit a quarterly report summarizing reclaimed water use, including the total amount of reclaimed water supplied, the total number of reclaimed water use sites, and the locations of those sites, including the names of the hydrologic areas underlying the reclaimed water use sites;
- A requirement that the permittee conduct periodic inspections of the facilities of the reclaimed water users to monitor compliance by the users with the uniform statewide reclamation criteria established pursuant to Section 13521 and the requirements of the master reclamation permit; and
- Any other requirements determined to be appropriate by the regional board."



If the RWQCB determines that a proposed recycled water reuse project has the potential to impact public health, safety, or welfare, it will consult with the CDPH and consider its recommendations when issuing WRRs and MRRs.

### 6.2.3 California Department of Public Health Title 22 CCR

The CDPH establishes criteria and guidelines for producing and using recycled water. These criteria are codified in the CCR, Title 22, Division 4, Chapter 3, entitled "Water Recycling Criteria." The CDPH has regulatory authority over recycled water reuse projects in California. The CDPH utilizes the provisions of California Health Laws, including the Health and Safety Code, the CWC, and the CCR to regulate recycled water reuse.

### **6.2.3.1** Treatment Requirements

Prior to reuse, wastewater needs to undergo certain levels of treatment to minimize health risks to humans and impacts to the environment. At a minimum, secondary treatment of wastewater is required prior to recycled water reuse. Un-disinfected secondary-treated recycled water may be used, for example, for orchards and vineyards where the recycled water does not come into contact with the food crop. Disinfected secondary-treated recycled water is authorized for use at sites and during times not accessible by the public (e.g. at WWTPs or at golf courses if irrigation is scheduled at non-use times). According to CCR Title 22, Division 4, Chapter 3, Article 2, there are two qualities of recycled water that can be used on a limited basis: "disinfected secondary-2.2 recycled water" and "disinfected secondary-23 recycled water."

For unrestricted reuse, the minimum level of treatment is tertiary followed by disinfection. The CCR describes this quality of water as "disinfected tertiary recycled water." According to CCR Title 22, Division 4, Chapter 3, Article 1, disinfected tertiary recycled water (i.e. tertiary treated recycled water) must meet the following criteria prior to reuse:

- Process to include media filtration with a peak filter loading rate less than or equal to the approved loading rate. For cloth media filtration, the peak loading rate shall not exceed 6 gpm/ft<sup>2</sup>.
- "The turbidity of filtered wastewater shall not exceed any of the following:
  - o An average of 2 nephelometric turbidity units (NTU) within a 24-hour period.
  - o 5 NTU more than 5-percent of the time within a 24-hour period.
  - o 10 NTU at any time."
- Process to include "[a] chlorine disinfection process following filtration that provides a contact time (CT)<sup>18</sup> value of not less than 450 mg-min/L at all times, with a modal CT of at least 90-minutes, based on peak dry weather design flow; or a disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque-forming units of F-specific

<sup>&</sup>lt;sup>18</sup> CT is defined as the product of total chlorine residual and modal contact time measured at the same point.



November 2010 009-020-012 bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of the demonstration."

"The median concentration of total coliform bacteria measured in the disinfected effluent must not exceed a most probable number (MPN) of 2.2 per 100 mL utilizing the bacteriological results of the last 7 days for which analyses have been completed. Also, the number of total coliform bacteria must not exceed an MPN of 23 per 100 mL in more than one sample in any 30-day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 mL."

Additional treatment beyond tertiary and disinfection may be required to satisfy the RWQCB and/or CDPH *Draft Groundwater Recharge Reuse Regulations* (CDPH, 2008) for groundwater recharge projects that employ injection. For recharge projects that use surface spreading, advanced treatment could also be implemented to provide greater operational flexibility in reuse. The benefit of recharging advanced treated recycled water is that less dilution water is required by the recharge regulations, thereby adding operational flexibility.

### **6.2.3.2** Treatment Facility Reliability Requirements

In accordance with CCR Title 22, Division 4, Chapter 3, Articles 7, 8, 9, and 10, certain reliability features are required to maintain the proper function of the treatment processes used to produce recycled water. These include, but are not limited to:

- Multiple units, emergency storage or disposal methods, alternative treatment, or other
  means capable of providing treatment process reliability for conditions when one unit
  is out of service.
- "A preventive maintenance program shall be [in place at all recycling and treatment facilities] to ensure that all equipment is kept in a reliable operating condition."
- "Alarm devices required for various unit processes as specified in [the CCR] shall be installed to provide warning of:
  - O Loss of power from the normal power supply.
  - o Failure of a biological treatment process.
  - o Failure of a coagulation process.
  - o Failure of a filtration process.
  - o Failure of a disinfection process.
  - o Any other specific process failure for which warning is required by the regulatory agency."
- "All required alarm devices shall be independent of the normal power supply."
- "Process or equipment failures triggering an alarm shall be recorded and maintained as
  a separate record file. The record information shall include the time and cause of
  failure and corrective action taken."
- "The power supply shall be provided with one of the following reliability features:



- o Alarm and standby power source.
- O Alarm and automatically actuated [retention/storage] or disposal provisions [for untreated or partially treated wastewater]."

The reliability requirements pertain to all treatment processes including, but not limited to, primary, biological, sedimentation, coagulation, filtration, and disinfection treatment units. Specific reliability requirements for primary treatment, biological treatment, secondary sedimentation, coagulation, filtration, and disinfection are described in CCR Title 22, Division 4, Chapter 3, Articles 9 and 10.

### **6.2.3.3 Distribution and Use Area Requirements**

According to Division 104, Part 12, Chapter 5, Article 2 of the California Health and Safety Code, all pipes that are installed above or below ground and designed to carry recycled water shall be colored purple or distinctively wrapped with purple tape.

Non-potable distribution pipelines that convey recycled water must maintain a minimum horizontal and vertical separation from potable water distribution pipelines. Non-potable pipelines that convey tertiary treated recycled water must be at least four feet horizontally from and one foot vertically below any parallel pipeline that conveys potable water.

CCR Title 17, Division 1, Chapter 5, Group 4, Article 2, which governs the protection of water systems, requires the water supplier, in areas where recycled water is to be reused, to protect the public water supply from contamination by implementing a cross-connection control program. Specifications on the construction and location of the backflow preventers are also included in Title 17 of the CCR.

In accordance with CCR Title 22, Division 4, Chapter 3, Article 4, which governs use area requirements, the following criteria apply:

- "No irrigation with [tertiary treated recycled water] shall take place within 50-feet of any domestic water supply well unless the following conditions have been met:
  - o A geological investigation demonstrates that an aquitard exists at the well between the uppermost aquifer being drawn from and the ground surface.
  - O The well contains an annular seal that extends from the surface into the aquitard.
  - o The well is housed to prevent any recycled water spray from coming into contact with the well head facilities.
  - o The ground surface immediately around the wellhead is contoured to allow surface water to drain away from the well.
  - o The owner of the well approves of the elimination of the buffer zone requirement."
- "No impoundments of [tertiary treated recycled water] shall occur within 100-feet of any domestic water supply well."



- "[...] Irrigation runoff shall be confined to the recycled water use area, unless the runoff does not pose a public health threat and is authorized by the regulator agency."
- "Spray, mist, or runoff shall not enter dwellings, designated outdoor eating areas, or food handling facilities."
- "Drinking water fountains shall be protected against contact with recycled water spray, mist, or runoff."
- "All use areas where recycled water is used that are accessible to the public shall be posted with signs that are visible to the public [...]".
- "[...] No physical connection shall be made or allowed to exist between any recycled water system and any separate system that conveys potable water [unless the connection between the two systems is protected by an air gap separation]."
- "The portions of the recycled water piping system that are in areas subject to access by the general public shall not include standard hose bids."

### 6.2.3.4 Engineering Report

In accordance with CCR Title 22, Division 4, Chapter 3, Article 7, agencies that plan to produce or supply recycled water for recharge or direct reuse must submit an engineering report (Title 22 Engineering Report) to the CDPH for review and approval. The report must be prepared by a qualified engineer that is licensed in California and experienced in the field of wastewater treatment, must contain a description of the proposed water recycling system design, must clearly indicate the means for compliance with Title 22 regulations and any other features specified by the regulatory agency, and must contain a contingency plan that ensures no untreated or inadequately treated wastewater is delivered to the use area. For groundwater recharge projects, the engineering report must document how the project complies with the latest CDPH *Draft Groundwater Recharge Reuse Regulations*.

### 6.2.4 San Bernardino County Health Department

The San Bernardino County Department of Public Health, Division of Environmental Health Services (SBCDPH) will not be directly involved in regulating recycled water reuse projects. The SBCDPH is not responsible for the administration of a cross-connection control program. In San Bernardino County, this responsibility lies with the potable water supplier where recycled waster is used. The SBCDPH is however involved with the permitting of new wells and, thus, will be involved with the permitting of new monitoring wells and the maintenance of buffer zones around the proposed recharge basins.<sup>19</sup>

<sup>19</sup> http://www.sbcounty.gov/dehs/general\_information/water\_wastewater\_land\_use.htm





### 6.3 Use-Specific Criteria

CCR, Title 22 contains use-specific criteria that apply to recycled water users. Specifically, these use-specific criteria are included in CCR Title 22, Division 4, Chapter 3, Articles 3, 5.1, and 6, and are described below.

### **6.3.1** Groundwater Recharge

CCR Title 22, Division 4, Chapter 3, Article 5.1 presents regulations for recycled water projects involving groundwater recharge of recycled water. CCR Title 22 requires recycled water that is used for groundwater recharge of domestic (potable) water supply aquifers to be of a quality that protects public health. Proposed groundwater recharge projects are reviewed by the CDPH on an individual basis where the recharge of recycled water may involve a potential risk to public health. Moreover, the CCR specifies that the CDPH must review a proposed groundwater recharge project, conduct a public hearing, prepare findings, and make recommendations to the RWQCB.

Groundwater recharge projects may be planned for different purposes, such as injection into seawater intrusion barrier wells (e.g. Talbert Barrier in the Orange County Groundwater Basin), indirect potable use (e.g. via spreading basins, as done by the Inland Empire Utilities Agency and Orange County Water District), or for the hydraulic control of groundwater flow (e.g. where regional contamination may be present).

The following sections describe the regulatory criteria associated with the use of recycled water for groundwater recharge as well as the WRRs issued to the Orange County Water District in 2004 (SARWQCB, 2004) and the Inland Empire Utilities Agency in 2009 (SARWQCB, 2009).

### **6.3.1.1** Status of Regulations for Groundwater Recharge

The Draft Groundwater Recharge Reuse Regulations contained in Article 5.1 were last updated by the CDPH on August 5, 2008. The final proposed version of the regulations will be approved through the formal regulation adoptions process and will be subject to public review and comment. As of this writing there is no official estimate of when the regulations will be adopted.

### **6.3.1.2 Draft Recharge Regulations**

Requirements for using recycled water for groundwater recharge are significantly different from those for direct use. Since groundwater basins are used for potable water supply purposes, the regulations are designed to protect public health as well as the beneficial uses of the receiving aquifer. The key elements of the Draft Groundwater Recharge Regulations requirements are summarized below.

Compliance of Regulated Chemicals and Physical Characteristics:



O The recycled water must comply with drinking water Maximum Contaminant Levels (MCLs) and action levels (now referred to as notification levels).

### Control of Pathogenic Organisms:

- o The recycled water must meet the requirements of disinfected tertiary recycled water (defined above): filtration and disinfection—turbidity, and 450 CT, or 5log virus reduction—and total coliform limits.
- o The recycled water must be retained underground in the aquifer for a minimum 6 months before it is extracted as a drinking water supply.
- O Within 3 months of commencing operations, the groundwater recharge reuse project (GRRP) must demonstrate that the minimum 6-month underground retention time to the closest downgradient drinking water well has been met, based on sample results at a monitoring well that is sited along the flow path towards and at least 3 months underground travel time from the nearest downgradient drinking water well.

### Control of Nitrogen Compounds:

- o Establishes three methods of control of nitrogen compounds, requiring that the GRRP comply with one of the required methods.
- O Under Method 1, the regulations set a low average concentration of total nitrogen (5 mg/L) and a requirement for sampling twice weekly, based on the rationale that if the recycled water is applied at this concentration, there is very little chance that the drinking water MCLs for nitrite (NO<sub>2</sub>) or nitrate (NO<sub>3</sub>) will be exceeded. Compliance samples may be taken before or after surface or subsurface application and must be representative of the recycled water prior to recharge or the recharge water in or above the mound.
- O Under Method 2, the regulations set a maximum total nitrogen limit of 10 mg/L and a requirement for more intensive sampling for other constituents, such as NO<sub>2</sub>, NO<sub>3</sub>, ammonia, organic nitrogen, dissolved oxygen (DO), and biochemical oxygen demand (BOD). Limits for these other constituents are as approved by CDPH with the rationale that the low limit of total nitrogen will result in a low risk of exceeding a drinking water NO<sub>2</sub> or NO<sub>3</sub> MCL. Compliance sampling requirements are the same as those above.
- o Method 3 applies only to GRRPs that have been in operation for at least 20 years. It requires that the most recent year's total nitrogen levels in the recycled water do not exceed those in the most recent ten years' of historical data and that downgradient drinking water wells do not exceed NO<sub>2</sub> and NO<sub>3</sub> MCLs.

### Control of Total Organic Carbon (TOC):

O Because recycled water contains organics that originate from wastewater, the CDPH limits the amount of TOC in recycled water that enters a groundwater basin. This is done by setting a Recycled Water Contribution (RWC) value for each GRRP, based on the TOC level in the recycled water. The RWC is the



amount of recycled water applied at the GRRP divided by the total amount of water recharged into the basin (recycled water plus diluent water). Diluent water is defined as water of a non-wastewater origin. Examples of diluent water include imported water, raw surface water, groundwater, and stormwater.

o The TOC limit varies depending upon the maximum RWC and is established by the following equation:

$$TOC_{\text{max}} = \frac{0.5mg/L}{RWC}$$

Based on:

- (a) a 20-week running average of all TOC results, and
- (b) the average of the last four results.

For example, for a maximum RWC of 20 percent, the TOC limit would be 2.5 mg/L.

- Control of Emerging Contaminants:
  - O Standards for these compounds do not yet exist, and they are not anticipated to be established in the near future. Currently, the CDPH does not recommend specific chemicals as emerging contaminants that should be monitored. Each GRRP shall propose a monitoring program for emerging contaminants, including endocrine disrupting compounds (EDCs) and pharmaceuticals and personal care products (PPCPs). At present, research work is being done to identify surrogates that can be used to monitor the most critical compounds in the vast array of existing chemicals that fall into this category.
- Source Control:
  - O A source control program needs to be in place to regulate contaminants entering the sewer system.

### **6.3.1.3** Dilution Requirements

As noted above, the Draft Groundwater Recharge Reuse Regulations specify requirements for the GRRP to comply with maximum RWC limits. The RWC is defined as the quantity of recycled water divided by the sum of the recycled water and diluent water applied at each recharge site. In other words, the RWC is the fraction of the total recharge water that is of recycled water origin. The CDPH determines the maximum RWC for each GRRP based on its review of the respective Title 22 Engineering Report. The Draft Groundwater Recharge Reuse Regulations specify an initial maximum RWC of 50-percent for subsurface application GRRPs and for surface spreading GRRPs with reverse osmosis and advanced oxidation treatment. For surface spreading without these advanced treatment processes, the initial maximum RWC is 20-percent. Compliance with the RWC limit is determined on a monthly-running-average basis with a maximum duration of 60 months at each recharge location. For a GRRP in operation less than 60 months, the RWC calculation may begin after 30 months of



operation. The CDPH may increase the allowable maximum RWC based on the successful demonstration of certain requirements.

An example of increased RWC is the OCWD Groundwater Replenishment System (GWRS). The initial RWC was set at 75-percent in OCWD's WRR permit for both its injection and surface spreading operations. The OCWD was on the forefront of recycled water reuse with its Water Factory 21 and Interim Water Factory 21, both of which featured advanced treated recycled water for injection at the Talbert Barrier. In this permit, the SARWQCB and CDPH provided the OCWD with a list of requirements to increase the RWC to 100-percent. In 2008-09, the OCWD conducted a demonstration complying with the permit requirements to increase the RWC at the Talbert Barrier. The SARWQCB and CDPH approved the maximum 100-percent RWC at the barrier in December 2009. Blending with potable water as a diluent at the barrier is still allowed but no longer required. At the OCWD's surface spreading basins, the maximum allowable RWC remains 75-precent. Compliance with the blending requirement is determined on a monthly running average basis over the preceding 60 months.

The IEUA has implemented a recycled water reuse program. This program includes recharge and direct use with tertiary treated recycled water. In their current WRR permit, the monthly running average RWC cannot exceed 33-percent of the total water recharged via surface spreading: the dilution requirement is two-parts diluent water to one-part recycled water. The IEUA achieves dilution in part from the use of stormwater that is diverted to spreading basins pursuant to a permit from the SWRCB and imported water that is recharged by the Chino Basin Watermaster pursuant to the Chino Basin Judgment Provisions within this permit, which allow for a 120-month RWC compliance period, the use of groundwater underflow for dilution, and nitrogen and TOC compliance measured in lysimeters located beneath the recharge basins following additional treatment from the underlying soils.

### 6.3.2 Direct Use

CCR Title 22, Division 4, Chapter 3, Article 3 presents regulations for the direct use of recycled water.

### **6.3.2.1** Direct Use Regulations

Regulations for the direct use of recycled water focus primarily on the quality of recycled water, protection against cross connections with potable systems, and the intended use.

According to CCR Title 22, Division 4, Chapter 3, Article 6, "[tertiary treated recycled water] shall be sampled at least once daily for total coliform bacteria<sup>20</sup> and shall be continuously monitored for turbidity using a continuous turbidimeter and recorder following filtration" by the producer or supplier of the recycled water. And, the results of the daily average turbidity

<sup>&</sup>lt;sup>20</sup> The samples shall be taken from the disinfected effluent and shall be analyzed by an approved laboratory.



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determinations shall be reported quarterly to the RWQCB or as specified in the WRR or MRR permit.

### **6.3.3** Industrial Use and Other Purposes

According to CCR Title 22, Division 4, Chapter 3, Article 2, recycled water supplied for industrial uses shall be treated to tertiary or secondary-23 standards, depending on its intended use.

"Recycled water used for the following industrial uses shall be [at least tertiary treated recycled water] [...]":

- "[. . .] industrial or commercial cooling or air conditioning that involves the use of a cooling tower, evaporative condenser, spraying or any mechanism that creates a mist [. . .]";
- "flushing toilets and urinals";
- "priming drain traps";
- "process water that may come in contact with workers";
- "decorative fountains";
- landscaping;
- "commercial laundries";
- "consolidation of backfill around potable water pipelines";
- "artificial snow making for commercial outdoor use; and
- "commercial car washes [(with some restrictions)]."

"[For cooling systems that] create mist that could come into contact with employees or members of the public, the cooling system [shall include] a drift eliminator [...], and chlorine or other biocide shall be used to treat the cooling system's recirculating water [...]."

"Recycled water used for the following industrial uses shall be at least disinfected secondary-23 recycled water":

- "[. . .] industrial or commercial cooling or air conditioning that does not involve the use of a cooling tower, evaporative condenser, spraying, or any mechanism that creates a mist [. . .];
- "industrial boiler feed";
- "non-structural fire fighting",
- "backfill consolidation around non-potable piping",
- "soil compaction",
- "mixing concrete";
- "dust control on roads and streets";
- "cleaning roads, sidewalks, and outdoor work areas"; and
- "industrial process water that will not come in contact with workers."



### **6.3.4** Recreational Impoundments

According to CCR Title 22, Division 4, Chapter 3, Article 2, recycled water used as a source water for non-restricted recreational impoundments shall be treated to tertiary standards and disinfected. For landscape impoundments, the regulations specify that if decorative fountains are not utilized, the recycled water can be disinfected secondary-23.

### 6.4 Process to Obtain Recycling Permit

The initial step in obtaining a recycling permit is to discuss the proposed project concept with the RWQCB. For recycling applications, the CDPH also needs to be engaged early in the permitting process. Following the receipt of preliminary comments from the regulatory authorities, a preliminary design for the project can be completed. Elements from the preliminary design report (PDR) can then be incorporated into the Title 22 Engineering Report. CEQA compliance is also required. For direct use recycling projects, the CDPH must review and approve the engineering report prior to recycled water being delivered to customers. The RWQCB may issue a WRR or combined WDR/WRR prior to the CDPH approval of the engineering report because other means of effluent disposal may be available until direct reuse is approved.

For GRRPs, following a review of the engineering report and after holding a public hearing, the CDPH will prepare a "Summary of Public Hearing" and recommend that the RWQCB incorporate all "Finding of Facts" and "Conditions" contained in the "Summary of Public Hearing" into the agency's WRR or MRR permit.<sup>21</sup> The RWQCB will then issue the recycling permit for the GRRP.

For this project, additional approval is needed through the ICGMP groundwater management and permit program to ensure that the proposed recharge activates do not adversely affect the remediation efforts of the Newmark and Muscoy plumes.



<sup>&</sup>lt;sup>21</sup> Process followed for the Chino Basin Watermaster and IEUA joint permit. See http://www.swrcb.ca.gov/santaana/board\_decisions/adopted\_orders/orders/2007/07\_039\_wdr\_ieuacbw\_cbrw grp\_06292007.pdf

### **Section 7 - Treatment Alternatives**

Based on the recycling criteria discussed in Section 6 and proven treatment technologies, an array of treatment processes were selected that could be used to produce recycled water that meets the regulatory requirements for reuse.

This section discusses the selected treatment processes individually and presents four treatment alternatives using those processes. These treatment alternatives are integrated into recycled water reuse alternatives in Section 11.

### 7.1 Conventional Tertiary Treatment Process Description

Conventional tertiary treatment was identified as a potential CWF process for producing recycled water that can be recharged, as part of a GRRP, or used to meet non-potable demands. Conventional tertiary treatment generally involves two components: filtration and disinfection.

Tertiary filters are designed to remove total suspended solids (TSS) from secondary effluent. There are several filter media options available, including fine sand, dual media (anthracite/sand), upflow sand filters (i.e. DynaSand®), and cloth filters. For this investigation, cloth filters were selected based on their small footprint and cost and because they are state-of-the-art for tertiary treatment.

Disinfection follows filtration and is most commonly accomplished with chemical or physical agents, mechanical means, or radiation. This investigation will focus on chemical and physical agents to eliminate bacteria and other organisms that pass through the tertiary filters.

### 7.1.1 Cloth Filters

Figure 7-1 shows a section of a typical AquaDisk® cloth-disk filter unit. AquaDisk® is available as either a 6-disk or 12-disk unit. The disks are completely submerged, liquid passes through the cloth media in an outside-in mode (by gravity), and entrained solids collect on the cloth filter surface. The collecting of solids leads to head loss across the cloth filter, resulting in rising water levels within the cloth filter tank. At a predetermined tank water level or time, the backwash cycle is initiated, and the solids are removed by a stationary backwash suction head, as shown in Figure 7-1. The suction head behaves similar to a vacuum cleaner: a manifold creates suction to force filtrate back through a small portion of the filter panels from both sides of each disk, removing solids. The disks rotate at 1 rpm to allow the entire surface of the filter panels to be cleaned. (The cloth disks are stationary except during the backwash cycle.) The disks are cleaned in multiples of two, and one backwash cycle takes 6 minutes for a 12-disk unit. During the backwash cycles, filtration continues. There are two 2-hp backwash pumps and one 0.75-hp shaft driver for each 12-disk unit. Backwash valves and motors are controlled automatically.



The CDPH has established a maximum loading rate of 6.0 gpm/square-ft for cloth filter operation. However, typical design loading rates would be around 3.25 gpm/square-ft. At this loading rate, the treatment capacities of the 6-disk and 12-disk units will be about 1.5 and 3.0 mgd, respectively.

### 7.1.2 Chlorine Disinfection

In order to meet Title 22 standards for recycled water reuse, the recycled water must be considered "disinfected tertiary recycled water." Typically, a chlorine disinfection process following filtration is sufficient to meet Title 22 standards. Chlorine disinfection is a chemical process that targets cell membranes and nucleic acids, altering transport across the membrane and causing cells to lysis (i.e. irreversible DNA damage). Title 22 specifies that chlorine contact basins (CCBs) provide a CT value of not less than 450 mg-min/L at all times, which is based on the assumed presence of monochloramines as the disinfecting agent with a modal CT of at least 90 minutes, based on peak dry weather design flow.

### 7.2 Advanced Treatment Process Description

Several advanced treatment alternatives were identified as potential processes for the CWF. Advanced treated recycled water for this investigation will involve a treatment train similar to Orange County Sanitation District's (OCSD) Groundwater Replenishment System (GWRS) (i.e. reverse osmosis [RO] followed by an advanced oxidation process [AOP]). These processes are described in the following sections. Recycled water treated to advanced standards will be of pristine quality and used solely for recharge as part of a GRRP.

### 7.2.1 Membrane Bioreactor

The Membrane Bioreactor (MBR) process combines conventional biological treatment with the use of membranes for the separation of the solid and liquid phases. The MBR treatment train is similar to the conventional activated sludge (CAS) process except membranes replace the secondary clarifiers and tertiary filters. Figure 7-2 is a schematic of the MBR process.

In the MBR process, the mixed liquor suspended solids (MLSS) can be increased beyond what is possible with CAS systems. Typically, MBR systems operate at MLSS concentrations in the range of 8,000 to 10,000 mg/L, compared to CAS systems in the range of 2,500 to 3,000 mg/L. Higher MLSS provides greater treatment capacity per unit volume of aeration basin. However, higher MLSS concentrations do result in solids buildup near the membrane surface, which reduces flow through the membranes. To minimize this effect, membrane agitation air is introduced to scour the membrane surface. This air, which is usually in addition to the process air requirements, increases the total air needed for treatment, thereby increasing operating costs.

Because the MBR process incorporates a membrane barrier, it produces low-turbidity effluent that is less affected by changes in feed water quality. And, the effluent TSS concentration is



low enough that tertiary filtration is not required. The MBR process produces a high-quality effluent and can be used as pretreatment for RO.

The MBR process does require additional screening to remove abrasive solids and hair to protect the membranes. Abrasive solids can wear through the membrane fibers and cause failures, and hair wraps around the fibers—causing clumping of the mixed liquor—and is very difficult to remove. Hair and abrasive solids removal can be accomplished using fine screens with openings in the range of 1 to 2 mm.

Even with air agitation, membranes lose their water permeability (flux rate) with time and require periodic cleaning. Most MBR systems include regular relaxing (zero flux) or back pulsing (using permeate to dislodge accumulated solids). Depending on operating conditions, a chemical clean may be required every 3 to 6 months. Chemical cleaning typically involves taking the membranes offline and submerging them in a solution of either sodium hypochlorite (to remove biological fouling) or citric acid (to remove lime scale) for several hours.

Various MBR systems are available. Each requires a different mechanical configuration and has different cleaning needs. These systems are typically not interchangeable, and a preferred supplier should be selected early in the design process.

### 7.2.2 Microfiltration / Ultrafiltration

Microfiltration (MF) and Ultrafiltration (UF) membranes are an efficient technology for particle removal and pathogen control in pressurized or submerged configurations. In a pressurized configuration, water is pumped through membranes in modules or cartridges. In a submerged configuration, membranes are submerged in tanks, and water is pulled through the membranes by a vacuum. Membrane filtration provides a near absolute barrier to suspended solids and microorganisms with average pore sizes ranging from less than 0.1 microns (for UF systems) to 0.5 microns. MF and UF are typically applied in a tertiary filtration application to replace conventional media and/or cloth filters. As with MBR systems, MF/UF systems vary from manufacturer to manufacturer, and membrane elements are generally not interchangeable.

For this investigation, pressurized MF membranes were evaluated as they generally provide greater efficiency and lower operating costs for the flows anticipated at the CWF. As water is pushed through the membranes using feed pumps, suspended solids and microorganisms are retained outside of the membrane. MF finished water turbidities are consistently below 0.1 NTU, independent of feed water quality. Due to the high-quality effluent they are capable of producing, MF systems are the preferred pretreatment for RO systems that treat wastewater. Figure 7-3 is a schematic of the MF process and illustrates the outside-in filtration configuration (most common) and the inside-out configuration.



### 7.2.3 Reverse Osmosis

High-pressure membrane processes, such as RO, are typically used for the removal of dissolved constituents, including both organic and inorganic compounds. RO is a process in which the mass-transfer of ions through membranes is diffusion controlled. The feed water is pressurized, forcing water through the membranes and concentrating the dissolved solids that cannot pass through the membrane. Consequently, these processes can remove salts, hardness, synthetic organic compounds, disinfection-by-product precursors, et cetera. Though, dissolved gases, such as hydrogen sulfide (H<sub>2</sub>S) and carbon dioxide, and neutral low molecular weight molecules do pass through RO membranes. And, the rejection by the RO membranes (removal efficiency) is not the same for all dissolved constituents and is influenced by molecular weight, charge, and other factors.

RO is considered a "high-pressure" process because it operates from 75 to 1,200 psi, depending upon the total dissolved solids (TDS) concentration of the feed water. Typical operating pressure in a wastewater application is in the range of 150 to 250 psi. Recoveries for RO plants operating on domestic wastewater are around 85 percent, depending on the type and concentrations of sparingly soluble salts (calcium sulfate, calcium carbonate, calcium phosphate, silica, et cetera) in the feed water. Silica can permanently scale RO membranes when its concentration in the process exceeds about 100 to 120 mg/L. In wastewater applications, calcium phosphate can often be the salt controlling overall recovery.

Given the TDS concentration of SBWRP influent, the estimated feed pressure for the RO system will be in the range of 200 to 225 psi. And, initial modeling results indicate that a recovery of 85 percent is possible, given the levels of silica and other scaling compounds in the wastewater stream (based on historical data).

During the RO process, the TDS that is removed from the feed water is concentrated in the brine stream, which needs to be disposed of. The obvious disposal route for SBWRP brine would be to SARI, which has a connection point at the plant. Based on initial modeling for this application, the brine stream TDS concentration is projected to be approximately 3,600 mg/L.

### 7.2.4 Ultraviolet Advanced Oxidation Process with Peroxide

When hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) is exposed to ultraviolet (UV) light, it reacts to form hydroxyl radicals, which are highly reactive high-energy molecules that attack the chemical bonds of organic molecules and oxidize them. The combination of UV and H<sub>2</sub>O<sub>2</sub> is an advanced oxidization process (AOP). Other AOP approaches that result in the formation of hydroxyl radicals include the use of ozone with UV and ozone with H<sub>2</sub>O<sub>2</sub>. It has been found that hydroxyl radicals are able to oxidize certain chemicals of emerging concern (CECs), such as certain endocrine disrupting compounds, pharmaceuticals and personal care products (PPCPs), and other microconstituents (e.g. 1,4-dioxane and NDMA).

In the UV/AOP process (UV plus H<sub>2</sub>O<sub>2</sub>), the UV dose required to break down the H<sub>2</sub>O<sub>2</sub> is significantly greater than that required for typical disinfection: 50 to 100 mJ/cm<sup>2</sup> for



disinfection versus 400 to 500 mJ/cm<sup>2</sup> for radical formation. Thus, the UV/AOP process provides both a disinfection barrier as well as a microconstituent barrier.

For GRRP systems that propose an initial RWC of 50 percent, the draft regulations require that both RO and AOP be provided to the entire recycled water flow and that the AOP provides at least 1.2 log NDMA reduction and 0.5 log 1,4-dioxane reduction. Regulations on controlling CECs in GRRP water are still being deliberated.

### 7.3 Formulation of Alternatives for Detailed Investigation and Assessment

Four treatment alternatives were developed for treating SBWRP secondary effluent to either tertiary or advanced standards. The alternatives are described below.

- Treatment Alternative A (Conventional Tertiary Treatment). Figure 7-4 shows a
  potential CWF treatment train that includes tertiary filtration and disinfection.
  Recycled water produced from this CWF would be of Title 22 quality and, thereby,
  available for recharge or direct use.
- Treatment Alternative B (Advanced Treatment). Figure 7-5 shows a potential CWF treatment train that includes MF, RO, UV/AOP, and stabilization. This treatment alternative also features a second treatment train that filters and disinfects a side stream of effluent, making it available for direct use. Recycled water produced from the RO plus UV/AOP treatment process will be of Title 22 quality and conveyed solely for recharge. Recycled water produced from the tertiary treatment train will also be of Title 22 quality and, thereby, available for recharge or direct use.
- Treatment Alternative C (Advanced Treatment). Figure 7-6 shows a potential CWF treatment train that includes an MBR, RO, UV/AOP, and stabilization. This treatment alternative features a second treatment train that filters and disinfects a side stream of recycled water, making it available for direct use. Recycled water that has received RO plus UV/AOP treatment will be of Title 22 quality and conveyed solely for recharge. Recycled water produced from the tertiary treatment train will also be of Title 22 quality and, thereby, available for recharge or direct use.
- Treatment Alternative D (Advanced Treatment). Figure 7-7 shows a treatment train similar to that identified in Figure 7-5 (MF, RO, and UV/AOP), but it uses a proprietary treatment process that accepts primary effluent rather than traditional secondary effluent. This treatment alternative features a second treatment train that filters and disinfects a side stream of recycled water, making it available for direct use. Recycled water produced using the proprietary treatment process will be of Title 22 quality and conveyed solely for recharge. Recycled water produced from the tertiary treatment train will also be of Title 22 quality and, thereby, available for recharge or direct use.



The addition of the RO process at the CWF (Alternatives B, C, and D) will generate a brine waste stream (i.e. salts). In 1993, anticipating future salt mitigation in its service area, the SBMWD purchased 2.5 mgd of capacity in the SARI line and had the pipeline extended to the SBWRP. The SBMWD's SARI capacity is a constraint on the advanced treatment capacity of the CWF. This is discussed further in Section 11.







Influent —

## 12-DISK CLOTH FILTER SCHEMATIC

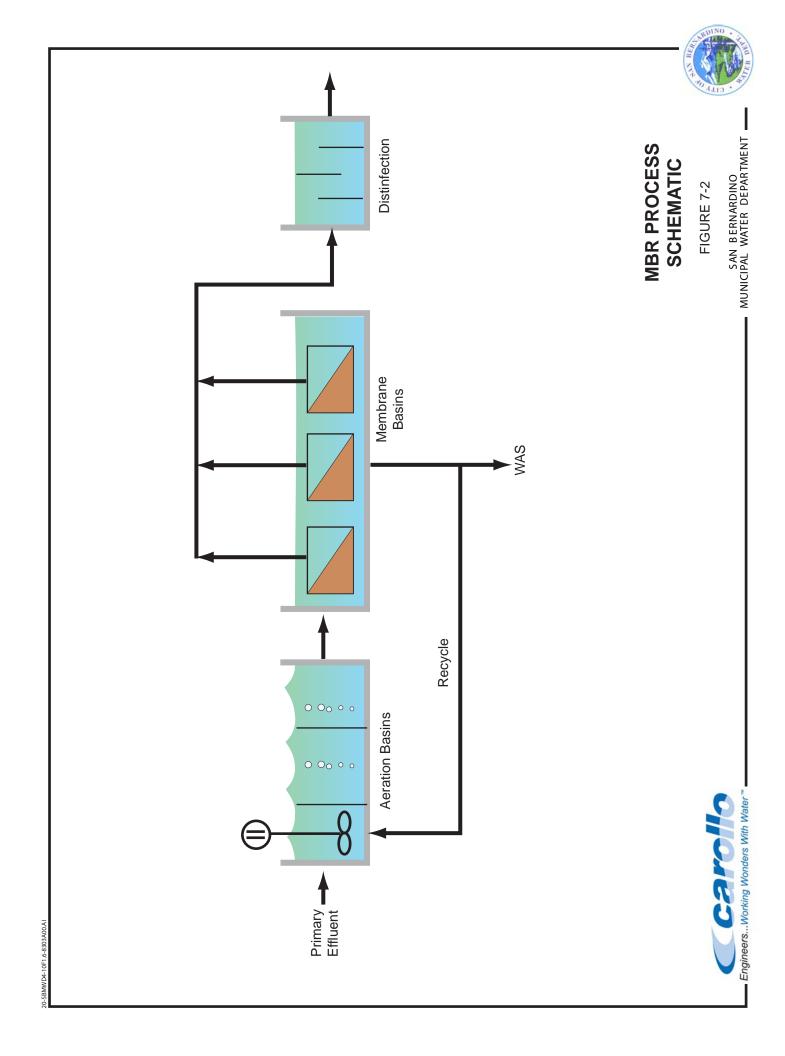
FIGURE 7-1

SAN BERNARDINO MUNICIPAL WATER DEPARTMENT

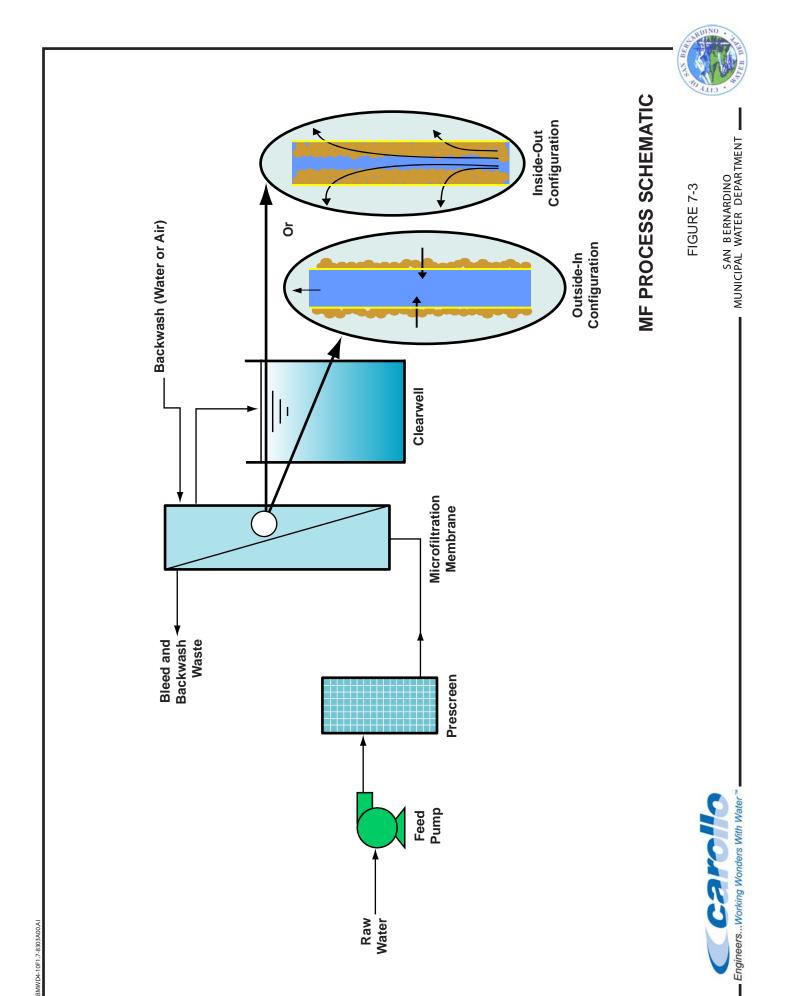


Backwash

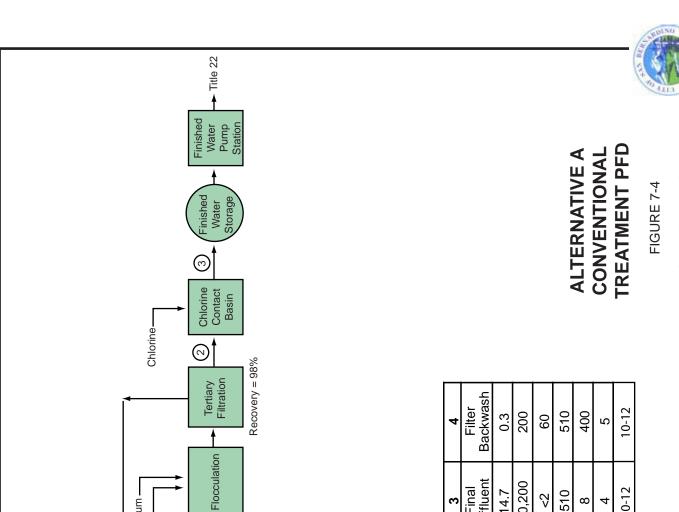












Alum –

4

Capacity = 15 mgd

(Not in Service)

(Existing) Capacity = 45 mgd Headworks

ŧ

(Existing)

Primary Clarifiers

Unit 3

Polymer-

Clarifiers

(Existing) Capacity - 15 mgd

Claerator

Unit 1

Secondary

 $\Theta$ 

Chlorine

<u>₩</u>

Box.

Lagoon Contact

Secondary Clarifiers

Box

(Existing) Capacity = 15 mgd

Claerators

Splitter Box

Unit 2

Secondary

Clarifier

Removal Carousel Capacity = 3 mgd

Nitrogen

(Existing)

SAN BERNARDINO MUNICIPAL WATER DEPARTMENT

10,200

10,200

10,400

14.7

14.7

15.0

Flow Rate (mgd) Flow Rate (gpm) 510

510

510

ω 4

ω 2

16

Biochemical Oxygen Demand (mg/L)

7

7

N

Total Suspended Solids (mg/L) Total Dissolved Solids (mg/L) 10-12

10-12

10-12

TOC (mg/L)

2

Ammonia (mg/L)

Effluent Final

Effluent Filter

Secondary Effluent

Description

Stream Number







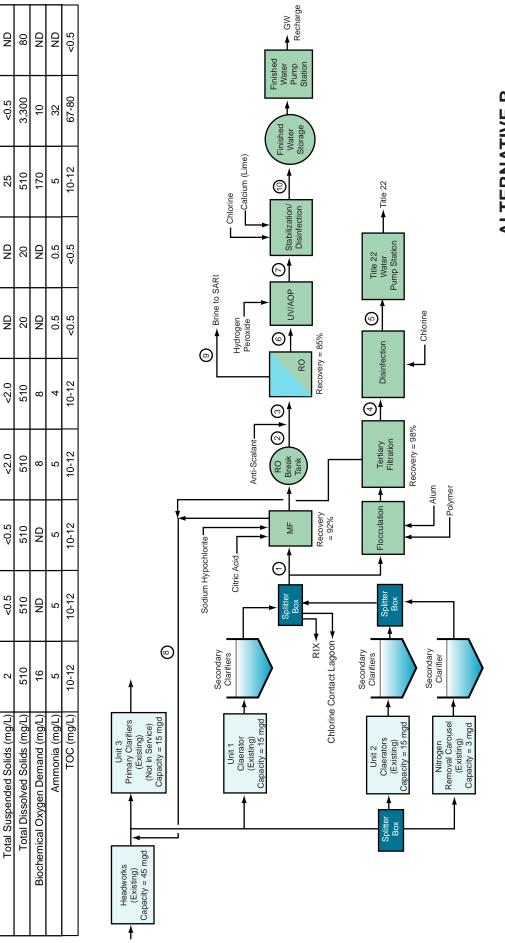
## O ADVANCED TREATMENT

## FIGURE 7-5

SAN BERNARDINO MUNICIPAL WATER DEPARTMENT

Engineers...Working Wonders With Water "

# ALTERNATIVE B MF/RO ADVANCED TREATMENT



Stabilized Product

RO Concentrate

MF Backwash

Product Water

RO Permeate

Title 22 Product

**CCB Feed** 

RO Feed

MF Product

Secondary Effluent

Stream Number

S

o

9,850

1,700

1,000

14.2 9,850

9,850

1,700

1,700

11,600

11,600

18.2

14.2

2.5

2.5

16.7

16.7

Flow Rate (mgd) Flow Rate (gpm)

Description

2.5

1.5





# ALTERNATIVE C ABR/RO ADVANCED TREATMENT PFD

FIGURE 7-6

SAN BERNARDINO MUNICIPAL WATER DEPARTMENT

<b>ALTERNATIVE</b>	<b>MBR/RO ADVANC</b>	
$\Box$	$\neg$	T

	zed	2	0					
9	Stabilized Product	14.2	9,850	ND	80	ND	ND	<0.5
2	RO Concentrate	2.5	1,700	4	3,600	14	17	08-29
4	Product Water	14.2	058'6	ΠN	20	ND	1.0	<0.5
3	RO Permeate	14.2	9,850	ND	20	ND	0.1	<0.5
2	RO Feed	16.7	11,600	<0.5	560	5	3	10-12
1	Primary Effluent	16.7	11,600	06	560	200	30	42
Stream Number	Description	Flow Rate (mgd)	Flow Rate (gpm)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Biochemical Oxygen Demand (mg/L)	Ammonia (mg/L)	TOC (mg/L)

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 ↓
 GW

 Recharge

Finished Water Storage

Stabilization

UV/AOP

**⊚**1

8

(2)

RO Break Tank

MBR

Unit 3
Primary Clarifiers
(Existing)
Capacity = 15 mgd

Headworks (Existing) Capacity = 45 mgd

ΘĪ

Brine to SARI

**⊕** 

0

Calcium (Lime) Chlorine-

Hydrogen Peroxide-

. Anti-Scalant

Recovery = 85%

Sodium Hypochlorite —

Citric Acid -

 ▼ Title 22

Title 22 Water Pump Station

Disinfection

Tertiary Filtration

Flocculation

Alum — Polymer — Chlorine

Recovery = 98%

── Chlorine Contact Lagoon

Splitter Box

Unit 2
Claerators
(Existing)
Capacity = 15 mgd

Splitter Box

Secondary Clarifier

Nitrogen
Removal Carousel
(Existing)
Capacity = 3 mgd

Secondary Clarifiers

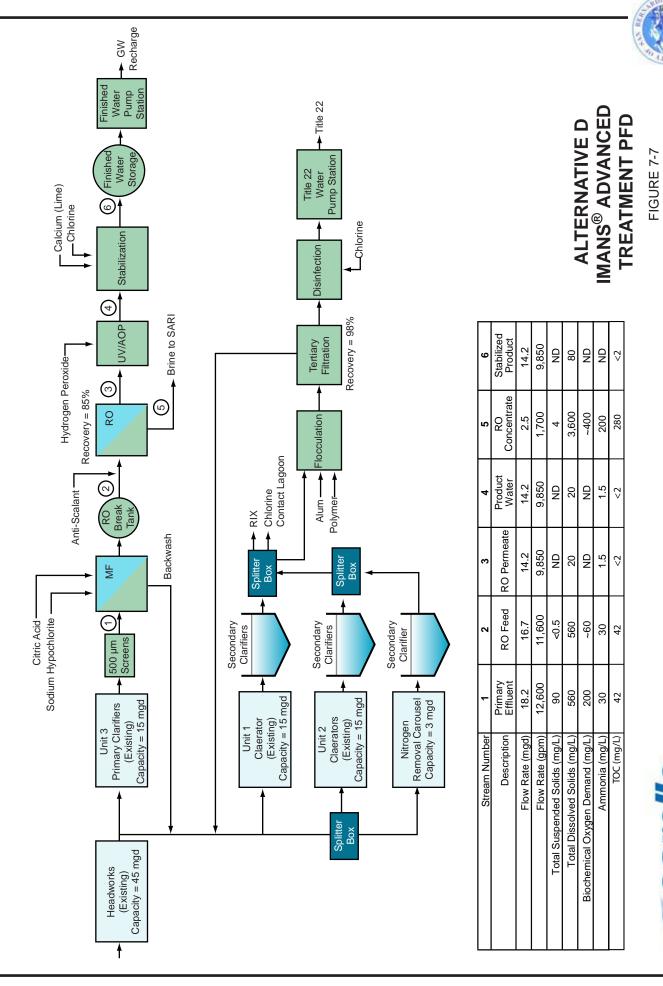
<u>₩</u>

Secondary Clarifiers

Unit 1
Claerator
(Existing)
Capacity = 15 mgd

Finished Water Pump Station





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# Section 8 - Groundwater Recharge with Recycled Water

#### 8.1 Spreading Facilities

A survey was conducted to identify and evaluate existing stormwater detention and spreading facilities located in the SBMWD service area that could be used to recharge recycled water. The criteria used to determine which facilities could be used are as follows: spreading basin must be located upgradient from SBMWD production wells to ensure that the SBMWD can materially benefit from the recharge and control high groundwater in the pressure zone of the SBBA; the spreading basin must be situated such that it can receive storm, imported, and recycled waters; the infiltration rates at the spreading basins must be large enough to make the recharge practical and be able to accommodate the recharge of storm, imported, and recycled waters; the spreading basins must be located far enough away from the SBMWD production wells to meet the underground travel time requirements; the spreading basins should not overlie a contaminant plume; and the spreading basin should be reasonably close to the SBWRP to minimize pipeline and pumping costs. The SBCFCD owns and operates several large stormwater facilities that meet this criteria. Based on these criteria, three spreading facilities were identified: the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins. These facilities are shown in Figure 8-1.

#### 8.1.1 Waterman Basins

Figures 8-1 and 8-2 show the location of the Waterman Basins. The Waterman Basins are located northeast of Wildwood Park and north of 40th Street in the City of San Bernardino. These basins are owned and operated by SBCFCD and have an active spreading area of about 70 acres. The estimated infiltration rate for this site is about 1.5 feet per day, which equates to a recharge capacity of about 3,150 acre-feet/month (i.e. 105 acre-feet/day) or about 34.2 mgd. This estimate is based on the facility's past performance while recharging imported water. During October and November of 2008, this facility recharged 3,054 acre-feet and 2,980 acre-feet, respectively. And, in August of 2010, this facility recharged 3,970 acre-ft.

The watershed area tributary to the Waterman Basins is about 6.4 square miles. The principle drainage course for this area is Waterman Canyon Creek. The tributary area and Waterman Canyon Creek are shown in Figure 8-1. The Waterman Basins collectively form an off-creek conservation facility. That is, stormwater in Waterman Canyon Creek must be diverted away from its natural channel into the basins. It is comprised of nine internal cascading cells, as shown in Figure 8-2. Water moves from north to south through the facility via spillways and outlet pipes. The most downgradient basin, Basin 4, outlets via a 20-inch steel pipe to the upper most cell of the East Twin Creek Spreading Grounds.

There is a turnout on the Foothill Pipeline (Waterman Turnout) that can discharge imported water into cell 2. The Foothill Pipeline is a 72-inch diameter imported water transmission pipeline that conveys imported water from the Devil Canyon afterbay to the Santa Ana River Crossing (SARC) Pipeline. The pipeline is part of the East Branch Extension and is owned



and operated by the Valley Water District. The Waterman Turnout has a capacity of 135 cfs (8,100 acre-ft/month or about 88 mgd).

The Waterman Basins overlie the Bunker Hill Basin and are located upgradient from wells owned by the SBMWD and EVWD. Water that recharges at this facility will boost local water levels and contribute to production at downgradient wells.

#### 8.1.2 East Twin Creek Spreading Grounds

Figures 8-1 and 8-3 show the location of the East Twin Creek Spreading Grounds. The East Twin Creek Spreading Grounds are located south of 40th Street—immediately south of the Waterman Basins—and are owned and operated by the SBCFCD. These spreading grounds have an active spreading area of about 93 acres and an estimated infiltration rate of about 1.5 feet per day, which equates to a recharge rate of about 4,170 acre-feet/month (i.e. 139 acre-feet/day) or about 45 mgd. There are no historic records on the operation of this facility. The watershed area tributary to the East Twin Creek Spreading Grounds is about 9.8 square miles. The principle drainage course for this area is East Twin Creek. Stormwater in Waterman Canyon Creek that is not captured at the Waterman Basins discharges into the East Twin Creek Spreading Grounds are shown in Figure 8-1. The East Twin Creek Spreading Grounds is a flow-through facility. Surface water discharge in East Twin Creek and Waterman Canyon Creek enter the facility at its north end and cascade through eight consecutive cells. Water moves from cell to cell through culverts and spillways. The most downgradient cell outlets to a large improved flood control channel.

There is no turnout to this facility from the Foothill Pipeline. Imported water deliveries to this facility could be made from the Waterman Turnout, allowing the water to cascade through the Waterman Basins to the East Twin Creek Basins.

The East Twin Creeks Spreading Grounds overlie the Bunker Hill Basin and are located upgradient from wells owned by the SBMWD and the EVWD. Water that recharges at this facility will boost local water levels and contribute to production at downgradient wells.

#### 8.1.3 Devil Canyon and Sweetwater Basins

Figures 8-1 and 8-4 show the location of the Devil Canyon and Sweetwater Basins. The Devil Canyon and Sweetwater Basins are located northwest of the Shandin Hills and north of Interstate 215. These basins are owned and operated by the SBCFCD and have an active spreading area of about 38 acres. The estimated infiltration rate for this site is about 1.5 feet per day, which equates to a recharge capacity of about 1,710 acre-feet/month (i.e. 57 acrefeet/day) or about 18.6 mgd. The watershed area tributary to the Devil Canyon and Sweetwater Basins is about 6.8 square miles. The principle drainage course for this area is Devil Canyon Creek. The tributary area and Devil Canyon Creek are shown in Figure 8-1.



The Devil Canyon and Sweetwater Basins are an off-creek conservation facility. The facility is comprised of seven cells as shown in Figure 8-4. Water generally moves from north to south through the facility via outlet pipes. Three of the Devil Canyon cells have inlets and outlets that connect to Devil Canyon Creek. There is a turnout on the Foothill Pipeline (Sweetwater Turnout) that can discharge imported water into the Sweetwater Basin. The Sweetwater Turnout has the capacity of 37 cfs (2,200 acre-ft/month or about 24 mgd). The Sweetwater Basin has two outlet pipes: one to Devil Canyon cell 2 and the other to Devil Canyon cell 6.

The Devil Canyon and Sweetwater Basins overlie the Bunker Hill Basin and are located upgradient from wells owned by the SBMWD. Water that recharges at this facility will boost local water levels and contribute to production at downgradient wells.

#### 8.2 Current Uses of Recharge Facilities

The SBCFCD currently uses the Waterman Basins to spread stormwater from Waterman Canyon. The storage and recharge capacity of this facility generally exceeds the volume of tributary stormwater runoff. The stormwater diverted to this facility rarely discharges to the East Twin Creek Spreading Grounds. This facility is used periodically by the Valley Water District to recharge imported water. From September through December of 2008, the Valley Water District recharged approximately 9,200 acre-ft of imported water at this facility. And, from August through November of 2009, the Valley Water District recharged approximately 9,400 acre-ft of imported water at this facility. The East Twin Creek Spreading Grounds facility is used by SBCFCD for flood peak discharge attenuation and incidental recharge of stormwater from East Twin Creek. The recharge capacity of this facility generally exceeds the volume of tributary stormwater runoff. With the exception of large storm events, this facility does not discharge to the downgradient storm channel. The Valley Water District is planning to recharge imported water at this facility, but no spreading has occurred to date.

The Devil Canyon and Sweetwater Basins are currently used by SBCFCD to recharge stormwater from Devil Canyon Creek. In 2007 and 2008, the Valley Water District recharged about 5,000 acre-ft/yr of imported water at this facility. In 2009 and 2010, the Valley Water District recharged about 3,000 and 4,000 acre-ft/yr, respectively.

# 8.3 Recharge Capacity

The following parameters were evaluated for each recharge facility to determine the maximum recharge capacity: effective area, infiltration rate, and maintenance requirements. The total area of the recharge facility, or gross area, is the surface area of the parcel(s). The effective area is the surface area of the recharge facility available for storing and infiltrating water. The infiltration rate, expressed as ft/day, is the spatially averaged rate at which surface water infiltrates on the wetted area of the recharge basin. In this investigation, the long-term infiltration rate was estimated to be 1.5 ft/day. Though initial infiltration rates may be significantly higher at startup and for the first few months, the infiltration rate will decrease



over time due to the deposition of fine-grained materials on the bottom of the basins. Annual maintenance will be required to remove fine sediments from the bottom of the basins and to perform weed abatement and erosion control at the facilities. Before heavy equipment can enter a spreading basin to remove silt and debris, the site must dry. This investigation assumes that some part of each facility will be offline for a two-month period per year for maintenance related activities. Table 8-1 shows the maximum recharge capacity for the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins. The total maximum recharge capacity for all three sites is about 91,000 acre-ft/yr.

## 8.4 Source Waters Available for Recharge

#### 8.4.1 Stormwater

Figures 8-5a, 8-5b, and 8-5c show average daily discharge as reported by the USGS for the gauging stations on Waterman Canyon Creek (11058600), East Twin Creek (11058500), and Devil Canyon Creek (11063680), respectively. The Wasteload Allocation Model (WLAM) (WEI, 2009) was used to route the historical average daily discharges at these gauging stations through the recharge facilities and to estimate how much stormwater recharge could occur. The basin geometry and hydraulic information was obtained from as-built drawings and other information from the SBCFCD. The facilities were simulated as they currently exist for the Waterman Basins and the Devil Canyon and Sweetwater Basins. The internal berms that separate cells within the East Twin Creek Spreading Grounds were assumed to be reconstructed. Tables 8-2, 8-3, and 8-4 summarize the simulation results from the WLAM, using 50 years of average daily discharge for the stream gauging stations listed above. The tables list the average monthly inflow to the facility, the average monthly outflow from the facility, and the average monthly stormwater recharge. The potential average annual stormwater recharge is about 2,100 acre-ft/yr for the Waterman Basins, about 3,900 acre-ft/yr for the East Twin Creek Spreading Grounds, and about 1,500 acre-ft/yr for the Devil Canyon and Sweetwater Basins. The qualifier "potential" is used to characterize this recharge because it was assumed that these recharge facilities were operated to maximize recharge.

As discussed in Section 1.4, the Valley District and the WMWD have commissioned a stormwater recharge enhancement study to identify opportunities throughout the SBBA to increase stormwater recharge. Projects implemented from this study will provide an additional diluent source to the groundwater basin and may increase the amount of storm recharge at the facilities described above.

## 8.4.2 Imported Water

Tables 8-5 and 8-6 list historic imported water deliveries at the Waterman and Sweetwater Turnouts, respectively, for the period of November 1972 through August 2010. The Waterman Turnout was used significantly from November 1972 through December 1977, intermittently from January 1978 through August 2008, and significantly from September



2008 through August 2010. The maximum amount of imported water discharged from the Waterman Turnout to the Waterman Basins was about 20,300 acre-ft in 1973. The Sweetwater turnout was used significantly from November 1972 through August 1982 and intermittently from September 1982 through August 2010. The maximum amount of imported water discharged from the Sweetwater Turnout to the Devil Canyon and Sweetwater Basins was about 7,400 acre-ft in 1977.

The Valley Water District recently completed a report—Summary Reports of Recharge Parties Pursuant to RWQCB Resolution R8-2008-0019 Cooperative Agreement to Protect Water Quality and Encourage the Conjunctive Uses of Imported Water in the Santa Ana River Basin (Geoscience, 2009)—that contains projections of imported water recharge in the SBBA. This report provides imported water recharge estimates for the Bunker Hill A, Bunker Hill B, Lytle, Rialto, Colton, and Yucaipa Management Zones. In the Bunker Hill A Management Zone, the Valley Water District plans to spread 500 acre-ft/yr at the Badger Basins, between 3,000 to 5,000 acre-ft/yr at the Devil Canyon and Sweetwater Basins, between 3,000 to 9,000 acre-ft/yr at the East Twin Creek Spreading Grounds, and between 8,500 to 14,500 acre-ft/yr at the Waterman Basins. These projected recharge activities are based on future groundwater production projections and replenishment required pursuant to the Western San Bernardino Judgment.

#### 8.4.3 Recycled Water

The projected recycled water at the SBWRP available for reuse and discharge ranges from 27,300 acre-ft/yr (24.4 mgd) in 2010 to 39,600 acre-ft/yr (35.4 mgd) in 2030. Some quantity of recycled water will need to be discharged to the Santa Ana River; the specific quantity will be determined through the Petition for Change process that, as of this writing, is currently being processed. 14,500 acre-ft/yr of recycled water recharge was used to evaluate the amount of surplus recharge capacity at the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins. This volume of water is based on the information contained in Section 11 of this report.

## 8.4.4 Quality of Available Source Waters

Stormwater runoff from the mountains above these facilities is estimated to have a TDS concentration of 180 mg/l and a nitrogen concentration of 1 mg/l. The quality of imported SWP water varies, but it is estimated to have an average TDS concentration of 250 mg/l and a nitrogen concentration of 1 mg/l. Tertiary treated recycled water from the CWF is estimated to have a TDS concentration of 510 mg/l and a nitrogen concentration of 10 mg/l. And, advanced treated recycled water from the CWF is estimated to have a TDS concentration of 80 mg/l and a nitrogen concentration of 1 mg/l.

The SARWQCB will require the volume-weighted average TDS and nitrogen concentrations of the recharged waters to be less than or equal to the water quality objectives specified for the Bunker Hill A Management Zone: 310 mg/l and 2.7 mg/l, respectively. The CDPH will require that, on a volume basis, the RWC be less than or equal to some percentage, as



specified during its evaluation of the project (typically 20 percent to 33 percent for tertiary and 50 percent for advanced treated).

# 8.5 Operational Strategy and Estimated Recycled Water Recharge

The operational scheme for recharging these waters would be as follows:

- Stormwater recharge has the highest priority. The safe yield of the Bunker Hill Basin includes stormwater recharge, and this water is of excellent quality and free.
- Recycled water will be recharged whenever it is available and will be used to replace or augment imported water recharge. Recycled water can be recharged during storm periods as long as it does not cause a loss of stormwater recharge.
- Imported water will be recharged as required after consideration of the need to balance recharge and discharge in the investigation area, to meet dilution requirements, and to meet replenishment obligations pursuant to the Western San Bernardino Judgment.

#### 8.6 Conveyance of Recycled Water for Recharge

A new recycled water distribution system will be required to convey recycled water produced at the CWF to the recharge basins. This new conveyance system will require two pump stations and about 13 miles of pipeline to convey recycled water from the CWF to the recharge facilities.

#### 8.6.1 Waterman and East Twin Creeks Distribution Facilities

A preliminary alignment study determined that the most cost-effective route for a non-potable distribution pipeline from the CWF to the proposed recharge facilities is to parallel the East Twin Creek flood control channel, as shown in Figure 8-6. A pump station located at the SBWRP will boost recycled water about 7 miles to an elevation of 1,470 ft-msl, an increase of about 570 ft above the SBWRP, to the Waterman Basins. The pipeline will terminate at the upper most recharge basin on the Waterman site and will have three turnouts. The second turnout will be used to supply recycled water to the East Twin Creek Spreading Grounds, and the third will connect to a second pump station that will boost recycled water to the Devil Canyon and Sweetwater Basins.

## **8.6.2 Devil Canyon Distribution Facilities**

The distribution pipeline to the Devil Canyon and Sweetwater Facilities originates at the East Twin Creeks Spreading Grounds and travels along 40<sup>th</sup> St., as shown in Figure 8-6. A pump station located at the East Twin Creeks Spreading Grounds will boost recycled water from a storage tank about 6 miles to an elevation of 1,730 ft-msl, an elevation increase of about 400 ft, to the Devil Canyon and Sweetwater Basins.



#### 8.7 Recharge Facility Improvements

The recharge facilities will need site improvements to comply with recharge regulations prior to accepting recycled water. Recharge facilities that surface spread recycled water are required (1) to measure the flow of source waters, (2) to have monitoring wells between the facility and downgradient productions wells, and (3) to post signs that inform visitors of recycled water reuse. In addition, general improvements will be needed to increase the overall operational flexibility of these facilities. These improvements may include rehabilitating or replacing the outlet valves between cells, reconstructing berms between cells, and installing automatic gates and water level sensors.

One additional improvement will be required if tertiary treated recycled water is to be recharged. A series of lysimeters (i.e. shallow monitoring wells that are completed in the vadose zone) will be installed at each recharge facility to quantify the amount of nitrogen and TOC reduction that occurs in the vadose zone.

#### 8.8 Impact of Recycled Water Recharge on Groundwater

#### 8.8.1 Hydrogeology Background

The valley-fill aquifer in the SBBA includes both unconsolidated deposits and sedimentary rocks. The unconsolidated deposits, which constitute the primary reservoir for storing large quantities of water, are composed of gravel, sand, silt, and clay. This sediment was formed mostly by alluvial fans coalescing along the mountain front as well as by the Santa Ana River and Lytle Creek.

The unconsolidated alluvium aquifer was divided by Dutcher and Garrett (1963) into six hydrogeologic units: an upper confining member (UCM), an upper water-bearing zone (UWB), a middle confining member (MCM), a middle water-bearing zone (MWB), a lower confining member (LCM), and a lower water-bearing zone (LWB). The SBMWD and the Valley Water District jointly developed a groundwater flow model of the SBBA (GSS and Stantec, 2009). This model adopted these hydrogeologic units and features five layers with layer 1 representing the upper confining member and upper water bearing unit. Layers 1, 3, and 5 in the model represent the major aquifers, and layers 2 and 4 represent the confining units. This model was used in this investigation to evaluate the impact of recharging recycled water at the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins.

The unconsolidated alluvium tends to be thinner in areas adjacent to the bedrock highs, and the thickness ranges from 100 feet in areas adjacent to bedrock outcrops to more than 1,500 feet at the center of the Bunker Hill Basin, which is located adjacent to the intersection of the Santa Ana River and the San Jacinto Fault. Tertiary-age sedimentary rocks exist primarily in the southern part of the San Bernardino Valley between the San Jacinto Fault and the Crafton Hills and underlie unconsolidated deposits in the vicinity of Redlands.



The valley-fill aquifer system is mainly recharged by streams (69 percent), irrigation return flows (17 percent), mountain front recharge (7 percent), the deep percolation of precipitation (3 percent), subsurface inflows (2 percent), and imported water (2 percent). Aquifer system discharges include groundwater production (87 percent), stream discharge as rising groundwater (6 percent), evapotranspiration (5 percent), and subsurface outflow (2 percent) (Stantec, 2009).

Groundwater in the valley-fill aquifer system flows, in general, from the areas of recharge along the base of the San Gabriel Mountains and the San Bernardino Mountains to the area of discharge where the Santa Ana River crosses the San Jacinto fault, as shown in Figure 2-1.

#### 8.8.2 Project-Specific Site Geology-Hydrogeology

#### 8.8.2.1 Waterman Basins

The Waterman Basins are located south of the intersection of Waterman Canyon Creek and the San Andres Fault zone and range in elevation from 1,367 to 1,430 ft-msl. The subsurface is primarily composed of unconsolidated alluvial fan deposits from Waterman Canyon, ranging in thickness from about 300 to 926 feet under the Waterman Basins. Groundwater levels in the vicinity of the Waterman Basins fluctuate from a depth of about 200 feet to 350 feet below ground surface. Figure 8-7 shows historical water levels and depths to water for the 40th & Valencia well. This well is located just south of the Waterman Basins. Table 8-7 summarizes the hydrogeologic properties of layers 1 through 5 in the vicinity of the Waterman Basins, based on the SBBA flow model. The 40th & Valencia well is the only well within a half mile of the Waterman Basins.

#### 8.8.2.2 East Twin Creek Spreading Grounds

The East Twin Creek Spreading Grounds are located south of the Waterman Basins along East Twin Creek and range in elevation from 1,250 to 1,350 ft-msl. The subsurface is primarily composed of unconsolidated alluvium fan deposits from East Twin Creek and Waterman Canyon. Beneath the spreading grounds, the alluvium deposits range in thickness from 650 to 890 feet. Groundwater levels in the vicinity of the East Twin Creek Spreading Grounds fluctuate from a depth of about 140 feet to 320 feet below ground surface. Figure 8-8 shows historical water levels and depths to water for the Lynwood well. This well is located just south of the East Twin Creek Spreading Grounds. Table 8-8 summarizes the hydrogeologic properties of layers 1 through 5 in the vicinity of the East Twin Creek Spreading Grounds. There are five groundwater production wells within a half mile of the East Twin Creek grounds. These wells, their ownership, and their projected annual production for 2007 through 2032 are listed in Table 8-9.

#### 8.8.2.3 Devil Canvon and Sweetwater Basins

The Devil Canyon and Sweetwater Basins are located south of the intersection of Devil Canyon and the San Andres Fault zone and range in elevation from 1,613 to 1,736 ft-msl.



The subsurface is primarily composed of unconsolidated alluvium fan deposits from Devil Canyon. The thickness of the alluvium deposits underneath the basins is not accurately defined in the SBBA model. Review of the model input files shows that the thickness of the alluvial deposits underneath the Devil Canyon and Sweetwater Basins, as represented in the model, is only about 80 to 100 feet, but well construction data from the Devil Canyon wells indicate that the alluvial deposits in the area are more than 300 to 400 feet thick. Groundwater levels in the vicinity of the Devil Canyon and Sweetwater Basins fluctuate from a depth of about 70 feet to 200 feet below ground surface. Figures 8-9 through 8-11 show historical water levels and depths to water for three wells located just south of the Devil Canyon and Sweetwater Basins. Table 8-10 summarizes the hydrogeologic properties of layers 1 through 5 in the vicinity of the Devil Canyon and Sweetwater Basins. There are five groundwater production wells within a half mile of the Devil Canyon and Sweetwater Basins. There are five groundwater production wells within a half mile of the Devil Canyon and Sweetwater Basins. These wells, their ownership, and their projected annual production for 2007 through 2032 are listed in Table 8-11.

# 8.9 Underground Retention Time and Recycled Water Contribution

The underground retention time of recycled water is the elapsed time from when recharge operations commence to the time of potential extraction at a municipal well. Retention time estimates were computed for each recharge basin using the SBBA groundwater model and a new transport model developed by WEI for this project. A detailed description of the SBBA groundwater model can be found in *Newmark Groundwater Flow Modeling Draft Report* (Stantec, 2010). The methodology for estimating underground retention time and computing the recycled water contribution as well as conclusions regarding compliance with the draft regulations are presented below.

# 8.9.1 Methodology for Estimating the Recycled Water Contribution and Underground Retention Time

The underground retention time of recycled water was estimated as the sum of the travel time through the vadose zone and the travel time in the saturated zone from beneath the recharge basin to the nearest downgradient domestic or municipal well. Travel time estimates in the vadose zone are based on the application of Darcy's equation and the effective porosity of the alluvial deposits underneath the recharge basins. Travel times in the saturated zone are based on groundwater model simulations that use a recharge planning scenario developed by the Valley Water District. In all cases, the travel time in the vadose zone is small—on the order of a few days to 10 days. The travel time in the saturated zone is on the order of hundreds to thousands of days.



#### 8.9.1.1 Travel Time in the Vadose Zone

The travel time in the vadose zone was estimated by dividing the depth to groundwater under each recharge basin by an estimate of the seepage velocity through the vadose zone. The seepage velocity was estimated from Darcy's equation and the effective porosity:

$$V_v = K_v * I_v / \Theta$$

Where:

- $V_v$  is seepage velocity in the vertical direction (feet/day);
- $\mathbf{K}_{\mathbf{v}}$  is the vertical hydraulic conductivity of the vadose zone—values are from the SBBA flow model (feet/day);
- I<sub>v</sub> is the vertical hydraulic gradient, assumed to be unity or "1" (dimensionless); and
- $\Theta$  is the effective porosity of the vadose zone.

The travel time in the vadose zone is estimated from:

$$Tt_v = Sv / V_v$$

Where:

- $\mathbf{Tt_v}$  is the travel time through the vadose zone from the ground surface to the water table (days); and
- **Sv** is the distance through the vadose zone from the ground surface to the water table (feet).

Based on water level measurements near the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins, as well as the vertical hydraulic conductivity and effective porosity, the travel time in the vadose zone is small—on the order of a few days to 10 days.

#### 8.9.1.2 Travel Time in the Saturated Zone

Travel time in the saturated zone (**Tts**) is based on groundwater model simulation, using a modified version of the most recent baseline recharge and pumping plan currently being used by the Valley Water District. MODFLOW-2000 and MT3DMS were used to estimate groundwater flow and RWC, respectively.

The SBBA model grid consists of 944 rows, 1,472 columns, and five layers. Each cell has a dimension of 102.52 feet by 102.52 feet and is aligned in a north-south/east-west direction. There are a total of 6,947,840 cells, and 1,671,564 cells are active.

WEI slightly modified the SBBA model for the recycled water recharge scenarios. All artificial recharge—including imported water, water diverted from the Santa Ana River, and recycled water from local treatment plants—was removed from the original Recharge Package, and only the deep infiltration of precipitation and the recharge of local stormwater runoff were kept.

MT3DMS is a modular, three-dimensional, multi-species transport model for the simulation of advection, dispersion, and chemical reactions of contaminants in groundwater systems. MT3DMS works with output files from MODFLOW. For the MT3DMS model simulations, it was assumed that there was no soil adsorption or reactivity of recycled water in the percolation and migration processes (a conservative assumption). Longitudinal dispersivity was set to 30 feet, and transverse dispersivity was set to one-third of the longitudinal dispersivity.

The modeling strategy used to estimate travel time in the saturated zone from the recharge basin to the nearest downgradient wells was as follows:

- MODFLOW was first used to simulate groundwater flow velocity in each cell of the model domain for each recharge scenario.
- MT3DMS was used to simulate the transport of recycled water in the saturated zone. Recycled water was assumed to have a concentration of 100, and all other inflows and the initial concentration of groundwater were assumed to have a concentration of zero. The resulting time history of recycled water concentrations in each model cell is the cumulative recycled water contribution from all recycled water recharge projects in the model domain. The recycled water contribution at each well was then estimated from the recycled water contribution at each cell, given the construction information for each well.
- Finally, the travel time in the saturated zone was estimated as the elapsed time from the start of the recharge to the arrival of the recycled water plume at a well, which was determined when the recycled water contribution at the well exceeded 1 percent.

# 8.9.2 Project-Specific Recycled Water and Imported Water Recharge

Table 8-12 shows the baseline recharge planning scenario used by Valley Water District (J. Yeh, personal communication, March 30, 2010) for the period of 2007-2032. The sources of recharge water include Santa Ana River water, imported water, and recycled water. Two recharge scenarios were evaluated and are shown in Tables 8-13 and 8-14. These recharge scenarios preserve the essence of the Valley Water District's recharge planning with subtle differences: the Valley Water District assumed more recycled water recharge than was assumed herein.

In Scenario 1, the recycled water was assumed to be recharged in the Waterman Basins and East Twin Creek Spreading Grounds starting at about 5,000 acre-ft/yr each in 2015 and increasing to 7,250 acre-ft/yr each in 2020 and thereafter.

In Scenario 2, the recycled water was assumed to be recharged in the Waterman Basins, East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins starting at about 3,300 acre-ft/yr each in 2015 and increasing to about 4,800 acre-ft/yr each in 2020 and thereafter.



# 8.9.3 Recycled Water Contribution and Underground Retention Time Estimates for Each Basin

The CDPH's proposed draft regulations for groundwater recharge projects that use recycled water state (Section 60320.010 [c]):

For each GRRP, the recycled municipal wastewater shall be retained underground for a minimum of six months prior to extraction for use as a drinking water supply.<sup>22</sup> (CDPH, 2008)

Only two pumping wells in the SBMWD's service area are within 500 feet of the proposed recycled water recharge facilities: the 40th & Valencia well is about 160 feet from the Waterman Basins, and Devil Canyon 2 is about 180 feet from the Devil Canyon Basins. These wells cannot be used for potable supply after recycled water recharge begins. All other pumping wells meet the 500-foot distance criterion. Due to the negligible vadose zone travel times, the underground retention time of recycled water is determined by the travel time in the saturated zone.

Figures 8-12a through 8-12c show the area impacted by recycled water in Scenario 1 at six months and five years after recycled water recharge commences at the Waterman Basins and the East Twin Creek Spreading Grounds for model layers 1, 3, and 5, respectively. In Scenario 1, the impact of recycled water is limited to the area downgradient of the Waterman Basins and the East Twin Creek Spreading Grounds. Appendix C contains the projected RWC time series at downgradient wells. With the exception of the 40th St. and Valencia well, all downgradient production wells meet the CDPH criteria. Within five years, the recycled water has reached the EPA wells on Baseline Street. The maximum RWC is projected to occur at the 40th St. well at about 30 percent in 2020 or about five years after startup.

Figures 8-13a through 8-13c are identical in scope to Figures 8-12a through 8-12c except they show the area impacted by recycled water in Scenario 2. In Scenario 2, the projected impact of recycled water expands to the downgradient area of the Devil Canyon and Sweetwater Basins, including an area near California State University, San Bernardino and the Newmark plume on the north side of Shandin Hills. Appendix C contains the projected RWC time series at downgradient wells. The model projections for Scenario 2 are questionable because the model layers in the Devil Canyon and Newmark area are assumed to be much thinner than indicated in well completion reports and other published reports (see Danksin, et al., 2005). The confined aquifer assumption for the uppermost model layer also contributes to inaccuracies in the model projection. These modeling problems cause the recycled water plume to spread out longitudinally much faster than expected in nature. The Scenario 2 RWC projections should be considered very conservative. Some pumping wells in the Devil Canyon



<sup>&</sup>lt;sup>22</sup> In past versions of the CDPH draft regulations, this section stated: "For a surface spreading project, all the recycled water shall be retained underground for a minimum of six months prior to extraction for use as a drinking water supply, and shall not be extracted within 500 feet of any groundwater recharge reuse project surface spreading area" (CDPH, 2007); both the IEUA and Orange County permits require a 500-ft buffer between production wells and recycled water recharge.

area—including Devil Canyon Wells 1, 2, 5, 8, and 9—appear to be impacted by recycled water within six months. And, the retention time of recycled water to the 40th St. and Valencia well is still less than six months. Under Scenario 2, these wells should not be used for potable supply. Within five years, the recycled water is projected to reach the EPA wells on Baseline Street. At five years, the recycled water plume emanating from the Devil Canyon area is west and southwest of the recycled water plume emanating from the Waterman Basins and the East Twin Creek Spreading Grounds. The maximum RWC is projected to occur at DC-2 and DC-9, averaging about 30 percent and ranging within each year from a low of near zero to highs ranging near 30 to 60 percent. On a 60- to 120-month moving average, the RWC would typically be less than 30 percent.

## 8.10 Model Uncertainty and Limitations

The primary goal of the recycled water flow and transport modeling was to provide estimates of the underground retention time and RWC at downgradient production wells. The accuracy of the modeling results depends on the accuracy of the SBBA groundwater flow model. And, the accuracy of a groundwater flow model depends on the quality of the conceptual-numerical model, the quality of model calibration, and the accuracy of projected future groundwater production and recharge. Conceptual model errors arise from how accurately a real groundwater system is conceptualized and how accurately the conceptual model is represented in the numerical model. The accuracy of the underground retention time and RWC estimates at downgradient production wells presented herein cannot be reliably quantified due to certain issues that were identified in the review of the SBBA model conceptualization and implementation.

- Aquifer conceptualization in the vicinity of the Devil and Sweetwater Basins. The thickness of the aquifer underlying and adjacent to these spreading basins is about 400 feet based on well completion reports in this area. The aquifer thickness in the SBBA model in this area is about 100 feet. This apparent error causes the RWC in the area underlying and adjacent to these spreading basins to be significantly overestimated. This error contributes to overstating the speed of recycled water transport in the aquifer, which leads to overestimates of the area within the area delineated as the sixmonth underground retention area. Note that several SBMWD wells are projected to be within the six-month underground retention area.
- Confined aquifer assumption for the upper layer. The upper layer in the SBBA model is assumed to be confined, but in reality, it is not confined. The confined aquifer assumption is not appropriate for areas with significant recharge because it does not accurately predict the change in storage and gradient under and adjacent to the recharge basins. The confined aquifer assumption causes the RWC in the area underlying and adjacent to these spreading basins to be significantly overestimated. This assumption contributes to overstating the speed of recycled water transport in the aquifer, which leads to overestimates of the area within the area delineated as the six-month underground retention area. The aquifer thickness error described above and the



confined aquifer assumption compound each other, causing overestimates of the RWC and the area with the six-month underground retention time.

- Stream system conceptualization. The stream conceptualization in the SBBA model overestimates the amount of stormwater recharge that occurs in the East Twin Creek retention basin. The use of a monthly time step to compute stormwater recharge in the SBBA model also contributes to an overestimate of stormwater recharge in this area. These assumptions in the SBBA model lead to an underestimate of the RWC and an overestimate of the six-month underground retention time area.
- Quality of calibration. The quality of SBBA model calibration along the mountain front appears to be poor. This can be seen by an analysis of comparative time histories at wells and the residuals map contained in the report documenting the SBBA model (Stantec, 2010). A demonstrably poor calibration will not be acceptable to the regulatory agencies and could contribute to public opposition.

The SBBA model, in its current form, should not be used for a formal Title 22 Engineering Report of the proposed recycled water recharge project. A new localized model should be developed and used for the formal Title 22 Engineering Report that will be required by the DPH. The domain of this new localized model should be limited to the region around the recharge basins and downgradient areas of interest. Useful information from the SBBA model could be exploited for the new localized model.

## 8.11 Integration of Recycled Water Recharge with the IRWMP

The IRWMP for the Upper Santa Ana River Watershed was completed in 2007. It included projections of imported water recharge and recycled water reuse. The projections related to imported water recharge are consistent with the quantities assumed in this feasibility investigation. The IRWMP includes only 800 acre-ft/yr of recycled water reuse for the SBMWD, as described in the SMBWD 2005 Urban Water Management Plan. Implementation of the CWF, as described herein, will increase recycled water reuse by about 14,500 acre-ft/yr over that projected in the IRWMP.



Spreading Grounds, and Devil Canyon and Sweetwater Basins Recharge Capacity at the Waterman Basins, East Twin Creek Table 8-1

Recharge Site	Site Area	Effective Area	Infiltration Rate <sup>1</sup>	Storage Capacity <sup>2</sup>	Maximum Recharge Capacity	Maximum Recharge Capacity <sup>3</sup>
	(acres)	(acres)	(ft / day)	(acre-ft)	(acre-ft / day)	(acre-ft / year)
Waterman Basins	230	70	1.5	280	105	32,000
East Twin Creek Spreading Grounds	170	63	1.5	480	139	42,100
Devil Canyon and Sweetwater Basins	540	38	1.5	150	25	17,100
Total	940	201		910	301	91,200

<sup>1.</sup> This is the estimated average infiltration rate, expressed in feet per day, at which water will infiltrate to the subsurface.



<sup>2.</sup> For the Waterman Basins and East Twin Creek Spreading Grounds, storage capacity is the volume of water that can be stored at an elevation of 8-ft above bottom of 8-ft above bottom of basin. For the Devil Canyon and Sweetwater Basins, storage capacity is the volume of water that can be stored at an elevation of 9-ft above bottom of basin.

<sup>3.</sup> This calculation is based on all recharge basins within the spreading facility being online about 300 days or 10 months per year. Annual maintenance of the recharge facility will occur during a 2-month period.

Table 8-2 Stormwater Inflow to the Waterman Basins

		(4.			
		Inflow <sup>1</sup>		Outflow <sup>2</sup>	Recharge <sup>2</sup>
Month	From Waterman Canyon Creek	To Cell 1 <sup>3</sup>	To Cells 2 thru 4	From Cells 2 through 4 to the East Twin Creek Spreading Grounds	From Cells 1 through 4
January	380	100	280	100	280
February	480	100	380	160	320
March	590	110	480	200	390
April	340	100	240	30	310
May	210	100	110	0	210
June	120	70	50	0	120
July	70	50	20	0	70
August	40	30	10	0	40
September	40	30	10	0	40
October	50	40	10	0	50
November	110	60	50	0	110
December	170	80	90	10	160
Total	2,600	870	1,730	500	2,100

<sup>1.</sup> Stormwater runoff was estimated using 50 years of historical data from a USGS stream gauging station.

<sup>2.</sup> Calculation assumes 4-ft of conservation storage and a spillway elevation at 8-ft from the bottom of cell.

<sup>3.</sup> Storm water diverted to cell 1 is fully retained and infiltrates to the Bunker Hill Basin. Cell 1 is upgradient of the Waterman turnout.

Table 8-3
Stormwater Inflow to the East Twin Creek Spreading Grounds

		(doi			
		Inflow <sup>1</sup>		Outflow <sup>2</sup>	
Month	From Waterman Creek / Basins	From East Twin Creek	Total	To the Flood Control Channel	Recharge <sup>2</sup>
January	100	660	760	210	550
February	160	880	1,040	350	690
March	200	1,060	1,260	350	910
April	30	500	530	20	510
May	0	310	310	0	310
June	0	170	170	0	170
July	0	110	110	0	110
August	0	80	80	0	80
September	0	70	70	0	70
October	0	90	90	0	90
November	0	160	160	10	150
December	10	300	310	50	260
Total	500	4,390	4,890	990	3,900

<sup>1.</sup> Stormwater runoff was estimated using 50 years of historical data from a USGS stream gauging station.



<sup>2.</sup> Calculation assumes 4-ft of conservation storage and a spillway elevation at 8-ft from the bottom of cell.

Table 8-4
Stormwater Inflow to the Devil Canyon and Sweetwater Basins

		Inflow <sup>1</sup>		Outflow <sup>2</sup>	
Month	From Devil Canyon Creek	From the Area Tributary to Sweetwater Basin	Total	To Devil Canyon Creek	Recharge <sup>2</sup>
January	310	30	340	150	190
February	480	50	530	310	220
March	500	50	550	290	260
April	290	30	320	110	210
May	170	20	190	30	160
June	80	10	90	0	90
July	50	0	50	0	50
August	30	0	30	0	30
September	30	0	30	0	30
October	30	0	30	0	30
November	70	10	80	20	60
December	140	10	150	20	130
Total	2,180	210	2,390	930	1,460

<sup>1.</sup> Storm water runoff was estimated using 50 years of historical data from a USGS stream gauging station on Devil Canyon Creek and average rainfall data (for local area runoff).



<sup>2.</sup> Calculation assumes 4-ft of conservation storage and a spillway elevation at 9-ft from the bottom of cell.

Table 8-5
Imported Water Deliveries through the Waterman Turnout

						(do	e-It)						
Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1972	0	0	0	0	0	0	0	0	0	0	52	1,103	1,155
1973	2,63	618	300	0	1,785	923	2,688	3,880	932	2,598	3,309	3,251	20,284
1974	2,857	3,323	2,746	814	0	7	0	0	0	0	0	0	9,747
1975	254	219	196	0	0	4	0	0	637	1,349	1,972	2,190	6,821
1976	2,043	369	25	13	0	0	0	1,608	1,270	808	595	305	7,036
1977	1,105	1,113	988	25	0	18	42	0	23	3	62	231	3,610
1978	0	0	0	0	0	16	165	0	0	0	0	0	181
1979	0	0	48	0	0	0	0	0	0	0	0	0	48
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	7	0	0	0	7
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	620	1,092	902	914	3,528
2003	0	0	124	126	0	0	0	0	0	0	0	0	250
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	39	0	39
2008	0	0	0	0	0	0	0	0	1,461	3,054	2,980	1,721	9,216
2009	0	0	0	0	0	0	0	383	2,371	3,412	3,202	0	9,368
2010 <sup>1</sup>	0	29	0	0	0	0	1,100	3,970	N/A	N/A	N/A	N/A	5,099

<sup>1.</sup> Data were collected through August 2010.



Table 8-6 Imported Water Deliveries through the Sweetwater Turnout

						(do	e-II)						
Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1972	0	0	0	0	0	0	0	0	0	0	14	84	98
1973	88	210	123	0	343	386	290	520	99	257	254	339	2,907
1974	248	273	279	110	0	379	388	403	365	165	193	351	3,152
1975	169	173	76	0	0	288	566	409	361	680	949	922	4,594
1976	653	115	193	10	0	0	265	627	539	326	242	86	3,055
1977	862	832	611	325	326	19	264	404	855	749	1,030	1,096	7,372
1978	1,006	632	0	0	113	290	894	923	896	906	843	740	7,243
1979	435	404	6	0	59	545	625	615	536	335	351	90	4,000
1980	67	671	107	0	0	163	569	621	581	518	314	358	3,970
1981	0	0	0	0	0	244	70	0	2	1,646	1,913	2,203	6,077
1982	975	911	718	13	0	0	257	25	0	0	0	0	2,899
1983	0	0	0	0	0	54	0	0	0	0	0	54	108
1984	0	0	0	0	0	70	99	0	0	0	0	0	169
1985	0	0	0	0	119	385	60	421	176	0	0	0	1,161
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	992	1,407	999	973	629	0	0	654	1,180	6,834
1991	165	0	0	0	0	0	0	0	0	0	0	817	982
1992	0	128	0	0	0	0	0	0	0	0	0	0	128
1993	0	0	0	0	0	0	0	0	91	907	807	565	2,370
1994	430	129	0	0	0	0	554	328	511	460	248	14	2,674
1995	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	54	4	0	0	0	0	38	0	0	0	96
1997	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	4	0	0	0	0	0	0	4
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	1	5	0	0	0	0	246	853	1,259	934	896	4,194
2001	517	0	0	0	0	0	0	0	0	0	152	1,056	1,725
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	342	961	465	32	0	347	909	723	261	614	4,654
2004	0	0	2	0	408	831	932	511	0	0	0	0	2,684
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	854	668	892	0	0	0	0	0	0	0	0	0	2,414
2007	0	336	625	617	438	0	0	0	557	884	861	887	5,205
2008	893	835	620	611	646	486	0	0	0	0	0	903	4,994
2009	779	196	252	506	495	662	112	0	0	0	0	0	3,002
2010 <sup>1</sup>	286	3	568	570	570	579	859	548	N/A	N/A	N/A	N/A	3,983

<sup>1.</sup> Data were collected through August 2010.



Table 8-7
Summary of Hydrogeologic Properties underneath the Waterman Basins

Hydrogeologic Data		Layer1	Layer 2	Layer 3	Layer 4	Layer 5
	MAX	247.9	140.1	121.3	108.0	309.1
Thickness (feet)	MIN	75.2	46.7	40.4	36.0	89.1
	Average	157.4	91.8	79.4	70.7	182.6
	MAX	139.3	11.90	12.24	3.81	3.00
Hydraulic Conductivity (feet/day) 1	MIN	39.2	4.46	4.00	3.00	3.00
	Average	52.9	6.89	5.74	3.03	3.00
	MAX	0.087				
Effective Porosity <sup>2</sup>	MIN	0.066				
	Average	0.077				

<sup>1.</sup> Data from GSSI-Stantec model.

<sup>2.</sup> Data from USGS model.

Table 8-8
Summary of Hydrogeologic Properties underneath the East Twin Creek Spreading Grounds

Hydrogeologic Data		Layer1	Layer 2	Layer 3	Layer 4	Layer 5
	MAX	252.3	180.6	123.0	109.5	264.8
Thickness (feet)	MIN	183.5	109.2	92.3	83.8	133.8
	Average	228.1	148.4	116.3	98.1	219.5
	MAX	78.95	11.64	40.70	101.81	16.86
Hydraulic Conductivity (feet/day) 1	MIN	28.80	4.00	4.00	3.00	3.00
	Average	45.50	4.53	19.21	19.60	6.22
	MAX	0.130				
Effective Porosity <sup>2</sup>	MIN	0.084				
	Average	0.117				

<sup>1.</sup> Data from GSSI-Stantec model.

<sup>2.</sup> Data from USGS model.

Table 8-9
Production Wells near the East Twin Creek Spreading Grounds

Well Name	Owner	Average Pumping Rate <sup>1</sup>
		(acre-ft/yr)
No. 1	Arrowhead Country Club	308
Plant No. 24A	East Valley Water District	361
Plant No. 24B	East Valley Water District	1549
Plant No. 25A	East Valley Water District	329
Lynwood Well	San Bernardino, City Of	1746
Total		4293

<sup>1.</sup> Average pumping rate is for the period of 2007 to 2032.

Table 8-10 Summary of Hydrogeologic Properties underneath the Devil Canyon and Sweetwater Basins

Hydrogeologic Data		Layer1	Layer 2	Layer 3	Layer 4	Layer 5
	MAX	57.1	29.1	25.1	22.3	62.3
Thickness (feet)	MIN	10.0	10.0	10.0	10.0	10.0
	Average	21.0	13.5	12.6	12.0	20.0
	MAX	175.34	101.62	100.38	112.05	86.23
Hydraulic Conductivity (feet/day) 1	MIN	42.08	13.80	16.96	2.00	2.00
	Average	92.22	62.73	62.12	25.09	24.37
	MAX	0.061				
Effective Porosity <sup>2</sup>	MIN	0.055				
	Average	0.067				

<sup>1.</sup> Data from GSSI-Stantec model.

<sup>2.</sup> Data from USGS model.

Table 8-11
Production Wells Downgradient of the Devil Canyon and Sweetwater Basins

Well Name	Owner	Average Pumping Rate <sup>1</sup>
		(acre-ft/yr)
Devil Canyon Well 1	City of San Bernardino	933
Devil Canyon Well 5	City of San Bernardino	310
Devil Canyon Well 2	City of San Bernardino	1048
Devil Canyon Well 8	City of San Bernardino	663
Devil Canyon Well 9	City of San Bernardino	431
Total		3385

<sup>1.</sup> Average pumping rate is for the period of 2007 to 2032.

Table 8-12
Valley District Recharge Planning Scenario
(acre-ftyr)

		Devil Can	Devil Canyon & Sweetwater Basins	ter Basins	W	Vaterman Basins	S	East Twin 0	East Twin Creek Spreading Grounds	g Grounds	Other SBE	Other SBBA Recharge Facilities <sup>2</sup>	acilities <sup>2</sup>		Total		
Model Year	Hydrologic Year	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Total Recharge
2007	1979	10,141	1,082	0	13,521	4,040	0	13,521	1,880	0	30,422	31,880	0	67,605	38,881	0	106,486
2008	1980	11,473	1,680	0	15,297	3,677	0	15,297	1,322	0	34,419	50,773	0	76,486	57,451	0	133,937
2009	1981	7,034	0	0	9,378	0	0	9,378	0	0	21,101	5,154	0	46,892	5,154	0	52,046
2010	1982	12,137	0	0	16,182	0	0	16,182	0	0	36,410	15,240	0	80,910	15,240	0	96,150
2011	1983	11,144	1,671	0	14,859	3,117	1,397	14,859	1,251	0	33,432	42,905	0	74,294	48,945	1,397	124,636
2012	1984	11,999	0	0	15,998	0	2,794	15,998	0	0	35,996	9,187	0	79,990	9,187	2,794	91,971
2013	1985	8,467	0	0	11,289	0	4,191	11,289	0	0	25,400	2,983	0	56,445	2,983	4,191	63,619
2014	1986	6,705	0	0	8,940	0	5,588	8,940	0	0	20,115	12,846	0	44,699	12,846	5,588	63,133
2015	1987	5,559	0	0	7,411	0	6,985	7,411	0	0	16,676	736	0	37,057	736	6,985	44,778
2016	1988	0	0	0	0	0	8,202	0	0	0	0	0	0	0	0	8,202	8,202
2017	1989	260'6	0	0	10,917	0	9,599	12,130	0	0	28,505	0	0	60,648	0	9,599	70,247
2018	1990	0	0	0	0	0	10,996	0	0	0	0	0	0	0	0	10,996	10,996
2019	1991	0	0	0	0	0	12,393	0	0	0	0	1,319	0	0	1,319	12,393	13,712
2020	1992	006	0	0	1,201	0	13,068	1,201	0	0	2,701	8,411	0	6,003	8,411	13,068	27,482
2021	1993	9,856	2,036	0	6,570	432	14,382	13,141	2,759	0	36,137	45,498	0	65,704	50,726	14,382	130,812
2022	1994	3,806	0	0	2,537	0	15,779	5,074	0	0	13,954	4,944	0	25,370	4,944	15,779	46,093
2023	1995	10,529	1,171	0	0	2,581	17,176	14,039	1,891	0	45,626	34,634	0	70,194	40,277	17,176	127,647
2024	1996	10,019	0	0	0	0	18,573	13,359	0	0	43,417	10,882	0	96,796	10,882	18,573	96,251
2025	1997	8,355	0	0	0	0	19,637	11,141	0	0	36,207	10,098	0	55,703	10,098	19,637	85,438
2026	1998	10,584	1,032	0	0	395	20,810	14,112	1,584	0	45,864	34,254	0	70,560	37,264	20,810	128,634
2027	1999	14,669	0	0	0	0	21,600	13,691	0	209	69,433	3,007	0	97,793	3,007	22,207	123,007
2028	2000	14,459	0	0	0	0	21,600	13,495	0	2,004	68,441	0	0	96,396	0	23,604	120,000
2029	2001	14,250	0	0	0	0	21,600	13,300	0	3,401	67,449	0	0	94,999	0	25,001	120,000
2030	2002	14,175	0	0	0	0	21,600	13,230	0	3,900	67,095	0	0	94,500	0	25,500	120,000
2031	2003	13,845	0	0	0	0	21,600	10,650	0	3,900	82,005	0	0	106,500	0	25,500	132,000
2032	2004	15,405	0	0	0	0	21,600	11,850	0	3,900	91,245	0	0	118,500	0	25,500	144,000

1. Data received from GSSI.
2. Other Basins include the Lower Lytle Basins, Badger Spreading Grounds, Patton Spreading Grounds, Airport Spreading Grounds, City Creek Spreading Grounds, Santa Ana Spreading Grounds, and Mill Creek Spreading Grounds.

Table 8-13
Recharge Scenario 1 Modified Valley District Recharge Planning Scenario
SBMWD Recycled Water Recharge in Waterman Basins and East Twin Creek Spreading Grounds <sup>1</sup>
(acre-ft/yr)

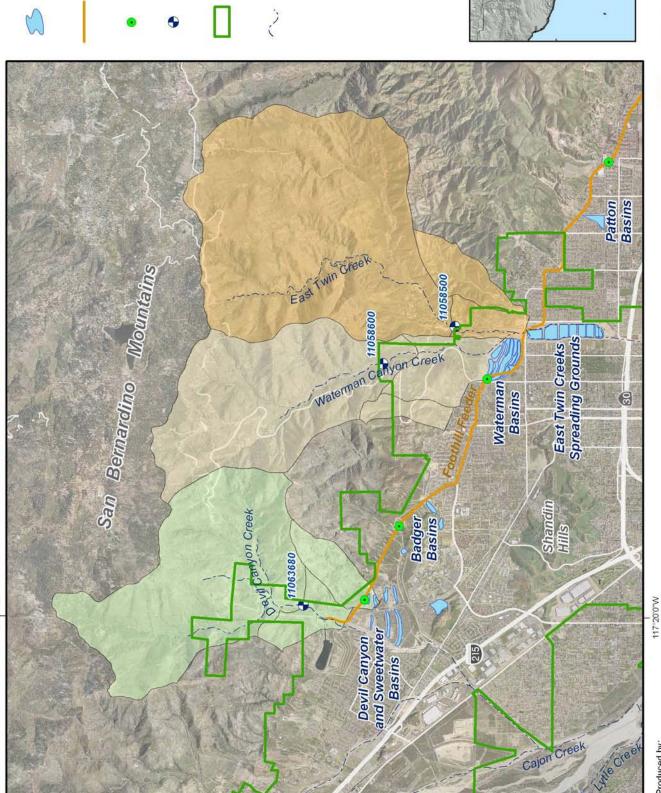
								(acie-iuyi)	11,711,								
		Devil Cany	Devil Canyon & Sweetwater Basins	er Basins	W	Vaterman Basins	(4)	East Twin C	East Twin Creek Spreading Grounds	g Grounds	Other SBB	Other SBBA Recharge Facilities <sup>2</sup>	cilities <sup>2</sup>		Total		
Model Year	Hydrologic Year	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water <sup>3</sup>	Total Recharge
2007	1979	10,141	1,082	0	13,521	4,040	0	13,521	1,880	0	30,422	31,880	0	67,605	38,881	0	106,486
2008	1980	11,473	1,680	0	15,297	3,677	0	15,297	1,322	0	34,419	50,773	0	76,486	57,451	0	133,937
2009	1981	7,034	0	0	9,378	0	0	9,378	0	0	21,101	5,154	0	46,892	5,154	0	52,046
2010	1982	12,137	0	0	16,182	0	0	16,182	0	0	36,410	15,240	0	80,910	15,240	0	96,150
2011	1983	11,144	1,671	0	14,859	3,117	0	14,859	1,251	0	33,432	42,905	0	74,294	48,945	0	123,239
2012	1984	11,999	0	0	15,998	0	0	15,998	0	0	35,996	9,187	0	79,990	9,187	0	89,177
2013	1985	8,467	0	0	11,289	0	0	11,289	0	0	25,400	2,983	0	56,445	2,983	0	59,428
2014	1986	6,705	0	0	8,940	0	0	8,940	0	0	20,115	12,846	0	44,699	12,846	0	57,545
2015	1987	5,559	0	0	7,411	0	5,000	7,411	0	5,000	16,676	736	0	37,057	736	10,000	47,793
2016	1988	0	0	0	0	0	5,000	0	0	5,000	0	0	0	0	0	10,000	10,000
2017	1989	6,097	0	0	10,917	0	5,000	12,130	0	5,000	28,505	0	0	60,648	0	10,000	70,648
2018	1990	0	0	0	0	0	5,000	0	0	5,000	0	0	0	0	0	10,000	10,000
2019	1991	0	0	0	0	0	5,000	0	0	5,000	0	1,319	0	0	1,319	10,000	11,319
2020	1992	006	0	0	1,201	0	7,250	1,201	0	7,250	2,701	8,411	0	6,003	8,411	14,500	28,914
2021	1993	9,856	2,036	0	6,570	432	7,250	13,141	2,759	7,250	36,137	45,498	0	65,704	50,726	14,500	130,930
2022	1994	3,806	0	0	2,537	0	7,250	5,074	0	7,250	13,954	4,944	0	25,370	4,944	14,500	44,814
2023	1995	10,529	1,171	0	0	2,581	7,250	14,039	1,891	7,250	45,626	34,634	0	70,194	40,277	14,500	124,971
2024	1996	10,019	0	0	0	0	7,250	13,359	0	7,250	43,417	10,882	0	96,796	10,882	14,500	92,178
2025	1997	8,355	0	0	0	0	7,250	11,141	0	7,250	36,207	10,098	0	55,703	10,098	14,500	80,301
2026	1998	10,584	1,032	0	0	395	7,250	14,112	1,584	7,250	45,864	34,254	0	70,560	37,264	14,500	122,324
2027	1999	14,669	0	0	0	0	7,250	13,691	0	7,250	69,433	3,007	0	97,793	3,007	14,500	115,300
2028	2000	14,459	0	0	0	0	7,250	13,495	0	7,250	68,441	0	0	96,396	0	14,500	110,896
2029	2001	14,250	0	0	0	0	7,250	13,300	0	7,250	67,449	0	0	94,999	0	14,500	109,499
2030	2002	14,175	0	0	0	0	7,250	13,230	0	7,250	67,095	0	0	94,500	0	14,500	109,000
2031	2003	13,845	0	0	0	0	7,250	10,650	0	7,250	82,005	0	0	106,500	0	14,500	121,000
2032	2004	15,405	0	0	0	0	7,250	11,850	0	7,250	91,245	0	0	118,500	0	14,500	133,000

1. Imported and Santa Ana River water data is from GSSI.
2. Other Basins include the Lower Lytle Basins, Badger Spreading Grounds, Patton Spreading Grounds, Airport Spreading Grounds, City Creek Spreading Grounds, Santa Ana Spreading Grounds, and Mill Creek Spreading Grounds.

Table 8-14
Recharge Scenario 2 Modified Valley District Recharge Planning Scenario
SBMWD Recycled Water Recharge in Waterman Basins, East Twin Creek Spreading Grounds, and Devil Canyon and Sweetwater Basins <sup>1</sup>
(acre-ft/yr)

		Devil Cany	Devil Canyon & Sweetwater Basins	ter Basins	W	Waterman Basins	(Δ	East Twin 0	East Twin Creek Spreading Grounds	g Grounds	Other SB	Other SBBA Recharge Facilities <sup>2</sup>	acilities <sup>2</sup>		Total		
Model Year	Hydrologic Year	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water	Imported Water	Santa Ana River	Recycled Water <sup>3</sup>	Total Recharge
2007	1979	10,141	1,082	0	13,521	4,040	0	13,521	1,880	0	30,422	31,880	0	67,605	38,881	0	106,486
2008	1980	11,473	1,680	0	15,297	3,677	0	15,297	1,322	0	34,419	50,773	0	76,486	57,451	0	133,937
2009	1981	7,034	0	0	9,378	0	0	9,378	0	0	21,101	5,154	0	46,892	5,154	0	52,046
2010	1982	12,137	0	0	16,182	0	0	16,182	0	0	36,410	15,240	0	80,910	15,240	0	96,150
2011	1983	11,144	1,671	0	14,859	3,117	0	14,859	1,251	0	33,432	42,905	0	74,294	48,945	0	123,239
2012	1984	11,999	0	0	15,998	0	0	15,998	0	0	35,996	9,187	0	79,990	9,187	0	89,177
2013	1985	8,467	0	0	11,289	0	0	11,289	0	0	25,400	2,983	0	56,445	2,983	0	59,428
2014	1986	6,705	0	0	8,940	0	0	8,940	0	0	20,115	12,846	0	44,699	12,846	0	57,545
2015	1987	5,559	0	3,333	7,411	0	3,333	7,411	0	3,334	16,676	736	0	37,057	736	10,000	47,793
2016	1988	0	0	3,333	0	0	3,333	0	0	3,334	0	0	0	0	0	10,000	10,000
2017	1989	9,097	0	3,333	10,917	0	3,333	12,130	0	3,334	28,505	0	0	60,648	0	10,000	70,648
2018	1990	0	0	3,333	0	0	3,333	0	0	3,334	0	0	0	0	0	10,000	10,000
2019	1991	0	0	3,333	0	0	3,333	0	0	3,334	0	1,319	0	0	1,319	10,000	11,319
2020	1992	006	0	4,833	1,201	0	4,833	1,201	0	4,834	2,701	8,411	0	6,003	8,411	14,500	28,914
2021	1993	9,856	2,036	4,833	6,570	432	4,833	13,141	2,759	4,834	36,137	45,498	0	65,704	50,726	14,500	130,930
2022	1994	3,806	0	4,833	2,537	0	4,833	5,074	0	4,834	13,954	4,944	0	25,370	4,944	14,500	44,814
2023	1995	10,529	1,171	4,833	0	2,581	4,833	14,039	1,891	4,834	45,626	34,634	0	70,194	40,277	14,500	124,971
2024	1996	10,019	0	4,833	0	0	4,833	13,359	0	4,834	43,417	10,882	0	96,796	10,882	14,500	92,178
2025	1997	8,355	0	4,833	0	0	4,833	11,141	0	4,834	36,207	10,098	0	55,703	10,098	14,500	80,301
2026	1998	10,584	1,032	4,833	0	395	4,833	14,112	1,584	4,834	45,864	34,254	0	70,560	37,264	14,500	122,324
2027	1999	14,669	0	4,833	0	0	4,833	13,691	0	4,834	69,433	3,007	0	97,793	3,007	14,500	115,300
2028	2000	14,459	0	4,833	0	0	4,833	13,495	0	4,834	68,441	0	0	96,396	0	14,500	110,896
2029	2001	14,250	0	4,833	0	0	4,833	13,300	0	4,834	67,449	0	0	94,999	0	14,500	109,499
2030	2002	14,175	0	4,833	0	0	4,833	13,230	0	4,834	67,095	0	0	94,500	0	14,500	109,000
2031	2003	13,845	0	4,833	0	0	4,833	10,650	0	4,834	82,005	0	0	106,500	0	14,500	121,000
2032	2004	15,405	0	4,833	0	0	4,833	11,850	0	4,834	91,245	0	0	118,500	0	14,500	133,000

1. Imported and Santa Ana River water data is from GSSI.
2. Other Basins include the Lower Lyte Basins, Badger Spreading Grounds, Patton Spreading Grounds, Airport Spreading Grounds, City Creek Spreading Grounds, Santa Ana Spreading Grounds, and Mill Creek Spreading Grounds.



Streams, Rivers, and Channels

**USGS Stream Gaging Station** 

Imported Water Turnout

San Bernardino Municipal Water District Boundary

San Bernardino County Flood Control District Recharge Facilities

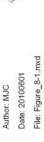
117°20'0"W

Foothill Feeder (Imported Water Pipeline)

Riverside San Bernardino County an Bernardin © Sant Orange County P

Produced for:

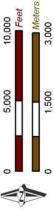
and USGS Stream Gauging Stations Location of Recharge Basins, Watershed



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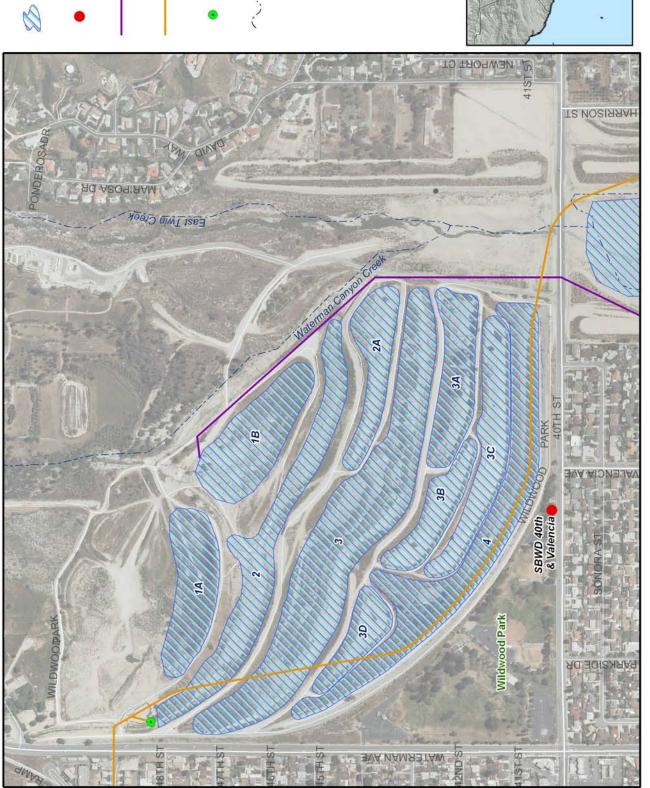
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SBMWD Recycled Water Planning Investigation





Streams, Rivers, and Channels

Imported Water Turnout

San Bernardino County Flood Control District Recharge Facilities

Proposed Recharge Pipeline

Active Production Well

Foothill Pipeline (Imported Water Pipeline)

Recharge Facilities Location of Waterman Basins

Riverside County

Santa

Orange

P

San Bernardino County

County



Produced for:





SBMWD Recycled Water Planning Investigation

Feet

200

File: Figure\_8-2.mxd Date: 20091020 Author: MJC

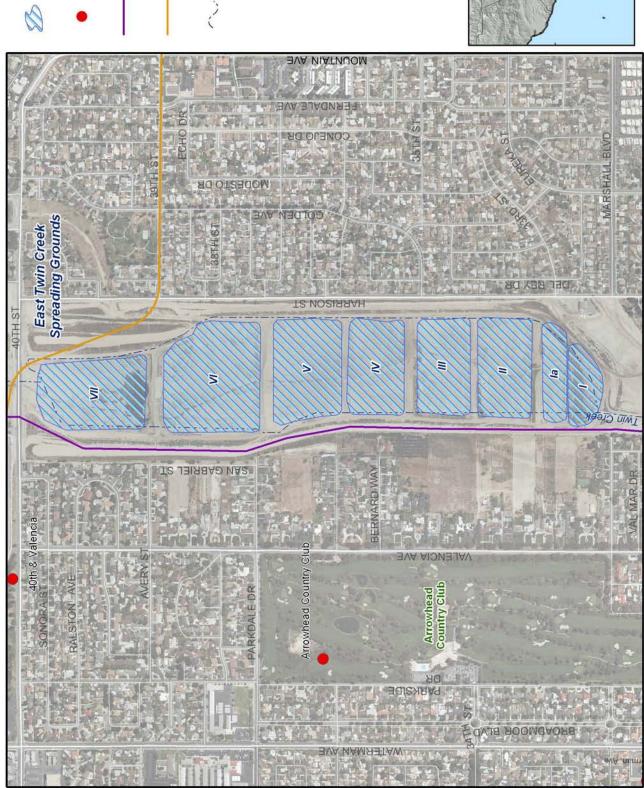
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1,000





San Bernardino County Flood Control District Recharge Facilities

Streams, Rivers, and Channels

Proposed Recharge Pipeline

Active Production Well

Foothill Pipeline (Imported Water Pipeline)



**Location of East Twin Creeks** Recharge Facilities

> Feet 1,000

200

SBMWD Recycled Water Planning Investigation



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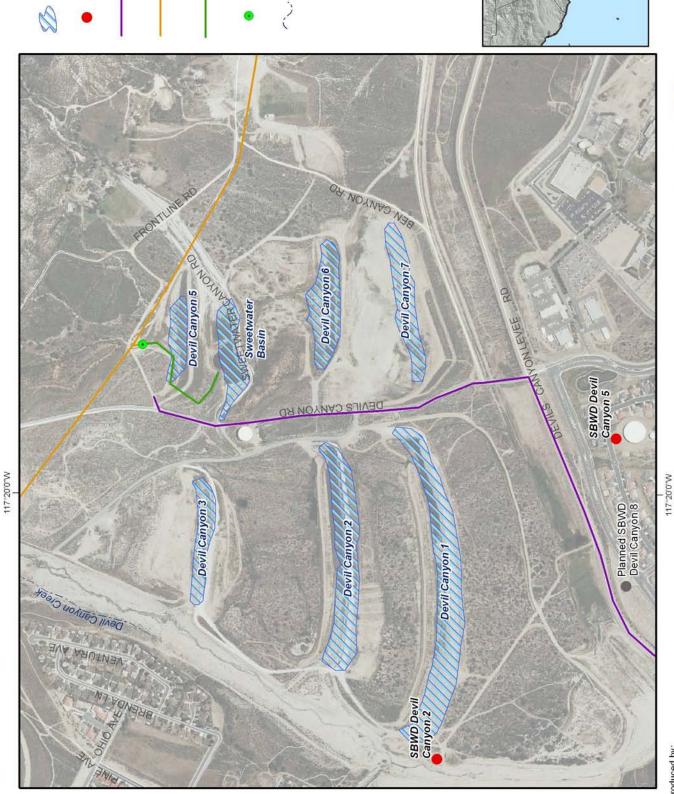


Author: MJC

WILDERMUTH'

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Streams, Rivers, and Channels

Imported Water Turnout

San Bernardino County Flood Control District Recharge Facilities

Proposed Recharge Pipeline

Active Production Well

Foothill Pipeline (Imported Water Pipeline)

SBCFCD Imported Water Conveyance Facilities

Location of Devil Canyon and Sweetwater Recharge Facilities

Riverside County

Santa

Orange

D

San Bernardino County

County

San Bernardino



File: Figure\_8-4.mxd Date: 20091020

Author: MJC

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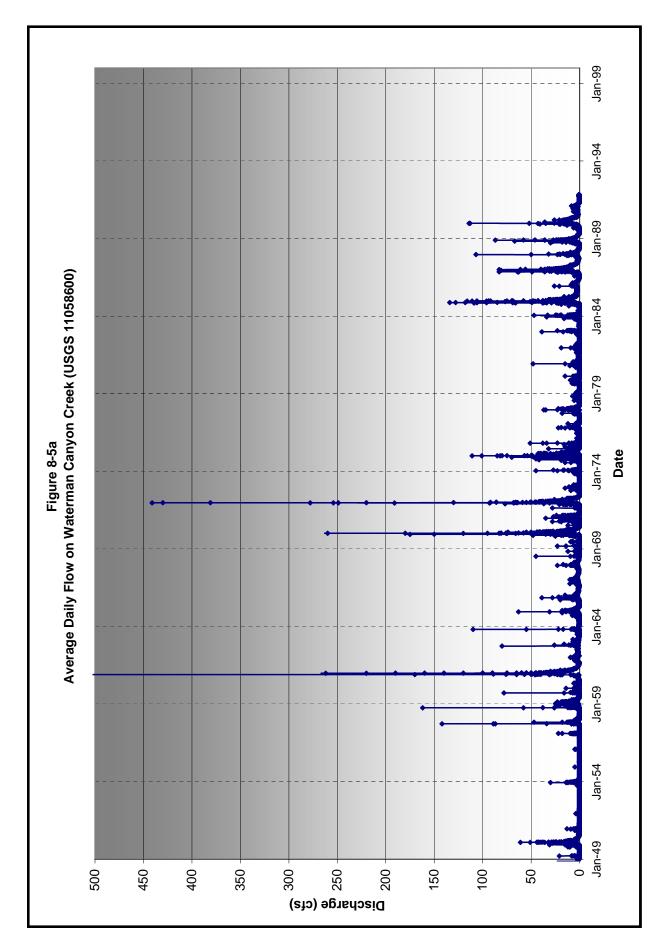
Feet 1,000

SBMWD Recycled Water Planning Investigation

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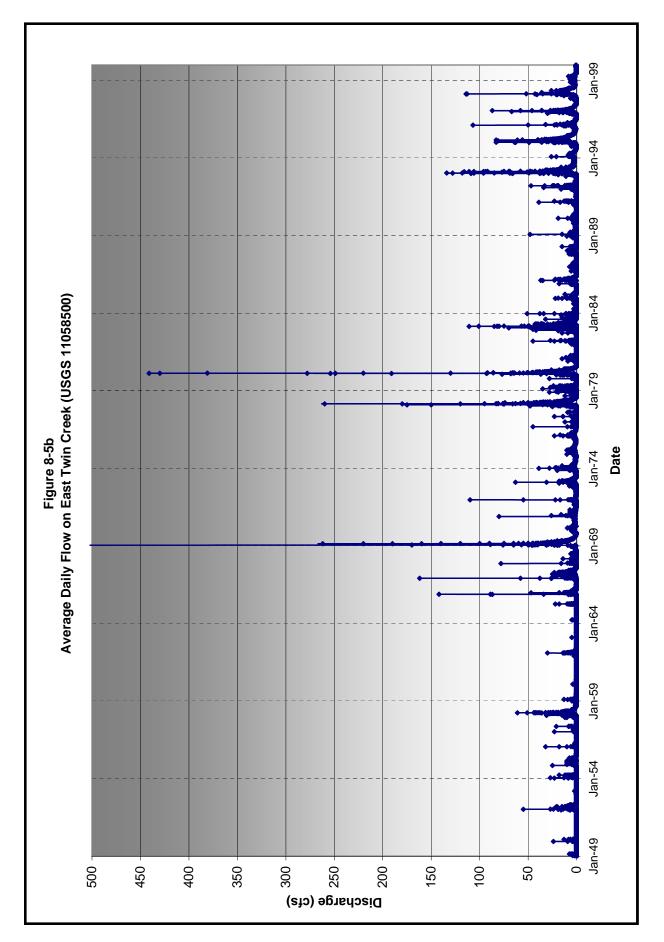
200





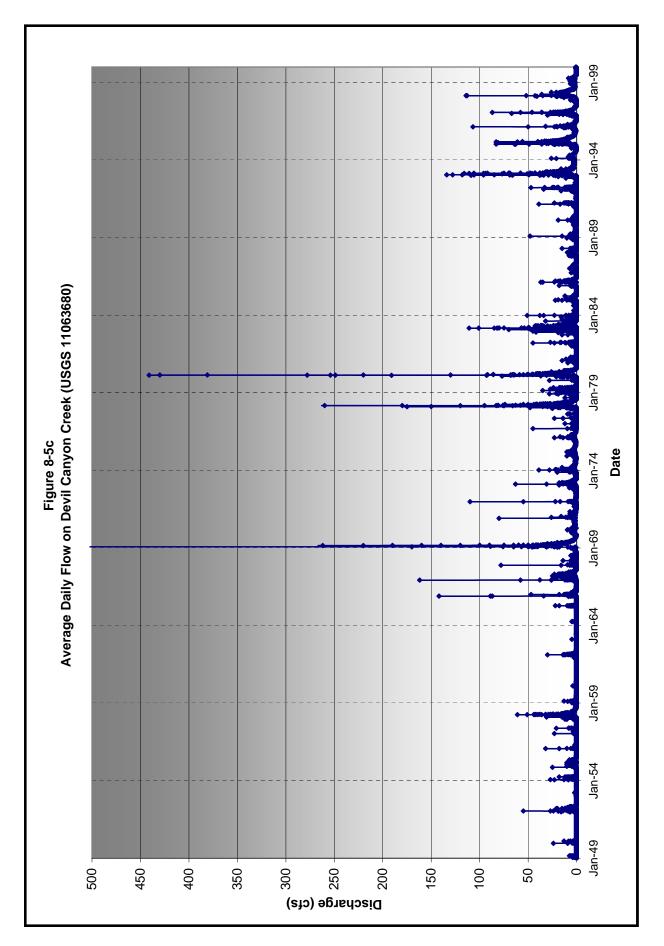
Figure\_8-5abc.xls -- Figure8-5a 8/17/2010 -- 2:11 PM





Figure\_8-5abc.xls -- Figure8-5b 8/17/2010 -- 2:11 PM





Figure\_8-5abc.xls -- Figure8-5c 8/17/2010 -- 2:11 PM



Phase II - Proposed Recharge Pipeline to Devil Canyon and Sweetwater Facilities (20" diameter, 5.88 miles long)

Recycled Water Pump Station

Recycled Water Turnout

0

San Bernardino County Flood Control District Recharge Facilities

Streams, Rivers, and Flood Control Channels

Warm Creek

30

San Bernardino Municipal Water Department Service Area

Phase I - Proposed Recharge Pipeline to Waterman and East Twin Creek Facilities

Water Reclamation Facility

east Twin

(Project Alternative 1 and 3 -

30" diameter, 7.11 miles long) (Project Alternative 2 -36" diameter, 7.11 miles long)

Bornstalino

File: Figure\_8-6.mxd Date: 20100406

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WILDERMUTH-

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117°20'0"W

9

☐ Miles

SBMWD Recycled Water Planning Investigation

Produced for:



Location of Proposed Recycled Water

San Bernardino

Santa Ana Rive

County

County

Riverside County

@ ©

Orange

Recharge Facilities











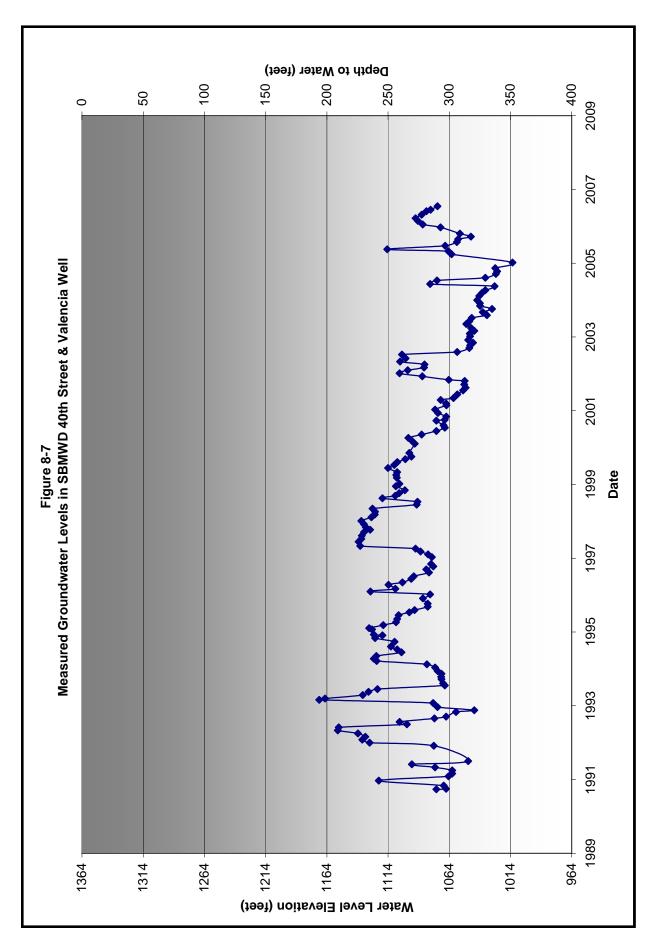


Figure8-7\_Figure8-8.xls -- Figure8-7 10/6/2010 -- 9:20 AM



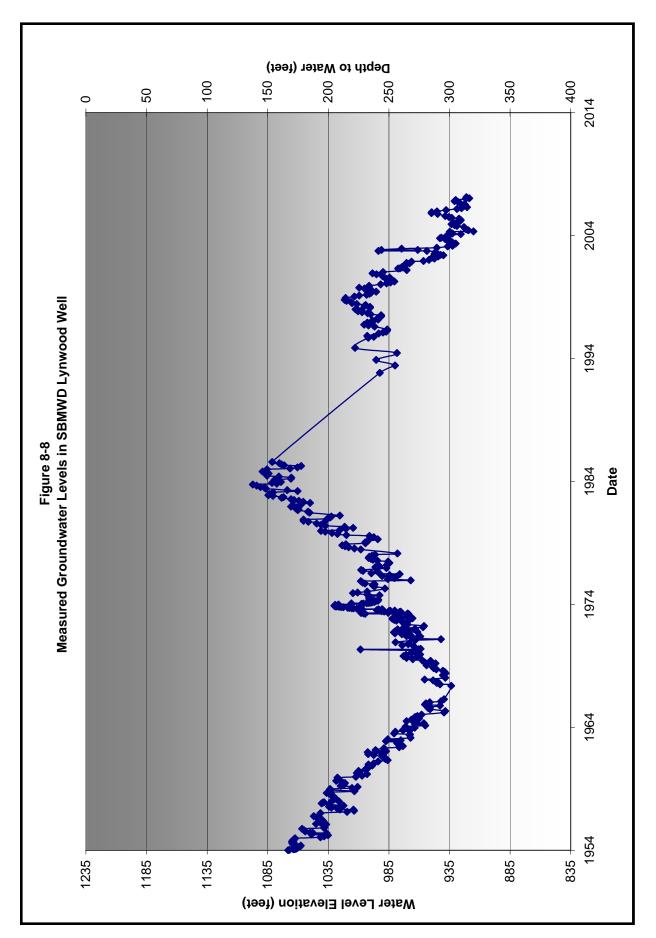


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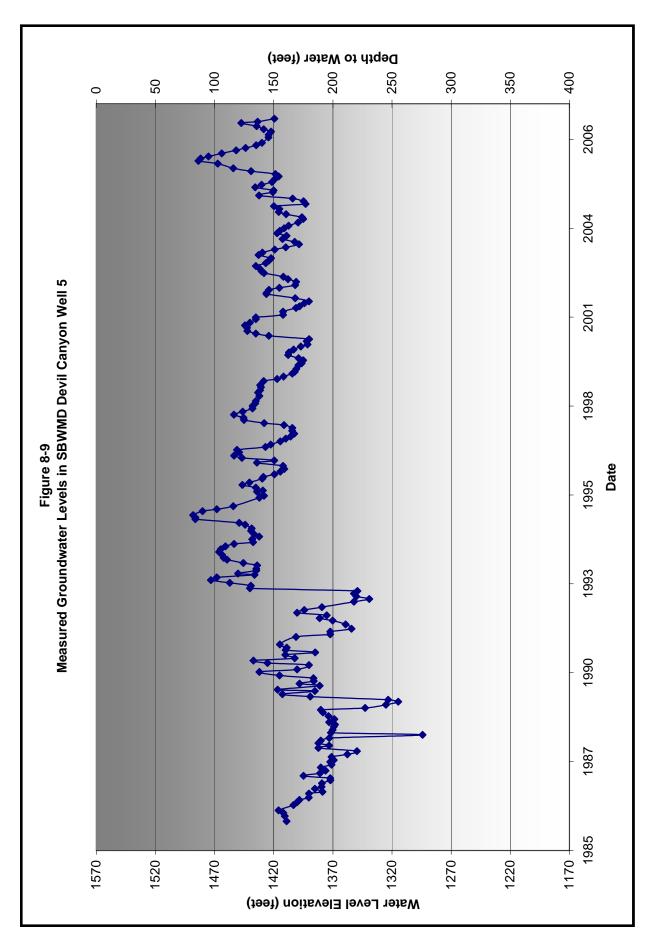


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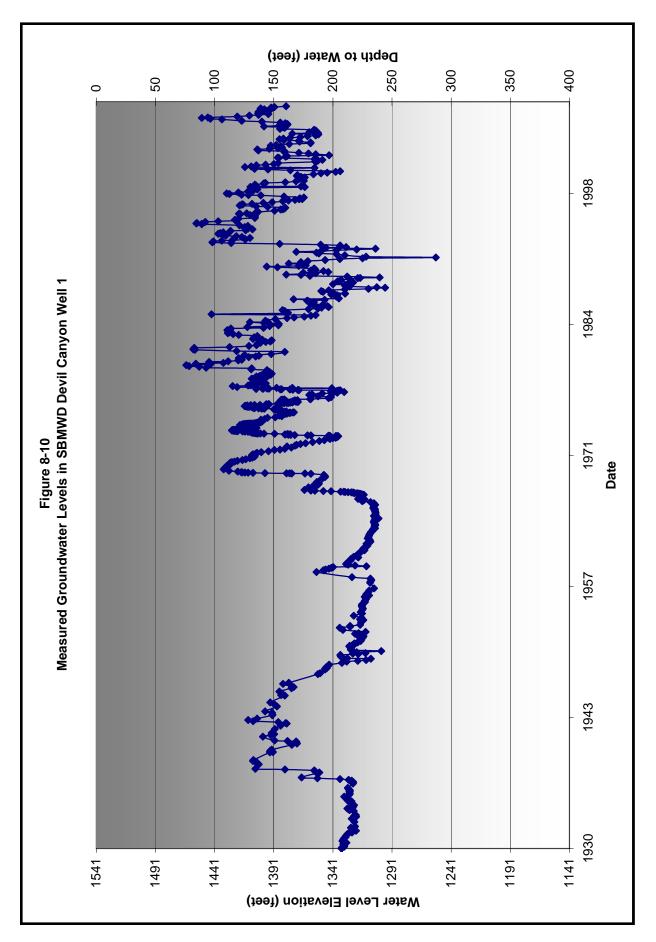


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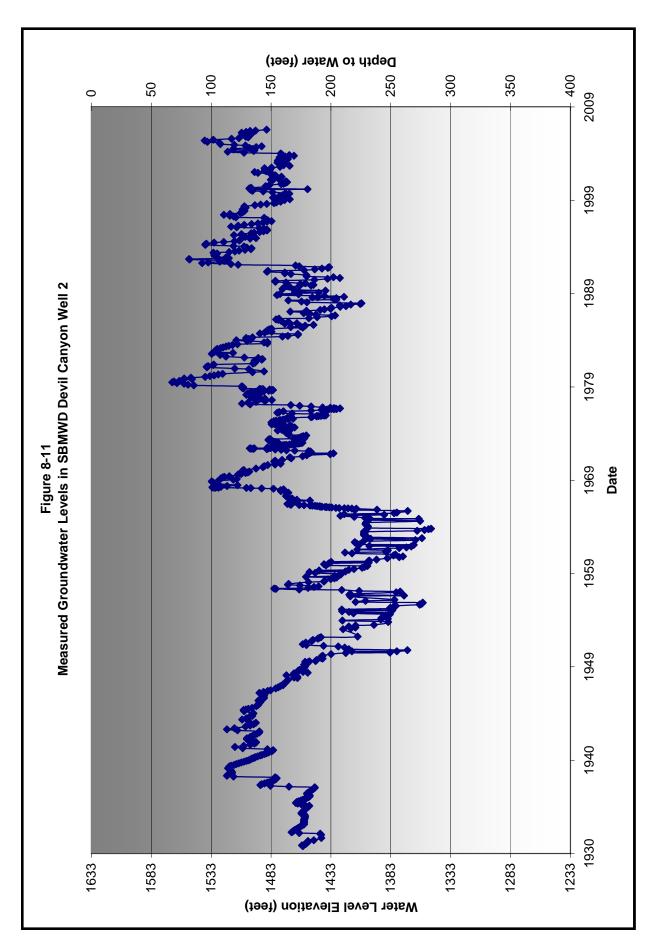


Figure8-9\_Figure8-11.xls -- Figure8-11 10/6/2010 -- 9:17 AM



San Bernardino County Flood Control District Recharge Facilities

117°20'0"W

500 ft Buffer around Recharge Basin

Recycled Water Migration After Six Months (greater than 1% RWC)

Recycled Water Migration After Five Years (greater than 1% RWC)

Note: Recycled water is only recharged at the Waterman and East Twin Creek Facilities.

# Average Pumping Rate (acre-ft/yr) 2007-2032

0 - 200

500 - 1,000

1,000 - 1,500

1,500 - 4,000

San Bernardino Municipal Water Department Service Area

Streams, Rivers, and Channels



## Scenario 1 Model Results

Recycled Water Migration in Layer 1 after Six Months and Five Years

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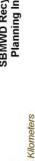
117°20'0"W

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Date: 20100819 Author: MJC







Produced for:



117°20'0"W

San Bernardino County Flood Control District Recharge Facilities

500 ft Buffer around Recharge Basin

Recycled Water Migration After Six Months (greater than 1% RWC)

Recycled Water Migration After Five Years (greater than 1% RWC)

Note: Recycled water is only recharged at the Waterman and East Twin Creek Facilities.

# Average Pumping Rate (acre-ft/yr) 2007-2032

0 - 200

500 - 1,000

1,000 - 1,500

1,500 - 4,000

San Bernardino Municipal Water Department Service Area

Streams, Rivers, and Channels



## Scenario 1 Model Results

Recycled Water Migration in Layer 3 after Six Months and Five Years

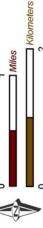
WILDERMUTH ENVIRONMENTAL INC. Produced by:

117°20'0"W

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Author: MJC

File: Figure\_8-12b.mxd Date: 20100819





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117°20'0"W

San Bernardino County Flood Control District Recharge Facilities



500 ft Buffer around Recharge Basin

Recycled Water Migration After Five Years (greater than 1% RWC)



Note: Recycled water is only recharged at the Waterman and East Twin Creek Facilities. Recycled water does not migrate to Layer 5 within 6 months.

# Average Pumping Rate (acre-ft/yr) 2007-2032

0 - 200

500 - 1,000

1,000 - 1,500

1,500 - 4,000

San Bernardino Municipal Water Department Service Area

Streams, Rivers, and Channels



## Scenario 1 Model Results

Recycled Water Migration in Layer 5 after Six Months and Five Years

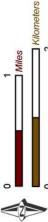


117°20'0"W

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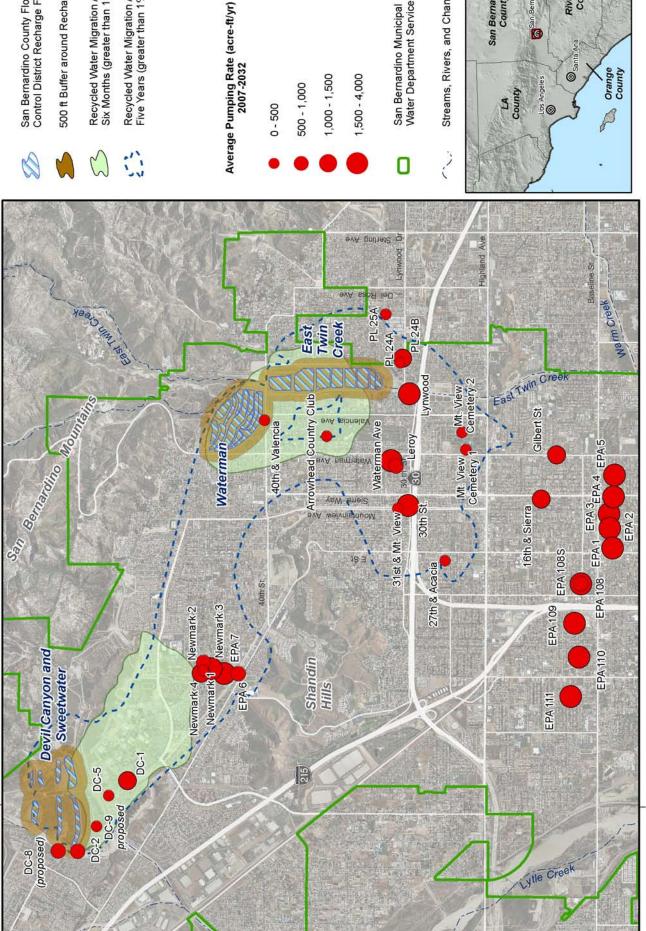
Date: 20100819 Author: MJC





Produced for:





San Bernardino Municipal Water Department Service Area

1,000 - 1,500

500 - 1,000

0 - 200

1,500 - 4,000

Streams, Rivers, and Channels

500 ft Buffer around Recharge Basin

San Bernardino County Flood Control District Recharge Facilities

117°20'0"W

Recycled Water Migration After Six Months (greater than 1% RWC)

Recycled Water Migration After Five Years (greater than 1% RWC)

Scenario 2 Model Results

Riverside County

Santa A

Orange

San Bernardino County

County

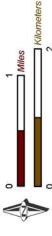
San Bernardino

Recycled Water Migration in Layer 1 after Six Months and Five Years

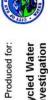


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Date: 20100819 Author: MJC

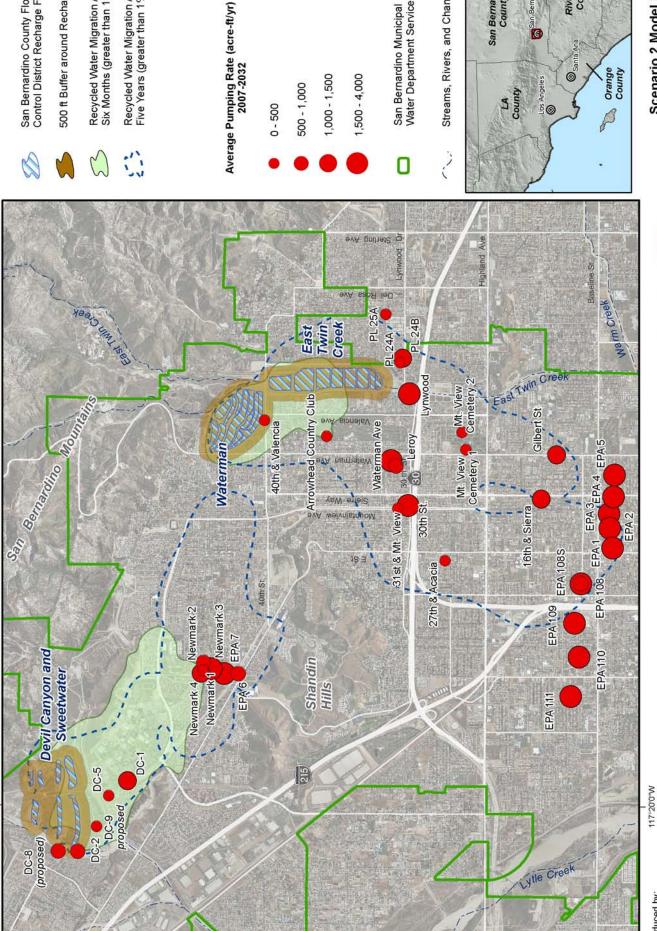


SBMWD Recycled Water Planning Investigation









San Bernardino Municipal Water Department Service Area

1,000 - 1,500

500 - 1,000

0 - 200

1,500 - 4,000

Streams, Rivers, and Channels

500 ft Buffer around Recharge Basin

San Bernardino County Flood Control District Recharge Facilities

117°20'0"W

Recycled Water Migration After Six Months (greater than 1% RWC)

Recycled Water Migration After Five Years (greater than 1% RWC)

Scenario 2 Model Results

Riverside County

Santa A

Orange

San Bernardino County

County

San Bernardino

Recycled Water Migration in Layer 3 after Six Months and Five Years

SBMWD Recycled Water Planning Investigation

Kilometers

File: Figure\_8-13b.mxd

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WILDERMUTH ENVIRONMENTAL INC.

Produced by:







117°20'0"W

San Bernardino County Flood Control District Recharge Facilities

500 ft Buffer around Recharge Basin

Recycled Water Migration After Six Months (greater than 1% RWC)

Recycled Water Migration After Five Years (greater than 1% RWC)

Note: Recycled water does not migrate to Layer 5 within 6 months in the Waterman and East Twin Creek Basins.

Average Pumping Rate (acre-ft/yr) 2007-2032

0 - 200

500 - 1,000

1,000 - 1,500

1,500 - 4,000

San Bernardino Municipal Water Department Service Area

Streams, Rivers, and Channels



## Scenario 2 Model Results

Recycled Water Migration in Layer 5 after Six Months and Five Years

SBMWD Recycled Water Planning Investigation

Kilometers

Produced for:

117°20'0"W

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Date: 20100819 Author: MJC



### **Section 9 - Direct Recycled Water Reuse**

### 9.1 Market for Direct Use in the SBMWD Service Area

Early in this investigation, it was decided that the direct use of recycled water would be limited to the San Bernardino Public Golf Course, potential irrigation customers along the East Twin Creek flood control channel, and on-site use at the SBWRP. Potential direct use customers outside of the East Twin Creek flood control channel were not considered because past studies have shown that the cost of constructing non-potable distribution facilities to serve recycled water throughout the SBMWD's service area is cost prohibitive. Potential direct uses identified in this investigation include irrigation water for parks, schools, and golf courses; utility water for the SBWRP; and supplying water to Secombe Lake. Table 9-1 lists the direct use sites identified in this investigation.

### 9.2 Direct Use Demand

The irrigation water demands for the selected direct use sites were acquired from Carollo's Reclamation Feasibility Study (2005). The direct use water demands for the SBWRP and for landscaping along Interstate 215 (i.e. Caltrans) are based on historic water use. The average monthly water demand for each site and the total demand and demand fraction (calculated as the monthly demand divided by the annual average) for each month are listed in Table 9-1.

As shown in Table 9-1, the direct use water demand increases in warmer summer months and decreases in cooler winter months. Irrigation demands are discussed as maximum month demands (MMD), maximum day demands (MDD), and peak hour demands (PHD). Since irrigation schedules are usually varied on a seasonal rather than daily basis, the MMD and MDD are similar. For the PHD, an 8-hour irrigation schedule is assumed because most parks, schools, and golf courses irrigate late at night through the early morning hours. The peaking factors used in this investigation are:

- Maximum Month Demand (MMD) = 1.3 \* average day demands (ADD)
- Maximum Day Demand (MDD) = 1.3 \* ADD
- Peak Hour Demand (PHD) = 3.0 \* MMD

The peaking factors were used in determining the size of the treatment system and conveyance facilities that will supply recycled water to the direct use sites. Excluding the utility water demand at the SBWRP, the ADD is approximately 1.1 mgd for the direct use sites listed in Table 9-1. This equates to an MDD of 1.4 mgd and a PHD of 4.2 mgd. The ADD and MDD for utility water to the SBWRP are 1.7 mgd and 2.2 mgd, respectively. Thus the combined ADD and MDD for the direct use sites listed in Table 9-1 are 2.8 mgd and 3.6 mgd, respectively. A 3.0 mgd tertiary system could be combined with a small (approximately 500,000 gallon) recycled water storage tank to satisfy the direct use MDD and PHD.



### 9.3 Conveyance of Recycled Water for Direct Use

A preliminary alignment study determined that the most cost effective route for a non-potable distribution pipeline is to parallel the existing East Twin Creek flood control channel, as shown in plan view in Figure 9-1 and profile in Figure 9-2. The distribution facilities needed to serve recycled water to the proposed direct use sites include three pump stations, 11.2 miles of pipeline, and 10 turnouts.

The first pump station, located at the SBWRP, will distribute recycled water to the SBWRP, to the San Bernardino Public Golf Course, and along the 215 freeway, and will be capable of boosting 2,400 gpm to an elevation of 1,100 ft-msl. Currently, these sites receive groundwater from a well located at the SBWRP. With the exception of the golf course, the existing pipelines from the SBWRP well can be used to distribute recycled water to those sites. The golf course currently uses groundwater from both the SBWRP well and onsite golf course wells. Therefore, the distribution capacity to the golf course may need to be increased to supply the site with enough water to meets its full irrigation demand.

Based on preliminary calculations, two pump stations will be required to boost tertiary treated recycled water along the East Twin Creek flood control channel to the northernmost direct use site, Wildwood Park. The pipeline will range in diameter from 16 to 12 inches. The main distribution pipeline is about 6.6 miles, and the sum of the direct use laterals is approximately 4.6 miles. The second pump station, which can be located in the same building as the first pump station, will be capable of boosting 1,900 gpm to a 100,000 gallon reservoir at Perris Hill Park at an elevation of 1,160 ft-msl, an increase in elevation of about 260 feet. From the reservoir at Perris Hill Park, a third pump station will boost 1,300 gpm to a 100,000 gallon terminal reservoir located just above Wildwood Park at an elevation of 1,435 ft-msl, an increase in elevation of about 275-ft.

Both pump stations at the SBWRP will pull from the 500,000 gallon recycled water storage tank.

### 9.4 Direct Use Site Improvements

Direct use sites that currently operate independent of recycled water supplies will need site improvements to comply with the reuse regulations prior to accepting recycled water.

Direct use sites that irrigate or use recycled water are required:

- (1) to have dual plumbing (i.e. no physical connection is allowed between potable and non-potable conveyance systems);
- (2) to contain recycled water used on-site (i.e. ensure recycled water does not drain offsite);
- (3) to have a 50-ft irrigation buffer from domestic water supply wells;
- (4) to have a 100-ft buffer between impounded recycled water and domestic water supply wells;



- (5) to control recycled water spray, mist, or runoff from entering dwellings, designated outdoor eating areas, or food handling facilities; and
- (6) to post signs that inform visitors of recycled water use.

In addition, each direct use site will need to be listed in the SBMWD's Master Recycling Permit prior to accepting recycled water.

# 9.5 Benefits of Direct Recycled Water Reuse for the City

Benefits from direct recycled water reuse include: (1) reduced demand on the potable distribution system, (2) increased water supply reliability, (3) reduced load on the RIX facility, (4) new water supply to support growth, (5) consistency with CDPH policy by reserving the best water for potable use, (6) reduction in the City's overall greenhouse gas emissions related to water supply, and (7) support for the City's effort to comply with the recently enacted SBX-7 that mandates a 15 percent reduction in per capita potable use by 2015 and 20 percent by 2020.

# 9.6 Integration of Direct Recycled Water Reuse with the IRWMP

The IRWMP projection for SBMWD recycled water reuse was 800 acre-ft/yr. The SBMWD direct uses identified in this investigation could reach about 3,100 acre-ft/yr. In addition to directly benefiting the SBMWD, the direct uses of recycled water identified in this investigation will benefit all retail water providers in the region and the Valley Water District because they will reduce the SBMWD's groundwater production and reduce the Valley Water District's future groundwater replenishment obligations.





Table 9-1 Direct Use Water Demand <sup>1</sup>

																					-	
Month	San Bernardino th Water Reclamation	San Bernardino On Bernardino Course	Caltrans	Mill Community Park	Meadowbrook Recreational Park	Meadowbrook Park	Secombe Lake State Recreational Area	Pioneer Memorial Cemetery	Palm Field	Community Gardens	Sierra High School	Perris Hill Park	Mountain View Cemetery	Wilson Elementary	Horine Park	Arrowhead Country Club	Golden Valley Middle School	Parkside Elementary	Wildwood Park	Total	Total	<b>Demand</b> <b>Fraction</b>
	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(pgm)	
Jan	133	14.1	6.7	1.7	1.7	6:0	3.8	2.5	9.0	1.8	6.5	3.9	7.1	0.7	0.7	16.7	0.7	2.0	2.9	207	2.2	0.80
Feb	b 119	12.6	0.9	1.5	1.5	0.8	3.4	2.2	0.5	1.6	5.3	3.5	6.3	0.5	9.0	14.9	0.5	0.5	2.6	184	2.0	0.71
Mar	133	14.0	6.7	1.7	1.7	0.8	3.7	2.4	9.0	1.8	5.4	3.8	2.0	0.5	2.0	16.5	0.5	0.5	2.9	204	2.2	62.0
Apr	142	14.6	7.1	1.8	1.8	6:0	3.9	5.6	9.0	1.9	5.9	4.0	7.3	2.0	2.0	17.3	0.7	7.0	3.1	217	2.3	0.84
Мау	у 165	17.1	8.3	2.1	2.1	1.0	4.6	3.0	0.7	2.2	5.2	4.7	8.5	6:0	0.8	20.2	6.0	6:0	3.6	252	2.7	0.98
ηη	188	19.7	9.4	2.4	2.4	1.2	5.3	3.4	0.8	2.5	7.8	5.4	8.6	8:	1.0	23.3	1.8	1.8	4.1	292	3.1	1.13
Ъ	211	22.1	10.6	2.7	2.7	1.3	5.9	3.9	1.0	2.9	8.3	6.1	11.1	2.4	1.1	26.2	2.4	2.4	4.6	329	3.5	1.28
Aug	g 215	22.7	10.8	2.7	2.8	4.1	6.1	4.0	1.0	2.9	9.1	6.3	11.3	2.5	17	26.8	2.5	2.5	4.7	336	3.6	1.30
Sep	р 197	20.9	6.6	2.5	2.5	1.2	5.5	3.6	6.0	2.7	7.6	5.7	10.3	2.5	1.0	24.3	2.5	2.5	4.3	307	3.3	1.19
O	188	19.5	9.4	2.4	2.4	1.2	5.2	3.4	0.8	2.5	7.2	5.4	8.6	2.1	1.0	23.1	2.1	2.1	4.1	292	3.1	1.13
N <sub>0</sub>	v 161	16.9	8.0	2.0	2.1	1.0	4.5	3.0	0.7	2.2	7.1	4.7	8.5	1.3	9.0	20.0	1.3	1.3	3.5	250	2.7	76.0
Dec	146	15.2	7.3	1.8	1.8	6:0	4.1	2.7	0.7	2.0	0.9	4.2	9.7	2.0	2.0	17.9	0.7	0.7	3.2	224	2.4	0.87
Total	al <u>2,000</u>	210	100	25	<u>36</u>	13	20	37	6	27	81	28	105	16	10	250	16	16	44	3,100		
Average Monthly	age hly	17.5	8.4	2.1	2.1	1.1	4.7	3.1	0.7	2.3	6.8	4.8	8.7	1.4	6.0	20.6	1.4	1.4	3.6	258	2.8	
1 Obta	amelyad mod paris	1. Obtained from Beclamation Feasibility Study (Carollo 2005)	(Carollo 2005)																			



Proposed Recycled Water Direct Use Pipelines and Laterals (1.5" to 16" diameter, 11.6 miles long)

San Bernardino Municipal Water Department Service Area

Recycled Water Pump Station

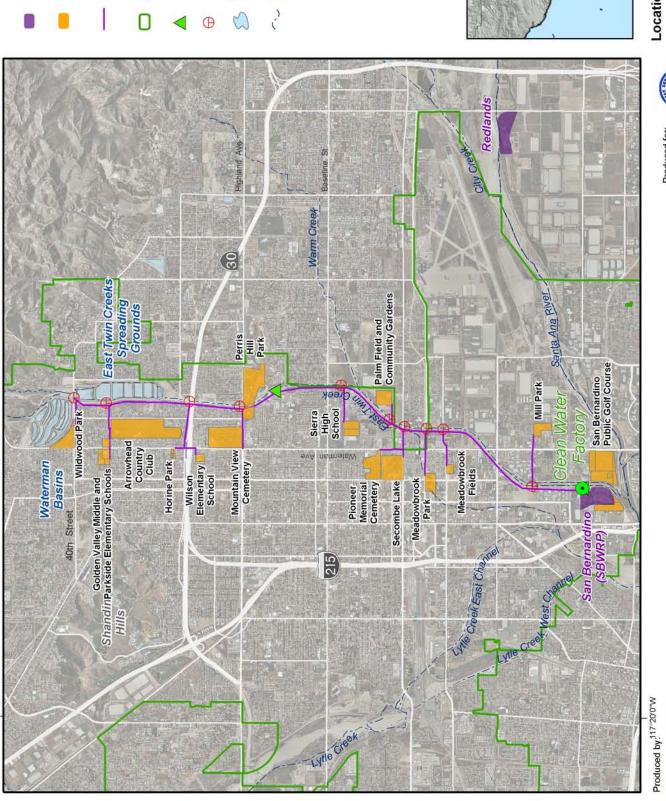
Recycled Water Turnout

Potential Direct Users within the SBMWD Service Area

Water Reclamation Facility

San Bernardino County Flood Control District Recharge Facilities

Streams, Rivers, and Flood Control Channels



Location of Potential Direct Use Areas

San Bernardino

County

County

Riverside County

Santa /

Orange

Adjacent to the SBWRP and along the East Twin Creek Flood Control Channel

SBMWD Recycled Water Planning Investigation

☐ Miles

Kilometers

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Date: 20100406 Author: MJC

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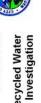




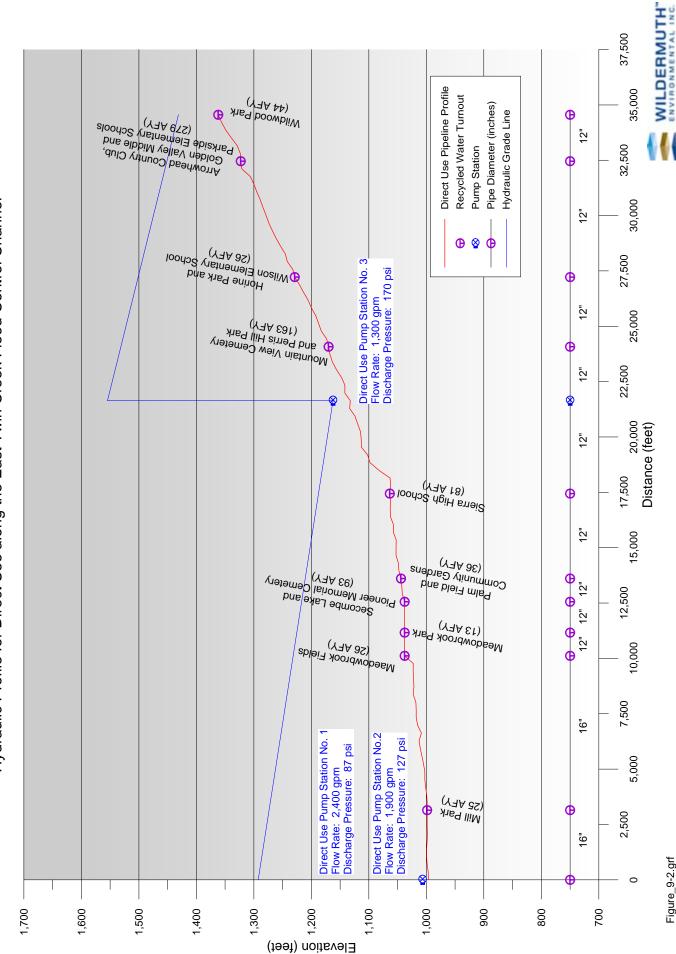












Figure\_9-2.grf

Hydraulic Profile for Direct Use along the East Twin Creek Flood Control Channel Figure 9-2



# **Section 10 - Marketing of Surplus Recycled Water**

# **10.1** Market Survey

The SBMWD currently discharges all of its effluent to the Santa Ana River at the RIX facility with occasional wet-weather discharges to the river from the SBWRP. With the implementation of the CWF, it is anticipated that the SBMWD will produce about 10,000 acre-ft/yr of recycled water in excess of its recharge, direct use demands, and discharge to the Santa Ana River. The table below shows the distribution of recycled water use potential and brine discharge that were evaluated in this investigation.

	2020	2030
RIX Discharge to the Santa Ana River	20,960	22,920
CWF Recharge in the Bunker Hill Basin	10,300	14,500
Direct Use of CWF Water	3,100	3,100
CWF Brine Discharge to SARI	1,800	2,600
SBMWD Recycled Water Available for Sale Outside of the SBMWD Service Area	10,000	10,000
Totals	46,160	53,120

Other water agencies may be interested in acquiring some or all of the 10,000 acre-ft/yr of recycled water that would available either from the RIX facility or the CWF. Recycled water deliveries from the RIX facility would be made using the Santa Ana River, new conveyance facilities, or both. Recycled water deliveries from the CWF would require expansion of the CWF's planned tertiary treatment capacity and new conveyance facilities.

The potential surplus recycled water customers identified in this investigation include:

- West Valley Water District. The WVWD may be interested in recycled water, in addition to that provided by the City of Rialto, to improve its water supply reliability and reduce its water supply cost. The SBMWD recycled water source would be the SBWRP or the RIX Facility, depending on the intended use sites.
- City of Rialto. The City may be interested in recycled water, in addition to that provided by the Rialto WWTP, to improve its water supply reliability and reduce its water supply cost. The SBMWD recycled water source would be the RIX Facility.
- Chino Basin Watermaster. The Chino Basin Watermaster is interested in acquiring new sources of water for replenishment of the Chino Basin. The SBMWD recycled water source would be the RIX Facility.



- City of Fontana. The City is interested in recycled water, in addition to that provided by the IEUA, to improve its water supply reliability and reduce its water supply cost. The SBMWD recycled water source would be the RIX Facility.
- Fontana Water Company. The Company is interested in recycled water, in addition to that provided by the IEUA, to improve its water supply reliability and reduce its water supply cost. The SBMWD recycled water source would be the RIX Facility.
- Cucamonga Valley Water District. The CVWD is interested in recycled water, in addition to that provided by the IEUA, to improve its water supply reliability and reduce its water supply cost. The SBMWD recycled water source would be the RIX Facility.
- WMWD. The WMWD may be interested in acquiring recycled water from the SBMWD to improve water supply reliability and to reduce its demand on the Metropolitan Water District of Southern California (Metropolitan). The WMWD would likely be more interested in purchasing recycled water from the RIX facility and only SBMWD recycled water that is not already being recovered through groundwater pumping by the City of Riverside.
- City of Riverside. The City of Riverside would like to have the SBMWD continue to discharge as much water as possible at the RIX facility as some of that water is recovered in their wells in the Riverside Basin. However, the City of Riverside might be willing to pay the SBMWD to continue to discharge a certain quantity of recycled water to the Santa Ana River if the SBMWD has another market for that water at RIX, such as a Chino Basin customer. The loss of SBMWD recycled water that is currently being used by the City will have to be replaced with new imported water purchases from Metropolitan.
- Orange County Interests. Currently, groundwater users in the Orange County Basin benefit from the discharge of RIX effluent that ultimately is recharged in the Orange County Basin. These Orange County groundwater users would like to have the SBMWD continue to discharge as much water as possible at the RIX facility. However, these users might be willing to pay the SBMWD to continue to discharge a certain quantity of recycled water to the Santa Ana River if the SBMWD has another market for that water at RIX, such as a Chino Basin customer. The loss of SBMWD recycled water that is currently being used by these Orange County groundwater users will have to be replaced with new imported water purchases from Metropolitan.

All potential customers identified above are in the Metropolitan service area. For the Chino Basin entities (Chino Basin Watermaster, City of Fontana, Fontana Water Company, Cucamonga Valley Water District, and other Chino Basin water retailers), the acquisition of SBMWD recycled water would reduce their future demands for Metropolitan water, which would be priced at Metropolitan's untreated Tier 2 rate. The downstream entities (City of Riverside, Orange County and WMWD) listed above would have to replace the recycled water that they currently get from the SBMWD for free with imported water from Metropolitan at its treated Tier 2 rate. Metropolitan's water rates have been increasing significantly in the last two years and are expected to increase substantially in the future. Table 10-1 contains a



projection of Metropolitan's Tier 2 rates. This projection is based on recent historical rates, planned near-term rate increases, and Metropolitan's historical rate increase of about 7 percent per year over the period 2003 through 2012. These projections do not include future anticipated rate increases for planned improvements to the Sacramento – San Joaquin Delta. These rates assume the projected Metropolitan sales of about 1.9 to 2.0 million acre-ft/yr. The implication of the latter two assumptions is that the rates will be higher when the cost of Delta improvements are factored in and if Metropolitan sales fall below 2.0 million acre-ft/yr.

# 10.2 Recycled Water Delivery from the RIX Facility to the Chino Basin

In 2005, Tom Dodson & Associates prepared RIX Facility Recycled Water Sales Program – Program Environmental Impact Report, which provided a variety of recycled water marketing concepts for recycled water produced at the RIX facility. The concepts included delivering the tertiary treated recycled water to Chino Basin customers by pipeline from RIX and to downstream entities through the Santa Ana River.

In 2009 and 2010, the Chino Basin Watermaster updated its recharge master plan. In the 2010 Recharge Master Plan Update (RMPU) (WEI, 2010), the Chino Basin Watermaster identified the RIX facility as a potential new source of local supplemental water. The Chino Basin Watermaster would use this recycled water to reduce its replenishment obligation and for replenishment supply. The project description and the cost to connect the RIX facility to existing recycled water infrastructure are described below.

This concept includes the construction of a new connection from the RIX facility to the IEUA's recycled water<sup>23</sup> distribution system in the vicinity of Interstate 15 and Jurupa Ave. The SBMWD could sell up to 10,000 acre-ft/yr of recycled water for use in the Chino Basin.

The distribution facilities needed to convey recycled water from the RIX facility to the Chino Basin include a new pipeline and pump station. The pipeline would be approximately thirteen miles long and 24 inches in diameter and have the capacity to convey 10,000 acre-ft/yr. The connection would include a flow meter, a check valve, and isolation valves. A 1,750 horsepower pump station would be required to overcome elevation changes and pipeline losses and to meet the hydraulics within the IEUA distribution system. The facilities are shown in plan view in Figure 10-1. The estimated capital cost to construct the facilities, as shown in Table 10-2, is about \$53,000,000; and the annual cost,<sup>24</sup> as shown in Table 10-3, is about \$4,700,000. The unit cost of building and operating this facility would be about \$472/acre-ft.



<sup>&</sup>lt;sup>23</sup> Note that the connection to the IEUA recycled water system was assumed for assessing the feasibility of the use of SBMWD recycled water. The IEUA has not expressed an interest in acquiring SBMWD water. However, IEUA member agencies are interested in acquiring SBMWD water and would likely use the IEUA system to route SBMWD recycled water for their use.

<sup>&</sup>lt;sup>24</sup> Annual cost, as used herein, includes amortized capital (30-year term at 5 percent) plus annual O&M.

Assuming the facilities were constructed and put into operation in 2015 and that the Chino Basin entities would pay the Tier 2 untreated cost, the SBMWD would net about \$400 per acre-ft and that amount would increase every year. In 2015, the SBMWD would receive about \$4.1 million per year. This number would escalate to about \$7.8 million per year by 2020 and to about \$21 million per year by 2030. This revenue stream could be used to offset some of the cost of the CWF.

Coordination with the IEUA and the SARWQCB will be necessary to develop new recycling and discharge permits and to develop and operate the project. A water sales agreement between the SBMWD and the Chino Basin entities will have to be developed and executed.

# 10.3 Recycled Water Delivery from the RIX Facility to Downstream Entities

If the SBMWD were to reduce its discharge at RIX, the downstream entities would have to replace that water with imported water from Metropolitan at the treated Metropolitan Tier 2 rate. The downstream entities would only purchase recycled water from the SBMWD if the SBMWD had a viable alternative to discharge. Presuming that this is the case by 2015 and that the downstream entities agree to purchase SBMWD water at RIX, the SBMWD would receive revenues probably on the order of what would have been received if its recycled water were diverted to the Chino Basin entities.



Table 10-1
Historical and Projected Tier 2 Rates for Metropolitan Water District

(\$/acre-ft)

Year <sup>1,2</sup>	Tier 2	Rates
	Untreated	Treated
2003	\$407	\$489
2004	\$407	\$499
2005	\$412	\$524
2006	\$427	\$549
2007	\$427	\$574
2008	\$508	\$606
2009	\$528	\$695
2010	\$594	\$781
2011	\$665	\$811
2012	\$769	\$869
2013	\$789	\$920
2014	\$846	\$986
2015	\$907	\$1,057
2016	\$973	\$1,133
2017	\$1,043	\$1,215
2018	\$1,118	\$1,302
2019	\$1,198	\$1,396
2020	\$1,284	\$1,497
2021	\$1,377	\$1,605
2022	\$1,476	\$1,720
2023	\$1,582	\$1,844
2024	\$1,696	\$1,977
2025	\$1,818	\$2,119
2026	\$1,949	\$2,272
2027	\$2,090	\$2,435
2028	\$2,240	\$2,610
2029	\$2,401	\$2,798
2030	\$2,574	\$3,000

<sup>1.</sup> Based on historical rates for 2003 through 2010.

<sup>2.</sup> Rates for 2011 and 2012 are published future rates by Metropolitan (http://www.mwdh2o.com/mwdh2o/pages/finance/finance\_03.html); after 2012 the rates are escalated at about 7 percent per year based on rate increase from 2003 through 2012.

# Table 10-2 Capital Cost Estimate

Component	Cost
Construction Cost	
Pipeline	\$24,700,000
Pump Station	\$8,750,000
Valves & Metering	\$25,000
Undeveloped Land	\$250,000
General Mechanical <sup>1</sup>	\$271,000
General Electrical <sup>2</sup>	\$903,000
General Site Work <sup>3</sup>	\$451,000
General Requirements (mob/demob) 4	\$439,000
Total Construction Cost	<u>\$35,800,000</u>
Contingency <sup>5</sup>	\$8,950,000
Engineering / Administration <sup>6</sup>	\$5,370,000
Construction Management <sup>7</sup>	\$2,510,000
Total Capital Cost	<u>\$52,600,000</u>

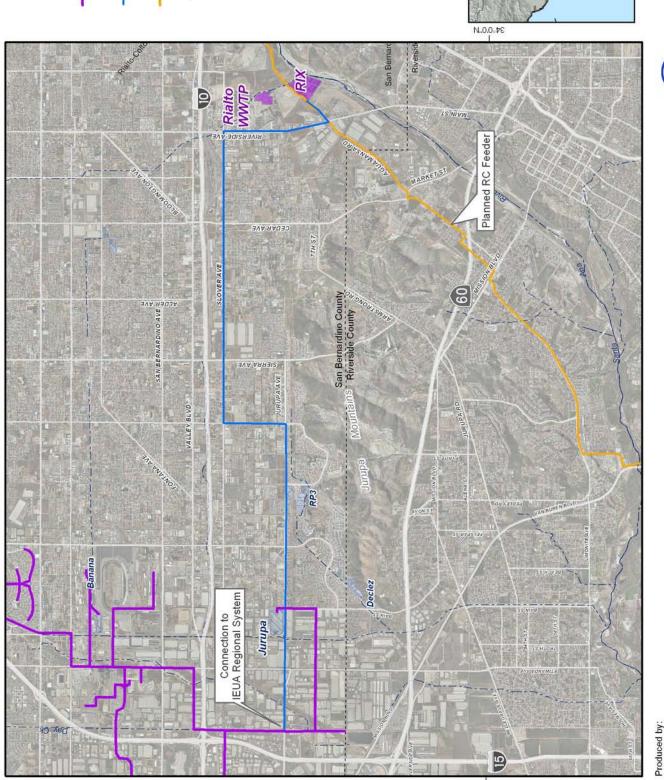
- 1. Based on 3% of total construction cost for all facilities except pipeline
- 2. Based on 10% of total construction cost for all facilities except pipeline costs.
- 3. Based on 5% of total construction cost for all facilities except pipeline
- 4. Based on 5% of total construction cost for all components except land and pipeline costs.
- 5. 25% added for contingency at this preliminary phase of project design.
- 6. Based on 15% of total project cost.
- 7. Based on 7% of total project cost.

Table 10-3
Annual Cost Estimate

Component	Cost
Annual O&M Cost	
Pipeline	\$52,000
Pump Station	\$175,000
Power (pump station)	\$1,070,000
Total Annual O&M	<u>\$1,300,000</u>
Annualized Capital Cost <sup>1</sup>	\$3,420,000
Total Annual Cost	<u>\$4,720,000</u>
Total Maximum Recharge (AFY)	10,000
Total Unit Water Cost (\$/AFY) <sup>2, 3</sup>	<u>\$472</u>

- 1. Amortized cost assumes a 30 year project life and 5% interest.
- 2. This unit cost includes facilities to connect the RIX plant to the IEUA's system only and does not include the cost of the water supply or an evaluation of system compatibility.
- 3. Costs to modify the RIX plant have not been included. A more detailed analysis of the plant's treatment process is recommended.





Main Features

Existing IEUA Recycled Water Distribution Pipeline

Proposed Pipeline

Planned Riverside Corona Feeder

Streams, Rivers, and Channels

Riverside County Orange County County

San Bernardino County

RIX Recycled Water Connection to the Chino Basin

SBMWD Recycled Water Planning Investigation



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# **Section 11 - Recycled Water Reuse Alternatives**

The objective of this planning investigation was to develop projects that will reuse as much SBMWD recycled water as is economically and institutionally feasible and that increase the SBMWD's water supply reliability and decrease its demand for imported water. Approved uses of recycled water include indirect potable reuse (i.e. recharge) and direct use. Previous studies have shown that conventional direct use throughout the SBMWD service area is not economically feasible. As a result, this investigation has focused on developing concepts that emphasize indirect potable reuse and limited direct use to targets of opportunity adjacent to and near the indirect reuse facilities.

The indirect potable reuse element needs to comply with the SARWQCB Basin Plan and the CDPH draft guidelines. Compliance with the Basin Plan for the recharge of recycled water will require advanced treatment specifically to reduce the TDS concentration and to reduce the amount of dilution water to a feasible level.

Recycled water that is surplus to the SBMWD's indirect potable reuse and direct use efforts has value to other agencies that use or plan to use recycled water. Therefore, rather than discharging surplus recycled water to the Santa Ana River without benefit to the SBMWD, it will be marketed to agencies within the Santa Ana River Watershed that need recycled water and will pay for it. The revenue generated from the sale of the SBMWD's surplus recycled water can be used to offset the costs associated with recycled water reuse in the SBMWD service area.

# 11.1 Clean Water Factory Capacity

The capacity of the CWF will be limited to the recycled water that can be diverted at the SBWRP. Currently (summer 2010), the SBWRP produces about 24 mgd (27,400 acre-ft/yr) of secondary-treated effluent. The SBMWD projects that the SBWRP will produce about 31 mgd (34,200 acre-ft/yr) by 2020 and 35 mgd (39,600 acre-ft/yr) by 2030. These projections and their use in constructing the bounding limits on CWF capacity are shown in Table 11-1.

# 11.1.1 Capacity Constraints Related to Discharge Commitments

Santa Ana River water rights were settled in 1969 in the litigation that produced the Orange County Judgment. Coincident with the Orange County Judgment, the City of San Bernardino entered into a contract with Valley Water District that, among other things, committed the SBMWD to discharge 16,000 acre-ft/yr of recycled water to the Santa Ana River for the purpose of helping Valley Water District meets its Orange County Judgment flow obligations at Riverside Narrows. In 1969, the SBMWD's point of discharge to the Santa Ana River was near E Street in the City of San Bernardino. In 1996, the SBMWD began conveying its effluent from the SBWRP to the RIX facility in Colton for tertiary treatment and discharge to the Santa Ana River. The locations of these points of discharge are shown in Figure 11-1. Since 1969, the SBMWD has discharged treated effluent to the Santa Ana River in excess of the required 16,000 acre-ft /yr, and, partially due to the SBMWD's discharge, the Valley Water



District has accrued over 1,100,000 acre-ft in credits. Not coincidentally, the SBMWD's cumulative discharge at E Street and RIX has been about 1,100,000 acre-ft since 1969. The agreement between the SBMWD and the Valley Water District has not been used to constrain the capacity of the CWF or recycled water reuse.

# 11.1.2 Capacity Constraints Related to Treatment Technology and SARI Capacity

The proposed treatment processes for the CWF are discussed in detail in Section 7. The volume of product water from the CWF is controlled by the volume of source water provided to the CWF and the recovery rate of the CWF treatment process. Based on the analysis of SBWRP influent and secondary effluent water quality, an RO recovery rate of about 85 percent is anticipated. If the SBMWD wishes, the RO recovery rate can be increased above 85 percent by providing additional treatment to brine waste (i.e. brine recovery). Brine recovery is expensive and is generally avoided until the demand for recycled water justifies the increased expense. The brine waste generated from the CWF will be discharged to the SARI. The SBMWD owns 2.5 mgd of capacity in the SARI. For an RO recovery rate of 85 percent and a maximum brine discharge of 2.5 mgd, the CWF can provide advanced treatment for up to 16.7 mgd of raw water supply and produce about 14.2 mgd (14,500 acre-ft/yr) of recycled water. Table 11-1 illustrates the relationship between the RO recovery rate of the CWF's advanced treatment process and the SARI capacity constraint.

# 11.1.3 Capacity Constraints related to Spreading Grounds Capacity

The Waterman Basins, East Twin Creek Spreading Grounds, and Devil Canyon and Sweetwater Basins have significant unused recharge capacity. The combined recharge capacity at the Waterman Basins and East Twin Creek Spreading Grounds is estimated to be 74,000 acre-ft/yr (66 mgd), which is far in excess of the combined planned imported water recharge and recycled water recharge described herein. In fact, the analysis in Section 8 shows that the planned recharge of imported and recycled waters could occur during most storm events without the loss of storm, imported, or recycled waters. The Devil Canyon and Sweetwater Basins can add about 17,000 acre-ft/yr (15 mgd) of additional recharge capacity. The recharge capacity at these facilities will not constrain the recharge of recycled water.

# **11.1.4** Dilution Requirements

The availability of diluent water is another constraint on recycled water recharge. Diluent water is a requirement of the draft CDPH regulations regarding the recharge of groundwater with recycled water. Diluent water is essentially non-recycled water and consists of stormwater, imported water, and dry-weather discharge of a non-recycled water origin. The CDPH will require a maximum recycled water contribution (RWC) for the CWF based on (1) the level of treatment provided by the CWF, (2) the effectiveness of subsequent soil aquifer treatment processes, and (3) the volume of groundwater (unrelated to the recharge from these spreading grounds) that is transiting under the spreading grounds, and will apply the RWC



either to the nearest downstream domestic or municipal well or at the spreading grounds, as determined by the SBMWD.

Based on the recent IEUA/Chino Basin Watermaster recharge permit and related compliance monitoring and reporting, the SBMWD can expect the controlling RWC for the CWF with conventional tertiary treatment to range between 30 to 40 percent at the spreading grounds, which would require about two parts dilution water to one part recycled water with a running compliance period of 120 months. Based on Orange County's Groundwater Replenishment System (GWRS) permit and related compliance monitoring and reporting, the SBMWD can expect the controlling RWC for the CWF with advanced treatment to range between 50 to 75 percent at their spreading grounds, which would require initially about one part dilution water to one part recycled water and eventually a one part dilution water to three parts recycled water, both with a running compliance period of 120 months. The diluent requirements for spreading tertiary and advanced treatment recycled water are shown in Table 11-1. The estimated average annual stormwater recharge at the Waterman Basins and the East Twin Creek Spreading Grounds is 6,000 acre-ft/yr. The estimated average annual stormwater recharge at the Devil Canyon and Sweetwater Basins is about 1,400 acre-ft/yr. The imported and Santa Ana River water recharge by the Valley Water District at the Waterman Basins and the East Twin Creek Spreading Grounds is projected to range between 0 and 36,000 acre-ft/yr and average about 16,700 acre-ft/yr. The imported and Santa Ana River water recharge by the Valley Water District at the Devil Canyon and Sweetwater Basins is projected to range between 0 and 15,000 acre-ft/yr and average about 9,400 acre-ft/yr.<sup>25</sup>

Based on the RWC limitations of 30 percent for tertiary treated recycled water and 50 percent for advanced treated recycled water and the available planned recharge of diluent water, the recycled water recharge in the Waterman Basins and the East Twin Creek Spreading Grounds could be about 9,700 acre-ft/yr and 22,700 acre-ft/yr for tertiary and advanced treatment, respectively. For the Devil Canyon and Sweetwater Basins, the recycled water recharge could be about 4,600 acre-ft/yr and 10,800 acre-ft/yr for tertiary and advanced treatment, respectively.

Table 11-1 shows the calculation for the minimum dilution supply required to meet CDPH requirements for recycled water recharge. On average, diluent recharge is not a limitation for the recharge of recycled water that is treated to either level. Though, there may be some limitations on the recharge of tertiary treated water due to extended dry periods.

## 11.1.5 Basin Plan Requirements

The final constraint on the CWF is compliance with the Basin Plan. Recycled water produced at the CWF will be primarily used in the Bunker Hill A Management Zone, which has TDS and nitrogen objectives of 310 mg/L and 2.7 mg/L, respectively. The current ambient TDS



<sup>&</sup>lt;sup>25</sup> Based on the 2009 recharge projections obtained from the Valley Water District (J. Yeh, personal communication, March 30, 2010).

and nitrogen concentrations<sup>26</sup> are 350 mg/L and 4.5 mg/L, respectively; thus, there is no assimilative capacity for TDS or nitrogen. The estimated TDS concentrations of advanced and tertiary treated recycled water are 80 mg/L and 510 mg/L, respectively. The estimated nitrate concentrations of advanced and tertiary treated recycled water are 1.0 mg/L and less than 10.0 mg/L, respectively. Table 11-1 shows the calculation for the minimum dilution supply required to mitigate TDS and nitrate impacts from the recharge of tertiary treated recycled water. On average, there appears to be enough diluent supply to meet the Basin Plan requirements for the recharge of tertiary treated recycled water; however, there may be some limitations due to extended dry periods. There will be no diluent limitations on the recharge of advanced treated recycled water.

Because the TDS and nitrogen concentrations of the tertiary treated recycled water are greater than the water quality objectives for the Bunker Hill A Management Zone, the SBMWD will need to demonstrate that reuse from the CWF will not degrade the Bunker Hill Basin before the SARWQCB will issue a recycling permit for direct use. Based on the 310 mg/L TDS objective for Bunker Hill A, 3,100 acre-ft/yr of direct use, and 14,500 acre-ft/yr of recharge, the net impact to the Bunker Hill Basin would be:

Type of Recycled Water Reuse	Quantity of Reuse	TDS Concentration of Recycled Water	TDS Concentration above/below the TDS Objective for Bunker Hill A	Net Tons of Salt per Year
	(acre-ft/yr)	(mg/L)	(mg/L)	(tons/yr)
Direct Use	3,100	510	200	840
Recharge	14,500	80	-230	-4,530
Total	17,600	-	-	-3,690

The analysis shows that the overall net impact of reuse from the CWF will not degrade the Bunker Hill Basin and will, in fact, result in an overall improvement to the basin.

#### 11.2 Initial CWF and Reuse Alternatives

Eleven project alternatives were developed for this planning investigation. Each project alternative contains a number and letter and includes three main elements: capacity, treatment, and reuse. The number associated with the project alternative defines the total capacity of the CWF, describes where and to what level available SBWRP effluent will be treated, and characterizes recycled water reuse. As shown in Table 11-1, there is about 35 mgd of SBWRP effluent available to the CWF for treatment in the out years. It has been assumed that the priorities for recycled water reuse are (1) to recharge the Bunker Hill Basin, (2) to meet direct use demands, and (3) to be marketed to other water users. Direct use demands, for this investigation, are those demands at and adjacent to the SBWRP and along the East Twin



<sup>&</sup>lt;sup>26</sup> Last computed in 2006. It is unlikely that the 2009 ambient water quality estimates (that are currently being computed) will result in a finding of assimilative capacity.

Creek flood control channel and are estimated at 2.1 mgd (2,310 acre-ft/yr) and 0.7 mgd (790 acre-ft/yr), respectively. The letter associated with the project alternative describes a candidate treatment process for the CWF and corresponds to treatment alternatives A, B, C, and D, as described in Section 7.3 of this report.

Table 11-2 lists the universe of project alternatives that were initially evaluated for the CWF. The total treatment capacity ranges from about 16 to 35 mgd, and reuse includes a combination of recharge, direct use, and sale to other water users.

Project Alternative 1A produces 15.2 mgd of tertiary treated recycled water for recharge and direct use in the SBMWD's service area. The recharge of tertiary treated recycled water will be limited to 12.2 mgd based on the amount on diluent water available to the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins. In this alternative, up to 3.0 mgd of tertiary treated recycled water is used to meet direct use demands, and 0.3 mgd is lost to backwash the tertiary filters. Backwash water will be conveyed to the SBWRP headworks for reprocessing. 19.5 mgd of the SBWRP effluent available to the CWF is not treated at the CWF; instead, this effluent is conveyed to RIX to be treated and marketed outside the SBMWD service area.

Project Alternatives 1B through 1D produce 14.2 mgd of advanced treated recycled water for recharge at the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins, and 2.5 mgd of brine waste. These alternatives produce 3.0 mgd of tertiary treated recycled water to meet direct use demands, and 0.1 mgd is lost to backwash the tertiary filters. 15.3 mgd of the SBWRP effluent that is available to the CWF is not treated at the CWF; instead, this effluent is conveyed to RIX to be treated and marketed outside the SBMWD service area.

There is no Project Alternative 2A because a blend of advanced and tertiary treated recycled water is needed for this series of alternatives. Project Alternatives 2B through 2D produce 14.2 mgd of advanced treated recycled water and 2.5 mgd of brine waste. These alternatives produce 8.0 mgd of tertiary treated recycled water, of which up to 3.0 mgd is used to meet direct use demands. 19.2 mgd of advanced and tertiary treated recycled water is conveyed to the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins for recharge. 10.1 mgd of the SBWRP effluent available to the CWF is not treated at the CWF; instead, this effluent is conveyed to RIX to be treated and marketed outside of the SBMWD service area.

Project Alternative 3A produces 34.3 mgd of tertiary treated recycled water for recharge and direct use in the SBMWD service area and to be marketed outside the SBMWD service area. In this alternative, 12.2 mgd of tertiary treated recycled water is recharged, up to 3.0 mgd is used to meet direct use demands, and 0.7 mgd is lost to backwash the tertiary filters. 19.1 mgd of tertiary treated recycled water is available at the CWF to be marketed.

Project Alternatives 3B through 3D produce 14.2 mgd of advanced treated recycled water for recharge at the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins, and 2.5 mgd of brine waste. These alternatives produce 17.9



mgd of tertiary treated recycled water, of which up to 3.0 mgd is used to meet local direct use demands and 0.4 mgd is lost to backwash the tertiary filters. 15.0 mgd of tertiary treated recycled water is available at the CWF to be marketed.

#### 11.3 Final Alternatives Evaluated for the CWF and Reuse

The technical memorandum prepared by Carollo Engineers evaluated all of the alternatives described above. This technical memorandum is included herewith in Appendix B. A reduced set of alternatives was analyzed in detail in this investigation. These alternatives are discussed in Section 12. These alternatives will provide about 3,100 acre-ft/yr of tertiary-treated recycled water for direct use and 14,500 acre-ft/yr for recharge. The primary difference among these alternatives is the advanced treatment technology that each assumes. Only the B, C, and D treatment alternatives were evaluated. The tradeoffs between the expansion of tertiary treatment capacity at the SBWRP versus the continued use of RIX facility were not analyzed herein.



Table 11-1
Analysis of Bounding Constraints on the Capacity of the Clean Water Factory

			Units		Year		Notes	Formula
				2010	2020	2030	ž	
(1) (2)	Source	Recycled Water Production at SBWRP	mgd acre-ft/yr	24.4 27,400	30.5 34,200	35.4 39,600	а	(2)=(1)*1120
(3) (4)	ind RIX	Recycled Water Production at CWRF	mgd acre-ft/yr	5.3 5,940	6.1 6,830	7.1 7,950	b	(4)=(3)*1120
(5) (6)	Colton and	Santa Ana River Discharge Pursuant to the Wastewater Change Petition	mgd acre-ft/yr	11.9 13,300	11.9 13,300	11.9 13,300	С	(5)=(6)/1120
(7) (8)	Max Supply at SBWRP	SBWRP Recycled Water Available for the CWF	mgd acre-ft/yr	17.9 <u>20,000</u>	24.7 <u>27,700</u>	30.5 34,200		(7)=(8)/1120 (8)=(2)+(4)-(6)
(9) (10)		SARI Capacity CWF Advanced Treatment (RO) Recovery Rate	mgd %	2.5 85%	2.5 85%	2.5 85%	d e	
(11) (12) (13)	SARI Capacity Constraints on Recycled Water Production	Brine Generation CWF Utilization CWF Advanced Treated Recycled Water	mgd % mgd	2.5 92% 14.2	2.5 92% 14.2	2.5 92% 14.2	f	(11)=(13)/(10)-(13) (13)=if{(7)*[1-(10)]≤(9), (9)*(10), (9)/[1-(10)]-(9)}
(14) (15) (16)		CWF Tertiary Treated Recycled Water	acre-ft/yr mgd acre-ft/yr	14,500 1.2 1,200	14,500 7.9 8,100	14,500 13.6 14,000	g	(14)=(12)*(13)*1120 (15)=((7)-(11)-(13))*0.98 (16)=(12)*(15)*1120
(17) (18) (19)	DPH Dilution Requirements for Recharge	Diluent Required by CDPH to Spread Advanced Treated Recycled Water Diluent Required by CDPH to Spread	mgd acre-ft/yr mgd	12.9 <u>14,500</u> 2.1	12.9 <u>14,500</u> 14.5	12.9 <u>14,500</u> 25.0	h	(17)=(18)/1120 (18)=(14)*1 (19)=(20)/1120
(20)		Tertiary Treated Recycled Water TDS Objective for the Bunker Hill A	acre-ft/yr mg/l	<u>2,400</u> 310	16,200 310	<u>28,000</u> 310	i	(20)=(16)*2
(22)	Dilution Requirements Recharge	Management Zone  TDS of Tertiary Treated Recycled Water	mg/l	550	550	550	ŕ	
(23) (24) (25)	TDS for	TDS of Imported Water TDS of Storm Water	mg/l mg/l mgd	250 100 1.9	250 100 12.9	250 100 22.2		(25)=(26)/1120
(26)	Basin Plan	Diluent Required to Spread Tertiary Treated Recycled Water	acre-ft/yr	2,100	14,400	24,900	k	(26)=((((16)*(22))/(21))-(16))/(1 (((23)+(24))/2)/(21))
(27)	Requirements	NO <sub>3</sub> -N Objective for the Bunker Hill A Management Zone	mg/l	2.7	2.7	2.7	I	
(28)	ion Re arge	NO <sub>3</sub> -N of Tertiary Treated Recycled Water	mg/l	8.5	8.5	8.5		
(29) (30) (31)	Basin Plan Nitrate Dilution F for Recharge	NO <sub>3</sub> -N of Imported Water NO <sub>3</sub> -N of Storm Water	mg/l mg/l mgd	1.0 0.5 2.1	1.0 0.5 13.7	1.0 0.5 23.6		(31)=(32)/1120
(32)	Basin Plan	Diluent Required to Spread Tertiary Treated Recycled Water	acre-ft/yr	2,300	15,300	26,400	k	(32)=((((16)*(28))/(27))-(16))/(1 (((29)+(30))/2)/(27))

#### Notes a

- Projected raw wastewater inflow to the SBWRP.
- b Projected discharge from the CWRF to the RIX facility.
- In May 2010, the SBMWD filed a Wastewater Change Petition requesting a reduction in discharge to the SAR from 44,822 acre-ft/year to 13,322 acre-ft/year. Assumes the 1969 agreement with the Valley Water District to discharge 16,000 acre-ft/yr to the Santa Ana River is rescinded.
- SARI capacity owned by the City of San Bernardino.
- e Based on the water quality data provided on the SBWRP's influent, Carollo calculated an RO recovery rate of about 85%.
- f Assumed fraction of year that the CWF is operating.
- g Carollo estimates that the tertiary filters will be about 98% efficient.
- Based on CDPH's Title 22 draft Groundwater Recharge Regulations, the initial maximum recycled water contribution (RWC) when surface spreading advanced treated recycled water is 50%. Therefore, for every one part recycled water recharged, an equal part of diluent water must be recharged.
- Based on CDPH's Title 22 draft Groundwater Recharge Regulations, the initial maximum recycled water contribution (RWC) when surface spreading tertiary treated recycled water is 20%. The IEUA was able to gain approval from CDPH to increase its RWC to 33%. Therefore, for every 1 part recycled water recharged, two parts diluent water must be recharged.
- Based on RWQCB's Water Quality Control Plan for the Santa Ana River Watershed (Basin Plan), the water quality objective for TDS is 310 mg/L.
- k Assumes the diluent source is an equal blend of imported and storm water.
- Based on RWQCB's Water Quality Control Plan for the Santa Ana River Watershed (Basin Plan), the water quality objective for Nitrate as Nitrogen (NO<sub>3</sub>-N) is 2.7 mg/L.



# Table 11-2 Universe of Alternatives for the Clean Water Factory

	Treatmen	Treatment Alternatives	Ultimat	Ultimate Hydraulic Capacity	apacity		Advanced	Advanced Treatment	ant 1		Tertiary	Tertiary Treatment		Re	Recycled Water Reuse	er Reuse		Discharge to the	o to the	Recycled Wate	Water .
Project Alternatives	Description	Treatment Processes	Total Capacity	Advanced Tertiary Treatment Treatment Train 3 Train	Tertiary Treatment Train	Product Water	uct er	SQT	SARI Utilization	lon	Product Water	. ct	TDS	Recharge	ge 4	Direct Use <sup>5</sup>	Use	Santa Ana River	a River <sup>6</sup>	Available to be Marketed	ole to ceted <sup>7</sup>
			(mgd)	(pGm)	(mgd)	(pgm)	(acre-ft/yr)	(mg/L)	) (p6w)	% of Capacity	) (p6m)	(acre-ft/yr)	(mg/L)	) (pGm)	(acre-ft/yr)	) (pßw)	(acre-ft/yr)	(mgd)	(acre-ft/yr)	(mgd)	(acre-ft/yr)
14	Conventional Tertiary	Filtration + Disinfection	15.5	0.0	15.5	0.0	0	0	0.0	%0	15.2	15,600	550	12.2	12,500	3.0	3,100	11.9	13,300	15.1	15,500
18	Advanced Treatment	MF + RO + UV/AOP	19.7	16.7	3.0	14.2	14,500	80	2.5	100%	3.0	3,060	220	14.2	14,500	3.0	3,100	11.9	13,300	10.8	11,100
5	Advanced Treatment	MBR + RO + UV/AOP	19.7	16.7	3.0	14.2	14,500	80	2.5	100%	3.0	3,060	220	14.2	14,500	3.0	3,100	11.9	13,300	10.8	11,100
10	Advanced Treatment	IMANS (MF+RO+UV/AOP)	19.7	16.7	3.0	14.2	14,500	80	2.5	100%	3.0	3,060	220	14.2	14,500	3.0	3,100	11.9	13,300	10.8	11,100
2B	Advanced Treatment	MF + RO + UV/AOP	24.9	16.7	8.2	14.2	14,500	80	2.5	100%	8.0	8,300	550	19.2	19,700	3.0	3,100	11.9	13,300	5.5	5,700
SC SC	Advanced Treatment	MBR + RO + UV/AOP	24.9	16.7	8.2	14.2	14,500	8	2.5	100%	8.0	8,300	220	19.2	19,700	3.0	3,100	11.9	13,300	5.5	5,700
2D	Advanced Treatment	IMANS (MF+RO+UV/AOP)	24.9	16.7	8.2	14.2	14,500	80	2.5	100%	8.0	8,300	220	19.2	19,700	3.0	3,100	11.9	13,300	5.5	5,700
3A	Conventional Tertiary	Filtration + Disinfection	35.4	0.0	35.4	0.0	0	0	0.0	%0	34.7	35,600	550	12.2	12,500	3.0	3,100	11.9	13,300	14.7	15,100
38	Advanced Treatment	MF + RO + UV/AOP	35.4	16.7	18.7	14.2	14,500	80	2.5	100%	18.3	18,800	220	14.2	14,500	3.0	3,100	11.9	13,300	10.6	10,900
ဒ္ထ	Advanced Treatment	MBR + RO + UV/AOP	35.4	16.7	18.7	14.2	14,500	80	2.5	100%	18.3	18,800	220	14.2	14,500	3.0	3,100	11.9	13,300	10.6	10,900
3D	Advanced Treatment	IMANS (MF+RO+UV/AOP)	35.4	16.7	18.7	14.2	14,500	8	2.5	100%	18.3	18,800	220	14.2	14,500	3.0	3,100	11.9	13,300	10.6	10,900

1. The advanced treatment train is estimated to have an RO recovery rate of 85%. This is based on analysis of SBWRP influent and secondary effluent water quality.

2. The tertiary treatment train is estimated to have a recovery rate of 98%. This is based on analysis of SBWRP secondary effluent water quality.

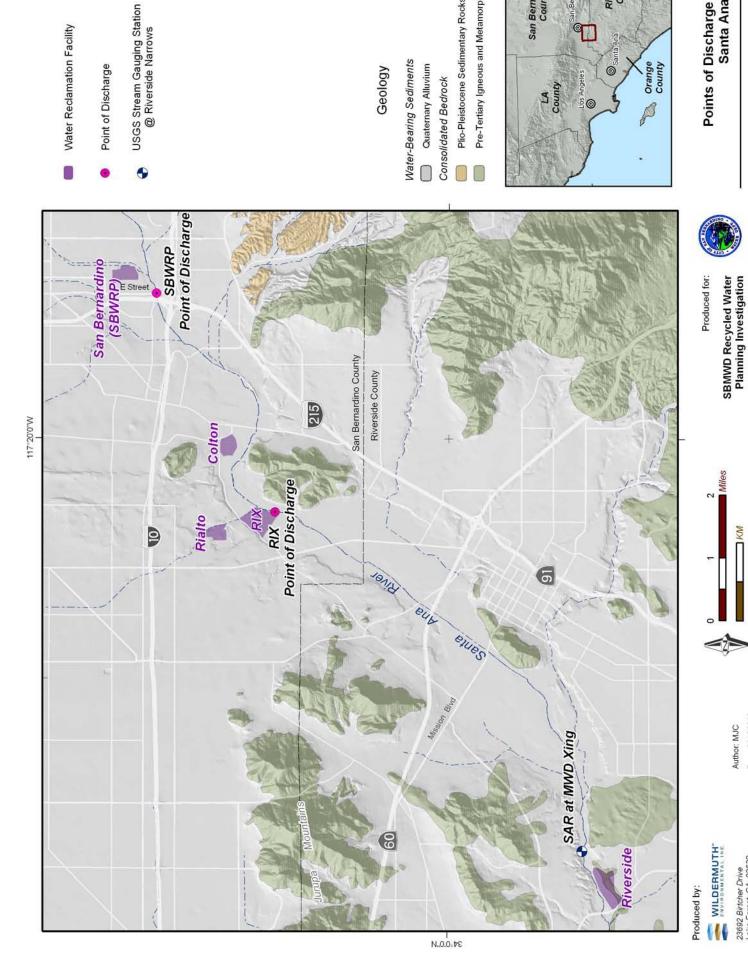
3. The initial size of the advanced treatment train is assumed to be 5 mgd.

4. The rechage of recycled water will occur in the Bunker Hill A Management Zone. The spreading basins being considered are the Waterman Basins, the East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins. For project alternatives 1A, 2B through 2D, and 3A, the amount of tertiary treated follows a variable diluent supply.

5. The direct use demands are those demands that are at or adjacent to the SBWRP and along the East Twin Creek flood control channel. They are estimated at 2.1 mgd (2,310 acre-flyyear) and 0.7 mgd (7790 acre-flyyear). respectively.

6. In May 2010, the SBMWD filed a Wastewater Change Petition requesting a reduction in discharge to the Santa Ana River (SAR) from 44,822 acre-ft/year to 13,322 acre-ft/year. Assumes the 1969 agreement with the Valley Water District to discharge 16,000 acre-ft/yr to the SAR is rescinded. By 2030, about 7,950 acre-ft/year to 13,322 acre-ft/year. Assumes the 1969 agreement with the Valley Water District to discharge 16,000 acre-ft/yr to the SAR by the SBMWD will be from the CWRF.

7. SBWRP effluent that is surplus to discharge to the SAR and to the water reuse needs of the SBMWD is available to be marketed. Losses from tertiary filtration have been accounted for. In Project Alternatives 1A through 1D and 2B through 2D, surplus effluent is treated to tertiary levels at the CWF.



Geology

Pre-Tertiary Igneous and Metamorphic Rocks Riverside County San Bernardino County Plio-Pleistocene Sedimentary Rocks Orange County

Points of Discharge to the Santa Ana River

File: Figure\_11-1.mxd Date: 20100819 Author: MJC

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# Section 12 – Assessment of Recycled Water Reuse Alternatives

#### **12.1** Treatment Alternatives

Per discussions with SBWMD staff, the CWF was assumed to be implemented over time in three phases. For Treatment Alternatives B, C, and D, Phase I included an advanced treatment system capable of producing 5 mgd and a tertiary treatment system capable of producing 3.0 mgd. Phase II increased the advanced treatment capacity of the CWF by an additional 5 mgd, and Phase III further increased the advanced treatment capacity by 4.2 mgd. The ultimate advanced treatment capacity for Treatment Alternatives B, C, and D was 14.2 mgd, and the ultimate tertiary treatment capacity for direct use was 3.0 mgd. Figure 12-1 shows the projected wastewater collection, treatment, and recycled water fate with this proposed phasing.

#### **12.1.1** Treatment Alternative B

Treatment Alternative B employs advanced treatment technology to produce a high-quality effluent that meets the more stringent requirements for groundwater recharge and a smaller tertiary treatment train for direct use water. The tertiary treatment train would consist of tertiary filtration followed by chlorine disinfection, as shown in Figure 7-5. For this alternative, secondary effluent from the existing SBWRP would be fed to the advanced treatment process. MF would be the first process in the advanced treatment train and would serve as pretreatment for the RO process. The MF process consistently produces a low TSS product regardless of influent quality and provides the high quality feed needed for stable RO operation. It is estimated that the MF process will recover 92 percent of the influent flow. The other 8 percent would be returned to the process, upstream of the primary clarifiers, as MF backwash. The MF product would be conveyed to the RO system for further treatment. The RO system is designed to remove TDS from the influent stream and is estimated to achieve a recovery of 85 percent. Permeate (i.e. product water from the RO process) would be conveyed to the UV/AOP, and the concentrate (i.e. brine waste) would be disposed of in the SARI line. After passing through the UV/AOP, the final product would be stabilized using lime (or other post-treatment chemicals) and conveyed to the spreading basins for recharge.

The estimated water quality of the recycled water produced from this alternative is shown in Figure 7-5. As depicted, the MF/RO process produces a high-quality effluent for groundwater recharge. The RO process is capable of removing greater than 95 percent of the influent TDS with a final product TDS concentration of approximately 80 mg/L, which would comply with the Basin Plan requirements. The stabilized RO permeate would have a total nitrogen concentration of approximately 1 mg/L. This is well below the limits set by the CDPH and complies with the Basin Plan.



Figure 12-2 shows a conceptual site layout for Treatment Alternative B. Secondary effluent will either gravity flow or be pumped from an effluent box to the advanced and tertiary treatment. The advanced treatment facility would be located in the northeast corner of the SBWRP and the parallel tertiary treatment train would be located on the south side. The advanced treatment system would consist of MF, RO, UV/AOP, and stabilization. The footprints for the advanced treatment system shown have a capacity of 14.2 mgd, which would be installed in phases, as described above. The footprints shown for the advanced treatment processes include storage space for the required chemicals. The location in the northeast corner provides space for expansion and is in proximity to the potential discharge route.

#### 12.1.2 Treatment Alternative C

Figure 7-6 is a process flow diagram of Alternative C. This alternative is similar to Alternative B: it produces two different qualities of water, one for recharge and the other for direct use. However, Alternative C treats primary effluent, rather than secondary effluent, with a Membrane Bioreactor (MBR), thereby adding secondary treatment capacity to the SBWRP. Moreover, since this process treats primary effluent, less flow would be sent to the existing secondary treatment process, freeing up secondary treatment capacity, thereby delaying future plant expansion needs and reducing the overall operating costs of the plant. Alternative C is the only alternative that adds secondary capacity to the SBWRP.

Alternative C employs advanced treatment technology to produce high-quality effluent for recharge and a smaller tertiary treatment train for direct use. The tertiary system would be similar to that described in Alternative B. The MBR process basically combines the aeration basin and the MF process and produces a high-quality effluent similar to the MF process described in Alternative B. Further treatment of the MBR effluent would be similar to the advanced treatment process described in Alternative B.

Figure 7-6 shows the estimated water quality of recycled water produced from the MBR/RO process. The stabilized product would have a similar quality to that produced in Alternative B and would meet the Title 22 requirements for groundwater recharge and complies with the Basin Plan requirements.

Figure 12-3 shows a conceptual site layout for Alternative C. The MBR and advanced treatment would be located in the northeast corner of the facility. This location is near the existing Unit No. 3 Primary Clarifiers, which would be used to feed the MBR process. The footprints for the advanced treatment system shown have a capacity of 14.2 mgd, which would be installed in phases, as described above. To save space for the expansion of the MBR and advanced treatment process, the tertiary treatment process would be located at the south side of the facility.



#### 12.1.3 Treatment Alternative D

Treatment Alternative D uses an advanced treatment process developed by Carollo (the IMANS® process) to produce high-quality effluent for groundwater recharge. As with the other alternatives, a smaller tertiary treatment train would be included in parallel for the production of direct use water. The tertiary system would be similar to that described in Alternative B. For this alternative, primary effluent from the SBWRP would be fed to a non-biological combination of MF followed by RO. This alternative would yield roughly the same quality of water as that produced in the other advanced treatment alternatives. Similar to Alternative C, this alternative treats primary effluent, thereby delaying future plant expansion needs and reducing the overall operating costs of the SBWRP.

Figure 7-7 shows the estimated water quality of recycled water produced by the IMANS® process. The stabilized product would have a similar quality to that produced in Alternative B and would meet the Title 22 requirements for groundwater recharge and complies with the Basin Plan.

Since primary effluent is fed to the membrane process, ammonia is not nitrified, and a small amount (approximately 1 mg/L) of ammonia would pass through the RO membranes into the permeate. This should not be an issue because the total nitrogen concentration (approximately 1 mg/L) is still well below the limits for groundwater recharge. And, this ammonia could be combined with chlorine to form chloramines, which would provide a disinfection residual for water in the distribution pipeline.

Figure 12-4 shows a conceptual site layout for Treatment Alternative D. Because the primary effluent is fed to the MF process, the advanced treatment process would be located in the northeast corner of the facility near the Unit No. 3 Primary Clarifiers, which would be used to feed the MF process. As depicted, the advanced treatment system would have the same unit operations as Alternative B with the addition of fine screens ahead of the MF step. The footprints for the advanced treatment system shown have a capacity of 14.2 mgd, which would be installed in phases, as described above. The IMANS® MF process would have a slightly larger footprint than the tertiary MF process in Alternative B due to lower design flux rates. The parallel tertiary treatment train would be located on the south side of the site, similar to the other alternatives.

#### 12.1.4 Treatment Cost

Table 12-1 shows the capital costs associated with the proposed treatment alternatives. Phase I includes costs related to infrastructure that will be needed at build-out. For example, the buildings that will house the Phase I treatment equipment would be constructed large enough to house the Phase II and III treatment equipment, and the yard piping constructed in Phase I would be designed to convey the ultimate capacity of the selected alternative. As a result, the unit costs for Phase I are higher than those associated with Phases II and III.

Table 12-2 shows the operation and maintenance (O&M) costs associated with the proposed treatment alternatives.



The proposed treatment alternatives would add secondary, tertiary, and/or advanced treatment capacity to the SBWRP. Implementation of the CWF would reduce the quantity of wastewater currently treated at the SBWRP and RIX and eliminate the need to expand the secondary and/or tertiary treatment capacity at these facilities over the next three decades. Therefore, the avoided treatment costs and future avoided capital costs are considered in the cost opinions for each treatment alternative. The detailed line item capital and operations and maintenance costs are documented in Appendix B.

#### 12.1.4.1 Tertiary Treatment Costs

The capital cost to produce 3.0 mgd of tertiary treated recycled water is estimated to be \$10,000,000. The unit capital cost based on 30-year, 5-percent financing is \$190 per acre-ft. The operations and maintenance cost is about \$60 per acre-ft. The total unit cost to produce tertiary treated water is about \$250 per acre-ft. Because this volume of water will be treated at the CWF rather than at the RIX facility, there will be a reduction in the operations and maintenance cost at the RIX facility of \$150 per acre-ft. Thus, the net unit cost will be \$100 per acre-ft to produce tertiary treated water.

#### 12.1.4.2 Advanced Treatment Costs

Table 12-1 shows the incremental capital cost for each phase of treatment Alternatives B, C, and D. Table 12-2 shows a similar breakdown by phase for the treatment alternatives. For Treatment Alterative B, the capital cost to produce 14.2 mgd of advanced treated recycled water is estimated to be \$98,800,000. The unit capital cost based on 30-year, 5-percent financing is about \$520 per acre-ft for Phase 1 and declines to about \$400 per acre-ft at full capacity. The operations and maintenance cost is about \$440 per acre-ft. The total unit cost to produce advanced-treated water for treatment Alternative B will be about \$960 per acre-ft for Phase 1 and will decline to about \$840 per acre-ft at full capacity. There will be a reduction in operations and maintenance cost to treat water at the RIX facility of \$150 per acre-ft with this alternative. Therefore, the net unit cost will be about \$810 per acre-ft for Phase 1 and will decline to about \$690per acre-ft at full capacity.

For Treatment Alterative C, the capital cost to produce 14.2 mgd of advanced treated recycled water is estimated to be \$214,000,000. The unit capital cost based on 30-year, 5-percent financing is about \$960 per acre-ft for Phase 1 and declines to about \$870 per acre-ft at full capacity. The unit operations and maintenance cost is about \$520 per acre-ft. The total unit cost to produce advanced-treated water for treatment Alternative C will be about \$1,480 per acre-ft for Phase 1 and will decline to about \$1,390 per acre-ft at full capacity. There will be a reduction in operations and maintenance cost to treat water at the SBWRP and RIX facilities of about \$220 per acre-ft with this alternative. Therefore, the net unit cost will be about \$1,260 per acre-ft for Phase 1 and will decline to about \$1,170 per acre-ft at full capacity.

For Treatment Alterative D, the capital cost to produce 14.2 mgd of advanced treated recycled water is estimated to be \$121,000,000. The unit capital cost based on 30-year, 5-percent financing is about \$610 per acre-ft for Phase 1 and declines to about \$490 per acre-ft at full



capacity. The unit operations and maintenance cost is about \$520 per acre-ft. The total unit cost to produce advanced-treated water for treatment Alternative D will be about \$1,130 per acre-ft for Phase 1 and will decline to about \$1,010 per acre-ft at full capacity. There will be a reduction in operations and maintenance cost to treat water at the SBWRP and RIX facilities of abut \$280 per acre-ft with this alternative. Therefore, the net unit cost will be about \$850 per acre-ft for Phase 1 and will decline to about \$730 per acre-ft at full capacity.

Treatment Alternatives C and D may have additional cost offsets related to reducing future expansions at the SBWRP facility and operations and maintenance at the SBWRP and RIX facilities. These are discussed in Section 12.3.

# 12.2 Distribution Systems

Distribution systems have three main components: reservoirs, pump stations, and pipelines. The recharge and direct use distribution systems associated with the treatment alternatives are the same. Both the recharge and direct use distribution systems are anticipated to be constructed in phases.

## 12.2.1 Recharge Distribution

At build-out, the recharge distribution system used to convey recycled water to the three proposed recharge facilities would include: two pump stations, about 13.0 miles of pipeline, three turnouts, and two reservoirs. These facilities are shown in plan view in Figure 8-6 and profile view in Figures 12-5 and 12-6 for the Waterman Basins and East Twin Creek Spreading Grounds and for the Devil Canyon and Sweetwater Basins, respectively. At build-out this system would convey 14.2 mgd of advanced treated recycled water for recharge. Recharge distribution would be constructed in three phases to correspond with advanced treatment expansions. Phase I would include constructing a recycled water storage reservoir and pump station at the SBWRP and a pipeline from the pump station at the SBWRP to the upper most recharge cell at the Waterman Basins. The reservoir and pipeline would be sized to build-out capacities. Phase III would include expanding the pump station at the SBWRP and constructing an advanced treated recycled water storage reservoir and pump station at the East Twin Creek Spreading Grounds and a pipeline from the pump station at the East Twin Creek Spreading Grounds to the Devil Canyon and Sweetwater Basins.

Phases I, II, and III would produce 5.0 mgd, 10.0 mgd, and 14.2 mgd of advanced treated recycled water, respectively. At build-out, a 2,100 HP pump station would be required to boost up to 10,000 gpm (14,500 acre-ft/yr) of recycled water and overcome the elevation change (i.e. about 480 feet) and pipeline losses (7.1 miles of 30-inch pipe) from the SBWRP to the Waterman Basins. This pipeline would have three turnouts, one at the upper end of the Waterman Basins and two at the East Twin Creek Spreading Grounds. One turnout at the East Twin Creek Spreading Grounds for spreading, and the other turnout would deliver recycled water to a 100,000 gallon storage reservoir at the East Twin Creek Spreading Grounds. A 550 HP pump station would be required to boost 3,500 gpm (5,000 acre-ft/yr) and overcome the elevation



change (i.e. about 400 feet) and pipeline losses (5.9 miles of 20-inch pipe) from the East Twin Creek Spreading Grounds to the Devil Canyon and Sweetwater Basins.

#### 12.2.2 Direct-Use Distribution

At build-out, the direct-use distribution system used to convey recycled water to the selected direct-use sites would include three pump stations, about 11.2 miles of pipeline, thirteen turnouts, and three storage reservoirs. Figure 9-1 shows this system in plan view and Figure 9-2 shows the system profile.

As with the recharge distribution system, the direct-use system would be constructed in three phases. Phase I would include constructing a tertiary-treated recycled water storage reservoir and pump station at the SBWRP and adding a pipeline to the existing non-potable distribution system at the SBWRP that supplies groundwater to the San Bernardino Public Golf Course, Caltrans, and the SBWRP. The connection to the existing well would be terminated. A 200-HP pump station would be required for Phase I to boost 2,400 gpm (i.e. 3.5 mgd or about 2,310 acre-ft/yr) and overcome the elevation change (i.e. about 60 feet) and pipeline losses (0.6 miles of pipe ranging in diameter from 8 to 12 inches) from the SBWRP to the Bernardino Public Golf Course, Caltrans, and the SBWRP. Phase II would include constructing a second pump station at the SBWRP and a pipeline to the Sierra High School turnout. A 50-HP pump station would be required for Phase II to boost 700 gpm (i.e. 1.0 mgd or about 275 acre-ft/yr) and overcome the elevation change (i.e. about 80 feet) and pipeline losses (5.8 miles of pipe ranging in diameter from 1.5 to 16 inches) from the SBWRP to the Sierra High School turnout. Phase III would include expanding the Phase II pump station at the SBWRP, extending the direct use pipeline from the Sierra High School turnout to Perris Hill Park, constructing a tertiary treated recycled water storage reservoir and pump station at the Perris Hill Park, and constructing a direct use pipeline to Wildwood Park. A total of 250 HP would be required for the pump station at the SBWRP to boost 1,900 gpm and overcome the elevation change and pipeline losses to Perris Hill Park. A 200-HP pump station would be required for Phase III to boost 1,300 gpm (i.e. 1.9 mgd or about 515 acreft/yr) and overcome the elevation change (i.e. about 230 feet) and pipeline losses (4.8 miles of pipe ranging in diameter from 2 to 12 inches) from Perris Hill Park to the terminus reservoir just above Wildwood Canyon Park.

#### 12.2.3 Distribution Costs

Table 12-3 shows the capital and O&M costs associated with conveying recycled water to the proposed use areas.

#### 12.2.3.1 Recharge Distribution Costs

The capital cost to convey 14.2 mgd of advanced treated recycled water to the recharge basins is about \$39,300,000. The unit capital cost based on 30-year, 5-percent financing is about \$120 per acre-ft for Phase 1 and increases to about \$180 per acre-ft at full capacity. The operations and maintenance cost is about \$130 per acre-ft for Phase 1 and increases to about



\$160 per acre-ft at full capacity. The total cost to convey advanced-treated water to the recharge basins is about \$250 per acre-ft for Phase 1 and increases to about \$340 per acre-ft at full capacity.

#### 12.2.3.2 Direct Use Distribution Costs

The capital cost associated with the direct-use distribution system for Project Alternatives 1, 2, and 3 is estimated to be \$16,800,000. The unit capital cost based on 30-year, 5-percent financing is about \$70 per acre-ft for Phase 1 and increases to about \$350 per acre-ft at full capacity. The operations and maintenance cost is about \$80 per acre-ft for Phase 1 and increases to about \$130 per acre-ft at full capacity. The total cost to convey tertiary-treated water to direct use sites is about \$150 per acre-ft for Phase 1 and increases to about \$480 per acre-ft at full capacity.

#### **12.2.4** Use Area Improvements

As discussed in Sections 6, 8, and 9, use areas that currently operate independent of recycled water would need to be improved prior to accepting recycled water per the CCR.

#### 12.2.4.1 Recharge Sites

Regulations for using recycled water for groundwater recharge are designed to protect the beneficial uses of the underlying aquifer. The following site improvements will be needed at the Waterman Basins, East Twin Creek Spreading Grounds, and the Devil Canyon and Sweetwater Basins prior to recycled water recharge:

- Flow measuring and recording devices are required for all source waters (i.e. storm, imported, and recycled) recharged at the proposed sites. Currently, imported water is measured and recorded by the Valley Water District.
- Monitoring wells are required between the recharge sites and nearby potable wells.
  One monitoring well per recharge facility has been included in the use area capital
  costs. It may be possible, however, to use existing production wells within six months
  travel time of the proposed recharge facilities for monitoring purposes, saving the cost
  of new monitoring wells.
- Signs are required throughout the facilities to inform visitors that recycled water is being used.
- General improvements are required to increase the operational flexibility of the recharge facilities. At the Waterman Basins, required improvements include rehabilitating or replacing the outlet valves from each cell (i.e. sub-basin), adding level transmitters to each cell and telemetry, performing weed abatement, and adding erosion control near the outlet of the recharge distribution pipeline. At the East Twin Creek Spreading Grounds, required improvements include repairing the internal berms between cells, adding a turnout on the Foothill pipeline, adding level transmitters to each cell and telemetry, performing weed abatement, and adding



erosion control near the outlet of the recharge distribution pipeline. At the Devil Canyon and Sweetwater Basins, required improvements include rehabilitating or replacing the outlet valves from each cell, adding level transmitters to each cell and telemetry, performing weed abatement, and adding erosion control near the outlet of the recharge distribution pipeline.

#### 12.2.4.2 Direct Use Sites

In accordance with CCR Title 22, Division 4, Chapter 3, Article 4, which governs use area requirements, the following site improvements will be needed at each direct use site that proposes to use recycled water:

- Irrigation pipelines and other non-potable pipelines used to distribute recycled water will need to be isolated from the potable water system unless an approved CDPH backflow prevention measure, such as an air gap, is constructed to separate the systems.
- All sprinklers that irrigate within 50-feet of a potable water well or that spray or generate mist near eating areas, food handling facilities, or drinking fountains will need to be eliminated.
- Areas within direct use sites that use or irrigate with recycled water will need to be improved to ensure that no recycled water becomes impounded and that the recycled water remains onsite and does not drain into eating areas or food handling facilities.
- Each site will need to inform the public that recycled water is being used. These
  improvements include posting signs throughout the site and replacing irrigation valve
  covers with purple covers. In addition, standard hose bids will need to be replaced
  with another type of fitting to ensure that recycled water is not easily accessible by the
  public.

#### 12.2.4.3 Use Area Costs

Table 12-4 shows the capital and operation and maintenance costs associated with recharge and direct use site improvements. Included in the annual operation and maintenance costs are costs related to regulatory reporting for recycled water reuse, as set by the SARWQCB and the CDPH.

The capital cost associated with the recharge site improvement is about \$10,100,000 and includes \$3,000,000 to replace the 40<sup>th</sup> and Valencia and Devil Canyon No. 2 wells. The unit capital cost based on 30-year, 5-percent financing is about \$50 per acre-ft for all phases. The operations and maintenance cost is about \$20 per acre-ft for all phases. The total recharge site improvement costs are about \$70 per acre-ft for all phases.

The capital cost associated with direct-use site improvements is about \$1,100,000. The unit capital cost based on 30-year, 5-percent financing is about \$5 per acre-ft for Phase 1 and increases to about \$20 per acre-ft at full capacity. The operations and maintenance cost is about \$10 per acre-ft for Phase 1 and increases to about \$40 per acre-ft at full capacity. The



total direct use site improvement cost is about \$15 per acre-ft for Phase 1 and increases to about \$60 per acre-ft at full capacity.

## 12.3 Analysis of the Project Alternatives

Table 12-5a lists the alternatives carried through for detailed analysis and summarizes their yield, capital costs, operations and maintenance costs, gross total project costs, and expected cost offsets. These costs are presented as first costs (cost of construction), annual cost (amortized capital plus operations and maintenance), and as a unit cost (\$ per acre-ft). The only difference among the alternatives is the treatment technology used at the CWF.

The capital cost estimates for these alternatives are about \$176,000,000 for Alternative 1B (MF+RO+UV/AOP), \$291,000,000 for Alternative 1C (MBR+RO+UV/AOP), and \$198,000,000 for Alternative 1D ([IMANS] MF+RO+UV/AOP). The operations and maintenance costs for these alternatives are fairly close: \$10,400,000 per year for Alternative 1B, \$11,700,000 for Alternative 1C, and \$11,600,000 for Alternative 1D. The spread in capital cost for the alternatives is quite large at \$115,000,000 or about 65 percent of the lowest capital cost estimate. By comparison, the spread in operations and maintenance costs is comparatively small at about \$1,300,000 or about 13 percent of the lowest operations and maintenance cost. The annual and unit water costs are about \$21,800,000 per year and \$1,240 per acre-ft for Alternative 1B, \$30,600,000 per year and \$1,740 per acre-ft for Alternative 1C, and \$24,500,000 per year and \$1,390 per acre-ft for Alternative 1D. On a gross total project cost basis, Alternative 1B is the least cost alternative and achieves the goals of the project.

There are some cost offsets that need to be factored into the economic analysis. These offsets have been grouped into two categories: cost offsets A and cost offsets B. Cost offsets A include the reduced operations and maintenance cost at the SBWRP and the RIX facilities due to the treatment of water at the CWF and the cost savings from the avoided purchase of imported water from the Valley Water District. The annual operations and maintenance savings at full project capacity are \$3,500,000 per year for Alternative 1B, \$4,600,000 per year for Alternative 1C, and \$5,600,000 for Alternative 1D. The avoided imported water purchase savings at full capacity would be \$5,300,000, which is based on the avoided purchase of 17,600 acre-ft/yr at \$300 per acre-ft. The \$300 per acre-ft water cost is greater than the current cost of imported water from Valley Water District but is probably a low estimate of this cost when the cost of Delta improvements are added to the rate and the Valley Water District purchases additional supplemental water supplies to augment its existing Table A contract water. With these cost offsets factored in, the annual and unit water costs are about \$13,000,000 per year and \$740 per acre-ft for Alternative 1B, \$20,700,000 per year and \$1,180 per acre-ft for Alternative 1C, and \$13,600,000 per year and \$770 per acre-ft for Alternative 1D. With these offsets, Alternative 1B is still the least cost alternative and achieves the goals of the project.

Cost offsets B include the reduced future capital cost at the SBWRP facility due to the addition of treatment capacity that would have to be constructed anyway to expand the



 $<sup>^{27}</sup>$  65 percent = 100\*(\$291,000,000-\$176,000,000)/\$176,000,000

treatment plant. Alternative 1B does not increase the capacity of the SBWRP. The avoided capital cost from the expansion of the SBWRP from Alternatives 1C and 1D is about \$63,700,000, which equates to an annual savings of about \$4,100,000. With cost offsets A and B factored in, the annual and unit water costs are about \$13,000,000 per year and \$740 per acre-ft for Alternative 1B, \$16,600,000 per year and \$940 per acre-ft for Alternative 1C, and \$9,500,000 per year and \$540 per acre-ft for Alternative 1D. With these offsets Alternative 1D is the least cost alternative and achieves the goals of the project.

The reuse scenario described above for project alternatives 1B, 1C, and 1D provides the SBMWD with practical recycled water reuse projects that meet the current reuse regulations. However, the scope of the reuse scenario could be modified to reduce the unit cost of recycled water. The variants are described below.

Initial CWF Alternatives without the Devil Canyon and Sweetwater Basins. For this variant, recycled water recharge would only occur at the Waterman Basins and the East Twin Creek Spreading Grounds. Therefore, the costs related to recycled water recharge at the Devil Canyon and Sweetwater Basins were removed. The advantage of this scenario would be that the capital, annual, and unit costs are reduced. The disadvantage would be that the wells in the Devil Canyon area would continue to be dependent on imported water recharge.

Initial CWF Alternatives with a Single Distribution Pipeline. For this variant, a single distribution pipeline would be used to convey advanced and tertiary treated recycled water to recharge and direct use sites. The water quality of the recycled water blend would be 156 mg/L and 2.6 mg/L for TDS and nitrogen, respectively. At these concentrations the recycled water blend would meet the water quality objectives for the Bunker Hill A Management Zone. The advantage of this scenario would be that the capital, annual, and unit costs are reduced. The disadvantages would be that the concept would need approval from the CDPH, more diluent water would be needed to meet the CDPH *Draft Groundwater Recharge Reuse Regulations* (i.e. about 2,550 acre-ft/yr), and the water pressure at each direct use site would be greater in the single pipeline configuration than in the dual pipeline configuration.

Initial CWF Alternatives with a Single Distribution Pipeline and without the Devil Canyon and Sweetwater Basins. For this variant, a single distribution pipeline would be used to convey advanced and tertiary treated recycled water to the Waterman Basins, the East Twin Creek Spreading Grounds, and direct use sites. The advantage of this scenario would be that the capital, annual, and unit costs are further reduced. The disadvantages would be that the concept would need approval from the CDPH, more diluent water would be needed to meet the CDPH *Draft Groundwater Recharge Reuse Regulations* (i.e. about 2,550 acre-ft/yr), the water pressure at each direct use site would be greater in the single pipeline configuration than in the dual pipeline configuration, and the wells in the Devil Canyon area would continue to be dependent on imported water recharge.

Initial CWF Alternatives with Limited Direct Use. For this variant, direct use would be limited to the SBWRP, the San Bernardino Public Golf Course, and the Caltrans sites. These sites have a total water demand of approximately 2,300 acre-ft/yr. Therefore, about 800 acre-ft/yr of tertiary treated recycled water would be available for recharge and could be conveyed



with the advanced treated recycled water in a single pipeline to the recharge sites. For this scenario the costs related to the direct use distribution pipeline along the East Twin Creek channel and the direct use site improvements for sites along the East Twin Creek channel were removed. The advantages of this scenario include about 800 acre-ft/yr of additional recharge and reduced capital, annual, and unit costs. The disadvantages would be that the concept would need approval from the CDPH and more diluent water would be needed to meet the CDPH *Draft Groundwater Recharge Reuse Regulations* (i.e. about 1,600 acre-ft/yr).

Initial CWF Alternatives with Limited Direct Use and without the Devil Canyon and Sweetwater Basins. For this variant, direct use would be limited to the SBWRP, the San Bernardino Public Golf Course, and the Caltrans sites. Therefore, about 800 acre-ft/yr of tertiary treated recycled water would be available for recharge and could be conveyed with the advanced treated recycled water in a single pipeline to the recharge sites. For this scenario the costs related to the direct use distribution pipeline along the East Twin Creek channel, the direct use site improvements for sites along the East Twin Creek channel, and recharge at the Devil Canyon and Sweetwater Basins were removed. The advantages of this scenario include about 800 acre-ft/yr of additional recharge and further reduced capital, annual, and unit costs. The disadvantages would be that the concept would need approval from the CDPH, more diluent water would be needed to meet the CDPH *Draft Groundwater Recharge Reuse Regulations* (i.e. about 1,600 acre-ft/yr), and the wells in the Devil Canyon area would continue to be dependent on imported water recharge.

Initial CWF Alternatives with Groundwater Recharge Only. For this variant, all of the recycled water produced at the CWF would be recharged. For this scenario, there would be no direct use of recycled water; thus, all associated costs were removed. The advantages of this scenario include 3,100 acre-ft/yr of additional recharge and reduced capital, annual, and unit costs. The disadvantages would be that the concept would need approval from the CDPH and more diluent water would be needed to meet the CDPH *Draft Groundwater Recharge Reuse Regulations* (i.e. about 6,200 acre-ft/yr).

Initial CWF Alternatives with Groundwater Recharge Only and without the Devil Canyon and Sweetwater Basins. For this variant, all of the recycled water produced at the CWF will be conveyed in a single pipeline to the Waterman Basins and East Twin Creek Spreading Grounds. The advantages to this scenario include 3,100 acre-ft/yr of additional recharge and reduced capital, annual, and unit costs. The disadvantages would be that the concept would need approval from the CDPH, more diluent water would be needed to meet the CDPH *Draft Groundwater Recharge Reuse Regulations* (i.e. about 6,200 acre-ft/yr), and the wells in the Devil Canyon area would continue to be dependent on imported water recharge.

The cost opinions for the variants to the initial CWF alternatives are described in Tables 12-5b, 12-5c, 12-5d, 12-5e, 12-5f, 12-5g, and 12-5h, and the unit costs in US dollars per acre-ft with cost offsets A and B included are summarized below:



Variant	Alternative 1B	Alternative 1C	Alternative 1D
Initial CWF Alternatives without Devil Canyon	\$650	\$860	\$450
Initial CWF Alternatives with a Single Pipeline	\$690	\$900	\$490
Initial CWF Alternatives with a Single Pipeline without Devil Canyon	\$610	\$810	\$400
Initial CWF Alternatives with Limited Direct Use	\$690	\$890	\$490
Initial CWF Alternatives with Limited Direct Use without Devil Canyon	\$600	\$800	\$400
Initial CWF Alternatives with Groundwater Recharge Only	\$700	\$900	\$500
Initial CWF Alternatives with Groundwater Recharge Only without Devil Canyon	\$610	\$810	\$410

### 12.4 Conclusions and Recommended Recycled Water Alternative

In Section 4, it was demonstrated that regionally within the Valley Water District service area that there is not enough water to meet projected water demands. The cumulative unmet replenishment obligation (CURO) through 2030 is projected to be about 236,000 acre-ft (see Table 4-5). This assumes aggressive recharge of Santa Ana River water. Table 12-6 shows the CURO analysis with the proposed SBMWD recycled water recharge project. With the project, the CURO would drop substantially to 108,000 acre-ft. The CURO would be further reduced by the proposed direct use of recycled water.

Section 8 demonstrated that recycled water recharge is feasible using the Waterman Basins and the East Twin Creek Spreading Grounds and probably feasible if the recharge project is extended to the Devil Canyon area. And, while using only the Waterman Basins and the East Twin Creek Spreading Grounds appears feasible, extending recharge to the Devil Canyon area will provide recharge to SBMWD wells located in that area and provide additional recharge capacity if the recharge capacity of Waterman and East Twin Creek Spreading Grounds is less than determined herein. Section 8 also demonstrated that the SBBA model, in its current form, should not be used for a formal Title 22 Engineering Report of the proposed recycled water recharge project. A new localized model should be developed and used for the formal Title 22 Engineering Report that will be required by the DPH. The domain of this new localized model should be limited to the region around the recharge basins and downgradient areas of interest. Useful information from the SBBA model could be exploited for the new localized model.



Section 9 identified about 3,100 acre-ft/yr of recycled water direct uses at sites adjacent to the SBWRP and along the East Twin Creek flood control channel.

Section 10 described the marketing of surplus SBMWD recycled water. 10,000 acre-ft/yr of surplus recycled water and potential downstream markets were identified. Water purveyors in the Chino Basin area have specifically shown interest in this surplus recycled water. Assuming that a sales agreement and facilities were in place by 2015 and that the value of the recycled water was pegged to Metropolitan's untreated Tier 2 rate, the SBMWD could receive about \$4.1 million per year, and this number would escalate to about \$7.8 million per year by 2020 and about \$21 million per year by 2030.

Section 11 described the facilities required to recharge up to 14,500 acre-ft/yr of advanced treated recycled water and to provide up to 3,100 acre-ft/yr of tertiary treated water for direct uses. The universe of treatment options is discussed in detail in Appendix B.

Finally, Section 12 provides an assessment of recycled water project alternatives and concludes:

- If the future avoided cost from capacity expansion at SBWRP is ignored, the lowest cost alternative is Alternative 1B with a full capacity capital cost of \$176,000,000, an annual cost of about \$13,000,000, and a unit cost of \$740 per acre-ft.
- If future avoided cost from capacity expansion at SBWRP in is included in the economic assessment, the lowest cost alternative is Alternative 1D with a full capacity capital cost of \$134,300,000, an annual cost of about \$9,500,000, and a unit cost of \$540 per acre-ft.

At these unit costs, Alternatives 1B and 1D are economically feasible. These unit costs are comparable or less than the cost of acquiring new imported water supplies, and the water supply developed by these alternatives is more reliable than imported water. The project alternatives were analyzed assuming project financing with conventional municipal bonds using an interest rate of 5 percent and a 30-year term. The SBMWD may be able to secure lower interest financing and grants that would lower the cost of the proposed recycled water project.

Section 12 also shows that if the scope of the reuse scenario is modified, the SBMWD could reduce the capital, annual, and unit costs, and maintain a viable recycled water reuse project. The following summarizes the possible savings:

- If the Devil Canyon and Sweetwater Basins are not utilized for recharge, the capital cost would be reduced by about \$15,000,000, the annual cost would be reduced by about \$1,500,000, and the unit cost would be reduced by about \$90 per acre-ft.
- If the CDPH were to approve the single pipeline configuration, the capital cost would be reduced by about \$11,000,000, the annual cost would be reduced by about \$800,000, and the unit cost would be reduced by about \$50 per acre-ft.



- If direct use is limited to the SBWRP and adjacent sites, the capital cost would be reduced by about \$14,000,000, the annual cost would be reduced by about \$900,000, and the unit cost would be reduced by about \$50 per acre-ft.
- If the CDPH were to approve 17,600 acre-ft/yr of recharge from the CWF, the capital cost would be reduced by about \$16,000,000, the annual cost would be reduced by about \$700,000, and the unit cost would be reduced by about \$40 per acre-ft.



Table 12-1 Capital Costs Related to Treatment

	Treatmen	Treatment Alternatives				Capital Cost 1,2		Ì	Avoided Expansion Costs 1, 2, 3	ion Costs <sup>1, 2, 3</sup>		Adjus	Adjusted Capital Cost 1, 2	t <sup>1, 2</sup>
Project Alternative	Description	Treatment Processes	Phase	Product Water Produced	Total Cost	Unit Cost	Unit Cost	Total Freed or Added	Total Cost	Unit	Unit	Total Cost	Unit	Unit
				mgd	69	\$/MG	\$/acre-ft	p6m	69	\$ / MG	\$ / acre-ft	69	\$/MG	\$ / acre-ft
1B, 1C, 1D	Tertiary Treatment	Filtration + Disinfection	At Build-out	3.0	\$10,000,000	\$590	\$190	:	;	;	:	\$10,000,000	\$590	\$190
	Advanced Treatment	MF + RO + UV/AOP	Phase I	5.0	\$44,500,000	\$1,590	\$520	;	:	;	;	\$44,500,000	\$1,590	\$520
18	Advanced Treatment	MF + RO + UV/AOP	Phase II	5.0	\$29,500,000	\$1,050	\$340	:	:	:	;	\$29,500,000	\$1,050	\$340
	Advanced Treatment	MF + RO + UV/AOP	Phase III	4.2	\$24,800,000	\$1,050	\$340	:	:	:	;	\$24,800,000	\$1,050	\$340
	Advanced Treatment	MF + RO + UV/AOP	At Build-out	14.2	\$98,800,000	\$1,240	\$400	;	:	:	;	\$98,800,000	\$1,240	\$400
	Advanced Treatment	MBR + RO + UV/AOP	Phase I	5.0	\$82,400,000	\$2,940	096\$	5.9	\$22,500,000	\$680	\$220	\$59,900,000	\$2,140	\$700
5	Advanced Treatment	MBR + RO + UV/AOP	Phase II	5.0	\$71,300,000	\$2,540	\$830	5.9	\$22,500,000	\$680	\$220	\$48,800,000	\$1,740	\$570
	Advanced Treatment	MBR + RO + UV/AOP	Phase III	4.2	\$59,900,000	\$2,540	\$830	4.9	\$18,700,000	\$680	\$220	\$41,200,000	\$1,750	\$570
	Advanced Treatment	MBR + RO + UV/AOP	At Build-out	14.2	\$213,600,000	\$2,680	\$870	16.7	\$63,700,000	\$680	\$220	\$149,900,000	\$1,880	\$610
				_										
	Advanced Treatment	Advanced Treatment IMANS (MF+RO+UV/AOP)	Phase I	5.0	\$52,700,000	\$1,880	\$610	5.9	\$22,500,000	\$680	\$220	\$30,200,000	\$1,080	\$350
<b>Q</b>	Advanced Treatment	IMANS (MF+RO+UV/AOP)	Phase II	5.0	\$36,900,000	\$1,320	\$430	5.9	\$22,500,000	\$680	\$220	\$14,400,000	\$510	\$170
	Advanced Treatment	IMANS (MF+RO+UV/AOP)	Phase III	4.2	\$31,000,000	\$1,320	\$430	4.9	\$18,700,000	\$680	\$220	\$12,300,000	\$520	\$170
	Advanced Treatment	IMANS (MF+RO+UV/AOP)	At Build-out	14.2	\$120,600,000	\$1,510	\$490	16.7	\$63,700,000	\$680	\$220	\$56,900,000	\$710	\$230
1 Coots are board	Paralla's 2010 Bearing of Water	Octoberate are based on Carollo's 2010 Beaucled Mater Eassibility Investigation - Technical Mamorandium No. 1	Momoroodim No. 1											

Costs are based on Carolio's 2010 Recycled Water Feasbility Investigation - Technical Memorandum No. 1.
 Financing assumes a 30-year term and a 5-percent interest rate.
 The avoided cost associated with the MBR or IMANS process is the avoided cost of not expanding secondary treatment at the SBWRP in the future.

Table 12-2 Operation & Maintenance Costs Related to Treatment

	Treatment	Treatment Alternatives				O&M Cost 1			Avoided Treatment Costs <sup>1, 2</sup>	nent Costs 1, 2		Ad	Adjusted O&M Cost <sup>1</sup>	t1
Project Alternatives	Description	Treatment Processes	Phase	Product Water Produced	Annual Cost	Unit Cost	Unit Cost	Total Freed or Added Capacity	Annual Cost	Unit	Unit	Annual Cost	Unit Cost	Unit Cost
				mgd	\$/ yr	\$ / MG	\$ / acre-ft	p6m	\$/ yr	\$/ MG	\$ / acre-ft	\$/yr	\$/MG	\$ / acre-ft
1B, 1C, 1D	Conventional Tertiary	Filtration + Disinfection	At Build-out	3.0	\$197,000	\$180	\$60	3.1	\$515,000	\$470	\$150	(\$318,000)	(\$290)	(06\$)
	Advanced Treatment	MF + RO + UV/AOP	Phase I	5.0	\$2,470,000	\$1,350	\$440	5.9	\$858,000	\$470	\$150	\$1,612,000	\$880	\$290
18	Advanced Treatment	MF + RO + UV/AOP	Phase II	5.0	\$2,470,000	\$1,350	\$440	5.9	\$858,000	\$470	\$150	\$1,612,000	\$880	\$290
	Advanced Treatment	MF + RO + UV/AOP	Phase III	4.2	\$2,070,000	\$1,350	\$440	4.9	\$721,000	\$470	\$150	\$1,349,000	\$880	\$290
	Advanced Treatment	MF + RO + UV/AOP	At Build-out	14.2	\$7,010,000	\$1,350	\$440	16.7	\$2,440,000	\$470	\$150	\$4,570,000	\$880	\$290
	Advanced Treatment	MBR + RO + UV/AOP	Phase I	5.0	\$2,930,000	\$1,610	\$520	5.9	\$1,259,000	069\$	\$220	\$1,671,000	\$920	\$300
10	Advanced Treatment	MBR + RO + UV/AOP	Phase II	5.0	\$2,930,000	\$1,610	\$520	5.9	\$1,259,000	\$690	\$220	\$1,671,000	\$920	\$300
	Advanced Treatment	MBR + RO + UV/AOP	Phase III	4.2	\$2,460,000	\$1,600	\$520	4.9	\$1,058,000	\$690	\$220	\$1,402,000	\$910	\$300
	Advanced Treatment	MBR + RO + UV/AOP	At Build-out	14.2	\$8,320,000	\$1,610	\$520	16.7	\$3,580,000	\$690	\$230	\$4,740,000	\$910	\$300
	Advanced Treatment	IMANS (MF+RO+UV/AOP)	Phase I	5.0	\$2,900,000	\$1,590	\$520	5.9	\$1,588,000	\$870	\$280	\$1,312,000	\$720	\$230
10	Advanced Treatment	IMANS (MF+RO+UV/AOP)	Phase II	5.0	\$2,900,000	\$1,590	\$520	5.9	\$1,588,000	\$870	\$280	\$1,312,000	\$720	\$230
	Advanced Treatment	IMANS (MF+RO+UV/AOP)	Phase III	4.2	\$2,440,000	\$1,590	\$520	4.9	\$1,334,000	\$870	\$280	\$1,106,000	\$720	\$240
	Advanced Treatment	IMANS (MF+RO+UV/AOP)	At Build-out	14.2	\$8,240,000	\$1,590	\$520	16.7	\$4,510,000	\$870	\$280	\$3,730,000	\$720	\$230
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1. Costs are based on Carolio's 2010 Recycled Water Feasbilty Investigation - Technical Memorandum No. 1.
2. The avoided treatment costs include the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tentary standards, respectively.

Table 12-3 Capital and Operation & Maintenance Costs Related to Distribution

									Total		Capital 1	tal 1	Operation & Maintenance <sup>2</sup>	aintenance <sup>2</sup>
Distribution System	Type of Water Conveyed	of the	Location	Phase	Hydraulic Capacity	Units	Diameter	Length	Dynamic Head	Horse-power	Total Cost	Unit	Annual Cost	Unit
		9350			capacity		.⊑	ft	ft	hP	S	\$ /acre-ft	\$/yr	\$/acre-ft
Direct Use Distribution	Conventional Tertiary	Reservoir	SBWRP	Phase I	500,000	gals	;	;	;	;	\$1,000,000	\$28	\$10,000	\$4
Direct Use Distribution	Conventional Tertiary	Pump Station	SBWRP	Phase I	2,400	mdg	:	;	200	200	\$1,000,000	\$28	\$160,000	69\$
Direct Use Distribution	Conventional Tertiary	Pipeline / Laterals	to SBWRP, Golf Course, and Caltrans	Phase I	2,310	afy	8 to 12	3,000	;	:	\$601,000	\$17	\$6,000	\$3
							- ,	Direct L	Direct Use Distribution for Phase I	for Phase I	\$2,600,000	\$70	\$176,000	\$80
Direct Use Distribution	Conventional Tertiary	Pump Station	SBWRP	Phase II	200	mdg	;	;	200	20	\$250,000	\$29	\$12,500	\$50
Direct Use Distribution	Conventional Tertiary	Pipeline / Laterals	to Sierra High School	Phase II	275	afy	1.5 to 16	30,800	:	:	\$5,940,000	\$1,405	\$59,400	\$220
								Direct U	Direct Use Distribution for Phase II	or Phase II	\$6,190,000	\$1,460	\$72,000	\$260
:				i										
Direct Use Distribution	Conventional Tertiary	Reservoir	Perris Hill Park	Phase III	100,000	gals	:	:	:	:	\$200,000	\$25	\$2,000	\$4
Direct Use Distribution	Conventional Tertiary	Reservoir	Wildwood Park	Phase III	100,000	gals	:	:	;	:	\$200,000	\$25	\$2,000	\$4
Direct Use Distribution	Conventional Tertiary	Pump Station	SBWRP	Phase III	1,900	mdg	:	;	300	200	\$1,000,000	\$126	\$50,000	\$100
Direct Use Distribution	Conventional Tertiary	Pump Station	Perris Hill Park	Phase III	1,300	mdb	;	;	400	200	\$1,000,000	\$130	\$50,000	\$100
Direct Use Distribution	Conventional Tertiary	Pipeline / Laterals	to Wildwood Park	Phase III	515	afy	2 to 12	25,100	;	;	\$5,610,000	\$209	\$56,100	\$110
								Direct Us	Direct Use Distribution for Phase III	or Phase III	\$8,010,000	\$1,010	\$160,000	\$310
							•	Direct U	Direct Use Distribution at Build-out	at Build-out	\$16,800,000	\$350	\$408,000	\$130
Recharge Distribution	Advanced Treated	Reservoir	SBWRP	Phase I	300,000	gals	:	;	:	:	\$600,000	\$3	\$6,000	\$1
Recharge Distribution	Advanced Treated	Pump Station	SBWRP	Phase I	3,500	mdg	:	:	510	200	\$2,100,000	\$28	\$560,000	\$116
Recharge Distribution	Advanced Treated	Pump Station	SBWRP	Phase II	7,000	mdg	:	:	540	1,400	\$4,200,000	\$28	\$1,120,000	\$116
Recharge Distribution	Advanced Treated	Pump Station	SBWRP	Phase III	10,000	mdg		:	280	2,100	\$6,300,000	\$28	\$1,680,000	\$116
Recharge Distribution	Advanced Treated	Pipeline	to Waterman Basins	Phase I	14,500	afy	30	38,000	:	:	\$19,400,000	06\$	\$194,000	\$13
					Recharge Distri	oution to W	Recharge Distribution to Waterman Basins and East Twin Creek Spreading Grounds	and East Twin	Creek Spreadi	ng Grounds	\$26,300,000	\$120	\$1,880,000	\$130
	!			i										;
Recharge Distribution	Advanced Treated	Keservoir	East I win Creek SG	Phase III	100,000	gals	:	:	:	:	\$200,000	£	\$2,000	£
Recharge Distribution	Advanced Treated	Pump Station	East Twin Creek SG	Phase III	3,500	mdg	:	:	400	450	\$2,250,000	\$29	\$360,000	\$72
Recharge Distribution	Advanced Treated	Pipeline	to Devil Canyon Basins	Phase III	2,000	afy	20	31,000	:	:	\$10,540,000	\$137	\$105,400	\$21
						Rech	Recharge Distribution to Devil Canyon and Sweetwater Basins	n to Devil Cany	on and Sweetv	ater Basins	\$13,000,000	\$170	\$467,000	06\$
			Recharge Distribution to Waterman Basins, East Twin Creek Spreading Grounds, and Devil Canyon and Sweetwater Basins	Waterman Bas	ins, East Twin (	Creek Sprea	ading Grounds, a	and Devil Cany	on and Sweetv	ater Basins	\$39,300,000	\$180	\$2,347,000	\$160
							_	Total Di	Total Distribution Cost at Build-out	at Build-out	\$56,100,000	\$210	\$2,755,000	\$160
1. Costs are based on Carollo's	1. Costs are based on Carolio's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.	Investigation - Technical I	Memorandum No. 1.											

2. Friancing assumes a 30-year term and a 5-percent interest rate.
3. Direct Use is assumed to occur over an 84r irrigation period, except for direct use at the SBWRP, which is assumed to occur over a 244r period.

**Table 12-4** Capital and Operation & Maintenance Costs Related to Recharge and Direct Use Site Improvements

			Quantity of		Сар	ital <sup>1</sup>	Operations &	Maintenance <sup>2</sup>
Site	Туре	Area	Recycled Water Used	Types of Capital Improvements	Total Cost	Unit Cost	Annual Cost	Unit Cost
		acres	acre-ft / yr		\$	\$ / acre-ft	\$/yr	\$ / acre-ft
SBWRP	Direct Use Site	38	2,000	Signage, Misc Pipework	\$50,000	\$2	\$20,000	\$10
San Bernardino Public Golf Course	Direct Use Site	93	210	Backflow Prevention, Misc. Pipework, Signage	\$93,000	\$29	\$9,300	\$44
Caltrans	Direct Use Site	20	100	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$33	\$5,000	\$50
Direct Use Site Im	provements for Phase I	151	2,310		\$193,000	\$5	\$34,300	\$10
Mill Community Park	Direct Use Site	14	25	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$130	\$5,000	\$200
Meadowbrook Recreational Park	Direct Use Site	14	26	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$120	\$5,000	\$190
Meadowbrook Park	Direct Use Site	7	13	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$240	\$5,000	\$370
Secombe Lake State Recreational Area	Direct Use Site	31	56	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$60	\$5,000	\$90
Pioneer Memorial Cemetery	Direct Use Site	20	37	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$90	\$5,000	\$130
Palm Field	Direct Use Site	5	9	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$350	\$5,000	\$530
Community Gardens	Direct Use Site	15	27	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$120	\$5,000	\$180
Total Capital Cost	Direct Use Site	50	81	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$40	\$5,000	\$60
Direct Use Site Imp	provements for Phase II	156	280		\$400,000	\$90	\$40,000	\$140
Perris Hill Park	Direct Use Site	32	58	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$60	\$5,000	\$87
Mountain View Cemetery	Direct Use Site	58	105	Backflow Prevention, Misc. Pipework, Signage	\$58,000	\$40	\$5,800	\$55
Wilson Elementary	Direct Use Site	10	16	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$200	\$5,000	\$305
Horine Park	Direct Use Site	6	10	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$320	\$5,000	\$490
Arrowhead Country Club	Direct Use Site	110	247	Backflow Prevention, Misc. Pipework, Signage	\$110,000	\$30	\$5,000	\$20
Golden Valley Middle School	Direct Use Site	10	16	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$200	\$5,000	\$305
Parkside Elementary	Direct Use Site	10	16	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$200	\$5,000	\$305
Wildwood Park	Direct Use Site	24	44	Backflow Prevention, Misc. Pipework, Signage	\$50,000	\$70	\$5,000	\$115
Direct Use Site Imp	rovements for Phase III	260	510		\$468,000	\$60	\$40,800	\$80
Cost Related to Direct	Use Site Improvements	567	3,100		\$1,100,000	\$20	\$115,000	\$40
Waterman Basins	Recharge Facility	70	4,833	Valve Rehab / Replacement, Misc. Pipework, Monitoring Wells, Instrumentation and Telemetry, Signage, Replacement Well for the 40th and Valencia Well	\$3,700,000	\$50	\$100,000	\$21
East Twin Creek Spreading Grounds	Recharge Facility	93	4,833	Imported Water Turnout, Internal Berm Construction, Valve Rehab / Replacement, Instrumentation and Telemetry, Signage	\$3,700,000	\$50	\$150,000	\$31
Devil Canyon and Sweetwater Basins	Recharge Facility	38	4,833	Berm Construction, Valve Rehab / Replacement, Misc. Pipework, Instrumentation and Telemetry, Signage, Replacement Wells for DC-2 and DC-8	\$2,700,000	\$36	\$85,000	\$18
Cost Relat	ted to Recharge Facility Improvements	131	14,500		\$10,100,000	\$50	\$335,000	\$20
Total Cost	Related to Site/Facility Improvements	391	17,600		\$11,200,000	\$40	\$450,000	\$30

<sup>1.</sup> Included in the capital costs for the recharge facilities is \$3,000,000 to replace the 40th and Valencia, and Devil Canyon No. 2 wells.

<sup>2.</sup> Included in the O&M cost is annual back preventer inspection/certification, laboratory costs, and annual reports.

Table 12-5a
Initial Project Alternatives' Capital and Operation & Maintenance Costs

		P	roject Alternative	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	14,500	14,500	14,500
Direct Use	acre-ft/yr	3,100	3,100	3,100
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs <sup>1, 2, 3</sup>				
Recharge				
Total Cost	\$	\$148,000,000	\$263,000,000	\$170,000,000
Annual Cost	\$/yr	\$9,600,000	\$17,100,000	\$11,100,000
Unit Cost	\$/acre-ft	\$660	\$1,180	\$770
Direct Use				
Total Cost	\$	\$28,000,000	\$28,000,000	\$28,000,000
Annual Cost	\$/yr	\$1,800,000	\$1,800,000	\$1,800,000
Unit Cost	\$/acre-ft	\$580	\$580	\$580
Total Capital Cost	******	****	****	•
Total Cost	\$	\$176,000,000	\$291,000,000	\$198,000,000
Annual Cost	\$/yr	\$11,400,000	\$18,900,000	\$12,900,000
Unit Cost	\$/acre-ft	\$650	\$1,070	\$730
Operation & Maintenance Costs <sup>1, 2</sup>	4, 4.0.0	****	<b>4</b> 1,212	4.22
Recharge				
Annual Cost	\$/yr	\$9,700,000	\$11,000,000	\$10,900,000
Unit Cost	\$/acre-ft	\$670	\$760	\$750
Direct Use	φιασίστι	φονο	ψ, σσ	ψ, σσ
Annual Cost	\$/yr	\$720,000	\$720,000	\$720,000
Unit Cost	\$/acre-ft	\$230	\$230	\$230
Total O&M Cost	ψ/ασισ π	Ψ200	Ψ200	Ψ200
Annual Cost	\$/yr	\$10,400,000	\$11,700,000	\$11,600,000
Unit Cost	\$/acre-ft	\$590	\$660	\$660
Gross Total Project Costs	ψ/ασισ π	φοσο	φοσο	φοσσ
Total Capital Cost	\$	\$176,000,000	\$291,000,000	\$198,000,000
Annual Cost	\$/yr	\$21,800,000	\$30,600,000	\$24,500,000
Unit Cost	\$/acre-ft	\$21,800,000	\$1,740	\$1,390
Cost Offsets - A	ф/асте-п	\$1,240	\$1,740	\$1,390
Operation & Maintenance <sup>4</sup>	\$/yr	\$3,500,000	\$4,600,000	\$5,600,000
Imported Water Purchases 5	\$/yr	\$5,300,000	\$5,300,000	\$5,800,000
Net Total Project Costs with Cost Offse	-	\$5,500,000	\$3,300,000	\$3,300,000
Total Cost	\$	\$176,000,000	\$291,000,000	\$198,000,000
Annual Cost	\$/yr	\$170,000,000	\$20,700,000	\$13,600,000
Unit Cost	\$/acre-ft	\$13,000,000	\$20,700,000	\$13,600,000 \$770
Cost Offsets - B	ψ/ασισ-ιι	\$740	\$1,100	\$110
Capital  Total Cost <sup>6</sup>	ø	\$0	¢62 700 000	¢62 700 000
Annual Cost	\$ \$\delta r	· ·	\$63,700,000 \$4,100,000	\$63,700,000 \$4,100,000
Net Total Project Costs with Cost Offse	\$/yr	\$0	\$4,100,000	\$4,100,000
		\$176 000 000	¢227 000 000	\$134 000 000
Total Cost	\$	\$176,000,000 \$13,000,000	\$227,000,000	\$134,000,000
Annual Cost	\$/yr \$/acro.ft	\$13,000,000 \$740	\$16,600,000 \$040	\$9,500,000 \$540
Unit Cost	\$/acre-ft	\$740	\$940	\$540

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include (1) the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively; (2) an avoided distribution cost of \$175 per acre-ft related to not pumping, treating (i.e. chlorination), and distributing well water to irrigation customers in the SBMWD's service area.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.

Table 12-5b
Initial CWF Alternatives' Capital and Operation & Maintenance Costs
Without the Devil Canyon and Sweetwater Basins

		Pı	roject Alternativ	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	14,500	14,500	14,500
Direct Use	acre-ft/yr	3,100	3,100	3,100
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs <sup>1, 2, 3</sup>		, , , , , ,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,
Recharge				
Total Cost	\$	\$133,000,000	\$247,000,000	\$154,000,000
Annual Cost	\$/yr	\$8,700,000	\$16,100,000	\$10,000,000
Unit Cost	\$/acre-ft	\$600	\$1,110	\$690
Direct Use				·
Total Cost	\$	\$28,000,000	\$28,000,000	\$28,000,000
Annual Cost	\$/yr	\$1,800,000	\$1,800,000	\$1,800,000
Unit Cost	\$/acre-ft	\$580	\$580	\$580
Total Capital Cost	******	,	****	****
Total Cost	\$	\$161,000,000	\$275,000,000	\$182,000,000
Annual Cost	\$/yr	\$10,500,000	\$17,900,000	\$11,800,000
Unit Cost	\$/acre-ft	\$600	\$1,020	\$670
Operation & Maintenance Costs 1, 2	φιασιστι	\$555	<b>\$.,020</b>	\$0.0
Recharge				
Annual Cost	\$/yr	\$9,100,000	\$10,500,000	\$10,400,000
Unit Cost	\$/acre-ft	\$630	\$720	\$720
Direct Use	φιασίστι	<b>\$555</b>	Ų. <u>2</u> 0	Ų. <u>2</u> 0
Annual Cost	\$/yr	\$720,000	\$720,000	\$720,000
Unit Cost	\$/acre-ft	\$230	\$230	\$230
Total O&M Cost	φιασίστι	<b>\$200</b>	<b>\$200</b>	<b>\$255</b>
Annual Cost	\$/yr	\$9,800,000	\$11,200,000	\$11,100,000
Unit Cost	\$/acre-ft	\$560	\$640	\$630
Gross Total Project Costs	φιασιστι	4000	ψ0.0	4000
Total Capital Cost	\$	\$161,000,000	\$275,000,000	\$182,000,000
Annual Cost	\$/yr	\$20,300,000	\$29,100,000	\$22,900,000
Unit Cost	\$/acre-ft	\$1,150	\$1,650	\$1,300
Cost Offsets - A	φιασιστι	ψ1,100	ψ1,000	ψ1,000
Operation & Maintenance 4	\$/yr	\$3,500,000	\$4,600,000	\$5,600,000
Imported Water Purchases 5	\$/yr	\$5,300,000	\$5,300,000	\$5,300,000
Net Total Project Costs with Cost Offse		ψο,οσο,σσο	φο,οοο,οοο	ψο,οοο,οοο
Total Cost	\$	\$161,000,000	\$275,000,000	\$182,000,000
Annual Cost	\$/yr	\$11,500,000	\$19,200,000	\$12,000,000
Unit Cost	\$/acre-ft	\$650	\$1,090	\$680
Cost Offsets - B	Ψ, αστο τι	ψ330	ψ1,000	ψ000
Capital				
Total Cost <sup>6</sup>	\$	\$0	\$63,700,000	\$63,700,000
Annual Cost	\$/yr	\$0 \$0	\$4,100,000	\$4,100,000
Net Total Project Costs with Cost Offse	-		ψ., 100,000	ψ., 100,000
Total Cost	\$	\$161,000,000	\$211,000,000	\$118,000,000
Annual Cost	\$/yr	\$11,500,000	\$15,100,000	\$7,900,000
Unit Cost	\$/acre-ft	\$650	\$860	\$450
	Ţ, 2.3.0 .t	<b>\$530</b>	<b>4030</b>	<b>\$.50</b>

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include (1) the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively; (2) an avoided distribution cost of \$175 per acre-ft related to not pumping, treating (i.e. chlorination), and distributing well water to irrigation customers in the SBMWD's service area.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.

Table 12-5c
Initial Project Alternatives' Capital and Operation & Maintenance Costs
With A Single Distribution Pipeline

		Pr	oject Alternative	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	14,500	14,500	14,500
Direct Use	acre-ft/yr	3,100	3,100	3,100
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs 1, 2, 3		11,000	,	,555
Recharge				
Total Cost	\$	\$148,000,000	\$263,000,000	\$170,000,000
Annual Cost	\$/yr	\$9,600,000	\$17,100,000	\$11,100,000
Unit Cost	\$/acre-ft	\$660	\$1,180	\$770
Direct Use	φιασίστι	φοσο	ψ1,100	Ψπο
Total Cost	\$	\$17,000,000	\$17,000,000	\$17,000,000
Annual Cost	\$/yr	\$1,100,000	\$1,100,000	\$1,100,000
Unit Cost	\$/acre-ft	\$350	\$350	\$350
Total Capital Cost	ψ/ασισ-ιι	φοσο	ψ330	ψ330
Total Cost	\$	\$165,000,000	\$280,000,000	\$187,000,000
Annual Cost	-			\$187,000,000
	\$/yr	\$10,700,000	\$18,200,000	
Unit Cost	\$/acre-ft	\$610	\$1,030	\$690
Operation & Maintenance Costs 1, 2				
Recharge	Φ 6 ···	<b>\$0,000,000</b>	¢40,000,000	¢40,000,000
Annual Cost	\$/yr	\$9,600,000	\$10,900,000	\$10,800,000
Unit Cost	\$/acre-ft	\$660	\$750	\$740
Direct Use	•	<b>^-</b>	<b>^-</b>	<b>^-</b>
Annual Cost	\$/yr	\$710,000	\$710,000	\$710,000
Unit Cost	\$/acre-ft	\$230	\$230	\$230
Total O&M Cost	•		•	
Annual Cost	\$/yr	\$10,300,000	\$11,600,000	\$11,500,000
Unit Cost	\$/acre-ft	\$590	\$660	\$650
Gross Total Project Costs				
Total Capital Cost	\$	\$165,000,000	\$280,000,000	\$187,000,000
Annual Cost	\$/yr	\$21,000,000	\$29,800,000	\$23,700,000
Unit Cost	\$/acre-ft	\$1,190	\$1,690	\$1,350
Cost Offsets - A				
Operation & Maintenance 4	\$/yr	\$3,500,000	\$4,600,000	\$5,600,000
Imported Water Purchases <sup>5</sup>	\$/yr	\$5,300,000	\$5,300,000	\$5,300,000
Net Total Project Costs with Cost Offse	ts - A			
Total Cost	\$	\$165,000,000	\$280,000,000	\$187,000,000
Annual Cost	\$/yr	\$12,200,000	\$19,900,000	\$12,800,000
Unit Cost	\$/acre-ft	\$690	\$1,130	\$730
Cost Offsets - B				
Capital				
Total Cost 6	\$	\$0	\$63,700,000	\$63,700,000
Annual Cost	\$/yr	\$0	\$4,100,000	\$4,100,000
Net Total Project Costs with Cost Offse	ts - A and B			
		\$405,000,000	£246,000,000	\$123,000,000
Total Cost	\$	\$165,000,000	\$216,000,000	Ψ123,000,000
Total Cost Annual Cost	\$ \$/yr	\$165,000,000	\$216,000,000	\$8,700,000

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include (1) the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively; (2) an avoided distribution cost of \$175 per acre-ft related to not pumping, treating (i.e. chlorination), and distributing well water to irrigation customers in the SBMWD's service area.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.

### Table 12-5d

### Initial Project Alternatives' Capital and Operation & Maintenance Costs With A Single Distribution Pipeline and Without the Devil Canyon and Sweetwater Basins

	Heite	Pi	roject Alternative	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	14,500	14,500	14,500
Direct Use	acre-ft/yr	3,100	3,100	3,100
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs <sup>1, 2, 3</sup>		11,000	,	,555
Recharge				
Total Cost	\$	\$133,000,000	\$247,000,000	\$154,000,000
Annual Cost	\$/yr	\$8,700,000	\$16,100,000	\$10,000,000
Unit Cost	\$/acre-ft	\$600	\$1,110	\$690
Direct Use	·	·	. ,	
Total Cost	\$	\$17,000,000	\$17,000,000	\$17,000,000
Annual Cost	\$/yr	\$1,100,000	\$1,100,000	\$1,100,000
Unit Cost	\$/acre-ft	\$350	\$350	\$350
Total Capital Cost	φ/ασίσ π	φοσσ	φοσο	φοσσ
Total Cost	\$	\$150,000,000	\$264,000,000	\$171,000,000
Annual Cost	\$/yr	\$9,800,000	\$17,200,000	\$11,100,000
Unit Cost	\$/acre-ft	\$5,000,000 \$560	\$980	\$630
Operation & Maintenance Costs <sup>1, 2</sup>	φ/acιe-π	φ300	φθου	φ030
Recharge				
Annual Cost	\$/yr	\$9,600,000	\$10,900,000	\$10,800,000
Unit Cost	\$/acre-ft	\$660	\$750	\$740
Direct Use	<b>O</b> t	<b>#740.000</b>	<b>#740.000</b>	<b>6740.000</b>
Annual Cost	\$/yr	\$710,000	\$710,000	\$710,000
Unit Cost	\$/acre-ft	\$230	\$230	\$230
Total O&M Cost	•	<b>#</b> 40.000.000	<b>0.1.1</b> 000 000	<b>0.1.1</b> = 0.0 0.00
Annual Cost	\$/yr	\$10,300,000	\$11,600,000	\$11,500,000
Unit Cost	\$/acre-ft	\$590	\$660	\$650
Gross Total Project Costs	_	•		•
Total Capital Cost	\$	\$150,000,000	\$264,000,000	\$171,000,000
Annual Cost	\$/yr	\$20,100,000	\$28,800,000	\$22,600,000
Unit Cost	\$/acre-ft	\$1,140	\$1,640	\$1,280
Cost Offsets - A				
Operation & Maintenance 4	\$/yr	\$3,500,000	\$4,600,000	\$5,600,000
Imported Water Purchases <sup>5</sup>	\$/yr	\$5,300,000	\$5,300,000	\$5,300,000
Net Total Project Costs with Cost Offse				
Total Cost	\$	\$150,000,000	\$264,000,000	\$171,000,000
Annual Cost	\$/yr	\$11,300,000	\$18,900,000	\$11,700,000
Unit Cost	\$/acre-ft	\$640	\$1,070	\$660
Cost Offsets - B				
Capital				
Total Cost <sup>6</sup>	\$	\$0	\$63,700,000	\$63,700,000
Annual Cost	\$/yr	\$0	\$4,100,000	\$4,100,000
Net Total Project Costs with Cost Offse	ts - A and B			
Total Cost	\$	\$150,000,000	\$200,000,000	\$107,000,000
Annual Cost	\$/yr	\$11,300,000	\$14,800,000	\$7,600,000
Unit Cost	\$/acre-ft	\$640	\$840	\$430

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include (1) the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively; (2) an avoided distribution cost of \$175 per acre-ft related to not pumping, treating (i.e. chlorination), and distributing well water to irrigation customers in the SBMWD's service area.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.

### Table 12-5e Initial Project Alternatives' Capital and Operation & Maintenance Costs With Limited Direct Use

		Pr	oject Alternative	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	15,290	15,290	15,290
Direct Use	acre-ft/yr	2,310	2,310	2,310
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs <sup>1, 2, 3</sup>	acio ia ji	,000	,000	,000
Recharge				
Total Cost	\$	\$149,000,000	\$264,000,000	\$171,000,000
Annual Cost	\$/yr	\$9,700,000	\$17,200,000	\$11,100,000
Unit Cost	\$/acre-ft	\$630	\$1,120	\$730
Direct Use	φ/ασισ π	φοσσ	ψ1,120	Ψίου
Total Cost	\$	\$13,000,000	\$13,000,000	\$13,000,000
Annual Cost	\$/yr	\$800,000	\$800,000	\$800,000
Unit Cost	\$/acre-ft	\$350	\$350	\$350
Total Capital Cost	ψ/ασισ-π	ψ330	ΨΟΟΟ	Ψ330
Total Cost	\$	\$162,000,000	\$277,000,000	\$184,000,000
Annual Cost			\$18,000,000	\$104,000,000
	\$/yr	\$10,500,000		
Unit Cost	\$/acre-ft	\$600	\$1,020	\$680
Operation & Maintenance Costs 1, 2				
Recharge	Φ / · · ·	<b>\$0,000,000</b>	¢40,000,000	¢40,000,000
Annual Cost	\$/yr	\$9,600,000	\$10,900,000	\$10,800,000
Unit Cost	\$/acre-ft	\$630	\$710	\$710
Direct Use	Φ.	<b>#</b> 440 000	<b>#</b> 440.000	<b>0.440.000</b>
Annual Cost	\$/yr	\$410,000	\$410,000	\$410,000
Unit Cost	\$/acre-ft	\$180	\$180	\$180
Total O&M Cost	•			<b>^</b>
Annual Cost	\$/yr	\$10,000,000	\$11,300,000	\$11,200,000
Unit Cost	\$/acre-ft	\$570	\$640	\$640
Gross Total Project Costs				
Total Capital Cost	\$	\$162,000,000	\$277,000,000	\$184,000,000
Annual Cost	\$/yr	\$20,500,000	\$29,300,000	\$23,100,000
Unit Cost	\$/acre-ft	\$1,160	\$1,660	\$1,310
Cost Offsets - A				
Operation & Maintenance 4	\$/yr	\$3,400,000	\$4,500,000	\$5,400,000
Imported Water Purchases 5	\$/yr	\$5,300,000	\$5,300,000	\$5,300,000
Net Total Project Costs with Cost Offse		0.000		
Total Cost	\$	\$162,000,000	\$277,000,000	\$184,000,000
Annual Cost	\$/yr	\$11,800,000	\$19,500,000	\$12,400,000
Unit Cost	\$/acre-ft	\$670	\$1,110	\$700
Cost Offsets - B				
Capital				
Total Cost <sup>6</sup>	\$	\$0	\$63,700,000	\$63,700,000
Annual Cost	\$/yr	\$0	\$4,100,000	\$4,100,000
Net Total Project Costs with Cost Offse	1			
Total Cost	\$	\$162,000,000	\$213,000,000	\$120,000,000
Annual Cost	\$/yr	\$11,800,000	\$15,400,000	\$8,300,000
Unit Cost	\$/acre-ft	\$670	\$880	\$470

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include (1) the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively; (2) an avoided distribution cost of \$175 per acre-ft related to not pumping, treating (i.e. chlorination), and distributing well water to irrigation customers in the SBMWD's service area.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.

Table 12-5f
Initial Project Alternatives' Capital and Operation & Maintenance Costs
With Limited Direct Use and without the Devil Canyon and Sweetwater Basins

		Pi	roject Alternativ	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	15,290	15,290	15,290
Direct Use	acre-ft/yr	2,310	2,310	2,310
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs <sup>1, 2, 3</sup>		,	,	,555
Recharge				
Total Cost	\$	\$133,000,000	\$248,000,000	\$155,000,000
Annual Cost	\$/yr	\$8,700,000	\$16,100,000	\$10,100,000
Unit Cost	\$/acre-ft	\$570	\$1,050	\$660
Direct Use	******	**	* /	****
Total Cost	\$	\$13,000,000	\$13,000,000	\$13,000,000
Annual Cost	\$/yr	\$800,000	\$800,000	\$800,000
Unit Cost	\$/acre-ft	\$350	\$350	\$350
Total Capital Cost	φιασίστι	ψ000	4000	φοσσ
Total Cost	\$	\$146,000,000	\$261,000,000	\$168,000,000
Annual Cost	\$/yr	\$9,500,000	\$16,900,000	\$10,900,000
Unit Cost	\$/acre-ft	\$540	\$960	\$620
Operation & Maintenance Costs 1, 2	φιασίστι	\$1.0	4000	<b>4020</b>
Recharge				
Annual Cost	\$/yr	\$9,600,000	\$10,900,000	\$10,800,000
Unit Cost	\$/acre-ft	\$630	\$710	\$710
Direct Use	******	****	,	•
Annual Cost	\$/yr	\$410,000	\$410,000	\$410,000
Unit Cost	\$/acre-ft	\$180	\$180	\$180
Total O&M Cost	******	,	•	•
Annual Cost	\$/yr	\$10,000,000	\$11,300,000	\$11,200,000
Unit Cost	\$/acre-ft	\$570	\$640	\$640
Gross Total Project Costs				
Total Capital Cost	\$	\$146,000,000	\$261,000,000	\$168,000,000
Annual Cost	\$/yr	\$19,500,000	\$28,200,000	\$22,100,000
Unit Cost	\$/acre-ft	\$1,110	\$1,600	\$1,260
Cost Offsets - A			. ,	
Operation & Maintenance 4	\$/yr	\$3,400,000	\$4,500,000	\$5,400,000
Imported Water Purchases <sup>5</sup>	\$/yr	\$5,300,000	\$5,300,000	\$5,300,000
Net Total Project Costs with Cost Offse			. , ,	
Total Cost	\$	\$146,000,000	\$261,000,000	\$168,000,000
Annual Cost	\$/yr	\$10,800,000	\$18,400,000	\$11,400,000
Unit Cost	\$/acre-ft	\$610	\$1,050	\$650
Cost Offsets - B				
Capital				
Total Cost <sup>6</sup>	\$	\$0	\$63,700,000	\$63,700,000
Annual Cost	\$/yr	\$0	\$4,100,000	\$4,100,000
Net Total Project Costs with Cost Offse				
Total Cost	\$	\$146,000,000	\$197,000,000	\$104,000,000
Annual Cost	\$/yr	\$10,800,000	\$14,300,000	\$7,300,000
Unit Cost	\$/acre-ft	\$610	\$810	\$410

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include (1) the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively; (2) an avoided distribution cost of \$175 per acre-ft related to not pumping, treating (i.e. chlorination), and distributing well water to irrigation customers in the SBMWD's service area.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.

## Table 12-5g Initial Project Alternatives' Capital and Operation & Maintenance Costs With Groundwater Recharge Only

		P	roject Alternative	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	17,600	17,600	17,600
Direct Use	acre-ft/yr	0	0	0
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs 1, 2, 3	,		·	
Recharge				
Total Cost	\$	\$160,000,000	\$275,000,000	\$182,000,000
Annual Cost	\$/yr	\$10,400,000	\$17,900,000	\$11,800,000
Unit Cost	\$/acre-ft	\$590	\$1,020	\$670
Direct Use	******	,	* /	, ,
Total Cost	\$	\$0	\$0	\$0
Annual Cost	\$/yr	\$0	\$0	\$0
Unit Cost	\$/acre-ft	\$0	\$0	\$0
Total Capital Cost	ψ/ασισ π	ΨΟ	ΨΟ	ΨΟ
Total Cost	\$	\$160,000,000	\$275,000,000	\$182,000,000
Annual Cost	\$/yr	\$10,400,000	\$17,900,000	\$11,800,000
Unit Cost	\$/acre-ft	\$10,400,000	\$17,900,000	\$11,800,000
Operation & Maintenance Costs <sup>1, 2</sup>	ψ/ασισ-ιι	ψ390	ψ1,020	Ψ070
Recharge				
Annual Cost	\$/yr	\$9,600,000	\$10,900,000	\$10,800,000
Unit Cost	\$/acre-ft	\$5,000,000	\$620	\$610
Direct Use	ψ/ασισ-π	ΨΟΟΟ	ΨΟΖΟ	φοιο
Annual Cost	\$/yr	\$0	\$0	\$0
Unit Cost	\$/acre-ft	\$0 \$0	\$0 \$0	\$0
Total O&M Cost	ψ/ασισ-π	ΨΟ	ΨΟ	ΨΟ
Annual Cost	\$/yr	\$9,600,000	\$10,900,000	\$10,800,000
Unit Cost	\$/acre-ft	\$5,000,000	\$620	\$610
Gross Total Project Costs	ψ/ασισ-ιι	ψ550	ψυΖυ	φοιο
Total Capital Cost	\$	\$160,000,000	\$275,000,000	\$182,000,000
Annual Cost	\$/yr	\$20,000,000	\$28,800,000	\$22,600,000
Unit Cost	\$/acre-ft	\$20,000,000	\$1,640	\$1,280
Cost Offsets - A	ψ/ασισ-ιι	Ψ1,140	Ψ1,040	ψ1,200
Operation & Maintenance <sup>4</sup>	\$/yr	\$3,000,000	\$4,100,000	\$5,000,000
Imported Water Purchases 5	\$/yr	\$5,300,000	\$5,300,000	\$5,300,000
Net Total Project Costs with Cost Offse		ψ5,500,000	ψ5,500,000	ψ5,500,000
Total Cost	\$	\$160,000,000	\$275,000,000	\$182,000,000
Annual Cost	\$/yr	\$11,700,000	\$19,400,000	\$12,300,000
Unit Cost	\$/acre-ft	\$660	\$1,100	\$700
Cost Offsets - B	φ/ασισ π	φοσο	ψ1,100	Ψίου
Capital				
Total Cost <sup>6</sup>	\$	\$0	\$63,700,000	\$63,700,000
Annual Cost	\$/yr	\$0 \$0	\$4,100,000	\$4,100,000
Net Total Project Costs with Cost Offse		φυ	ψ, 100,000	ψ-, 100,000
Total Cost	\$	\$160,000,000	\$211,000,000	\$118,000,000
Annual Cost	\$/yr	\$100,000,000	\$15,300,000	\$8,200,000
Unit Cost	\$/acre-ft	\$660	\$13,300,000	\$470
5.m. 565t	ψ/ασισ−ιτ	ΨΟΟΟ	ΨΟΙΟ	ΨτίΟ

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.

### Table 12-5h

### Initial Project Alternatives' Capital and Operation & Maintenance Costs With Groundwater Recharge Only and Without the Devil Canyon and Sweetwater Basins

	Halica	Pi	oject Alternativ	es
	Units	1B	1C	1D
Quantity of Recycled Water Used				
Recharge	acre-ft/yr	17,600	17,600	17,600
Direct Use	acre-ft/yr	0	0	0
Total	acre-ft/yr	17,600	17,600	17,600
Capital Costs <sup>1, 2, 3</sup>		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,	,
Recharge				
Total Cost	\$	\$144,000,000	\$259,000,000	\$166,000,000
Annual Cost	\$/yr	\$9,400,000	\$16,800,000	\$10,800,000
Unit Cost	\$/acre-ft	\$530	\$950	\$610
Direct Use	******	,	****	,
Total Cost	\$	\$0	\$0	\$0
Annual Cost	\$/yr	\$0	\$0	\$0
Unit Cost	\$/acre-ft	\$0 \$0	\$0	\$0 \$0
Total Capital Cost	ψ/αυισ-ιι	ΨΟ	ΨΟ	ΨΟ
Total Cost	\$	\$144,000,000	\$259,000,000	\$166,000,000
			\$16,800,000	. , ,
Annual Cost	\$/yr	\$9,400,000		\$10,800,000
Unit Cost	\$/acre-ft	\$530	\$950	\$610
Operation & Maintenance Costs 1, 2				
Recharge	• (			
Annual Cost	\$/yr	\$9,600,000	\$10,900,000	\$10,800,000
Unit Cost	\$/acre-ft	\$550	\$620	\$610
Direct Use				
Annual Cost	\$/yr	\$0	\$0	\$0
Unit Cost	\$/acre-ft	\$0	\$0	\$0
Total O&M Cost				
Annual Cost	\$/yr	\$9,600,000	\$10,900,000	\$10,800,000
Unit Cost	\$/acre-ft	\$550	\$620	\$610
Gross Total Project Costs				
Total Capital Cost	\$	\$144,000,000	\$259,000,000	\$166,000,000
Annual Cost	\$/yr	\$19,000,000	\$27,700,000	\$21,600,000
Unit Cost	\$/acre-ft	\$1,080	\$1,570	\$1,230
Cost Offsets - A				
Operation & Maintenance 4	\$/yr	\$3,000,000	\$4,100,000	\$5,000,000
Imported Water Purchases <sup>5</sup>	\$/yr	\$5,300,000	\$5,300,000	\$5,300,000
Net Total Project Costs with Cost Offse	ets - A			
Total Cost	\$	\$144,000,000	\$259,000,000	\$166,000,000
Annual Cost	\$/yr	\$10,700,000	\$18,300,000	\$11,300,000
Unit Cost	\$/acre-ft	\$610	\$1,040	\$640
Cost Offsets - B			. ,	
Capital				
Total Cost <sup>6</sup>	\$	\$0	\$63,700,000	\$63,700,000
Annual Cost	\$/yr	\$0	\$4,100,000	\$4,100,000
Net Total Project Costs with Cost Offse			Ţ.,100,000	ψ.,100,000
Total Cost	\$ \$	\$144,000,000	\$195,000,000	\$102,000,000
Annual Cost	\$/yr	\$10,700,000	\$14,200,000	\$7,200,000
Unit Cost	\$/acre-ft	\$10,700,000	\$14,200,000	\$410
5.m. 500t	ψ/ασισ−ιί	ΨΟΙΟ	ΨΟ1Ο	Ψ-10

<sup>1.</sup> Costs are based on Carollo's 2010 Recycled Water Feasibility Investigation - Technical Memorandum No. 1.

<sup>6.</sup> The capital cost offset associated with the MBR or IMANS process is the avoided cost of expanding secondary treatment at the SBWRP in the future.



<sup>2.</sup> Costs are for build-out conditions.

<sup>3.</sup> Financing assumes a 30-year term and a 5-percent interest rate.

<sup>4.</sup> The operation and maintenance cost offsets include the avoided O&M costs at the SBWRP and the RIX facility related to not treating this effluent to secondary and tertiary standards, respectively.

<sup>5.</sup> This project offsets 17,600 acre-ft/yr of imported water for the SBMWD, valued at \$300 per acre-ft.



Table 12-6
Cumulative Unmet Replenishment Obligation of the Valley District with SBMWD Recycled Water Recharge – 2010 through 2030
(acre-ft/yr)

	Cumulative Unmet Replenishment Obligation <sup>7</sup>	0	0	0	0	0	0	0	0	0	0	0	0	440	4,585	12,435	23,989	37,297	52,359	69,175	87,746	108,070
	Actual Replenishment <sup>6</sup>	0	0	0	0	0	12,725	31,460	34,527	37,594	40,661	35,652	38,954	41,814	41,411	41,007	40,604	40,540	40,477	40,413	40,350	40,286
	Replenishment Credits at the end of the Year <sup>56</sup>	157,070	127,072	93,505	56,371	15,668	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
er Project Water	Available for Replenishment	50,516	49,117	47,717	46,318	44,918	43,519	43,339	43,160	42,980	42,801	42,621	42,218	41,814	41,411	41,007	40,604	40,540	40,477	40,413	40,350	40,286
Valley District Supply of State Water Project Water	Direct	10,924	12,323	13,723	15,122	16,522	17,921	18,101	18,280	18,460	18,639	18,819	19,222	19,626	20,029	20,433	20,836	20,900	20,963	21,027	21,090	21,154
Valley District S	Table A deliveries at 60% Reliability <sup>3</sup>	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440	61,440
	Replenishment Obligation²	26,430	29,998	33,566	37,134	40,703	28,393	31,460	34,527	37,594	40,661	35,652	38,954	42,255	45,556	48,857	52,158	53,848	55,539	57,230	58,920	60,611
	Excess Extractions from the SBBA	31,094	35,292	39,490	43,688	47,885	33,403	37,011	40,620	44,228	47,836	41,944	45,828	49,711	53,595	57,478	61,362	63,351	65,340	67,329	69,318	71,307
	Total Production Rights from the SBBA	232,100	232,100	232,100	232,100	232,100	249,100	249,100	249,100	249,100	249,100	258,600	258,600	258,600	258,600	258,600	258,600	258,600	258,600	258,600	258,600	258,600
SBBA Production Rights	SBBA Augmentation from SBMWD Recycled Water Recharge	0	0	0	0	0	5,000	5,000	5,000	5,000	5,000	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500
SBBA Produ	SBBA Augmentation from New Santa Ana River Water Right	0	0	0	0	0	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
	Safe Yield	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100	232,100
	Water Use from the SBBA <sup>1</sup>	263,194	267,392	271,590	275,788	279,985	282,503	286,111	289,720	293,328	296,936	300,544	304,428	308,311	312,195	316,078	319,962	321,951	323,940	325,929	327,918	329,907
	Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

1. SBB supple is richuld a groundwater from the Bunker Hill and Lytle Creek basins and surface water from the Santa Ana River. Mill Creek, and Lytle Creek. The Paintiff's are assumed to pump at their aggregate inghts so they do not have a repensant reduction in potable per capita demand by 2015 and a 20-percent reduction by 2020.

<sup>2.</sup> The replenishment obligation is equal to the total volume of excess extractions from the SBBA minus the return flow (15%) from the extractions above the safe yield.

<sup>3.</sup> The Valley District's Table A allocation of State Water Project water 102,400 acre-ft/yr.

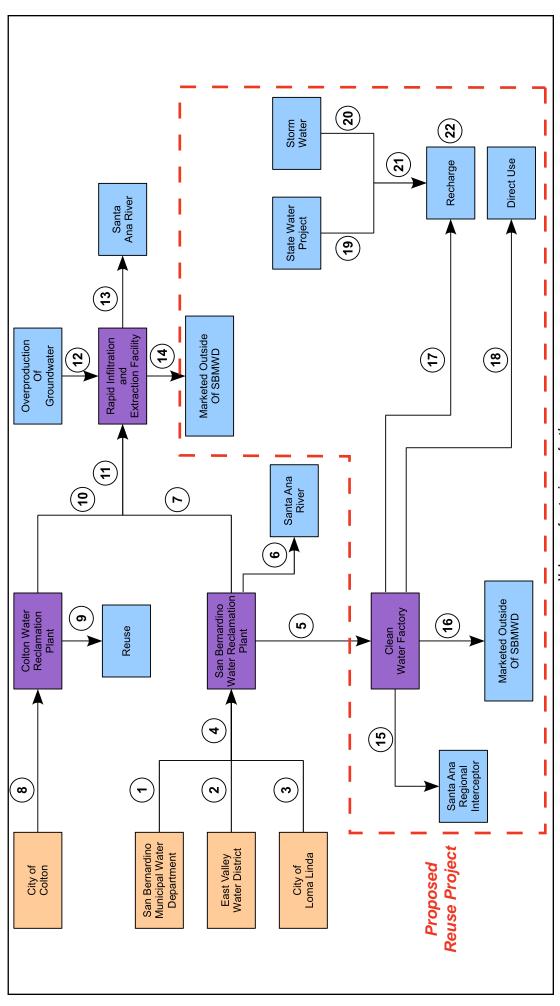
<sup>4.</sup> Direct Deliveries are the Valley District's obligations to individual agencies for consumptive use, including the Fontana Water Company, West Valley Water District, City of Redlands, and Yucaipa Valley Water District.

<sup>5.</sup> Assumes that the Valley District has a credit of about 183,500 acre-ft at the end of 2009.

<sup>6.</sup> Assumes that the Valley District only replenishes the SBBA when the replenishment credits have expired.

<sup>7.</sup> The CURO describes the total amount of water that the Valley District must recharge to balance the storage of the SBBA.





Stream 1,2	<sup>2</sup> 1 2 3	2	3	4	5 63	၉	7	œ	6	10	$9 \mid 10 \mid 11 \mid 12 \mid 13 \mid 14^4 \mid 15 \mid 16^4 \mid 17 \mid 18 \mid 19 \mid 20 \mid 21 \mid 22$	12	13	144	15	164	17	18	19	20	21	22
Year																						
2015	18,300	10,300	2,250	18,300 10,300 2,250 30,850 9,000	9,000	0	21,850	6,410	0	6,410	6,410 28,260 5,700 23,960 10,000	5,700	23,960	10,000	006	0	5,100	3,100	5,100 3,100 23,500 4,800 28,300 33,400	4,800	28,300	33,400
2020	20,500	11,000	2,620	20,500 11,000 2,620 34,120 14,900	14,900	0	19,220	6,840	0	6,840	6,840 26,060 5,200 21,260 10,000 1,800	5,200	21,260	10,000	1,800	0	10,300	3,100	10,300 3,100 23,500 4,800 28,300 38,600	4,800	28,300	38,600
2030	24,600	11,600	3,420	24,600 11,600 3,420 39,620 20,200		0	0 19,420 8,000	8,000	0	8,000	8,000   27,420   5,500   22,920   10,000   2,600	5,500	22,920	10,000	2,600	0	14,500	3,100	23,500	4,800	28,300	42,800
0001	4,000	20,-	0,4	22,00			2,7	200,0	,	0,000	021,12	0,0	25,050	200,01	11	200,1	5	000,1	000000	000,000	2,000	2,000

1 This schematic represents Project Alternative 1B. (see Section 11)

2 Assumes the CWF will be built using a phased approach. 3 SBWRP intermittently discharges to the Santa Ana River during large storm events.

4 Assumes that all marketed recycled water is conveyed from the RIX facility.

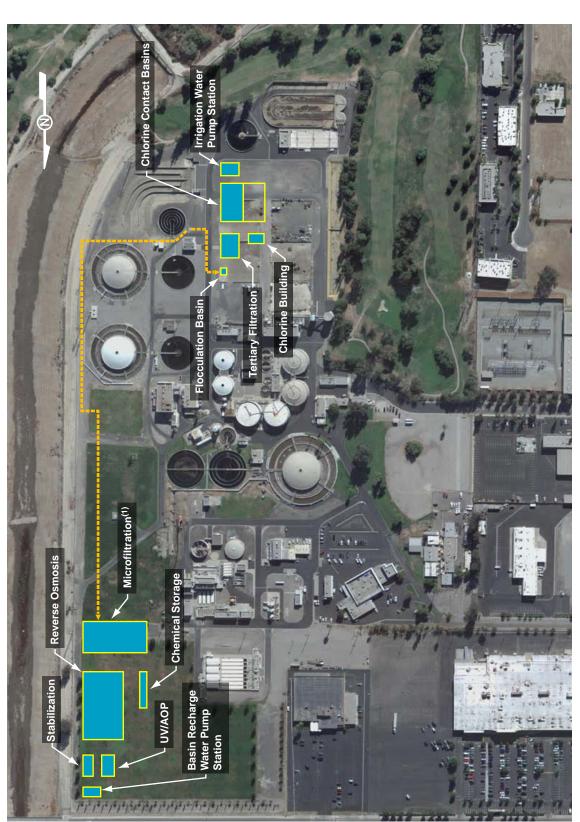




Produced for:







# TREATMENT ALTERNATIVE B SITE LAYOUT

FIGURE 12-2

SAN BERNARDINO MUNICIPAL WATER DEPARTMENT

Note: 1. Feed for microfiltration unit is from the existing secondary treatment process.







# Flocculation Basin Reverse Osmosis

# TREATMENT ALTERNATIVE C SITE LAYOUT

FIGURE 12-3

SAN BERNARDINO MUNICIPAL WATER DEPARTMENT



BMW D4-10F1.11-8303A00.AI

Basin Recharge Water Pump Station

UV/AOP

Chemical Storage

Stabilization



# Microfiltration<sup>(1)</sup> Reverse Osmosis Basin Recharge Water Pump Station Stabilization UV/AOP Chemical Storage

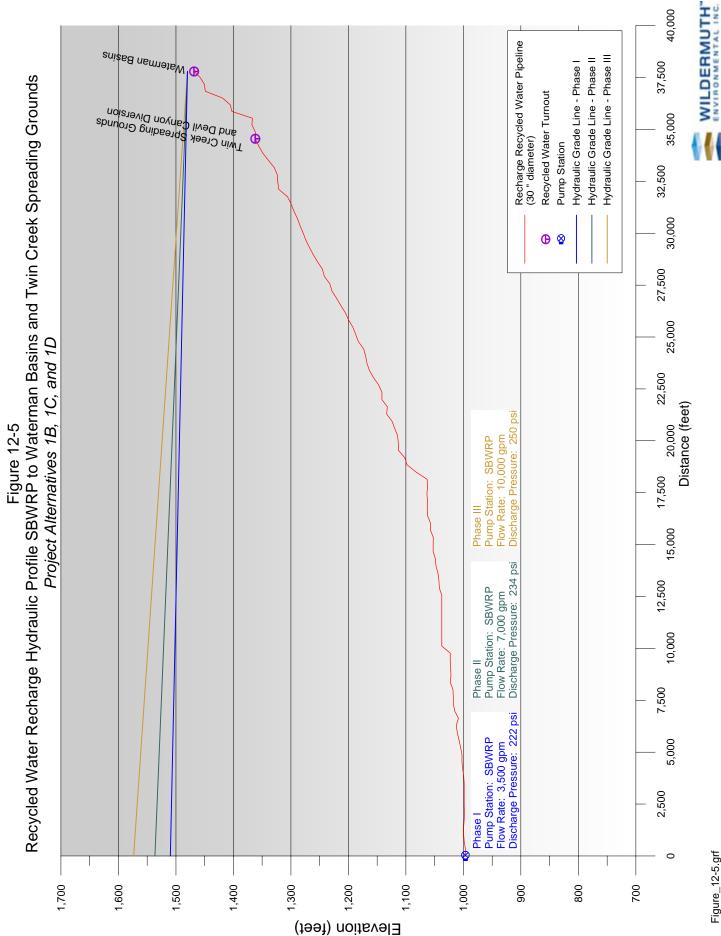
# TREATMENT ALTERNATIVE D SITE LAYOUT

FIGURE 12-4

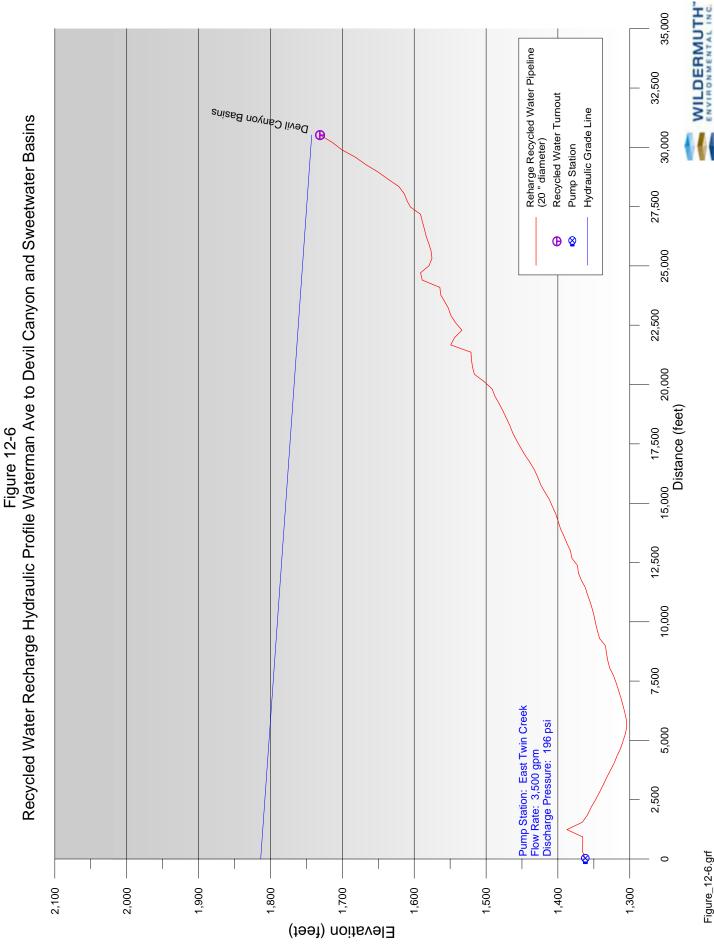
 $\underline{\text{Note:}} \\ 1. \ \text{Feed for microfiltration unit is from the existing primary treatment process.}$ 







Figure\_12-5.grf



Figure\_12-6.grf

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 $\label{eq:Appendix A-1} Appendix A-1$  Water Demand and Supply Plan for the Fontana Water Company  $^1$ 

		Non Potable	Surplus / Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Potable	Surplus / Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Non-Potable		Recycled Water Available for Use	(acre-ft/yr)	2,500	2,500	2,500	2,500	2,500	000'9	6,000	000'9	000'9	9,000	000'9	000'9	6,000	000'9	9,000	000'9	6,000	6,000	9000'9	9000'9	000'9
			Total Potable Supply	(acre-ft/yr)	37,000	37,600	38,200	38,800	39,400	30,500	31,000	31,500	32,000	32,500	33,000	33,500	34,000	34,500	35,000	35,500	35,700	35,900	36,100	36,300	36,500
			Imported Water from the SWP <sup>3</sup>	(acre-ft/yr)	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Supplies	Potable	,	Surface Water from Lytle Creek	(acre-ft/yr)	4,500	4,500	4,500	4,500	4,500	4,500	4,600	4,700	4,800	4,900	5,000	5,200	5,400	5,600	5,800	000'9	6,000	6,000	6,000	000'9	000,9
	Pot	υ	Rialto Basin	(acre-ft/yr)	7,860	8,838	9,816	10,794	11,772	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
		Groundwater from	Chino Basin	(acre-ft/yr)	13,500	13,750	14,000	14,250	14,500	10,000	10,200	10,400	10,600	10,800	11,000	11,100	11,200	11,300	11,400	11,500	11,600	11,700	11,800	11,900	12,000
		)	Lytle Basin	(acre-ft/yr)	6,140	5,512	4,884	4,256	3,628	3,000	3,200	3,400	3,600	3,800	4,000	4,200	4,400	4,600	4,800	5,000	5,100	5,200	5,300	5,400	5,500
			Total Demand	(acre-ft/yr)	39,500	40,100	40,700	41,300	41,900	36,500	37,000	37,500	38,000	38,500	39,000	39,500	40,000	40,500	41,000	41,500	41,700	41,900	42,100	42,300	42,500
Demands			Non Potable	(acre-ft/yr)	2,500	2,500	2,500	2,500	2,500	000'9	6,000	6,000	6,000	6,000	000'9	6,000	6,000	6,000	6,000	00009	6,000	6,000	6,000	6,000	6,000
			Potable 2	(acre-ft/yr)	37,000	37,600	38,200	38,800	39,400	30,500	31,000	31,500	32,000	32,500	33,000	33,500	34,000	34,500	35,000	35,500	35,700	35,900	36,100	36,300	36,500
			Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

<sup>&</sup>lt;sup>1</sup> Water Supply Plan adapted from Wildermuth Environmental, Inc (2009) and GEI Consultants, Inc. (2007).



<sup>&</sup>lt;sup>2</sup> The total demand for the Fontana Water Company ranges from 44,000 acre-ft/yr in 2010 to 49,500 acre-ft/yr in 2030. However, part of this demand is met with imported water supplied from the Metropolitain Water District of Southern California (MWDSC). Therefore, the potable demand has been reduced by the amount met by imported water supplied from MWDSC.

<sup>3</sup> The Fontana Water Company is supplied imported water from both the Valley Water District and MWDSC. The values in this table only represent the amount of imported water supplied by the Valley Water District.

Appendix A-2

# Water Demand and Supply Plan for the West Valley Water District Service Area

	Nos	Potable	Surplus / Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Potable Surplus /	Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	Non Potable Supply	(acre-ft/yr)	1,360	1,506	1,652	1,798	1,944	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090
	Non-Potable	Recycled	Water from the Rialto WWTP	(acre-ft/yr)	0	146	292	438	584	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730	730
			backwash Water from WFF	(acre-ft/yr)	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360
		Ē	Lotal Potable Supply	(acre-ft/yr)	31,360	34,500	37,640	40,780	43,920	47,060	48,200	49,340	50,480	51,620	52,760	53,800	54,840	55,880	56,920	57,960	57,960	57,960	57,960	57,960	57,960
		,	Imported Water from the SWP	(acre-ft/yr)	2,860	4,000	5,140	6,280	7,420	8,560	8,600	8,640	8,680	8,720	8,760	8,800	8,840	8,880	8,920	8,960	8,960	8,960	8,960	8,960	8,960
Supplies		Surface	Water from Lytle Creek	(acre-ft/yr)	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
3,	ole		Riverside North Basin	(acre-ft/yr)	4,500	4,600	4,700	4,800	4,900	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
	Potable m Rialto Basin N		(acre-ft/yr)	4,500	4,900	5,300	5,700	6,100	6,500	008'9	7,100	7,400	7,700	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	
	Groundwater from Chino Basin		(acre-ft/yr)	0	0	0	0	0	0	200	400	009	800	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
		Ğ	Lytle Basin	(acre-ft/yr)	8,000	8,300	8,600	8,900	9,200	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500
			Bunker Hill Basin <sup>3</sup>	(acre-ft/yr)	000'9	7,200	8,400	009,6	10,800	12,000	12,600	13,200	13,800	14,400	15,000	16,000	17,000	18,000	19,000	20,000	20,000	20,000	20,000	20,000	20,000
		Total	Demand	(acre-ft/yr)	31,360	34,646	37,932	41,218	44,504	47,790	48,930	50,070	51,210	52,350	53,490	54,530	55,570	56,610	57,650	58,690	58,690	58,690	58,690	58,690	58,690
Demands			Potable	(acre-ft/yr)	1,360	1,506	1,652	1,798	1,944	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090	2,090
			Potable <sup>2</sup>	(acre-ft/yr)	30,000	33,140	36,280	39,420	42,560	45,700	46,840	47,980	49,120	50,260	51,400	52,440	53,480	54,520	55,560	56,600	56,600	56,600	56,600	56,600	56,600
			Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

<sup>&</sup>lt;sup>1</sup> Water Supply Plan obtained from Engineering Resources of Southern California, Inc. (2009).



<sup>&</sup>lt;sup>2</sup> Potable water demand includes both (1) sales of water to other agencies (Marygold Mutual Water Company) and (2) unaccounted for water.

<sup>&</sup>lt;sup>3</sup> Includes Bunker Hill-A groundwater purchased from the Valley Water District and delivered by the Baseline Feeder.

Appendix A-3

# Water Demand and Supply Plan for the City of Rialto Service $\operatorname{Area}^1$

		Non	Potable	Surplus / Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		:	Potable	Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Men Detable	Non-Fotable		Recycled Water from the Rialto WWTP	(acre-ft/yr)	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260
				Total Potable Supply	(acre-ft/yr)	13,300	13,420	13,540	13,660	13,780	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900
				Imported Water from the SWP	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Surface	Water from Lytle Creek	(acre-ft/yr)	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Supplies	Datable	rable		Riverside North Basin	(acre-ft/yr)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
	D		и	Rialto Basin	(acre-ft/yr)	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
			Groundwater from	Chino Basin	(acre-ft/yr)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
		(	5	Lytle Basin	(acre-ft/yr)	4,000	4,020	4,040	4,060	4,080	4,100	4,000	3,900	3,800	3,700	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
				Bunker Hill Basin <sup>2</sup>	(acre-ft/yr)	4,000	4,100	4,200	4,300	4,400	4,500	4,600	4,700	4,800	4,900	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
			F	lotal Demand	(acre-ft/yr)	15,560	15,680	15,800	15,920	16,040	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160	16,160
Demands			,	Non Potable	(acre-ft/yr)	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260
				Potable	(acre-ft/yr)	13,300	13,420	13,540	13,660	13,780	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900	13,900
				Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030



<sup>&</sup>lt;sup>1</sup> Water Supply Plan adapted from GEI Consultants, Inc. (2007).
<sup>2</sup> Includes Bunker Hill-A groundwater purchased from the Valley Water District and delivered by the Baseline Feeder.

 ${\bf Appendix} \ A-4$  Water Demand and Supply Plan for the City of Colton Service  ${\bf Area}^1$ 

		Non Potable	Surplus / Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Potable	Surplus / Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Non-Potable		Recycled Water Available for Use	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Total Potable Supply	(acre-ft/yr)	13,500	13,780	14,060	14,340	14,620	14,900	15,140	15,380	15,620	15,860	16,100	16,360	16,620	16,880	17,140	17,400	17,400	17,400	17,400	17,400	17,400
			Imported Water from the SWP	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Supplies	Potable		Riverside North Basin	(acre-ft/yr)	2,400	2,460	2,520	2,580	2,640	2,700	2,740	2,780	2,820	2,860	2,900	2,940	2,980	3,020	3,060	3,100	3,100	3,100	3,100	3,100	3,100
	Pot	Groundwater from	Colton Basin	(acre-ft/yr)	1,025	1,045	1,065	1,085	1,105	1,125	1,145	1,165	1,185	1,205	1,225	1,245	1,265	1,285	1,305	1,325	1,325	1,325	1,325	1,325	1,325
		Groundw	Rialto Basin	(acre-ft/yr)	3,075	3,135	3,195	3,255	3,315	3,375	3,435	3,495	3,555	3,615	3,675	3,735	3,795	3,855	3,915	3,975	3,975	3,975	3,975	3,975	3,975
			Bunker Hill Basin	(acre-ft/yr)	7,000	7,140	7,280	7,420	7,560	7,700	7,820	7,940	8,060	8,180	8,300	8,440	8,580	8,720	8,860	00066	9,000	9,000	0,000	0,000	9,000
			Total Demand	(acre-ft/yr)	13,500	13,780	14,060	14,340	14,620	14,900	15,140	15,380	15,620	15,860	16,100	16,360	16,620	16,880	17,140	17,400	17,400	17,400	17,400	17,400	17,400
Demands			Non Potable	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Potable	(acre-ft/yr)	13,500	13,780	14,060	14,340	14,620	14,900	15,140	15,380	15,620	15,860	16,100	16,360	16,620	16,880	17,140	17,400	17,400	17,400	17,400	17,400	17,400
			Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

 $^{\rm 1}\,\rm Water$  Supply Plan adapted from GEI Consultants, Inc. (2007).



Appendix A-5 Water Demand and Supply Plan for the East Valley Water District Service Area  $^{\rm 1}$ 

	Non Dotable	Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Detable	Surplus /	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Non-Potable	Recycled Water Available for Use	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total Potable Supply	(acre-ft/yr)	31,400	31,960	32,520	33,080	33,640	34,200	34,540	34,880	35,220	35,560	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900
Supplies		Imported Water from the SWP	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Potable	Surface Water from the Santa Ana River	(acre-ft/yr)	4,710	4,794	5,854	6,059	6,162	6,264	6,327	6,389	6,451	6,514	6,576	6,576	6,576	6,576	6,576	6,576	6,576	6,576	6,576	6,576	6,576
	Groundwater from the Bunker Hill Si		(acre-ft/yr)	26,690	27,166	26,666	27,021	27,478	27,936	28,213	28,491	28,769	29,046	29,324	29,324	29,324	29,324	29,324	29,324	29,324	29,324	29,324	29,324	29,324
		Total Demand	(acre-ft/yr)	31,400	31,960	32,520	33,080	33,640	34,200	34,540	34,880	35,220	35,560	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900
Demands	Demands Non Potable		(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Potable		(acre-ft/yr)	31,400	31,960	32,520	33,080	33,640	34,200	34,540	34,880	35,220	35,560	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900	35,900
		Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

<sup>&</sup>lt;sup>1</sup> Water Supply Plan adapted from GEI Consultants, Inc. (2007) and Lilburn Corporation, (2005). Plan was verified with EVWD's Engineering Staff.



Appendix A-6 Water Demand and Supply Plan for the City of Loma Linda Service Area  $^{\rm 1}$ 

		Demands			Supl	Supplies			
					Potable		Non-Potable	;	;
Ā	Potable	Non Potable	Total Demand	Groundwater from the Bunker Hill Basin <sup>2,3</sup>	Imported Water from the SWP	Total Potable Supply	Recycled Water Available for Use	Potable Surplus / Shortfall	Non Potable Surplus / Shortfall
(ac	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)
	6,445	0	6,445	6,445	0	6,445	0	0	0
	6,653	0	6,653	6,653	0	6,653	0	0	0
	6,861	0	6,861	6,861	0	6,861	0	0	0
	7,068	0	7,068	7,068	0	7,068	0	0	0
	7,276	0	7,276	7,276	0	7,276	0	0	0
	7,484	0	7,484	7,484	0	7,484	0	0	0
. `	7,692	0	7,692	7,692	0	7,692	0	0	0
. `	7,899	0	7,899	7,900	0	7,900	0	0	0
~	8,107	0	8,107	8,107	0	8,107	0	0	0
~	8,315	0	8,315	8,315	0	8,315	0	0	0
	8,523	0	8,523	8,523	0	8,523	0	0	0
~	8,730	0	8,730	8,731	0	8,731	0	0	0
~	8,938	0	8,938	8,938	0	8,938	0	0	0
	9,146	0	9,146	9,146	0	9,146	0	0	0
	9,353	0	9,353	9,353	0	9,353	0	0	0
	9,561	0	9,561	9,561	0	9,561	0	0	0
٥,	69,769	0	692,6	692,6	0	692,6	0	0	0
	9,977	0	726,6	726,6	0	726,6	0	0	0
	10,184	0	10,184	10,184	0	10,184	0	0	0
1	10,392	0	10,392	10,392	0	10,392	0	0	0
1	10,600	0	10,600	10,600	0	10,600	0	0	0

<sup>&</sup>lt;sup>1</sup> Water Supply Plan obtained from GEI Consultants, Inc. (2007) and Engineering Resources of Southern California, Inc. (2006b). Plan was verified by the City of Loma Linda Engineering Staff.

<sup>&</sup>lt;sup>3</sup> Several wells in the Loma Linda service area are considered non-potable due to nitrate, fluoride, or arsenic concentrations. These wells are used to meet demands of dedicated irrigation accounts.



 $<sup>^2\,\</sup>mathrm{Pumping}$  from the Bunker Hill Basin is only limited by well and/or reservoir capacity.

 $\label{eq:Appendix A-7} \mbox{Water Demand and Supply Plan for the City of Redlands Service Area} \ ^1$ 

		Non	Potable Surplus / Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Potable	Surplus / Shortfall	(acre-ft/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Non-Potable		Recycled Water from Redlands WWTP	(acre-ft/yr)	4,223	4,384	4,546	4,707	4,869	5,031	5,192	5,354	5,516	5,677	5,839	5,900	5,962	6,024	6,085	6,147	6,209	6,270	6,332	6,393	6,455
			Total Potable Supply	(acre-ft/yr)	38,094	39,082	40,069	41,057	42,044	43,032	44,019	45,007	45,994	46,982	47,970	49,057	50,145	51,232	52,320	53,407	54,495	55,582	56,670	57,758	58,845
			Imported Water from the SWP		1,524	1,563	1,603	1,642	1,682	1,721	1,761	1,800	1,840	1,879	1,919	1,962	2,006	2,049	2,093	2,136	2,180	2,223	2,267	2,310	2,354
Supplies	Potable	Surface Water from	Mill Creek	(acre-ft/yr)	6,857	7,035	7,212	7,390	7,568	7,746	7,923	8,101	8,279	8,457	8,635	8,830	9,026	9,222	9,418	9,613	608'6	10,005	10,201	10,396	10,592
	Potz	Surface W	Santa Ana River	(acre-ft/yr)	10,285	10,552	10,819	11,085	11,352	11,619	11,885	12,152	12,419	12,685	12,952	13,245	13,539	13,833	14,126	14,420	14,714	15,007	15,301	15,595	15,888
		ater from	Yucaipa Basin	(acre-ft/yr)	381	391	401	411	420	430	440	450	460	470	480	491	501	512	523	534	545	556	292	578	588
		Groundwater from	Bunker Hill Basin	(acre-ft/yr)	19,047	19,541	20,035	20,528	21,022	21,516	22,010	22,503	22,997	23,491	23,985	24,529	25,072	25,616	26,160	26,704	27,247	27,791	28,335	28,879	29,423
			Total Demand	(acre-ft/yr)	42,317	43,466	44,615	45,764	46,913	48,063	49,212	50,361	51,510	52,659	53,808	54,958	56,107	57,256	58,405	59,554	60,703	61,853	63,002	64,151	65,300
Demands			Non Potable <sup>2</sup>	(acre-ft/yr)	4,223	4,384	4,546	4,707	4,869	5,031	5,192	5,354	5,516	5,677	5,839	5,900	5,962	6,024	6,085	6,147	6,209	6,270	6,332	6,393	6,455
			Potable	(acre-ft/yr)	38,094	39,082	40,069	41,057	42,044	43,032	44,019	45,007	45,994	46,982	47,970	49,057	50,145	51,232	52,320	53,407	54,495	55,582	56,670	57,758	58,845
			Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

<sup>&</sup>lt;sup>1</sup> Water Supply Plan adapted from Total Dissolved Solids and Nitrogen Projections for the Bunker Hill-B Management Zone (WEI, 2009.).

20100824 Section 4 Tables.xls -- Redlands, City of 8/24/2010



 $<sup>^2</sup>$  XXXX

 ${\bf Appendix \ A-8}$  Water Demand and Supply Plan for Other Private/Mutual Water Companies that Rely on SBBA  $^1$ 

	Demand		Sup	plies		
			Pot	able		
Year	Total Potable Demand	Groundwater from the Bunker Hill Basin	Groundwater from the Lytle Basin	Surface Water from Mill Creek	Total Potable Supply	Potable Surplus / Shortfall
	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)
2010	22,300	15,900	2,100	4,300	22,300	0
2011	22,240	15,840	2,100	4,300	22,240	0
2012	22,180	15,780	2,100	4,300	22,180	0
2013	22,120	15,720	2,100	4,300	22,120	0
2014	22,060	15,660	2,100	4,300	22,060	0
2015	22,000	15,600	2,100	4,300	22,000	0
2016	21,940	15,540	2,100	4,300	21,940	0
2017	21,880	15,480	2,100	4,300	21,880	0
2018	21,820	15,420	2,100	4,300	21,820	0
2019	21,760	15,360	2,100	4,300	21,760	0
2020	21,700	15,300	2,100	4,300	21,700	0
2021	21,640	15,240	2,100	4,300	21,640	0
2022	21,580	15,180	2,100	4,300	21,580	0
2023	21,520	15,120	2,100	4,300	21,520	0
2024	21,460	15,060	2,100	4,300	21,460	0
2025	21,400	15,000	2,100	4,300	21,400	0
2026	21,340	14,940	2,100	4,300	21,340	0
2027	21,280	14,880	2,100	4,300	21,280	0
2028	21,220	14,820	2,100	4,300	21,220	0
2029	21,160	14,760	2,100	4,300	21,160	0
2030	21,100	14,700	2,100	4,300	21,100	0

<sup>&</sup>lt;sup>1</sup> Private/Mutual Water Companies that Rely on SBBA include the Muscoy Mutual Water Company, Marygold Mutual Water Company, Terrace Water Company, Riverside Highlands Water Company, Baseline Water Company, and Eastwood Farms, among others. The demand and supply data was adapted from the Upper Santa Ana Watershed Integrated Regional Water Plan.



 ${\bf Appendix\ A-9}$  Water Demand for Plaintiffs of the Western Judgment that Export from the SBBA  $^1$ 

		Ex	kport	
	Groun	dwater		
Year	From the Bunker Hill Basin	From the Lytle Creek Basin	Surface Water Diversions From Lytle Creek	Total Water Exported from the SBBA
	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)	(acre-ft/yr)
2010	62,300	2,500	0	64,800
2011	62,300	2,500	0	64,800
2012	62,300	2,500	0	64,800
2013	62,300	2,500	0	64,800
2014	62,300	2,500	0	64,800
2015	62,300	2,500	0	64,800
2016	62,300	2,500	0	64,800
2017	62,300	2,500	0	64,800
2018	62,300	2,500	0	64,800
2019	62,300	2,500	0	64,800
2020	62,300	2,500	0	64,800
2021	62,300	2,500	0	64,800
2022	62,300	2,500	0	64,800
2023	62,300	2,500	0	64,800
2024	62,300	2,500	0	64,800
2025	62,300	2,500	0	64,800
2026	62,300	2,500	0	64,800
2027	62,300	2,500	0	64,800
2028	62,300	2,500	0	64,800
2029	62,300	2,500	0	64,800
2030	62,300	2,500	0	64,800

<sup>&</sup>lt;sup>1</sup> Plantiffs of the Western Judgment include City of Riverside, Meeks & Daley Water Company, Riverside Highland Water Company, and the University of California Regents.







San Bernardino Municipal Water Department

2010 RECYCLED WATER FEASIBILITY INVESTIGATION
RECYCLED WATER ALTERNATIVES EVALUATION
TECHNICAL MEMORANDUM NO. 1
FINAL
July 2010



#### **San Bernardino Municipal Water Department**

#### 2010 RECYCLED WATER FEASIBILITY INVESTIGATION

#### **RECYCLED WATER ALTERNATIVES EVALUATION**

#### **TECHNICAL MEMORANDUM**

NO. 1

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#### RECYCLED WATER ALTERNATIVES EVALUATION

#### 1.0 INTRODUCTION

The San Bernardino Municipal Water Department (SBMWD) is evaluating the use of recycled water in its service area. The proposed Clean Water Factory (CWF) will treat effluent from the San Bernardino Water Reclamation Plant (SBWRP) to a quality approved for groundwater recharge as set by Title 22 through the California Department of Public Health (CDPH) and the Santa Ana Regional Water Quality Control Board (RWQCB). This facility will treat and convey recycled water to the Waterman Basins and the East Twin Creek Spreading Grounds for surface spreading. Recycled water spread at these facilities will recharge the Bunker Hill Groundwater Basin (Bunker Hill Basin) and, more specifically, the Bunker Hill A Management Zone, as described in the Water Quality Control Plan for the Santa Ana River Watershed (Basin Plan). Diluent water for the groundwater recharge reuse project (GRRP) to meet CDPH requirements will be provided by natural stormwater flow and imported State Water Project water.

#### 2.0 PURPOSE

The purpose of this technical memorandum (TM) is to evaluate several treatment train alternatives for the production of reuse water at the SBWRP. The TM includes a description and cost estimate of treatment trains designed to produce water for two potential uses:

1) Title 22 water for the irrigation of local fields, golf courses, cemeteries, etc., and 2) GRRP quality water for the Waterman and East Twin Creek Spreading Grounds to recharge the Bunker Hill Basin. In addition, this TM presents plant layouts, at various phases, to determine the space requirements for future facilities.

#### 3.0 REGULATORY REQUIREMENTS FOR RECYCLED WATER

The regulatory requirements for recycled water are summarized in the following sections. For a more detailed description of recycled water regulations see Appendix A.

#### 3.1 Recycled Water for Irrigation – Title 22

Recycled water used for irrigation of parks, schoolyards, and golf courses shall be "disinfected tertiary recycled water" and must meet the following criteria:

- 1. Process includes a chlorine disinfection process following filtration that provides a contact time (CT) value of not less than 450 mg-min/L at all times, with a modal CT of at least 90 minutes based on peak dry weather design flow.
- 2. The median concentration of total coliform bacteria measured in the disinfected effluent must not exceed a most probable number (MPN) of 2.2 per 100 mL utilizing

the bacteriological results of the last 7 days for which analyses have been completed. Also, the number of total coliform bacteria must not exceed an MPN of 23 per 100 mL in more than one sample in any 30-day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 mL.

- Process includes media filtration with a peak filter loading rate less than or equal to the approved loading rate. For cloth media filtration, the peak loading rate shall not exceed 6 gpm/ft<sup>2</sup>.
- 4. The turbidity of the filtered wastewater shall not exceed any of the following:
  - a. An average of 2 nephelometric turbidity unit (NTU) within a 24-hour period.
  - b. 5 NTU more than 5 percent of the time within a 24-hour period.
  - c. 10 NTU at any time.

#### 3.2 Recycled Water for Groundwater Recharge

Regulations for using recycled water for groundwater recharge are significantly different from those for irrigation use. Since the groundwater basins are used for potable purposes, the regulations are designed to protect the beneficial uses of each specific aquifer.

- 1. Control of Pathogenic Organisms:
  - a. The recycled water must meet the requirements of disinfected tertiary recycled water (defined above) – 450 CT or 5-log virus reduction; and the total coliform limits.
  - b. The aquifer must allow for a minimum 6-month retention time of the water underground before it is extracted as a drinking water supply from the closest well.
  - c. The GRRP must demonstrate within 3 months of commencing operation that the minimum retention time to the closest drinking water well has been met.
- 2. Control of Nitrogen Compounds:
  - a. Sets a low average concentration of total nitrogen (5 mg/L) and sampling twice weekly, with the rationale that if the recycled water is applied at this concentration then there is very little chance of the drinking water maximum contaminant level (MCL) for nitrogen dioxide (NO2) or nitrate (NO3) ever being exceeded.
  - b. Sets a maximum total nitrogen limit of 10 mg/L with more intensive sampling, with the rationale that the low limit of total nitrogen will result in a low risk of exceeding a drinking water MCL.
  - c. Control of Total Organic Carbon (TOC):
- 3. Due to the fact that recycled water contains organic material that originated from wastewater, CDPH's approach is to limit the amount of recycled water TOC that enters a groundwater basin. This is done by setting a Recycled Water Contribution

(RWC) value for each GRRP. The RWC is the amount of recycled water applied at the GRRP divided by the total amount of water recharged into the basin (recycled water plus diluent water). Diluent water is defined as water that does not contain organic material of wastewater origin. Examples of diluent water include raw surface water, groundwater, and stormwater.

#### 4. Control of Emerging Contaminants:

a. Standards for these compounds do not yet exist and it is anticipated that it will be some time before such standards are established. Each GRRP is to propose a monitoring program for emerging contaminants. These include endocrine disrupting compounds (EDCs) and pharmaceuticals and personal care products (PPCPs). Work is being done in this area to identify surrogates that can be used to monitor the most critical compounds in the vast array of existing chemicals that fall into this category.

#### 5. Source Control:

a. A source control program needs to be in place to regulate contaminants entering the sewer system.

#### 4.0 RAW WATER QUALITY

The proposed CWF would treat either primary or secondary effluent from the SBWRP, depending on the selected alternative. A summary of the historical water quality data used as a basis in the preliminary analysis is shown in Table 1.1.

Table 1.1 Summary of Plant Historical I	Data Used as Basis fo	or Analysis
	Primary Effluent	Secondary Effluent
Total Suspended Solids (TSS), mg/L	90	2
Total Dissolved Solids (TDS), mg/L	560	510
Biochemical Oxygen Demand (BOD), mg/L	200	16
Ammonia, mg/L	30	5
Silica, mg/L <sup>(1)</sup>	27 <sup>(2)</sup>	27
TOC, mg/L	42 <sup>(3)</sup>	10-12 <sup>(3)</sup>

#### Notes:

- 1. Silica will limit the recovery of the reverse osmosis (RO) membrane process and is critical to determining the overall system recovery.
- 2. Silica is not typically analyzed in primary effluent, but is expected to be similar to secondary effluent quality.
- TOC data is not available. Values shown are based on data from the Orange County Sanitation District.

#### 5.0 DEVELOPMENT OF TREATMENT ALTERNATIVES

#### 5.1 Phasing of Clean Water Factory Projects

In this report, it is assumed that the CWF would be built in three phases. For each alternative, Phase I would include building a basin recharge water treatment system with a capacity of 5 mgd and an irrigation water treatment system with a capacity of 3.0 mgd. Phase I would also install the infrastructure, such as buildings and yard piping, for the ultimate capacity of each alternative. For example, the RO building would be built in Phase I to house the RO units that would be installed in Phases II and III. Phase II would increase the basin recharge treatment system capacity by 5 mgd, and Phase III would further increase the basin recharge treatment system capacity to its ultimate capacity. It is assumed that the ultimate capacity of the irrigation water system is 3.0 mgd and that it would not be expanded in Phases II or III.

#### 5.2 Identification of Alternatives

Several treatment alternatives have been indentified for the production of recycled water at the SBWRP and include the following:

- Treatment Alternative A (Conventional Title 22 Tertiary Treatment):
   A process flow diagram (PFD) of Alternative A is presented on Figure 1.1.
   Alternative A consists of tertiary filtration (cloth filters) followed by disinfection to meet Title 22 recycled water standards. Secondary effluent would be obtained from an existing splitter box at the plant.
- 2. Treatment Alternative B (Microfiltration/Reverse Osmosis (MF/RO) Advanced Treatment):

A PFD of Alternative B is presented on Figure 1.2. As shown, a portion of SBWRP secondary effluent would be treated using the advanced treatment process and would be used for groundwater recharge. For this alternative, additional secondary effluent would be treated in a parallel train to produce Title 22 irrigation water.

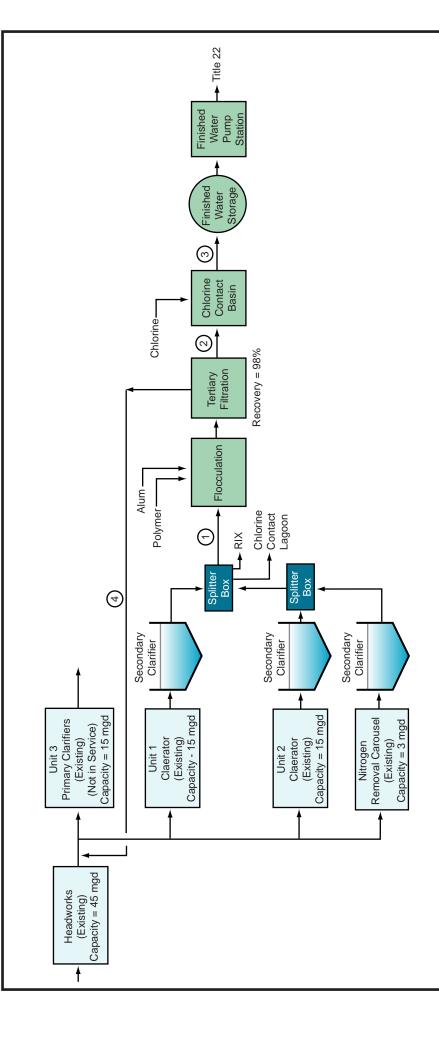
3. Treatment Alternative C (Membrane Bioreactor/Reverse Osmosis (MBR/RO) Advanced Treatment):

A PFD of Alternative C is presented on Figure 1.3. This alternative is similar to Alternative B in that it produces two different qualities of water, one for irrigation and the other for recharge. The difference between Alternatives B and C is that Alternative C adds secondary treatment capacity with a MBR instead of treating secondary effluent from the existing facility.

4. Treatment Alternative D (Integrated Membrane Anaerobic Stabilization (IMANS®) Advanced Treatment):

A PFD of Alternative D is presented on Figure 1.4. As shown, the *IMANS*<sup>®</sup> process eliminates the need for secondary effluent treatment by using MF to filter the primary effluent ahead of the RO process. As with the other advanced treatment alternatives, Alternative D would treat a portion of the secondary effluent for irrigation in a parallel tertiary filtration process train.





### TREATMENT PFD CONVENTIONAL **ALTERNATIVE A**

10-12

10-12

10-12

10-12

TOC (mg/L)

2

Ammonia (mg/L)

2

Backwash Filter

Effluent

Effluent Filter

Secondary Effluent

Description

Flow Rate (mgd) Flow Rate (gpm)

Stream Number

Final

200

10,200

10,200

10,400 15.0

0.3

14.7

14.7

510 400

510

510 7

510

N

Total Suspended Solids (mg/L) Total Dissolved Solids (mg/L) ω 4

ω 2

16

Biochemical Oxygen Demand (mg/L)

9

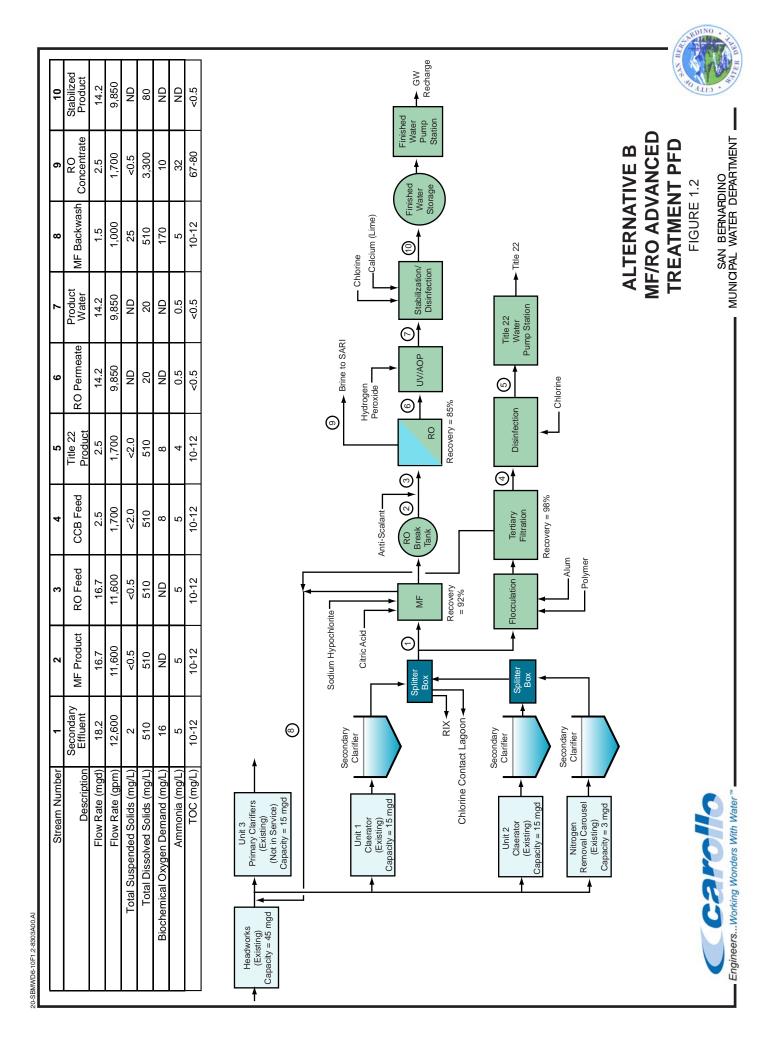
 $\frac{7}{2}$ 

FIGURE 1.1

SAN BERNARDINO
MUNICIPAL WATER DEPARTMENT











## **MBR/RO ADVANCED** TREATMENT PFD **ALTERNATIVE C**

 ↓
 GW

 Recharge

Water Pump Station Finished

Water Storage

9

Calcium (Lime) Chlorine-

Hydrogen Peroxide-

. Anti-Scalant

Recovery = 85%

Sodium Hypochlorite —

Citric Acid -

Stabilization

UV/AOP

**⊚** 

RO

(2)

RO Break Tank

MBR

Unit 3
Primary Clarifiers
(Existing)
Capacity = 15 mgd

(Existing) Capacity = 45 mgd Headworks

ΘÎ

Brine to SARI

**⊕** 

 ▼ Title 22

Title 22 Water Pump Station

Disinfection

Tertiary Filtration

Flocculation

Alum | Polymer — Chlorine

Recovery = 98%

─► Chlorine Contact Lagoon

Splitter Box

Secondary Clarifier

> Nitrogen Removal Carousel (Existing) Capacity = 3 mgd

Capacity = 15 mgd

Unit 2 Claerator (Existing)

Secondary Clarifier

\<u>\</u>

Secondary Clarifier

Unit 1
Claerator
(Existing)
Capacity = 15 mgd

FIGURE 1.3

9	Stabilized Product	14.2	9,850	ND	80	ND	ND	<0.5
5	RO Concentrate	2.5	1,700	4	3,600	14	17	67-80
4	Product Water	14.2	9,850	ND	20	ND	0.1	<0.5
3	RO Permeate	14.2	9,850	ΠN	20	ΩN	0.1	<0.5
7	RO Feed	16.7	11,600	<0.5	260	5	3	10-12
1	Primary Effluent	16.7	11,600	90	560	200	30	42
Stream Number	Description	Flow Rate (mgd)	Flow Rate (gpm)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Biochemical Oxygen Demand (mg/L)	Ammonia (mg/L)	TOC (mg/L)

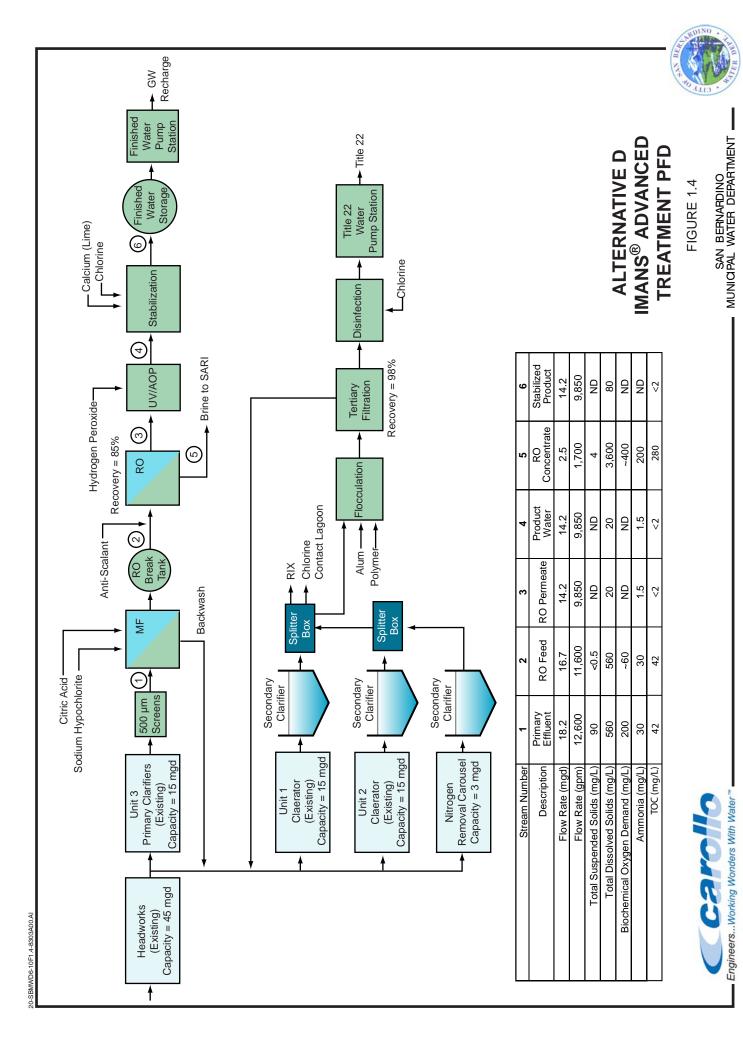
	<0.5	
•	10-12	
99	42	
(3;	TOC (mg/L)	

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The following sections discuss the various treatment technologies.

#### 5.3 Conventional Treatment Process Description

Conventional tertiary treatment has been identified as a potential process for the CWF to produce Title 22 water. These processes are described in the following sections.

#### 5.3.1 <u>Tertiary Filtration</u>

Tertiary filters are designed to remove TSS from secondary effluent. There are several filter media options available including fine sand, dual-media (anthracite/sand), upflow sand filters (e.g., DynaSand<sup>®</sup>), and cloth filters. For this evaluation, cloth filters were selected and are discussed in more detail below.

Figure 1.5 shows a section of a typical AquaDisk® cloth-disk filter unit. The AquaDisk® unit is available in either 6- or 12-disk units that are completely submerged. Liquid passes through the cloth media in an outside-in mode (by gravity) and entrained solids collect on the cloth filter surface. These solids will lead to head loss across the cloth filter, resulting in rising water levels within the cloth filter tank. At a predetermined tank water level or time, the backwash cycle is initiated and the solids are removed by a stationary backwash suction head, as shown on Figure 1.5. The suction head behaves similar to a vacuum cleaner; a manifold creates suction to force filtrate back through a small portion of the filter panels from both sides of each disk, removing solids. The disks rotate at 1 rpm during cleaning to allow the entire surface of the filter panels to be cleaned. The disks are cleaned in multiples of two, and one backwash cycle takes 6 minutes for a 12-disk unit. During the backwash cycles, filtration continues. The cloth disks are stationary except during the backwash cycle. There are two 2-hp backwash pumps and one 0.75-hp shaft driver for each unit. Backwash valves and motors are controlled automatically.

The CDPH has established a maximum loading rate of 6.0 gpm/ft<sup>2</sup> for cloth filter operation. However, typical design loading rates would be around 3.25 gpm/ft<sup>2</sup>. At this loading rate, the 6- and 12-disk units will have treatment capacities of 1.5 and 3.0 mgd, respectively.

#### 5.3.2 Chlorine Disinfection

In order to meet Title 22 standards for recycled water for irrigation use, the recycled water must be considered "disinfected tertiary recycled water." Typically, a chlorine disinfection process following filtration is sufficient to meet Title 22 irrigation water standards. Chlorine disinfection is a chemical process that targets cell membranes and nucleic acids, altering transport across the membrane and causing cell lysis, effecting irreversible damage to the DNA. Title 22 regulations specify that the chlorine contact basins (CCBs) provide a CT value of not less than 450 mg-min/L at all times, which is based on assumed presence of mono-chloramines as the disinfecting agent, with a modal CT of at least 90 minutes based on peak dry weather design flow.







Influent —

## 12-DISK CLOTH FILTER SCHEMATIC

FIGURE 1.5

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Backwash



#### 5.4 Advanced Treatment Process Description

Several advanced treatment alternatives have been identified as a potential process for the CWF. These processes are described in the following sections.

#### 5.4.1 <u>Membrane Bioreactor</u>

The MBR process combines conventional biological treatment with the use of membranes for separation of solid and liquid phases. The MBR treatment train is similar to the conventional activated sludge (CAS) process except that membranes replace secondary clarifiers and tertiary filters. Figure 1.6 shows a process schematic for the MBR process.

In the MBR process, mixed liquor suspended solids (MLSS) can be increased beyond what is possible in CAS systems. Typically, MBR systems operate at MLSS concentrations in the range of 8,000 to 10,000 mg/L, compared with a value of around 2,500 to 3,000 mg/L in CAS systems. Higher MLSS provides the benefit of greater treatment capacity per unit volume of aeration basin. However, higher MLSS concentrations result in solids buildup near the membrane surface, which reduces flow through the membranes. To minimize this effect, membrane agitation air is introduced to scour the membrane surface. This air, which is usually in addition to process air requirements, increases the total air needed for treatment, and therefore increases the operating costs.

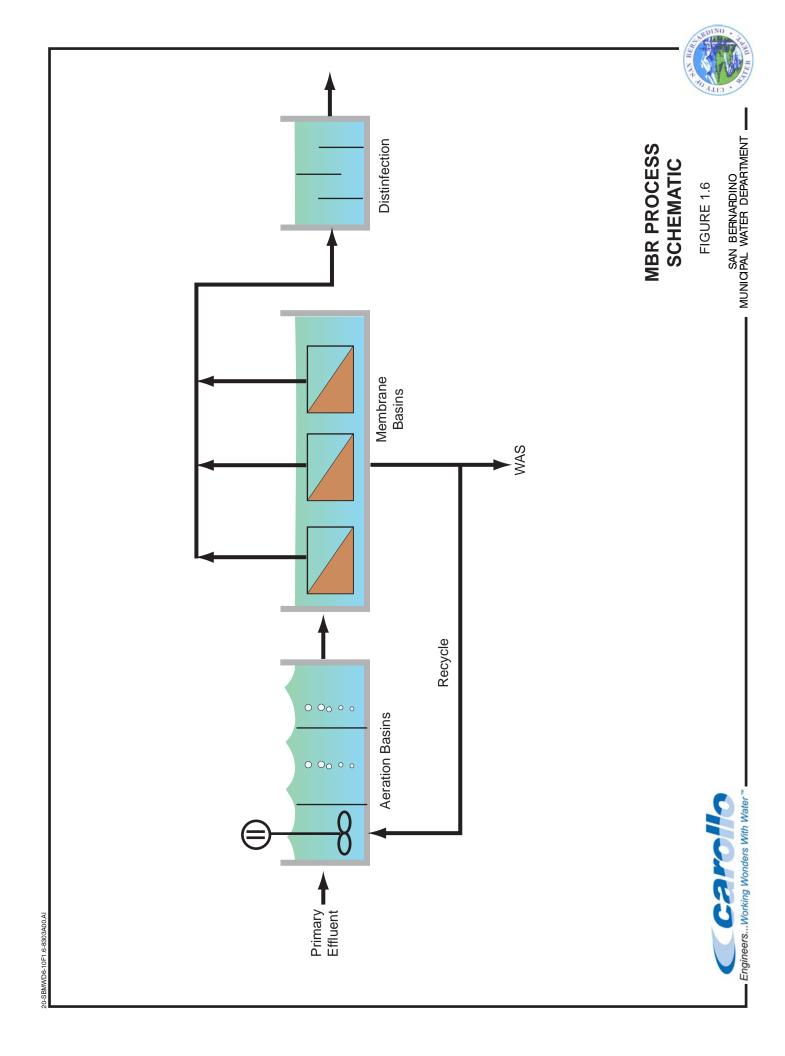
Because the MBR process incorporates a membrane barrier, it produces a low-turbidity effluent that is less affected by changes in feed water quality. Another benefit is that the effluent TSS concentration is low enough that tertiary filtration is not required. Therefore, the MBR process produces a high-quality effluent and can be used as pretreatment for RO.

One consideration of the MBR process is additional screening requirements required by MBR systems to protect the membranes through the removal of abrasive solids and hair. This is accomplished using fine screens with openings in the range of 1 to 2 mm for hollow fiber systems, and around 3 mm for flat sheet membrane systems. Abrasive solids can wear through membrane fibers and cause failures, while hair wraps around fibers, causes clumping of the mixed liquor, and is difficult to remove.

Even with air agitation, membranes lose their water permeability (flux rate) with time and require periodic cleaning. Most MBR systems include regular relaxing (zero flux) or back pulsing (using permeate to dislodge accumulated solids). Depending on operating conditions, a chemical clean may be required every 3 to 6 months. Chemical cleaning typically involves taking the membrane off-line and submerging them in a solution of either sodium hypochlorite (to remove biological fouling) or citric acid (to remove lime scale) for several hours.

There are a multitude of MBR membrane configurations available today. Each is different and requires a different mechanical configuration and has different cleaning needs. These systems are typically not interchangeable and, therefore, selection of a preferred supplier is usually made early on in the design process.







### 5.4.2 <u>Microfiltration/Ultrafiltration</u>

MF (and ultrafiltration (UF)) membranes are an efficient technology for particle removal and pathogen control either in a pressurized or submerged configuration. For the former, water is pumped through the membranes in modules or cartridges. In the latter form, membranes are submerged in tanks and water is pulled through the membranes by vacuum. Overall, membrane filtration provides a near absolute barrier to suspended solids and microorganisms with average pore sizes ranging from less than 0.1 (for UF systems) to 0.5 microns. MF and UF are typically applied in a tertiary filtration application to replace conventional media and/or cloth filters. However, MF and UF can also be applied directly on primary effluent as in the case of the *IMANS*® configuration. As in the case of MBR membrane systems, MF/UF systems vary from manufacturer to manufacturer and membrane elements are generally not interchangeable.

For this analysis, pressurized MF membranes were used as they generally provide greater efficiency and lower operating costs at this flow range. As water is pushed through the membranes using feed pumps, the suspended solids and microorganisms are retained on the outside of the membrane. MF finished water turbidities will be consistently below 0.1 NTU, independent of feed water quality. Due to high-quality effluent produced, MF has been shown to be the preferred pretreatment for RO systems treating wastewater. A schematic of the MF process is presented on Figure 1.7, which illustrates both the outside-in filtration configuration (most common) and the inside-out configuration.

### 5.4.3 Reverse Osmosis

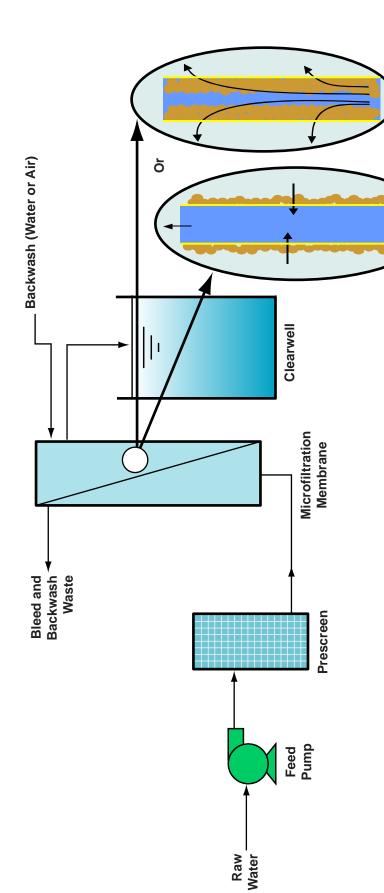
High-pressure membrane processes, such as RO, are typically used for the removal of dissolved constituents including both inorganic and organic compounds. RO is a process in which the mass-transfer of ions through membranes is diffusion controlled. The feed water is pressurized, forcing water through the membranes concentrating the dissolved solids that cannot pass through the membrane. Consequently, these processes can remove salts, hardness, synthetic organic compounds, disinfection by-product precursors, etc. However, dissolved gases such as hydrogen sulfide (H<sub>2</sub>S) and carbon dioxide, and neutral low molecular weight molecules, pass through RO membranes. The rejection by the RO membranes (removal efficiency) is not the same for all dissolved constituents, and is influenced by molecular weight, charge, and other factors.

RO is considered a high-pressure process because it operates from 75 to 1,200 psig, depending upon the TDS concentration of the feed water. Typical operating pressure in a wastewater application is in the range of 150 to 250 psi. Recoveries for RO plants operating on domestic wastewater are around 85 percent depending on the type and concentrations of sparingly soluble salts (calcium sulfate, calcium carbonate, calcium phosphate, silica, etc.) in the feed water. Silica can permanently scale RO membranes when its concentration in the process exceeds about 100 to 120 mg/L. In wastewater applications, calcium phosphate can often be the salt controlling overall recovery.



Inside-Out Configuration

Outside-In Configuration







Given the TDS of SBWRP, the estimated feed pressure for the RO system will be in the range of 200 to 225 psi. In addition, initial modeling results indicate a recovery of 85 percent is possible given the levels of silica and other scaling compounds in the wastewater stream (based on historical data).

One of the issues with the RO process is discharge of the concentrate stream. The TDS removed from the feed water is concentrated in the brine stream and needs to be disposed. At SBWRP, the obvious brine disposal route the brine would be to the Santa Ana Regional Interceptor (SARI) line, which has a connection point at the plant. Initial modeling projections indicate brine stream TDS under this application will be around 3,600 mg/L.

### 5.4.4 <u>Ultraviolet Advanced Oxidation Process with Peroxide</u>

When hydrogen peroxide  $(H_2O_2)$  is exposed to ultraviolet (UV) light it reacts to form hydroxyl radicals that are high-energy, highly reactive molecules that attack chemical bonds of organic molecules and oxidize them. Combining UV with  $H_2O_2$  is called an Advanced Oxidation Process (AOP). Other AOP approaches that result in hydroxyl radical formation include the use of ozone with UV, and ozone with  $H_2O_2$ . It has been found that hydroxyl radicals are able to oxidize certain constituents or chemicals of emerging concern (CECs) such as certain endocrine disrupting compounds, PPCPs, and other microconstituents such as 1,4-dioxane and NDMA that can be found in wastewater effluents.

In the UV/AOP process (UV plus  $H_2O_2$ ) the UV dose required to break down the  $H_2O_2$  is significantly greater than that required for typical disinfection (50 to 100 mJ/cm<sup>2</sup> for disinfection compared with 400 to 500 mJ/cm<sup>2</sup> for radical formation). Thus, a UV/AOP process provides both a disinfection barrier as well as a microconstituent barrier.

In GRRP systems, the regulations require that for surface applications (as planned for the CWF project) proposing an initial recycled water contribution of 50-percent both RO and AOP must be provided to the entire recycled water flow, and the AOP must provide at least 1.2 log NDMA reduction and 0.5 log 1,4-dioxane reduction.

As previously mentioned, the direction with respect to control of CECs in GRRP water is still being decided but may result in other specific contaminant targets for the AOP system.

### 5.5 Description of Alternatives

The following sections discuss treatment alternatives identified above in more detail.

### 5.5.1 <u>Treatment Alternative A - Conventional Tertiary Treatment</u>

Treatment Alternative A consists of a conventional tertiary treatment train for the production of Title 22 water. The water produced would be used for both irrigation and basin recharge. For this alternative, secondary effluent from the existing SBWRP would be further treated to tertiary (Title 22) standards. The tertiary treatment trains would consist of tertiary filtration followed by chlorine disinfection as shown on Figure 1.1. Title 22 also requires the plant to

have the ability to add coagulant chemicals (typically alum and polymer) ahead of the tertiary filtration. This addition could be achieved in a flocculation basin, as shown on Figure 1.1, or an in-pipe pump mix system. Alternative A would also include a Title 22 irrigation water pump station to meet the reclaimed water demand and a basin recharge water pump station to convey Title 22 water to the spreading basins.

An estimate of water quality for each stream is also presented on Figure 1.1. Typically, secondary effluent of the SBWRP has a low TSS concentration. With a low TSS feed, the filters would be able to consistently meet Title 22 irrigation water turbidity requirements of less than 2 NTU. A potential issue with Treatment Alternative A is the total nitrogen in the effluent. To meet groundwater recharge regulations the total nitrogen concentration must be less than 10 mg/L. Currently, the average secondary effluent total nitrogen concentration is 11 mg/L, which will not be removed in the conventional tertiary process. Nitrogen would need to be removed by either increasing the existing secondary treatment denitrification capacity or adding an attached growth denitrification process ahead of the conventional tertiary process before this water could be used for groundwater recharge. Attached growth denitrification processes have been shown to consistently produce denitrified effluent of less than 10 mg/L and are included in the cost for Alternative A. The total nitrogen concentration does not affect the ability to use this water for irrigation. Another issue is TOC concentration in the tertiary effluent. To meet an initial recycled water contribution of 20 percent, the GRRP regulations require TOC to be less than 2.5 mg/L. Typical secondary treatment TOC is in the range of 10 to 15 mg/L, which is not removed in conventional tertiary treatment; therefore, this alternative would not be feasible without additional treatment for TOC removal. This removal could be achieved through a side stream RO process, but this addition would significantly increase the costs for Treatment Alternative A. However, one GRRP system has been permitted in California that uses the aguifer to reduce influent TOC to acceptable levels for CDPH. A similar approach may be acceptable in this case. Nevertheless, the recycled water contribution for this alternative would be initially limited to 20 percent, which would require significant volumes of diluent water.

### 5.5.2 <u>Treatment Alternative B - MF/RO Advanced Treatment</u>

Treatment Alternative B employs advanced treatment technology to produce a high-quality effluent that meets the more stringent requirements for groundwater recharge and a smaller conventional treatment train for irrigation water. The conventional system would be similar to that described in Section 5.5.1. For this alternative, secondary effluent from the existing SBWRP would be fed to the advanced treatment process. MF would be the first process in the advanced treatment train and would serve as pretreatment for the RO process. The MF process consistently produces a low TSS product regardless of influent quality and provides a high-quality feed needed for stable RO operation. It is estimated that the MF process would recover 92 percent of the influent flow. The additional 8 percent would be returned to the process, upstream of the primary clarifiers, as MF backwash. The MF product would be conveyed to the RO system for further treatment. The RO system is designed to remove TDS from the influent stream and is estimated to achieve a recovery of 85 percent.

Permeate would be conveyed to the UV/AOP and concentrate would be disposed of in the SARI line. After passing through the UV/AOP, the final product would be stabilized using lime (or other post-treatment chemicals) and conveyed to spreading basins for recharge.

The water quality throughout the MF/RO process is presented in the stream table shown on Figure 1.2. As shown, the MF/RO process produces a high-quality effluent for groundwater recharge. The RO process is capable of removing greater than 95-percent of the influent TDS, with a final product TDS of approximately 80 mg/L, which would meet all Title 22 requirements for groundwater recharge including the nitrogen and TOC control measures. The stabilized RO permeate would have a total nitrogen concentration of approximately 1 mg/L and a TOC concentration of less than 0.5 mg/L. This is below the nitrogen limit of 5 mg/L when only sampling twice per week and the TOC limit of 1 mg/L with a 50-percent dilution factor.

### 5.5.3 Treatment Alternative C - MBR/RO Advanced Treatment

Treatment Alternative C involves secondary treatment in an MBR to produce water for groundwater recharge and a smaller conventional treatment train for irrigation water. The conventional system would be similar to that described in Section 5.5.1. For this alternative, primary effluent from the SBWRP would be conveyed to a new MBR process. Building a new MBR process would increase the overall secondary treatment capacity of the SBWRP. Alternative C is the only alternative that adds secondary capacity to the plant. The MBR process basically combines the aeration basin and the MF process and produces a high-quality effluent similar to the MF process described in Section 5.5.2. Further treatment of the MBR effluent would be similar to the advanced treatment process described in Alternative B.

Water quality throughout the MBR/RO process is presented in the stream table shown on Figure 1.3. The stabilized product would have a similar quality to that produced in Alternative B and would meet all Title 22 requirements for groundwater recharge including the total nitrogen and TOC limitations.

### 5.5.4 <u>Treatment Alternative D - IMANS® Advanced Treatment</u>

Treatment Alternative D uses an advanced treatment process developed by Carollo Engineers, Inc. (Carollo) to produce a high-quality effluent for groundwater recharge. As with the other alternatives, a smaller conventional treatment train would be included in parallel for irrigation water production. The conventional system would be similar to that described in Section 5.5.1. For this alternative, primary effluent from SBWRP would be fed to a non-biological combination of MF followed by RO. This alternative would yield roughly the same quality of water produced in the other advanced treatment alternatives. Since this process treats primary effluent, less flow would be sent to the existing secondary treatment process, freeing up secondary treatment capacity (thereby delaying future plant expansion needs), and reducing overall plant operating costs. It is anticipated that there will be 15 to 20 storm days per year in which recharge basins will be off-line for supplemental recharge.

During this time, the advanced treatment process could be shut down and flow treated in existing secondary facilities, if there is spare capacity, or the advanced treatment process could remain online and discharge to the river.

The water quality throughout the *IMANS*<sup>®</sup> process is presented in the stream table shown on Figure 1.4. The stabilized product would have a similar quality to that produced in Alternative B and would meet all Title 22 requirements for groundwater recharge including the total nitrogen limitations. The difference with the IMANS® process is the form of the nitrogen. Since primary effluent is fed to the membrane process, the ammonia is not nitrified. A small amount (approximately 1 mg/L) of ammonia would pass through the RO membranes into the permeate. This is not an issue for this process because the total nitrogen concentration (approximately 1 mg/L) is still well below the limits for groundwater recharge. In addition, this ammonia could be combined with chlorine to form chloramines, which would provide a disinfection residual for water in the distribution pipeline. A potential issue with Treatment Alternative D is the effluent TOC level. The TOC concentration is estimated to be less than 2, but this may limit the amount of water that can be recharged based on the amount of diluent water available. Site specific testing will determine the actual TOC removal that can be achieved. As discussed previously, one GRRP system has been permitted in California that uses the aquifer to reduce the influent TOC to acceptable levels for CDPH. A similar approach may be acceptable in this case.

### 5.6 Site Layout of Alternatives

Conceptual site layouts have been developed for the Title 22 irrigation water treatment facilities and the groundwater recharge treatment facilities. The site layouts are preliminary and show the general footprints of each unit operation on the project site. To develop the site layouts, the footprints of each unit operation were estimated using rule of thumb parameters, vendor quotes, and previous projects. For example, the RO building was sized assuming 1,500 square feet per million gallons per day produced. The footprints were developed for each unit operation based on an assumed ultimate system capacity of 14.2 mgd. The alternatives for Title 22 irrigation water and groundwater recharge treatment are shown on the SBWRP site. An aerial photograph of the existing site and facilities is presented on Figure 1.8.

### 5.6.1 Treatment Alternative A - Conventional Tertiary Treatment

The conventional tertiary treatment system would require the construction of several unit operations as described previously. Secondary effluent would either flow or be pumped from an effluent box to tertiary treatment. A conceptual site layout for Treatment Alternative A is shown on Figure 1.9. As indicated, the conventional tertiary treatment train consists of flocculation, tertiary filtration, CCBs, and pump stations for the irrigation and basin recharge water. The footprints for the flocculation basins and tertiary filters are shown for a capacity of 21 mgd and the CCBs shown have a total capacity of 24 mgd. The tertiary filters would be added in phases. Up to eight 12-disk cloth filters would fit in the footprint shown. The flocculation basins and CCBs would also be added in phases depending on the desired



### EXISTING SITE LAYOUT

IE LAYOU FIGURE 1.8









## Basin Recharge Water Pump Station Irrigation Water Storage Unit 3 Secondary Clarifiers Unit 3 Aeration Basins

# TREATMENT ALTERNATIVE A SITE LAYOUT

FIGURE 1.9

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capacity. The conventional tertiary treatment facilities could be located at either the south side (as shown) or northeast corner of the facility. The site layout indicates that there is sufficient space at either location for the facility and expansion of the tertiary treatment.

### 5.6.2 <u>Treatment Alternative B - MF/RO Advanced Treatment</u>

A conceptual site layout for Treatment Alternative B is presented on Figure 1.10. As previously discussed, Alternative B would include both advanced and conventional treatment. Secondary effluent would either flow or be pumped from an effluent box to the advanced and tertiary treatment. As shown on Figure 1.10, the advanced treatment facility could be located in the northeast corner of the SBWRP and the parallel conventional treatment train could be located on the south side. The conventional treatment system is similar to the process described previously except that the CCBs shown have a total capacity of 8 mgd and only two cloth filter units would be installed in the filter structure. The advanced treatment system would consist of MF, RO, UV/AOP, stabilization, and a basin recharge water pump station. The footprints for the advanced treatment system shown have a capacity of 14.2 mgd, which would be installed in phases as previously described. The footprints shown for the advanced treatment processes include storage space for the required chemicals. The location in the northeast corner provides space for expansion and is in close proximity to the potential discharge route.

### 5.6.3 <u>Treatment Alternative C - MBR/RO Advanced Treatment</u>

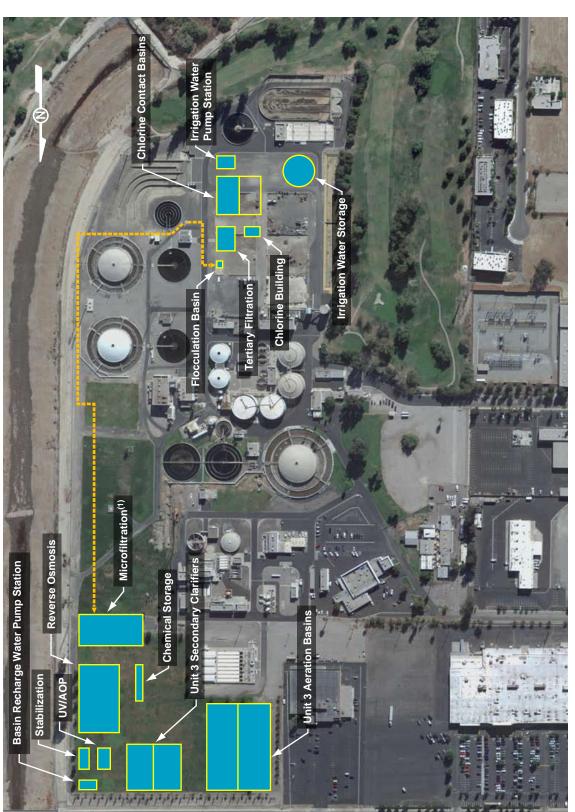
Treatment Alternative C is similar to Alternative B except for the addition of the MBR process. Adding secondary treatment and fine screens would increase the footprint of Alternative C when compared to Alternative B. A conceptual site layout for Treatment Alternative C is presented on Figure 1.11. As shown, the MBR and advanced treatment could be located in the northeast corner of the facility. The advanced treatment system would consist of a MBR, RO, UV/AOP, stabilization, and a basin recharge water pump station. The footprints for the advanced treatment system shown have a capacity of 14.2 mgd, which would be installed in phases as described previously. This location is near the existing Unit No. 3 Primary Clarifiers that could be used to feed the MBR process. To save space for MBR expansion and advanced treatment process, the conventional tertiary treatment process could be located at the south side of the facility as previously discussed.

### 5.6.4 Treatment Alternative D - IMANS® Advanced Treatment

Treatment Alternative D is also similar to Alternative B. The difference between Alternatives D and B is the feed to the MF process. For Alternative D, primary effluent is fed to the MF process instead of secondary effluent. Because of this, the advanced treatment process could be located in the northeast corner of the facility near the Unit No. 3 Primary Clarifiers that could be used to feed the MF process. A conceptual site layout for Treatment

Alternative D is presented on Figure 1.12. As shown, the advanced treatment system would have the same unit operations as Alternative B with the addition of fine screens ahead of the MF step. The footprints for the advanced treatment system shown have a capacity of





### TREATMENT ALTERNATIVE B SITE LAYOUT

FIGURE 1.10

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Note: 1. Feed for microfiltration unit is from the existing secondary treatment process.







### Irrigation Water Storage Flocculation Basin Basin Recharge Water Pump Station Reverse Osmosis UV/AOP Stabilization Chemical Storage

### TREATMENT ALTERNATIVE C SITE LAYOUT

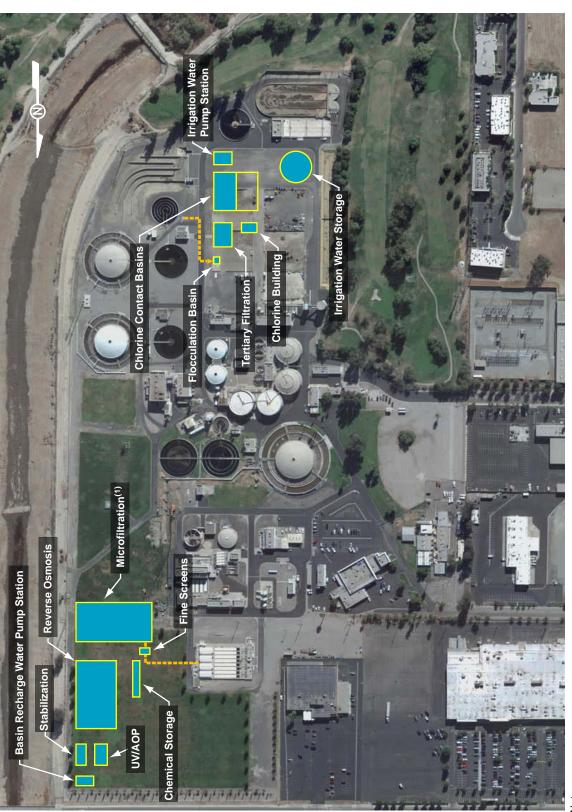
FIGURE 1.11

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### TREATMENT ALTERNATIVE D SITE LAYOUT

FIGURE 1.12

 $\underline{\text{Note:}} \\ 1. \ \text{Feed for microfiltration unit is from the existing primary treatment process.}$ 



14.2 mgd, which would be installed in phases as previously described. The *IMANS*<sup>®</sup> MF process would have a slightly larger footprint than the tertiary MF process in Alternative B due to lower design flux rates but, as shown on Figure 1.12, would still fit well on the site. The parallel conventional tertiary filtration system would be located on the south side of the site, similar to the other alternatives.

### 6.0 PUMPING AND PIPELINE REQUIREMENTS

A preliminary estimate of the pumping and pipeline systems that would be needed to transport and distribute the Title 22 basin recharge and irrigation water was developed. The estimate identifies potential direct users along Waterman Avenue, estimates the peak irrigation water demand, and develops approximate sizes for pump stations and pipelines. Carollo's February 2005 Reclamation Feasibility Study report was used as a basis to develop the irrigation water demand along the proposed pipe route.

### 6.1 Types of Potential Recycled Water Users

Recycled water has many uses in Southern California. A majority of recycled water is used for irrigation of farms, parks, schools, golf courses, and landscaping. Recycled water also has many other beneficial uses including firefighting, seawater intrusion barriers, groundwater recharge, and recreational lakes. The potential uses identified in this report are SBWRP utility water; irrigation water for parks, schools, Caltrans, and golf courses along the proposed pipeline route; and groundwater recharge.

### 6.2 Potential Irrigation Water Users

The potential irrigation customers along the proposed pipeline route are listed in Table 1.2.

Table 1.2 Potential Irrigation Customers	
Irrigation Customers	Approximate Gross Area (acres)
San Bernardino Public Recreational Park	93
Arrowhead Country Club	110
Mill Community Park	14
Meadowbrook Recreational Park	14
Meadowbrook Park	7
Secombe Lake State Recreational Area	31
Perris Hill Park	32
Horine Park	6
Wildwood Park	24
Palm Field	5

Table 1.2	Potential Irrigation Custon	ners
I	rrigation Customers	Approximate Gross Area (acres)
Community	Gardens	15
Pioneer Mer	morial Cemetery	20
Mountain Vi	ew Cemetery	58
Golden Valle	ey Middle School	N/A
Parkside Ele	ementary	N/A
Wilson Elem	entary	N/A
Monterey El	ementary	N/A
Sierra High	School	N/A

### 6.3 Irrigation Water Demand

The irrigation water demand was determined using the average demand for parks, golf courses, and schools developed in the 2005 Reclamation Feasibility Study. The average monthly irrigation water use demands, in acre-feet of water per year (ac-ft/yr), for the area adjacent to the proposed basin recharge water pipeline are listed in Table 1.4. The total demand and the demand fraction (calculated as the monthly demand divided by the yearly average) for each month are also presented in Table 1.4.

As shown in Table 1.4, irrigation water demand increases in warmer summer months and decreases in cooler winter months. Typically, irrigation demands are discussed as maximum month demands (MMD), maximum day demands (MDD), and peak hour demands (PHD). Since irrigation schedules are usually varied on a seasonal basis rather than a daily basis, MMD and MDD are similar. For the PHD, an 8-hour irrigation schedule is assumed. The peaking factors estimated in this report are summarized in Table 1.3.

Table 1.3 Irrigation Water Demand and Peaking Factors					
Demand Condition	Peaking Factor				
Average Day Demand (ADD)	-				
Maximum Month Demand (MMD)	1.3 × ADD				
Maximum Day Demand (MDD)	1.3 × ADD				
Peak Hour Demand (PHD) <sup>(1)</sup>	1.3 × MDD				
Notes:  1. Assumes an 8-hour irrigation schedule.					

As shown in Table 1.3, peaking factors can be high for irrigation water systems. This is due to the fact that most parks, golf courses, and schools tend to irrigate late at night through the early morning hours. ADD is approximately 1.1 mgd for the irrigation users shown in Table 1.4. This value excludes water used at the treatment plant. When using the peaking

Table 1.4 Irrigation Water Demand												
				2	Monthly	Demand (ac-ft)	d (ac-ft)					
Irrigation Customers	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
San Bernardino Water Reclamation Plant	133	119	133	142	165	188	211	215	197	188	161	146
San Bernardino Public Recreational Park	14.1	12.6	14.0	14.6	17.1	19.7	22.1	22.7	20.6	19.5	16.9	15.2
CalTrans	6.7	0.9	6.7	7.1	8.3	9.4	10.6	10.8	6.6	9.4	8.0	7.3
Arrowhead Country Club	16.7	14.9	16.5	17.3	20.2	23.3	26.2	26.8	24.3	23.1	20.0	17.9
Mill Community Park	1.7	1.5	1.7	1.8	2.1	2.4	2.7	2.7	2.5	2.4	2.0	1.8
Meadowbrook Recreational Park	1.7	1.5	1.7	1.8	2.1	2.4	2.7	2.8	2.5	2.4	2.1	1.8
Meadowbrook Park	6.0	9.0	8.0	6.0	1.0	1.2	1.3	4.	1.2	1.2	1.0	0.9
Secombe Lake State Recreational Area	3.8	3.4	3.7	3.9	4.6	5.3	5.9	6.1	5.5	5.2	4.5	1.1
Perris Hill Park	3.9	3.5	3.8	4.0	4.7	5.4	6.1	6.3	2.7	5.4	4.7	4.2
Horine Park	0.7	9.0	0.7	0.7	0.8	1.0	1.7	<del>[.</del>	1.0	1.0	0.8	0.7
Wildwood Park	2.9	2.6	2.9	3.1	3.6	4.1	4.6	4.7	4.3	4.1	3.5	3.2
Palm Field	9.0	0.5	9.0	9.0	0.7	0.8	1.0	1.0	0.9	0.8	0.7	0.7
Community Gardens	1.8	1.6	1.8	1.9	2.2	2.5	2.9	2.9	2.7	2.5	2.2	2.0
Pioneer Memorial Cemetery	2.5	2.2	2.4	2.6	3.0	3.4	3.9	4.0	3.6	3.4	3.0	2.7
Mountain View Cemetery	7.1	6.3	7.0	7.3	8.5	9.8	11.1	11.3	10.3	9.8	8.5	9.7
Golden Valley Middle School	0.72	0.49	0.45	99.0	0.87	1.83	2.36	2.46	2.50	2.07	1.30	0.73
Parkside Elementary	0.72	0.49	0.45	99.0	0.87	1.83	2.36	2.46	2.50	2.07	1.30	0.73
Wilson Elementary	0.72	0.49	0.45	99.0	0.87	1.83	2.36	2.46	2.50	2.07	1.30	0.73
Sierra High School	6.46	5.30	5.43	5.89	5.17	7.82	8.31	9.02	7.58	7.17	7.05	00.9
Sum (ac-ft) <sup>(1)</sup>	209	186	207	221	255	296	333	340	311	296	253	227
Demand Fraction (No.) <sup>(2)</sup>	0.80	0.71	0.79	0.84	0.98	1.13	1.27	1.30	1.19	1.13	0.97	0.87
Notes:												

Average monthly water use is 261 ac-ft. Total monthly demand fraction is 12.

factors shown on Table 1.3, this equates to a PHD of 4.3 mgd. If the irrigation water system is designed to treat an average of 3.0 mgd (4.5 mgd peak), the PHD could be met by building a small (approximately 450,000 gallons) recycle water storage tank.

Irrigation water system would also supply utility water for SBWRP as shown in Table 1.4. As shown, maximum average daily flow is 2.2 mgd (215 ac ft in August). Supplying utility water would require a separate pumping system because the utility water system would not require as high a pressure as the irrigation water system. While the two systems will require separate pumps, they can share the same wet well.

### 6.4 Groundwater Recharge Production

The amount of water available for groundwater recharge varies between the different alternatives. Conventional treatment alternatives are limited by the amount of dilution water available at recharge basins while advanced treatment alternatives are limited by the SARI capacity owned by SBMWD. Total amounts of water to be pumped to recharge basins for each alternative are listed in Table 1.5, which were used as the basis to develop capital and operation and maintenance (O&M) costs for the pumping and pipeline systems.

Table 1.5 Basin Recharge Water Production	
Alternative	Production (mgd)
Conventional Treatment	12.2
Advanced Treatment	14.2 <sup>(1)</sup>
Combined Conventional and Advanced Treatment	19.2 <sup>(1)</sup>
Notes:  1. The production of the advanced treatment alternatives cou	ld be increased in the future if RO

The flows shown in Table 1.5 assume that the advanced treatment system has an overall recovery of 85 percent. At 85-percent recovery, the advanced treatment system would produce 2.5 mgd of concentrate, which equals the capacity the SBMWD owns in the SARI line. It is estimated that overall recovery could be increased to approximately 92 percent if a concentrate treatment system is installed. This increase in recovery would increase the amount of advanced treated water available for groundwater recharge to approximately 29 mgd. The concentrate treatment system could consist of several processes including, but not limited to, secondary RO or electrodialysis reversal (EDR) with an intermediate softening step.

### 7.0 COST ESTIMATES

Preliminary capital, O&M, and life-cycle costs were developed for the four treatment alternatives. Also, capital costs for the pumping and pipeline requirements were estimated. The estimated costs are presented in the following sections and detailed cost estimates can be found in Appendix B.

### 7.1 Level of Accuracy

The expected accuracy level for the cost estimates for this analysis is Class 4, as classified by the Association for the Advancement of Cost Engineering International (AACEI, 1999). The expected accuracy range of a Class 4 estimate is within 30 percent over the estimate to 15 percent under the estimate. To reduce the risk of the impact of underestimation for capital costs, a contingency, as described below, is applied to the developed estimates.

### 7.2 Cost Assumptions

### 7.2.1 Operation and Maintenance Cost Assumptions

O&M costs include the labor, utility costs for operations, brine disposal, chemicals, membrane replacement, and UV lamp replacement. O&M costs are based on information provided by the following:

- Historical costs from recent Carollo projects.
- Vendor-supplied costs.
- Average electrical rate of \$0.13/kWh.
- Labor.

The cost estimates are generally based on applying the above information to flow diagrams for main process systems that have been developed for each alternative. O&M costs are escalated for inflation as described in Section 7.2.2.

### 7.2.2 <u>Capital Cost Assumptions</u>

Capital costs consist of all items that will be constructed/purchased for the evaluated alternatives. The direct cost of each process area is based on the following:

- Vendor-quoted information.
- Cost curves based on historical costs from other Carollo projects or scale-up or scale-down of similar sized projects.
- Scale-up of costs to account for inflation, using a base Engineering News-Record (ENR) value of 9770 (Los Angeles, March 2010).

For most projects, depending on applicability, general factors are added to the direct costs derived from the information listed above. These factors include the following:

### 1. Site Work and Electrical and Instrumentation:

These costs are estimated as percentages of the subtotal direct cost. Typical percentages are 10 percent and 15 percent, respectively.

### 2. Contingency:

An amount added to construction cost estimate for undefined project elements to reduce risk of underestimation. Contingency usually ranges from 0 to 30 percent. The contingency of 25 percent of the total direct cost was used in this case.

### 3. General Conditions:

This includes the cost of mobilization/demobilization, bonds and insurance, contractor temporary project facilities and supervisory personnel, testing, start-up, and other constraints. This was calculated as 2 percent of the total direct cost plus contingency.

### 4. General Contractor Overhead and Profit:

This refers to the general contractor's home office overhead and profit. It was estimated to be 10 percent of the subtotal of above costs.

### 5. Cost at Approximate Construction Midpoint:

Costs presented in this report do not include an escalation to midpoint of construction.

### 6. Sales Tax:

Estimated at 9.00 percent on materials, based on material cost equaling 50 percent of the total direct cost and contingency.

### 7. Engineering, Management, and Legal:

This encompasses engineering, planning, design and construction oversight costs, legal fees, and administration expenses to oversee the project from planning through construction. For this project, a factor of 30 percent of the total construction cost was used, including all above items.

### 7.3 Alternatives Project Cost

Preliminary project cost estimates were developed for the four treatment alternatives. For comparison purposes, the total production rate (recharge water plus irrigation water) for each alternative was assumed to be equal. Since each alternative has a different overall recovery, feed water flow requirements vary for each treatment train. Project cost estimates for Phases I, II, and III are summarized in Table 1.6, Table 1.7, and Table 1.8, respectively.

Table 1.6 Alternatives Phase I Project Cost (8.0 mgd Total)				
		Alterr	native	
	Α	В	С	D
Description	Conventional Treatment	MF/RO	MBR/RO	IMANS <sup>®</sup>
Advanced Treatment				
Production Rate, mgd	-	5.0	5.0	5.0
Project Cost, \$	-	\$44,500,000	\$82,400,000	\$52,700,000
Conventional Treatment				
Production Rate, mgd	8.0	3.0	3.0	3.0
Project Cost, \$	\$31,200,000	\$5,900,000	\$5,900,000	\$5,900,000
Total Title 22 Water				
Production Rate, mgd	8.0	8.0	8.0	8.0
Phase I Project Cost, \$	\$31,200,000	\$50,400,000	\$88,300,000	\$58,600,000

Table 1.7 Alternatives Phase	II Project Cost	(additional 5	mgd)	
		Alteri	native	
	Α	В	С	D
Description	Conventional Treatment	MF/RO	MBR/RO	IMANS®
Advanced Treatment				
Production Rate, mgd	-	5.0	5.0	5.0
Project Cost, \$	-	\$29,500,000	\$71,300,000	\$36,900,000
Conventional Treatment				
Production Rate, mgd	5.0	-	-	-
Project Cost, \$	\$21,500,000	-	-	-
Total Title 22 Water				
Additional Production Rate, mgd	5.0	5.0	5.0	5.0
Phase II Project Cost, \$	\$21,500,000	\$29,500,000	\$71,300,000	\$36,900,000

Table 1.8 Alternatives Phase	III Project Cos	t (to ultimate	capacity)	
		Alterr	native	
	Α	В	C	D
Description	Conventional Treatment	MF/RO	MBR/RO	IMANS <sup>®</sup>
Advanced Treatment				
Production Rate, mgd	-	4.2	4.2	4.2
Project Cost, \$	-	\$24,800,000	\$59,900,000	\$31,000,000
Conventional Treatment				
Production Rate, mgd	2.2	-	-	-
Project Cost, \$	\$5,800,000	-	-	-
Total Title 22 Water				
Additional Production Rate, mgd	2.2	4.2	4.2	4.2
Phase III Project Cost, \$	\$5,800,000	\$24,800,000	\$59,900,000	\$31,000,000

As shown in Table 1.6, Table 1.7, and Table 1.8, Alternative A (Conventional Tertiary Treatment) is the lowest project cost alternative. However, Alternative A does not provide demineralization and the amount of water available for recharge is limited by the diluent supply at the spreading basins. Comparing the advanced treatment alternatives, Alternatives B and D have similar project costs and Alternative C is the highest. Alternative C is the highest because secondary treatment capacity is added in this

alternative. Adding secondary treatment now creates a future avoided capital cost benefit. Alternative D does not add secondary capacity, but frees up capacity in the existing secondary treatment because primary effluent is fed to the MF process. The *IMANS*<sup>®</sup> process also creates a future avoided capital cost benefit. Alternative B has no effect on the existing secondary treatment because it would accept flow from the existing secondary process. The total avoided secondary treatment costs are summarized in Table 1.9.

Table 1.9 Avoided Secondary	Treatment Proje	ect Costs		
		Alter	native	
	Α	В	С	D
Description	Conventional Treatment	MF/RO	MBR/RO	IMANS <sup>®</sup>
Phase I Freed or Added Secondary Capacity, mgd	0	0	5.9	5.9
Avoided Project Cost, \$(1)(2)(3)	-	-	\$22,500,000	\$22,500,000
Avoided Project Cost, \$/AF <sup>(4)(5)</sup>	-	-	\$220	\$220
Avoided Project Cost, \$/MG <sup>(4)(5)</sup>	-	-	\$670	\$670
Phase II Freed or Added Secondary Capacity, mgd	0	0	5.9	5.9
Avoided Project Cost, \$(1)(2)(3)	-	-	\$22,500,000	\$22,500,000
Avoided Project Cost, \$/AF <sup>(4)(5)</sup>	-	-	\$350	\$350
Avoided Project Cost, \$/MG <sup>(4)(5)</sup>	-	-	\$1,075	\$1,075
Phase III Freed or Added Secondary Capacity, mgd	0	0	4.9	4.9
Avoided Project Cost, \$(1)(2)(3)	-	-	\$18,700,000	\$18,700,000
Avoided Project Cost, \$/AF <sup>(4)(5)</sup>	-	-	\$347	\$347
Avoided Project Cost, \$/MG <sup>(4)(5)</sup>	-	-	\$1,064	\$1,064

### Notes:

- 1. Avoided cost is shown in 2010 dollars.
- 2. Includes site work and electrical and instrumentation for the avoided facilities.
- 3. Includes General Conditions; Contractor Overhead and Profit; Contingency; and Engineering, Management, and Legal.
- 4. Assumes a 20-year term and 6-percent interest rate.
- 5. Based on the total capacity of each phase of the CWF. 8.0 mgd for Phase I, 5 mgd for Phase II, and 4.2 mgd for Phase III.

As shown in Table 1.9, Alternatives A and B do not offset any future capital costs because these alternatives treat secondary effluent from the SBWRP. Alternatives C and D both treat primary effluent, therefore reducing the flow to the existing secondary treatment. The costs shown in Table 1.9 represent the estimated value of the avoided secondary capacity in each phase of the CWF. These are costs that would be incurred in the future to expand the SBWRP as influent flow increases. Costs are estimated in 2010 dollars and are not escalated to the midpoint of the future projects. This is similar to how costs are calculated throughout this report.

The project costs presented represent the treatment capacities required to produce basin recharge water and irrigation water for direct use along Waterman Avenue. The SBWRP has several other options for the production of recycled water. For all of these options, the capacities and project costs for the advanced treatment systems are the same as presented above, but the conventional tertiary treatment process capacities and project costs vary widely. The SBWRP could produce a minimum of 1.5 mgd of tertiary treated water for use on site and at the adjacent golf course, to a maximum of 34.5 mgd for groundwater recharge, direct use, and supplying irrigation water outside of the City of San Bernardino (City). A summary of the potential tertiary treatment capacities and project costs is presented in Table 1.10.

Table 1.10 Conventional Trea	atment Alternatives Projec	ct Costs	
	Phase I	Phase II	Phase III
Direct Use On Site			
Capacity, mgd	1.5	-	-
Project Cost, \$	\$6,000,000 <sup>(1)</sup>	-	-
Direct Use Waterman Avenue			
Capacity, mgd	3.0	-	-
Project Cost, \$	\$10,000,000 <sup>(1)</sup>	-	-
Direct Use and Marketed Outside	the City		
Capacity, mgd	6	6	6
Proj	ect Cost, \$ \$24,900,000 <sup>(2)</sup>	\$23,400,000	\$23,400,000
Direct Use, Basin Recharge, and Outside the City	Marketed		
Capacity, mgd	12	12	12
Project Cost, \$ <sup>(3)</sup>	\$46,300,000	\$44,300,000	\$31,800,000
Notes:			

### Notes

- 1. Total project cost includes a new CCB. Total cost would be reduced if the existing Unit 2 CCB could be used for disinfection.
- 2. Total project cost includes filter structure for ultimate capacity and one standby cloth filter.
- 3. Phases I and II include filter structures for eight filters each. Phase I includes one standby cloth filter.

### 7.4 Alternatives Operation and Maintenance Cost

Preliminary O&M cost estimates were developed for the four treatment alternatives (excluding effluent pumping). The O&M costs discussed in this report are for Phase I of the CWF and include operating a 5-mgd advanced treatment system and a 3.0-mgd conventional tertiary treatment system. It is assumed that the expansions would have a similar O&M cost on a dollar per acre-foot basis. The O&M cost estimates include power, labor, brine disposal, chemicals, membrane replacement, and UV lamp replacement. The O&M cost estimates are summarized in Table 1.11.

Table 1.11 Alternatives O&M Cos	st			
		Altern	ative	
	Α	В	С	D
Description	Conventional Treatment	MF/RO	MBR/RO	IMANS <sup>®</sup>
Electrical Cost, \$/yr	\$3,300	\$684,000	\$1,142,000	\$718,000
Chemical Cost, \$/yr	\$250,000	\$471,000	\$472,000	\$483,000
Waste Disposal Cost, \$/yr	-	\$758,000 <sup>(1)</sup>	\$765,000 <sup>(1)</sup>	\$1,043,000 <sup>(1)</sup>
Filter Media Replacement, \$/yr	\$63,000	\$12,000	\$12,000	\$12,000
Membrane Replacement, \$/yr	-	\$310,000	\$303,000	\$416,000
UV Lamp Replacement, \$/yr	-	\$55,000	\$55,000	\$55,000
Labor, \$/yr	\$209,000(2)	\$374,000 <sup>(3)</sup>	\$374,000 <sup>(3)</sup>	\$374,000 <sup>(3)</sup>
Total O&M Costs, \$/yr	\$525,000	\$2,664,000	\$3,125,000	\$3,101,000
Total O&M Costs, \$/AF <sup>(4)</sup>	\$60	\$300	\$350	\$346
Total O&M Costs, \$/MG <sup>(4)</sup>	\$180	\$912	\$1,070	\$1,062
Avoided O&M Costs, \$/yr <sup>(5)</sup>	\$1,300,000	\$1,300,000	\$1,715,000	\$2,041,000
Avoided O&M Costs, \$/AF <sup>(4)(5)</sup>	\$145	\$145	\$190	\$230
Avoided O&M Costs, \$/MG <sup>(4)(5)</sup>	\$445	\$445	\$590	\$700
Total Adjusted O&M Costs, \$/yr	(\$775,000)	\$1,364,000	\$1,410,000	\$1,060,000
Total Adjusted O&M Costs, \$/AF <sup>(4)</sup>	(\$85)	\$155	\$160	\$116
Total Adjusted O&M Costs, \$/MG <sup>(4)</sup>	(\$265)	\$467	\$480	\$362

### Notes:

- 1. Cost includes amortized cost of treatment capacity at the Orange County Sanitation District.
- 2. Assumes one additional person working 40 hours per week at \$90 per hour, including benefits.
- 3. Assumes two additional people working 40 hours per week at \$90 per hour, including benefits.
- 4. Based on total capacity of Phase I for the CWF (8.0 mgd).
- 5. Includes avoided O&M costs at the SBWRP and Rapid Infiltration and Extraction (RIX) facilities.

As shown in Table 1.11, the O&M costs for conventional treatment are significantly less than the advanced treatment processes. The conventional treatment train is a simpler and less energy-intensive process, and is an effective method for production of Title 22 irrigation water. Comparing the advanced treatment options, Alternative B has the lowest O&M costs. The O&M costs for Alternative C are higher due to the costs associated with the operation of the MBR and higher for Alternative D because of the higher cost of concentrate disposal. The concentrate disposal costs are higher for Alternative D because of the increased BOD in the waste stream when compared to Alternatives B and C. However, Alternatives C and D reduce the amount of water being treated at the existing SBWRP, therefore reducing the operating cost of the existing facility. The added benefit of Alternative D, which is represented in the greater avoided O&M costs when compared to Alternative C, is that the *IMANS*<sup>®</sup> process significantly reduces the amount of solids produced, reducing solids handling costs.

### 7.5 Pumping and Pipeline Project Costs

Distribution facilities, which include pipelines and pumping stations, are proposed to deliver irrigation and basin recharge water to potential users and the recharge basins, respectively. A preliminary cost estimate was developed for the pumping and pipeline requirements discussed in Sections 6.3 and 6.4. The irrigation and basin recharge water would require separate pump stations and distribution systems to deliver water to end users and the recharge basins. The pipeline cost estimates assume that both the irrigation and basin recharge pipelines can be routed along the flood control channel and that limited pavement removal and restoration would be required for their installation. The pump stations are assumed to be single-lift pump stations installed at the SBWRP. A summary of assumptions for the pumping and pipeline systems are shown in Table 1.12.

Table 1.12 Pumping and Pipeline Design Assumptions			
	Value		
SBWRP Pump Station			
Elevation Change to Recharge Basins, ft	455		
Flow Velocity in Pipeline, ft/s	<6		
Pipeline Material	AWWA C200 Steel Pipe		
Pipeline Average Cover, ft	3.5		
Pipeline Length, ft	38,000		
Waterman Avenue Pump Station			
Elevation Change to Recharge Basins, ft	380		
Flow Velocity in Pipeline, ft/s	<6		
Pipeline Material	AWWA C200 Steel Pipe		
Pipeline Average Cover, ft	3.5		
Pipeline Length, ft	th, ft 31,000		
Irrigation Water System			
Elevation Change to End Users, ft	370		
Minimum System Pressure, psi	30		
Flow Velocity in Pipeline, ft/s	<3 <sup>(1)</sup>		
Pipeline Material	AWWA C905 PVC Pipe		
Pipeline Average Cover, ft	3.5		
Pipeline Length, ft	38,000		

A summary of the cost estimates for the pumping and pipeline systems are shown in Table 1.13 and Table 1.14.

Table 1.13 Basin Recharge Pumping and Pipeline Project Cost					
Alternative					
	1	2	3		
Description	Conventional Treatment	Advanced Treatment	Conventional and Advanced Treatment		
SBWRP Pump Station					
Production Rate, mgd	12.2	14.2	19.2		
Pipe Size, inches	30	30	36		
Pump Station Project Cost, \$	\$5,400,000	\$5,400,000	\$6,100,000		
Pipeline Project Cost, \$ <sup>(1)</sup>	\$19,500,000	\$19,500,000	\$24,600,000		
Total Project Cost, \$	\$24,900,000	\$24,900,000	\$30,700,000		
Unit Project Cost, \$/AF <sup>(2)</sup>	\$159	\$136	\$124		
Unit Project Cost, \$/MG <sup>(2)</sup>	\$488	\$419	\$382		
Waterman Avenue Pump Station <sup>(3)</sup>					
Production Rate, mgd	5.0	5.0	5.0		
Pipe Size, inches	24	24	24		
Pump Station Project Cost, \$	\$3,900,000	\$3,900,000	\$3,900,000		
Pipeline Project Cost, \$(1)	\$17,000,000	\$17,000,000	\$17,000,000		
Total Project Cost, \$	\$20,900,000	\$20,900,000	\$20,900,000		
Unit Project Cost, \$/AF <sup>(2)</sup>	\$325	\$325	\$325		
Unit Project Cost, \$/MG <sup>(2)</sup>	\$1,000	\$1,000	\$1,000		

### Notes:

- 1. Pipeline costs are shown for the maximum capacity of the advanced treatment system without concentrate treatment. The pipeline would cost an additional \$6 million to increase its capacity to the ultimate capacity of the advanced treatment system with concentrate treatment.
- 2. Assumes a 20-year term and 6-percent interest rate.
- 3. Pump station is designed to pump water from the Waterman Basin to the Devil Canyon and Sweetwater Basins.

As shown, the capital costs for the pipelines decrease with greater utilization. For this reason, it may be economically favorable to add ultimate capacity upfront. If concentrate treatment is something the SBMWD would seriously consider for expansion of the CWF in the future, installing a pipeline designed for the ultimate capacity with concentrate treatment would be the least expensive option over the life of the project.

Table 1.14 Irrigation Pumping and Pipeline Project Cost			
	Alternative		
Description	Conventional Treatment		
Production Rate, mgd	3.0		
Pipe Size, inches	18		
Pump Station Project Cost, \$	\$2,565,000		
Pipeline Project Cost, \$ <sup>(1)</sup>	\$6,535,000		
Total Project Cost, \$	\$9,100,000		
Unit Project Cost, \$/AF <sup>(2)</sup>	\$236		
Unit Project Cost, \$/MG <sup>(2)</sup>	\$725		

### Notes:

- 1. Pipeline cost includes lateral pipelines to deliver irrigation water to end users.
- 2. Assumes a 20-year term and 6-percent interest rate.

### 7.6 Pumping and Pipeline Operation and Maintenance Costs

Preliminary O&M cost estimates were developed for the three basin recharge pumping alternatives and the irrigation water system. The O&M cost estimates include the power required to pump the basin recharge water from the SBWRP to the recharge basins or the irrigation water users. The O&M cost estimates for Phase I are summarized in Table 1.15 and Table 1.16.

Table 1.15 Basin Recharge Pumping and Pipeline O&M Cost				
	Alternative			
	1	2	3	
Description	Conventional Treatment	Advanced Treatment	Conventional and Advanced Treatment	
SBWRP Pump Station				
Pumping Rate, mgd	5	5	5	
Pump Discharge Pressure, psi	200	200	200	
Total O&M Cost, \$/yr <sup>(1)</sup>	\$493,000	\$493,000	\$486,000	
Unit O&M Cost, \$/AF	\$90	\$90	\$90	
Unit O&M Cost, \$/MG	\$270	\$270	\$266	
Waterman Avenue Pump Station <sup>(3</sup>	)			
Pumping Rate, mgd	5	5	5	
Pump Discharge Pressure, psi	165	165	165	
Total O&M Cost, \$/yr <sup>(1)(2)</sup>	\$90,000	\$90,000	\$90,000	
Unit O&M Cost, \$/AF	\$16	\$16	\$16	
Unit O&M Cost, \$/MG	\$50	\$50	\$50	

### Notes:

- O&M costs shown are for Phase I of the advanced treatment system, which is assumed to be 5 mgd.
- 2. Total O&M cost for pumping 3 months of the year.

As shown in Table 1.15, the O&M costs are the same for the three pumping alternatives. The similarity is due to the assumption that the CWF would be producing 5 mgd after Phase I. The discharge pressures for the pump station are also the same for the different pumping alternatives because of the change in elevation between the SBWRP and the recharge basins.

Table 1.16 Irrigation Pumping and Pipeline O&M Cost				
	Alternative			
Description	Conventional Treatment			
Pumping Rate, mgd	4.3			
Pump Discharge Pressure, psi <sup>(1)</sup>	215			
Total O&M Cost, \$/yr <sup>(2)</sup>	\$130,000			
Unit O&M Cost, \$/AF <sup>(3)</sup>	\$38			
Unit O&M Cost, \$/MG <sup>(3)</sup> \$116				

### Notes:

- 1. Assumes a minimum system pressure of 30 psi.
- 2. O&M costs shown are for irrigation water direct users. Assumes irrigation occurs for 8 hours overnight.
- 3. Based on irrigation water production of 3.0 mgd.

As shown in Table 1.16, the discharge pressure for the irrigation water system is slightly higher than the basin recharge pipeline. This increase is due to the irrigation water system pressure, which is assumed to be a minimum of 30 psi. The higher discharge pressure increases the energy usage, increasing the unit cost for irrigation water pumping.

### 7.7 Capital and Operation and Maintenance Cost Summary

The total capital, O&M, and avoided costs for Phase I of the CWF are summarized in Table 1.17.

Table 1.17 Phase I Alternatives Capital and O&M Cost Summary						
		Alternative				
	Α	В	С	D		
Description	Conventional Treatment	MF/RO	MBR/RO	IMANS <sup>®</sup>		
Project Costs						
Total Production Rate, mgd	8.0	8.0	8.0	8.0		
Treatment Facility, million \$	\$31.2	\$50.4	\$88.3	\$58.6		
Pumping and Pipelines, million \$	\$54.9	\$54.9	\$54.9	\$54.9		
Total, million \$	\$86.1	\$105.3	\$143.2	\$113.5		

Table 1.17 Phase I Alternatives Capital and O&M Cost Summary					
	Alternative				
	Α	В	С	D	
O&M Costs					
Treatment Facility, \$/yr	\$525,000	\$2,664,000	\$3,125,000	\$3,101,000	
Pumping and Pipelines, \$/yr	\$713,000	\$713,000	\$713,000	\$713,000	
Total, \$/yr	\$1,238,000	\$3,377,000	\$3,838,000	\$3,814,000	
Avoided Costs					
Treatment Facility Capital Cost, million \$	-	-	\$22.5	\$22.5	
Treatment Facility O&M Cost, \$	\$1,300,000	\$1,300,000	\$1,715,000	\$2,041,000	

As shown in Table 1.17, the majority of the cost of the CWF is in Phase I. This is because the buildings, yard piping, and distribution systems are all sized for the ultimate capacity of the facility. The initial cost of treatment on a dollar per acre-foot basis would be high because of the increased size of the infrastructure, but would reduce expansion costs. To evaluate the true costs of treatment, the total costs of the ultimate treatment plant need to be assessed. The capital and O&M costs for the ultimate capacity of the treatment and pumping alternatives are summarized in Table 1.18.

Table 1.18 Alternatives Capital and O&M Cost Summary				
	Alternative			
	Α	В	С	D
Description	Conventional Treatment	MF/RO	MBR/RO	IMANS <sup>®</sup>
Project Costs				
Total Production Rate, mgd	15.2	17.2	17.2	17.2
Treatment Facility, million \$	\$58.5	\$104.7	\$219.5	\$126.5
Pumping and Pipelines, million \$	\$54.9	\$54.9	\$54.9	\$54.9
Total, million \$	\$113.4	\$159.6	\$274.4	\$181.4
Total Unit Cost, \$/AF <sup>(1)</sup>	\$580	\$722	\$1,242	\$820
Total Unit Cost, \$/MG <sup>(1)</sup>	\$1,782	\$2,216	\$3,810	\$2,519
O&M Costs <sup>(2)</sup>				
Treatment Facility, \$/yr	\$525,000	\$2,664,000	\$3,125,000	\$3,101,000
Pumping and Pipelines, \$/yr	\$713,000	\$713,000	\$713,000	\$713,000
Total, \$/yr	\$1,238,000	\$3,377,000	\$3,838,000	\$3,814,000
Total Unit Cost, \$/AF	\$138	\$377	\$428	\$425
Total Unit Cost, \$/MG	\$424	\$1,157	\$1,314	\$1,306

Table 1.18 Alternatives Capital and O&M Cost Summary				
	Alternative			
	Α	В	С	D
Avoided Costs				
Treatment Facility Capital Cost, million \$	-	-	\$63.7	\$63.7
Treatment Facility O&M Cost, \$	\$1,300,000	\$1,300,000	\$1,715,000	\$2,041,000
Total Unit Cost, \$/AF <sup>(1)</sup>	\$145	\$145	\$480	\$516
Total Unit Cost, \$/MG <sup>(1)</sup>	\$445	\$445	\$1,470	\$1,584
Total Treatment Costs				
Total Unit Cost of Treatment, \$/AF <sup>(1)(3)</sup>	\$573	\$954	\$1,190	\$729
Total Unit Cost of Treatment, \$/MG <sup>(1)(3)</sup>	\$1,761	\$2,928	\$3,654	\$2,241

### Notes:

- 1. Assumes a 20-year term and 6-percent interest rate.
- 2. O&M costs shown are for Phase I of the CWF. The O&M costs for the ultimate capacity of the facility are assumed to be equal on a \$/AF basis.
- 3. Includes avoided future costs.

As shown, Alternative A has the lowest treatment cost and Alternative C has the highest. Alternative A is the lowest cost, but the amount of water available for recharge is limited by the diluent water in the recharge basis. Alternative A also may not be able to meet the total nitrogen limits for groundwater recharge. Alternative C is the highest cost of treatment because it includes a secondary treatment process and would increase the secondary treatment capacity of the plant. Alternatives B and D are similar processes and have similar costs of treatment when ignoring the avoided costs. The difference between the two processes is the feed source. For Alternative B, the feed would be from the existing secondary treatment while Alternative D would be fed from the existing primary treatment. Because Alternative D accepts primary effluent, less water is fed to the existing secondary system freeing up capacity. This freed capacity has value and, when considering the avoided costs, Alternative D has the lowest cost of treatment when comparing the advanced treatment alternatives.

### 8.0 CONCLUSIONS

The SBMWD is evaluating the use of recycled water in its service area. Four alternative treatment processes were evaluated for the CWF: conventional tertiary treatment, MF/RO, MBR/RO, and *IMANS*<sup>®</sup>. All four alternatives would include a small conventional tertiary treatment process for the production of irrigation water to supply to direct users along the pipeline route. The three advanced treatment alternatives would meet the Title 22 groundwater recharge guidelines, while the conventional treatment process may have difficulty meeting the total nitrogen limitations. On a cost basis, Alternative A (Conventional Tertiary Treatment) is the least cost option. The advanced treatment alternatives are more

# SAN BERNARDINO MUNICIPAL WATER DEPARTMENT RECYCLED WATER ALTERNATIVES EVALUATION

expensive, but provide more flexibility for groundwater recharge. When comparing the advanced treatment alternatives, Alternative D (*IMANS*®) has the lowest cost of treatment when considering the avoided capital and O&M costs associated with this process.



# REGULATORY REQUIREMENTS FOR RECYCLED WATER

STA	ATE WATER RESOURCES CONTROL BOARD	A-2
CAI	LIFORNIA DEPARTMENT OF PUBLIC HEALTH	A-2
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#### STATE WATER RESOURCES CONTROL BOARD

The State Water Resources Control Board (SWRCB) establishes general policies governing the permitting of recycled water projects based on its role of protecting water quality and sustaining water supplies. The SWRCB reviews the permitting practices of the Regional Water Quality Control Board (RWQCB) and is also responsible for developing a general permit for irrigation uses of recycled water.

#### CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

The California Department of Public Health (CDPH) is responsible for protection of public health and drinking water supplies. It is also responsible for developing uniform water recycling criteria appropriate to particular uses of water. The latest version of the Regulations Related to Recycled Water is dated January 1, 2009. The latest update of the Draft Groundwater Recharge Reuse Regulations is dated August 5, 2008. The RWQCBs rely on CDPH to establish permit conditions for recycled water projects that will protect human health.

#### **REGIONAL WATER QUALITY CONTROL BOARDS**

The RWQCBs are responsible for protecting the surface and groundwater resources of the State. They are also responsible for issuing permits that implement CDPH recommendations for each recycled water project.

#### Recycled Water for Irrigation

Chapter 3 of Division 4 of Title 22 of the California Code of Regulations defines the water recycling criteria and uses, and water quality requirements for recycled water. These criteria are commonly referred to as "Title 22."

In terms of required water quality, recycled water used for irrigation of the following shall be "disinfected tertiary recycled water":

- 1. Food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop.
- 2. Parks and playgrounds.
- 3. School yards.
- 4. Residential landscaping.
- Unrestricted access golf courses.

Such water is defined as a filtered and subsequently disinfected wastewater that meets the following criteria for disinfection:

- Includes a chlorine disinfection process following filtration that provides a contact time (CT) value of not less than 450 mg-min/L at all times, with a modal CT of at least 90 minutes based on peak dry weather design flow; or
- 2. Includes a disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent (5-log reduction) of the plaque forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of demonstration.

In addition, the median concentration of total coliform bacteria measured in the disinfected effluent must not exceed a most probably number (MPN) of 2.2 per 100 mL utilizing the bacteriological results of the last 7 days for which analyses have been completed. Also, the number of total coliform bacteria must not exceed an MPN of 23 per 100 mL in more than one sample in any 30-day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 mL.

For the recycled water to be considered as filtered, it must be an oxidized wastewater that is either filtered through a membrane or other filter media, and in either case meets the criteria below:

- 1. For non-membrane filters, the recycled water has been coagulated and passed through natural unisturbed soils or a bed of filter media pursuant to the following:
  - a. At a rate that does not exceed 5 gpm/ft2 of surface area in mono, dual, or mixed media gravity, upflow or pressure systems, or does not exceed 2 gpm/ft² of surface area in a traveling bridge automatic backwash filter.

    (Note: Several filtration systems other than media filters have received "Title 22 approval" for which specific filtration rates are defined in order for the systems to meet the required turbidity limits shown below. For example, cloth-media filters have been approved for loading rates not to exceed 6 gpm/ft². However, experience with cloth-media filters has shown that they can be reliably operated in the range of 3 to 3.5 gpm/ft².)
  - b. So that the turbidity of the filtered wastewater does not exceed any of the following:
    - 1) An average of 2 NTU within a 24-hour period.
    - 2) 5 NTU more than 5 percent of the time within a 24-hour period.
    - 3) 10 NTU at any time. (Note: Coagulation may be waived if the filter effluent does not exceed 2 NTU, the filter influent is continuously measured, the filter influent turbidity does not exceed 5 NTU, and automatically activated chemical addition or diversion facilities are provided in the event filter effluent turbidity exceeds 5 NTU.)

- 2) For membrane filters, the recycled water has passed through a microfiltration, ultrafiltration, nanofiltration, or reverse osmosis membrane so that the turbidity of the filtered wastewater does not exceed any of the following:
  - a. 0.2 NTU more than 5-percent of the time within a 24-hour period.
  - b. 0.5 NTU at any time.

#### Recycled Water for Groundwater Recharge

The regulations for using recycled water for groundwater recharge are significantly different to those for using recycled water for irrigation. Since the groundwater basins are aquifers used for potable purposes, the regulations are designed to protect the beneficial uses of each specific aquifer. Prior to making its recommendations to the RWQCB for the initial permit to operate a Groundwater Recharge Reuse Project (GRRP) the CDPH will hold a Public Hearing.

Recharging an aquifer with recycled water that will later be withdrawn and used for potable purposes is called Indirect Potable Reuse (IPR). In this way, the aquifer presents a natural barrier and also acts as a large storage area so that changes in water quality are more gradual. There are two ways in which recycled water can be used to recharge a groundwater basin, either by spreading the recycled water in a recharge basin and allowing natural infiltration to take place, or by injecting the recycled water directly into the underground basin. Minimum treatment requirements for spreading and injection are different and are discussed later.

Because recycled water originates from wastewater, the regulations are focused on controlling several key water quality parameters. Each is discussed briefly below:

#### 1. Control of Pathogenic Organisms

In order to meet the requirements for control of pathogenic organisms:

- a. The recycled water must meet the requirements of disinfected tertiary recycled water (defined above) 450 CT, or 5-log virus reduction; and the total coliform limits.
- b. The aquifer must allow for a minimum of 6-months retention time of the water underground before it is extracted as a drinking water supply from the closest well.
- c. The GRRP must demonstrate within 3 months of commencing operation that the minimum retention time to the closest drinking water well has been met. This must be done by using a tracer study. Until the tracer study is applied, other minimum detention periods apply (calculated by applying a safety factor to the minimum 6-month period, resulting in detention periods varying between 9 and 24 months) depending on the method initially used to establish the aquifer detention period:
  - 1) Tracer study using an added chemical tracer (6 months).

- 2) Tracer study using intrinsic tracer, such as TDS (9 months).
- 3) Calibrated 3-D numerical model (12 months).
- 4) Developed analytical method to determine distance (24 months).

Monitoring wells need to be established, per CDPH requirements, in order to establish tracer movement.

#### 2. Control of Nitrogen Compounds

There are three methods for controlling nitrogen:

- a. Method 1 sets a low average concentration of total nitrogen (5 mg/L) and sampling twice weekly, with the rationale that if the recycled water is applied at this concentration then there is very little chance of the drinking water maximum containment level (MCL) for NO<sub>2</sub> or NO<sub>3</sub> ever being exceeded.
- b. Method 2 sets a maximum total nitrogen limit of 10 mg/L with more intensive sampling, with the rationale that the low limit of total nitrogen will result in a low risk of exceeding a drinking water MCL.
- c. Method 3 relies on compliance monitoring and is only for projects that have been in operation for more than 20 years. Monitoring points are set up between the recharge area and the down gradient domestic wells with relatively frequent sampling. Method 3 relies on the demonstration over a long period of time that nitrogen contamination in the drinking water wells has not been a problem, and that the NO<sub>2</sub> and NO<sub>3</sub> drinking water MCLs have been met.

#### 3. Control of Total Organic Carbon (TOC)

Due to the fact that recycled water contains organic material that originated from wastewater, CDPH's approach is to limit the amount of recycled water TOC that enters a groundwater basin. This is done by setting a Recycled Water Contribution (RWC) value for each GRRP. The RWC is the amount of recycled water applied at the GRRP divided by the total amount of water recharged into the basin (recycled water plus diluent water). Diluent water is defined as water that does not contain organic material of wastewater origin. Examples of diluent water include raw surface water, groundwater, and stormwater.

For example, if 1,000 acre-feet (AF) of recycled water is combined with 4,000 AF of diluent water, the RWC would be 1,000/5,000 = 0.20 or 20 percent. The RWC is calculated on a 60-month average.

The maximum TOC concentration permissible in the recycled water used for a GRRP is calculated using the following equation:

$$TOC_{max} = \frac{0.5 \text{ mg/L}}{\text{RWC}_{proposed}}$$

Thus, for a GRRP with a proposed RWC of 20 percent, the  $TOC_{max}$  concentration for the recycled water would be 2.5 mg/L. For an RWC of 50 percent, the  $TOC_{max}$  would be 1.0 mg/L. The TOC concentration limit for the GRRP is calculated on a 20-week average basis. Monitoring requirements have been established for TOC.

For each GRRP, CDPH will establish an initial RWC to be used for the project. This value will be based on review of the Engineer's Report and information obtained during the public hearing, but will not exceed the following limits:

- 20 percent for surface spreading projects.
- 50 percent for groundwater injection.
- 50 percent for surface spreading projects that include reverse osmosis.

For projects that require additional treatment to meet the desired RWC, then advanced treatment with reverse osmosis followed by an advanced oxidation process (AOP) are to be provided. The AOP process (ultraviolet/hydrogen peroxide (UV/H<sub>2</sub>O<sub>2</sub>)), Ozone/H<sub>2</sub>O<sub>2</sub>) must provide:

- 1.2 log NDMA reduction, and
- 0.5 log 1,4 dioxane reduction

#### 4. Control of Emerging Contaminants

Standards for these compounds do not yet exist and it is anticipated that it will be some time before such standards are established. Each GRRP is to propose a monitoring program for emerging contaminants. These include endocrine disrupting compounds (EDCs) and pharmaceuticals and personal care products (PPCPs). Work is being done in this area to identify surrogates that can be used to monitor the most critical compounds in the vast array of existing chemicals that fall into this category.

#### 5. Source Control

A source control program needs to be in place to regulate contaminants entering the sewer system.

#### Salt/Nutrient Management Plans

The SWRCB's Recycled Water Policy includes a requirement that Salt and Nutrient Management Plans be established for every groundwater basin/sub-basin in California. In some areas of the state, basin plans already exist that stipulate both nutrient and salt limits. If the planned GRRP produces a recycled water that meets the requirements of the existing plan, then additional work may not be needed. However, if no plan exists, then one needs to be developed, and if the proposed project exceeds the limits of an existing plan then modifications to the plan may be needed; both of which may include significant effort. Where new plans need to be developed, these are to be complete within 5 years of the adoption of the Recycled Water Policy, which is by February 3, 2014.

The Salt and Nutrient Management Plans shall also include provisions for annual monitoring of emerging contaminants/constituents of emerging concern.

# Appendix B

### **DETAILED COST ESTIMATE**

PHASE I COST ESTIMATE	B-2
PHASE II COST ESTIMATE	B-6
PHASE III COST ESTIMATE	B-10
PUMPING AND PIPELINE COST ESTIMATE	B-14

Alternatives:	San Bernardino Option 1	Treatment Option Option 4	Option 5	Option 6	_
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
Mass Balance for Treatment System:					_
Feed Water to ozonation system - Treated water flowrate (mgd)	7.5	7.5	7.5	7.5	
- Treated water flowrate (fligd) - Treated water flowrate (gpm)	5,208	5,208	5,208	5,208	
- Ultimate Capacity (mgd)	12.2	16.7	16.7	16.7	
First Well Input					
- Feed Stream - Influent Flow (mgd)	Secondary 7.7	Secondary 8.9	Primary 8.4	Primary 8.9	
- Influent Flow (mga) - Influent Flow (gpm)	5,315	6,212	5,857	6,212	
- Color (c.u.)		0		0	
- Chloride (mg/L)		0		0	
<ul><li>Bromide (ug/L)</li><li>TOC (mg/L)</li></ul>		0 0.0		0.0	
- Alkalinity (mg/L CaCO3 - Total)		0	300	0	
- EC		0		0	
<ul><li>Fluoride (mg/L)</li><li>Total Hardness (mg/L)</li></ul>		0.00 0		0.00	
- pH		0.00		0.00	
- Sulfate (mg/L)		0		0	
<ul><li>Sodium (mg/L)</li><li>Nitrate (mg/L)</li></ul>		0 0.0		0 0.0	
- Calcium (mg/L)		0.0		0.0	
- Potassium (mg/L)		0.0		0.0	
<ul><li>Magnesium (mg/L)</li><li>TDS (mg/L)</li></ul>	510	0.0 510	560	0.0 560	Eat from plant data
- BOD (mg/L)	16	16	200	200	Est. from plant data Est. from plant data
- TSS (mg/L)	2	2	90	90	Est. from plant data
- NH3-N (mg/L)	5	5	30	30	Est. from plant data
- COD (mg/L)	45	45	450	450	Est. from plant data
Tertiary Filtration					
- Alum Dose (mg/L)	2	2	2	2	
<ul><li>Flow (gpm)</li><li>BOD removal (%)</li></ul>	5315 50%	1771 50%	1771 50%	1771 50%	
- TSS removal (%)	60%	60%	60%	60%	Default from BioTran
Page (an (0))	98%	98%	98%	000/	Average backwash flow over one hour period. Estimated
- Recovery (%) Filtered Water Quality	90%	90%	90%	98%	as 4 filters backwashing every 20 min.
- Flow (gpm)	5208	1736	1736	1736	
- TDS (mg/L)	510	510	510	510	
- BOD (mg/L) - TSS (mg/L)	8 1	8 1	8 1	8 1	
- NH3-N (mg/L)	5	5	5	5	
Backwash Water Quality					
backwash water Quality					Average backwash flow over one hour period. Estimated
- Flow (gpm)	106	35	35	35	as 4 filters backwashing every 20 min.
- TDS (mg/L) - BOD (mg/L)	510 400	510 400	510 400	510 400	
- TSS (mg/L)	60	60	60	60	
- NH3-N (mg/L)	5	5	5	5	
Microfiltration					
- Flowrate (gpm)		4,440		4,440	MF recycle will increse Secondary flow
- Recovery (%)		92%		92%	
<ul><li>Treated Water Flowrate (gpm)</li><li>BOD removal (%)</li></ul>		4,085 85%		4,085 75%	% reduction from Metcalf & Eddy
- TSS removal (%)		97%		100%	% reduction from Metcalf & Eddy
- Feed Water Quality:Á					•
- TDS (mg/L) - BOD (mg/L)		510 16		560Á 200Á	
- TSS (mg/L)		2		200A 90Á	
- NH3-N (mg/L)		5		30Á	
- Treated Water Quality:Á					
- TDS (mg/L)		510		560Á	
- BOD (mg/L)		2.6		54.3Á	
<ul><li>TSS (mg/L)</li><li>NH3-N (mg/L)</li></ul>		0.1 5		0.5Á 30Á	
- Ni io-iv (ilig/L)		3		30A	
- Reject StreamÁ				_	
<ul><li>Flowrate (gpm)</li><li>TDS (mg/L)</li></ul>		355 510		355Á 560Á	
- BOD (mg/L)		170.0		1875.0Á	
- TSS (mg/L)		24.3		1119.4Á	
- NH3-N (mg/L)		5		30Á	
Membrane Bio Reactor (MBR)Á					
- Flowrate (gpm)			4,085Á		
<ul><li>Recovery (%)</li><li>Treated Water Flowrate (gpm)</li></ul>			100%Á 4,085Á		
- Treated water Flowrate (gpm) - BOD removal (%)			4,085A 98%Á		Estimate from Metcalf and Eddy
- TSS removal (%)			99.5%		Estimate from Metcalf and Eddy
- NH3-N removal (%)			91%		Estimate from Metcalf and Eddy
- Feed Water Quality:					
- TDS (mg/L)			560		
- BOD (mg/L) - TSS (mg/L)			200 90		
. 55 (g. 2)			50		

Alternatives:	San Bernardino 1 Option 1	Treatment Option Option 4	S Option 5	Option 6	_
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
- NH3-N (mg/L)			30		_
- Treated Water Quality: - TDS (mg/L)			560		
- TDS (mg/L) - BOD (mg/L)			4		
<ul><li>TSS (mg/L)</li><li>NH3-N (mg/L)</li></ul>			0.45 2.7		
Reverse Osmosis (RO)					
Percent Flow		67%	67%	67%	Insert flow split here
- Flowrate (gpm) - Recovery (%)		4,085 85%	4,085 85%	4,085 85%	Value from ROSA Membrane software
- Treated Water Flowrate (gpm)		3,472	3,472	3,472	
- TDS removal (%) - BOD removal (%)		97% 50%	97% 50%	97% 95%	% reduction from Metcalf & Eddy % reduction from Metcalf & Eddy
- TSS removal (%)		99%	99%	99%	% reduction from Metcalf & Eddy
<ul><li>NH3-N removal (%)</li><li>Feed Water Quality:</li></ul>		96%	96%	96%	% reduction from Metcalf & Eddy
- TDS (mg/L)		510.0	560.0	560.0	
- BOD (mg/L) - TSS (mg/L)		2.6 0.1	4.0 0.5	54.3 0.5	
- NH3-N (mg/L)		5.0	2.7	30.0	
- Treated Water Quality:		40.0	40.0	40.0	
- TDS (mg/L) - BOD (mg/L)		18.0 1.5	19.8 2.4	19.8 3.2	
- TSS (mg/L)		0.0 0.2	0.0 0.1	0.0	
- NH3-N (mg/L)		0.2	0.1	1.4	
<ul><li>Reject Stream</li><li>Flowrate (gpm)</li></ul>		613	613	613	
- TDS (mg/L)		3,298	3,621	3,621	
<ul><li>BOD (mg/L)</li><li>TSS (mg/L)</li></ul>		8.7 0.4	13.3 3.0	344.2 3.2	
- NH3-N (mg/L)		32.0	17.3	192.0	
Disinfection - Percent Flow	100%	33%	33%	33%	
- Flowrate (gpm)	5208	1,736	1,736	1,736	
- Chlorine Dose (mg/L)	10	10	10	10	
<ul><li>Treated Water Quality:</li><li>TDS (mg/L)</li></ul>	510.0	510.0	510.0	510.0	
- BOD (mg/L)	8.0	8.0	8.0	8.0	
- TSS (mg/L) - NH3-N (mg/L)	0.8 5.0	0.8 5.0	0.8 5.0	0.8 5.0	
UV/AOP					
<ul><li>Flowrate (gpm)</li><li>Peroxide Dose (mg/L)</li></ul>		3472.4 15.0	3472.4 15.0	3472.4 15.0	
- Treated Water Quality:					
- TDS (mg/L) - BOD (mg/L)		18.0 1.5	19.8 2.4	19.8 3.2	
- TSS (mg/L)		0.0	0.0	0.0	
- NH3-N (mg/L)		0.2	0.1	1.4	
- Final Treated Water:					
<ul> <li>Treated Water Quality: Advanced</li> <li>Flowrate (gpm)</li> </ul>		3472.40	3472.40	3472.40	
- Flowrate (gpm) - Flowrate (mgd)		5.00	5.00	5.00	
<ul><li>Flowrate (AF/yr)</li><li>TDS (mg/L)</li></ul>		5601.00 18.00	5601.00 19.76	5601.00 19.76	
- BOD (mg/L)		1.53	2.35	3.20	
- TSS (mg/L) - NH3-N (mg/L)		0.00 0.24	0.01 0.13	0.01 1.41	
- Treated Water Quality: Conventional					
- Flowate (gpm)	5,208.33	1,735.94		1,735.94	5,208.33
- Flowrate (mgd) - Flowrate (AF/yr)	7.50 8401.08	2.50 2800.08	2.50 2800.08	2.50 2800.08	
- TDS (mg/L)	510.00	510.00	510.00	510.00	
<ul><li>BOD (mg/L)</li><li>TSS (mg/L)</li></ul>	8.00 0.80	8.00 0.80		8.00 0.80	
- NH3-N (mg/L)	5.00	5.00	5.00	5.00	
Cost Calculations:					
- Capital Costs - Incremental Cost					
- Equipment - Tertiary Filtration					
- Unit Cost of Filter Equipment (\$/gal)	0.40	0.40	0.40	0.40	Based on recent Auga Quotes (SCATT and SJ). Not installed cost
- Filter Equipment and Piping Cost (\$)	3,061,224	1,020,306	1,020,306	1,020,306	
- Microfiltration					
<ul> <li>Unit Cost of Microfiltration Equipment (\$/gal)</li> <li>Microfiltration Equipment Cost (\$)</li> </ul>		0.90 5,754,763		1.15 7,353,309	cost estimated from quote from Pall
		.,. = .,, 00		, ,,,,,,,,,,	

Alternatives:			Option 1	Treatment Option Option 4	Option 5	Option 6	
Descript	tion:		Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
	- Piping (\$)	10%		575,476		735,331	_
-	MBR						leadelled and Indiades Character Applies having
	- Unit Cost of MBR (\$/gal)				4.10		Installed cost. Includes Fine screens, Aeration basins, membranes, etc. From MBR Cost Curve.
	- MBR Equipment Cost (\$)	2%			24,118,853 482,377		
	- Piping (\$)	270			402,377		
-	RO - Unit Cost of RO Equipment (\$/gal)			0.85	0.85	1.05	Installed Cost
	- RO Equipment Cost (\$)			4,250,213	4,250,213	5,250,263	
	- Piping (\$)	15%		637,532	637,532	787,539	
-	UV/AOP						Est Form accord Toring III/ accident leadelled Ocal form
	- Uint Cost of UV/AOP Equipment (\$/gal)			0.30	0.30	0.30	Est. From recent Trojan UV project. Installed Cost fror Coombs-Hopkins
	- UV/AOP Equipment Cost (\$) - Piping (\$)	10%		1,500,075 150,008	1,500,075 150,008	1,500,075 150,008	
	- Tiping (ψ)	1078		130,000	130,000	130,000	
-	Disinfection - Volume to SWD (ft^3)		83,556	27,849	27,849	27,849	Use in Carollo Cost Curve.
							Number from Carollo Cost Curve Need to update whe
	- Value from Carollo Cost curve (\$/ft^3)		37	40	40	40	flows change.  Installed cost. Includes general conditions, sitework,
							structure, metals, finishes, equipment, mechanical,
	- Disinfection Equipment Cost (\$)		\$3,540,378	\$1,278,788	\$1,278,788	\$1,278,788	startup, contractor O&P.
-	Denitrification		0.05				
	<ul> <li>Unit Cost of Denitrification Equipment (\$/gal)</li> <li>Denitrification Equipment Cost (\$)</li> </ul>		0.65 4,875,000				
	- Piping (\$)	15%	731,250				
- S	ubtotal Equipment Cost (\$)		\$12,207,853	\$15,167,161	\$33,438,151	\$18,075,619	
- B	uilding/Structure						
-	Tertiary Filtration						From Moreno Valley. Structure designed for 8 filters. N
	- Unit Area of Filter Equipment (sf/mgd)		550	550	550	550	installed cost
	<ul><li>Unit Cost of Structure (\$/sf)</li><li>Structure Cost (\$)</li></ul>		100 825,000	100 165,000	100 165,000	100 165,000	
	Microfiltration - Unit Area of Microfiltration Structure (sf/mgd)			1000		1100	
	<ul><li>Unit Cost of Structure (\$/sf)</li><li>Structure Cost (\$)</li></ul>			150 2,505,000		150 2,755,500	
				2,303,000		2,733,300	
-	MBR - Unit Area of MBR Equipment (sf/mgd)						See above installed cost for MBR System
	- Unit Cost of Structure (\$/sf)				0		
	- Structure Cost (\$)				0		
-	RO - Unit Area of RO Equipment (sf/mgd)			1500	1500	1500	
	- Unit Cost of Structure (\$/sf)			150	150	150	Installed cost.
	- Structure Cost (\$)			3,195,000	3,195,000	3,195,000	
-	UV/AOP						
	<ul> <li>Unit Area of UV/AOP Equipment (sf/mgd)</li> <li>Unit Cost of Structure (\$/sf)</li> </ul>						Structure Costs included above
	- Structure Cost (\$)			0	0	0	
-	Disinfection						
	<ul> <li>Unit Area of Disinfection Equipment (sf/mgd)</li> <li>Unit Cost of Structure (\$/sf)</li> </ul>		See Above estima	ate			
	- Structure Cost (\$)						
- SI	ubtotal Structure Cost (\$)		\$825,000	\$5,865,000	\$3,360,000	\$6,115,500	
	quipment Installation						
			4				
	lectrical estrumentation	10% 5%	\$1,303,285 \$651,643	\$2,103,216 \$1,051,608	\$3,679,815 \$1,839,908	\$2,419,112 \$1,209,556	
	ub-total	400/	\$14,987,781	\$24,186,985 \$2,418,699	\$42,317,874 \$4,231,787	\$27,819,786	
	ite Work - grading, paving, yard pipes etc ub-total - Direct Cost	10%	\$1,498,778 \$16,486,559	\$26,605,684	\$46,549,661	\$2,781,979 \$30,601,765	
	ontingency (Missed Items) ub-Total	25%	\$4,121,640 \$20,608,198	\$6,651,421 \$33,257,105	\$11,637,415 \$58,187,077	\$7,650,441 \$38,252,206	
- C	ontractor General Conditions	2%	\$412,164	\$665,142	\$1,163,742	\$765,044	
	ub-Total ontractor Overhead and Profit	10%	\$21,020,362 \$2,102,036	\$33,922,247 \$3,392,225	\$59,350,818 \$5,935,082	\$39,017,250 \$3,901,725	
- SI	ub-Total		\$23,122,399	\$37,314,472	\$65,285,900	\$42,918,975	
	ales Tax ub-Total	9.00%	\$927,369 \$24,049,768	\$1,496,570 \$38,811,041	\$2,618,418 \$67,904,319	\$1,721,349 \$44,640,325	
- E	scalation to Mid Point (%/yr)	0%	\$0	\$0	\$0	\$0	
	id Market Allowance ub-total - Construction Cost	0%	\$0 \$24,049,768	\$0 \$38,811,041	\$0 \$67,904,319	\$0 \$44,640,325	
- D	esign Engineering	10%	\$2,404,977	\$3,881,104	\$6,790,432	\$4,464,032	
	onstruction Management egal and Administration	10% 10%	\$2,404,977 \$2,404,977	\$3,881,104 \$3,881,104	\$6,790,432 \$6,790,432	\$4,464,032 \$4,464,032	
- Le			\$31,264,698	\$50,454,354	\$88,275,614	\$58,032,422	

Alternatives:	San Bernardino Option 1	Treatment Option Option 4	Option 5	Option 6	
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	
- Ammortization of Capital					
- Period (years)	20	20	20	20	
<ul> <li>Annual Average Interest Rate (%)</li> </ul>	6%	6%	6%	6%	
- Annual Payment (\$)	\$2,725,799	\$4,398,840	\$7,696,270	\$5,059,531	
- Unit Cost of Capital (\$/AF)	\$324	\$524	\$916	\$602	

Alternatives:	San Bernardino Option 1	Treatment Option Option 4	Option 5	Option 6	
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
Mass Balance for Treatment System:					_
Feed Water to ozonation system - Treated water flowrate (mgd)	5	5	5	5	
- Treated water flowrate (gpm)	3,472	3,472	3,472	3,472	
- Ultimate Capacity (mgd)	12.2	16.7	16.7	16.7	
First Well Input - Feed Stream	Secondary	Secondary	Primary	Primary	
- Influent Flow (mgd)	5.1	6.4	5.9	6.4	
- Influent Flow (gpm)	3,543	4,440	4,085	4,440	
- Color (c.u.) - Chloride (mg/L)		0 0		0	
- Bromide (ug/L)		0		0	
- TOC (mg/L)		0.0	000	0.0	
<ul><li>Alkalinity (mg/L CaCO3 - Total)</li><li>EC</li></ul>		0 0	300	0	
- Fluoride (mg/L)		0.00		0.00	
<ul><li>Total Hardness (mg/L)</li><li>pH</li></ul>		0 0.00		0 0.00	
- pH - Sulfate (mg/L)		0.00		0.00	
- Sodium (mg/L)		0		0	
<ul><li>Nitrate (mg/L)</li><li>Calcium (mg/L)</li></ul>		0.0 0		0.0 0	
- Potassium (mg/L)		0.0		0.0	
- Magnesium (mg/L)	540	0.0	500	0.0	Est from plant data
- TDS (mg/L) - BOD (mg/L)	510 16	510 16	560 200	560 200	Est. from plant data Est. from plant data
- TSS (mg/L)	2	2	90	90	Est. from plant data
- NH3-N (mg/L) - COD (mg/L)	5 45	5 45	30 450	30 450	Est. from plant data Est. from plant data
- COD (mg/L)	45	45	450	430	Est. Horri piant data
Tertiary Filtration		_			
<ul><li>Alum Dose (mg/L)</li><li>Flow (gpm)</li></ul>	2 3543	2	2 0	0	
- BOD removal (%)	50%	50%	50%	50%	
- TSS removal (%)	60%	60%	60%	60%	Default from BioTran
- Recovery (%)	98%	98%	98%	98%	Average backwash flow over one hour period. Estimated as 4 filters backwashing every 20 min.
Filtered Water Quality					,
<ul><li>Flow (gpm)</li><li>TDS (mg/L)</li></ul>	3472 510	0 510	0 510	0 510	
- BOD (mg/L)	8	8	8	8	
- TSS (mg/L)	1	1	1	1	
- NH3-N (mg/L)	5	5	5	5	
Backwash Water Quality					
- Flow (gpm)	71	0	0	0	Average backwash flow over one hour period. Estimated as 4 filters backwashing every 20 min.
- TDS (mg/L)	510	510	510	510	
- BOD (mg/L) - TSS (mg/L)	400 60	#DIV/0! #DIV/0!	#DIV/0! #DIV/0!	#DIV/0! #DIV/0!	
<ul><li>TSS (mg/L)</li><li>NH3-N (mg/L)</li></ul>	5	#DIV/0:	#DIV/0!	#DIV/0:	
Microfiltration					
- Flowrate (gpm)		4,440		4,440	MF recycle will increse Secondary flow
- Recovery (%)		92%		92%	
<ul><li>Treated Water Flowrate (gpm)</li><li>BOD removal (%)</li></ul>		4,085 85%		4,085 75%	% reduction from Metcalf & Eddy
- TSS removal (%)		97%		100%	% reduction from Metcalf & Eddy
<ul><li>Feed Water Quality:</li><li>TDS (mg/L)</li></ul>		E40		560	
- TDS (mg/L) - BOD (mg/L)		510 16		200	
- TSS (mg/L)		2		90	
- NH3-N (mg/L)		5		30	
- Treated Water Quality:					
- TDS (mg/L)		510		560	
- BOD (mg/L) - TSS (mg/L)		2.6 0.1		54.3 0.5	
- NH3-N (mg/L)		5		30	
- Reject Stream					
- Flowrate (gpm)		355		355	
- TDS (mg/L) - BOD (mg/L)		510 170.0		560 1875.0	
- TSS (mg/L)		24.3		1119.4	
- NH3-N (mg/L)		5		30	
Membrane Bio Reactor (MBR)					
- Flowrate (gpm)			4,085		
- Recovery (%)			100%		
<ul><li>Treated Water Flowrate (gpm)</li><li>BOD removal (%)</li></ul>			4,085 98%		Estimate from Metcalf and Eddy
- TSS removal (%)			99.5%		Estimate from Metcalf and Eddy
- NH3-N removal (%)			91%		Estimate from Metcalf and Eddy
- Feed Water Quality:					
- TDS (mg/L)			560		
- BOD (mg/L) - TSS (mg/L)			200 90		
· (···ʊ -)					

Alternatives:	San Bernardino Treatment Options Option 1 Option 4 Option 5			Option 6	
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
- NH3-N (mg/L)			30		_
- Treated Water Quality: - TDS (mg/L) - BOD (mg/L) - TSS (mg/L) - NH3-N (mg/L)			560 4 0.45 2.7		
Reverse Osmosis (RO) Percent Flow		100%	100%	100%	Insert flow split here
- Flowrate (gpm)		4,085	4,085	4,085	Value from Rosa Membrane software
<ul><li>Recovery (%)</li><li>Treated Water Flowrate (gpm)</li></ul>		85% 3,472	85% 3,472	85% 3,472	
- TDS removal (%) - BOD removal (%)		97% 50%	97% 50%	97% 95%	% reduction from Metcalf & Eddy % reduction from Metcalf & Eddy
- TSS removal (%) - NH3-N removal (%)		99% 96%	99% 96%	99% 96%	% reduction from Metcalf & Eddy % reduction from Metcalf & Eddy
- Feed Water Quality:					78 reduction from welcan & Eddy
- TDS (mg/L) - BOD (mg/L)		510.0 2.6	560.0 4.0	560.0 54.3	
- TSS (mg/L) - NH3-N (mg/L)		0.1 5.0	0.5 2.7	0.5 30.0	
		0.0	2	00.0	
<ul><li>Treated Water Quality:</li><li>TDS (mg/L)</li></ul>		18.0	19.8	19.8	
- BOD (mg/L) - TSS (mg/L)		1.5 0.0	2.4 0.0	3.2 0.0	
- NH3-N (mg/L)		0.2	0.1	1.4	
- Reject Stream - Flowrate (gpm)		613	613	613	
- TDS (mg/L)		3,298	3,621	3,621	
- BOD (mg/L) - TSS (mg/L)		8.7 0.4	13.3 3.0	344.2 3.2	
- NH3-N (mg/L)		32.0	17.3	192.0	
Disinfection - Percent Flow	100%	0%	0%	0%	
- Flowrate (gpm)	3472	0	0	0	
- Chlorine Dose (mg/L)	10	10	10	10	
<ul><li>Treated Water Quality:</li><li>TDS (mg/L)</li></ul>	510.0	510.0	510.0	510.0	
- BOD (mg/L) - TSS (mg/L)	8.0	8.0	8.0	8.0	
- NH3-N (mg/L)	0.8 5.0	0.8 5.0	0.8 5.0	0.8 5.0	
UV/AOP					
<ul><li>Flowrate (gpm)</li><li>Peroxide Dose (mg/L)</li></ul>		3472.2 15.0	3472.2 15.0	3472.2 15.0	
- Treated Water Quality:					
- TDS (mg/L) - BOD (mg/L)		18.0 1.5	19.8 2.4	19.8 3.2	
- TSS (mg/L)		0.0	0.0	0.0	
- NH3-N (mg/L)		0.2	0.1	1.4	
- Final Treated Water:					
<ul> <li>Treated Water Quality: Advanced</li> <li>Flowrate (gpm)</li> </ul>		3472.22	3472.22	3472.22	
<ul><li>Flowrate (mgd)</li><li>Flowrate (AF/yr)</li></ul>		5.00 5600.72	5.00 5600.72	5.00 5600.72	
- TDS (mg/L)		18.00	19.76	19.76	
- BOD (mg/L) - TSS (mg/L)		1.53 0.00	2.35 0.01	3.20 0.01	
- NH3-N (mg/L)		0.24	0.13	1.41	
<ul> <li>Treated Water Quality: Conventional</li> <li>Flowate (gpm)</li> </ul>	3,472.22				3,472.22
- Flowrate (mgd)	5.00	0.00	0.00	0.00	U;+1 E.EE
<ul><li>Flowrate (AF/yr)</li><li>TDS (mg/L)</li></ul>	5600.72 510.00	0.00 510.00	0.00 510.00	0.00 510.00	
- BOD (mg/L) - TSS (mg/L)	8.00 0.80	8.00 0.80	8.00 0.80	8.00 0.80	
- NH3-N (mg/L)	5.00	5.00	5.00	5.00	
Cost Calculations:					
- Capital Costs - Incremental Cost					
- Equipment - Tertiary Filtration					
- Unit Cost of Filter Equipment (\$/gal)	0.40	0.40	0.40	0.40	Based on recent Auqa Quotes (SCATT and SJ). Not installed cost
- Filter Equipment and Piping Cost (\$)	2,040,816	0	0	0	
<ul> <li>Microfiltration</li> <li>Unit Cost of Microfiltration Equipment (\$/gal)</li> </ul>		0.90		1.15	cost estimated from quote from Pall
- Microfiltration Equipment Cost (\$)		5,754,476		7,352,941	

Alternatives:		Option 1	reatment Option Option 4	Option 5	Option 6	_
Description:		Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
- Piping (\$)	10%		575,448		735,294	_
- MBR						Installed aget Institutes Fire agreems Agestion begins
- Unit Cost of MBR (\$/gal)				4.10		Installed cost. Includes Fine screens, Aeration basins, membranes, etc. From MBR Cost Curve.
- MBR Equipment Cost (\$)				24,117,647		
- Piping (\$)	2%			482,353		
- RO						
<ul><li>Unit Cost of RO Equipment (\$/gal)</li><li>RO Equipment Cost (\$)</li></ul>			0.85 4,250,000	0.85 4,250,000	1.05 5,250,000	Installed Cost
- RO Equipment Cost (\$) - Piping (\$)	15%		637,500	637,500	787,500	
- UV/AOP						Est. From recent Trojan UV project. Installed Cost from
- Uint Cost of UV/AOP Equipment (\$/gal)			0.30	0.30	0.30	Coombs-Hopkins
<ul><li>UV/AOP Equipment Cost (\$)</li><li>Piping (\$)</li></ul>	10%		1,500,000 150,000	1,500,000 150,000	1,500,000 150,000	
- Piping (\$)	10%		150,000	150,000	150,000	
- Disinfection						
- Volume to SWD (ft <sup>3</sup> )		89,127	0	0	0	Use in Carollo Cost Curve.  Number from Carollo Cost Curve Need to update wher
- Value from Carollo Cost curve (\$/ft^3)		35	40	40	40	flows change.
						Installed cost. Includes general conditions, sitework,
- Disinfection Equipment Cost (\$)		\$3,572,274	\$0	\$0	\$0	structure, metals, finishes, equipment, mechanical, startup, contractor O&P.
Bioinication Equipment Goot (4)		ψο,οτ Σ,Στ .	Ψū	Ų0	<b>Q</b> 0	startup, commusion our .
- Denitrification		0.05				
<ul> <li>Unit Cost of Denitrification Equipment (\$/gal)</li> <li>Denitrification Equipment Cost (\$)</li> </ul>		0.65 3,250,000	0	0	0	
- Piping (\$)	15%	487,500				
- Subtotal Equipment Cost (\$)		\$9,350,590	\$12,867,423	\$31,137,500	\$15,775,735	
- Subtotal Equipment Cost (4)		ψ3,330,330	\$12,007,423	\$31,137,300	\$13,773,733	
- Building/Structure - Tertiary Filtration						
•						From Moreno Valley. Structure designed for 8 filters. N
<ul><li>Unit Area of Filter Equipment (sf/mgd)</li><li>Unit Cost of Structure (\$/sf)</li></ul>		550 100	550 100	550 100	550 100	installed cost
- Structure Cost (\$)		0	0	0	0	
- Microfiltration						
- Unit Area of Microfiltration Structure (sf/mgd)			1000		1100	
- Unit Cost of Structure (\$/sf)			150		150	
- Structure Cost (\$)			0		0	
- MBR						
<ul><li>Unit Area of MBR Equipment (sf/mgd)</li><li>Unit Cost of Structure (\$/sf)</li></ul>						See above installed cost for MBR System
- Structure Cost (\$)				0		
- RO						
<ul> <li>Unit Area of RO Equipment (sf/mgd)</li> </ul>			1500	1500	1500	
- Unit Cost of Structure (\$/sf)			150	150	150	Installed cost.
- Structure Cost (\$)			0	0	0	
- UV/AOP						<b>-</b> 0 0
<ul><li>Unit Area of UV/AOP Equipment (sf/mgd)</li><li>Unit Cost of Structure (\$/sf)</li></ul>						Structure Costs included above
- Structure Cost (\$)			0	0	0	
- Disinfection						
- Unit Area of Disinfection Equipment (sf/mgd)		See Above estima	te			
- Unit Cost of Structure (\$/sf)						
- Structure Cost (\$)						
- Subtotal Structure Cost (\$)		\$0	\$0	\$0	\$0	
- Equipment Installation						
- Electrical - Instrumentation	10% 5%	\$935,059 \$467,529	\$1,286,742 \$643,371	\$3,113,750 \$1,556,875	\$1,577,574 \$788,787	
- Sub-total		\$10,753,178	\$14,797,537	\$35,808,125	\$18,142,096	
- Site Work - grading, paving, yard pipes etc	5%	\$537,659 \$11,200,837	\$739,877 \$15,537,414	\$1,790,406 \$37,598,531	\$907,105	
- Sub-total - Direct Cost - Contingency (Missed Items)	25%	\$11,290,837 \$2,822,709	\$15,537,414 \$3,884,353	\$37,598,531 \$9,399,633	\$19,049,200 \$4,762,300	
- Sub-Total		\$14,113,547	\$19,421,767	\$46,998,164	\$23,811,500	
- Contractor General Conditions - Sub-Total	2%	\$282,271 \$14,395,818	\$388,435 \$19,810,202	\$939,963 \$47,938,127	\$476,230 \$24,287,730	
- Contractor Overhead and Profit	10%	\$14,395,818 \$1,439,582	\$19,810,202	\$47,938,127 \$4,793,813	\$24,287,730	
- Sub-Total		\$15,835,399	\$21,791,223	\$52,731,940	\$26,716,504	
- Sales Tax - Sub-Total	9.00%	\$635,110 \$16,470,509	\$873,980 \$22,665,202	\$2,114,917 \$54,846,857	\$1,071,518 \$27,788,021	
- Escalation to Mid Point (%/yr)	0%	\$0	\$0	\$0	\$0	
- Bid Market Allowance	0%	\$0	\$0	\$0	\$0	
- Sub-total - Construction Cost - Design Engineering	10%	\$16,470,509 \$1,647,051	\$22,665,202 \$2,266,520	\$54,846,857 \$5,484,686	\$27,788,021 \$2,778,802	
Design Engineering	10%	\$1,647,051	\$2,266,520	\$5,484,686	\$2,778,802	
- Construction Management						
- Construction Management - Legal and Administration - Estimated Total Project Cost	10%	\$1,647,051 <b>\$21,411,662</b>	\$2,266,520 <b>\$29,464,763</b>	\$5,484,686 <b>\$71,300,915</b>	\$2,778,802 <b>\$36,124,427</b>	

Alternatives:	San Bernardino Option 1	Treatment Option Option 4	S Option 5	Option 6
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS
- Ammortization of Capital				
- Period (years)	20	20	20	20
- Annual Average Interest Rate (%)	6%	6%	6%	6%
A	\$1,866,766	\$2,568,872	\$6,216,339	\$3,149,492
- Annual Payment (\$)	φ1,000,700			

Alternatives:	San Bernardino Option 1	Treatment Option Option 4	Option 5	Option 6	_
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
Mass Balance for Treatment System: Feed Water to ozonation system					<del>-</del>
- Treated water flowrate (mgd)	2.2	4.2	4.2	4.2	
- Treated water flowrate (gpm)	1,528	2,917	2,917	2,917	
- Ultimate Capacity (mgd)	12.2	16.7	16.7	16.7	
First Well Input - Feed Stream	Secondary	Secondary	Primary	Primary	
- Influent Flow (mgd)	2.2	5.4	4.9	5.4	
- Influent Flow (gpm) - Color (c.u.)	1,559	3,730 0	3,431	3,730	
<ul><li>Color (c.u.)</li><li>Chloride (mg/L)</li></ul>		0		0	
- Bromide (ug/L)		0		0	
<ul><li>TOC (mg/L)</li><li>Alkalinity (mg/L CaCO3 - Total)</li></ul>		0.0 0	300	0.0 0	
- EC		0	000	0	
- Fluoride (mg/L)		0.00		0.00	
<ul><li>Total Hardness (mg/L)</li><li>pH</li></ul>		0 0.00		0 0.00	
- Sulfate (mg/L)		0		0	
<ul><li>Sodium (mg/L)</li><li>Nitrate (mg/L)</li></ul>		0 0.0		0 0.0	
<ul><li>Nitrate (mg/L)</li><li>Calcium (mg/L)</li></ul>		0.0		0.0	
- Potassium (mg/L)		0.0		0.0	
<ul><li>Magnesium (mg/L)</li><li>TDS (mg/L)</li></ul>	510	0.0 510	560	0.0 560	Est. from plant data
- BOD (mg/L)	16	16	200	200	Est. from plant data
- TSS (mg/L)	2	2	90	90	Est. from plant data
- NH3-N (mg/L) - COD (mg/L)	5 45	5 45	30 450	30 450	Est. from plant data Est. from plant data
005 (g.z)	10	.0	100	100	Lot from plant data
Tertiary Filtration - Alum Dose (mg/L)	2	2	2	2	
- Flow (gpm)	1559	0	0	0	
- BOD removal (%)	50%	50%	50%	50%	D ( )/( D) T
- TSS removal (%)	60%	60%	60%	60%	Default from BioTran Average backwash flow over one hour period. Estimated
- Recovery (%)	98%	98%	98%	98%	as 4 filters backwashing every 20 min.
Filtered Water Quality - Flow (gpm)	1528	0	0	0	
- TDS (mg/L)	510	510	510	510	
- BOD (mg/L) - TSS (mg/L)	8 1	8 1	8 1	8 1	
- NH3-N (mg/L)	5	5	5	5	
Backwash Water Quality					
					Average backwash flow over one hour period. Estimated
- Flow (gpm)	31 510	0 510	0 510	0 510	as 4 filters backwashing every 20 min.
- TDS (mg/L) - BOD (mg/L)	400	#DIV/0!	#DIV/0!	#DIV/0!	
- TSS (mg/L)	60	#DIV/0!	#DIV/0!	#DIV/0!	
- NH3-N (mg/L)	5	5	5	5	
Microfiltration		0.700		0.700	
<ul><li>Flowrate (gpm)</li><li>Recovery (%)</li></ul>		3,730 92%		3,730 92%	MF recycle will increse Secondary flow
- Treated Water Flowrate (gpm)		3,431		3,431	
- BOD removal (%)		85%		75%	% reduction from Metcalf & Eddy
<ul><li>TSS removal (%)</li><li>Feed Water Quality:</li></ul>		97%		100%	% reduction from Metcalf & Eddy
- TDS (mg/L)		510		560	
- BOD (mg/L) - TSS (mg/L)		16 2		200 90	
- NH3-N (mg/L)		5		30	
- Treated Water Quality:					
- TDS (mg/L)		510		560	
- BOD (mg/L)		2.6		54.3	
<ul><li>TSS (mg/L)</li><li>NH3-N (mg/L)</li></ul>		0.1 5		0.5 30	
		-			
- Reject Stream - Flowrate (gpm)		298		298	
- TDS (mg/L)		510		560	
- BOD (mg/L)		170.0		1875.0	
- TSS (mg/L) - NH3-N (mg/L)		24.3 5		1119.4 30	
		Ŭ		50	
Membrane Bio Reactor (MBR) - Flowrate (gpm)			3,431		
- Recovery (%)			100%		
- Treated Water Flowrate (gpm) - BOD removal (%)			3,431		Estimate from Matcelf and Eddy
- BOD removal (%) - TSS removal (%)			98% 99.5%		Estimate from Metcalf and Eddy Estimate from Metcalf and Eddy
- NH3-N removal (%)			91%		Estimate from Metcalf and Eddy
- Feed Water Quality:					
- TDS (mg/L)			560		
- BOD (mg/L) - TSS (mg/L)			200 90		
. 55 (g.=)			50		

Alternatives:	San Bernardino Option 1	Treatment Optior Option 4	Option 6		
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
- NH3-N (mg/L)			30		_
- Treated Water Quality:					
- TDS (mg/L) - BOD (mg/L)			560 4		
- TSS (mg/L)			0.45		
- NH3-N (mg/L)			2.7		
Reverse Osmosis (RO) Percent Flow		100%	100%	100%	Insert flow split here
- Flowrate (gpm)		3,431	3,431	3,431	
<ul><li>Recovery (%)</li><li>Treated Water Flowrate (gpm)</li></ul>		85% 2,917	85% 2,917	85% 2,917	Value from ROSA membrane software
- TDS removal (%)		97%	97%	97%	% reduction from Metcalf & Eddy
- BOD removal (%) - TSS removal (%)		50% 99%	50% 99%	95% 99%	% reduction from Metcalf & Eddy % reduction from Metcalf & Eddy
- NH3-N removal (%) - Feed Water Quality:		96%	96%	96%	% reduction from Metcalf & Eddy
- TDS (mg/L)		510.0	560.0	560.0	
- BOD (mg/L) - TSS (mg/L)		2.6 0.1	4.0 0.5	54.3 0.5	
- NH3-N (mg/L)		5.0	2.7	30.0	
- Treated Water Quality:					
- TDS (mg/L)		18.0	19.8	19.8	
- BOD (mg/L) - TSS (mg/L)		1.5 0.0	2.4 0.0	3.2 0.0	
- NH3-N (mg/L)		0.2	0.1	1.4	
- Reject Stream					
<ul><li>Flowrate (gpm)</li><li>TDS (mg/L)</li></ul>		515 3,298	515 3,621	515 3,621	
- BOD (mg/L)		8.7	13.3	344.2	
- TSS (mg/L) - NH3-N (mg/L)		0.4 32.0	3.0 17.3	3.2 192.0	
Disinfection - Percent Flow	100%	0%	0%	0%	
<ul><li>Flowrate (gpm)</li><li>Chlorine Dose (mg/L)</li></ul>	1528 10	0 10	0 10	0 10	
	10	10	10	10	
<ul><li>Treated Water Quality:</li><li>TDS (mg/L)</li></ul>	510.0	510.0	510.0	510.0	
- BOD (mg/L)	8.0	8.0	8.0	8.0	
- TSS (mg/L) - NH3-N (mg/L)	0.8 5.0	0.8 5.0	0.8 5.0	0.8 5.0	
UV/AOP					
- Flowrate (gpm)		2916.7	2916.7	2916.7	
- Peroxide Dose (mg/L)		15.0	15.0	15.0	
- Treated Water Quality:		40.0	40.0	40.0	
<ul><li>TDS (mg/L)</li><li>BOD (mg/L)</li></ul>		18.0 1.5	19.8 2.4	19.8 3.2	
- TSS (mg/L)		0.0	0.0	0.0	
- NH3-N (mg/L)		0.2	0.1	1.4	
- Final Treated Water:					
- Treated Water Quality: Advanced			2045-5-	204	
<ul><li>Flowrate (gpm)</li><li>Flowrate (mgd)</li></ul>		2916.67 4.20	2916.67 4.20	2916.67 4.20	
- Flowrate (AF/yr)		4704.60	4704.60	4704.60	
<ul><li>TDS (mg/L)</li><li>BOD (mg/L)</li></ul>		18.00 1.53	19.76 2.35	19.76 3.20	
- TSS (mg/L)		0.00	0.01	0.01	
- NH3-N (mg/L)		0.24	0.13	1.41	
Treated Water Quality: Conventional     Flowate (gpm)	1,527.78				2,916.67
- Flowrate (mgd)	2.20	0.00	0.00	0.00	2,010.07
<ul><li>Flowrate (AF/yr)</li><li>TDS (mg/L)</li></ul>	2464.32 510.00	0.00 510.00	0.00 510.00	0.00 510.0	0
- BOD (mg/L)	8.00	8.00	8.00	8.0	0
- TSS (mg/L) - NH3-N (mg/L)	0.80 5.00	0.80 5.00		0.8 5.0	
Cost Calculations:					
- Capital Costs - Incremental Cost					
- Equipment					
- Tertiary Filtration					Based on recent Auga Quotes (SCATT and SJ). Not
- Unit Cost of Filter Equipment (\$/gal)	0.40	0.40	0.40	0.40	installed cost
- Filter Equipment and Piping Cost (\$)	897,959	0	0	0	
<ul> <li>Microfiltration</li> <li>Unit Cost of Microfiltration Equipment (\$/gal)</li> </ul>		0.90		1.15	cost estimated from quote from Pall
Microfiltration Equipment Cost (\$)		4,833,760		6,176,471	and the state of t

Iternatives:	1	San Bernardino T Option 1	reatment Option Option 4	S Option 5	Option 6	_
escription:		Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS	Notes
- Piping (\$)	10%		483,376		617,647	_
- MBR						Installed cost. Includes Fine screens, Aeration basins,
- Unit Cost of MBR (\$/gal)				4.10		membranes, etc. From MBR Cost Curve.
<ul><li>MBR Equipment Cost (\$)</li><li>Piping (\$)</li></ul>	2%			20,258,824 405,176		
- RO						
<ul><li>Unit Cost of RO Equipment (\$/gal)</li><li>RO Equipment Cost (\$)</li></ul>			0.85 3,570,000	0.85 3,570,000	1.05 4,410,000	Installed Cost
- Piping (\$)	15%		535,500	535,500	661,500	
- UV/AOP						Fat From recent Traign IIV project Installed Cost from
- Uint Cost of UV/AOP Equipment (\$/gal)			0.30	0.30	0.30	Est. From recent Trojan UV project. Installed Cost from Coombs-Hopkins
<ul><li>UV/AOP Equipment Cost (\$)</li><li>Piping (\$)</li></ul>	10%		1,260,000 126,000	1,260,000 126,000	1,260,000 126,000	
- Disinfection						
- Volume to SWD (ft^3)		89,127	0	0	0	Use in Carollo Cost Curve.  Number from Carollo Cost Curve Need to update when
- Value from Carollo Cost curve (\$/ft^3)		0	40	40	40	flows change.
						Installed cost. Includes general conditions, sitework, structure, metals, finishes, equipment, mechanical,
- Disinfection Equipment Cost (\$)		\$0	\$0	\$0	\$0	startup, contractor O&P.
<ul> <li>Denitrification</li> <li>Unit Cost of Denitrification Equipment (\$/gal)</li> </ul>		0.65				
- Denitrification Equipment Cost (\$)	450/	1,430,000	0	0	0	
- Piping (\$)	15%	214,500				
- Subtotal Equipment Cost (\$)		\$2,542,459	\$10,808,636	\$26,155,500	\$13,251,618	
- Building/Structure - Tertiary Filtration						
- Unit Area of Filter Equipment (sf/mgd)		550	550	550	550	From Moreno Valley. Structure designed for 8 filters. N installed cost
- Unit Cost of Structure (\$/sf)		100	100	100	100	
- Structure Cost (\$)		0	0	0	0	
<ul> <li>Microfiltration</li> <li>Unit Area of Microfiltration Structure (sf/mgd)</li> </ul>			1000		1100	
<ul><li>Unit Cost of Structure (\$/sf)</li><li>Structure Cost (\$)</li></ul>			150 0		150 0	
- MBR						
<ul> <li>Unit Area of MBR Equipment (sf/mgd)</li> </ul>						See above installed cost for MBR System
<ul><li>Unit Cost of Structure (\$/sf)</li><li>Structure Cost (\$)</li></ul>				0		
- RO						
<ul><li>Unit Area of RO Equipment (sf/mgd)</li><li>Unit Cost of Structure (\$/sf)</li></ul>			1500 150	1500 150	1500 150	Installed cost.
- Structure Cost (\$)			0	0	0	
- UV/AOP						Chrystyna Casta included shave
<ul><li>Unit Area of UV/AOP Equipment (sf/mgd)</li><li>Unit Cost of Structure (\$/sf)</li></ul>						Structure Costs included above
- Structure Cost (\$)			0	0	0	
<ul> <li>Disinfection</li> <li>Unit Area of Disinfection Equipment (sf/mgd)</li> </ul>		See Above estimat	te			
<ul><li>Unit Cost of Structure (\$/sf)</li><li>Structure Cost (\$)</li></ul>						
- Subtotal Structure Cost (\$)		\$0	\$0	\$0	\$0	
- Equipment Installation		<b>4</b> -	<b>4</b> 5	**	<b>4</b> 0	
- Electrical	100/	\$254,246	\$1.080.864	\$2 61E EEO	\$1,325,162	
- Instrumentation	10% 5%	\$127,123	\$540,432	\$2,615,550 \$1,307,775	\$662,581	
<ul><li>Sub-total</li><li>Site Work - grading, paving, yard pipes etc</li></ul>	5%	\$2,923,828 \$146,191	\$12,429,931 \$621,497	\$30,078,825 \$1,503,941	\$15,239,360 \$761,968	
- Sub-total - Direct Cost - Contingency (Missed Items)	25%	\$3,070,019 \$767,505	\$13,051,427 \$3,262,857	\$31,582,766 \$7,895,692	\$16,001,328 \$4,000,332	
- Sub-Total		\$3,837,524	\$16,314,284	\$39,478,458	\$20,001,660	
<ul><li>Contractor General Conditions</li><li>Sub-Total</li></ul>	2%	\$76,750 \$3,914,275	\$326,286 \$16,640,570	\$789,569 \$40,268,027	\$400,033 \$20,401,694	
- Contractor Overhead and Profit - Sub-Total	10%	\$391,427 \$4,305,702	\$1,664,057 \$18,304,627	\$4,026,803 \$44,294,830	\$2,040,169 \$22,441,863	
- Sales Tax	9.00%	\$172,689	\$734,143	\$1,776,531	\$900,075	
<ul><li>Sub-Total</li><li>Escalation to Mid Point (%/yr)</li></ul>	0%	\$4,478,391 \$0	\$19,038,770 \$0	\$46,071,360 \$0	\$23,341,938 \$0	
- Bid Market Allowance - Sub-total - Construction Cost	0%	\$0 \$4,478,391	\$0 \$19,038,770	\$0 \$46,071,360	\$0 \$23,341,938	
- Design Engineering	10%	\$447,839	\$1,903,877	\$4,607,136	\$2,334,194	
- Construction Management - Legal and Administration	10% 10%	\$447,839 \$447,839	\$1,903,877 \$1,903,877	\$4,607,136 \$4,607,136	\$2,334,194 \$2,334,194	
		\$5,821,908	\$24,750,401	\$59,892,768	\$30,344,519	

Alternatives:	San Bernardino  Option 1	Treatment Option Option 4	Option 5	Option 6
Description:	Conventional	MF/RO Hybrid	MBR/RO Hybrid	IMANS
- Ammortization of Capital	20	20	20	20
<ul> <li>Period (years)</li> <li>Annual Average Interest Rate (%)</li> <li>Annual Payment (\$)</li> </ul>	6% \$507,580	6% \$2,157,853	6% \$5,221,724	6% \$2,645,573

# Pumping and Pipeline Cost Estimate Finished Water Pump Station

5.00 5.00 5.00	3,472 3,472 3,472	201 201 198	407.1 407.1 401.0	303.6	%02 %02 %02	3,795,620 3,795,620 3,738,969	0.13 0.13 0.13	\$493,431 \$48	\$0.27 \$0.27 \$0.27
- Flowrate (mgd)	low (gpm)	Average Operating Pressure (psi)	Sumping Power (hp)	werage pump power, kW	Overall Efficiency (%)	h/y)	Power Cost (\$/kWh)	Power Cost (\$/year)	Power costs as \$/1000 gal

5.00 5.00 5.00 5.00 3.472 3.472 3.472 1472 201 201 407.1 198 407.1 407.1 401.0 303.6 303.6 299.1 70% 70% 70% 70% 3.795,620 3.795,620 3.738,969 0.13 6,493,431 \$493,431 \$486,066 \$5.07 10% \$470,000 \$415,000 \$2.00,000 10% \$470,000 \$415,000 \$200,000 10% \$470,000 \$415,000 \$200,000 10% \$470,000 \$415,000 \$200,000 10% \$470,000 \$415,000 \$200,000 10% \$470,000 \$415,000 \$200,000 10% \$470,000 \$415,000 \$200,000 10% \$415,000 \$200,000 10% \$415,000 \$200,000 10% \$415,000 \$200,000 10% \$415,000 \$200,000	2.50 1,736	240	243.1	181.2	%02	2,266,042	0.13	\$294,585	\$0.32						
5.00 3.472 201 407.1 303.6 70% 3,795.620 3,795.620 0.13 \$433,431 \$0.27 \$0.27 \$4,700,000 \$415.00 \$470,000 \$415.0 \$470,000 \$415.0 \$470,000 \$415.0 \$470,000 \$415.0 \$415.0	5.00 3,472	198	401.0	299.1	%02	3,738,969	0.13	\$486,066	\$0.27	2.5 mgd	\$2,000,000	\$200,000	\$200,000	\$200,000	\$2,600,000
3,795 <b>\$49</b> <b>\$47</b> 20 mg <b>\$4,700.0</b> <b>\$470.00</b> <b>\$470.00</b> <b>\$470.00</b>	5.00 3,472	201	407.1	303.6	%02	3,795,620	0.13	\$493,431	\$0.27	15 mgd	\$4,150,000	\$415,000	\$415,000	\$415,000	\$5,395,000
10%	5.00 3,472	201	407.1	303.6	%02	3,795,620	0.13	\$493,431	\$0.27	20 mgd	\$4,700,000	\$470,000	\$470,000	\$470,000	\$6,110,000
												10%	10%	10%	

36 in 30 in \$13,020,000 \$10,53,000 \$10,53,000 \$10,500

Construction Cost Est. from cost curve

See File Pipeline Cost Est Updated for Construction Cost Est.

Contractor Overhead and Profit **Contractor General Conditions** 

Sub-Total

Sub-Total Sales Tax

Sub-Total

Contingency (Missed Items) Sub-Total

Sub-total - Direct Cost

Pipeline costs

Escalation to Mid Point (%yr)

Sub-total - Construction Cost **Bid Market Allowance** 

Design Engineering
Construction Management
Legal and Administration
Estimated Total Project Cost

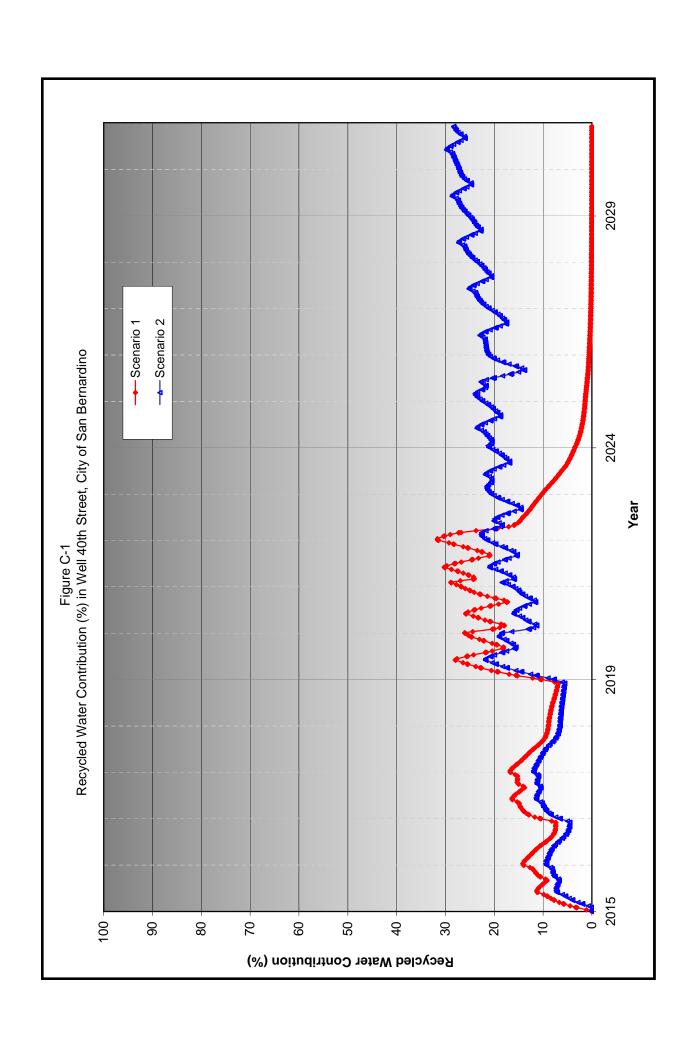
Construction Management Legal and Administration Estimated Total Project Cost

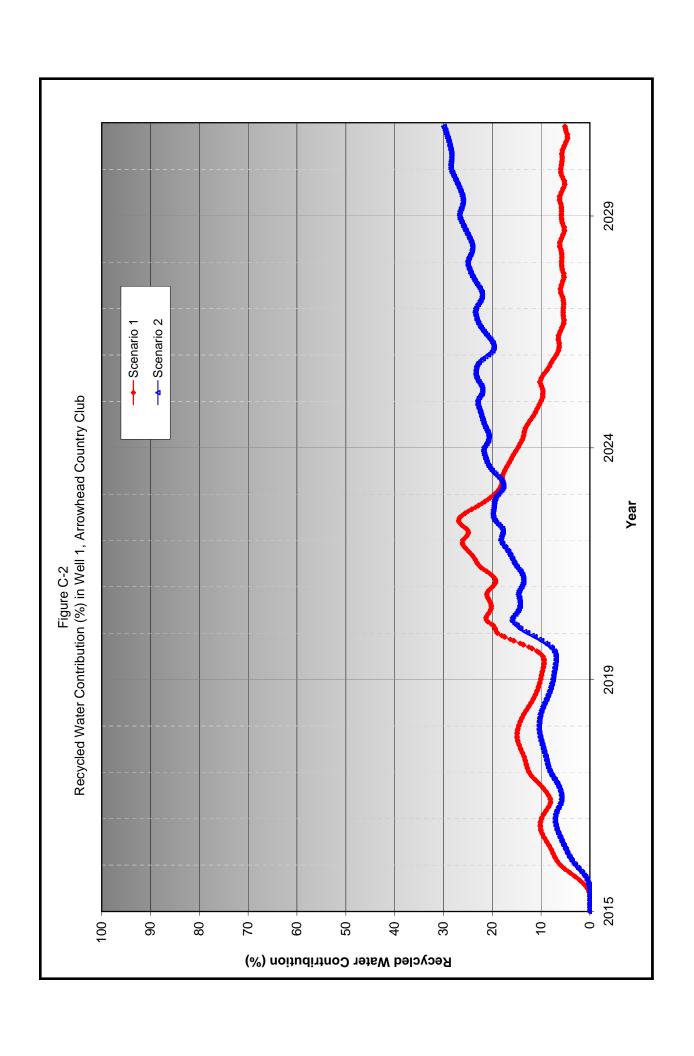
Sub-total - Construction Cost Design Engineering

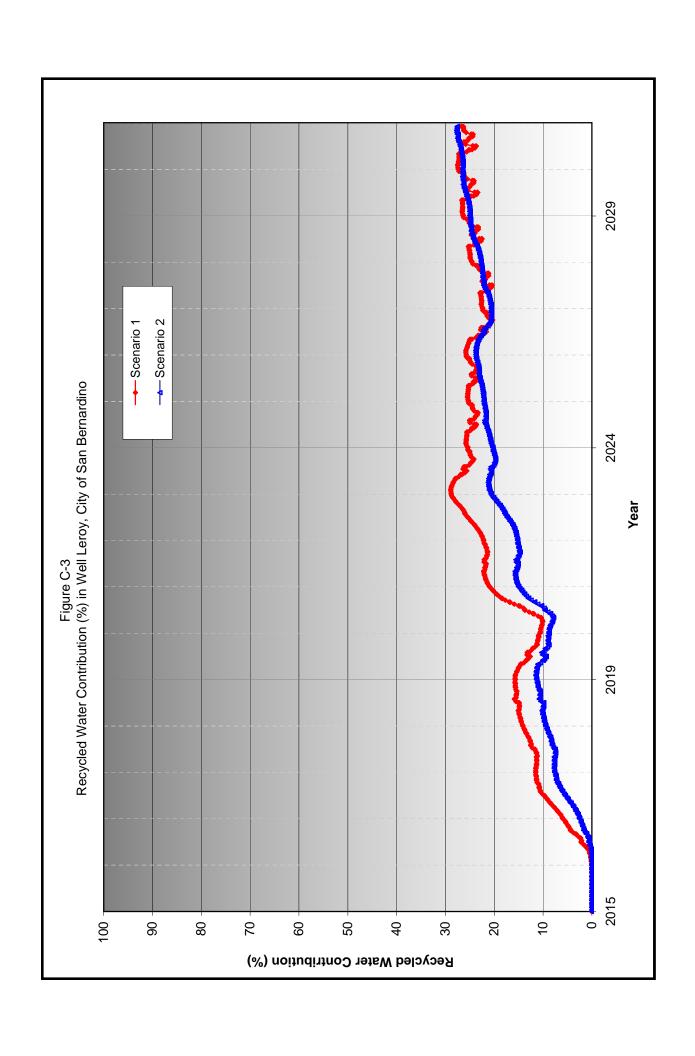
Pump Station Costs

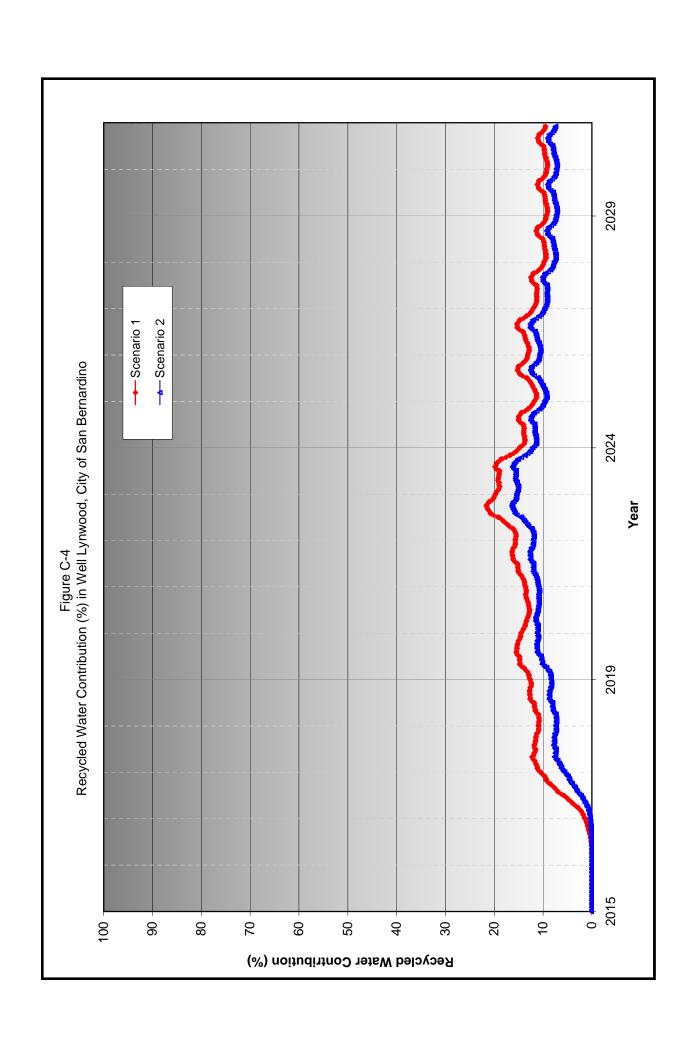


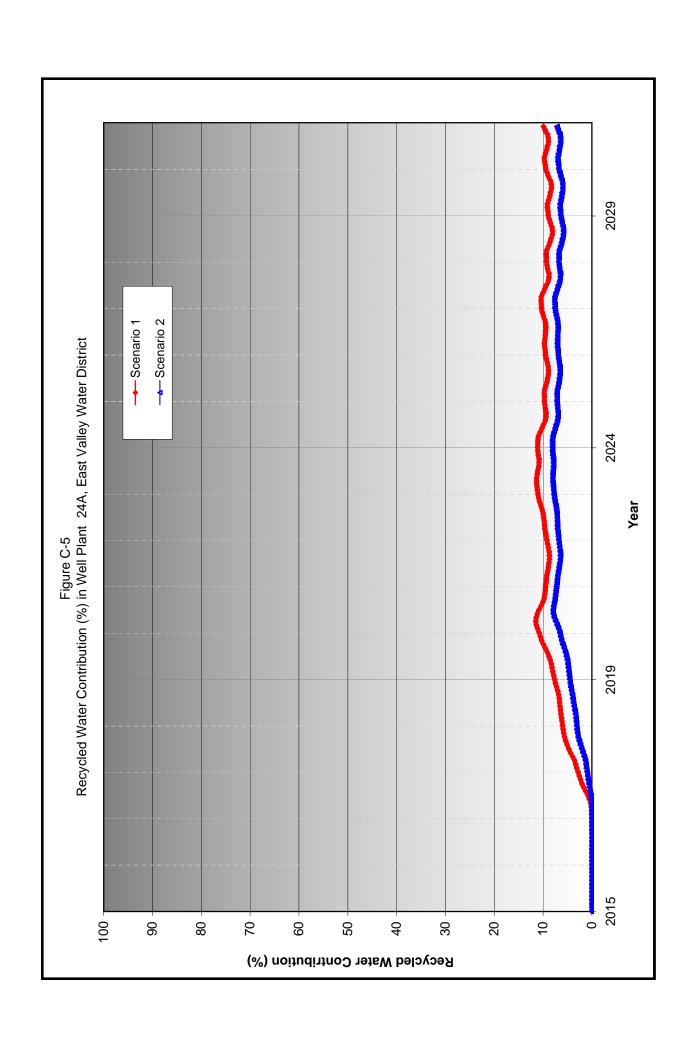


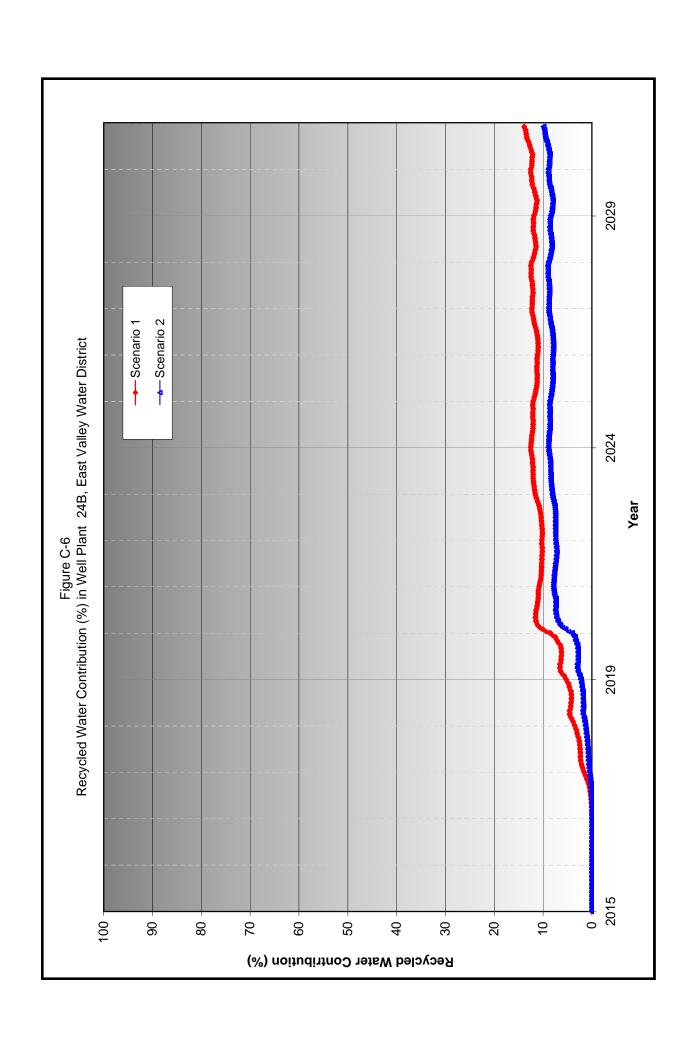


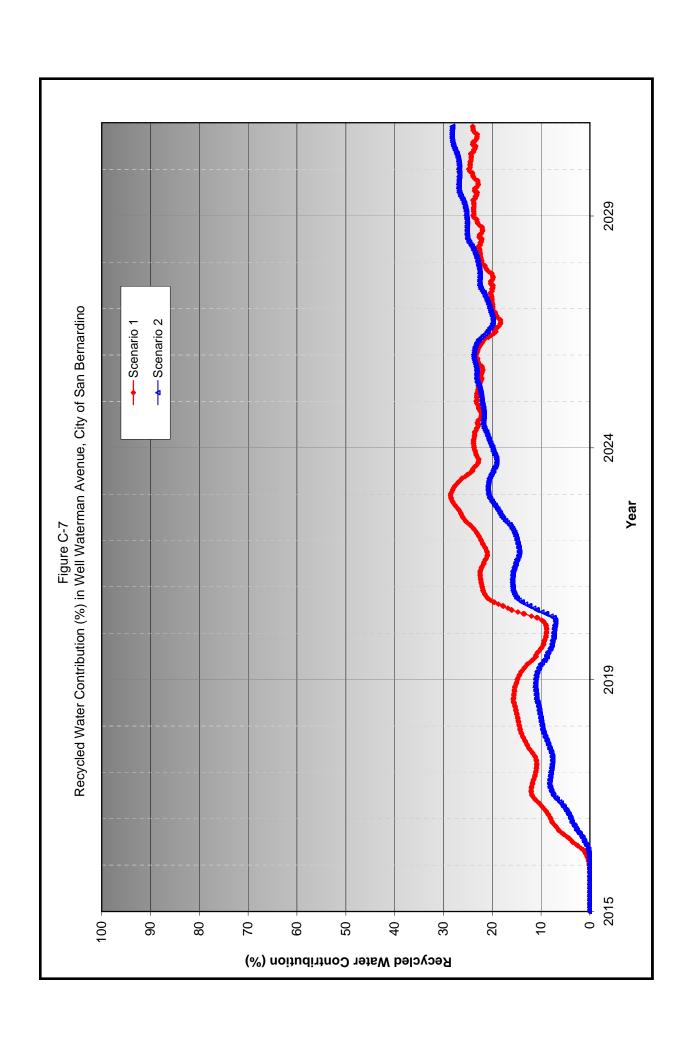


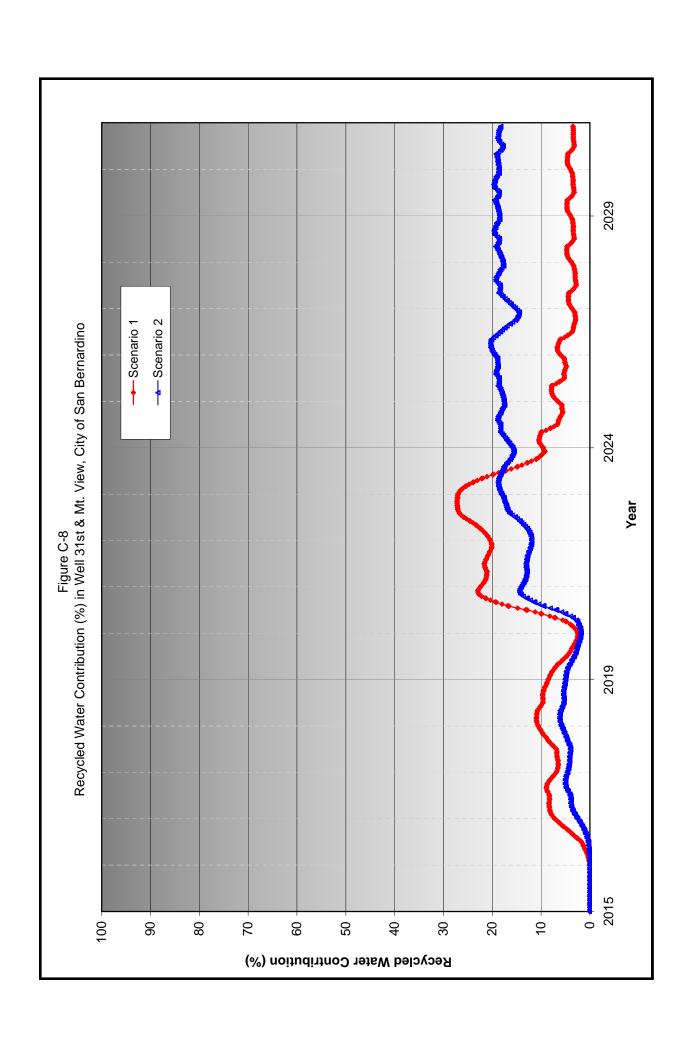


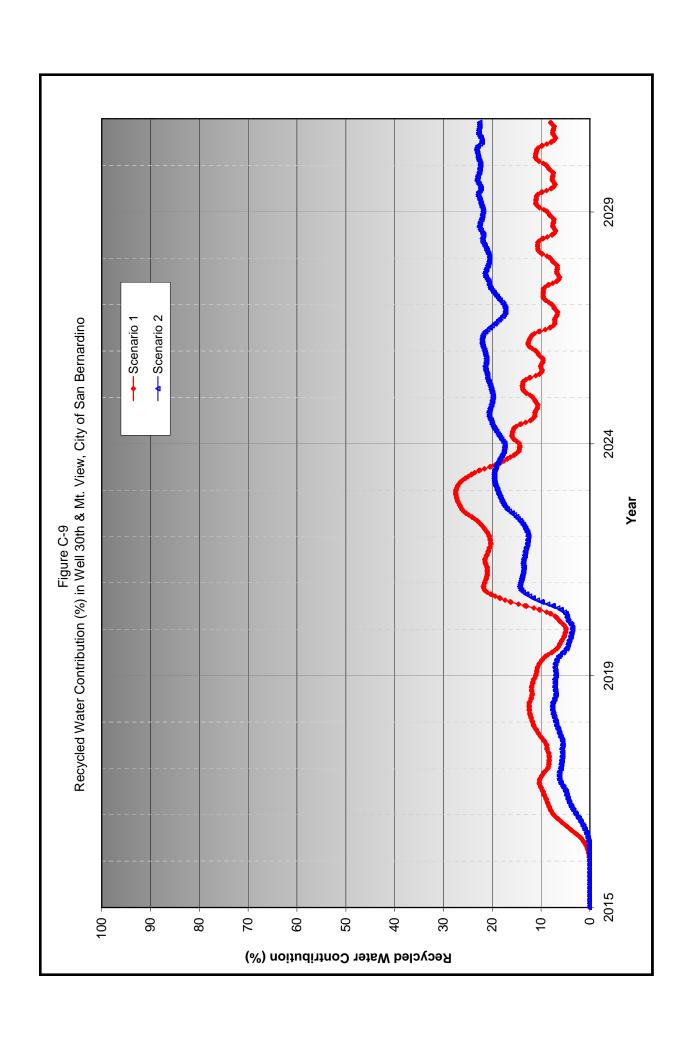


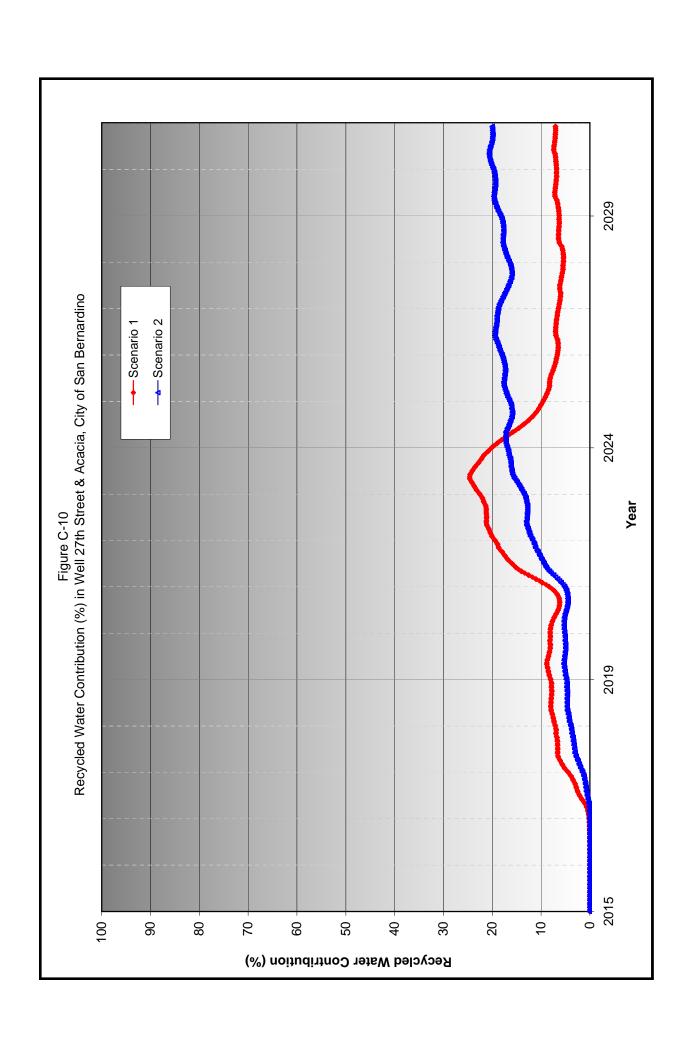


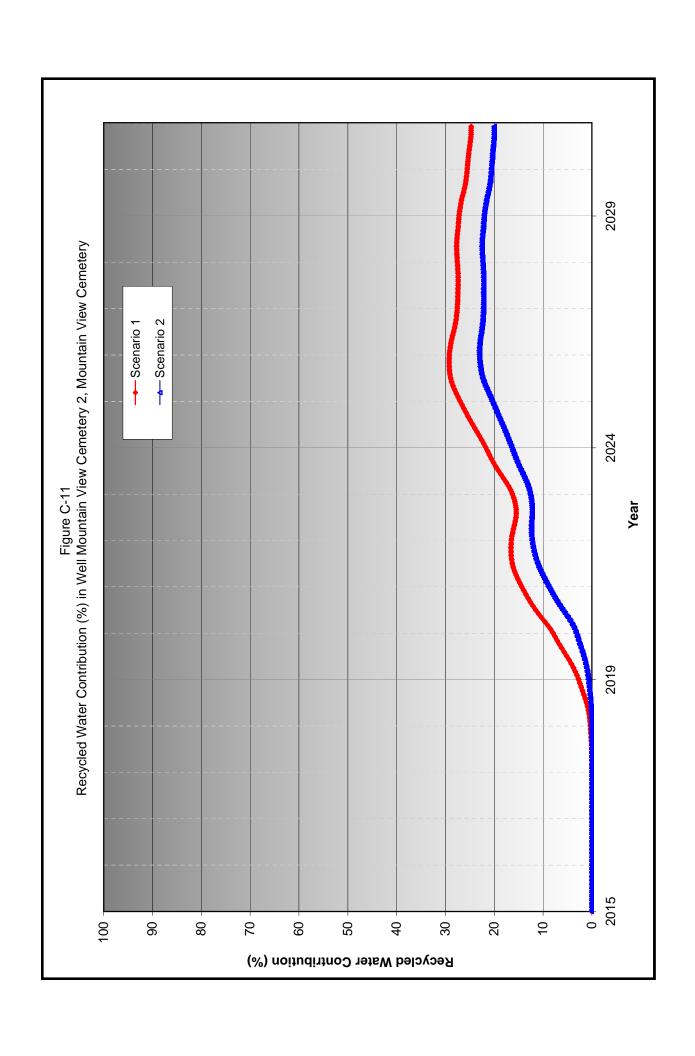


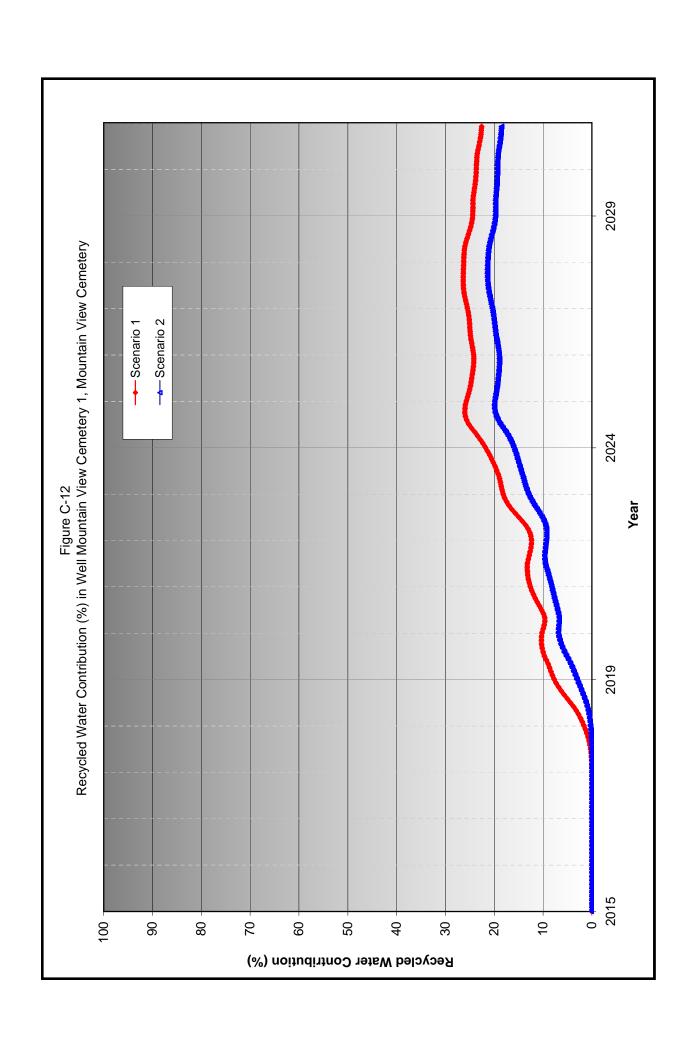


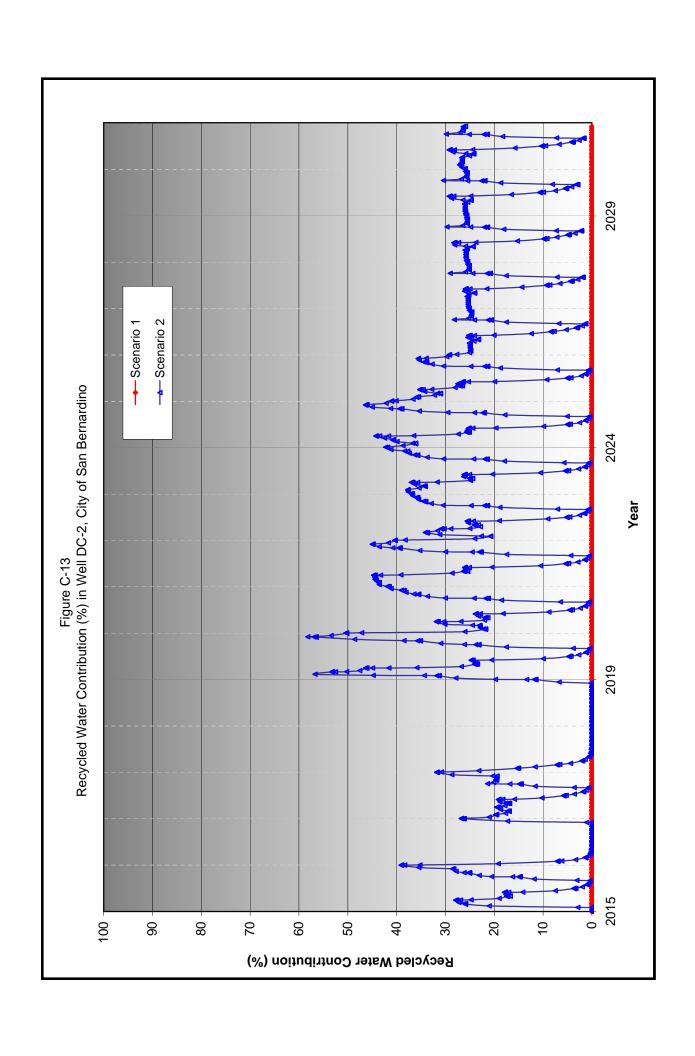


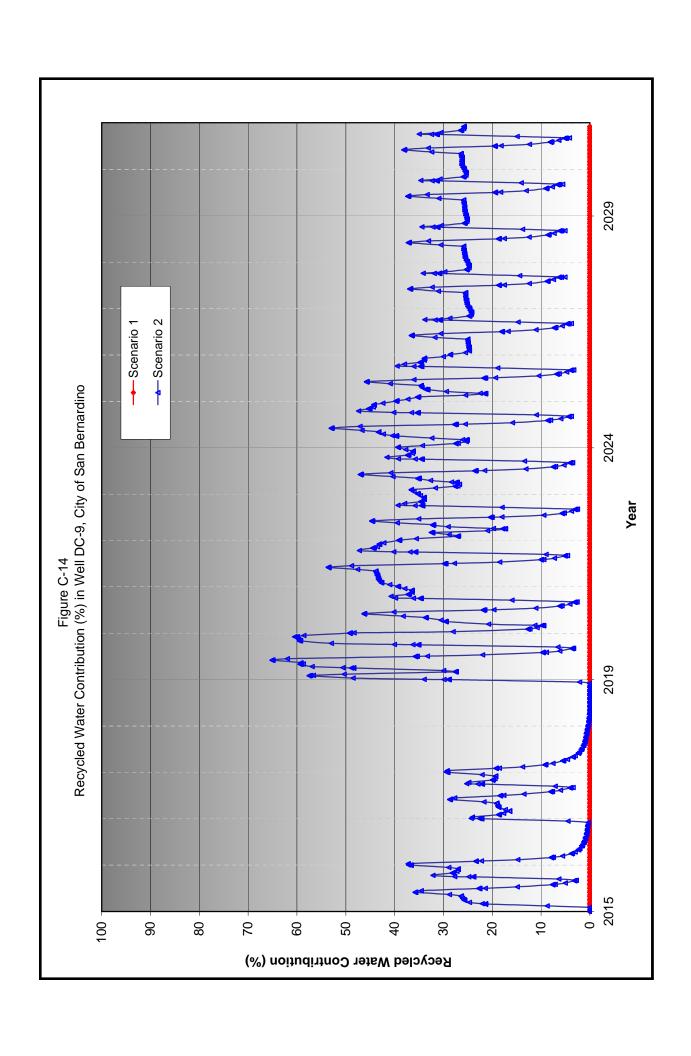


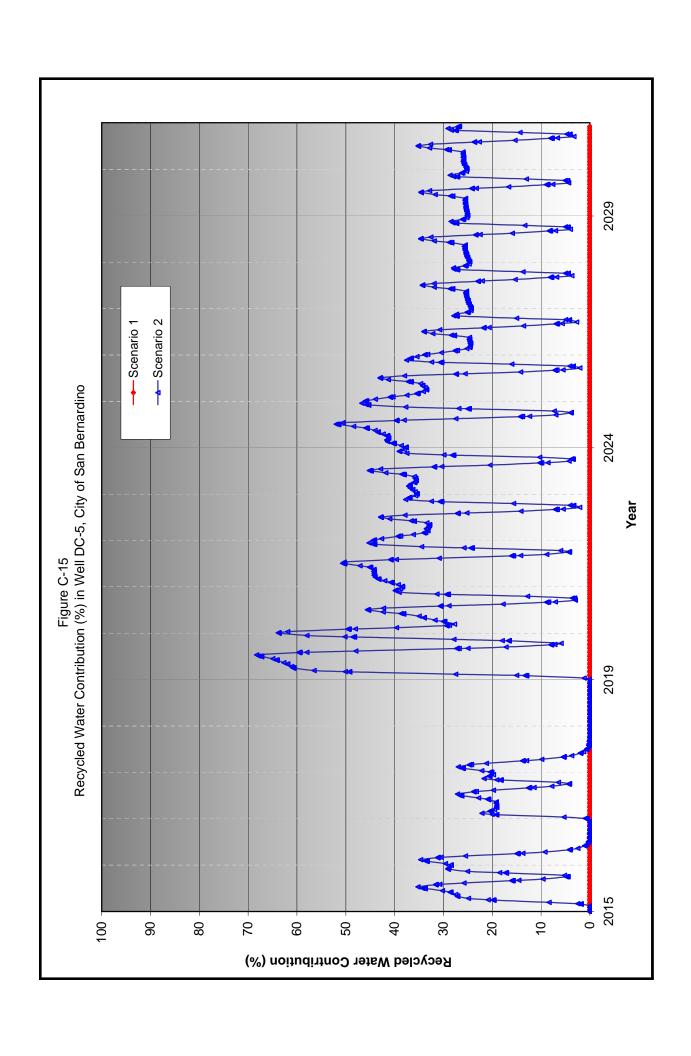


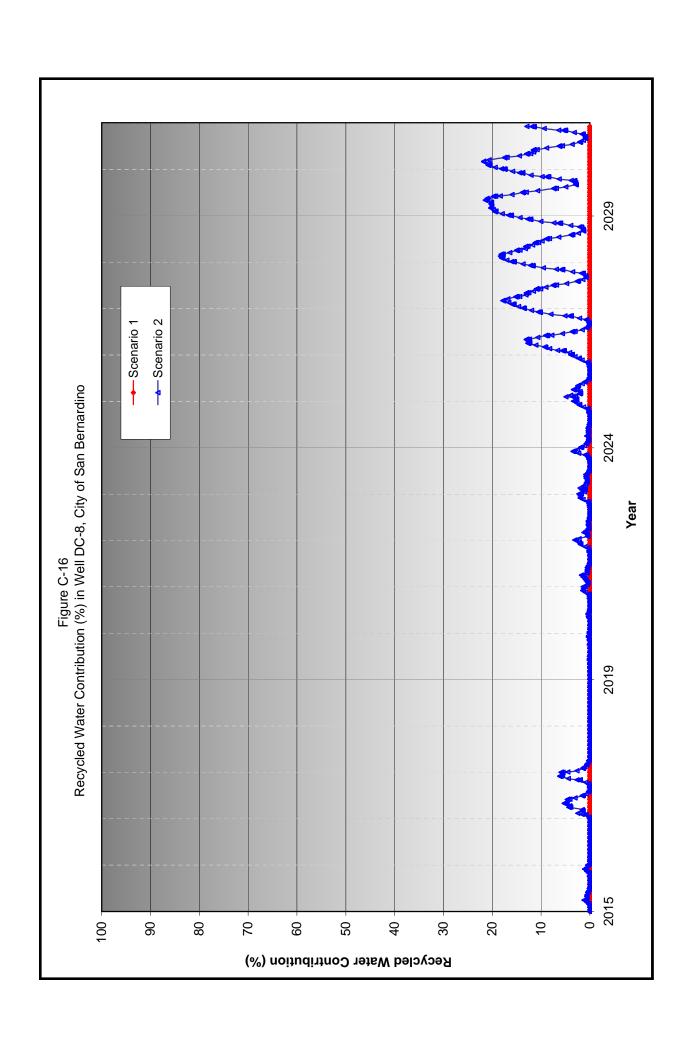


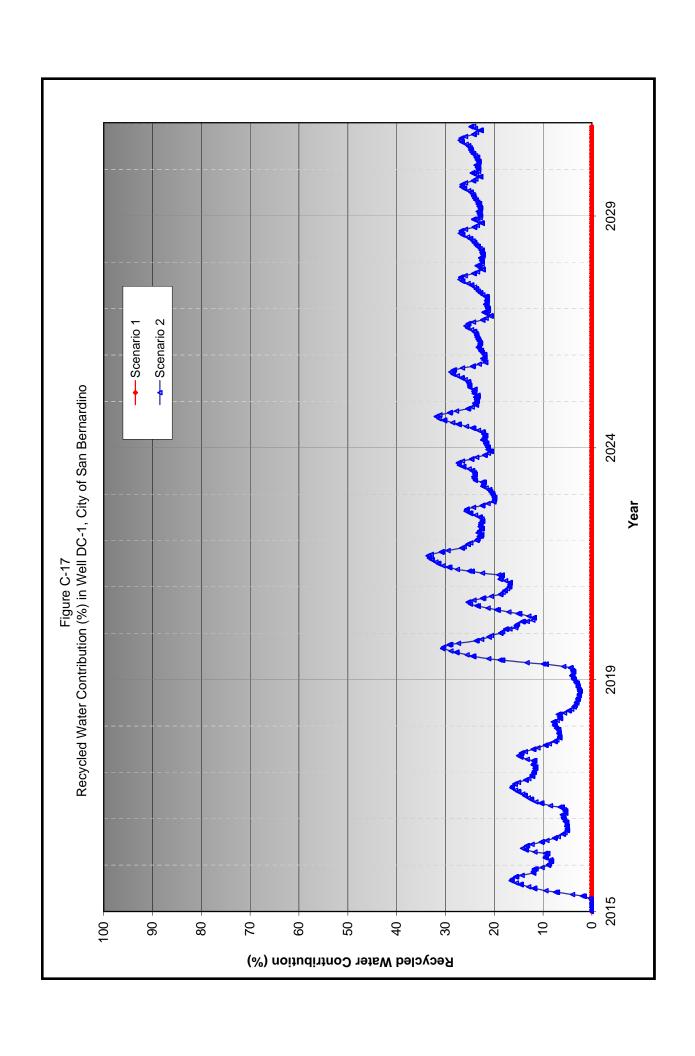


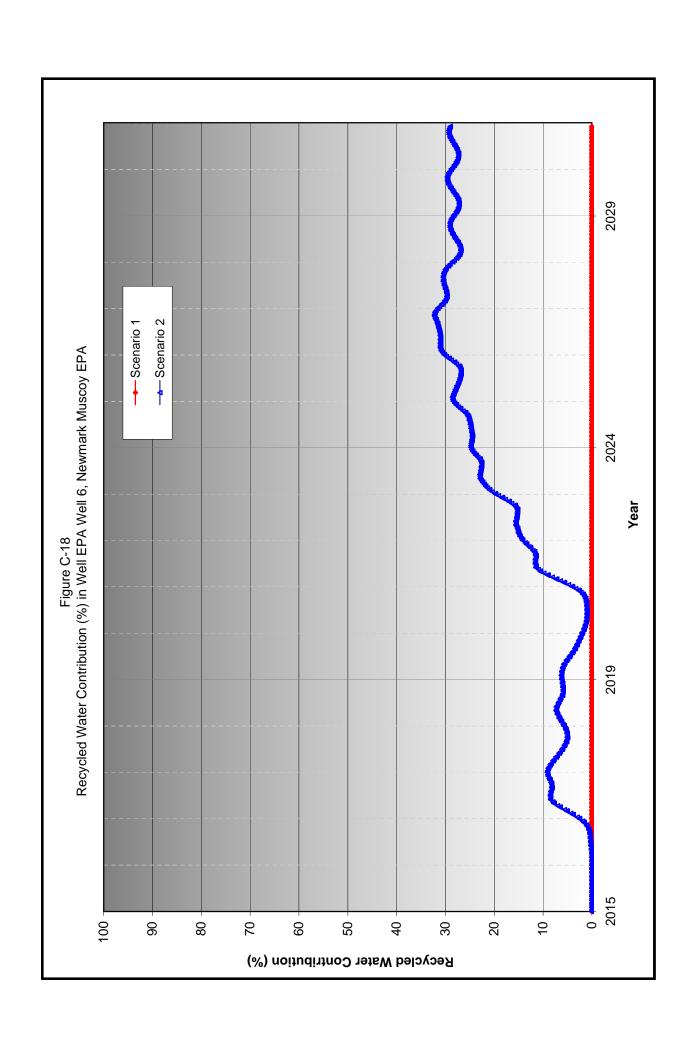


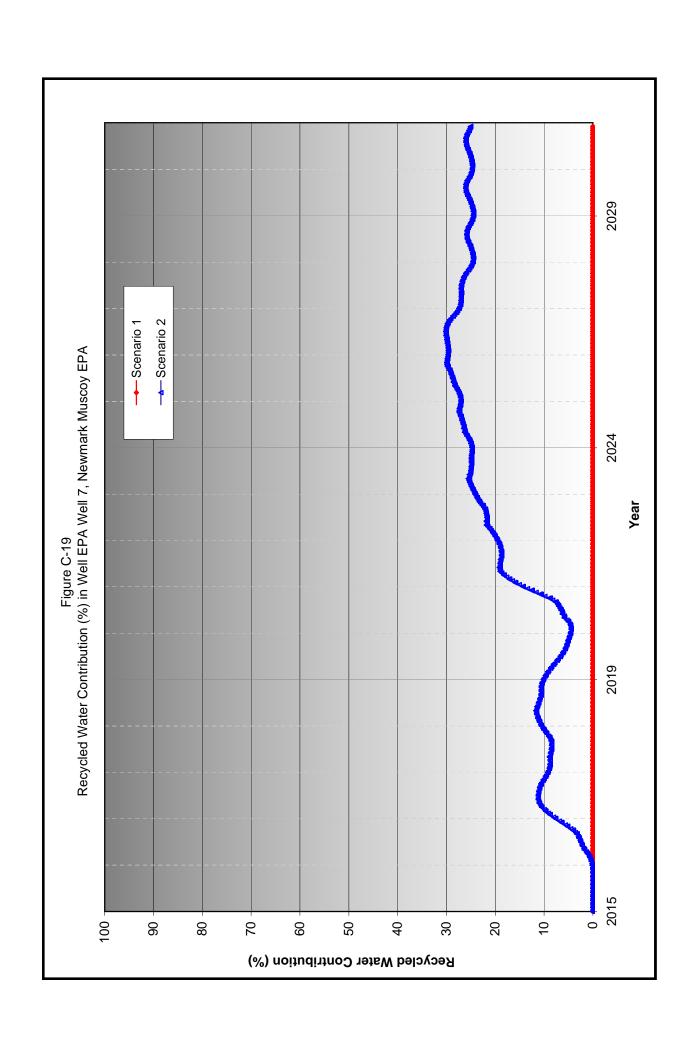


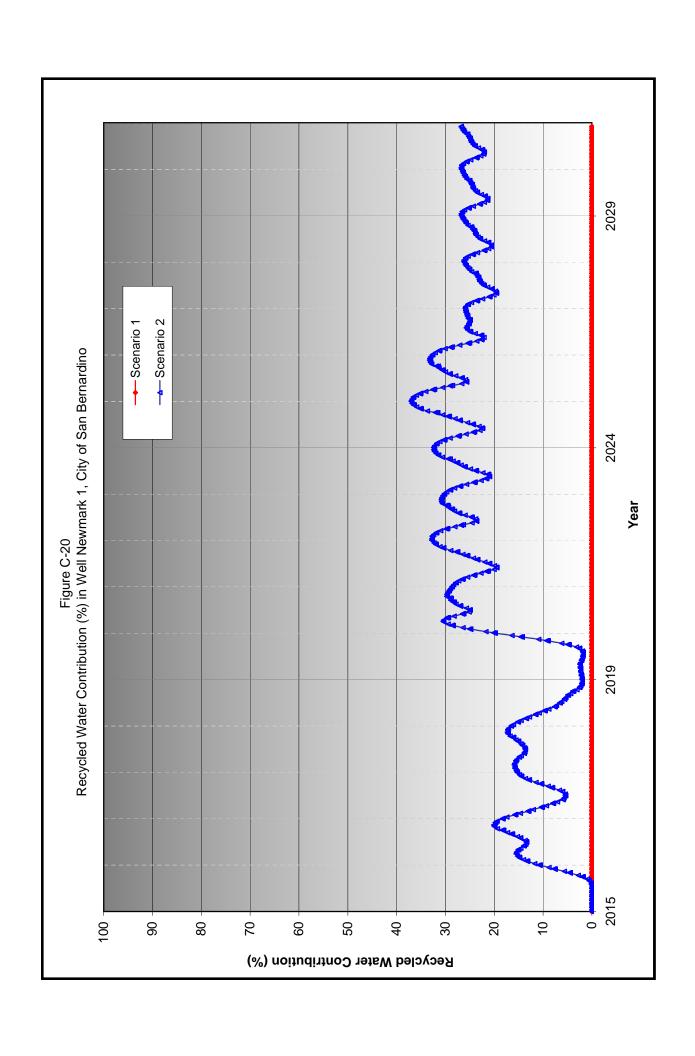


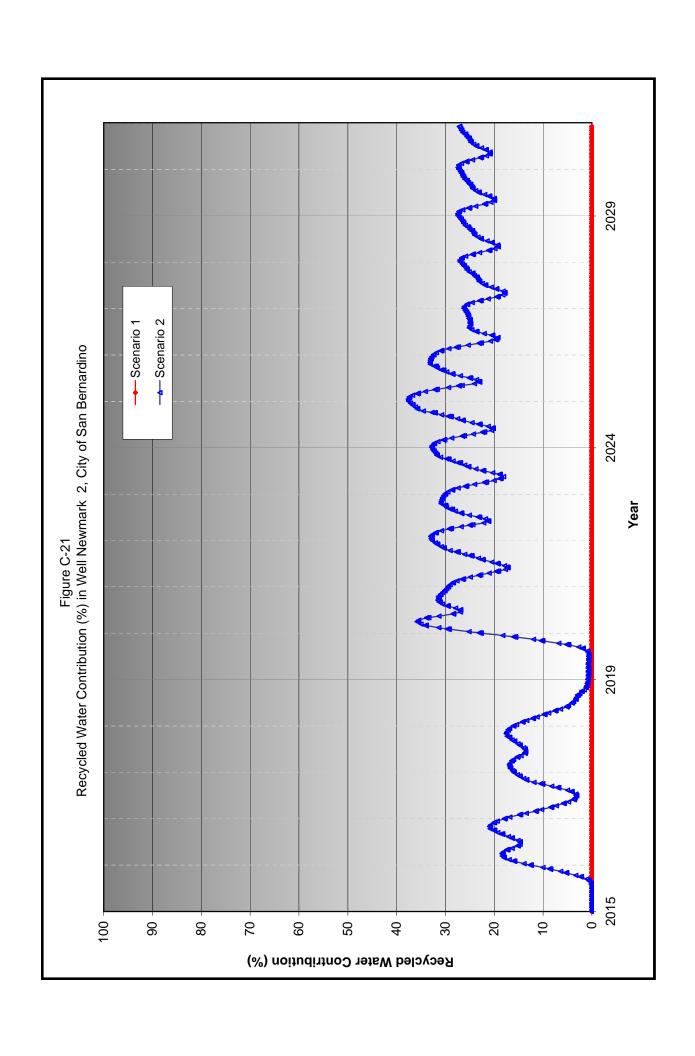


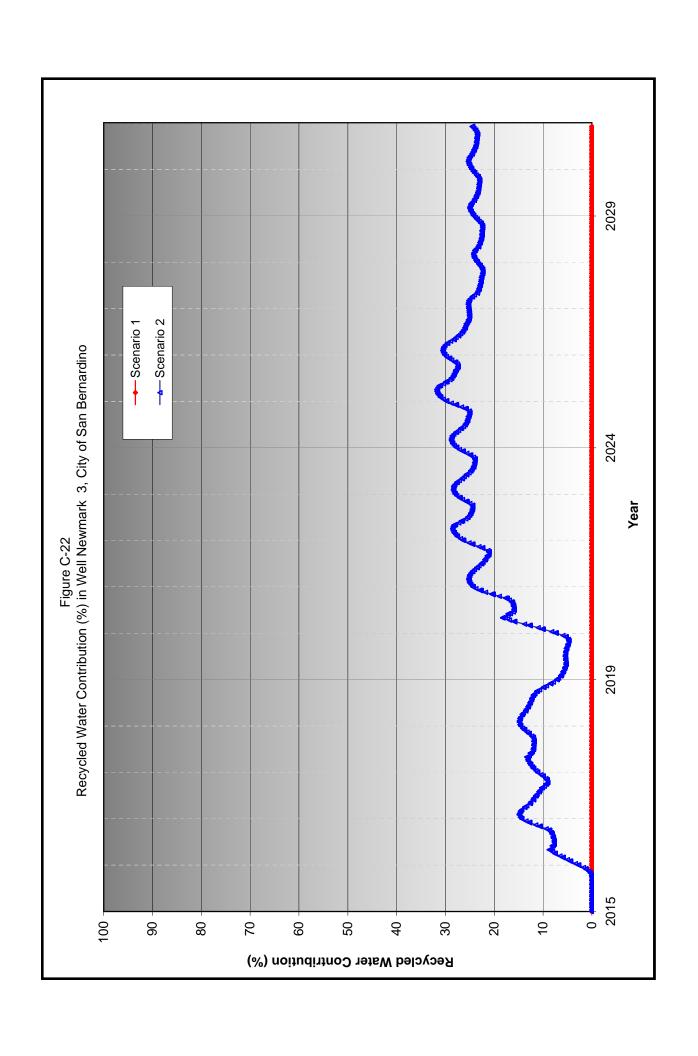


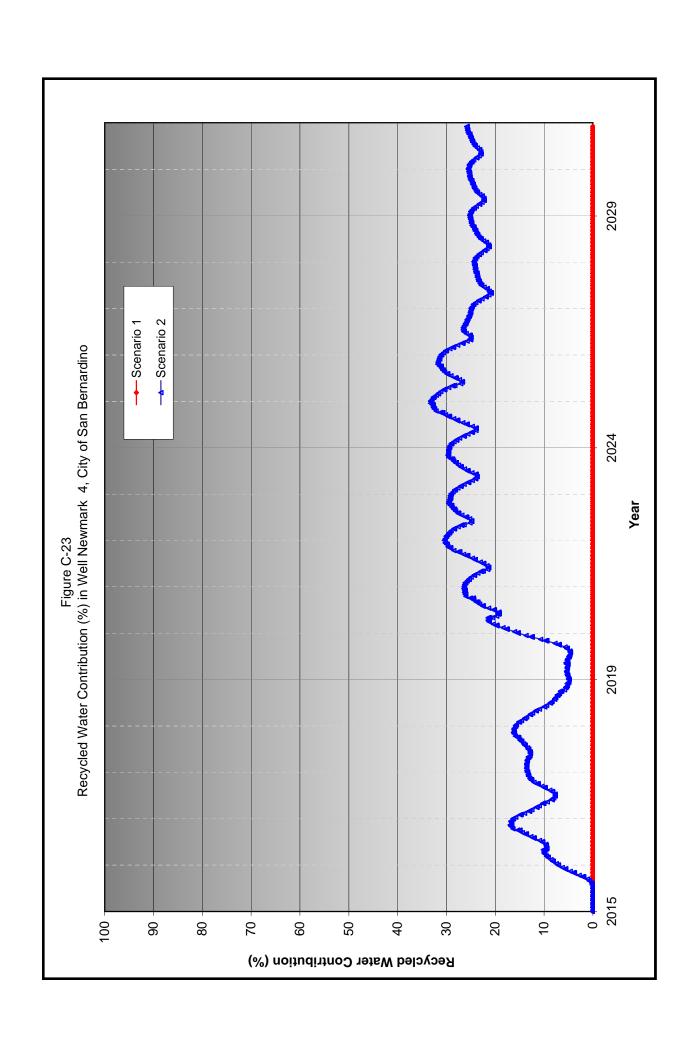












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