Report Documenting the Reasonableness of the Conjunctive Use Benefit of Treated Water to Groundwater and Surface Water Customers

and the

Benefit of Agriculture Customers to Municipal & Industrial Customers

for the

Santa Clara Valley Water District

Final Report

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Executive Summary

In mid 2010, the Santa Clara Valley Water District (District) engaged Raftelis Financial Consultants, Inc. (RFC) to assist in determining the reasonableness of the District's rate setting practices as it relates to the treated water surcharge and the agriculture (AG) discount. Specifically, RFC estimated the conjunctive use benefit of the treated water system to groundwater and surface water customers, using the help of the firms Carollo Engineers and HydroMetrics Water Resources (a water resource engineering firm). In addition, RFC calculated the benefit of AG usage to M&I users if interruptible rates are established.

While at least *four* alternatives were identified for both the calculation of the conjunctive use benefit of the treated water system to groundwater and surface users and the benefit of AG users to M&I users, only one alternative for each was found to be viable based on criteria such as equity to users, cost considerations, availability of data, legality, sustainability, and ease of future updates. It was determined that costs under each viable alternative could be calculated and then compared to the District's existing costs. The alternative used to calculate the conjunctive use benefit of the treated water system to groundwater and surface water users was Alternative 3 – Predominately Groundwater Only System, which assumes the District built groundwater infrastructure instead of treated water infrastructure. The alternative used to calculate the benefit of AG users to M&I users was Alternative 3 – Interruptible Rates, which calculates the benefits assuming the District is able to interrupt AG use during specified time frames.

<u>Summary of Calculation of Conjunctive Use Benefit of Treated Water to Groundwater and Surface Water Customers</u>

Several steps are required in estimating the benefit of treated water under Alternative 3 – Predominately Groundwater Only System. The fixed and operating costs under the existing system are compared to the fixed and operating costs of a predominately groundwater only system. The replacement costs of the *existing* facilities (treatment, groundwater, surface, and recycled water) are calculated as if the system was built in 2010. The fixed costs to construct a system that would allow the District to replace treated water with groundwater are also estimated assuming these assets are constructed in 2010. The operating costs for both the existing system and the Alternative 3 - Predominately Groundwater Only System are also estimated. These costs are annualized and then calculated into perpetuity to represent the life cycle costs of both systems. The ratio between the capital and operating costs into perpetuity under the existing system and under Alternative 3 establish the conjunctive use benefit of treated water. The ratios are calculated under various scenarios to establish a range of the conjunctive use benefit of treated water. The scenarios involved estimating the costs for both the existing system and Alternative 3 in 2010 dollars, and had they incurred in 1965, the point in time at which the District decided to build treatment plants as documented in a report dated July 18, 1962 and titled "Proposed Water Treatment & Distribution System". Both the scenarios with 2010 and 1965 costs also include various assumptions regarding land costs required for Alternative 3. The resulting ratios under all of these analyses establish a range of the conjunctive use benefit of treated water.

In establishing its FY 2011 groundwater rates, the District set rates such that the difference between the treated water rate and the groundwater rate was $100.00. This differential is referred to as the treated water surcharge. This was accomplished by transferring $22.2 million in costs for the conjunctive use benefit of treated water to groundwater and surface water customers. **Using the range of results from comparing the costs for the existing system to those under Alternative 3, the District could have set rates by transferring <u>at least</u> $22.2 million in costs for the conjunctive use benefit of treated water to groundwater and surface water customers**. Because this analysis indicates the District could have transferred more costs, the District's estimation of the conjunctive use benefit of treated water is reasonable and justified by the results of this analysis. Furthermore, the District's rate setting practice of establishing a treated water surcharge ensures the effective management of both groundwater and treated water. The District applies a treated water surcharge to the groundwater production charge which has ranged between $90.00 to $100.00. This surcharge represents the point of indifference between a customer receiving treated water or groundwater that then has to be pumped at an additional cost to the retailer. A 2010 survey completed by several of the District's retailers indicated that the cost to pump and treat groundwater is $91.00 per acre foot. **Therefore, the District's existing treated water surcharge is near the point of equilibrium and allows the District to effectively manage its water sources.**

<u>Summary of Calculation of Benefit of AG users to M&I Users Under Interruptible Rates</u>

In establishing its FY 2011 agriculture rates, the District was able to achieve its AG discount by using offsets. To determine if the District could justify the discount through the benefit of AG use to M&I use, the discount was calculated using the concept of interruptible rates. The establishment of interruptible rates, would allow the District to interrupt service to AG users during drought conditions for a specified period of time, such as once in every five years, and in turn allow M&I users to be able to use water when they otherwise would have to conserve. The benefit of these interruptible rates can be calculated based on the incremental costs the District could avoid if it can curtail AG use. Because AG customers have direct access to groundwater, there are no substantial costs that would be eliminated if AG use is curtailed. However, the District could achieve savings relating to banked water. The District purchased 20,000 and 10,000 AF of banked water in FY 2007 and 2008, respectively, which averages to 15,000 AF per year. Based on historic costs to purchase and bank water, the cost per AF for the District is approximately $200.00. However, a 1 AF reduction in AG use does not equate to a 1 AF reduction in banked water because the District will bank water to ensure that demand is met. To be conservative we can assume that any reduction in AG use would be spread over the timeframe in which an AG customer's use could be interrupted. For example, RFC has assumed that the District could only interrupt an AG customer's use once in every 5 years. The total calculated discount per AF of AG use based on interruptible rates ranges from $4.00 to $40.00 per AF.

The calculated interruptible rates are consistent with current trends in the water industry. For example, the FY 2011 AG discount for Metropolitan Water District of Southern California (MWD) is $45.00, and the FY 2011 AG discount for San Diego County Water Authority (CWA) is $115.00. It should be noted that MWD recently announced that it will eliminate its AG rate by 2013 due to requiring all customers to adhere to drought restrictions which means the savings that MWD once was able to attribute to AG users is also realized by M&I users. As a result, the discount is no longer valid. This implies that if the District were to establish interruptible rates, the cost savings associated with AG rates would only be valid if the District did not require M&I users to conserve water. If the District implements mandatory conservation restrictions for both M&I and AG users, then these cost savings would benefit both M&I and AG and any differentiating benefits between the two customer classes would be eliminated or substantially reduced.

As mentioned, the District was able to achieve its FY 2011 AG discount by using offsets such as interest earnings, revenues from 1% ad valorem property taxes, and a transfer of 1% ad valorem property taxes from the Watershed or General Fund. **Because the benefits calculated using interruptible rates do not produce substantial cost savings to M&I users, in the future, the District should continue to use offsets, but determine the flexibility in being able to increase the transfer of 1% ad valorem property taxes from the Watershed or General Fund in order to replace the interest earnings currently used for the AG discount.**

Section I: Background

In early 2010, the Santa Clara Valley Water District (District) engaged Raftelis Financial Consultants, Inc[1]. (RFC) to review, and if appropriate, validate the cost of service principles used in determining the FY 2011 groundwater production charges (GW). Furthermore, RFC was to offer recommendations for future rate updates, which were discussed in detail in a report dated March 5, 2010 and titled "Review of the Santa Clara Valley Water District's Cost of Service Rate Setting Methodology for Setting FY 2011 Groundwater Production Charges", (hereinafter referred to as "Review of District's FY 2011 GW Production Charges"). The District subsequently engaged RFC, and an engineering team comprised of Carollo Engineers and HydroMetrics Water Resources Inc. (Carollo/HydroMetrics)", to address two of the key observations documented in the Review of District's FY 2011 GW Production Charges report, as shown below:

- "The District should consider engaging a water resource engineer to more precisely calculate the treated water surcharge to ensure it mirrors the conjunctive use benefit of treated water going forward.
    - Regarding the District's establishment of a fixed dollar amount for the treatment water surcharge, the District should consider a fixed percentage differential in order to ensure that in the future, the District is able to maintain the appropriate pricing and continue to effectively manage all water sources.
- Over the past five years, the District has set the agriculture rate between 6% and 10% of the South Zone groundwater production charge, as allowed by Resolution 99-21. The District should consider establishing the percentage based on the benefit of serving agriculture customers."

This report documents the analysis of the two key observations listed above and how the results of the analysis should be incorporated into the District's rate setting process for GW production charges and for agriculture (AG) charges for fiscal year (FY) 2012 and beyond.

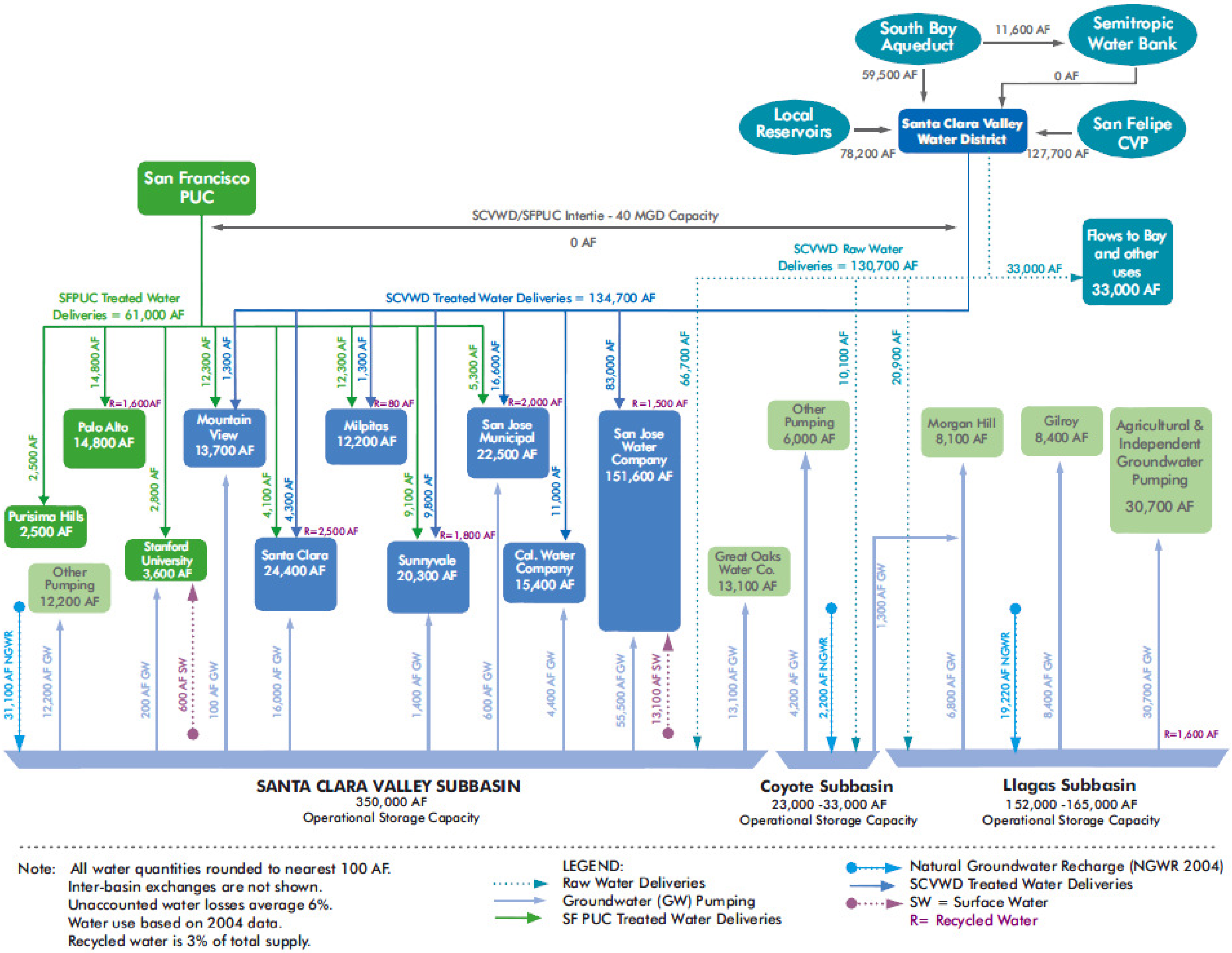
A. Water Supply

Approximately half of the District's water supply comes from water imported through the Sacramento-San Joaquin Delta. The other half of the District's water supply comes from local surface water and groundwater. Rainfall and runoff captured in 10 reservoirs and imported water from the State Water Project (SWP) and the federal Central Valley Project (CVP) replenish groundwater basins or supply water to the District's three treatment plants. The District also supplies recycled water which is generated from the South County Regional Wastewater Authority. In addition, Santa Clara County water supplies include non-District managed supplies like water purchased from the City and County of San Francisco through the Hetch Hetchy system, recycled water from the City of San Jose's wastewater facility and locally owned supplies.

[1] Raftelis Financial Consultants, Inc. (RFC) was established in 1993 and has conducted over 600 rate and financial planning studies for water and wastewater utilities across the country. Please go to www.raftelis.com for more information on RFC.

The District sells and manages potable and raw water to both retailers (13 in total) and 5,000 private well owners. As shown in Exhibit 1, the District supplies groundwater, treated water, surface water and recycled water in various combinations. The District is tasked with managing its sources of water supply, such that no one source is depleted. Since imported water is used to produce treated water and to recharge the groundwater basins, the District's customers benefit from the District's efficient management of all water supply sources and the conjunctive use nature of the entire system.

Exhibit 1: Santa Clara County Water Supply and Schematic[2]



[2] Santa Clara Valley Water District Urban Water Management Plan 2005, Figure 3-2: Santa Clara County Water Supply and Use Schematic, page 23.

B. Customer Classes and Zones

The District has established two distinct zones of benefit based on the groundwater basins and water sources used within each zone and as required by the Santa Clara Valley Water District Act[3]. Zone W-2, or the North Zone, encompasses the Santa Clara Valley groundwater basin north of Metcalf Road. The District's three water treatment plants are located in the North Zone. Local rainfall is blended with imported SWP and CVP water purchases before being released to replenish the Santa Clara Valley groundwater basin or sent to one of the District's three treatment plants. Several of the District's retailer customers in the North Zone purchase treated water from the plants and pump water from the groundwater basin in order to serve their retail customers. Over the past five years approximately 80% of the District's water usage occurred in the North Zone, of which only approximately 0.3% was for agriculture use.

Zone W-5, or the South Zone, is comprised of the Llagas and Coyote groundwater sub basins from Metcalf Road south to the Pajaro River. The South Zone is supplied water mainly through the groundwater basins. Approximately two-thirds of the groundwater usage is artificially recharged each year by the District using CVP water imported via the San Felipe Division or locally captured rain water diverted by the District to various recharge facilities. Over the past five years approximately 20% of the District's water usage occurred in the South Zone, of which approximately 48% was for agriculture use.

The District first classifies its water customers based on the zone of benefit in which they are located. The District then classifies its customers based on the type of water they purchase from the District:

- Treated water customers are located in the North Zone and receive treated water from the District's three treatment plants.
- Groundwater customers pump groundwater directly from the groundwater basins.
- Surface water customers receive water from the District's streams or pipelines that have been replenished with local or imported water.
- Recycled water customers receive recycled water that has been obtained from the District through partnerships with neighboring agencies that have wastewater facilities and are able to produce recycled water.

The District further classifies its customers as either municipal and industrial (M&I) or agricultural (AG). M&I use relates to all water other than that used for agricultural purposes and is water pumped by or sold to retailers comprised of municipalities or private water companies, which resell their water to retail customers, and to approximately 5,000 private well owners who pump groundwater.

The District's rates for each customer class and zone for FY 2011 are provided in Exhibit 2. The District establishes a basic water charge, or groundwater production charges for M&I customers. As specified in

[3] The Santa Clara Valley Water District Act can be viewed by going to the District's website at the following link: www.valleywater.org

Resolution 99-21[4], the rate setting policies established by the District's Board of Directors, the District establishes a treatment surcharge. Section II of Resolution 99-21 states that "A treated water surcharge shall be added to the basic water charge for the price of treated surface water delivered by the District. The charge should be established at an amount that would promote the effective use of available water resources". This surcharge is combined with the groundwater production charge to represent the rate for customers that receive treated water.

As shown in Exhibit 2, the District assesses two treatment surcharges: 1) contract treated water surcharge and 2) non-contract treated water surcharge. Since 2005, the District has established a treated water contract surcharge (for treated water up to a specified level of use) that has ranged between $90 and $100 per AF. This surcharge is added to the groundwater production charge to derive the final treated water charge per AF. The District also assesses a treated water non-contract surcharge, which has ranged from $50 to $150, which is added to the groundwater production charge and is assessed to treated water above the specified treated water contract use. The treated water contract surcharge attempts to equalize the total cost for treated water to the total costs that groundwater users incur to pump and treat groundwater. The treated water non-contract surcharge also varies based on the District's availability of groundwater. As a result, both surcharges serve as regulation mechanisms to ensure that no one water source is depleted, in addition to reflecting the benefit these customers receive from treated water. As shown in Exhibit 2, the District also asses a surface water charge of $11.75 per AF for water master costs. The $11.75 is added to the basic user charge to derive the final surface water charge per AF.

Exhibit 2: District's FY 2011 Rates

	FY 2011
North Zone W-2	
Groundwater / Basic User Charge	
M&I	**$520.00**
AG	**$ 16.50**
Treated Water Surcharge – Contract	**$100.00**
Treated Water Surcharge Non-Contract	**$ 50.00**
Surface Water Charge – Water Master	**$ 11.75**
South Zone W-5	
Groundwater / Basic User Charge	
M&I	**$275.00**
AG	**$ 16.50**
Surface Water Charge – Water Master	**$ 11.75**
Recycled Water	
M&I	**$275.00**
AG	**$ 41.50**

[4] Resolution 99-21 can be viewed by going to the District's website at the following link: www.valleywater.org

C. District's Rate Setting Process

As documented in the report titled "Review of FY 2011 GW Production Charges", the District follows a six step rate setting process comprised of the following steps, and as shown in Exhibit 3:

- Step 1: Identify utility pricing objectives and constraints
- Step 2: Identify revenue requirements
- Step 3: Allocate costs to customer classes
- Step 4: Allocate offsets to customer classes
- Step 5: Develop unit costs of service by customer class
- Step 6: Develop unit rates by customer class

The District followed the steps above to calculate the groundwater production charges for FY 2011. In Step 6, the District makes two adjustments. The first is a treated water adjustment and the second is an agricultural adjustment. To make the treated water adjustment, the District shifts costs from treated water customers to groundwater and surface water customers such that the resulting rate between groundwater and treated water customers in the North, is approximately $100, which represents the point of indifference between customers purchasing groundwater and pumping it or purchasing treated water. As shown in Exhibit 3, the unit costs per AF <u>prior to any adjustments</u> are $318/AF for groundwater, $822/AF for treated water, with the average unit cost of the total system being $510/AF. Since the District is targeting a $100 differential, the District is applying a treated water surcharge of approximately 1.22 to the total system unit cost ($510/AF) to derive a treated water rate of $620/AF ($510 X 1.22). The difference between the treated water unit cost ($822/AF) and the unit rate of $620/AF represents the conjunctive use benefit of treated water that is allocated to groundwater and surface water users, which was approximately $22.2 million in FY 2011. The conjunctive use benefit represents the benefit that all customers receive from the District's effective management of all of its water sources. For example, if all customers shown in Exhibit 1 were to obtain all of their water supply from groundwater in their respective sub basins, then eventually some of the sub basins would be depleted. The District's ability to supply treated water to some of these customers allows the sub basins to have adequate water supply and, therefore, all customer classes benefit from the conjunctive use nature of the District's system even though they may be buying only one source of water.

The second adjustment is an agriculture adjustment. To make the agriculture adjustment (AG) for FY 2011, the District used offsets to reduce the agriculture rate to less than 10%, as required by Resolution 99-21, which states that the AG rate "shall not exceed one-tenth the rate for all water other than agricultural water". The District used interest earnings, revenues from 1% ad valorem property taxes, and a transfer of 1% ad valorem property taxes from the Watershed or General Fund to reduce the AG rate.

The District engaged both RFC and Carollo/HydroMetrics to calculate and quantify the conjunctive use benefit of treated water to groundwater and surface water users, and the benefit of servicing AG users to M&I users, which is documented in the remainder of this report. The remainder of this report documents the process that RFC, Carollo/HydroMetrics and District staff underwent to address these two issues and how the results of this analysis can be used in the District's rate setting process in future years.

Exhibit 3: Districts Rate Setting Process for Establishing FY 2011 GW Production Charges

	FY '11 Projection ($K)	Zone W-2						Zone W-5							Total
		GW		TW	SW		Total W-2	GW		SW		RW		Total W-5	
		M&I	AG	M&I	M&I	Ag		M&I	AG	M&I	AG	M&I	AG		
1	**Operating Outlays**														
2	Operations/Operating Projects	28,412	107	66,277	905	9	95,710	5,372	4,974	52	339	123	70	10,930	106,641
3	SWP Imported Water Costs	4,987	19	17,079	323	3	22,411	-	-	-	-	-	-	-	22,411
4	Debt Service	3,473	13	12,811	115	1	16,413	-	-	-	-	-	-	-	16,413
5	**Total Operating Outlays**	36,872	139	96,166	1,343	14	134,535	5,372	4,974	52	339	123	70	10,930	145,465
6	Step 2- Identify revenue reqmnts														
7	**Capital & Transfers**														
8	Operating Transfers Out	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Capital Outlays excl. carryfor	16,443	62	35,168	527	6	52,207	-	-	-	-	-	-	-	52,207
10	**Total Capital & Transfers**	16,443	62	35,168	527	6	52,207	-	-	-	-	-	-	-	52,207
11	**Total Annual Program Costs**	53,315	201	131,334	1,870	20	186,741	5,372	4,974	52	339	123	70	10,930	197,671
12	Step 3 - Allocate costs to customer classes							Step 3 - Allocate costs to customer classes							
13	**Revenue Requirement Offsets**														
14	Capital Cost Recovery	(1,394)	(5)	(1,443)	(46)	(0)	(2,889)	1,045	967	8	50	522	298	2,889	-
15	Debt Proceeds	(6,723)	(25)	(14,379)	(216)	(2)	(21,346)	-	-	-	-	-	-	-	(21,346)
16	Inter-governmental Services	(512)	(2)	(529)	(17)	(0)	(1,060)	(55)	(51)	(0)	(3)	-	-	(109)	(1,169)
17	SWP and W-1 Property Taxes	(3,765)	(14)	(13,436)	(244)	(3)	(17,462)	(524)	(485)	(4)	(25)	(27)	(16)	(1,080)	(18,542)
18	Inter-zone Interest Step 4- Allocate offsets	(107)	(0)	(110)	(4)	(0)	(221)	107	99	1	5	6	3	221	-
19	Capital Contributions	(3,542)	(13)	(3,666)	(117)	(1)	(7,339)	-	-	-	-	-	-	-	(7,339)
20	Perchlorate Response	(1,174)	(4)	(1,215)	(39)	(0)	(2,433)	1,263	1,170	-	-	-	-	2,433	-
21	Other	(349)	(1)	(1,922)	(18)	(0)	(2,291)	(20)	(19)	(0)	(1)	-	-	(40)	(2,331)
22	Reserve Requirements	(2,090)	(8)	(4,469)	(67)	(1)	(6,634)	-	-	-	-	-	-	-	(6,634)
23	**Adjusted Revenue Requirement**	33,659	127	90,164	1,103	12	125,066	**7,188**	**6,656**	**56**	**366**	**623**	**356**	**15,244**	**140,310**
24															
25	Volume (KAF)	105.9	0.4	109.6	3.5	0.0	219.5	27.0	25.0	0.2	1.3	1.4	0.8	55.7	275.2
26															
27	Revenue Requirement per AF	$ 318	$ 318	$ 822	$ 315	$ 315		$ 266	$ 266	$ 281	$ 281	$ 445	$ 445		**$ 510**
28															**System Unit**
29	Step 5 - Develop unit costs by customer class							Step 5 - Develop unit costs by customer class							**Cost**
30	**Adjustments for Agricultural Preservation**														
31	Allocate WU 1% Ad Valorem Prop Tax	0	(120)	-	-	(10)	(131)	-	(3,895)	-	-	-	-	(3,895)	(4,026)
32	Allocate Interest Earnings	-	-	-	-	-	-	-	(2,348)	-	(304)	-	-	(2,652)	(2,652)
33	Transfer WS 1% Ad Valorem Prop Tax	-	-	-	-	-	-	-	-	-	(25)	-	(323)	(348)	(348)
34	Revenue Requirement per AF	$ 317.7	$ 16.5	$ 822	$ 315	$ 28.3		$ 266	$ 16.5	$ 281	$ 28.3	$ 445	$ 41.5		
35	**Adjustments to Facilitate Conjunctive Use**														
36	Treated Water Surcharge Differential Step 6 - Develop unit rates by customer class														**1.22**
37	Apply Differential to System Unit Cost			620											
38	Conjuctive Use Benefit	21,475	-	(22,184)	710	-	-	237	-	1	-	(238)	-	-	-
40	Charge per AF	$ 520	$ 16.5	$ 620	$ 518	$ 28.3		$ 275.0	$ 16.5	$ 287	$ 28	$ 275	$ 41.5		

Section II: Alternatives Considered

In order to calculate the conjunctive use benefit of treated water and the benefit of serving AG customers, RFC initially identified several approaches, or alternatives for quantifying both the conjunctive use benefit of treated water and agriculture water. RFC then held a webinar with District staff to discuss each of these preliminary alternatives. During the webinar, RFC reviewed and discussed each alternative in order to determine the viability of each alternative and to give District staff an opportunity to react to RFC's findings and to identify any other alternatives for consideration. RFC then refined each alternative and prepared a series of criteria to assess the viability of each alternative. In August of 2010, RFC held a workshop with District staff to further discuss each alternative and identify the most viable alternatives to pursue further based on the evaluation criteria.

The alternatives that were considered examined the District's overall water system, making no distinction between the North and South zones. This approach was appropriate since the alternatives considered issues that were relevant to both zones.

A. Alternatives Considered for Calculating the Conjunctive Use Benefit of Treated Water

Exhibit 4 shows the summary of the four alternatives that were identified for calculating the conjunctive use benefit of treated water. The alternatives are based on either the concept of "avoided costs", or "alternative costs". Alternatives 1 through 3 consider various scenarios regarding the District's groundwater infrastructure, and alternative 4 focuses on alternative water supply sources in the absence of the District. For alternatives 1 and 2, the conjunctive use benefit can be estimated by the costs that are avoided if the District did not manage its water supply sources. In the paper written by Janice Beecher titled "Avoided Cost: An Essential Concept for Integrated Resource Planning[5]", one way to ensure that a utility is choosing the most economic alternative is to consider all costs, including those costs that would not be incurred or would be "avoided". In alternatives 3 and 4, the conjunctive use benefit can be calculated by the "alternative costs" that can be compared to the existing system for comparison. The total costs under each alternative could be calculated and compared to the total costs of the District's existing system. The ratio of costs under each alternative to the existing system costs would represent the conjunctive benefit of treated water.

Exhibit 4: Alternatives Considered for Calculating Conjunctive Use Benefit of Treated Water

	Avoided Costs/Treated Water Benefit Alternatives			
	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**
	Deplete Groundwater - Subsidence	**Deplete Groundwater - Restore**	**Predominately Groundwater Only System**	**Retailer Abandons District - no access to groundwater**
Alternatives	Assume groundwater supply is depleted to levels seen in 1920's which caused subsidence	Assume groundwater rate is set to cost of service unit cost and customers shift some of their usage from treated water to groundwater and therefore deplete the basins below safe yields	Assume the District chose to go with groundwater, rather than building treatment plants.	Retailer Abandons District and gets water from San Francisco PUC (Hetch Hetchy) or directly from CVP/SWP

[5] Beecher, Janice. "Avoided Cost: An Essential Concept for Integrated Resource Planning"; Water Resources update 104, Summer 1996.

Alternative 1: Deplete Groundwater and Address Subsidence – This alternative assumes the District does not manage the groundwater supply but rather that retailers manage their water supply without any oversight from the District. It assumes retailers do not have minimum amounts of treated water contract use that they must purchase. Under this scenario we would expect groundwater levels to be depleted due to retailers taking water according to their water rights. We would expect groundwater depletion to occur to levels as experienced in the 1920's prior to the formation of the District and when subsidence occurred due to the over withdrawal of the basins. Based on the District's experience in the 1920's, the retailers or agencies would have to address the economic impacts of subsidence on both the water system infrastructure and the County's infrastructure. In addition, the agencies would have to incur costs to address salt water intrusion and water quality. To calculate the conjunctive use benefit of the system, we would estimate the costs associated with addressing the economic impacts of subsidence, salt water intrusion, and water quality. We would assume these avoided costs represent the benefit provided by the District's management of its water sources and the conjunctive use nature of the system.

Alternative 2: Deplete Groundwater and Restore Groundwater Levels – This alternative assumes the District lowers the groundwater production charge from $520 to the cost of service unit cost shown in Exhibit 3 ($318), prior to the recognition of the conjunctive use adjustment. It also assumes that retailers do not have purchased water contracts whereby they would purchase more groundwater than treated water due to the reduced rate. This would cause the groundwater levels to be depleted below safe yields. To calculate the conjunctive use benefit of the system, we would estimate the costs associated with replenishing the groundwater levels and any salt water intrusion and resulting water quality issues. We would assume these avoided costs represent the benefit provided by the conjunctive use system.

Alternative 3: Predominately Groundwater Only System – This alternative assumes the District abandons its treated water system and builds the infrastructure necessary to supply groundwater instead of treated water. Under this scenario the District would still supply recycled water and surface water to customers in the same amounts, but treated water would be replaced with groundwater. The infrastructure and operating costs necessary to provide predominately groundwater represent the alternative costs. These costs would be compared to the existing system costs.

Alternative 4: Retailers Abandon District – This alternative assumes the retailers abandon the District and turn to other water sources such as Hetch Hetchy water from San Francisco or CVP and SWP project. The costs incurred by retailers associated with acquiring this water and infrastructure necessary to obtain this water represent alternative costs. These costs could be compared to the costs currently paid to the District for either groundwater or treated water to determine the least cost alternative.

B. Evaluation of Alternatives to Calculate the Benefit of Treated Water

In order to evaluate the viability of each alternative as a method for calculating the conjunctive use benefit of the treated water system RFC, with District staff's input, developed a set of criteria. RFC and District staff discussed each alternative and each alternative's viability based on each criterion, as shown below. A rating of "high" was assigned if the alternative rated high for a criteria, a rating of "medium' was assigned if the alternative rated medium for the criteria, and a rating of "low' was given if the alternative rated low for the criteria. The results of the ratings for each alternative against the criterion are shown in Exhibit 5.

1. Equity to Users – Ability to accurately assign costs to each customer class
2. Sustainability – Ability to sustain effective management of water supply
3. Least costly for District – Affordability of capital and O&M costs to District
4. Least costly for Retailers – Affordability of capital and O&M costs to retailers
5. Data requirements – Ability to gather data for alternative efficiently, timely and inexpensively
6. Ease of update – Ability to use similar analysis in future for rate setting purposes
7. Legality – Ability of District to manage water resources and comply with District Act, Resolution 99-21 and Prop 218

Exhibit 5: Criteria Used to Evaluate Alternatives

		Avoided Costs/Treated Water Benefit Alternatives			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
		Deplete Groundwater - Subsidence	Deplete Groundwater - Restore	Predominately Groundwater Only System	Retailer Abandons District - no access to groundwater
	Ranking Criteria: 3 = High; 2 = Medium and 1 = Low **Criteria to Determine Most Viable Alternative to Model**				
1)	**Equity to users (ex: relevant for all basins)**	Low	Low/Medium	Medium/High	Low
	Appropriate allocation of costs to user classes				
2)	**Sustainability**	Very Low	Low	Medium	Low
	Comprehensive management of water resources				
	Consistency with growth management plans of Cities and Counties				
	Elimination of subsidence				
	Revenue sufficiency				
	Rate affordability				
	Environmental stewardship				
3)	**Least costly for District:**	Low	Medium	Medium/High	High
	Affordability of Capital costs				
	Affordability of O&M costs				
4)	**Least costly for Retailer:**	High	High	Medium	Low
	Affordability of Capital costs				
	Affordability of O&M costs				
5)	**Data:**	Low	Medium	Medium	Medium
	Availability of data				
	Ease of gathering data				
	Timeliness of gathering data				
	Accuracy of data				
	Availability of District staff to gather data				
6)	**Ease of update**	Low	High	High	High
7)	**Legality**	Very Low	Medium	Medium	Low/Medium
	Prop 218				
	District Act				
	Resolution 99-21				
	Overall Score	**Very Low**	**Medium**	**Medium/High**	**Low/Medium**

After discussing each alternative and rating each alternative based on the established criteria, it was determined that Alternative 3 – Predominately Groundwater Only System was the most viable alternative. Under this alternative, the data could be gathered with less effort and in less time than the other alternatives, it would produce a data point that is equitable to all water users because it assumes all District customers receive groundwater, and it was the alternative that is most consistent with Prop 218, the District Act and Resolution 99-21. It was therefore decided that Alternative 3 would be used to quantify the conjunctive use benefit of the treated water system.

C. Alternatives Considered for Calculating the Benefit of AG Use to M&I Users

A similar exercise was conducted for identifying the alternatives for calculating the benefit of AG use. Exhibit 6 shows the summary of the alternatives that were identified for calculating the benefit to M&I users of serving AG users. Five alternatives were identified for calculating the benefit of AG water, as described below.

Exhibit 6: Alternatives Considered for Calculating Benefit of AG Users to M&I Users

	Water Cost Alternatives for Calculating AG Water Benefit				
	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	Rainfalls ability to penetrate vast areas versus impervious surface areas	Return coefficient of AF purchases	Interruptible rates	AG user only	M&I users only
Alternatives	Assumes rainfall for AG land is able to recharge basin to a much greater degree than M&I land	Assumes AG use returns more to basin than M&I use	Assume that the District can discontinue service to AG customers but not M&I customers.	Assumes that District only serves AG users and AG users use less water than M&I customers	Assumes District only serves M&I users and M&I users use more water than AG customers

Alternative 1- Rainfalls ability to penetrate vast and impervious surface areas

Alternative 1 would analyze rainfall and its ability to recharge AG land, which is vast areas, versus its ability to recharge M&I land which is often times impervious. Under this alternative we would quantify the percentage of water that percolates into the ground due to AG land (exclusive of evaporation, plant use, etc) and we would then quantify the percentage of water that percolates into the ground due to M&I land. We would compare the penetration factors to see if one type of land facilitates more recharge than the other, which then implies a benefit.

Alternative 2- Return Coefficients of AG and M&I Purchases

Alternative 2 would analyze the return coefficient of AG use, meaning we would investigate and compare the amount of water returned to the basin from AG users and the amount of water returned to the basin from M&I users (water that is returned through irrigation or from the wastewater system). We would quantify the percentage of residential use that is not consumed or used and eventually makes it back to the basin through wastewater discharge or irrigation. We would also have to quantify the percentage of AG use that recharges basin, exclusive of evaporation, plant use, etc. We would compare the return coefficients for each user type to see if one type of user returns more to the basin than the other, which then implies a benefit.

Alternative 3- Interruptible AG Rates

Alternative 3 would analyze the costs savings if the District can interrupt service to AG customers but not M&I customers. Under this alternative, we would calculate the costs that the District is able to avoid if they can interrupt service to AG customers. For instance, the District currently banks water for future water use in case of drought situations. If the District could discontinue service to AG users then the District might be able to bank less water since it would not need to supply water to AG users. The avoided costs would represent the benefit of AG customers to the District.

Alternative 4- AG Users Only

Alternative 4 would assume that the District only serves AG users (meaning all M&I customer are now AG customers with AG user characteristics). We would estimate the water use of serving AG only customers and the costs to serve only AG customers. We would then compare these costs to the District's existing costs. If the costs to serve AG users are lower than the District's existing costs, then the difference could be used as a justification for discounting the AG rate.

Alternative 5- M&I Users Only

Alternative 5 would assume that the District only serves M&I users (meaning all AG customer are now M&I customers with M&I user characteristics). We would estimate the water use of serving M&I only customers and the costs to serve only M&I customers. We would then compare these costs to the District's existing costs. If the costs to serve M&I users are higher than the District's existing costs, then the difference could be used as a justification for discounting the AG rate.

D. Evaluation of Alternatives to Calculate the Benefit of AG Water

After a preliminary review of each alternative it was determined that Alternatives 1 and 2 should not be pursued. Based on RFC's experience with return factors for M&I use and the runoff of M&I land that eventually is returned back to the original water source, it was determined that the there would not be much differentiation between the M&I and AG return coefficients or penetration of land, and therefore little justification for discounting the AG rate. In addition, these alternatives would require significant effort to conduct these analyses but would result in minimal justification of the AG benefit. It was therefore determined that other alternatives with higher potential justifications should be pursued.

Based on discussions, it was determined that Alternative 3 should be pursued further because there appeared to be justification for discounting the AG rate using this alternative. In addition, the effort required to calculate this justification was reasonable. Currently the District does not have interruptible agreements with AG customers, however, by establishing interruptible rates the District could allow M&I users to use water when they otherwise would have to conserve. The benefit of these interruptible rates can be calculated based on any costs the District is able to save by having interruptible rates.

Based on discussions it was also determined that Alternative 4 and 5 should be investigated further because there appeared to be justification for discounting the AG rate using these alternatives and because the District had readily available information to conduct this analysis. Alternatives 4 and 5 are based on the ratio of M&I use to AG use per acre. A review of District water use by customers, GIS system data , parcel maps, etc. could be analyzed to determine if there is a difference in the M&I versus AG water use per acre.

Section III: Calculation of Benefit of Treated Water System Using Alternative 3 – Predominately Groundwater Only System

Alternative 3 – Predominately Groundwater Only System was the most viable alternative for estimating the conjunctive use benefit of treated water. Several steps are required in estimating the conjunctive use benefit of treated water. Using Alternative 3, the fixed and operating costs under the existing system will be compared to the fixed and operating costs of a system that replaces the treated water component with groundwater. This approach involves estimating the capital costs and operating costs in 2010, assuming that the District would have built groundwater facilities that would allow groundwater to replace treated water. This also requires estimating the capital costs if all the *existing* facilities (treatment, groundwater, surface, and recycled water) were built in 2010 (and the existing operating costs), for comparative purposes. These costs are annualized and then calculated into perpetuity to represent the life cycle costs of both systems. The ratio between the capital and operating costs into perpetuity under the existing system and under Alternative 3 establish the conjunctive use benefit of treated water. The ratios are calculated under various scenarios to establish a range of the conjunctive use benefit of treated water. The scenarios involve estimating the costs for both the existing system and Alternative 3 in 2010 dollars, and had they been incurred in 1965, the point in time at which the District decided to build treatment plants as documented in a report dated July 18, 1962 and titled "Proposed Water Treatment & Distribution System". Both the scenarios with 2010 and 1965 costs also include various assumptions regarding land costs required for Alternative 3. The resulting ratios under all of these analyses establish a range of the conjunctive use benefit of treated water.

The methodology used to calculate the ratio between the existing system and Alternative 3 is described in detail in the following sections, and is based on calculating the ratio using costs in 2010 dollars and without any land costs. Because land costs are excluded, the resulting ratio represents a conservative data point of the conjunctive use benefit of treated water, whereas the ratios calculated with land costs represent the higher range of the conjunctive use benefit of treated water.

A. Analysis of Existing System

i. Description of Existing System[6]

General Overview

The District's water supply operations include raw water conveyance, storage, water treatment, and treated water distribution. The District operates several local pipelines that transport imported raw water and locally captured water for treatment and distribution or for groundwater recharge. The raw water conveyance system meets the demands of the District's three water treatment plants and then delivers the remaining water to groundwater recharge systems. The three water treatment plants distribute treated water to local water retailers.

[6] The following paragraphs are adapted from Chapter 1 of the District's 2003 Integrated Water Resources Planning Study, and from Chapter 3 of the District's 2005 Urban Water Management Plan.

Groundwater and Surface Water: The groundwater system is comprised of 3 groundwater sub basins that transmit, filter and store water: the Santa Clara Valley, Coyote Valley, and the Llagas sub basins. Water enters the basins through recharge areas and undergoes natural filtration as it is transmitted into deeper aquifers. Groundwater basins are replenished naturally through rainfall and through managed recharge areas which consist of 18 major recharge systems. These managed recharge systems include over 70 off-stream ponds and over 30 local creeks. Runoff is captured in the District's 10 reservoirs (along with imported water) and released to ponds for percolation into the groundwater sub basins. Local rainfall contributes to the local water supply when it is captured, used, or stored by reservoirs and streams, and through infiltration (percolation) into the groundwater basins. Eventually the groundwater reaches pumping zones, where it is extracted for municipal, industrial, and agricultural uses. Through its rigorous groundwater recharge activities, the District works to keep the groundwater basins "full," banking water locally to protect against drought or emergency outages. In addition to providing water for M&I and AG uses, the groundwater basins have vast storage capacity. Storing surplus water in the groundwater basins enables part of the County's supply to be carried over from wet years to dry years.

Imported Water : Imported water comes to the county from Northern California watersheds via the Sacramento-San Joaquin Delta. This water is delivered by the SWP and the CVP. Imported water is conveyed to Santa Clara County through two main conveyance facilities: the South Bay Aqueduct, which carries SWP water from the South Bay Pumping Plant; and the Santa Clara Conduit and Pacheco Conduit, which bring CVP water from the San Luis Reservoir. Imported water is stored in several of the District's 10 reservoirs and either released to recharge groundwater or transported to the District's 3 treatment plants.

Treated Water: Imported water or runoff water captured in the District's 10 reservoirs is also transported to the District's three treatment plants, treated, and then distributed to several of the District's retailer customers. The Rinconada Water Treatment Plant (WTP) was constructed in 1967 , the Penitencia WTP was constructed in 1974, and the Santa Teresa WTP was constructed in 1989. Treated water pipelines that distribute water from the treatment plants to the water retail agencies include the West Pipeline, the Campbell Distributary, the Santa Clara Distributary, the Mountain View Distributary and the Sunnyvale Distributary from Rinconada WTP; the Snell Pipeline and Graystone Pipeline from Santa Teresa WTP; and the East Pipeline, Parallel East Pipeline, and Milpitas Pipeline, which can be fed from the Santa Teresa WTP or from the Penitencia WTP.

Recycled Water : Recycled water involves the collection of wastewater discharged within the county, treating and purifying the water to the standards set forth by the California Department of Public Health (DPH), and using the recycled water for non-potable uses in lieu of potable supplies. Recycled water is a local water source developed by Santa Clara County's four wastewater treatment plants. The District works with the wastewater authorities in the county on partnerships to promote water recycling for non-potable uses such as irrigation and industrial uses. In south Santa Clara County, the District is the recycled water wholesaler and is responsible for the recycled water distribution system.

ii. O&M Costs of Existing System

O&M costs include such items as purchased water from SWP and the CVP, chemical, electric and personnel costs to operate and maintain the treatment plants, general and administrative costs necessary to manage the District's water system, as well as other operating costs. The District classifies its O&M costs by function[7], as follows:

- Source of Supply – Costs that relate to obtaining water supply sources.
- Raw Water Transmission and Distribution (T&D) – Costs that relate to the transmission of water supply sources to the District.
- Treatment Plant – Costs that relate to the treatment of water at the District's three treatment plants.
- Treated Water Transmission and Distribution – Costs that relate to distributing water from the treatment plants to the District's wholesale customers.
- General & Administration - Costs, as discussed previously, that relate to direct water utility management and administration costs, such as division management, billing, training and data maintenance.

Exhibit 7 shows the District's actual O&M costs for the past 10 years, the actual AF sold, and the annual percent change in O&M costs. It should be noted this only represents the O&M portion of the District's costs. It does not represent costs associated with annual debt service payments or costs associated with capital projects funded through water production charges or reserve funds. It also shows actual costs through FY 2009 because actual FY 2010 costs were not available as of the writing of this report. The historical O&M costs are used to calculate the 3-year, 5-year and 10-year annual percentage change in existing system O&M costs.

[7] The District's costs for each function also include overhead, or indirect general fund services which relate to shared administrative services for both the Water Utility and Watersheds, such as Finance, Human Resources, etc.

Exhibit 7: History of Actual O&M Expenses for Existing System (1)

Existing O&M Costs for North and South Zones

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	3-Year Avg.	5-Year Avg.	10-Year Avg.
	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	Average of '07 - '09 (1)	Average of '05 - '09 (1)	Average of 00 - '09 (1)
Source of Supply	$ 46,913,988	$ 46,335,997	$ 54,771,739	$ 57,214,155	$ 54,877,704	$ 66,430,701	$ 64,600,300	$ 72,124,703	$ 74,138,929	$ 82,099,418	$ 76,121,017	$ 71,878,810	$ 61,950,763
Raw Water T&D	$ 6,856,208	$ 6,340,593	$ 5,750,153	$ 7,915,463	$ 7,821,905	$ 7,686,173	$ 7,144,380	$ 7,679,725	$ 8,816,567	$ 9,252,136	$ 8,582,809	$ 8,115,796	$ 7,526,330
Treated Water	$ 14,736,327	$ 14,735,516	$ 16,395,725	$ 20,247,449	$ 21,553,417	$ 24,549,875	$ 22,690,621	$ 23,309,543	$ 27,095,936	$ 32,504,763	$ 27,636,747	$ 26,030,147	$ 21,781,917
Treated Water T&D	$ 1,048,571	$ 893,185	$ 1,504,439	$ 1,887,773	$ 2,158,035	$ 1,639,673	$ 1,353,597	$ 1,754,857	$ 2,877,577	$ 3,709,732	$ 2,780,722	$ 2,267,087	$ 1,882,744
Admin & Gen	$ 5,105,910	$ 6,786,539	$ 9,097,554	$ 11,084,823	$ 10,959,842	$ 12,066,648	$ 13,342,807	$ 14,930,079	$ 14,764,370	$ 18,584,983	$ 16,093,144	$ 14,737,777	$ 11,672,356
	$ 74,661,004	**$ 75,091,830**	**$ 87,519,611**	**$ 98,349,662**	**$ 97,370,903**	**$112,373,070**	**$109,131,705**	**$119,798,907**	**$127,693,379**	**$146,151,032**	**$131,214,439**	**$123,029,619**	**$104,814,110**
Annual % change in O&M		*0.6%*	*16.6%*	*12.4%*	*-1.0%*	*15.4%*	*-2.9%*	*9.8%*	*6.6%*	*14.5%*	*10.3%*	*8.7%*	*8.0%*
Total AF Sold	306,734	303,224	298,094	288,272	302,401	274,553	274,284	302,144	304,106	285,009	297,087	288,019	293,882
Annual % Change in Source of Supply		*-1.2%*	*18.2%*	*4.5%*	*-4.1%*	*21.1%*	*-2.8%*	*11.6%*	*2.8%*	*10.7%*	*8.4%*	*8.7%*	*6.8%*

Note: (1) Audited FY 2010 O&M costs were not available as of the writing of this report.

iii. Fixed Assets of Existing System

The District provided a detailed list of its fixed assets, which included the original cost of each asset, the useful life of each asset and the year the asset was placed in service. Each asset was categorized by function, similar to that used for categorizing O&M Costs: source of supply, raw water T&D, water treatment, treated water T&D, and general and administrative. To determine the 2010 costs, or replacement cost of each asset, the Handy-Whitman Index of Public Utility Construction Costs[8] was used. This source provides indices for water utility construction costs by region. Specifically, indices for the Pacific region were used to escalate the original costs to 2010 dollars. To escalate land, the Bureau of Reclamation Construction Cost Trends[9] was used, specifically the land indices for the state of California. Refer to Appendix A for a list of the indices used.

For each of the District's assets, the appropriate index was used, depending on the year each asset was placed in service, to determine the cost of constructing those assets in 2010. The sum of these costs represent the replacement costs, or the costs required today to re-construct (or replace) the District's existing groundwater, treated water, surface water and recycled water system in 2010. The table below shows the summary of the original cost and the replacement cost by function and by system. The categorization by function was used to also reclassify the assets by system. For example, some assets relate to groundwater only (GW), to the recycled water system (RW), specifically to imported water from the CVP or the SWP, to the treated water system (T), or to all systems [(groundwater, surface water, treated water, and recycled water (GST)]. Appendix B shows a sample list of the fixed data and the various categories of costs. As shown in Exhibit 8, the original costs of the fixed assets in the existing system are approximately $607 million and the escalated costs (replacement costs) in 2010 dollars are approximately $1.9 billion.

Exhibit 8: Existing System Original and Escalated Fixed Asset Costs

By Cost Center	Sum of Original Cost	Sum of Replacement Costs
Admin & General	$ 8,770,917	$ 15,384,497
Raw Water T&D	$ 148,510,970	$ 493,754,019
Source of Supply	$ 68,203,449	$ 661,444,462
Treated Water T&D	$ 93,719,031	$ 209,961,327
Water Treatment	$ 288,107,260	$ 559,904,648
Subtotal: Existing System Fixed Assets	**$ 607,311,627**	**$ 1,940,448,953**

By System	Sum of Original Cost	Sum of Replacement Costs
CVP	$ 1,119,423	$ 2,264,367
GST	$ 189,953,049	$ 1,090,985,814
GW	$ 11,864,252	$ 40,972,620
RW	$ 3,404,117	$ 5,308,604
SWP	$ 275,757	$ 539,604
T	$ 400,695,029	$ 800,377,943
Subtotal: Existing System Fixed Assets	**$ 607,311,627**	**$ 1,940,448,953**

8 Handy-Whitman Index of Public Utility Construction Costs, Trends of Construction Costs, Bulletin No. 172 ; 1912 to July 1, 2010.
9 Construction Cost Trends, United Sates Department of the Interior Bureau of Reclamation, Land Indexes for California.

B. Analysis of Alternative 3 – Predominately Groundwater Only System

The capital and operating costs of the existing system must be compared to the capital costs and operating costs under Alternative 3, assuming that the District replaces treated water infrastructure with groundwater infrastructure. This requires the identification of the infrastructure required to replace treated water with groundwater, and then estimating the capital and operating costs of this system in 2010 dollars.

i. Description of Predominately Groundwater Only System

General Overview of Predominately Groundwater Only System

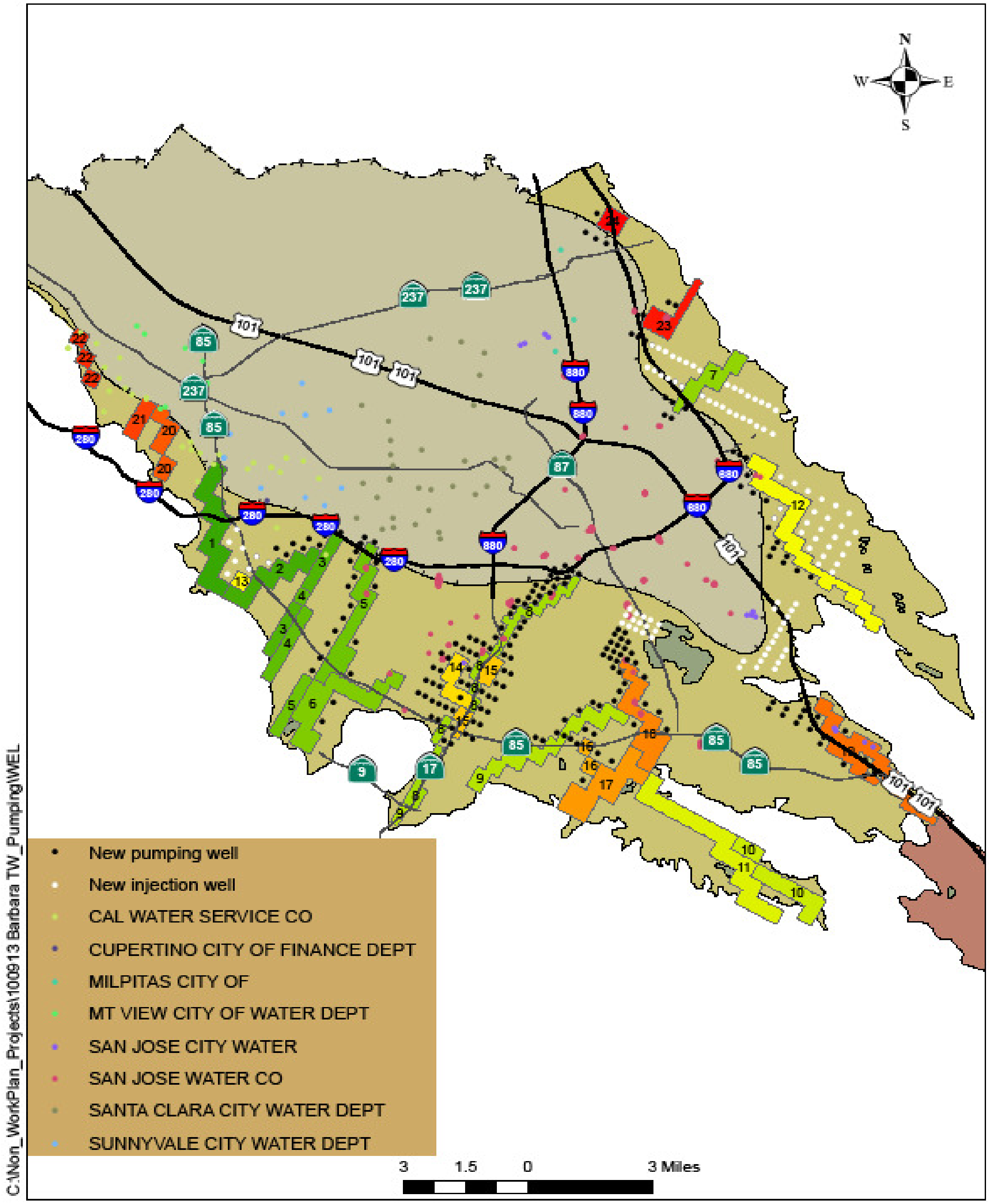
District engineering staff utilizes a model to analyze risks of water supply shortage. This same model was used to determine the assets required if the District abandoned its treatment plants and instead supplied groundwater to all treated water customers, *assuming the same amounts of surface water and recycled water are available for customers.* The detailed analysis that District staff conducted in shown in Appendix C, and is summarized below.

District staff utilized the model to determine the capacity of the existing groundwater system and the additional infrastructure required to supply groundwater to all District customers, assuming that surface water and recycled water sales remain the same as under existing conditions (in other words, no change in the amount of surface or recycled water available and sold to retailers). District staff assumed that historic treated water sales were replaced with groundwater pumping and that imported water used at the treatment plants would be used to recharge groundwater. District staff then used the model to identify facilities that could meet demand without violating District operational policies or physical constraints, such as subsidence thresholds and flooding. After modeling several scenarios that violated District operational policies, the District was able to identify the scenario that would meet water demand without resulting in subsidence or excess flooding. The most viable scenario includes:

1. Maximizing recharge in existing facilities up to the annual percolation capacities provided by the District's operations and Planning Unit.
2. Adding groundwater recharge facilities exceeding annual percolation capacities at existing locations within physical constraints. Recharge that would exceed physical constraints at existing locations is moved to facilities at new locations, requiring 689 acres of new recharge area.
3. Locating new groundwater pumping and spreading the additional groundwater pumping evenly among 133 new extraction wells.

The results of the District's analysis was reviewed by Carollo/HydroMetrics and they verified the validity and the reasonableness of the required groundwater infrastructure if the treatment plants are abandoned. The resulting additional infrastructure needed for this scenario is shown in Exhibit 9. Refer to the report from Carollo/HydroMetrics (Appendix D) for more detail on the groundwater infrastructure required and their analysis.

Exhibit 9: Infrastructure of Assets Required for Alternative 3 – Predominately Groundwater Only System



Note: Numbers on map refer to new recharge facilities.

ii. O&M Costs of Predominately Groundwater Only System

In order to determine the O&M costs of a predominately groundwater only system, the District's existing O&M costs were used and then modified. As mentioned previously, the District categorizes O&M costs by function[10]. The percentage of O&M costs included in the predominately groundwater only alternative are discussed below.

- Source of Supply – Costs that relate to obtaining water supply sources. ***100%** of these costs would exist under Alternative 3 only scenario because the District would still have to purchase imported water and maintain existing reservoirs and other water supply infrastructure.*
- Raw Water T&D – These costs relate to the transmission of water supply sources to the District. ***100%** of these costs would exist under Alternative 3 scenario because imported water is diverted to recharge ponds instead of the treatment plants.*
- Treatment Plant **–** These costs relate to the treatment of water at the District's three treatment plants. ***0%** of these costs would exist under the groundwater only scenario because the treatment plants are abandoned.*
- Treated Water T&D – These costs relate to the distribution costs associated with distributing water from the treatment plants to the District's wholesale customers. ***100%** of T&D costs would be incurred because Alternative 3 assumes that the treated water T&D system is used but instead of distributing treated water, groundwater would be distributed using this existing infrastructure.*
- General & Administration Costs - As discussed previously, these relate to direct water utility management and administration costs, such as division management, billing, training and data maintenance. These costs would continue to be incurred. However, in order to estimate these costs it was determined that only a percent of these costs **(approximately 76%)** should be included, which is based on the composite allocation of the proportion of costs. The sum of the costs listed above represent approximately 76% of the total O&M costs, including treatment plant costs. Therefore this percentage was used to estimate General & Administrative costs under Alternative 3.

As mentioned, the groundwater only system requires the use of 133 new extraction wells and 689 acres for new recharge locations, which will cause the District to incur additional O&M costs to operate these assets. To estimate the additional costs for the 133 new extraction wells, a pumping cost of $91 per AF was used. This pumping cost was obtained from an October 2010 survey sent to the District's retailers, which is explained further in section G – Price Elasticity Analysis. The pumping costs of $91 per AF represents the average cost retailers reported they incur to pump and treat groundwater from the District's groundwater system. To determine the total costs with the 133 extraction wells it was assumed retailers would be substituting groundwater for treated water. The amount of water pumped is assumed to be equal to the

[10] The District's costs for each function also include overhead, or indirect general fund services which relate to shared administrative services for both the Water Utility and Watersheds, such as Finance, Human Resources, etc.

amount of treated water retailers actually purchased in prior years. The pumping cost of $91.00 per AF is used to estimate the amount the District will now have to incur to treat and pump the groundwater that would then be distributed through the District's existing distribution system (that is currently used to transport treated water). The pumping cost of $91.00 per AF (which is a 2010 cost) has to be discounted back to prior years in order to be able to compare these to the historic O&M costs of the existing system. This is done using the electricity cost indices for San Francisco-Oakland-San Jose, California, as reported by the following source: http://www.economagic.com/em-cgi/data.exe/blscu/CUURA422SEHF01.

To estimate the O&M costs to operate new recharge areas District staff reviewed the cost per acre for existing recharge ponds and determined that the District incurs approximately $15,000 (in 2010 dollars) per acre to operate and maintain (cleaning, planning, etc.). Based on HydroMetrics analysis, (see Appendix D), the new recharge ponds will require 689 acres. Multiplying the 689 acres by the $15,000 O&M cost per acre results in the additional O&M costs per year to operate and maintain these recharge ponds. Again these costs have to be discounted back for comparative purposes.

Exhibit 10: Annual O&M Costs of Alternative 3 – Predominately Groundwater Only System

O&M Costs for Alternative 3 - Predominately Groundwater Only System

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	ACTUAL (1)	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL
Source of Supply (100%)	$ 46,913,988	$ 46,335,997	$ 54,771,739	$ 57,214,155	$ 54,877,704	$ 66,430,701	$ 64,600,300	$ 72,124,703	$ 74,138,929	$ 82,099,418
Raw Water T&D (100%)	$ 6,856,208	$ 6,340,593	$ 5,750,153	$ 7,915,463	$ 7,821,905	$ 7,686,173	$ 7,144,380	$ 7,679,725	$ 8,816,567	$ 9,252,136
Treated Water (0%)										
Treated Water T&D (100%)	$ 1,048,571	$ 893,185	$ 1,504,439	$ 1,887,773	$ 2,158,035	$ 1,639,673	$ 1,353,597	$ 1,754,857	$ 2,877,577	$ 3,709,732
Admin & Gen (composite allocation of 76%) (2)	$ 3,880,492	$ 5,157,770	$ 6,914,141	$ 8,424,465	$ 8,329,480	$ 9,170,652	$ 10,140,533	$ 11,346,860	$ 11,220,921	$ 14,124,587
	$ 58,699,259	$ 58,727,545	$ 68,940,473	$ 75,441,856	$ 73,187,124	$ 84,927,199	$ 83,238,811	$ 92,906,145	$ 97,053,994	$ 109,185,873
	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated
Additional costs for 133 extraction wells (3)	$ 6,349,336	$ 6,367,874	$ 9,293,939	$ 9,305,550	$ 9,111,420	$ 8,035,573	$ 8,480,807	$ 11,284,143	$ 9,944,228	$ 10,719,349
Additional costs for 689 acres of recharge area (4)	$ 5,325,711	$ 5,325,711	$ 5,260,896	$ 6,431,853	$ 6,732,053	$ 6,467,923	$ 8,192,663	$ 7,972,980	$ 9,024,070	$ 9,283,325
Total Predominately Groundwater Only O&M costs	**$ 70,374,306**	**$ 70,421,130**	**$ 83,495,308**	**$ 91,179,259**	**$ 89,030,596**	**$ 99,430,695**	**$ 99,912,281**	**$112,163,268**	**$116,022,292**	**$129,188,547**
		0.1%	18.6%	9.2%	-2.4%	11.7%	0.5%	12.3%	3.4%	11.3%

(1) O&M costs represent actual costs incurred.
(2) Composite allocation excluding treated water O&M costs.

(3) Calculation of Additional Costs for 133 Extraction Wells:

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010 Cost
Pumping Cost Escalator	100%	68%	104%	100%	109%	95%	80%	101%	88%	99%	
Pumping Costs per AF(3a) - Discounted back	$ 47.53	$ 47.53	$ 69.94	$ 67.30	$ 67.01	$ 61.47	$ 64.43	$ 80.47	$ 79.63	$ 90.07	**$ 91.00**
Acre Feet that can be pumped (3b)	133,580	133,970	132,890	138,260	135,980	130,720	131,622	140,234	124,882	119,007	118,979
Additional Pumping Costs for 133 Wells	**$ 6,349,336**	**$ 6,367,874**	**$ 9,293,939**	**$ 9,305,550**	**$ 9,111,420**	**$ 8,035,573**	**$ 8,480,807**	**$ 11,284,143**	**$ 9,944,228**	**$ 10,719,349**	**$ 10,827,089**

(3a) From the October 2010 retailer survey which concluded the average cost for retailers to pump and treat groundwater is $91.00 per AF. This cost was provided for 2010 and in order to determine the pumping cost in prior years, electricity costs indices for San Francisco were obtained from http://www.economagic.com/em-cgi/data.exe/blscu/CUURA422SEHF01.
(3b) Assumes groundwater would be substituted for treated water. Therefore this is the actual treated water purchases in AF per year.

(4) Calculation of Additional Costs for 689 Acres of Recharge Area:

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010 Cost
Current annual O&M Cost for ponds (4a)											$ 4,000,000
Water surface area of ponds (acres)											265
O&M Cost per acre											$ 15,094
O&M cost per acre foot - discounted back	$ 7,730	$ 7,730	$ 7,636	$ 9,335	$ 9,771	$ 9,387	$ 11,891	$ 11,572	$ 13,097	$ 13,474	**$ 15,094**
Total acres for additional recharge ponds (4b)	689	689	689	689	689	689	689	689	689	689	**689**
Additional O&M Costs for 689 Acres of Recharge Area	**$ 5,325,711**	**$ 5,325,711**	**$ 5,260,896**	**$ 6,431,853**	**$ 6,732,053**	**$ 6,467,923**	**$ 8,192,663**	**$ 7,972,980**	**$ 9,024,070**	**$ 9,283,325**	**$ 10,400,000**

(4a) Provided by District staff and is based on a review of O&M costs per acre for existing recharge ponds. The O&M cost per acre for FY 2010 is $15,094.
(4b) Total acres for additional recharge ponds were estimated by Carollo/Hydrometrics.

iii. Fixed Assets for Predominately Groundwater Only System

The next step was to determine the costs of the infrastructure necessary to supply groundwater if the treatment plants were never built. As mentioned previously, this scenario assumes that the majority of the District's existing infrastructure would still be used, with the exception of the treatment plants. In addition, the District would need 689 acres for new recharge areas and 133 extraction wells to facilitate a predominately groundwater only system. To estimate the infrastructure needed for this system, the District's fixed asset information was used as a starting point. As mentioned previously, the fixed asset data is categorized by system. For example, some assets relate to groundwater only (GW), to the recycled water system (RW), specifically to imported water from the Central Valley Project (CVP) or the State Water Project (SWP), to the treated water system (T), or to all systems [(groundwater, surface water, treated water, and recycled water (GST)]. Construction of the first treatment plant began in 1965. Therefore any fixed asset prior to this time is truly a groundwater only system asset. As such, Exhibit 11 shows the assets prior to 1965. The SWP and CVP costs are added since these assets are assumed to be used to recharge groundwater. It should be noted there are only minimal costs for these two assets because the majority of the infrastructure constructed for the delivery of SWP and CVP water was funded by the state and federal governments. GW and GST assets after 1965 are also included in this scenario since these assets are relevant to the predominately groundwater only alternative. In addition, T&D assets that would be used to convey groundwater are also added. As mentioned previously, some of the existing system assets currently used for transporting and distributing treated water would be used to transport and distribute groundwater. These assets are shown in detail in Appendix E. The total of the existing system assets that are to be included in the predominately groundwater only system scenario total $284 million, but these represent the original cost to construct these assets and represent costs at the time the assets were placed in service. Similar to the method explained in Section III (a) (iii) – Fixed Costs, we apply Handy Whitman indices to determine the replacement cost in 2010 dollars, which is $1.3 billion.

In addition to the replacement costs of $1.3 billion for the existing system assets that would still be used for the predominately groundwater only alternative, the new assets that are needed to facilitate additional groundwater must be included. These assets include the costs to construct 133 extraction wells and 689 acres of new recharge areas. These new assets total $891 million, which reflect costs in 2010 dollars. These costs were estimated by Carollo/HydroMetrics and the detail behind the calculation of these costs can be found in Appendix D of this report. The total costs of the predominately groundwater only alternative are $2.2 billion.

It should be noted that that $2.2 billion does <u>not</u> reflect any costs associated with land that would have to be purchased for the new recharge areas and 133 extraction wells. Carollo/HydroMetrics estimated that 689 acres of land would be needed for new recharge areas and 93 acres for 133 new wells. As explained in the report prepared by Carollo/HydroMetrics, using various land indices, the cost for purchasing these acres could range anywhere from $983 million to $1.9 billion. Because of the numerous assumptions regarding the value of land, these costs were excluded from the initial analysis. The costs for the predominately groundwater only system also exclude any costs to provide the level of reliability provided by the existing conjunctive use system and to ensure that all regulatory standards are addressed. The exclusion of these costs indicates that the costs for the predominately groundwater only system are very conservative.

Exhibit 11: Fixed Costs of Alternative 3 – Predominately Groundwater Only System (Exclusive of land costs)

Alternative 3 - Predominately Groundwater Only System

	Sum of Original Cost	Sum of Replacement Costs
Existing System Assets Still Used in Alternative 3		
Assets Prior to 1965		
GW	$ 1,833,693	$ 17,995,828
GST	$ 43,156,081	$ 679,092,261
ADD:		
SWP	$ 275,757	$ 539,604
CVP	$ 1,119,423	$ 2,264,367
Other GW costs > 1965	$ 10,030,559	$ 22,976,792
Other GST costs > 1965	$ 138,026,051	$ 396,509,056
ADD:		
Recycled Water	$ 3,404,117	$ 5,308,604
Treated Water T&D	$ 86,507,372	$ 193,398,664
Subtotal: Existing System Assets Still Used under Alt. 3	**$ 284,353,054**	**$ 1,318,085,177**
Additional Assets to Facilitate Predominately GW Only System (1)		
200 new extraction wells		
Pipeline Cost		$ 177,590,600
Well Cost		$ 164,993,928
Project Implementation Costs (at 30%) (2)		$ 102,775,358
		$ 445,359,886
100 recharge locations		
Pipeline Cost		$ 125,262,500
Recharge Pond Cost		$ 217,707,803
Project Implementation Costs (2)		$ 102,891,091
		$ 445,861,394
Land costs (3)		
Subtotal: additional assets		**$ 891,221,280**
Total Fixed Costs for Predominately Groundwater Only System		**$ 2,209,306,457**

(1) Refer to Appendix D, which is the calculation provided by Carollo/Hydrometrics.

(2) Project implementation costs include costs for designing, planning, engineering, construction management fees, legal fees, etc.

(3) **Excludes** any land costs associated with predominately groundwater only system.

C. Calculation of Conjunctive Use Benefit of Treated Water

To calculate the conjunctive use benefit of treated water, the existing O&M and fixed assets costs are compared to the O&M and fixed assets costs for the predominately groundwater only system. The predominately groundwater only system represents the costs the District would have incurred had it not built treatment facilities but instead built groundwater facilities. If the District had pursued the predominately groundwater system, all retailers would pay the same rate for water since there would no longer be a distinction between treated water and groundwater in the North Zone. The ratio between the existing system costs and the predominately groundwater only system costs provides an estimation of the conjunctive use benefit of treated water. The ratio allows us to estimate the treated water costs that should be shared by all customers due to the conjunctive use nature of the system.

To compare the existing system costs to the cost under the predominately groundwater only alternative, costs are annualized, as shown in Exhibit 13. The average O&M costs for FY 2009 from Exhibits 7 and 10 are carried forward. These costs are used since they represent the most current year for which actual O&M costs can be obtained. The FY 2009 costs are used as a base (because actual costs for FY 2010 were not available as of the writing of this report) and then these costs are escalated by the annual change in source of supply costs as shown in Exhibit 7. The percent change in the annual source of supply costs are used since these costs reflect the costs to obtain water supply which would occur under either scenario. The annual change in source of supply costs is used to escalate annual O&M costs in both scenarios.

To annualize the replacement costs for each scenario, the total replacement costs are divided by the weighted average service life of the system. For the existing system, the weighted average service life is approximately 53 years. For the predominately groundwater only alternative, the weighted average service life is approximately 79 years. The weighted average service life of the predominately groundwater only alternative is much higher due to the recharge ponds and wells having a service life of 100 years, whereas many of the treated water assets such as plants have a service life of 50 years. The annualized replacement cost represents the annual cost to purchase the system in 2010.

In performing the cost comparison of each scenario it is important to select a cost stream that is representative of the typical cost stream in the future, which is referred to as a "normalized year". This normalized year is used to calculate the "terminal value", which is used to estimate the costs for the normalized year into perpetuity. The object of the normalized year is to project one year of costs that would be representative of the system into perpetuity meaning over the lifetime of the system. The terminal value is calculated by dividing the annual costs by the capitalization rate, which is the weighted average cost of capital ("WACC") less the growth rate. Exhibit 12 shows the calculation of the WACC, which is comprised of the following components:

i. Cost of Equity:

Risk free rate

\+ Return on Risk Associated with Investing in the District

= Cost of equity

Where:

Cost of Debt: Represents the weighted average cost of all outstanding debt issued by the Santa Clara Valley Water District.

Risk Free Rate: The risk free rate can be determined by looking at the yield on long-term U.S. treasury bonds.

Return on Risk Associated with Investing in the District: The return on risk associated with investing in equity ("equity risk premium") can be determined by comparing the return on equity investments versus the risk free rate. This analysis is performed by Ibbotson Associates each year. However, the risk associated with investing in publicly traded water companies is less than the risk associated with the general stock market. Therefore, the risk associated with investing in equity is multiplied by the average beta of publicly traded water companies to adjust the risk downward.

The long-term sustainable growth rate is then subtracted from the WACC, which is also shown in Exhibit 12. The long-term sustainable growth rate represents the annual growth in the system into perpetuity. This factor was obtained from the Livingston Report dated June 9, 2010 and represents the annual projected growth in GDP for the next 10 years.

Exhibit 12: Calculation of Weighted Average Cost of Capital

COST OF DEBT CAPITAL		
Rate on Utility Bonds (1)		**4.57%**
COST OF EQUITY CAPITAL		
Risk Free Rate - Long-Term U.S. Treasury Bond Yield (2)		4.60%
Equity Risk Premium (2)	5.20%	
Beta for Water Companies (3)	0.80	
Adjusted Equity Risk Premium		4.16%
Total Buildup of Cost of Equity Capital		8.76%
DEBT STRUCTURE (4)		
Debt as Percentage of Capital		27.1%
Equity as Percentage of Capital		72.9%
WEIGHTED AVERAGE COST OF CAPITAL (WACC)		
Weighted Cost of Debt		1.24%
Weighted Cost of Equity		6.38%
Weighted Average Cost of Capital		**7.62%**
DISCOUNT AND CAPITALIZATION RATES		
Net Cash Flow Discount Rate (Equal to WACC)		7.62%
Less: Long-Term Sustainable Growth Rate (5)		2.80%
Net Cash Flow Capitalization Rate		**4.82%**

(1) Represents the w eighted average cost of all outstanding debt issued by the Santa Clara Valley Water District.
(2) Key Variables in Estimating the Cost of Capital, SBBI Valuation Edition 2010 Yearbook (based on 2009 data).
(3) Median beta for the 8 publicly traded w ater companies reported by Valueline on October 20, 2010.
(4) Calculated based on the long-term debt and net assets (or equity) as reported in the fiscal year 2009 Santa Clara Valley Water District Comprehensive Annual Financial Report, page 41.
(5) Based on the Livingston Report dated June 9, 2010 and represents the annual projected grow th in GDP for the next 10 years.
Source: http://w w w .philadelphiafed.org/research-and-data/real-time-center/livingston-survey/2010/livjun10.pdf

The terminal value of each scenario is then calculated by dividing the annual costs by the capitalization rate. As shown in Exhibit 13, the terminal value of existing system is approximately $4.0 billion and the terminal value for the predominately groundwater only alternative is $3.4 billion. The ratio of the terminal value of the existing system to the terminal value for the predominately groundwater only alternative is approximately **1.16.** A ratio of 1.16 indicates that the existing system will cost 16% more to build and operate over the lifetime of the system than if the treatment plants were abandoned and substituted with infrastructure able to provide groundwater. This is due to the predominately groundwater only system having assets with longer service lives which requires less replacement costs. It also does not include any land costs or other costs explained in Section D. Excluding land costs and other costs, the treated water rate should be 16% higher than the **total system unit cost**. And subsequently, the remaining costs should be shared by both groundwater and surface water customers since these costs would be incurred regardless of which system was constructed and used to supply water to retailers. **This ratio therefore establishes a basis for calculating the conjunctive use benefit of the system, and for testing the reasonableness of the District's current rate setting approach.**

Exhibit 13: Comparison of Existing System Costs to Costs for Alternative 3 – Predominately Groundwater Only System Using 2010 Costs <u>but Excluding Land Costs</u>

Existing Combined System Annual Costs (In $1,000)		**Actual Costs FY 2009**		**6.8% Normalized**
Annual Net O&M (based on Actual 2009 Costs) (1)	$	146,151		156,028
Depreciation Component (3)	$	36,726	$	36,726
52.84 Weighted Average Service Life				
Total Annual Costs	$	182,877	$	192,754
Terminal Value (at WACC less growth rate)			**$**	**3,999,051**

Predominantly Groundwater Only System Annual Costs (In $1,000)		**Estimated Actual Costs FY 2009**		**6.8% Normalized**
Annual Net O&M (based on Actual 2009 Costs) (2)		$129,189	$	137,919
Depreciation Component (3)	$	27,853	$	27,853
79.32 Weighted Average Service Life				
Total Annual Costs	$	157,042	$	165,773
Terminal Value (at WACC less growth rate)			**$**	**3,439,269**

Ratio of Terminal Value of Existing System to Terminal Value of Predominantly Groundwater Only System 116.3%

(1) Normalized O&M Costs are calculated by escalating the actual O&M costs in FY 2009 from by the 10-year average increase in source of supply costs of 6.8%, as shown in Exhibit 7.

(2) Normalized O&M Costs are calculated by escalating the actual O&M costs in FY 2009 from by the 10-year average increase in source of supply costs of 6.8%, as shown in Exhibit 10.

(3) The depreciation component is calculated by dividing the total replacement costs for each system by the weighted average service life for each system. The total replacement cost for the Existing System is provided in Exhibit 8 and the replacement cost for the Predominately GW Only System is provide in Exhibit 11.

D. Intangibles

As shown in Exhibit 13, the existing system appears to be more expensive than had the District built a predominately groundwater only system. However, as mentioned previously the costs for the predominately groundwater only alternative exclude several costs, such as land costs which would be needed for the additional wells and recharge ponds. In addition, the costs for the predominately groundwater only system exclude the following costs:

- any infrastructure to provide the same reliability as provided by the existing system
- costs to ensure that all regulatory standards are met
- costs to ensure system peaks are met on a continuous basis
- additional O&M and capital costs incurred by retailers to obtain groundwater instead of treated water from the District

If the costs listed above were quantified and added to the costs shown in Exhibit 12, the costs for the predominately groundwater alternative would increase significantly and would result in higher costs than under the existing system. The exclusion of the costs listed above highlights the benefits that are provided by the existing system to all customers. In addition to these benefits, there are other intangibles that provide benefits to all customers. For example, if the predominately groundwater only alternative was pursued the District would have to purchase land required for the new recharge areas and the 133 extraction wells, which equates to approximately 782 acres (689 plus 93 acres, as mentioned previously). Some of this land may be situated on land that is now developed and inhabited which generates tax revenues for the County. It could also be occupied by a commercial customer that has brought jobs to the County. While many of the intangibles cannot be quantified with exact certainty, we can conclude that if we included costs associated with these intangibles in Alternative 3, the terminal value of Alternative 3 as shown in Exhibit 13 would increase and therefore the resulting ratio would be less than 1.16. As an example, if we include costs that we can quantify, such as the land costs ranging from $936 million to $3.6 billion as estimated by Carollo/HydroMetrics (refer to Appendix D), into the analysis in Exhibit 13, the resulting ratio is **1.09 and 0.92,** respectively. While we acknowledge that land costs are speculative, the relevance of this analysis is that as more costs are included into Alternative 3 for all the intangibles listed above, the costs of Alternative 3 would approach those of the existing system, meaning that the life cycle costs under both systems are approximately equal. This implies that the treated water rate and groundwater water rate could be equal.

E. Consistency of Analysis with Previous Master Plan Study Results

The District operated a groundwater only system until 1965 when the first treated water plant was built. Prior to the construction of this treatment plant, and the other two, the District underwent a comprehensive study to determine whether the existing groundwater and surface system was adequate to supply water for the next 50 years or if alternative water supply sources and infrastructure were required to meet future demand.

i. 1962 Master Plan

The first comprehensive study is documented in a report dated July 18, 1962 and titled "Proposed Water Treatment & Distribution System" (Refer to Appendix G). On page 9 of this report the existing groundwater system was determined to be inadequate to meet future demand due to:

- The extended overdraft of the underground water had in some areas reversed the slope of the gradient and caused degradation of numerous wells by salt water intrusion, as evidenced by increasing chloride content of the well water.
- Ground water levels reached the lowest point in recorded history in certain areas during the late 1961 and early 1962.
- Withdrawal from some wells was severely curtailed in order to protect water quality but not before some wells were deteriorated to the point where recovery could not be expected for several years.

On page 10, the report went on to say that the existing surface water system was also inadequate to meet future demand because:

- There are two general areas of Zone W-1 (eastern foothill regions between Milpitas and Evergreen and the western foothill regions extending from Los Gatos, Monte Sereno, and Saratoga to Monte Vista, Los Altos, Los Altos Hills, Mountain View, Sunnyvale, and Palo Alto) where the local water supplies are inadequate and sub-surface geological conditions severely limit the availability of groundwater.

As a result, the study concluded on page 11 that in order for the District to meet water demand the District should pursue state project water from the South Bay Aqueduct and the construction of the Rinconada water treatment plant. On page 4, the study documents the benefits of this proposed project which include:

- the ability to attract industry and growth
- the elimination of subsidence and the costs to address subsidence, and
- the ability to facilitate recreational activities by ensuring constant water levels for boating and fishing.

ii. 1975 Master Plan

The District underwent another comprehensive study in 1974 – 1975 when the District prepared a master plan titled "Master Plan – Expansion of the In-County Water Distribution System". This study was initiated to address how to meet future water demand. Similar to the previous study, this study analyzed the existing system's capability to meet future demand and identified the most viable alternative to meeting future demand. The study first identified alternatives for meeting supplemental water needs which were: 1) additional local water conservation, 2) additional imported water, and 3) wastewater reclamation.

The District established a set of criteria to be used to evaluate each alternative. The evaluation criteria included 1) additional reservoir yield 2) cost and 3) environmental and socioeconomic impacts. The analysis concluded that the alternative that meets the supplemental water supply needs at the lowest cost is alternative 2 which was to obtain additional imported water from the Central Valley Project. The master plan then went on to analyze how this imported water could best be incorporated into the District's existing system. As stated on page III-32 of the 1975 Master Plan, "the desire was to select alternatives that would provide an economic comparison between surface treatment and groundwater recharge. To provide this comparison, alternative system components were selected which when combined in numerous ways with the existing water supply system would establish the most economical means of meeting the County's total projected water demands." The study examined the following alternatives:

1. Surface treatment alternatives
    a. Expansion of existing water treatment and distribution system
    b. Only the expansion of the distribution system of existing systems (with re-allocation of existing demand between surface and groundwater)
    c. The addition of new treatment and distribution systems
2. Surface irrigation alternatives
3. Groundwater alternatives (use of existing and combinations of proposed artificial recharge facilities to recharge all or part of the imported water supplies into the groundwater basin)
4. Raw water conveyance alternatives

An algorithm for the optimum selection was developed using a mathematical programming model to serve as a tool in the selection of the optimum In-County water distribution system. The results of the model and the other analyses allowed staff to recommend that the optimum solution was a combination of all of the alternatives as follows, with possible modifications if demand projections change in the future:

- Two new treatment plants
- Expansion of treated water pipelines
- Two additional treated water reservoirs
- Five additional raw water conveyance facilities
- Three additional groundwater recharge facilities
- Intensive O&M of existing groundwater recharge to obtain additional recharge in Central and Coyote sub basins

As evidenced by both master plans, the District underwent a comprehensive analysis to determine the most economical and viable configuration of its system in order to meet water supply demand within its service area. Both the economic analysis and socioeconomic factors identified for each alternative indicated that the District could best meet demand by importing water and building treatment plants rather than building infrastructure to allow more groundwater supply. This conclusion is further supported by two recent analyses: 1) An analysis by Berkeley Economic Consultants[11] shown in Appendix F that estimates the socioeconomic impacts under water shortages, and 2) An analysis by RFC to estimate the cost of the predominately groundwater only system in 1965.

[11] Memorandum from Berkeley Economic Consulting dated February 24, 2010 and titled "Economic Analysis of Water Shortage in Santa Clara County"

The analysis by Berkeley Economic Consultants documents the potential socioeconomic impacts (both affecting employment and sales) to the County under various water shortages. This analysis indicates that under a 10% shortage in water supply, the County could experience a loss of 3,000 jobs, a reduction in sales revenue of approximately $883 million, and payroll losses of approximately $262 million. This analysis supports the District's socioeconomic criteria used during previous master planning processes, specifically related to how choosing an optimal solution that provides adequate water supply can attract industry and growth.

As shown in Exhibit 14, RFC conducted the same analysis as shown in Exhibit 13 (using the same assets described earlier for a predominately groundwater only system) but reflecting the costs in 1965 dollars, which is the point in time prior to the construction of any treatment plants. RFC de-escalated the existing system fixed costs by discounting the assets placed in service each year back to 1965 dollars. RFC then de-escalated the assets assumed to exist under Alternative 3 back to 1965 dollars, including the costs identified by Carollo/HydroMetrics to build new recharge areas and 133 extraction wells. As shown in Appendix H, this analysis results in total fixed costs of approximately $197 million for the existing system and $247 million for Alternative 3. The fixed costs for Alternative 3 are more expensive than the existing system because this scenario assumes the assets required for the predominately groundwater only system would be placed in service in years that correspond with the timing of the treatment plants, which is approximately 1967, 1974, and 1989.

RFC also de-escalated the O&M costs for each system by using the annual average increase in source of supply costs over the past ten years (approximately 6.8%), also as shown in Appendix H. RFC then calculated the costs into perpetuity for each system to represent the costs over the lifetime of these two systems. The resulting ratio of the terminal values for each system is approximately **1.11**, as shown in Exhibit 14, meaning the existing system is approximately 11% more expensive to operate than a predominately groundwater only system. Again, it should be noted that the costs for Alternative 3 do not include any land costs or other costs for intangibles as mentioned in Section D. For example, if the land costs estimated by Carollo/Hydrometric ranging from $936 million or $3.6 billion are included, but discounted these back to 1965 dollars, then the ratios become approximately 1.02 and 0.82, respectively. These ratios indicate the groundwater only system would have been more expensive to build and operate than the existing system.

Exhibit 14: Comparison of Existing System Costs to Costs for Alternative 3 – Predominately Groundwater Only System Using 1965 Costs But Excluding Land Costs

Existing Combined System Annual Costs (In $1,000)	**1965 Costs**	**6.8% Normalized**
Annual Net O&M (based on Estimated 1965 Costs) (1)	$6,449	$ 6,884
Depreciation Component (2)	3,724	3,724
Total Annual Costs	$ 10,172	$ 10,608
		$ 220,089

Predominantly Groundwater Only System Annual Costs (In $1,000)		
Annual Net O&M (based on Estimated 1965 Costs) (1)	$6,078	$6,489
Depreciation Component (2)	$3,111	$3,111
Total Annual Costs	$ 9,189	$ 9,600
Terminal Value (at WACC less growth rate)		**$ 199,174**
Ratio of Terminal Value of Existing System to Terminal Value of Predominantly Groundwater Only System		**110.5%**

(1) Normalized O&M Costs are calculated by escalating the estimated O&M costs in FY 1965 by the 10-year average increase in source of supply costs of 6.8%.

(2) The depreciation component is calculated by dividing the total replacement costs for each system by the weighted average service life for each system. Replacement costs **exclude** land costs.

F. Application to the District's Rate Setting Process

As mentioned in Section I, the District follows a six-step rate setting process. In Step 6, the District makes a treated water adjustment by shifting costs from treated water customers to groundwater and surface water customers such that the resulting rate between groundwater and treated water customers in the North, is approximately $100, which represents the point of indifference between customers purchasing groundwater and pumping/treating it or purchasing treated water. As shown in Section I, Exhibit 3, the unit costs per AF prior to any adjustments are $318 for groundwater, $822 for treated water, and $510 for the total system. Since the District is targeting a $100 differential, the District is applying a treated water surcharge of 1.22 to the total system unit cost ($510) to derive a treated water rate of $620. The difference between the treated water unit cost ($822) and the unit rate of $620, which is $22.2 million, represents the conjunctive use benefit of treated water that is allocated to the groundwater and surface water users.

We can apply the range of results of the analyses in Section III to the District's rate setting process to test the reasonableness of the conjunctive use benefit that is being allocated to groundwater and surface water users. As an example, if we apply the 1.16 ratio (calculated in Exhibit 13 which assumes no land costs) to the rate setting process originally shown in Exhibit 3, then the results would be as follows (as shown in Exhibit 15):

1. The ratio of 1.16 would be applied to the unit cost of $510 to derive a unit rate of treated water of $593.
2. The conjunctive use benefit is calculated by subtracting the treated water unit cost of $822 by the treated water rate of $593, or $229.
3. The difference is then multiplied by the TW use of 109,600AF to derive the costs that could be shifted from treated water to groundwater and surface water customers (approximately $25.2 million).

Exhibit 15: Application to Rate Setting Process

	FY '11 Projection ($K)	Zone W-2						Zone W-5							Total
		GW		TW	SW		Total W-2	GW		SW		RW		Total W-5	
		M&I	AG	M&I	M&I	Ag		M&I	AG	M&I	AG	M&I	AG		
1	**Operating Outlays**														
2	Operations/Operating Projects	28,412	107	66,277	905	9	95,710	5,372	4,974	52	339	123	70	10,930	106,641
3	SWP Imported Water Costs	4,987	19	17,079	323	3	22,411	-	-	-	-	-	-	-	22,411
4	Debt Service	3,473	13	12,811	115	1	16,413	-	-	-	-	-	-	-	16,413
5	**Total Operating Outlays**	36,872	139	96,166	1,343	14	134,535	5,372	4,974	52	339	123	70	10,930	145,465
6															
7	**Capital & Transfers**														
8	Operating Transfer	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Capital Outlays exc	16,443	62	35,168	527	6	52,207	-	-	-	-	-	-	-	52,207
10	**Total Capital & Transfers**	16,443	62	35,168	527	6	52,207	-	-	-	-	-	-	-	52,207
11	**Total Annual Program Costs**	53,315	201	131,334	1,870	20	186,741	5,372	4,974	52	339	123	70	10,930	197,671
12															
13	**Revenue Requirement Offsets**														
14	Capital Cost Recovery	(1,394)	(5)	(1,443)	(46)	(0)	(2,889)	1,045	967	8	50	522	298	2,889	-
15	Debt Proceeds	(6,723)	(25)	(14,379)	(216)	(2)	(21,346)	-	-	-	-	-	-	-	(21,346)
16	Inter-governmental Services	(512)	(2)	(529)	(17)	(0)	(1,060)	(55)	(51)	(0)	(3)	-	-	(109)	(1,169)
17	SWP and W-1 Property Taxes	(3,765)	(14)	(13,436)	(244)	(3)	(17,462)	(524)	(485)	(4)	(25)	(27)	(16)	(1,080)	(18,542)
18	Inter-zone Interest	(107)	(0)	(110)	(4)	(0)	(221)	107	99	1	5	6	3	221	-
19	Capital Contribution	(3,542)	(13)	(3,666)	(117)	(1)	(7,339)	-	-	-	-	-	-	-	(7,339)
20	Perchlorate Respon	(1,174)	(4)	(1,215)	(39)	(0)	(2,433)	1,263	1,170	-	-	-	-	2,433	-
21	Other	(349)	(1)	(1,922)	(18)	(0)	(2,291)	(20)	(19)	(0)	(1)	-	-	(40)	(2,331)
22	Reserve Requireme	(2,090)	(8)	(4,469)	(67)	(1)	(6,634)	-	-	-	-	-	-	-	(6,634)
23	**Adjusted Revenue Requirement**	33,659	127	90,164	1,103	12	125,066	**7,188**	**6,656**	**56**	**366**	**623**	**356**	**15,244**	**140,310**
24															
25	Volume (KAF)	105.9	0.4	109.6	3.5	0.0	219.5	27.0	25.0	0.2	1.3	1.4	0.8	55.7	275.2
26															
27	Revenue Requirement per AF	$ 318	$ 318	$ 822	$ 315	$ 315		$ 266	$ 266	$ 281	$ 281	$ 445	$ 445		**$ 510**
28															System Unit Cost
29															
30	**Adjustments for Agricultural Preservation**														
31	Allocate WU 1% Ad Valorem Prop	0	(120)	-	-	(10)	(131)	-	(3,895)	-	-	-	-	(3,895)	(4,026)
32	Allocate Interest Earnings	-	-	-	-	-	-	-	(2,348)	-	(304)	-	-	(2,652)	(2,652)
33	Transfer WS 1% Ad Valorem Prop	-	-	-	-	-	-	-	-	-	(25)	-	(323)	(348)	(348)
34	Revenue Requirement per AF	$ 317.7	$ 16.5	$ 822	$ 315	$ 28.3		$ 266	$ 16.5	$ 281	$ 28.3	$ 445	$ 41.5		
35	**Adjustments to Facilitate Conjunctive Use**														
36	Treated Water Surcharge Differential														**1.16**
37	Apply Differential to System Unit Cost			593											
38	Conjunctive Use Benefit	24,362	-	(25,167)	805	-	-	237	-	1	-	(238)	-	-	-
39	Charge per AF	**$ 548**	**$ 16.5**	**$ 593**	**$ 545**	**$ 28.3**		**$ 275.0**	**$ 16.5**	**$ 287**	**$ 28**	**$ 275**	**$ 41.5**		

Step 2- Identify revenue reqmnts

Step 3 - Allocate costs to customer classes

Step 3 - Allocate costs to customer classes

Step 4- Allocate offsets

Step 5 - Develop unit costs by customer class

Step 5 - Develop unit costs by customer class

Step 6 - Develop unit rates by customer class

A ratio of 1.16 indicates the existing system costs approximately 16% more than if the treatment plants were abandoned and substituted with infrastructure able to provide additional groundwater. Therefore the treated water rate could be 16% higher than the **total system unit cost**. And subsequently, the remaining costs ($25.2 million as shown in Exhibit 15) could be shared by both groundwater and surface water customers since these costs would be incurred regardless of which system was constructed and used to supply water to retailers. Using this same methodology, we can estimate the conjunctive use benefit for each of the ratios calculated in Section III, as shown in Exhibit 16:

Exhibit 16: Resulting Range of Ratios and Estimated Conjunctive Use Benefit of Treated Water

FY 2011 Rate Setting Practices	Ratio	Conjunctive Use Benefit (in millions)
Existing FY 2011 Rates	1.22	$22.2
Scenario	**Resulting Ratios**	**Estimated Conjunctive Use Benefit (in millions)**
Analysis Using 2010 Dollars		
No land costs	1.16	$25.2
Lowest range of land costs ($936 million)	1.09	$29.2
High-range of land costs ($3.6 billion)	0.92	$38.8
Analysis Using 1965 Dollars		
No land costs	1.11	$28.1
Lowest range of land costs ($936 million)	1.02	$33.1
High-range of land costs ($3.6 billion)	0.82	$44.3

As shown in Exhibits 15 and 16, using ratios that are less than the existing ratio of 1.22, indicate the District could transfer more costs to groundwater and surface water users. Because the District is currently transferring <u>less</u> costs to groundwater and surface water users ($22.2 million shown in Exhibit 3 versus the $25.2 million shown in Exhibit 15), the District's existing rate setting process regarding the conjunctive use benefit of treated water is reasonable and is justified. Furthermore, the District by legislation can transfer less costs in order to effectively manage all water supply sources. Specifically, the District was formed under the District Act to "manage the groundwater system…" and therefore the District can choose to transfer fewer costs which would lower the groundwater rates and increase the treated water rates to the point where equilibrium is achieved. In effect this means the treated water surcharge should equal the cost to pump and treat groundwater. This equilibrium is achieved when the groundwater production unit rate per AF plus pumping costs per AF equals the treated water rate per AF. A recent survey completed by several of District's retailers indicated that the cost to pump and treat groundwater is $91.00 per acre foot. Therefore the District's existing treated water surcharge of $100 is near the point of equilibrium, which is confirmed by the data the District was able to gather from this recent survey, as explained below.

G. Price Elasticity Analysis

As mentioned previously, the District's rate structure includes treated water surcharges that are added to the groundwater production charges. Retailers that purchase treated water from the District have contracts with the District that specify a minimum amount of required treated water purchases per year. The District imposes a treated water contract surcharge ("TW contract surcharge") which is assessed to all treated water sales up to the contract minimum. Currently the TW contract surcharge is $100.00 per AF. The District also assesses a separate non-contract treated water surcharge for all treated water purchases above the required minimum contract amount. This is referred to as a "TW non-contract surcharge" which is currently $50.00 per AF. The District uses both the TW contract and TW non-contract surcharges as pricing mechanisms to assist the District in managing the groundwater supply. For example, in years of drought, imported water supplies may be restricted and therefore the District prefers that more groundwater be used than treated water. If the District wants retailers to use more groundwater, the District will increase the TW non-contract surcharge to promote the use of groundwater. To test the sensitivity of both treated water surcharges, RFC conducted a price elasticity exercise.

To determine how to gather data for the price elasticity exercise, retailer purchase data for the past five years (2006 – 2010) was reviewed. The following chart shows the average groundwater and treated water purchases of the District's 13 retailers over the past five years. As shown in Exhibit 17, on average, retailers purchased 46.5% groundwater sales and 53.5% treated water sales. Also, the largest users of treated water are San Jose Water Company, the City of San Jose, California Water, Santa Clara, and Sunnyvale. Therefore it was determined that these utilities would be used to gather data regarding the effects of various prices for treated water surcharge since these utilities would be the most affected by changes in the TW surcharges.

Exhibit 17: Average Retail Purchases from the District

Five Year Average of Purchases in AF (2006 - 2010) (1)				% of Treated Water
Retailer	**Groundwater**	**Treated Water**	**Total Purchases**	
California Water Company	4,543	10,150	14,693	**8.2%**
City of San Jose	790	15,657	16,447	**12.7%**
Cupertino	114	3,345	3,459	2.7%
Gilroy	8,640	0	8,640	0.0%
Great Oaks Water Company	12,488	0	12,488	0.0%
Milpitas	0	3,895	3,895	3.1%
Morgan Hill	7,961	0	7,961	0.0%
Mt View	460	1,236	1,696	1.0%
Palo Alto (2)	0	0	0	0.0%
Purrissima Hills (2)	0	0	0	0.0%
San Jose Water Company	56,371	75,812	132,183	**61.3%**
Santa Clara	14,777	4,246	19,023	**3.4%**
Stanford/Moffett Field (2)	0	0	0	0.0%
Sunnyvale	1,515	9,429	10,944	**7.6%**
	107,660	**123,771**	**231,431**	**100%**
% of Total	**46.5%**	**53.5%**		

(1) Data for 2010 represents estimated information.

(2) Purchase Hetch Hetchy water.

As mentioned, the District has contracts with retailers that state minimum required TW purchases. Exhibit 18 shows these minimum contract purchases and compares them to the average treated water purchases over the past five years (2006 -2010) to show the break out between contract and non-contract purchases for retailers with the largest amounts of treated water purchases. As shown in Exhibit 18, over the past five years, approximately 15% of treated water sales have been above the minimum contract amount, and which would be assessed the TW non-contract surcharge per AF.

Exhibit 18: Average Purchases from the District for the Largest Five Retailers

Five Year Average of Purchases in AF (2006 - 2010) (1)							
		Treated Water					
Retailer	Groundwater	Minimum Contract Purchases	Non-Contract Purchases (Over Contract)	Subtotal: TW Purchases	Total Purchases	Proportion of Non-Contract Purchases by Retailer
San Jose Water Company	56,371	63,396	12,416	75,812	132,183	71%
California Water	4,543	7,083	3,067	10,150	14,693	18%
Santa Clara	14,777	4,104	142	4,246	19,023	1%
San Jose City	790	13,903	1,754	15,657	16,447	10%
Sunnyvale	1,515	10,409	0	9,429	10,944	0%
Subtotal	**77,997**	**98,896**	**17,379**	**115,294**	**193,291**	100%
% of Total TW Purchases		**86%**	**15%**			

(1) Data for 2010 represents estimated information.

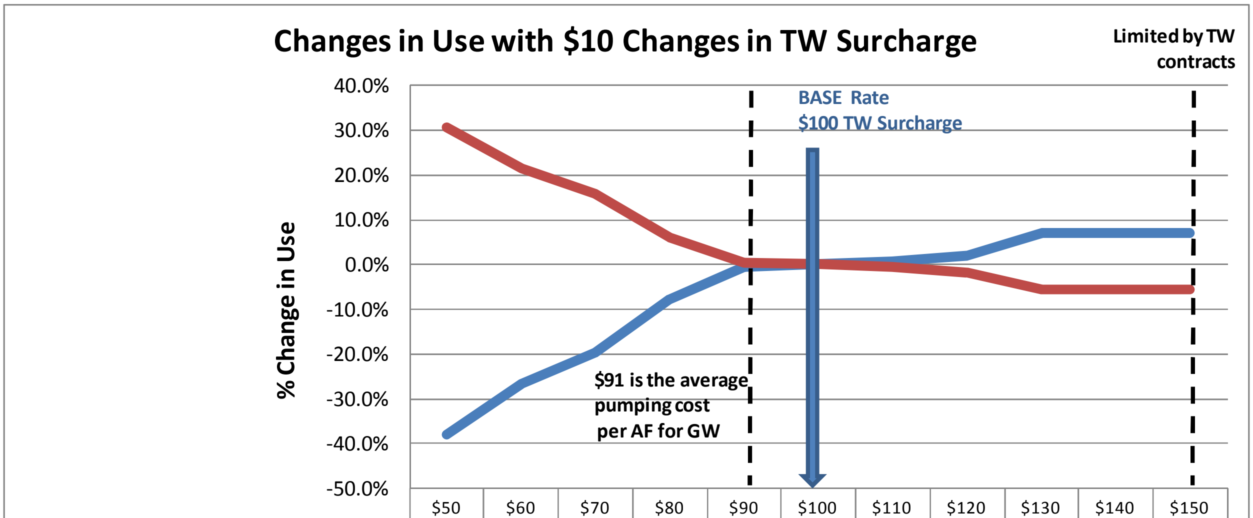
To determine the sensitivity of the changes to both the TW contract and non-contract surcharge, a survey was sent to the retailers with largest TW purchases. Retailers were asked to indicate how much treated water and groundwater they would purchase at various prices for TW contract and non-contract surcharges. Out of the 5 retailers that were sent surveys, 3 provided responses: San Jose Water Company, City of San Jose and Sunnyvale. These retailers combined represent approximately 83% of total purchases. As a result, it was determined that the responses obtained from these retailers would be representative of the entire group. The first question asked retailers to quantify the amount of groundwater and treated water they would purchase if the TW contract surcharge varied between $50 to $150 (as shown in Exhibit 19),and assuming the TW contract and the TW non-contract are equal. It was also assumed that retailers had to purchase the amount that they have purchased over the five-year average, as shown in Exhibit 18.

Exhibit 19: Survey Assumptions Regarding Prices for TW contract surcharge

Groundwater Production Charges	Average Pumping Costs	Total Costs to Purchase and Treat GW ($520 plus $91)	TW Surcharge	Total TW Costs ($520 plus TW surcharge)	Difference per AF
$520	$91	**$611**	$50	**$570**	($41)
$520	$91	**$611**	$60	**$580**	($31)
$520	$91	**$611**	$70	**$590**	($21)
$520	$91	**$611**	$80	**$600**	($11)
$520	$91	**$611**	$90	**$610**	($1)
$520	$91	**$611**	$100	**$620**	$9
$520	$91	**$611**	$110	**$630**	$19
$520	$91	**$611**	$120	**$640**	$29
$520	$91	**$611**	$130	**$650**	$39
$520	$91	**$611**	$140	**$660**	$49
$520	$91	**$611**	$150	**$670**	$59

Exhibit 20 shows the impact if the TW contract and non-contract surcharges are equal. The chart assumes the base rate is a TW surcharge of $100 for both the contract and non-contract TW purchases, and a groundwater production charge of $520. The percent changes are relative to this base rate of $100. The retailers were also asked to provide us with their average pumping and chemical costs to extract groundwater. The average pumping and chemical costs for the 3 retailers was $91, which is also shown in Exhibit 20 The assumed cost for retailers to purchase groundwater, pump, and treat it is therefore $611 ($520 + 91).

Exhibit 20: Survey Results



	$50	$60	$70	$80	$90	$100	$110	$120	$130	$140	$150
Percent Change in GW Use from Base Use	-37.9%	-26.7%	-19.7%	-7.6%	-0.6%	0.0%	0.7%	2.1%	7.0%	7.0%	7.0%
Percent Change in TW Use from Base Use	30.6%	21.5%	15.8%	6.2%	0.5%	0.0%	-0.6%	-1.7%	-5.7%	-5.7%	-5.7%

Based on the survey responses as documented in Exhibit 20, the following observations can be made:

- TW surcharge <$90: As the TW surcharge approaches $0, or the GW production charge, retailers will buy more treated water. The TW rate is less than the groundwater production charge plus the pumping costs.

- TW surcharge between $90 to $100: When the TW surcharge is between $90 and $100, the groundwater production charge plus pumping costs ($611) are close to the TW rate of $620 ($520 plus $100), and therefore retailers are indifferent between purchasing GW or TW.

- TW surcharge between $100 and $130: When the TW surcharge is between $110 and $130, retailers would prefer to use groundwater over treated water since treated water is more expensive than groundwater.

- TW surcharge > $130: As the TW surcharge increases, TW becomes more expensive than the total cost to purchase groundwater and therefore retailers will purchase more groundwater. However, retailers have a contract that specifies the minimum amount of treated water purchases. Therefore TW sales level off to the required minimum TW contract amount, and GW sales are capped due to the limitation in the survey that required retailers purchase up to their five-year average.

As shown in Exhibit 20, as the surcharge decreases, meaning the GW and TW rates approach equilibrium, retailers will trade groundwater use for treated water use. This is validated by the average pumping and chemical costs ($91) reported in the survey. When the surcharge increases such that TW becomes more expensive than GW, retailers will decrease their use of TW. However due to minimum TW purchase amounts imposed on each retailer, TW use cannot fall below the sum of the minimum TW purchase contract amounts. We can use the results of this survey to estimate the impact on the District's management of groundwater and treated water under various TW surcharges. As shown in Exhibit 21, if we apply the results of this analysis to the five-year average of retailer sales, then the District can estimate the shift in groundwater to treated water, assuming both the TW contract and non-contract surcharges are equal, and assuming that the responses from the District's retailers are indicative of their actual purchasing habits. This data can be used by the District in its rate setting process by using these elasticity factors as guidelines as to how much use may vary for each customer class depending on the treated water surcharge that is established. However, the District should also consider other factors that impact use such as weather, conservation restrictions, etc. in their final estimates.

Exhibit 21: Application of Survey Results to Historic Retail Use

	GW (AF)	TW (AF)	Total (AF)
Total Purchases (5-year average)	107,660	123,771	231,431

TW Surcharge (per AF)	% Change in GW Purchases	% Change in TW Purchases	Resulting GW Purchases (AF)	Resulting TW Sales (AF)	Total Purcahses (AF)
$50	-37.9%	30.6%	66,821	161,585	228,405
$60	-26.7%	21.5%	78,919	150,382	229,302
$70	-19.7%	15.8%	86,481	143,381	229,862
$80	-7.6%	6.2%	99,427	131,394	230,821
$90	-0.6%	0.5%	107,055	124,331	231,386
$100	0.0%	0.0%	107,660	123,771	231,431
$110	0.7%	-0.6%	108,416	123,070	231,487
$120	2.1%	-1.7%	109,929	121,670	231,599
$130	7.0%	-5.7%	115,222	116,769	231,991
$140	7.0%	-5.7%	115,222	116,769	231,991
$150	7.0%	-5.7%	115,222	116,769	231,991

The second question in the survey asked retailers to quantify the amount of groundwater and treated water they would purchase if the TW contract surcharge remained at $100 but the TW non-contract surcharge varied between $50 to $150 (in increments of $50). It was also assumed that retailers had to purchase the amount that they have purchased over the five-year average, as shown in Exhibit 18. Only one retailer provided a response to this question. As a result, it was determined that this data was not substantial enough to represent the purchasing patterns of all retailers with groundwater and treated water purchases.

The results of the retailer survey and the price elasticity analysis indicate that the District's treated water surcharge of $100 is within the range of equilibrium where retailers are indifferent between purchasing groundwater and treated water. Equilibrium is achieved when the treated water surcharge is between $90 and $100, which is approximately equal to the retailers cost to pump and treat groundwater. The District should continue to set the treated water surcharge within the dollar range that equates to the retailers cost to pump and treat groundwater since this will achieve a balance between the District's groundwater and treated water supply sources. It should be noted that in the Review of District's FY 2011 GW Production Charges Report, RFC originally suggested using a fixed *percentage t*o establish the treated water surcharge, rather than a fixed *dollar* amount. However, with the information and analysis attained through the retailer survey, RFC suggests that the treated water surcharge remain a fixed **dollar** surcharge. This will ensure that the treated water surcharge equates to the cost of retailers to pump and treat groundwater in the future, as these costs change over time.

Section IV: Calculation of Benefit of Agriculture Use Using Alternatives 3 through 5

As discussed in Section II (D) of this report, it was determined that three alternatives should be used to calculate the benefit of AG use:

- Alternative 3 – Interruptible Rates
- Alternatives 4 and 5 – AG versus M&I Use Only

A. AG versus M&I Use per AF

Based on discussions it was determined that Alternatives 4 and 5 should be investigated because data under these alternatives could be gathered with more ease than under the other alternatives. These alternatives are based on the ratio of M&I use to AG use per acre. Appendix I summarizes the analysis that District staff conducted to determine the coefficients of AG versus M&I use per AF, which included District staff analyzing the following:

- AG sales in the South Zone and acres served
- Retailer sales in the South Zone (which represents M&I use) and GIS data for these retailers

The results indicated a M&I coefficient of 0.7 AF/acre compared to an AG coefficient of 0.98 AF/acre which implies M&I users use slightly less than AG users on a AF/acre basis. To check the validity of their analysis, District staff then referred to published data from the California Water Plan regarding AG use for various crops which show larger coefficients for AG use in the range of 2 to 3 AF/acre. District staff also found a report by Johnson and Loux tilted "Water and Land Use: Planning Wisely for California's Future" which published M&I coefficients of 1.9 and 4.9 AF/acre depending on medium and high density, respectively. Comparing coefficients in these published documents also results in the conclusion that AG use and M&I is comparable. As a result, it was determined that further analysis for both Alternatives 4 and 5 were not warranted since use for either type of customer class will yield the same water demand and therefore no differentiating benefit among the two customer classes.

B. Interruptible Rates

Since the analysis for Alternatives 4 and 5 concluded no benefit between AG and M&I use, Alternative 3, the establishment of interruptible rates, was pursued. Currently the District does not have interruptible agreements with AG customers, but the District could establish these agreements. Interruptible rates would allow the District to interrupt service to AG users for a specified period of time, such as once every five years, during drought conditions and in turn allow M&I users to be able to use water when they otherwise would have to conserve. The benefit of these interruptible rates can be calculated based on the incremental costs the District could avoid if it can curtail AG use.

RFC and District staff reviewed the costs incurred to serve AG customers. Because AG customers have direct access to groundwater, there are not substantial costs that would be eliminated if AG use is curtailed. However, the District could achieve savings relating to banked water. The District purchased 20,000 and 10,000 AF of banked water in FY 2007 and 2008, respectively, which averages 15,000 AF per year. Based on historic costs to purchase and bank water, the cost per AF for the District is approximately $200.00. However, a 1 AF reduction in AG use does not equate to the 1 AF reduction in banked water because the District will bank water to ensure supplies are available to meet demand. To be conservative we can assume that any reduction in AG use would be spread over the timeframe in which an AG customer's use could be interrupted. For example, RFC has assumed that the District could only interrupt an AG customer's use once in every 5 years. In addition, the District would have to determine how much of an AG customer's use could be interrupted. Interrupting use that limits the AG customer's water to 0% in one year is not realistic since this would cause the AG customer to incur significant crop loss and revenue loss. However, the District may be able to interrupt service such that the AG customer uses 10 to 30% less water in a year and still be able to produce a crop. The type of crop and its irrigation needs would dictate the appropriate amount of interruptible service.

Exhibit 22 shows the savings, and the implied AG discount, that the District could incur if AG users could have service interrupted once every five years, under various interruptible percentage scenarios. The savings and the implied AG discount per AF (the savings divided by the total AG use in AF of 27,500) vary based on which scenario would be implemented.

Exhibit 22: Implied Discount for AG Rates Under Interruptible Rates

Assumption: Interupt rates only once in a 5-year period.

275,200 Total AF for District
27,500 AG use in AF

	Various Scenarios				
Interruptible Rates - Required Reduction	**10%**	**20%**	**30%**	**50%**	**100%**
Resulting Savings in AF	2,750	5,500	8,250	13,750	27,500
% Total District savings in AF	1%	2%	3%	5%	10%
Banked Water Cost	**$ 200.00**	**$ 200.00**	**$ 200.00**	**$ 200.00**	**$ 200.00**
Banked Water Cost Savings	**$ 550,000**	**$ 1,100,000**	**$ 1,650,000**	**$ 2,750,000**	**$ 5,500,000**
Savings in AF divided by **5 (1)**	550	1,100	1,650	2,750	5,500
	$ 110,000	**$ 220,000**	**$ 330,000**	**$ 550,000**	**$ 1,100,000**
Implied AG Discount	**$ 4**	**$ 8**	**$ 12**	**$ 20**	**$ 40**

(1) Savings in AG AF are divided by 5 years to represent reduction in banked water.

Because total AG sales are only 10% of the District's total system water sales, the savings and the resulting AG discount per AF are not substantial, in comparison to the existing AG discount which is $249.50. (Refer to Exhibit 3. The groundwater production unit cost in the South Zone W-5 is $266 but the resulting AG rate of $16.50 which is a difference of $249.50). The total discount per AG based on interruptible rates ranges from $4.00 to $40.00 per AF based on the scenario.

The calculated interruptible rates are consistent with current trends in the water industry. For example, the FY 2011 untreated M&I rate per AF and the AG rates per AF for Metropolitan Water District of Southern California (MWD) are $527 and $482, respectively, which equates to a $45 AG discount. The FY 2011 untreated M&I rate per AF and the AG rates per AF for San Diego County Water Authority (CWA) are $597 and $482, respectively, which equates to a $115.00 AG discount. CWA is a member agency of MWD. CWA passes on the MWD AG discount to its customers, plus an additional discount to reflect less storage and supplemental supply costs incurred by CWA as a result of interruptible AG use.

It should be noted that MWD recently announced that it will eliminate its interruptible AG rate by 2013 due to requiring all customers to adhere to drought restrictions which means the savings that MWD once was able to attribute to AG users is also realized by M&I users. As a result, the discount is no longer valid. This implies that if the District were to establish interruptible rates, the cost savings associated with AG rates would only be valid if the District did not require M&I users to conserve water. If the District implements mandatory conservation restrictions for both M&I and AG users, then these cost savings would benefit both M&I and AG and any differentiating benefits between the two customer classes would be eliminated or substantially reduced.

C. Application of Interruptible Rates to Rate Setting Process

Since there are not substantial cost savings from serving AG customers, the discount that the District provided to AG customers in FY 2011 cannot be justified by implementing interruptible AG rates. However, if we refer back to Exhibit 3, which shows the rate setting process, the District was able to achieve its FY 2011 AG discount by using offsets. As shown in Exhibit 3 the District used the interest earnings generated from reserve funds as an offset, as per the "Revenue Pooling" concept in Resolution 99-21. The District also applied revenues from 1% ad valorem property taxes to each zone and used a transfer of 1% ad valorem property taxes from the Watershed or General Fund in order to be able to maintain the AG rate at a certain percentage of the M&I groundwater production charge. All of the offsets represent an "open space credit" which is to preserve open space. The District used these offsets to reduce the AG rate as shown in lines 31, 32 and 33 of Exhibit 3.

In order for the District to reduce the AG rate to less than 10% to be in compliance with Resolution 99-21 which states, that the AG rate "shall not exceed one-tenth the rate for all water other than agricultural water", the District will have to continue to use offsets. For setting rates in future years, the District should determine the flexibility in offsets resulting from the 1% ad valorem property taxes, specifically the flexibility to increase the transfer of 1% ad valorem property taxes from the Watershed or General Fund in order to replace the interest earnings currently used for the AG discount. By using more 1% ad valorem property taxes from the Watershed or General Fund, the District can continue to maintain the AG discount in an effort to promote the continuance of agricultural use of land and to encourage the preservation of open space. The District should use these offsets to establish an AG discount that is consistent with Resolution 99-21 which states that the AG rate can be set between 6% and 10% of the South Zone groundwater production charge.

Appendices

APPENDIX A: Indices Used to Escalate Fixed Costs

Handy-Whitman Index - Pacific Region (1)								LAND (Bureau of Reclamation : Construction Cost Trends) LAND Indexes for California (2)
Original Date	**Distribution Mains-** Average All Types	Electric Pumping Equipment	Small Treatment Plant Equipment	**Source of Supply** - Collecting and Impounding Res.	Elevated Steel Tanks	Average Index (Used for Admin/Gen Only)	**Water Treatment Plant** - Structures and Improvements	
	D			**S**		**AG**	**W**	**L**
1934	20			16		17	15	
1935	20	24	19	16		18.8	15	
1936	20	25	19	16		19.2	16	
1937	23	26	21	18		21	17	
1938	23	26	22	18		21.2	17	
1939	23	26	22	18		21.2	17	
1940	23	26	22	17		21	17	12
1941	24	27	23	19		22.2	18	12
1942	26	27	24	21		23.6	20	14
1943	27	27	25	21		24	20	17
1944	27	27	25	21		24.2	21	20
1945	27	27	26	22		24.6	21	24
1946	32	31	31	25		28.6	24	27
1947	38	39	36	29		34.2	29	29
1948	44	43	40	33	26	38.4	32	28
1949	45	45	41	34	25	37.8	24	27
1950	46	49	43	35	26	41.6	35	25
1951	49	55	46	37	28	44.8	37	29
1952	50	55	46	39	29	45.4	37	32
1953	52	55	48	41	31	47	39	31
1954	55	55	50	43	31	48.6	40	32
1955	58	56	51	45	33	50.4	42	33
1956	61	63	54	48	35	54.4	46	36
1957	64	69	55	50	38	57.2	48	39
1958	67	73	57	52	38	59.8	50	42
1959	70	74	60	54	38	62	52	46
1960	73	74	62	56	38	63.6	53	48
1961	75	71	63	57	37	64	54	52
1962	76	71	63	58	36	64.4	54	55
1963	77	71	65	59	37	65.6	56	58
1964	78	73	66	61	38	67.2	58	63
1965	78	74	68	63	38	68.6	60	67

APPENDIX A: Indices Used to Escalate Fixed Costs (continued)

Handy-Whitman Index - Pacific Region (1)								LAND (Bureau of Reclamation : Construction Cost Trends) LAND Indexes for California (2)
Original Date	**Distribution Mains-** Average All Types	Electric Pumping Equipment	Small Treatment Plant Equipment	**Source of Supply** - Collecting and Impounding Res.	Elevated Steel Tanks	Average Index (Used for Admin/Gen Only)	**Water Treatment Plant** - Structures and Improvements	
	D			**S**		**AG**	**W**	**L**
1966	79	78	71	66	41	71.2	62	71
1967	80	81	73	69	44	73.4	64	72
1968	82	81	75	72	48	75.2	66	75
1969	84	84	79	75	55	78.6	71	77
1970	89	89	84	79	71	83.2	75	79
1971	96	93	91	85	80	89.4	82	79
1972	98	96	95	93	86	94.8	92	81
1973	100	100	100	100	100	100	100	86
1974	133	122	122	119	152	122.6	117	91
1975	152	155	146	134	183	143.8	132	96
1976	161	174	160	140	182	155	140	99
1977	168	184	170	148	183	163.8	149	101
1978	181	192	185	161	195	176	161	116
1979	194	205	201	177	206	191	178	137
1980	212	222	224	195	228	211.2	203	169
1981	233	245	248	205	250	230	219	209
1982	246	260	270	211	244	243.4	230	223
1983	254	271	286	215	197	252	234	225
1984	258	277	292	225	200	258.6	241	223
1985	265	282	301	231	198	265.6	249	218
1986	264	284	306	234	207	268.2	253	203
1987	271	299	312	240	219	275.8	257	201
1988	283	303	321	248	261	284.2	266	215
1989	295	336	333	255	267	298.8	275	231
1990	296	349	339	259	281	304.6	280	247
1991	301	350	340	259	246	306.2	281	263
1992	300	370	349	263	284	313.4	285	279
1993	311	378	360	274	249	324.4	299	291
1994	316	426	364	287	242	341.2	313	291
1995	318	437	370	292	250	347.6	321	292
1996	323	446	379	298	269	354.2	325	313
1997	331	476	393	309	271	368.6	334	335
1998	333	486	403	312	283	374.6	339	350
1999	346	499	413	319	288	384.8	347	359
2000	342	532	424	327	300	398.8	369	370

APPENDIX A: Indices Used to Escalate Fixed Costs (continued)

Handy-Whitman Index - Pacific Region (1)								LAND (Bureau of Reclamation : Construction Cost Trends) LAND Indexes for California (2)
Original Date	**Distribution Mains-** Average All Types	Electric Pumping Equipment	Small Treatment Plant Equipment	**Source of Supply** - Collecting and Impounding Res.	Elevated Steel Tanks	Average Index (Used for Admin/Gen Only)	**Water Treatment Plant** - Structures and Improvements	
	D			**S**		**AG**	**W**	**L**
2001	357	531	434	333	314	406	375	388
2002	365	533	449	339	429	415.2	390	396
2003	381	546	454	344	429	423.2	391	412
2004	383	569	470	359	481	439.4	416	424
2005	429	611	496	380	524	472	444	500
2006	454	619	511	394	596	488.4	464	540
2007	488	639	529	410	657	508.8	478	660
2008	509	640	592	431	680	535.4	505	780
2009	585	679	657	441	866	579.8	537	920
2010	589	707	683	445	866	594	546	800

(1) Handy-Whitman Index of Public Utility Construction Costs, Trends of Construction Costs, Bulletin No. 172 ; 1912 to July 1, 2010.

(2) Construction Cost Trends, United Sates Department of the Interior Bureau of Reclamation, Land Indexes for California.

Appendix B: Sample of Escalation of Existing Fixed Assets to 2010 Dollars

Cost Center	Asset Description	In-Service Date	Cost	HW I Code	HWI	HWI 2010	HWI Escalation Factor	Replacement Cost
Raw Water T&D	Coyote Percolation System	1/1/1934	48,672.00	D	20	589	29.450	$ 1,433,390
Source of Supply	Almaden Dam & Reservoir	1/1/1935	520,845.20	S	16	445	27.813	$ 14,486,007
Source of Supply	Calero Dam & Reservoir	1/1/1935	670,364.47	S	16	445	27.813	$ 18,644,512
Source of Supply	Gualalupe Dam & Reservoir	1/1/1935	527,624.65	S	16	445	27.813	$ 14,674,561
Source of Supply	Stevens Creek Dam & Reservoir	1/1/1935	3,916,877.14	S	16	445	27.813	$ 108,938,145
Source of Supply	Vasona Dam & Reservoir	1/1/1935	400,145.67	S	16	445	27.813	$ 11,129,051
Raw Water T&D	Page Percolation System	1/1/1935	96,220.09	D	20	589	29.450	$ 2,833,682
Source of Supply	Coyote Dam & Reservoir	1/1/1936	6,831,079.55	S	16	445	27.813	$ 189,989,400
Source of Supply	Anderson Dam & Reservoir	1/1/1950	12,723,132.38	S	35	445	12.714	$ 161,765,540
Source of Supply	Lexington Dam & Reservoir	1/1/1952	5,353,831.76	S	39	445	11.410	$ 61,088,593
Source of Supply	Chesbro Dam & Reservoir	1/1/1955	1,495,508.00	S	45	445	9.889	$ 14,788,912
Source of Supply	Uvas Dam & Reservoir	1/1/1957	1,974,410.00	S	50	445	8.900	$ 17,572,249
Raw Water T&D	Penitencia Percolation System	1/1/1958	578,160.65	D	67	589	8.791	$ 5,082,636
Raw Water T&D	Main Avenue Percolation System	1/1/1961	754,659.89	D	75	589	7.853	$ 5,926,596
Raw Water T&D	Camden Percolatin System	1/1/1962	134,570.41	D	76	589	7.750	$ 1,042,921
Raw Water T&D	Kooser Percolation System	1/1/1962	23,527.90	D	76	589	7.750	$ 182,341
Raw Water T&D	Central Pipeline	1/1/1964	8,742,262.51	D	78	589	7.551	$ 66,015,290
Raw Water T&D	Ford Road Percolation Area	1/1/1964	54,155.39	D	78	589	7.551	$ 408,943
Raw Water T&D	Los Capitancilos Percolation Sys	1/1/1964	143,726.52	D	78	589	7.551	$ 1,085,319
Raw Water T&D	Santa Clara Conduit	1/1/1965	16,427.09	D	78	589	7.551	$ 124,046
Treated Water T&D	Evergreen Distribution System	1/1/1965	815,220.27	D	78	589	7.551	$ 6,155,958
Treated Water T&D	Rinconada Force Main	1/1/1966	1,369,622.79	D	79	589	7.456	$ 10,211,491
Raw Water T&D	Almaden Valley Pipeline	1/1/1966	22,799,530.12	D	79	589	7.456	$ 169,986,370
Raw Water T&D	Budd Avenue Percolation Ponds	1/1/1967	40,284.05	D	80	589	7.363	$ 296,591
Raw Water T&D	Sunnyoaks Percolatin Ponds	1/1/1967	34,417.23	D	80	589	7.363	$ 253,397
Water Treatment	Rinconada Water Treatment Plant	1/1/1967	14,302,802.31	W	64	546	8.531	$ 122,020,782
Water Treatment	Control System RWTP	1/1/1967	2,630,447.38	W	64	546	8.531	$ 22,441,004
Raw Water T&D	Stevens Creek Pipeline	1/1/1968	769,425.76	D	82	589	7.183	$ 5,526,729
Raw Water T&D	Vasona Pump Station	1/1/1969	3,814,278.45	D	84	589	7.012	$ 26,745,357
Treated Water T&D	West Pipeline	1/1/1970	5,796,146.62	D	89	589	6.618	$ 38,358,768
Water Treatment	Rinconada Reservoir	1/1/1972	1,179,024.84	W	92	546	5.935	$ 6,997,256
Raw Water T&D	Penitencia Force Main	1/1/1973	989,114.79	D	100	589	5.890	$ 5,825,886
Water Treatment	Penitencia Water Treatment Plant	1/1/1974	8,694,977.66	W	117	546	4.667	$ 40,576,562
Water Treatment	Control System PWTP	1/1/1974	230,558.58	W	117	546	4.667	$ 1,075,940
Raw Water T&D	McClellan Road Percolation System	1/1/1976	365,840.23	D	161	589	3.658	$ 1,338,384
Raw Water T&D	Church Percolation System	1/1/1978	17,775.00	D	181	589	3.254	$ 57,842
Raw Water T&D	Coyote-Madrone Distribution Sys	1/1/1982	217,447.46	D	246	589	2.394	$ 520,636
Raw Water T&D	Cross Valley Pipeline	1/1/1985	20,293,528.36	D	265	589	2.223	$ 45,105,239
Raw Water T&D	Anderson Force Main	1/1/1985	2,590,403.98	D	265	589	2.223	$ 5,757,539
Treated Water T&D	East Pipeline	1/1/1985	3,797,756.22	D	265	589	2.223	$ 8,441,051
Treated Water T&D	Greystone Pump Station	1/1/1988	617,369.63	D	283	589	2.081	$ 1,284,914
Treated Water T&D	Greystone Pipeline	1/1/1988	755,974.25	D	283	589	2.081	$ 1,573,388
Treated Water T&D	Snell Pipeline	1/1/1988	27,912,115.31	D	283	589	2.081	$ 58,092,706

APPENDIX C: District Staff's Groundwater Only Analysis

Santa Clara Valley Water District

MEMORANDUM
FC 14 (01-02-07)

TO: Darin Taylor

FROM: Barbara Judd

SUBJECT: Agriculture Water Use Benefits

DATE: October 6, 2010

At our Conjunctive Use Benefit Study Meeting of September 10th, item 4b was discussion on how to value the benefit to groundwater users of treated water use. Groundwater Unit was asked to model a scenario without treated water sales and identify what additional facilities might be required to sustain the groundwater subbasin with this additional groundwater pumping. This memorandum summarizes the work done by Groundwater Unit as part of that analysis.

<u>Overall Approach and Assumptions</u>

The District's treated water is sold to water retailers within the Santa Clara Subbasin and Groundwater Charge Zone W-2. The District has a modflow model (GMOD) for the Santa Clara Subbasin. Alternative means of meeting water demand were evaluated by comparing the modeling results to that of a GMOD "base case" that uses historical input data from 1970 through 2009.

Some of the overall assumptions in the no-treated water scenarios are as follows.

- The historical hydrologic and water use record was duplicated; for example, 1977 in the modeling would reflect historical 1977 hydrology and 1977 water demands.
- The historical monthly treated water sales were replaced with equivalent additional monthly groundwater pumping throughout the time period.
- Hetch-Hetchy, other local water use (i.e., SJWC and Stanford water from their own water rights), and recycled water uses were unchanged.
- The water sent to the water treatment plants historically would be provided for additional recharge on that same monthly pattern.

<u>Scenarios Performed</u>

Groundwater models like GMOD calculate the groundwater elevations that would result from the input data given, such as pumping, recharge, rainfall. Determining whether different facilities could meet demand without violating District operational policies or physical constraints, such as subsidence thresholds, often requires running the model and analyzing its output iteratively until an acceptable result is achieved. The analysis described in this memo required multiple iterations of several scenarios before an acceptable outcome was reached.

1. Scenario 1 – Spread the equivalent of the treated water demand across all wells in the Santa Clara Subbasin.

   The purpose of this run was to confirm that the groundwater subbasin could not accommodate the additional pumping, assuming no additional actions were taken. As one would expect, the model failed quickly during the time sequence (meaning that groundwater elevations dropped so dramatically that cells within the groundwater model went dry). Although a simplified case, the results of this scenario run identified the areas with greatest groundwater drawdown, suggesting where additional groundwater recharge might be valuable.

2. Scenario 2 – add recharge equivalent to the increase in groundwater pumping while spreading the additional groundwater pumping only to wells owned by that treated water retailer.

   In this scenario, additional groundwater recharge equivalent to the additional groundwater pumping was added. It was assumed that all recharge water would be recharged through percolation ponds or District-managed creeks in the recharge zone. This modeling run also refined the pumping assumptions. The distribution of pumping was allocated such that the increased pumping only occurred at the wells owned by water retailers with treated water deliveries. In other words, the pumping at the SJWC wells were increased by the amount of treated water sold to SJWC, etc.

   The results showed that such a scenario would result in severe drawdown in much of the confined area, with groundwater elevations dropping below subsidence thresholds. In addition, this amount of recharge produced an infeasible condition in much of the recharge zone – groundwater elevations above land surface. The model does not constrain groundwater levels or storage; if more water is put into the subbasin than it can hold, the model adds that water to groundwater anyway. The hydrographs for this scenario produced groundwater elevations above land surface in much of the recharge zone, which is not physically possible since the recharge zone cannot have pressurized conditions. Such a modeling result indicates an invalid or infeasible scenario, a modeling violation of a physical constraint.

   These results illustrate that the groundwater subbasin cannot support the increased pumping occurring at the existing water retailer wells even with significant additional recharge being added in the recharge areas.

3. Scenario 3 -- Maximize recharge in existing facilities to the extent useful, add additional groundwater recharge facilities in the recharge area as necessary, and put the new groundwater pumping in areas likely to be able to accommodate it.

   In this scenario, groundwater pumping was shifted to recharge areas in an attempt to reduce the drawdown in the confined area and at the same time reduce the infeasible groundwater levels in parts of the recharge zone. Some of the additional groundwater recharge was spread out among new recharge facilities as well. Several iterations were necessary to identify an arrangement of pumping and recharge that would meet water demand without exceeding historically observed subsidence or storing water in the recharge areas to an infeasible level. The last iteration of scenario 3 did not violate any physical or operational constraints, and as such constitutes a feasible solution. The details of this iteration are described in more detail below.

<u>Scenario 3 Components</u>

Figure 1 shows the location of additional groundwater recharge and groundwater extraction used in the final Scenario 3 modeling iteration – the first modeling iteration that was able to meet the additional groundwater pumping without land subsidence over historic levels or infeasible amounts of water accumulating above ground surface in the recharge zone.

Figure 1. Locations of Additional Groundwater Pumping and Additional Recharge in Scenario 3

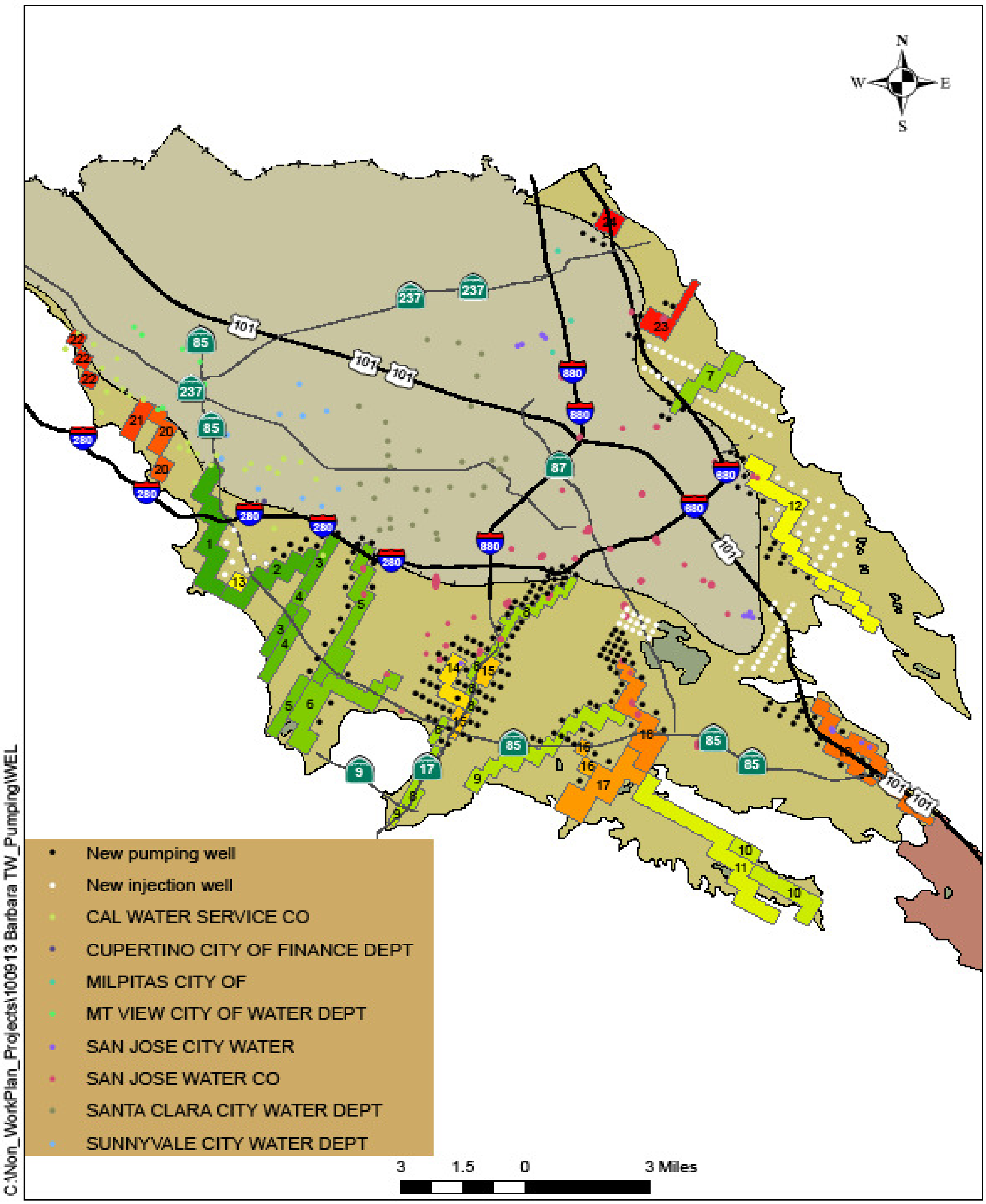
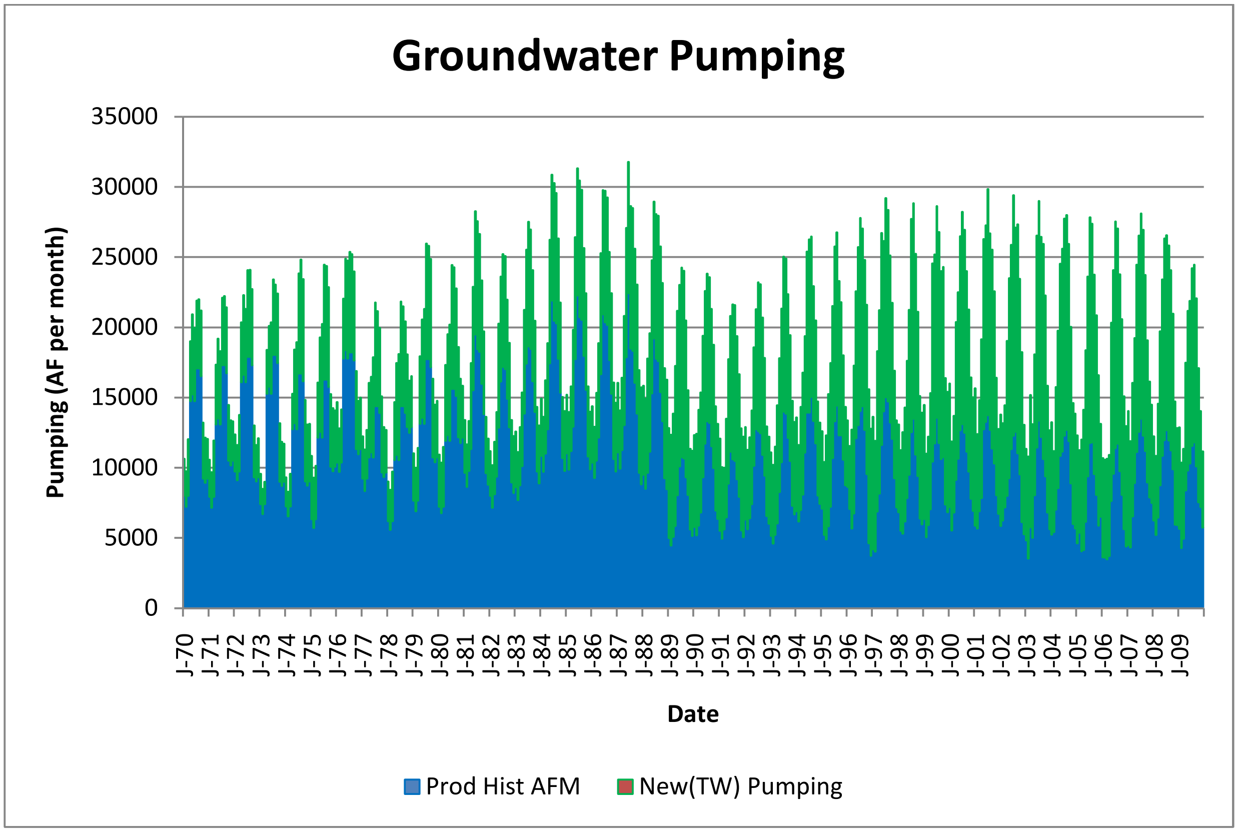


Figure 2 illustrates the groundwater pumping by month used in this analysis, over the 1970 through 2009 modeling sequence. The historical pumping over the 1970-2009 time sequence was retained, and an additional amount of groundwater pumping was added equivalent to the demand historically served by District treated water deliveries. In Scenario 3, the additional groundwater pumping was allocated to new extraction wells in the recharge zone since adding that quantity of pumping at the locations of the water retailers' existing wells produced unacceptable levels of drawdown and land subsidence. The additional groundwater pumping was spread evenly among 200 new locations as shown in Figure 1 by the black dots, and by the green bars in Figure 2.

Figure 2. Historical Groundwater Pumping and Switch to Groundwater of Treated Water Demand, in acre-feet per month



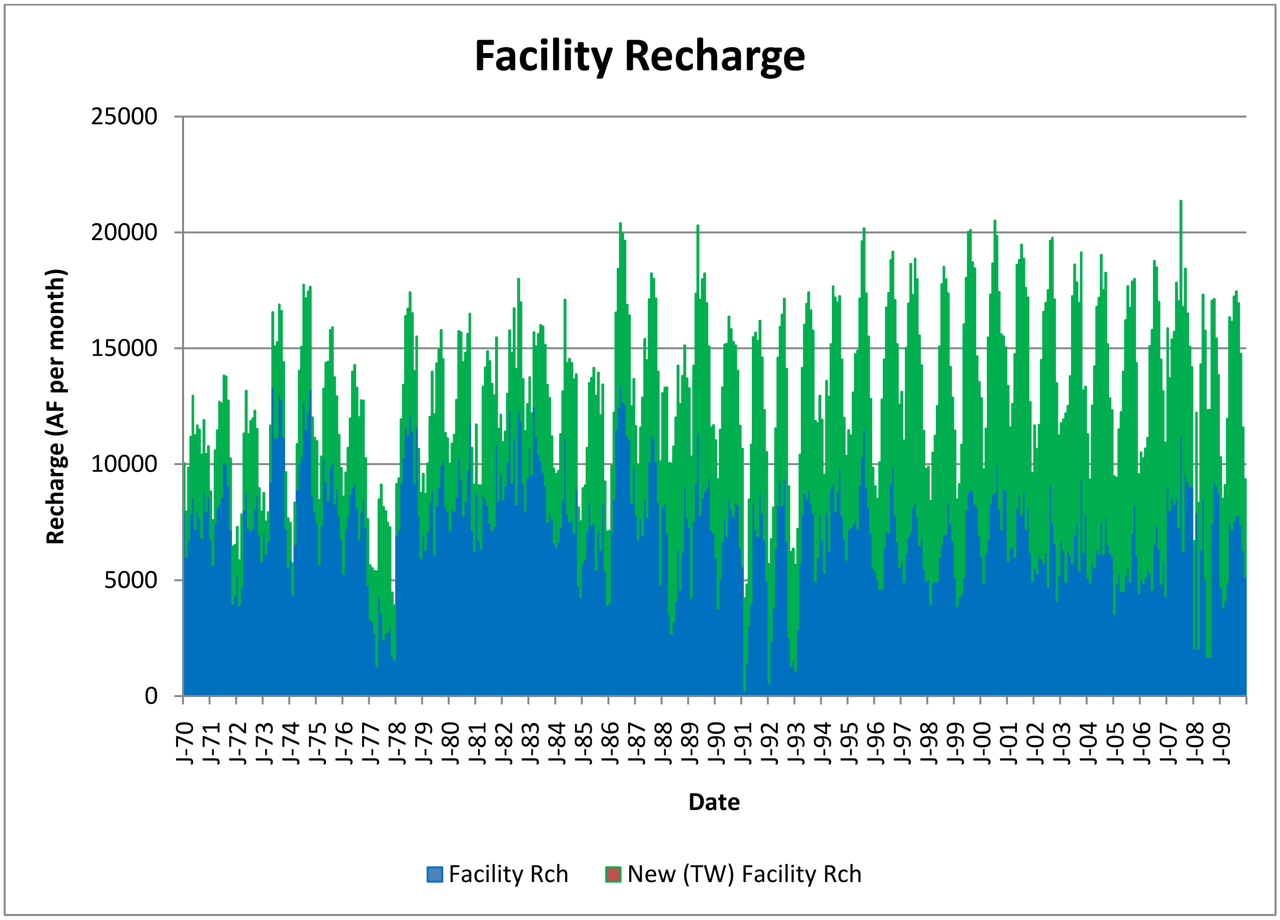
In the modeling, the term facilities recharge refers to any recharge, whether from District-controlled water releases or from natural streamflows, that occurs in specific facilities such as creeks and off-stream recharge ponds. This is to distinguish such recharge from "natural" recharge, which in the modeling refers to recharge from number of different water sources, including recharge at the mountain front areas and direct infiltration of precipitation. In Figure 1, the existing recharge facilities are shown as colored cells. It should be noted that the facilities labeled 20 through 24 are creeks not used for District managed recharge, but are considered stream recharge facilities by the groundwater model. The recharge facility names and corresponding code number are shown in Figure 3.

Figure 4 illustrates the facilities recharge used in the scenario. The historical facilities recharge over the 1970-2009 time sequence was retained, and an additional amount of groundwater recharge was added equivalent to the water used to meet historical treated water demand. This is a simplifying assumption – in reality, the District might have some ability to retime the deliveries of its imported and local supplies for facilities recharge.

Figure 3. Recharge Facilities Names and Codes

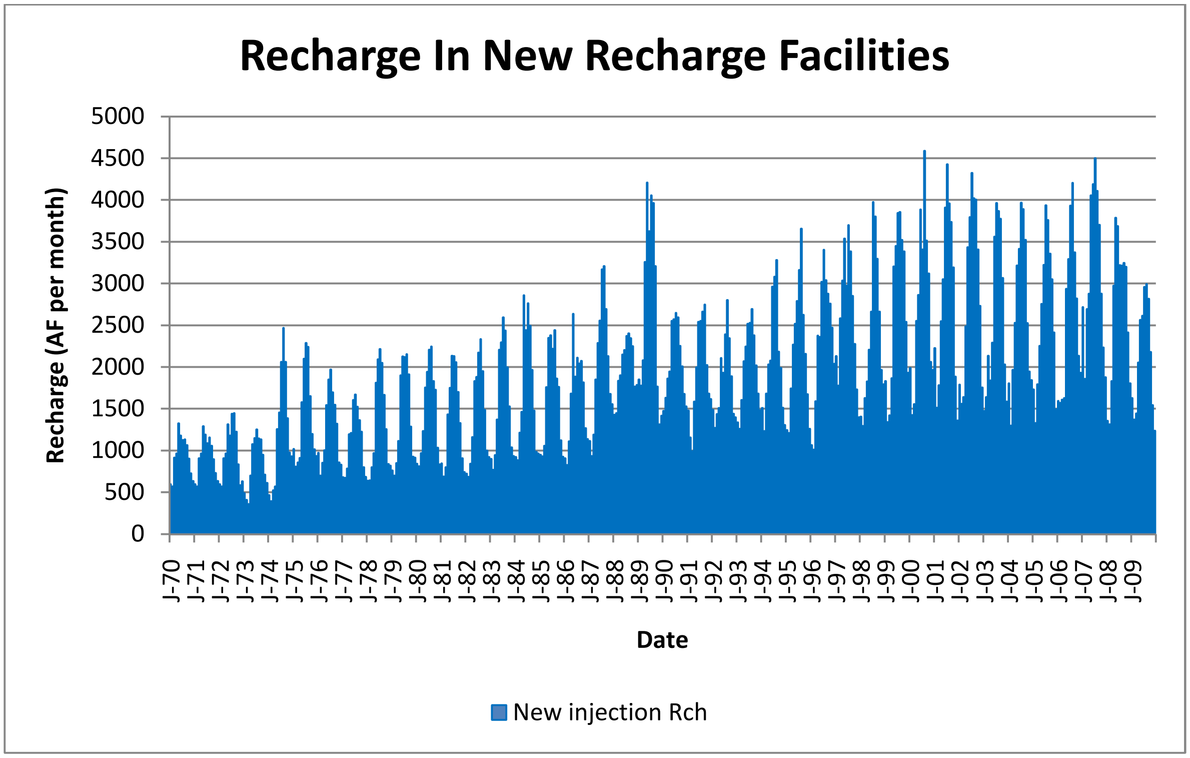
Facility Name	Model Code
STEVENS CREEK	1
REGNART CREEK	2
CALABAZAS CREEK	3
RODEO CREEK	4
SARATOGA CREEK	5
SAN TOMAS/WILDCAT/SMITH CREEKS	6
PENITENCIA FACILITIES	7
LOS GATOS CREEK	8
ROSS AND LONE HILL CREEKS	9
CALERO CREEK	10
ALAMITOS CREEK	11
THOMPSON CREEK	12
MCCLELLAN PONDS	13
PAGE SYSTEM-BUDD/CAMDEN/SNOAKS	14
KIRK SYSTEM-OKA/MCGLINCEY	15
KOOSER PONDS	16
GUADALUPE CREEK/LOS CAP PONDS	17
GUADALUPE RIVER/ALAMITOS/ETC.	18
LOWER COYOTE/FORD/COYOTE PONDS	19

Figure 4. Historical Facility Recharge with Additional Recharge of Water Historically Delivered to the Water Treatment Plants, in acre-feet per month



The modeling iterations that relied on existing groundwater recharge facilities for the additional groundwater recharge produced an invalid result – the groundwater subbasin could not accommodate this much recharge at the existing sites without producing infeasible groundwater levels in some areas. To address this, the last modeling iteration performed assumed that half of the additional groundwater recharge that had been added to the Los Gatos, Kirk, and Page recharge facilities would instead be distributed elsewhere in the recharge zone. The recharge occurring at new recharge facilities is shown in Figure 5. The additional recharge that could not be accommodated by the existing facilities was spread evenly at 100 sites, shown by white dots in Figure 1. For simplicity in modeling, the new facilities were modeled as injection wells; however, that is a shortcut for modeling and it is assumed that any new recharge facilities would be better sized and costed as groundwater recharge ponds.

Figure 5. Groundwater Recharge in New Recharge Facilities



<u>Conclusion</u>

This memo summarizes the modeling performed to define the facilities that could be used to meet historical water demands if treated water deliveries were to be replaced by additional groundwater extraction. The GMOD files and a spreadsheet with much of the modeling data has already been provided to the project team for their use.

In my experience, it is best if any modeling exercise (or other technical analysis for that matter) includes "reality checking" both of the input data used and the results produced. It should be noted that the schedule constraints of this project did not provide time enough to refine the recharge and extraction system identified in Scenario 3 nor to perform robust "reality checking" of some of the modeling assumptions used. I believe that this analysis is defensible as a quick evaluation, but that additional work may be indicated after evaluating the results – at this time, we have not taken that analytical step.

For the modeling analysis, we used existing recharge facilities to the extent that we could (while still producing a valid and feasible result of hydrographs and groundwater storage) in order to produce a reasonable-cost solution. In other words, we could have assumed existing recharge facilities were used at historical levels and all additional recharge would need occur at new recharge facilities, but I believed that would result in overbuilding the recharge system. To expedite modeling, we assumed that the existing recharge facilities could recharge up to the maximum historical monthly recharge in all months.

We are still working to check that the amounts recharged in the Scenario 3 run are reasonable. We have asked Operations Planning and Analysis Unit staff to evaluate our recharge and verify that our assumptions produced recharge values that can occur in the existing system. (For example, prior to 1990 the District used gravel spreader dams extensively in some creeks; such operations are no longer permitted. I don't know if any of the recharge quantities we used in Scenario 3 depends on such spreader dams.)

In addition, we chose to spread the additional groundwater pumping evenly among 200 new extraction wells. A more realistic approach would be to identify and test a smaller set of wells, each sized taking cost, infrastructure capacities and limitations into consideration. Likewise, we looked at what areas had infeasible groundwater elevations and chose to move 50% of the recharge in the Kirk, Page, and Los Gatos systems to new recharge facilities to alleviate that problem. We spread the recharge amounts evenly over 100 new recharge locations.

I will inform you via a subsequent memo of the results of our reality checking of the recharge and pumping data. As for configuration of the resultant new facilities (the 100 recharge locations and 200 extraction wells), I believe this scenario does provide useful information on what additional facilities might be required if District treated water sales were not available. I do not represent this as an optimal solution from an operational or capital cost perspective, however.

Appendix D: Carollo/HydroMetrics Analysis

Geohydrologic Analysis and Cost Estimates of the Groundwater Only Strategy for Supplemental Supply in the Santa Clara Subbasin

Prepared for:
Santa Clara Valley Water District

January 2011

Prepared by:

Appendix D

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SECTION 1 INTRODUCTION

The Santa Clara Valley Water District (District) pursues water management strategies that are intended to benefit all users of the Valley's water resources. The benefits of successful water management strategies accrue to users independently of the users' direct source of water supply. Therefore, the District applies a water charge to both groundwater users and customers receiving water deliveries from the District that reflect the water management benefits. This report helps quantify the financial benefit of one of the District's key water management strategies: treating imported water for delivery to retailers in the Santa Clara Subbasin (Groundwater Charge Zone W-2).

This treated water strategy benefits groundwater users in the Santa Clara Subbasin by supplying imported water to users that would otherwise use groundwater. The delivery of supplemental supplies allows water demand to be met while keeping groundwater withdrawals within the sustainable yield of the Subbasin's aquifers. Keeping the Subbasin in balance prevents unacceptable impacts from overpumping such as saltwater intrusion and subsidence. Subsidence has been historically observed in the Subbasin during periods of overdraft.

This report helps quantify the benefit of treating imported water by providing a cost estimate for an alternative strategy that achieves the same result of keeping the Subbasin in balance. This alternative strategy is to recharge all of the supplemental supply for the Subbasin into the groundwater basin; and to subsequently extract the water for delivery to retailers without the need for treatment. Although the District recharges some of its supplemental supply already, additional infrastructure would be required to recharge and extract the additional supply that has been historically treated and delivered.

This report documents the cost estimate for developing the additional infrastructure, which can be used to compare with the cost of the treatment infrastructure to evaluate the benefit of the treated water strategy.

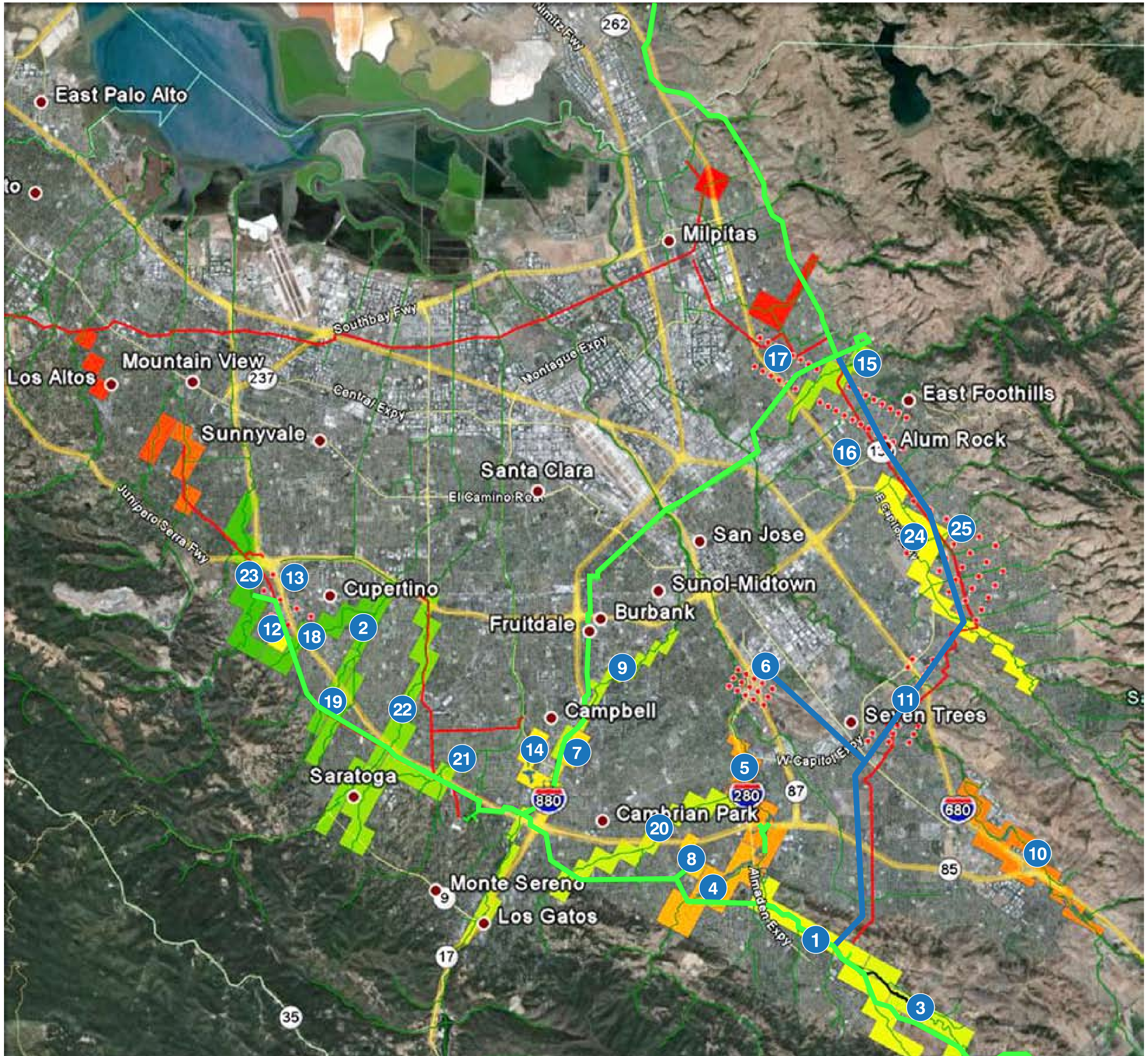
SECTION 2 SUMMARY OF ADDITIONAL INFRASTRUCTURE REQUIRED FOR GROUNDWATER ONLY STRATEGY

The cost estimate is based on additional infrastructure identified by the District's Groundwater Management Unit. This additional infrastructure includes both recharge facilities and extraction facilities. The strategy makes use of existing infrastructure where possible to minimize the cost of additional infrastructure. The conceptual strategy for additional infrastructure is based on a geohydrologic analysis by the Groundwater Management Unit and information about existing facility capacities from the District's Operations and Planning Unit. A summary of the geohydrologic analysis (Section 3) and existing facility capacity information (Section 4) is documented later in this report.

2.1 NEW RECHARGE FACILITIES

The creeks and ponds that make up existing recharge facilities do not have the capacity to recharge all of the supplemental water that was historically treated and distributed. The additional recharge in excess of existing capacities is recharged in new recharge ponds. A discussion of why recharge ponds instead of injection wells are assumed is included in Section 3.3 of this report. The acreage required for the new recharge ponds is based on the amount of land needed in the year with maximum additional recharge in excess of existing capacities. A detailed description of this analysis is included in Section 4.1 of this report.

Based on the results of the geohydrologic analysis (Section 3.4), the majority of the additional recharge is located near existing facilities, as shown in Figure 1. Locating new recharge ponds near existing facilities and raw water pipelines is advantageous because it minimizes the need for additional raw water supply pipelines. However, as shown in Figure 1, some recharge facilities that are located at some distance from existing recharge facilities do require new supply pipelines. At each new recharge pond, regardless of whether it is near an existing pipeline or recharge facility, new pipelines are required to distribute water internally.



Recharge Facility*

1 Alamitos Creek
2 Calabazas Creek
3 Calero Creek
4 Guadalupe Creek/Los Cap Ponds
5 Guadalupe River/Alamitos/Etc
6 North Guadalupe River*
7 Kirk System-Oka/McGlincey
8 Kooser Ponds
9 Los Gatos Creek
10 Lower Coyote/Ford/Coyote Ponds
11 Nower Coyote-101 and E Capital*
12 McClellan Ponds
13 North McClellan Ponds*
14 Page System-Budd/Camden/Snoaks
15 Penitencia Facilities
16 Penitencia East*
17 Penitencia West*
18 Regnart Creek
19 Rodeo Creek
20 Ross and Lone Hill Creeks
21 San Tomas/Wildcat/Smith Creeks
22 Saratoga Creek
23 Stevens Creek
24 Thompson Creek
25 East Thompson Creek*

** New recharge facilities are comprised of expanded existing facilities except for the recharge facilities at new locations, which are designated with an asterisk.*

Legend

- Surface Water Supply Pipeline
- Major Potable Water Pipeline
- Modeled Injection Wells
- 1 New or Expanded Recharge Facility
- New Recharge Pipeline (>1000 LF)
- Modeled Recharge Facilities

Figure 1
NEW RECHARGE SYSTEM FACILITIES
GROUNDWATER CONJUNCTIVE USE BENEFIT STUDY
SANTA CLARA VALLEY WATER DISTRICT

scv1210f1-8593.ai

2.2 New Extraction Facilities

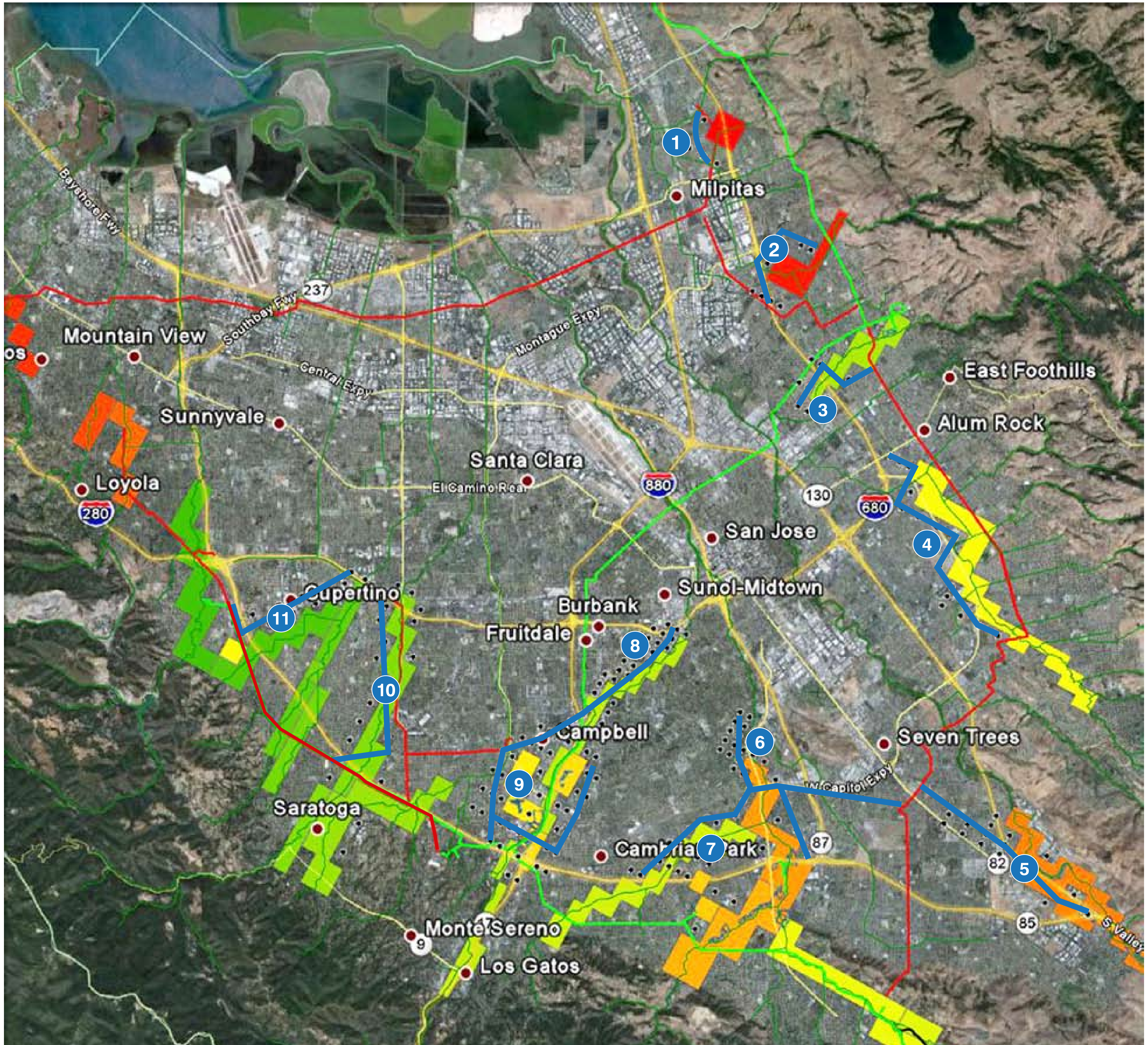
The geohydrologic analysis showed that new extraction wells would be required to extract the additional recharge quantity for use by the District's potable water customers (Section 3.2). Based on the geohydrologic analysis, the new extraction wells are generally located in recharge areas downgradient of existing recharge areas (Figure 2). The total well pumping capacity is based on the maximum monthly volume of water that would have to be extracted by these new facilities and delivered to the District's customers to replace potable water that has been historically provided by District water treatment facilities. The number of wells required to meet the maximum capacity is based on anticipated pumping rates for new wells and typical pumping and resting durations during peak pumping periods. A description of well sizing calculations is included in Section 4.3 of this report.

As shown in Figure 2, new pipelines connect these new well fields to the nearest major potable water distribution pipeline. These pipelines are typically longer than those required for new recharge ponds because the new well fields are located farther away from major potable water distribution pipelines.

2.3 Key Assumptions

There are two key assumptions that are part of the conceptual development of the recharge and extraction systems. If either of these assumptions are faulty, the cost for the groundwater only strategy cost estimate would increase.

1. **Groundwater extracted by the system will not require treatment.** Currently, imported surface water is treated to remove pathogens and particles. It is assumed that groundwater aquifers provide a natural filter that preclude the need for treatment. While some retailers in the Subbasin disinfect water produced by wells, not all do. It is also assumed that monitoring of extracted groundwater under the Ground Water rule will not require treatment.
2. **The existing pipelines have the capacity to meet any changes in the distribution of flow under the groundwater only strategy.** Imported water pipelines are sized to supply the quantity of water historically treated to treatment plants; we assume that they are also sized to deliver that water, plus water historically recharged, to the new recharge facilities. There is no net change in the potable water distribution system as groundwater replaces treated water, but we assume that delivering water from the new well fields will not exceed any local hydraulic capacities.



Well Field

1 Milpitas Well Field
2 Berryessa Well Field
3 Penitencia South Well Field
4 Thompson Creek Well Field
5 Lower Coyote Well Field
6 Guadalupe North Well Field
7 Guadalupe South Well Field
8 Campbell Northeast Well Field
9 Campbell Southwest Well Field
10 Saratoga Well Field
11 Stevens Creek Well Field

Legend

- Surface Water Supply Pipeline
- Major Potable Water Pipeline
- Modeled Extraction Wells
- New Well Field
- New Potable Water Pipeline

Figure 2
NEW EXTRACTION SYSTEM FACILITIES
GROUNDWATER CONJUNCTIVE USE BENEFIT STUDY
SANTA CLARA VALLEY WATER DISTRICT

SECTION 3 GEOHYDROLOGIC ANALYSIS OF GROUNDWATER ONLY STRATEGY

The District's Groundwater Management Unit performed a geohydrologic analysis using its groundwater model to identify the infrastructure required to implement the groundwater only strategy (Judd, 2010). The numerical groundwater model of the Santa Clara Subbasin is built using the U.S. Geological Survey's MODFLOW 2000 model code (Harbaugh, Banta, Hill, & McDonald, 2000) which is a public domain code that is considered a standard for groundwater modeling.

Groundwater model simulations of alternative strategies to supplying treated imported water are compared to the historical run simulating the 1970-2009 period. Because imported water was treated and delivered during the 1970-2009 period, the amount of groundwater pumping and recharge is less in the historical run than runs simulating alternative strategies.

3.1 SIMULATION DESIGN

As discussed in the District's memorandum on its groundwater modeling (Judd, 2010), the following assumptions were applied to the runs simulating alternative strategies:

- The historical hydrologic and water use record is duplicated; for example, 1977 results in the modeling reflect historical 1977 hydrology and 1977 water demands.
- The historical monthly treated water sales are replaced with equivalent additional monthly groundwater pumping throughout the time period.
- The water historically sent to the water treatment plants is provided for additional recharge on the same monthly pattern as the historical treated water use.
- Hetch-Hetchy system water use, other local water use (e.g., San Jose Water Company and Stanford University from their own water rights), and recycled water uses are unchanged.

The District’s model runs are designed to conceptually identify the additional infrastructure required to implement the groundwater only strategy. This is accomplished by first testing whether existing infrastructure can be used to recharge and extract the historically treated water. The extraction wells owned by water retailers and the District’s recharge facilities make up the existing infrastructure tested by the model runs. If the model runs show that unacceptable outcomes occur when using existing infrastructure, additional infrastructure is iteratively tested until outcomes are considered acceptable for providing the necessary water supply and sustainable management of the Subbasin.

3.2 Simulations Using Only Existing Infrastructure

The first model run (Scenario 1) testing existing infrastructure replaces all treated water with groundwater pumping. This run uses existing wells in the Subbasin to extract both historical extractions and the equivalent of historically treated water supplies from the Subbasin. Scenario 1 includes no additional recharge. This adds a significant amount of pumping to the Subbasin as shown in Figure 3. Annual pumping increases range from 29 to 159%, with an average annual increase of 83%. This run quickly results in unacceptable groundwater levels, with groundwater elevations dropping below subsidence thresholds. This is the expected result because the substantial increase in pumping without a corresponding increase in recharge takes the Subbasin's water budget out of balance.

The second model run (Scenario 2) testing existing infrastructure also uses existing wells for extraction, but recharges the historically treated water supply in the District's existing managed recharge facilities. Adding the historically treated water adds a significant amount of recharge to the existing managed facilities as shown on Figure 4. Annual facility recharge increases range from 38 to 208%, with an average annual increase of 120%. The monthly time series for the additional recharge exactly corresponds to the time series for additional extraction, so the Subbasin as a whole is brought into balance. Despite this overall water balance, the model still shows unacceptable groundwater elevations. This is because most of the existing extraction wells are located in the confined area where there is little available groundwater storage space. The additional recharge occurs in the unconfined area; and does not flow into the confined area quickly enough to prevent groundwater elevations in the confined area from dropping below subsidence thresholds. Figure 5 shows the locations of monitoring wells where simulated results were evaluated in this analysis. Figure 6 shows that Scenario 2 groundwater elevations (red line) at well 07S01W02G024 in the confined area are up to 60 feet lower than the historically simulated groundwater levels (blue line). These groundwater levels fall below subsidence thresholds more frequently and by greater amounts than the base simulation. In the recharge is area the model shows the infeasible condition of groundwater elevations above land surface. Figure 7 shows that Scenario 2 (red line) groundwater elevations at well 08S01W03K013 in the southern recharge area exceed ground surface elevations by approximately 200 feet by the end of the simulation (blue line). These results show that the geographic separation between the additional recharge and extraction causes sub-regional water imbalances.

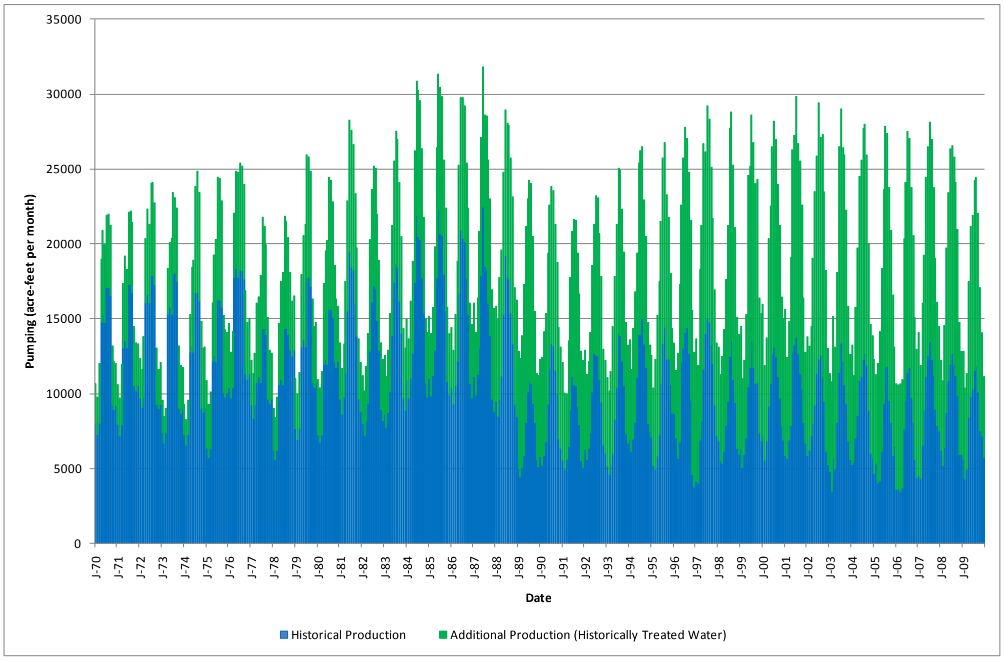


Figure 3. Historical Groundwater Production and Additional Production of Historically Treated Water Supply (adapted from Judd, 2010)

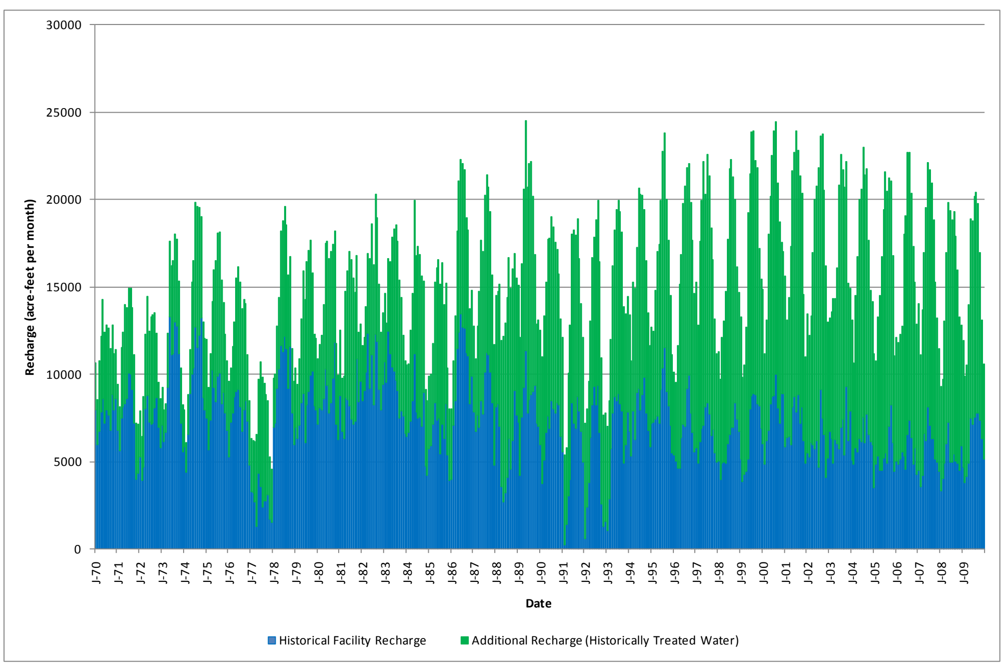


Figure 4. Historical District Facility Recharge and Additional Recharge of Historically Treated Water Supply

Figure 5. Monitoring Well Locations used for Model Evaluation

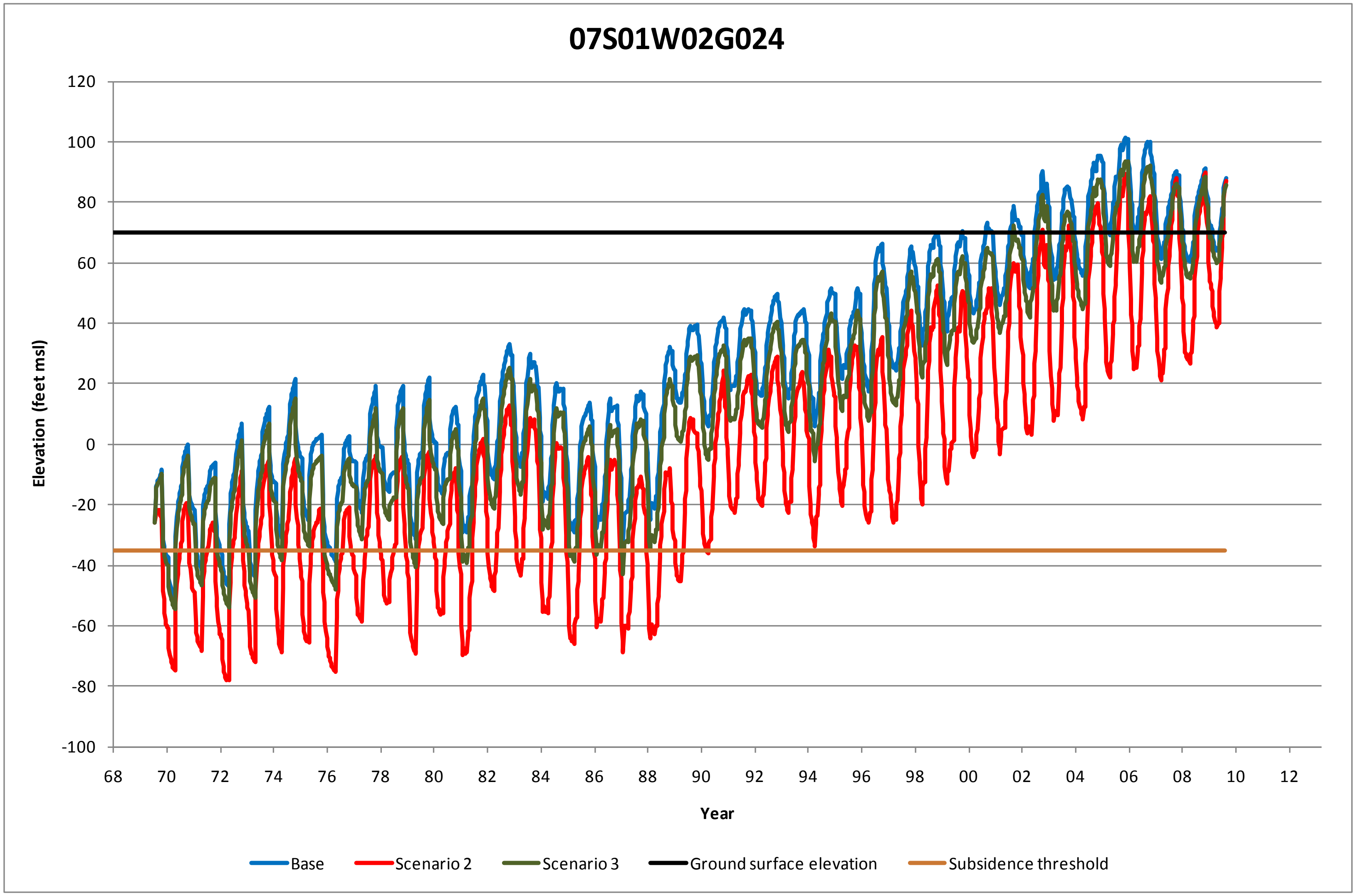


Figure 6. Simulated Groundwater Elevations at Well 07S01W02G024 in the Confined Area

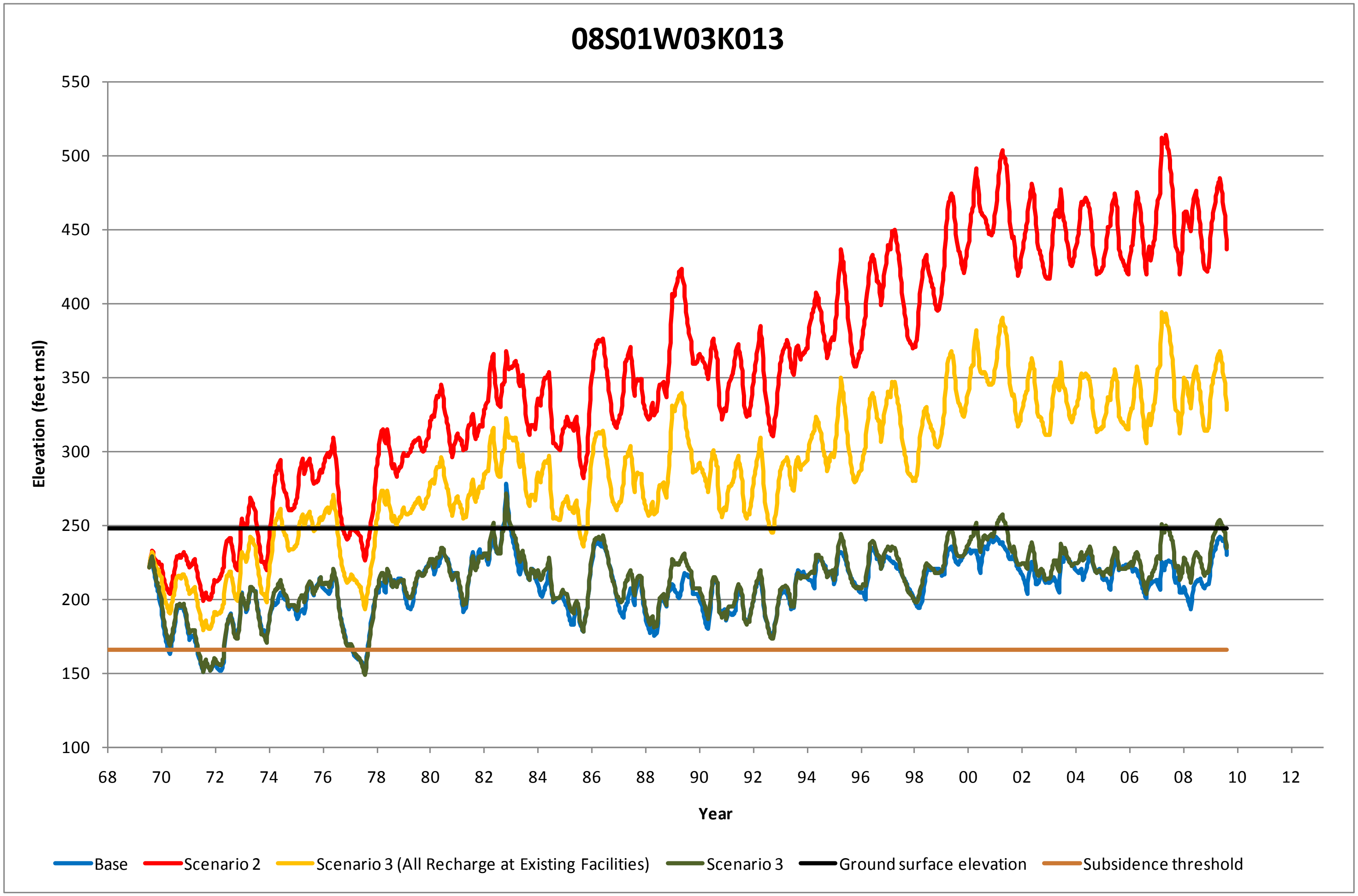


Figure 7. Simulated Groundwater Elevations at Well 08S01W03K012 in the Southern Recharge Area

3.3 Recharge Pond Assumptions for Simulating Additional Facilities

Two general strategies were considered for addressing the subregional water imbalances observed in Simulation 2:

1. Instead of recharging all water in existing facilities, install injection wells to recharge the historically treated water in the confined area; and continue to use existing retailer wells to extract the additional water.
2. Instead of extracting all recharged water with existing retailer wells, install extraction wells to extract from the recharge area; and recharge the historically treated water in the recharge area using surface recharge facilities such as ponds and creeks.

The first strategy is not evaluated further due to operational obstacles to using injection wells. The main obstacle is operational; injecting untreated water would result in physical and bacterial clogging of the wells. Physical clogging would result from the lack of filtration and bacterial clogging would result from lack of disinfection. The District's experience with its injection well confirms the infeasibility of this first strategy. According to the District's Groundwater Management Unit, an injection well that was tested by the District is no longer in operation due to operational difficulty, low injection rate, and Regional Water Quality Control Board issues.

The second strategy is evaluated further using the groundwater model; and forms the basis for the cost estimate of the groundwater only system. The District has experience with using its existing recharge facilities in the recharge area and extracting groundwater from the recharge area at the San Tomas well field.

3.4 Simulations Testing Additional Infrastructure

The third set of model run (Scenario 3) tests the use of new wells to extract the additional supply of water that is recharged in the unconfined area. These runs place the new wells near and downgradient of existing recharge facilities (Figure 2) to reduce the geographic separation between additional recharge and extraction that causes subregional water imbalances. Figure 6 shows Scenario 3 groundwater elevations (green line) at well 07S01W02G024 in the confined area. These results show that groundwater levels do not fall significantly using this strategy; and excessive drawdowns that exceed land subsidence thresholds occur at a similar frequency to the base simulation (blue line).

Even with the geographic separation between additional recharge and extraction reduced by installing new wells in the recharge area, model runs show that using only existing facilities cannot feasibly recharge all of the historically treated water. The modeling shows that using only existing recharge facilities to recharge all of this water results in simulated groundwater elevations rising above ground surface in the areas around the Los Gatos Creek, Page System, and Kirk System recharge facilities. Figure 7 shows this simulated groundwater levels (orange line) at well 08S01W03K013 near these recharge facilities.

Therefore, additional model runs tested shifting recharge from those three facilities to new recharge ponds primarily to the northeast. The model runs implement these new recharge ponds as injection wells, even though in practice they will likely be new recharge ponds (Figure 1, recharge facilities designated with asterisk). Using injection wells in the model is reasonable because the objective is to assess impacts on groundwater levels in the Subbasin from the additional recharge. It is not necessary to assess the percolation rate that could be achieved with new ponds in any specific area, which would require a detailed assessment unnecessary for developing a conceptual strategy for this cost estimate.

The model runs found that shifting half of the additional recharge (historically treated water) from the Los Gatos Creek, Page System, and Kirk System recharge facilities to recharge facilities in new locations results in acceptable groundwater elevations relative to ground surface. Figure 7 shows the final Scenario 3 groundwater elevations (green line) at well 08S01W03K013. Figure 7 shows that the final Scenario 3 groundwater elevations are similar to elevations observed in the the base simulation (blue line), generally remaining above subsidence thresholds and below ground surface. The groundwater model shows that recharging historically treated water supply at existing and new facilities can be feasibly received by the Subbasin. It does not assess whether the recharge facilities have the percolation capacity to recharge the additional supply to the Subbasin. An analysis of the percolation capacities of the existing facilities is provided in Section 4.1.

3.5 Limitations of Analysis

The District's Groundwater Unit used the groundwater model to identify only the general requirements for new infrastructure to implement the groundwater only strategy. It was unnecessary to optimize the distribution of recharge and extraction to minimize impacts on the Subbasin or operational and capital costs. Therefore, the groundwater only system used for the cost estimate should not be considered optimal. The lack of optimization for groundwater management objectives is evident when comparing the balance between new recharge and new extraction in the southern recharge area versus the same balance in the northern recharge area for the groundwater only system.

In the southern recharge area that stretches from Stevens Creek to the Lower Coyote/Ford/Coyote Ponds recharge facility, new extraction exceeds new recharge. In the northern recharge area that stretches from the Milpitas Well Field to the Thompson Creek area, new recharge exceeds new extraction by the equivalent amount. Table 1 summarizes the range of these imbalances.

Table 1. Water Balance of Historically Treated Supply in Northern and Southern Recharge Areas

Acre-feet per year		Balance of Recharge and Extraction of Historically Treated Supply			
		Recharge	Extraction	Balance	Percentage
Northern Recharge Area	Minimum	8,200	4,500	3,600	42%
	Average	18,400	9,900	8,500	46%
	Maximum	27,900	14,900	14,200	51%
Southern Recharge Area	Minimum	35,300	39,000	-3,600	-2%
	Average	77,300	85,800	-8,500	-7%
	Maximum	116,300	128,800	-14,200	-13%

This imbalance shows a potential for recharge in the north being unrecovered and extraction in the south pulling water from the southern confined area. Figure 8 shows the difference in flows to the confined area between model runs with and without the groundwater only system. Recharge in the northern area is consistently lost to the confined area. Since there are fewer extraction wells in the northern part of the confined area, this indicates a risk that the recharge is lost to San Francisco Bay. Surplus extraction in the southern area pulls water from the southern confined area. The surplus extraction was placed in the southern area to alleviate high groundwater levels related to the additional recharge, but the effectiveness of this is limited by the flow from the confined area. As a result, the groundwater only system raises water levels over 100 feet higher in some parts of the southern area. Although these water level increases are not considered infeasible when compared to ground surface, they do indicate imbalances in groundwater management.

A more effective system would locally balance recharge and extraction and possibly shift more recharge to the northern area to alleviate high water levels predicted for the southern area. However, the required capacity of new recharge ponds and extraction wells would be unchanged with this redistribution. As discussed in Section 4.1, new recharge pond capacity is not controlled by effects of the recharge on the Subbasin. Also, extraction wells would still have to be sited in the recharge area to reduce the geographic distance between extraction and recharge. As a result, the cost estimate is unlikely to change much except to account for changes to pipeline configuration.

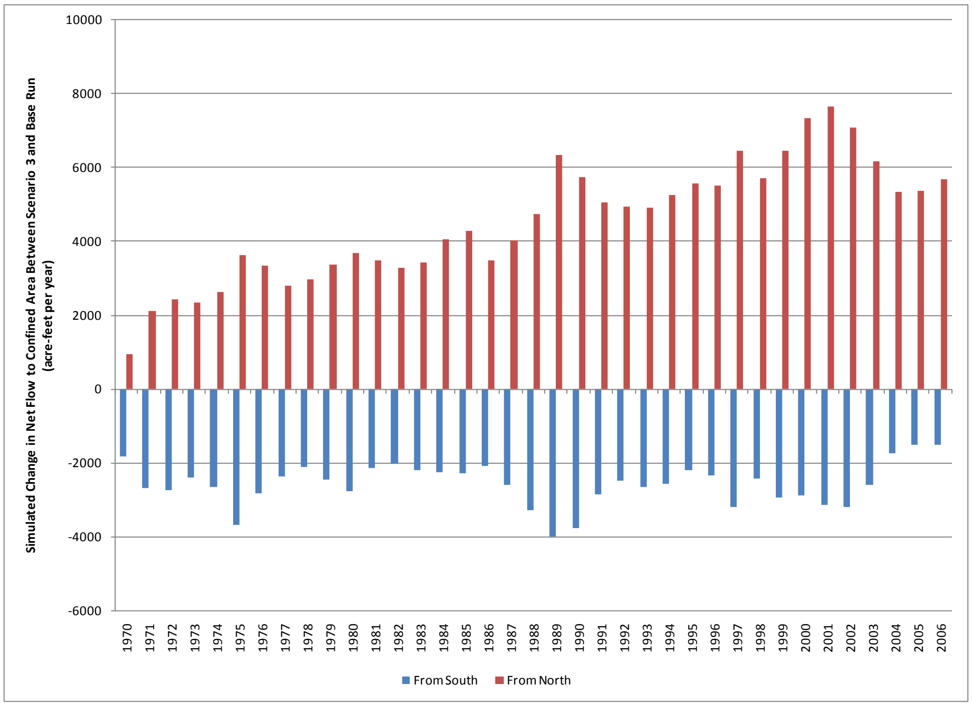


Figure 8. Change in Flow to the the Confined Area from the Northern and Southern Recharge Areas Due to Implementation of the Groundwater Only System

If there is a need for optimization or design of a groundwater only system with the groundwater model, additional model calibration to observation data will be necessary. Additional calibration was not necessary for the analysis because a comparative analysis was used to evaluate the need for additional infrastructure. However, to optimize the system design by shifting more recharge to the northern area, better calibration to recent data will be necessary. Figure 9 shows that the base simulation (blue line) does not match recent measured data (violet line) at well 07S01W02G024 in the confined area. Figure 10 shows that the base simulation (blue line) does not match recent measured data (violet line) at well 07S01E02J021 in the northern recharge area.

If the groundwater only system is designed, there should be some safety factors and redundancy incorporated into the design to account for uncertainties in hydrologic conditions and uncertainties in how the groundwater model represents the Subbasin's hydrogeology. These uncertainties will affect the reliability of the groundwater only system. Improving the reliability of the system to account for uncertainty would likely increase the cost estimate. Most importantly, the Subbasin is a natural, subsurface, and heterogeneous system with inherent uncertainties much greater than the uncertainties of an engineered system. Therefore, the groundwater only system would be much less reliable than the treated water system. The treated water system adds reliability to the goal of keeping the Subbasin in balance while meeting water demands by avoiding the use of the Subbasin to achieve those goals.

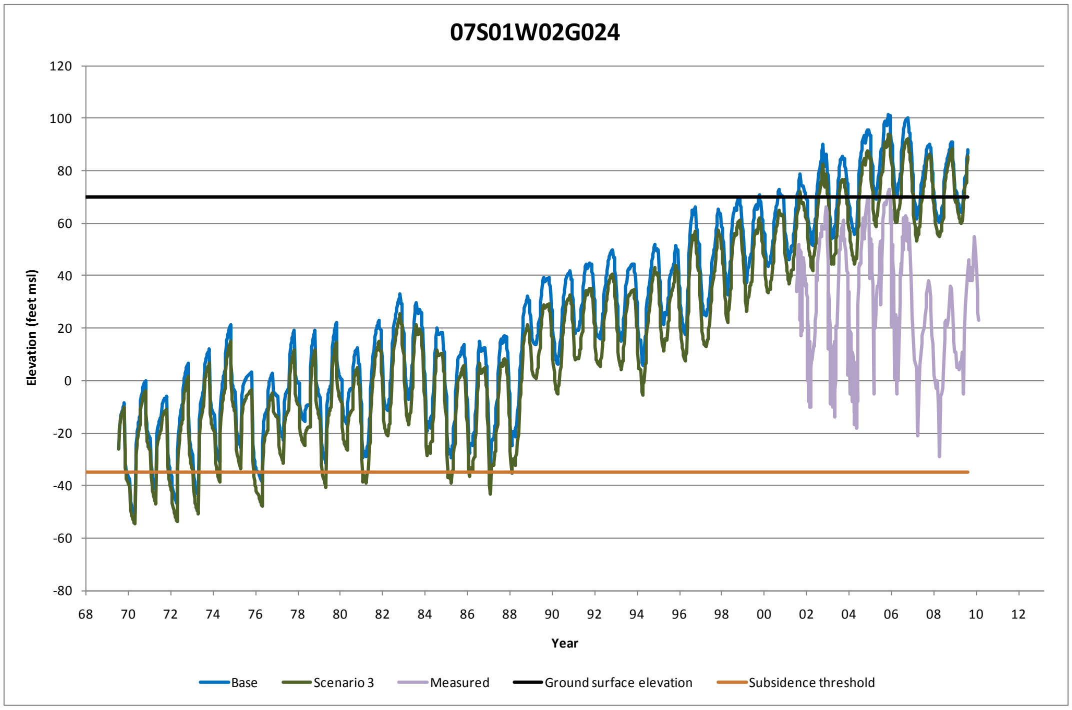


Figure 9. Simulated versus Measured Groundwater Elevations at Well 07S01W02G024 in the Confined Area

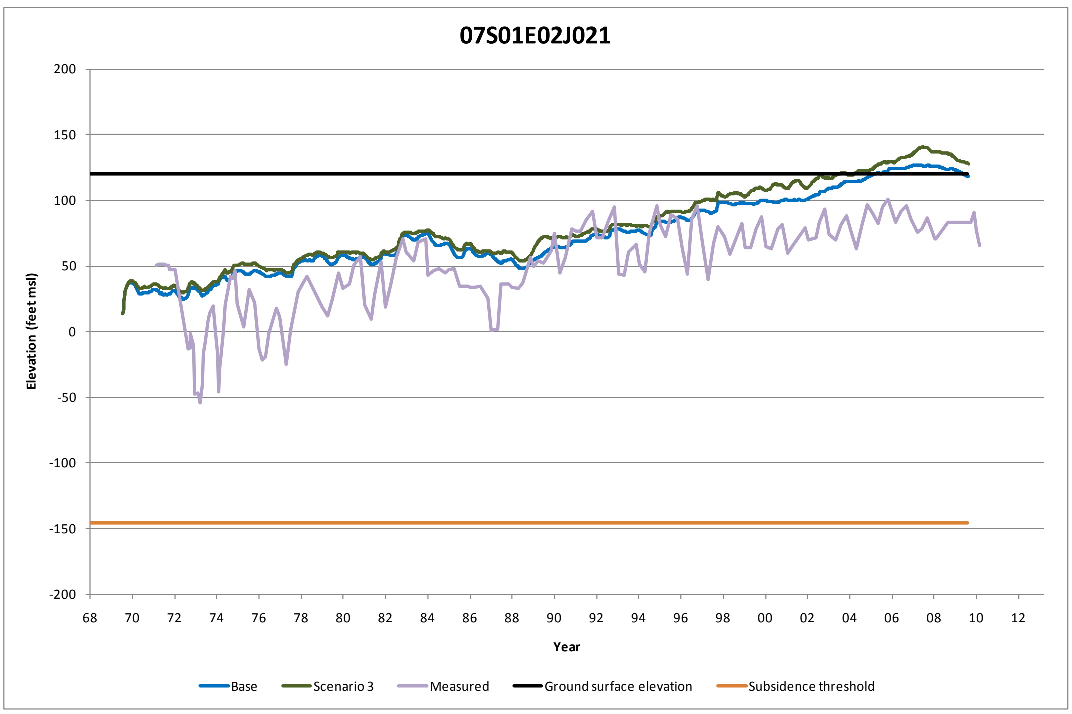


Figure 10. Simulated versus Measured Groundwater Elevations at Well 07S01E02J021 in the Northern Recharge Area

SECTION 4 CAPACITY REQUIREMENTS FOR ADDITIONAL INFRASTRUCTURE

In order to estimate the cost of the additional infrastructure, the capacities required for the additional infrastructure are needed. These capacities are needed to inform the sizes of the following infrastructure components:

1. Recharge Pond Acreage
2. Recharge System Pipeline Diameter and Length
3. Number of Extraction Wells
4. Extraction System Pipeline Diameter and Length

4.1 NEW RECHARGE POND ACREAGE

There are two types of new recharge ponds. First, there are recharge ponds in new locations as identified by the groundwater modeling. Second, there are new recharge ponds in the locations of existing facilities required to increase existing facility capacities.

The groundwater modeling showed that the Subbasin in the area around the Los Gatos Creek, Kirk System, and Page System recharge facilities could not feasibly receive all the additional recharge, so some of the additional recharge is moved to new locations. The model identified these locations as being parts of the Subbasin that could feasibly receive the redistributed additional recharge. The recharge ponds are identified with asterisks in the legend of Figure 1 and as "Modeled Injection Wells." The distribution of recharge between the new locations was identified by the groundwater modeling and is represented in Figure 1 by the number of injection wells in each new area.

The year with maximum recharge redistributed to these new locations is 2007. The 37,695 acre-feet of recharge at new locations in this year is the total capacity required for this type of new recharge pond. The capacity required for each new facility is listed on page 3 of Appendix A as "New Recharge."

The groundwater modeling showed that the Subbasin could feasibly receive the water not sent to the new facilities if it is recharged through existing facilities. However, the District's Operations and Planning Unit (OPAU) provided information that shows existing facilities do not have the annual percolation capacity to recharge all of the additional recharge, as well as historical recharge. These percolation capacities represent the ability of water to percolate into the ground over the year, while the groundwater modeling only evaluates the impacts to the Subbasin aquifers if the water percolates from the surface.

Annual totals of historic facility recharge and additional recharge modeled at each facility are compared to the OPAU capacities. In some years, historic facility recharge exceeds OPAU capacity. OPAU capacities are based on current operation practices. There were some practices used in the past but are no longer allowed that could increase recharge capacity. An example of this was the practice of building gravel dams in a number of creeks and streams. Since the objective of this work is to provide a cost estimate of the alternative strategy to treating and delivering imported supply, only the additional recharge of historically treated water requires new capacity for costing. Additional capacity to meet historic recharge that is no longer possible due to changes in operation practices is not included in the cost estimate. If historic recharge capacity at a facility exceeded OPAU capacity, the new capacity requirement is the total of the additional recharge applied to that facility. If historic recharge capacity is below OPAU capacity, the difference is the available capacity for additional recharge. If the additional recharge still exceeds the available capacity, the new capacity requirement is the additional recharge minus the available capacity.

The capacity requirements for new recharge ponds at existing facility locations are based on the quantities of additional recharge in 1997. This is the year with the maximum amount of historically treated water applied as recharge at existing facility locations. As Table 1 shows, every facility requires additional capacity in 1997 so it is not possible to redistribute the recharge between facilities to reduce the capacity requirement for new ponds. The total capacity requirement for new recharge ponds at existing locations is 88,383 acre-feet per year. Some facilities have recharge that exceed the capacity requirements shown in Table 1 in years other than 1997, but there is enough total capacity for this type of new recharge ponds that any excess recharge could be redistributed. The capacity required for new ponds at existing locations are listed on page 3 of Appendix A.

The acreage required to meet these capacity requirements is based on a recharge pond percolation rate of 1 acre-foot per day per acre. This estimate was based on an evaluation of aerial photos of existing facilities and were confirmed as representative of average observed recharge rates for existing District facilities by OPAU. It is estimated that only 50% of the area of a recharge facility can be utilized for recharge due to property line setbacks, maintenance roads, pipeline facilities, maintenance ramps, etc, the total annual recharge was divided by a net recharge rate of 0.5 acre-foot per day per acre to estimate the acreage of the new recharge ponds. The total acreage estimated for recharge ponds at new locations is 206 acres and the total acreage estimated for new recharge ponds at existing recharge facility locations is 484 acres. The grand total acreage estimated for new recharge ponds is 690 acres. The acreage required for each location is listed on page 3 of Appendix A.

Table 2. Recharge Capacity Analysis for Additional Facilities

acre-feet per year	OPAU Annual Capacity	1997 Recharge	1997 Additional Recharge (Currently Treated)	Additional Capacity Required
Alamitos Creek	2,190	1,527	2,252	1,589
Calabazas Creek	2,555	2,490	1,603	1,538
Calero Creek	916	712	844	640
Guadalupe Creek/Los Cap Ponds	5,840	4,327	5,468	3,955
Guadalupe River/Alamitos/Etc	12,186	11,652	6,214	5,680
Kirk System-Oka/Mcglincey	9,137	7,997	5,363	4,223
Kooser Ponds	1,744	1,412	1,899	1,567
Los Gatos Creek	5,840	6,617	9,074	9,074
Lower Coyote/Ford/Coyote Ponds	12,410	9,702	15,064	12,356
Mcclellan Ponds	1,744	658	1,714	628
Page System-Budd/Camden/Snoaks	14,671	14,501	16,943	16,773
Penitencia Facilities	6,765	4,245	3,250	730
Regnart Creek	730	1,392	1,734	1,734
Rodeo Creek	658	676	620	620
Ross And Lone Hill Creeks	2,190	1,184	2,216	1,210
San Tomas/Wildcat/Smith Creeks	1,413	1,807	2,533	2,533
Saratoga Creek	4,380	3,728	14,464	13,812
Stevens Creek	3,650	4,196	6,081	6,081
Thompson Creek	0	160	3,639	3,639
Total	**89,019**	**78,983**	**100,976**	**88,383**

4.2 RECHARGE SYSTEM PIPELINE DIAMETER AND LENGTH

Figure 1 shows that most of the recharge facility locations are near existing surface water supply lines. However, new pipelines are required to deliver historically treated water to recharge facility locations along the east side of the Subbasin. This includes a 80,000 foot long pipeline to serve these facilities as well as major branches to the new location at North Guadalupe River (15,000 feet) and the existing location at Lower Coyote/Ford/Coyote Ponds (10,000 feet). As shown on page 3 of Appendix A, every recharge facility requires some new pipelines to distribute water internally.

The pipeline diameters are calculated based on keeping peak velocities between 4 and 6 feet per second. The recharge capacities are used as peak flows for this calculation. Pipeline diameters required for each facility are shown on page 3 of Appendix A.

4.3 Number of New Extraction Wells

The extraction capacity required is estimated as 17,000 acre-feet per month, the maximum of monthly additional extractions. July 2002 was the month with maximum delivery of treated water at this quantity so this is also the month with maximum additional extraction for delivery to retailers. The number of new wells required to meet this capacity is based on the planned capacity for the District's new wells.

The District's 2005 Water Infrastructure Reliability Project (SCVWD, 2005) and 2008 Well Field Implementation Plan (SCVWD, 2008) use 1,500 gallons per minute (gpm) as the planned capacity of the District's new wells. This is assumed to represent instantaneous pumping rate for new wells and not a flow rate that can be averaged over a full day as wells should not be operated 24 hours per day. The average flow rate that can be sustained over a peak pumping month is the well capacity used to estimate the number of wells required to pump the maximum monthly supply of historically treated water.

The 1,500 gpm is considered an instantaneous rate based on the Draft Design Basin Report for the San Tomas Well Field (Luhdorff and Scalmanini, 2007). This report states that the pumps for this well field are to be designed for a flow rate of 1,000 gpm and approximates the range of flow rates as 350 to 1,250 gpm. Since pump design flow rate is an instantaneous rate and lower than 1,500 gpm, the planned well capacity of 1,500 gpm is more likely to represent an instantaneous rate than an average rate.

We recommend a maximum daily pumping duration of 16 hours with a resting duration of 8 hours during peak pumping periods. As a result, average flow rate capacities for new wells are assumed to be 2/3 of 1,500 gpm or 1,000 gpm, which totals 1.44 million gallons per day. This average flow rate is the capacity used to estimate the number of wells required in the cost estimate. The number of wells required at each new well field is shown on page 4 of Appendix A. The total number of new production wells required to meet this capacity is 133.

4.4 Extraction System Pipeline Diameter and Length

Figure 2 shows that pipelines are required to connect the new well fields to major potable water pipelines. The length of the pipelines range from 3,560 feet to 25,000 feet as listed for each facility on page 4 of Appendix A.

The pipeline diameters are calculated based on keeping peak velocities between 4 and 6 feet per second. The maximum monthly extraction rates are used as peak flows for this calculation. Pipeline diameters required for each facility are shown on page 4 of Appendix A.

SECTION 5 CAPITAL COST ESTIMATES

Capital cost estimates were developed for the construction of the new recharge and extraction infrastructure systems. Cost estimates were based on conceptual design criteria and the assumptions and findings of the previous sections of this report. The final project costs will depend on actual labor and material costs, property values, when the facilities are constructed, productivity, competitive market conditions, final project scope, project schedule, and other variable factors. Consequently, the final project costs will vary from the cost estimates presented in this report.

The estimates for the scenarios are in November 2010 dollars (ENR Construction Cost Index = 10124). The level of accuracy for construction costs varies depending on the level of detail to which the project has been defined. Feasibility studies and master plans represent the lowest level of accuracy, while pre-bid estimates (based on detailed plans and specifications) represent the highest level. The American Association of Cost Engineers (AACE) has developed the following guidelines:

Type of Estimate	Anticipated Accuracy
Order-of-Magnitude (Master Plans)	+50% to -30%
Budget Estimate (Predesign Report)	+30% to -15%
Definitive Estimate (Pre-Bid)	+15% to -5%

The estimates presented within this report are considered the "order-of-magnitude" accuracy level. The cost estimates were developed using a combination of quantity takeoffs, unit prices, and bid prices for past projects. Allowances for general conditions, contractor overhead and profit, inflation, sales tax, engineering (design and construction-related), legal, and administration were added to the construction cost estimates for both of the alternatives. An allowance for inflation was not included, as the infrastructure for groundwater only strategy was assumed to be constructed in 2010 in order to allow a comparison to the 2010 water charge

5.1 Basic Cost Estimate Assumptions

The cost estimates presented here are preliminary in that they were prepared in advance of any detailed engineering effort, without design-level geotechnical information, and without the benefit of knowing the environmental mitigation measures that would be required at each of the sites. As such, the following assumptions apply to the cost estimates presented here:

1. Real estate costs were not included in this analysis. The cost to acquire land for 801 acres of land for recharge ponds and land for 133 extraction wells will be significant as shown in Section 6 and Appendix C.

2. Construction of below grade infrastructure would be accomplished via conventional open trench or open pit methods.

3. The sites can be dewatered for construction using conventional methods.

4. Excavated material is stored onsite.

5. Spoil (excess excavated material) is assumed to be hauled to a disposal location within a 10 mile roundtrip from the project site.

6. The following construction contingencies are applied to each of the estimates:

   a. General contingency for unforeseen conditions, changes, or design details: 30 percent.

   b. General conditions (includes mobilization, demobilization, bonds, insurance, general supervision, temporary facilities, temporary utilities, on-site clerical support, special constraints, testing, start-up and commissioning): 15 percent.

   c. General Contractor Overhead, Profit, and Risk: 15 percent.

   d. Sales tax on materials: 9.75 percent on 50 percent of the estimated items (assuming that materials, which are taxable, comprise 50 percent of the estimated costs).

   e. Inflation: 0 percent

f. Bid Market Allowance: 0 percent

7. The following project implementation costs were applied the estimates:

   a. Engineering Fees: 15%

   b. Construction Management Fees: 5%

   c. Legal, CEQA Compliance, and Administrative Fees: 5%

   d. Owner's Reserve for Change Orders: 5%

5.2 PROJECT SPECIFIC COST ESTIMATE ASSUMPTIONS

Cost estimate assumptions specific to each of the recharge and extraction system components of the infrastructure required for the groundwater only system are described below:

1. Groundwater Recharge System

   a. Total construction cost for each acre of recharge ponds is $316,000 (not inclusive of project implementation costs). Recharge ponds are constructed using 11 cubic yard scrapers. Four 2000 square foot wood buildings are demolished for each acre of ponds. Soil excavated from ponds is used to create pond berms or levees. Cut and fill is balanced. Maintenance roads around ponds are paved with 4" of asphalt concrete over 8" of aggregate base. One 16-inch diameter, ductile iron supply pipeline with a butterfly isolation valve is required for each pond. The butterfly valve discharges to a reinforced concrete, 10' x 10' energy dissipation box. Detailed unit prices and quantities for the recharge ponds are included in Appendix B.

   b. Total construction costs for pipelines are $27.50 per inch of pipe diameter per linear foot of pipe length. Pipelines are assumed to be buried in trenches with 5 to 5.5 ft of cover. Pipe is Class 350 ductile iron with push on fittings. 75% of the trench will be shored with trench boxes while 25%

of the trench will be shored using sheet piles. Detailed unit prices and quantities for two different pipe diameters[1] are included in Appendix B.

2. Groundwater Extraction/Production System

    a. Pipeline costs were calculated as described above.

    b. Extraction/production well construction costs were assumed to be similar to the cost for the District's San Tomas Well. The low bid for the San Tomas well was $1,119,000 in 2007. The bid costs were escalated to 2010 dollars using the ENR CCI. Detailed unit prices are included in Appendix B.

5.3 COST ESTIMATE SUMMARY

The cost estimates for the groundwater only recharge and extraction system are summarized in Table 3 below.

Table 3. Summary of Capital Costs for Groundwater Only System to Supply Historically Treated Water

Phase	Capital Costs (Millions of Dollars)
Recharge System	$446
Extraction System	$445
Total for both Recharge and Extraction Systems	$891
Note:	
(1) Based on November 2010 dollars; ENR CCI=10,124.	

[1] Cost estimates were produced for a variety of pipe diameters. The two examples included in Appendix B were found to be representative of the costs for all of the pipe diameters required for the recharge and extraction systems.

SECTION 6 LAND COST ESTIMATES

As mentioned above, the real estate cost to acquire land for the new recharge ponds and extraction wells will be significant. Appendix C provides a cost estimate for real estate that ranges from $936 million to $3.6 billion for land costs that do not include real estate acquisition fees.

6.1 RECHARGE SYSTEM LAND COSTS

The large range of costs is based on the range of assumed property values used to estimate the cost of 689 acres of new recharge ponds. The low end of the range is based on an estimate equivalent to approximately $1.2 million per acre in 2010 dollars from the SCVWD Water Infrastructure Reliability Report (SCVWD, 2005). The high end of the range is based on information from the Santa Clara County Assessor's office and zillow.com for real estate value. This high end of the range includes the value of land and improvements and is estimated as approximately $4.3 million per acre in San Jose and Campbell and $6.5 million per acre in the suburbs (Cupertino, Saratoga, and Los Gatos). The mid range applies an assumed value of land to the real estate values to estimate values of land only in San Jose and Campbell as approximately $1.5 million per acre and $2.3 million in the suburbs.

Page 3 of Appendix C shows the three different real estate costs for each recharge facility based on the location of the facility. The total recharge system estimates range from $824 million for the low end real estate value, $1.2 billion for the mid-range real estate value, and $3.5 billion for the high end real estate value.

6.2 EXTRACTION SYSTEM LAND COSTS

Land costs are included for only 93 of the 133 extraction wells as the SCVWD Well Field Implementation Plan (SCVWD, 2008) states that 40 new wells can be sited on existing property on the west side of the Subbasin. Therefore, land costs are not included for 19 of the 22 Campbell Southwest wells and all 21 of wells in the Saratoga and Stevens Creek Well Fields.

Based on the Well Field Implementation Plan, it is assumed that 1 acre is required for each production well. Since wells have a smaller footprint than recharge ponds, they will be easier to site so it is assumed that the wells can be located on unimproved land at the low end of real estate values ($1.2 million per acre). The land cost for purchasing the 93 acres required for extraction wells is estimated as $111 million.

SECTION 7 USE OF COST ESTIMATE

The capital cost estimate of the groundwater only system infrastructure will be used to quantify the financial benefit to groundwater users of the District's treated water strategy. In order to calculate this benefit, the capital cost provided by this report will be combined with an estimate of the operational cost of a groundwater only system provided by the District. This estimated cost of a groundwater only system will be compared to the capital and operational cost of providing treated water to quantify the benefit of the treated water strategy.

When using the $891 million capital cost estimate provided by this report, it is important to acknowledge that this is an order of magnitude estimate with an anticipated accuracy of +50% to -30%. Therefore, the range for the capital cost is $600 million to $1.3 billion.

SECTION 8 REFERENCES

Harbaugh, A., Banta, E., Hill, M., & McDonald, M. (2000). *MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to modularization concepts and the Ground-Water Flow Process.* U.S. Geological Survey Open-File Report 00-92.

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APPENDIX A: INFRASTRUCTURE COST SUMMARY (2010 DOLLARS)

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DRAFT COST SUMMARY (2010 DOLLARS)

Project:	**Groundwater Conjuctive Use Fee Cost Estimates**	**Estimate Class:**	**5**
Client:	**Santa Clara Valley Water District**	**PIC:**	**LJC**
Location:	**San Jose, California**	**PM:**	**CB**
Zip Code:	**95118**	**Date:**	**December 8, 2010**
Carollo Job #	**8593A00**	**By:**	**CB**

<u>Recharge System Costs (2010 dollars)</u>

Includes recharge ponds and pipelines for the ponds:

Construction Cost	$343,000,000
Project Cost (includes project implementation costs)	$445,900,000

<u>Extraction System Costs (2010 dollars)</u>

Includes production wells and pipelines:

Construction Cost	$342,600,000
Project Cost (includes project implementation costs)	$445,400,000

<u>Total Cost for both Recharge and Extraction Systems (2010 dollars)</u>

Total Project Cost **$891,300,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

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	PROJECT ASSUMPTIONS (2010 DOLLARS)		**Estimate Class:**	**5**
Project:	**Groundwater Conjuctive Use Fee Cost Estimates**		**PIC:**	**LJC**
Client:	**Santa Clara Valley Water District**		**PM:**	**CB**
Location:	**San Jose, California**		**Date:**	**December 8, 2010**
Zip Code:	**95118**		**By:**	**CB**
Carollo Job #	**8593A00**			

ENR Construction Cost Index

Year	20-City Average	San Francisco	
1960	824	932	(extrapolated)
1975	2297	2807	
2005	7647	8462	
2007	8089	9132	
2010	8951	10124	

Infrastructure Cost

Construction Contigencies:

Design Contigency	30%	
General Conditions	15%	
Overhead and Profit	15%	
Sales Tax	9.75%	(on 50% of the Direct Cost)
Escalation	0%	(costs are in 2010 dollars)

Recharge/Percolation Pond Construction (See Exhibit A for detailed cost estimate)

$316,000 per acre

Pipeline Construction (See Exhibit B for examples of detailed cost estimates for pipes)

$27.5 per inch of pipe diameter per linear foot of pipe length

1500 gpm Extraction Well Construction (Based on 2008 SCVWD Well Field Implementation Plan)

$1,119,000 per Well (2007 dollars). Based on San Tomas Well bid results

$1,240,556 per Well (2010 dollars)

Project Implementation Costs

Covers planning, CEQA, design, donstruction services, legal, and administration costs

Engineering Fees	15%
Construction Management Fees	5%
Legal, CEQA, and Administration Fees	5%
Owner's Reserve for Change Orders	5%
Total	30%

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RECHARGE SYSTEM COST ESTIMATES

Project:	**Groundwater Conjuctive Use Fee Cost Estimates**	**Estimate Class:**	**5**
Client:	**Santa Clara Valley Water District**	**PIC:**	**LJC**
Location:	**San Jose, California**	**PM:**	**CB**
Zip Code:	**95118**	**Date:**	**December 8, 2010**
Carollo Job #:	**8593A00**	**By:**	**CB**

Recharge Assumptions

New Injection Wells from SCVWD Model:	100	wells
Injection Rate for New Wells per SCWVD Model:	37,695	acre-feet per year
Additional Recharge Required at Existing Facilities	88,383	acre-feet per year
Percolation Rate	1	acre-foot per day per acre of recharge ponds
Pond Density	50%	(percent of generic pond facility that is used for percolation)
Net Percolation Rate	0.5	acre-foot per day per acre of recharge ponds - including pond infrastructure requirements.
Pipeline Velocity	4 to 6	feet per second

Recharge Facility	Recharge Rate (AFY)	Recharge Rate (AFD)	Recharge Rate (MGD)	Recharge Land Required (0.5 AF/D/A)	Required Pipeline Diameter (in)	Pipeline Velocity (ft/s)	Pipeline Length (ft)	Pipeline Cost (based on Pipeline Cost Assumptions)	Recharge Pond Cost (based on Recharge Pond Cost Assumptions)
Alamitos Creek	1589	4.3	1.41	8.7	10	4.0	500	$137,500	$2,743,124
Calabazas Creek	1538	4.2	1.37	8.4	8	6.1	1000	$220,000	$2,655,681
Calero Creek	640	1.7	0.57	3.5	6	4.5	500	$82,500	$1,105,729
Guadalupe Creek/Los Cap Ponds	3955	10.8	3.52	21.6	14	5.1	500	$192,500	$6,829,617
Guadalupe River/Alamitos/Etc	5680	15.5	5.06	31.0	18	4.4	1000	$495,000	$9,807,571
New Recharge At Guadalupe River	**5654**	15.4	5.03	30.9	18	4.4	15000	$7,425,000	$9,763,623
Kirk System-Oka/Mcglincey	4223	11.5	3.76	23.1	14	5.4	1000	$385,000	$7,291,456
Kooser Ponds	1567	4.3	1.40	8.6	10	4.0	250	$68,750	$2,705,674
Los Gatos Creek	9074	24.8	8.08	49.6	20	5.7	500	$275,000	$15,669,067
Lower Coyote/Ford/Coyote Ponds	12356	33.8	11.00	67.5	24	5.4	10000	$6,600,000	$21,335,271
New Recharge At Lower Coyote-101 And E Capital	**7162**	19.6	6.38	39.1	18	5.6	500	$247,500	$12,367,256
Mcclellan Ponds	628	1.7	0.56	3.4	6	4.4	250	$41,250	$1,084,096
New Recharge At Mcclellan Ponds	**3016**	8.2	2.68	16.5	12	5.3	500	$165,000	$5,207,266
Page System-Budd/Camden/Snoaks	16773	45.8	14.93	91.7	30	4.7	500	$412,500	$28,963,941
Penitencia Facilities	730	2.0	0.65	4.0	6	5.1	500	$82,500	$1,261,287
New Recharge Penetencia East	**7162**	19.6	6.38	39.1	18	5.6	500	$247,500	$12,367,256
New Recharge Penetencia West	**5277**	14.4	4.70	28.8	16	5.2	2500	$1,100,000	$9,112,715
Regnart Creek	1734	4.7	1.54	9.5	10	4.4	500	$137,500	$2,994,089
Rodeo Creek	620	1.7	0.55	3.4	6	4.4	500	$82,500	$1,071,138
Ross And Lone Hill Creeks	1210	3.3	1.08	6.6	10	3.1	500	$137,500	$2,090,091
San Tomas/Wildcat/Smith Creeks	2533	6.9	2.26	13.8	12	4.4	500	$165,000	$4,373,974
Saratoga Creek	13812	37.7	12.30	75.5	28	4.4	500	$385,000	$23,850,921
Stevens Creek	6081	16.6	5.41	33.2	16	6.0	250	$110,000	$10,501,009
Thompson Creek	3639	9.9	3.24	19.9	14	4.7	500	$192,500	$6,283,248
New Recharge At Thompson Creek	**9424**	25.7	8.39	51.5	20	5.9	500	$275,000	$16,272,705
Combined Eastern Recharge Facilities Pipeline			40.42		48	5.0	80000	$105,600,000	$0
Totals	**126078**	**344**	**153**	**689**				**$125,262,500**	**$217,707,803**

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EXTRACTION SYSTEM ASSUMPTIONS

Project:	**Groundwater Conjuctive Use Fee Cost Estimates**	**Estimate Class:**	**5**
Client:	**Santa Clara Valley Water District**	**PIC:**	**LJC**
Location:	**San Jose, California**	**PM:**	**CB**
Zip Code:	**95118**	**Date:**	**December 8, 2010**
Carollo Job #	**8593A00**	**By:**	**CB**

<u>Extraction System Assumptions</u>

New Extraction Points from SCVWD Model:	200	wells
Extraction Rate for Points per SCWVD Model:	17,000	acre-feet per month (total for all extraction wells)
Extraction Rate for Points per SCWVD Model:	128,220	gpm (total for all extraction wells)
Extraction Rate for Points per SCWVD Model:	641	gpm per extraction well
Assumed Production Well Capacity:	1000	gpm (per 2008 SCVWD Well Field Implementation Plan and analysis by Hydrometrics WRI)
Pipeline Velocity:	4 to 6	feet per second

Extraction Pipeline Description	Extraction Points	Extraction Rate(GPM)	Required Production Wells	Pipeline Diameter (in)	Pipeline Velocity (ft/s)	Pipeline Length (ft)	Pipeline Cost	Well Cost
Milpitas Well Field	4	2,564	3	14	5.3	3560	$1,370,600	$3,721,668
Berryessa Well Field	7	4,488	5	18	5.7	8000	$3,960,000	$6,202,779
Penitencia South Well Field	8	5,129	6	20	5.2	9900	$5,445,000	$7,443,335
Thompson Creek Well Field	17	10,899	11	30	4.9	25000	$20,625,000	$13,646,114
Lower Coyote Well Field	17	10,899	11	30	4.9	22000	$18,150,000	$13,646,114
Guadeloupe North Well Field	21	13,463	14	36	4.2	16000	$15,840,000	$17,367,782
Gaudeloupe South Well Field	21	13,463	14	36	4.2	16000	$15,840,000	$17,367,782
Gaudeloupe Main Transmission Pipe	--	26,926	--	48	4.8	10000	$13,200,000	--
Campbell Northeast Well Field	40	25,644	26	48	4.5	25000	$33,000,000	$32,254,452
Campbell Southwest Well Field	33	21,156	22	42	4.9	22000	$25,410,000	$27,292,229
Saratoga Well Field	20	12,822	13	30	5.8	20000	$16,500,000	$16,127,226
Stevens Creek Well Field	12	7,693	8	24	5.5	12500	$8,250,000	$9,924,447
Totals	**200**	**155,146**	**133**				**$177,590,600**	**$164,993,928**

APPENDIX B: DETAILED COST ESTIMATE

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APPENDIX B

Project:	**Groundwater Conjuctive Use Fee Cost Estimates**	**Estimate Class:**	**5**
Client:	**Santa Clara Valley Water District**	**PIC:**	**LJC**
Location:	**San Jose, California**	**PM:**	**CB**
Zip Code:	**95118**	**Date:**	**November 18, 2010**
Carollo Job #	**8593A00**	**By:**	**CB**
		Reviewed:	

NO.	DESCRIPTION		TOTAL
01	Recharge Pond Construction (per acre)		$178,980
	TOTAL DIRECT COST		**$178,980**
	Contingency	30.0%	$53,694
	Subtotal		**$232,674**
	General Conditions	15.0%	$34,901
	Subtotal		**$267,575**
	General Contractor Overhead, Profit & Risk	15.0%	$40,136
	Subtotal		**$307,711**
	Sales Tax (Based on 9.75% of 50% of the Direct Cost)	9.75%	$8,725
	Subtotal		**$316,436**
	Bid Market Allowance	0.0%	$0
	TOTAL ESTIMATED CONSTRUCTION COST		**$316,436**

Engineers...Working Wonders With Water®

DETAILED COST ESTIMATE

Project: Groundwater Conjuctive Use Fee Cost
Client: Santa Clara Valley Water District
Location: San Jose, California
Element: 01 Recharge Pond Construction

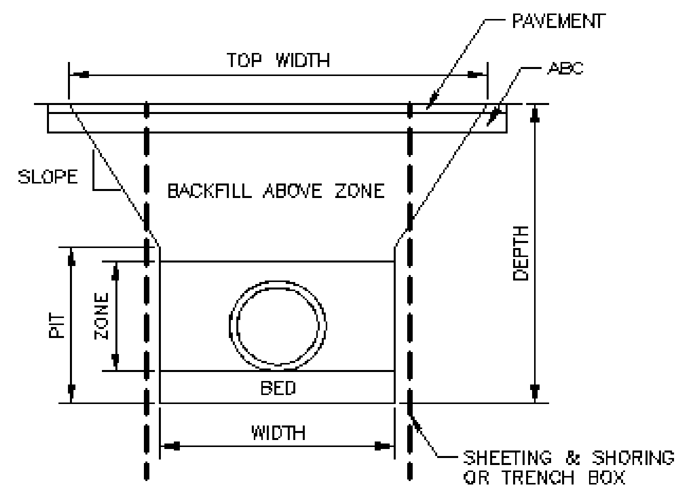
Date : November 18, 2010
By : CB
Reviewed: 0

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL
	Division 02 - Site Construction					
02220	Demo Small Wood Buildings	96000	CF	$.50	$48,000	
02220	Remove 4"-6" Asphalt Pavement	4160	SF	$.76	$3,158	
02300	Native Trench Backfill/Unconfined Struct. Bf, Class B Material	51.4	CY	$17.18	$882	
02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	77.0	CY	$76.77	$5,914	
02300	11Cy Scraper, Class A (Easy Dig), Grade, Fill & Compact, 500' Haul	2133	CY	$4.15	$8,845	
02300	Clearing & Grubbing Equipment Move-On Cost	1	LS	$1,756.50	$1,757	
02300	Remove Grass & Shrubs, 4" Depth Over 1 Acres	1	AC	$447.92	$448	
02742	4" AC pavement over 8" ABC	4560	SF	$6.85	$31,215	
02820	8' H Double Swing Gate, Chain Link, 12' Opening	1	EA	$2,986.05	$2,986	
02820	Galv. Chain Link Fence, 8' W/Barbed Wire, No Gates	208	LF	$56.79	$11,813	
	Total					**$115,017**
	Division 03 - Concrete					
03300	16" Straight Wall >8' High	14.81481481	CY	$819.43	$12,140	
03300	18" Structural Flat Mat On Grade	10.88888889	CY	$396.11	$4,313	
	Total					**$16,453**
	Division 15 - Mechanical					
15112	Add For Motor Operator 12" Through 20"	1	EA	$4,684.00	$4,684	
15112	16" 150# Fxf Awwa Butterfly Valve, No Op	1	EA	$3,703.66	$3,704	
15251	16" Cl52 Cldi Push-On Jt Pipe In Open Trench	208	LF	$75.85	$15,777	
	Total					**$24,164**
	Division 16 and 17 - Electrical and I&C					
16000	15% Allowance on Divisions 2 through 15	1	AL	$23,345.20	$23,345	
	Total					**$23,345**
	Grand Total					**$178,980**

APPENDIX B - Page 3

TYPE 1 TRENCH

Proj Name/No: **SCVWD/8593A00** Date: **18-Nov-10**
Item: **18" Pipe** Proj Mgr:: **CB**



ed Values

DESCRIPTION	INPUT	
Pipe Diameter (Nom.)	18.00	inches
Average Trench Depth	7.00	feet
Length	1.00	feet
Trench Slope: 1 Vert. to	0.00	Horiz.
Pavement Thickness:	6.00	inches
ABC Depth:	12.00	inches
No.of Pavement Cuts	2.00	Each

5.5 ft = Top Resoration Width

CALCULATED QUANTITIES for ESTIMATE		
Pavement Cutting (per Inch Depth x Length)	=	**12.00 In ft**
Pavement Removal	=	**5.50 sq ft**
Trench Excavation	=	**0.91 cu yd**
Bed + Zone fill (Excludes Pipe Volume)	=	**0.26 cu yd**
Zone Only Fill (Excludes Pipe Volume)	=	**0.19 cu yd**
Bed Only Fill	=	**0.06 cu yd**
Backfill Above Zone	=	**0.58 cu yd**
Waste if Import Bed, Zone	=	**0.32 cu yd**
Waste if Native Bed, Zone	=	**0.07 cu yd**
Surface Restoration Area	=	**5.50 sq ft**
Shoring Area: 25% Trench Shored Area	=	**3.50 sq ft**
Shoring Area: With 30% Toe-In	=	**4.66 sq ft**

INPUT VARIABLES		
Bed Depth =	6.0	in
Zone Depth Above Pipe =	6.0	in
Min. Width =	36.0	in
Side Width (per side x 2) =	24.0	in
Pit Depth =	7.0	ft
Surface Area Restore (per side) =	1.0	ft

= For driven solid shoring

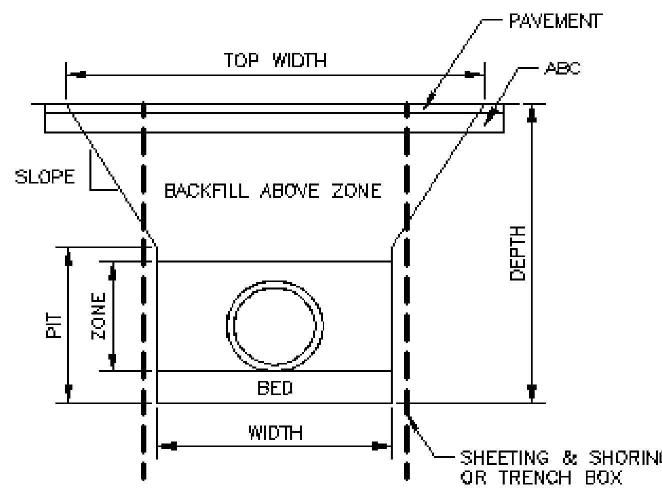
ESTIMATED COSTS:

DESCRIPTION	QTY	UNIT	$/UNIT	TOTAL	COMMENTS
Earthwork					
Pavement Cutting	12	in FT	$1.00	$12	AC Thickness = 6 in
Pavement Removal	6	SF	$0.50	$3	
Disposal Haul	0	CY	$10.00	$1	Haul Distance 10 mi round trip
Trench Excavation	1	CY	$5.00	$5	
Bed + Zone fill	0	CY	$50.00	$13	Imported confined material used
Backfill Above Zone	1	CY	$10.00	$6	Native material from trench
Waste if Import Bed, Zone	0	CY	$5.00	$2	Haul Distance 10 mi round trip
Surface Restoration Area	6	SF	$6.85	$38	4" AC over 8" ABC
Shoring Area	5	SF	$25.00	$116	
Earthwork Subtotal				$195	
Pipe					
18" DI Push-on	1	LF	$110.00	$110	
Pipe Subtotal				$110	
TOTAL DIRECT COST:				**$305**	
Indirect Costs					
Contingency			30.0%	$91	
Subtotal				**$396**	
General Conditions			15.0%	$59	
Subtotal				**$456**	
General Contractor Overhead, Profit & Risk			15.0%	$68	
Subtotal				**$524**	
Sales Tax (Based on 50% of Total Direct Cost)			9.75%	$30	
Subtotal				**$554**	
TOTAL ESTIMATED CONSTRUCTION COST				**$554**	**per LF of 18" pipe**
				$30.76	per inch-diameter per linear foot

Assumptions:

1. Project is in Downtown/Urban Area
2. Trench depth averages 8.5 feet.
3. Good soil conditions, medium digging
4. Imported bed and zone fill
5. Native fill above bed and zone
6. Disposal of spoils within 10 mile roundtrip
7. No groundwater, rock, hazardous material, or archaelogical finds
8. 75% of the trench will be shored with trench boxes. 25% will be shored using sheet piles.

APPENDIX B - Page 4
TYPE 1 TRENCH



ed Values

Proj Name/No: **SCVWD/8593A00** Date: **18-Nov-10**
Item: **36" Pipe** Proj Mgr:: **CB**

DESCRIPTION	INPUT	
Pipe Diameter (Nom.)	36.00	inches
Average Trench Depth	9.00	feet
Length	1.00	feet
Trench Slope: 1 Vert. to	0.00	Horiz.
Pavement Thickness:	6.00	inches
ABC Depth:	12.00	inches
No.of Pavement Cuts	2.00	Each

7.0 ft = Top Resoration Width

CALCULATED QUANTITIES for ESTIMATE		
Pavement Cutting (per Inch Depth x Length)	=	**12.00 In ft**
Pavement Removal	=	**7.00 sq ft**
Trench Excavation	=	**1.67 cu yd**
Bed + Zone fill (Excludes Pipe Volume)	=	**0.48 cu yd**
Zone Only Fill (Excludes Pipe Volume)	=	**0.39 cu yd**
Bed Only Fill	=	**0.09 cu yd**
Backfill Above Zone	=	**0.93 cu yd**
Waste if Import Bed, Zone	=	**0.74 cu yd**
Waste if Native Bed, Zone	=	**0.26 cu yd**
Surface Restoration Area	=	**7.00 sq ft**
Shoring Area: 25% Trench Shored Area	=	**4.50 sq ft**
Shoring Area: With 30% Toe-In	=	**5.99 sq ft**

INPUT VARIABLES		
Bed Depth =	6.0	in
Zone Depth Above Pipe =	6.0	in
Min. Width =	36.0	in
Side Width (per side x 2) =	24.0	in
Pit Depth =	9.0	ft
Surface Area Restore (per side) =	1.0	ft

ESTIMATED COSTS:

DESCRIPTION	QTY	UNIT	$/UNIT	TOTAL	COMMENTS
Earthwork					
Pavement Cutting	12	in FT	$1.00	$12	AC Thickness = 6 in
Pavement Removal	7	SF	$0.50	$4	
Disposal Haul	0	CY	$10.00	$1	Haul Distance 10 mi round trip
Trench Excavation	2	CY	$5.00	$8	
Bed + Zone fill	0	CY	$50.00	$24	Imported confined material used
Backfill Above Zone	1	CY	$10.00	$9	Native material from trench
Waste if Import Bed, Zone	1	CY	$5.00	$4	Haul Distance 10 mi round trip
Surface Restoration Area	7	SF	$6.85	$48	4" AC over 8" ABC
Shoring Area	6	SF	$25.00	$150	
Earthwork Subtotal				$260	
Pipe					
36" DI Push-on	1	LF	$250.00	$250	
Pipe Subtotal				$250	
TOTAL DIRECT COST:				**$510**	
Indirect Costs					
Contingency			30.0%	$153	
Subtotal				**$662**	
General Conditions			15.0%	$99	
Subtotal				**$762**	
General Contractor Overhead, Profit & Risk			15.0%	$114	
Subtotal				**$876**	
Sales Tax (Based on 50% of Total Direct Cost)			9.8%	$50	
Subtotal				**$926**	
TOTAL ESTIMATED CONSTRUCTION COST				**$926**	**per LF of 36" pipe**
				$25.72	per inch-diameter per linear foot

Assumptions:
1. Project is in Downtown/Urban Area
2. Trench depth averages 9 feet.
3. Good soil conditions, medium digging
4. Imported bed and zone fill
5. Native fill above bed and zone
6. Disposal of spoils within 10 mile roundtrip
7. No groundwater, rock, hazardous material, or archaeological finds
8. 90% of the trench will be shored with trench boxes. 10% will be shored using sheet piles.

APPENDIX C: LAND COST SUMMARY (2010 DOLLARS)

Engineers...Working Wonders With Water®

LAND COST SUMMARY (2010 DOLLARS)

Project:	**Groundwater Conjuctive Use Fee Cost Estimates**	**Estimate Class:**	**5**
Client:	**Santa Clara Valley Water District**	**PIC:**	**LJC**
Location:	**San Jose, California**	**PM:**	**CB**
Zip Code:	**95118**	**Date:**	**November 27, 2010**
Carollo Job #	**8593A00**	**By:**	**CB**

<u>Recharge System Land Costs (2010 dollars)</u>

Includes land for the recharge ponds:

Without Real Estate Acquisition Fees	Low Range	$824,263,423
	Mid Range	$1,218,022,572
	High Range	$3,480,064,490

<u>Extraction System Costs (2010 dollars)</u>

Includes land for the 93 of the 133 production wells:

Without Real Estate Acquisition Fees: $111,265,895

<u>Estimated Land Cost for both Recharge and Extraction Systems (2010 dollars)</u>

Guadelupe South Well Field

Guadelupe Main Transmissio **$936,000,000** **to** **$3,592,000,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

Engineers...Working Wonders With Water®

LAND VALUE ASSUMPTIONS (2010 DOLLARS)

Project:	**Groundwater Conjuctive Use Fee Cost Estimates**	**Estimate Class:**	**5**
Client:	**Santa Clara Valley Water District**	**PIC:**	**LJC**
Location:	**San Jose, California**	**PM:**	**CB**
Zip Code:	**95118**	**Date:**	**November 27, 2010**
Carollo Job #	**8593A00**	**By:**	**CB**

Assumed Property Values

From 2005 SCVWD Water Infrastructure Reliablity Project Report:

Assumed Real Estate	$1,000,000	per acre (2005 Dollars)
	$1,196,407	per acre (2010 Dollars)

From Sampling of Properties from Santa Clara County Assessor's Office website and Zillow.com:

Residential Real Estate Value attribute to land value:

	25 to 40	%
	35%	(assumed value)
Guadelupe South Well Field		
Guadelupe Main Transmission Pipe	$100	per sf (land & improvements)
	$4,356,000	per acre (land & improvements)
	$1,524,600	per acre (land only)
Approximate Residential Real Estate Values (Suburbs):		
	$150	per sf (land & improvements)
	$6,534,000	per acre (land & improvements)
	$2,286,900	per acre (land only)

Engineers...Working Wonders With Water®

RECHARGE SYSTEM LAND COST ESTIMATES

Project:	Groundwater Conjuctive Use Fee Cost Estimates	Estimate Class:	5
Client:	Santa Clara Valley Water District	PIC:	LJC
Location:	San Jose, California	PM:	CB
Zip Code:	95118	Date:	November 27, 2010
Carollo Job #:	8593A00	By:	CB

Recharge Assumptions

New Injection Wells from SCVWD Model:	100	wells
Injection Rate for New Wells per SCWVD Model:	37,695	acre-feet per year
Additional Recharge Required at Existing Facilities	88,383	acre-feet per year
Percolation Rate	1	acre-foot per day per acre of recharge ponds
Pond Density	50%	(percent of generic pond facility that is used for percolation)
Net Percolation Rate	0.5	acre-foot per day per acre of recharge ponds - including pond infrastructure (access roads, maintenance areas, landscaping, etc).

Recharge Facility	Recharge Rate (AFY)	Recharge Rate (AFD)	Recharge Rate (MGD)	Recharge Land Required (0.5 AF/D/A)	Value of Required Land ($1.20 M per Acre)	Value of Required Land ($1.52M to $2.29M per Acre)	Value of Required Land Inc. Existing Improvements ($4.36M to $6.53M per acre)
Alamitos Creek	1589	4.3	1.41	8.7	$10,385,742	$13,234,707	$37,813,448
Calabazas Creek	1538	4.2	1.37	8.4	$10,054,672	$19,219,229	$54,912,084
Calero Creek	640	1.7	0.57	3.5	$4,186,400	$5,334,792	$15,242,264
Guadalupe Creek/Los Cap Ponds	3955	10.8	3.52	21.6	$25,857,611	$32,950,742	$94,144,977
Guadalupe River/Alamitos/Etc	5680	15.5	5.06	31.0	$37,132,439	$47,318,425	$135,195,499
New Recharge At Guadalupe River	5654	15.4	5.03	30.9	$36,966,049	$47,106,391	$134,589,689
Kirk System-Oka/Mcglincey	4223	11.5	3.76	23.1	$27,606,178	$35,178,967	$100,511,334
Kooser Ponds	1567	4.3	1.40	8.6	$10,243,952	$13,054,022	$37,297,205
Los Gatos Creek	9074	24.8	8.08	49.6	$59,324,648	$113,397,435	$323,992,672
Lower Coyote/Ford/Coyote Ponds	12356	33.8	11.00	67.5	$80,777,461	$102,935,932	$294,102,663
New Recharge At Lower Coyote-101 And E Capital	7162	19.6	6.38	39.1	$46,823,662	$59,668,095	$170,480,272
Mcclellan Ponds	628	1.7	0.56	3.4	$4,104,497	$7,845,634	$22,416,096
New Recharge At Mcclellan Ponds	3016	8.2	2.68	16.5	$19,715,226	$37,685,113	$107,671,751
Page System-Budd/Camden/Snoaks	16773	45.8	14.93	91.7	$109,660,363	$139,741,847	$399,262,420
Penitencia Facilities	730	2.0	0.65	4.0	$4,775,357	$6,085,309	$17,386,597
New Recharge Penitencia East	7162	19.6	6.38	39.1	$46,823,662	$59,668,095	$170,480,272
New Recharge Penitencia West	5277	14.4	4.70	28.8	$34,501,646	$43,965,965	$125,617,043
Regnart Creek	1734	4.7	1.54	9.5	$11,335,920	$21,668,300	$61,909,428
Rodeo Creek	620	1.7	0.55	3.4	$4,055,434	$7,751,851	$22,148,145
Ross And Lone Hill Creeks	1210	3.3	1.08	6.6	$7,913,291	$15,126,038	$43,217,251
San Tomas/Wildcat/Smith Creeks	2533	6.9	2.26	13.8	$16,560,301	$31,654,560	$90,441,599
Saratoga Creek	13812	37.7	12.30	75.5	$90,301,964	$172,609,722	$493,170,635
Stevens Creek	6081	16.6	5.41	33.2	$39,757,865	$75,996,066	$217,131,616
Thompson Creek	3639	9.9	3.24	19.9	$23,789,003	$30,314,684	$86,613,383
New Recharge At Thompson Creek	9424	25.7	8.39	51.5	$61,610,081	$78,510,652	$224,316,148
Combined Eastern Recharge Facilities Pipeline			40.42				
Totals	**126078**	**344**	**153**	**689**	**$824,263,423**	**$1,218,022,572**	**$3,480,064,490**

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EXTRACTION SYSTEM LAND COST ESTIMATES

Project:	**Groundwater Conjuctive Use Fee Cost Estimates**	**Estimate Class:**	**5**
Client:	**Santa Clara Valley Water District**	**PIC:**	**LJC**
Location:	**San Jose, California**	**PM:**	**CB**
Zip Code:	**95118**	**Date:**	**11/27/2010**
Carollo Job #	**8593A00**	**By:**	**CB**

<u>Extraction System Assumptions</u>

New Extraction Points from SCVWD Model:	200	wells
Extraction Rate for Points per SCWVD Model:	17,000	acre-feet per month (total for all extraction wells)
Extraction Rate for Points per SCWVD Model:	128,220	gpm (total for all extraction wells)
Extraction Rate for Points per SCWVD Model:	641	gpm per extraction well
Assumed Production Well Capacity:	1000	gpm (per 2008 SCVWD Well Field Implementation Plan and additional analysis by Hydrometrics WRI)
Land requirement:	1	acre per production well (per 2008 SCVWD Well Field Implementation Plan)

Assumes that 40 wells on the west side of the valley can be sited on existing property - per Well Field Implementation Plan.

Assumed Property Values

Extraction Pipeline Description	Extraction Points	Extraction Rate(GPM)	Required Production Wells	Land Cost
Milpitas Well Field	4	2,564	3	$3,589,222
Berryessa Well Field	7	4,488	5	$5,982,037
Penitencia South Well Field	8	5,129	6	$7,178,445
Thompson Creek Well Field	17	10,899	11	$13,160,482
Lower Coyote Well Field	17	10,899	11	$13,160,482
Guadelupe North Well Field	21	13,463	14	$16,749,705
Guadelupe South Well Field	21	13,463	14	$16,749,705
Guadelupe Main Transmission Pipe	--	26,926	--	--
Campbell Northeast Well Field	40	25,644	26	$31,106,594
Campbell Southwest Well Field	33	21,156	22	$3,589,222
Saratoga Well Field	20	12,822	13	--
Stevens Creek Well Field	12	7,693	8	--
Totals	**200**	**155,146**	**133**	**$111,265,895**

Appendix E: Sample of Treated Water System Assets and Inclusion or Exclusion in Groundwater Only System

Cost Center	Asset Description	System	Treated Water Main to be Included in GW Only System	GST to be included in GW only system
Raw Water T&D	Coyote Percolation System	GW		Yes
Source of Supply	Almaden Dam & Reservoir	GST		Yes
Source of Supply	Calero Dam & Reservoir	GST		Yes
Source of Supply	Gualalupe Dam & Reservoir	GST		Yes
Source of Supply	Stevens Creek Dam & Reservoir	GST		Yes
Source of Supply	Vasona Dam & Reservoir	GST		Yes
Raw Water T&D	Page Percolation System	GW		Yes
Source of Supply	Coyote Dam & Reservoir	GST		Yes
Source of Supply	Anderson Dam & Reservoir	GST		Yes
Source of Supply	Lexington Dam & Reservoir	GST		Yes
Source of Supply	Chesbro Dam & Reservoir	GST		Yes
Source of Supply	Uvas Dam & Reservoir	GST		Yes
Raw Water T&D	Penitencia Percolation System	GW		Yes
Raw Water T&D	Main Avenue Percolation System	GW		Yes
Raw Water T&D	Camden Percolatin System	GW		Yes
Raw Water T&D	Kooser Percolation System	GW		Yes
Raw Water T&D	Central Pipeline	GST		Yes
Raw Water T&D	Ford Road Percolation Area	GW		Yes
Raw Water T&D	Los Capitancilos Percolation Sys	GW		Yes
Raw Water T&D	Santa Clara Conduit	GST		Yes
Treated Water T&D	Evergreen Distribution System	T	yes	
Treated Water T&D	Rinconada Force Main	T		
Raw Water T&D	Almaden Valley Pipeline	GST		Yes
Raw Water T&D	Budd Avenue Percolation Ponds	GW		Yes
Raw Water T&D	Sunnyoaks Percolatin Ponds	GW		Yes
Water Treatment	Rinconada Water Treatment Plant	T		
Water Treatment	Control System RWTP	T		
Raw Water T&D	Stevens Creek Pipeline	GST		Yes
Raw Water T&D	Vasona Pump Station	GST		Yes
Treated Water T&D	West Pipeline	T	yes	
Water Treatment	Rinconada Reservoir	T		
Raw Water T&D	Penitencia Force Main	T		
Water Treatment	Penitencia Water Treatment Plant	T		
Water Treatment	Control System PWTP	T		
Raw Water T&D	McClellan Road Percolation System	GW		Yes
Raw Water T&D	Church Percolation System	GW		Yes
Raw Water T&D	Coyote-Madrone Distribution Sys	GST		Yes
Raw Water T&D	Cross Valley Pipeline	GST		Yes
Raw Water T&D	Anderson Force Main	GST		Yes
Treated Water T&D	East Pipeline	T	yes	
Treated Water T&D	Greystone Pump Station	T	yes	
Treated Water T&D	Greystone Pipeline	T	yes	
Treated Water T&D	Snell Pipeline	T	yes	
Water Treatment	Santa Teresa Water Treatment Plant	T		
Admin & General	Anderson Hydrogeneration System	GST		
Raw Water T&D	Calero Pipeline	GST		Yes
Admin & General	Miscellaneous Project Locations	GST		
Admin & General	Land Use Review	GST		
Source of Supply	Water Reclamation Fac. - Gilroy	RW		
Raw Water T&D	Federal Water Project	CVP		Yes
Source of Supply	Water Reclamation Fac. - Palo Alto	GST		Yes
Source of Supply	Almaden Dam & Reservoir	GST		Yes
Source of Supply	Anderson Dam & Reservoir	GST		Yes
Source of Supply	Calero Dam & Reservoir	GST		Yes
Source of Supply	Coyote Dam & Reservoir	GST		Yes
Source of Supply	Guadalupe Dam & Reservoir	GST		Yes

Appendix F: Berkeley Economic Consulting Group's Analysis Titled "Economic Analysis of Water Shortage in Santa Clara County"

Memorandum

Date: February 24, 2010

To: Joan Maher

From: David Sunding

RE: Economic Analysis of Water Shortage in Santa Clara County

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Berkeley Economic Consulting developed a model to determine the impact of Santa Clara Valley Water District water shortages on employment and sales revenues in Santa Clara County. We calculate impacts for ten, twenty and thirty percent rationing scenarios. Impacts are disaggregated by the industrial and commercial sectors and between the northern and southern regions of Santa Clara County.

We find that employment impacts range from approximately $262 million in payroll losses (under a ten percent reduction scenario) to $4.1 billion (under a thirty percent reduction scenario). A ten percent shortage results in over 3,000 lost jobs and a thirty percent shortage in almost 53,000 lost jobs. Sales revenue is decreased by approximately $883 million, given ten percent rationing, and by more than $10 billion, given thirty percent rationing. This memo describes the methodology and data sources and presents the impacts by sector and region.

Methodology

Employment and sales revenue impacts were determined under various water reduction scenarios. We relied on the following data sources:

- US Census 2007 County Business Patterns data – Data on number of establishments available by zip code, by NAICS code. Total payroll and number of employees data available by zip code.
- UC Census 2002 Economic Census data – Total sales revenues data available by county.
- MHB Consultants Study[1] - Industrial and commercial elasticities reported in the study are for 0% to 15% and 15% to 30% reductions in water supply.

We used a GIS to analyze the revenue and payroll losses in the northern and southern portions of Santa Clara County. The north-south delineation was based on Metcalf Road. Zip codes lying north of Metcalf Road were assigned to the North County Region and zip codes lying south of Metcalf Road were assigned to the South County Region. The map below shows the allocation of zip codes to the North and South County Regions.

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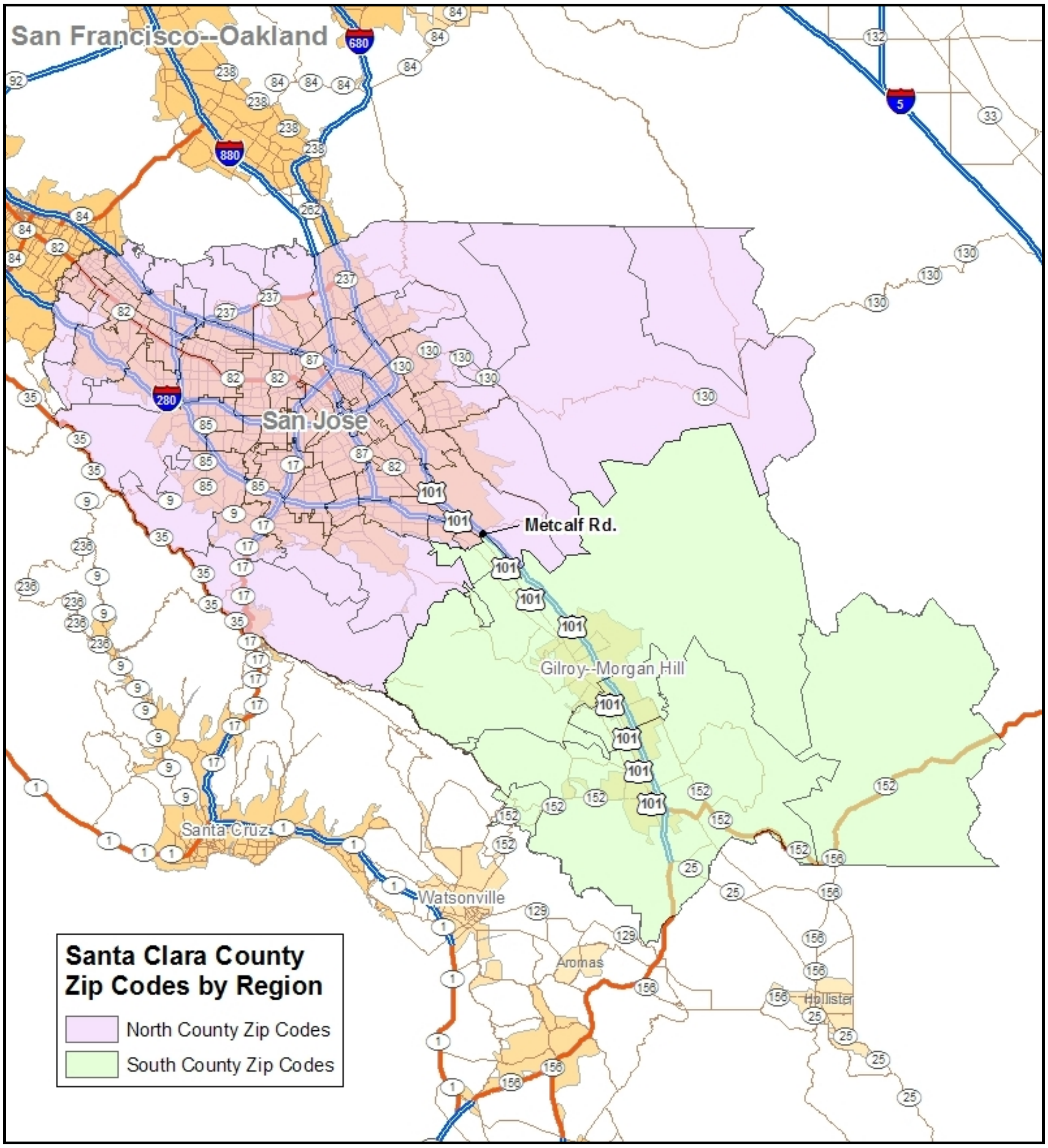
[1] MHB Consultants, Inc., "The Economic Impact of Water Delivery Reductions on the San Francisco Water Department's Commercial and Manufacturing Customers," 1994.



Payroll losses and job losses are functions of total payroll and employment, change in water consumption, and output elasticity. Sales revenue losses are determined by total sales, change in water consumption, and output elasticity. In both the employment and sales revenue calculations, consumption is assumed to decrease by ten, twenty and thirty percent in all sectors in both the North and South County Regions.

Data

Employment

The most refined data available on employment are given by zip code. However, employment data are only available by zip code and are not disaggregated by NAICS code. We calculated a weighted average of the number of establishments by zip code and applied it to the employment data. Specifically, we multiplied the share of establishments in a given zip code and NAICS code by the annual payroll and number of employees in the zip code, to approximate the annual payroll and number of employees in a zip code-NAICS code combination. We aggregated the annual payroll and employment data by sector and by county region. The industrial sector is assumed to be NAICS codes 31-33 and the commercial 42-81.

To calculate the output elasticities, we took an average of the industrial and commercial output elasticities, weighted by the annual payroll data. This calculation was done separately for the North and South County Regions.

Sales Revenue

The best available data on sales revenue are given by NAICS code at the county level. We used the County Business Patterns data to determine the share of establishments by NAICS code and zip code, in the North and South Regions. We applied this share to the county level sales data and aggregated the sales data by sector, for the North and South Regions.

To calculate the output elasticities, we took an average of the industrial and commercial output elasticities, weighted by the annual sales revenue data. This calculation was done separately for the North and South Regions.

Results

The economic impacts to sales revenues are presented in Table 1 below. As the calculations in the column headings show, the losses are calculated by multiplying the base level of sales revenue by the percent water shortage and the elasticity. This calculation is performed for each sector (industrial or commercial) and for each region (North or South).

Table 2 presents the payroll and job losses. In similar fashion to the sales losses, the payroll impacts are calculated by multiplying the base level of annual payroll by the elasticity and the percentage of rationing. The equivalent job losses are estimated by dividing the lost payroll by the average payroll per employee in each sector and region.

Note the two elasticities for each sector, which depend on the level of water reduction. Output is relatively elastic for a 0-15% shortage and relatively inelastic in the event of a 15-30% shortage. Thus, in estimating the economic impacts of a 20% or 30% shortage, we apply the more elastic elasticity to the first 15% of water restrictions, and then we apply the inelastic elasticity to the remainder of the water reduction. These calculations are denoted in the column headings in the tables below.

Payroll, jobs, and sales revenue losses are higher in the commercial sector than the industrial sector in all but one instance. For example, in the industrial sector, payroll losses are $64.5 million under a 10% shortage, compared with commercial payroll losses which are almost $198 million under the 10% shortage. And while payroll losses to the industrial sector are over $447 million under a 30% shortage, commercial sector payroll losses are approximately $3.7 billion, accounting for 89% of the payroll losses under the 30% reduction scenario. Likewise, 58% of the sales revenue losses occur in the commercial sector under the 20% rationing scenario and 62% of the sales losses occur in the commercial sector under the 30% shortage. In the case of sales revenues under the 10% reduction scenario, however, impacts in the industrial sector account for most (59%) of the impacts.

Losses in the North County Region are much greater than losses in the South County Region. Under a 10% shortage, for example, 95% of the payroll losses, 90% of lost jobs, and 88% of sales revenue losses would occur in the North. While payroll losses are estimated at over $60 million and sales revenue losses are approximately $479 million in the southern part of the County, the northern region of the County will see nearly $1.6 billion in payroll losses and almost $4 billion in sales revenue losses under a 20% water shortage.

Table 1: Industrial and Commercial Sector Sales Losses

Sector	Total Sales 2002 (millions $)	10% Water Shortage Scenario: % Change in Industrial Consumption	Elasticity (0-15%)	Sales Loss (millions)	20% Water Shortage Scenario: % Change in Industrial Consumption	Elasticity (15-30%)	Sales Loss (millions)	30% Water Shortage Scenario: % Change in Industrial Consumption	Elasticity (15-30%)	Sales Loss (millions)
	[I]	[II]	[III]	[IV] = [I]x[II]x[III]	[V]	[VI]	[VII] = 0.15x[I]x[III] + ([V]-0.15)x[I]x[VI]	[VIII]	[IX]	[X] = 0.15x[I]x[III] + ([VIII]-0.15)x[I]x[IX]
NORTH										
Industrial	$41,660	10.0%	0.110	$457	20.0%	0.468	$1,660	30.0%	0.468	$3,608
Commercial	$99,156	10.0%	0.033	$324	20.0%	0.365	$2,297	30.0%	0.365	$5,917
SOUTH										
Industrial	$5,450	10.0%	0.122	$66	20.0%	0.462	$225	30.0%	0.462	$477
Commercial	$10,884	10.0%	0.033	$36	20.0%	0.367	$254	30.0%	0.367	$654

Notes:

1) The Industrial sector is composed of NAICS codes 31-33.
2) The Commercial sector is composed of NAICS codes 41-82.
3) Total Sales includes all sales, shipments, receipts, and revenues in the industrial and commercial NAICS codes for Santa Clara County.

4) To determine the amount of sales revenue by sector in North and South Santa Clara County, total sales revenue were adjusted by the weighted average of the number of establishments by NAICS code, by region of the county (North or South). The number of establishments are given by NAICS, by zip code in the 2007 County Business Patterns data.
5) Weighted-average industrial and commercial output elasticities were calculated using MHB output elasticities and 2002 Economic Census data. The elasticities reported in the MHB study are for 0% to 15% and 15% to 30% reductions in water supply.
6) Some NAICS codes have data suppressed in the Economic Census to protect anonymity; this may influence the calculated average elasticity.

Sources:

[I]: 2002 Economic Census data and 2007 County Business Patterns Data
[II], [V], and [VIII]: SCVWD reduction scenarios
[III], [VI], and [IX]: MHB Study and 2002 Economic Census data

Table 2: Industrial and Commercial Sector Payroll and Job Losses

Sector	Total Payroll 2007 (thousands)	Avg Payroll per Employee (thousands)	10% Water Shortage Scenario: % Change in Industrial Consumption	Elasticity (0-15%)	Payroll Loss (thousands)	Equivalent Job Losses	20% Water Shortage Scenario: % Change in Industrial Consumption	Elasticity (15-30%)	Payroll Loss (thousands)	Equivalent Job Losses	30% Water Shortage Scenario: % Change in Industrial Consumption	Elasticity (15-30%)	Payroll Loss (thousands)	Equivalent Job Losses
	[I]	[II]	[III]	[IV]	[V] = [I]x[III]x[IV]	[VI] = [V] / [II]	[VII]	[VIII]	[IX] = 0.15x[I]x[IV] + ([VII]-0.15)x[I]x[VIII	[X] = [IX] / [II]	[XI]	[XII]	[XIII] 0.15x[I]x[IV] + ([XI]-0.15)x[I]x[XII]	[XIV] = [XIII] / [II]
NORTH														
Industrial	$5,757,763	$89.45	10.0%	0.108	$61,952	693	20.0%	0.393	$205,936	2,302	30.0%	0.393	$431,953	4,829
Commercial	$59,825,233	$79.71	10.0%	0.031	$187,975	2,358	20.0%	0.363	$1,366,299	17,141	30.0%	0.363	$3,534,974	44,349
SOUTH														
Industrial	$162,534	$39.03	10.0%	0.158	$2,562	66	20.0%	0.460	$7,579	194	30.0%	0.460	$15,050	386
Commercial	$1,922,127	$38.18	10.0%	0.051	$9,749	255	20.0%	0.398	$52,846	1,384	30.0%	0.398	$129,291	3,387

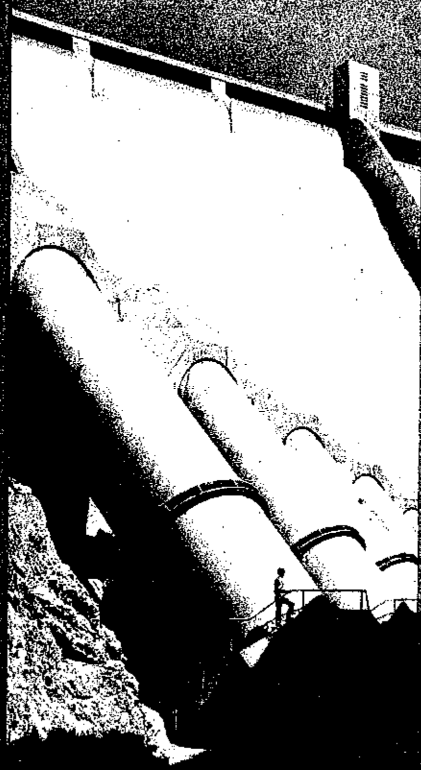
Notes:

1) The Industrial sector is assumed to be NAICS codes 31-33.
2) The Commercial sector is assumed to be NAICS codes 42-81.
3) Total Payroll includes all payroll in the industrial and commercial NAICS codes for Santa Clara County.
4) To determine the amount of payroll by sector in North and South Santa Clara County, payroll was adjusted by the weighted average of the number of establishments by NAICS code, by region of the county (North or South). The number of establishments are given by NAICS, by zip code in the 2007 County Business Patterns data.
5) Weighted-average industrial and commercial output elasticities were calculated using MHB output elasticities and 2002 Economic Census data. The elasticities reported in the MHB study are for 0% to 15% and 15% to 30% reductions in water supply.

Sources:

[I] and [II]: 2007 County Business Patterns data
[III], [VII], and [XI]: SCVWD reduction scenarios
[IV], [VIII], and [XII]: MHB Study and 2007 County Business Patterns data

Appendix G: Excerpts from 1962 Master Plan



PROPOSED WATER TREATMENT & DISTRIBUTION SYSTEM

July 18 1962

ENGINEER'S REPORT - ZONE W-1

PROPOSED WATER TREATMENT AND DISTRIBUTION SYSTEM

INTRODUCTION

A basic requisite to the continued economic growth and orderly development is water in adequate quantity and of good quality. A water distribution system that will supply sufficient water now and in the future is an immediate need in this county. Constructive action is now under way to make sure that a proper program will be planned, designed and under construction in time to receive "Imported" water.

Present Supply

The ground water basin has provided the primary source of water for domestic and industrial as well as agricultural use in the county since the area was first settled. For many years this source of water was fully adequate to meet all needs. There has been extensive industrial development in recent years, industry being a heavy water user. During World War II and the period since, population has increased rapidly from 291,000 in 1950 to approximately 740,000 in 1960, making Santa Clara County the second fastest growing county in the State. Water supply requirements have increased greatly, at an even faster rate than the population.

In recent years heavy overpumping of the ground water basin for the combined needs of industrial, agricultural and domestic consumption has seriously depleted the supply. The level of water in the ground water basin has dropped drastically causing a sharp increase in pumping costs, and expansion of areas of salt water intrusion resulting in degrading of the supply. Demands for water have already exceeded the firm supply. In some areas water has had to be rationed, in other areas development is restricted until additional potable water supplies are provided.

In south Santa Clara County a local supply of water exists which is reasonably adequate for present needs. For this reason primary consideration is given to the requirements of north Santa Clara County, an area shown as proposed Zone W-1 on Plate "A".

Planning Steps

The first major step taken to alleviate the condition of water scarcity was the approval by the people of California of the 1.75 billion dollar program for commencement of construction of the California Water Plan. The California Water Plan provides for conservation, control, protection and utilization of the State's water resources to meet present and future needs for all beneficial purposes and uses in various parts of the State. This is a bold, imaginative plan for conveying water from areas of the State with an excess of water supply to areas of the State with deficiency of water supply. Construction of the South Bay Aqueduct, a portion of this over-all plan, was started in 1959. It is now delivering water in Alameda County, and will bring additional water to Santa Clara County to meet the various demands.

In March of 1961, the Santa Clara County Water Commission was appointed by the Board of Supervisors to aid and advise the Board on all matters relating to Santa Clara County water problems. The Commission consists of elected members of the Santa Clara Valley Water Conservation District, South Santa Clara Valley Water Conservation District, the County of Santa Clara and each of the 16 cities in the county. The Commission has worked diligently. It has made many recommendations to the Board of Supervisors, all of which have either been put into effect or used as the foundation for this report.

Initial Action

Early in November 1961, the Commission recommended that the South Bay Aqueduct be used for importing water into northern Santa Clara County as soon as possible, and that the Pacheco Pass Adqueduct, scheduled to be completed about 1970, be used for additional supplies. In accordance with this recommendation, the Board of Supervisors of the Santa Clara County Flood Control and Water Conservation District took a major step to solve the water problems of Santa Clara County by signing a water importation contract with the State of California on November 20, 1961. This contract allocates an annual quantity of 88,000 acre feet of water to be delivered by the State to the District through the South Bay Aqueduct. It is anticipated that South Bay Aqueduct water supply will be available to the county by mid-1964.

Planning Distribution and Treatment

Having determined that the water should be imported from both the South Bay Aqueduct and the Pacheco Pass, the Water Commission next turned its attention to the method of distributing water from both of these importation facilities. In its analysis the Water Commission gave consideration to transporting waters to areas of percolation for recharge and replenishment of the underground as well as to the construction of water treatment plants and distribution lines to deliver purified water for municipal and industrial purposes. After discussion of many alternate routes and comparing the costs and benefits of each, the Water Commission made recommendations on the in-county facilities. Those recommendations provided the foundation of the proposed improvements contained in this report. It is now imperative that final design and construction of water distribution pipelines and treatment plants proceed immediately to assure completion in time to receive and utilize the additional water supply and to overcome the growing water deficit.

This report recommends construction of a water treatment and distribution system in Zone W-1 of the Santa Clara County Flood Control and Water Conservation District. The report comprising this document, maps and general construction plans, attached hereto, shows:

1. A general description of the work proposed to be included within the project, including schematic plans and diagrams of water treatment plants together with general plans, profiles, cross-sections and general specifications relating to that portion of the project constituting the water distribution system.

2. A general description of the land, rights of way, easements and property proposed to be taken, acquired or injured in carrying out said project.

3. Maps which show the location of each of the transmission lines, water treatment plant sites, and the improvements, lands, rights of way, easements and property to be taken, used, acquired or injured in carrying out said project, and any information in regard to the same that is deemed necessary or useful.

4. An estimate of the cost of each of the pipelines and treatment plants and related facilities proposed to be constructed including an estimate of the costs of said lands, rights of way and easements; costs heretofore advanced by the District for said project for which the District proposes to reimburse itself from the proceeds of sale of any bonds to be issued to pay for said project; a sum sufficient to pay interest on any bonds proposed to be issued during construction of said project, pending receipt of revenues, but for a period not to exceed 12 months; and also all incidental

expenses likely to be incurred in connection therewith including financing, legal, clerical, engineering, administration, inspection, printing, advertising and the total amount of bonds necessary to be issued to pay for the project within Zone W-1.

BENEFITS OF THE PROGRAM

The basic benefit, of course, is that the proposed project will assure ample water for rapidly growing Santa Clara County for the next 60 years-which is as far ahead as it is economically feasible to plan such a project.

Industry and Growth

An adequate water supply is one of the primary requisites for attracting industry to an area; in turn, industrial expansion assures economic growth and an accompanying steady increase in the standard of living for Santa Clara County residents.

Subsidence

Certain engineering studies have concluded that depletion of the underground water reserve causes consolidation of the aquifers and a companion settling of the ground surface. This damaging and expensive problem can be arrested and possibly reversed by adequate recharge made possible with imported water.

Recreation

The proposed circulation of imported water through the many existing county reservoirs will assure a year-round, reasonably constant level of water; the boating and fishing thus made possible will greatly enhance the recreational features of Santa Clara County. The importance of providing dependable water recreation facilities becomes more evident each passing day as its popularity increases.

Tax Free

The benefits outlined above will have immeasureable monetary value, yet by approving the bonds recommended in this report,Santa Clara County residents can acquire these benefits without a forseeable increase in taxes. The bonds will be paid off with fees collected from water users, at an average cost increase over present rates of only 12-1/2¢ per month to each person living in the average home.

SOURCES OF WATER

Wells

The major existing source of water is natural rainfall. Natural waters either percolate directly into the ground or are stored in reservoirs of the Santa Clara Valley Water Conservation District. Water stored by the Water Conservation District is released into percolation ponds or natural stream beds. The water then filters down through gravel strata to recharge our underground water supplies. Existing percolation ponds, the facilities which are the primary source of recharging our ground water basin, are located principally in the southern and west-central portions of Zone W-1. The location of the percolation ponds are shown on Plate "B". Percolation capacities in acre feet per year and rates in cubic feet per second are shown for each of the ponds and natural river beds in Table 1 . At present the recharge quantity is dependent on rainfall and the recurrent deficiency in rainfall over the past 6 years has had a serious effect in reducing the quantity of ground water in storage.

Other factors which determine the quantity of water which can be recharged to the ground water basin include topography and geologic structure of the surface and sub-surface aquifers. Table 1 illustrates the range of capacities of each of the percolation ponds and was compiled from information furnished by the Santa Clara Valley Water Conservation District. A small percentage of the local water is diverted from streambeds to filtration plants of the San Jose Water Works and there distributed to retail customers. The remainder of the local water supply is pumped from the underground and used for agricultural purposes or distributed for municipal and industrial uses. Local rainfall presently supplies over 90% of Santa Clara County's total water use.

Hetch-Hetchy

Water which cannot be supplied from local sources is purchased from the Hetch-Hetchy water system of the City and County of San Francisco by four agencies having direct contracts with the City of San Francisco. The Hetch-Hetchy system is now providing approximately 15,000 acre feet per year to the cities of Palo Alto, Mountain View and Sunnyvale and the Milpitas County Water District. Since neither the Hetch-Hetchy system nor the local supplies will provide sufficient water to meet the growing year to year needs of Santa Clara County, future supplies must of necessity be obtained from other sources.

South Bay Aqueduct

The South Bay Aqueduct, a portion of the California Water Plan, will import water to Santa Clara County from the Sacramento-San Joaquin Delta. The terminal facility of this project will be Airpoint Reservoir, east of Milpitas. Water will originate in the Feather River with initial storage facilities at Oroville Reservoir. Water will flow down the Feather and Sacramento Rivers through the cross delta channels. Here the water will be lifted from Old River in the San Joaquin Delta and flow southward by gravity through conduit and canal to be constructed parallel to the existing Delta Mendota Canal. Approximately two miles south of the first lift station the water will be relifted to an elevation of 700 feet above sea level, and discharged into the South Bay Aqueduct proper; from here, water will flow by gravity southwesterly through Alameda County to the Santa Clara County terminal reservoir at Airpoint. The seasonal fluctuations in water demand will be controlled in Del Valle Reservoir. The amount of water contracted for by the Santa Clara County Flood Control and Water Conservation District to be delivered through the South Bay Aqueduct is 88,000 acre feet per year. Routes of the South Bay and Pacheco Pass Aqueducts are shown on Plate 2 of Appendix A.

Pacheco Pass Aqueduct

The Pacheco Pass Aqueduct will take water from the San Luis Reservoir through a tunnel under Pacheco Pass east of Gilroy. This will provide water for distribution north into Santa Clara County. San Luis Reservoir is planned as a joint Federal-State facility and together with pump stations, power generating facilities and forebay structures, comprises the San Luis unit of the Central Valley Project of the U. S. Bureau of Reclamation. Water stored in San Luis Reservoir will be supplied from the San Joaquin Delta by the California Aqueduct and the Delta Mendota Canal. Water imported by the Pacheco Pass Aqueduct will come from the San Joaquin Delta, and will combine with local runoff from the San Luis Reservoir area. The water imported by the Pacheco Pass Aqueduct will have essentially the same source and quality as that of the South Bay Aqueduct. Similar type treatment facilities will be required for filtered and treated water to be distributed from either import system.

Staging Deliveries

Prior to 1970 the South Bay Aqueduct will supply all imported water requirements other than Hetch-Hetchy. After 1970 South Bay Aqueduct will supply water for the Penitencia percolation ponds and for the two proposed treatment plants, with the remaining South Bay Aqueduct water and water supplied by the Pacheco Pass Aqueduct supplying water for all other percolation ponds in the Santa Clara Valley. In later years it is anticipated that South Bay Aqueduct water will all be treated and used for municipal and industrial purposes. At such time water supplied from the Pacheco Pass Aqueduct will be the sole source for ground water recharge and replenishment and also will augment the South Bay Aqueduct supply to the proposed Westside Treatment Plant. Plate 2, of Appendix "A" indicates the importation routes of the South Bay Aqueduct and the Pacheco Pass Aqueduct.

QUALITY OF WATER

Acting upon the recommendation of the Santa Clara County Water Commission, the Santa Clara County Flood Control and Water Conservation District engaged the firm of Kennedy Engineers to analyze the quality of the present water supply and supplies to be imported from the South Bay and Pacheco Pass Aqueducts, to recommend the necessary treatment for supplies of water to be imported through these facilities, and to investigate sites for the treatment plant or plants. Kennedy Engineers have submitted their report which has been accepted by the Board of Supervisors. The report of Kennedy Engineers has been incorporated in this report as Appendix "A".

The quality of water presently pumped from underground sources varies from good to usable; these variations are illustrated on Plate 5, Appendix "A". Generally, the pumped water may be classified as moderately to extremely hard. In addition, some wells exhibit high seasonal salinity indicating overdraft of recharge. Hardness of water is caused principally by compounds of calcium and magnesium. Water having a range of total hardness up to 150 parts per million is suitable for most household uses. Where total hardness exceeds from 150 to 200 parts per million, water softening is frequently used in order to render the water more acceptable for domestic use. However, objections to hardness in water may depend on local opinion and a water considered too hard in certain localities might be considered satisfactory in others. An interesting recent medical report indicates that hard water appears to be associated with low heart disease death rate; no hardness limitations have been established for drinking water by the U. S. Public Health Service.

An intensive study of available records of the State Division of Water Resources, the Bureau of Reclamation and an independent analysis made by Kennedy Engineers, indicates that proper treatment of the water to be imported will produce a safe, high quality product for distribution in the treated surface water system, fully meeting U. S. Public Health Service drinking water standards.

Plates 5 through 9 of Appendix "A" graphically present average characteristics of water samples taken by the California State Department of Water Resources from the forebay of the Delta-Mendota Canal for the period 1951-1961. Table "B" of Appendix "A" presents additional chemical data on samples taken by the Bureau of Reclamation over a two and a quarter year period from a station on the Delta-Mendota Canal near the headworks pump station.

The State Board of Health adopted in September, 1959 an interim policy on mineral quality of drinking water. The available analyses of average mineral quality of Delta water indicate that the mineral constituents of this water will be less than the suggested limits which would permit full certification.

The Feather River project will ultimately provide regulatory storage on the Feather River near Oroville. It is judged that reduction in seasonal variation and an improvement in overall hardness characteristics from the values shown on the plates in Exhibit "A" may be expected upon completion of Oroville Reservoir and the Delta Protection Works of the Feather River Project. If it is later judged that softening is desirable during certain seasons of the year, a lime softening process can be installed in the treatment plants at nominal cost, see Plate 26, Appendix "A" for graphic illustration of the results of such a process.

CRITERIA FOR PLANNING

Existing Ground Water Hydrology

The first step taken in order to be able to make a proper recommendation for the project was to investigate existing conditions. Geologic and hydrologic studies indicate that over portions of the north county relatively impervious and generally continuous strata exist between the ground water surface and the principal pumping aquifers confining the ground water. Ground water zones found generally upstream from the confined pressure zones contain unconfined ground water and are replenished locally by percolating rainfall, stream flow or irrigation water. The unconfined ground water bodies, in addition to supplying water for use on overlying land, act as forebays supplying the confined zones by underflow.

The normal pressure gradient of the underground water slopes toward the San Francisco Bay. Extended overdraft of the underground water has in some areas reversed the slope of the gradient and caused degradation of numerous wells by salt water intrusion, as evidenced by increasing chloride content of the well water. It is reported that ground water levels reached the lowest point in recorded history in certain areas during late 1961 and early 1962. Withdrawal from some wells was severely curtailed in order to protect water quality but not before some wells were deteriorated to the point where recovery cannot be expected for several years.

Existing Recharge Facilities

Existing facilities of the Santa Clara Valley Water Conservation District played an important part in establishing the criteria for the project as proposed herein. Existing percolation ponds and distribution facilities of the Water Conservation District were given careful consideration so that these facilities could be put to maximum use. Consequently, the facilities in the proposed project augment but do not replace or duplicate facilities presently in existence. The percolation ponds and other areas of ground water recharge, the direction of underground flow from such areas, and ground water contours were analyzed to determine which areas of north Santa Clara County could be served from underground sources, and which areas would require service through a surface distribution system to distribute treated water.

Surface Distribution Needs

The Flood Control and Water Conservation District studies, coordinated with investigations of the Santa Clara Valley Water Conservation District and the Tri-County Water Authority, indicate that the areas underlying San Jose, Campbell and Santa Clara can continue to rely on underground sources of water. However, there are two general areas of Zone W-1 that have an immediate requirement for a supplemented surface supply.

These are the eastern foothill regions between Milpitas and Evergreen and the western foothill regions extending from Los Gatos, Monte Sereno, and Saratoga to Monte Vista, Los Altos, Los Altos Hills, Mountain View, Sunnyvale and Palo Alto. Within these areas local water supplies are inadequate and sub-surface geological conditions severely limit the availability of ground water. The condition is especially severe in the Monte Vista-Los Altos area. The project as proposed herein includes specific features to assure that ample water will be brought to the percolation ponds and other areas of ground water recharge as well as the above mentioned deficient regions as soon as imported water is available from the South Bay Aqueduct.

Estimated Future Demand

Of paramount importance in establishing one of the criteria for the proposed project is the amount of water presently available and the future water requirements. An evaluation of the future water requirements of northern Santa Clara County was made by the Santa Clara County Flood Control and Water Conservation District, the Santa Clara Valley Water Conservation District and the Tri-County Authority. In this evaluation full use has been made of many studies of other agencies.

The U. S. Bureau of Reclamation in its investigation of north Santa Clara County water requirements has estimated that by the year 2020 the domestic water needs of the predicted 2 1/2 million population, and the farm irrigation and industrial water needs will total 465,000 acre feet per year.

Projected Supply From All Sources

Further investigation by the Bureau, supplemented by studies of the local agencies, indicates that a safe yield of ground water and surface runoff within the area is approximately 180,000 acre feet per year. To augment the local ground water, and the minor amount of surface runoff supply, imported water in an amount of 285,000 acre feet per year will be required for north Santa Clara County by year 2020. Of this amount approximately 130,000 acre feet can be percolated into the underground water basin and the remaining 155,000 acre feet of water must be delivered through a surface distribution system. For planning purposes, a conservative estimate of the amount of Hetch-Hetchy water to be supplied within north Santa Clara County, after a proposed enlargement of existing facilities has been constructed, is 40,000 acre feet per year. There will then be a requirement for treating 115,000 acre feet per year of the water to be imported through the South Bay and Pacheco Pass Aqueducts.

Peaking Requirements

Water demands in Santa Clara County, now and in the future, will continue to vary widely at different seasons of the year. Summer irrigation and ground water recharge, heavy use by canneries and other seasonal industries, all combine to produce wide fluctuations in use. The maximum predicted demand is called the "peak", and pipeline capacities must provide for this situation. In order to provide this "peaking" capacity, raw water lines which are to serve percolation facilities have been designed to carry 125% of the annual flow, and treated water lines will have a capacity equal to 150% of the annual demand in the year 2020.

Summary

The natural geological conditions of north Santa Clara County, the present and future facilities of the Santa Clara Valley Water Conservation District, the location and capacity of percolation ponds, the capacity of the underground to transport the sub-surface flow of water, the areas which cannot adequately be supplied from the underground source, the indicated safe yield of local water, and the anticipated total future demand for water, all as set forth above have served to determine the criteria on which to plan the water importation program and the proposed project as set forth herein.

Appendix G: Excerpts from 1975 Master Plan

December 1975

Master Plan
expansion of in-county water distribution system

Santa Clara Valley Water District

Appendix G

PREFACE

This Engineer's Report and the Final Environmental Impact Report will jointly form the first stage in the planning process of the District's Master Plan for Expansion of the In-County Water Distribution System for the importation of water from the San Felipe Project.

The analyses presented in this Report are designed to give the Santa Clara Valley Water District maximum flexibility in meeting a range of possible future water demands. The expectation is that, in the future, several alternative means of meeting water demands will be required.

Subsequent stages in the planning process will include further studies on the specific needs for each proposed facility, and predesign studies and environmental impact reports on each required facility.

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INTRODUCTION

A primary responsibility of the District is to ensure an adequate quality and quantity of water supplies for growing community needs. Towards this goal, this Engineer's Report presents the results of studies in three major areas.

The first area is the assessment of future water needs; inherent to this study are the tasks of quantifying existing sources of supply, and assessing future community growth and water requirements. Taking into account that future technology may make other sources of water possible and desirable, the District selected a reasonable low estimate of future population growth as determined by the County Planning Department in May 1972; this is the growth rate to which future water supplies are matched in this report.

The second area of study evaluates ways of meeting the supplemental water needs established in the first section. The report compares the various importation alternatives such as obtaining additional water from the State Water Project, building a conveyance system parallel to the existing South Bay Aqueduct; and pursuing the construction of the San Felipe Division of the Central Valley Project. The report also evaluates alternatives of storing more local runoff in surface reservoirs, obtaining surplus water from Santa Clara County, and of reclaiming wastewater. In the final analysis, the report concludes that the San Felipe Project is the most viable alternative for meeting the County's future water demands.

The third and final section of the report analyzes the various alternatives available for the treatment and distribution of water from the San Felipe Project. It describes the mathematical modelling process used and recommends the additional facilities which would allow for the most economical treatment and distribution of water within the County.

Appendix H: Re-Calculation of Analysis using 1965 Costs

Step 1: Determine weighted average of treated water plants, based on date placed in service, and apply to Additional Groundwater Only System Assets

TREATED WATER COSTS ONLY - USED to determine how to discount back GW assets

Year	Original Cost	Discounted to 1965 Costs
1965	$ 815,220	$ 815,220
1966	$ 1,369,623	$ 1,307,367
1967	$ 16,933,250	$ 15,460,793
1970	$ 5,796,147	$ 4,622,244
1972	$ 1,179,025	$ 798,694
1973	$ 989,115	$ 623,142
1974	$ 8,925,536	$ 4,725,284
1985	$ 3,797,756	$ 1,035,752
1988	$ 29,285,459	$ 7,439,451
1989	$ 57,971,170	$ 14,322,289
1991	$ 15,611,793	
1992	$ 1,416,565	
1993	$ 295,502	
1994	$ 1,746,703	
1995	$ 8,333,798	
1996	$ 14,284	
1997	$ 1,140,114	
1998	$ 11,027,510	
1999	$ 26,944,308	
2000	$ 1,814,222	
2001	$ 3,582,081	
2002	$ 785,735	
2003	$ 10,243,556	
2004	$ 2,690,409	
2005	$ 45,042,812	
2006	$ 17,316,231	
2007	$ 3,124,555	
2008	$ 112,597,115	
2009	$ 9,748,218	
2010	$ 157,217	
	$ 400,695,029	

Total Additional Costs for Predominately GW Only System (2010 costs) (1)
$891,221,280

	Summary of Treatment Plant Original Costs	% of Treatment Plant Costs by Year	HWI De-escalator (Source of Supply)	De-escalated assuming treatment plant dates placed in service
Rinconada - 1967	$ 19,118,093	34%	0.15505618	$ 47,503,910
Penitencia -1974	$ 16,889,822	21%	0.26741573	$ 50,178,180
Santa Teresa -1989	$ 91,054,385	45%	0.573033708	$ 227,617,235
	$ 127,062,301	100%		$ 325,299,325

(1) Total additional costs for Predominately GW only system are from Exhibit 11.

Appendix H: Re-Calculation of Analysis using 1965 Costs

Step 2: De-escalate O&M Costs (1)

Existing System		
Annual O&M Costs	Year	Actual/Discounted
$ 146,151,032	2009	Actual
$ 127,693,379	2008	Actual
$ 119,798,907	2007	Actual
$ 109,131,705	2006	Actual
$ 112,373,070	2005	Actual
$ 97,370,903	2004	Actual
$ 98,349,662	2003	Actual
$ 87,519,611	2002	Actual
$ 75,091,830	2001	Actual
$ 74,661,004	2000	Actual
$ 69,615,278	1999	Discounted
$ 64,910,552	1998	Discounted
$ 60,523,779	1997	Discounted
$ 56,433,472	1996	Discounted
$ 52,619,596	1995	Discounted
$ 49,063,468	1994	Discounted
$ 45,747,670	1993	Discounted
$ 42,655,960	1992	Discounted
$ 39,773,193	1991	Discounted
$ 37,085,248	1990	Discounted
$ 34,578,960	1989	Discounted
$ 32,242,051	1988	Discounted
$ 30,063,075	1987	Discounted
$ 28,031,358	1986	Discounted
$ 26,136,948	1985	Discounted
$ 24,370,566	1984	Discounted
$ 22,723,559	1983	Discounted
$ 21,187,860	1982	Discounted
$ 19,755,946	1981	Discounted
$ 18,420,803	1980	Discounted
$ 17,175,892	1979	Discounted
$ 16,015,114	1978	Discounted
$ 14,932,783	1977	Discounted
$ 13,923,599	1976	Discounted
$ 12,982,617	1975	Discounted
$ 12,105,228	1974	Discounted
$ 11,287,135	1973	Discounted
$ 10,524,330	1972	Discounted
$ 9,813,077	1971	Discounted
$ 9,149,891	1970	Discounted
$ 8,531,525	1969	Discounted
$ 7,954,949	1968	Discounted
$ 7,417,339	1967	Discounted
$ 6,916,062	1966	Discounted
$ 6,448,662	**1965**	**Discounted**

Existing System		
Annual O&M Costs	Year	Estimated/Discounted
$ 129,188,547	2009	Estimated
$ 116,022,292	2008	Estimated
$ 112,163,268	2007	Estimated
$ 99,912,281	2006	Estimated
$ 99,430,695	2005	Estimated
$ 89,030,596	2004	Estimated
$ 91,179,259	2003	Estimated
$ 83,495,308	2002	Estimated
$ 70,421,130	2001	Estimated
$ 70,374,306	2000	Estimated
$ 65,618,283	1999	Discounted
$ 61,183,681	1998	Discounted
$ 57,048,777	1997	Discounted
$ 53,193,317	1996	Discounted
$ 49,598,416	1995	Discounted
$ 46,246,466	1994	Discounted
$ 43,121,046	1993	Discounted
$ 40,206,847	1992	Discounted
$ 37,489,596	1991	Discounted
$ 34,955,981	1990	Discounted
$ 32,593,592	1989	Discounted
$ 30,390,858	1988	Discounted
$ 28,336,989	1987	Discounted
$ 26,421,924	1986	Discounted
$ 24,636,283	1985	Discounted
$ 22,971,318	1984	Discounted
$ 21,418,875	1983	Discounted
$ 19,971,348	1982	Discounted
$ 18,621,648	1981	Discounted
$ 17,363,164	1980	Discounted
$ 16,189,730	1979	Discounted
$ 15,095,598	1978	Discounted
$ 14,075,411	1977	Discounted
$ 13,124,169	1976	Discounted
$ 12,237,214	1975	Discounted
$ 11,410,201	1974	Discounted
$ 10,639,079	1973	Discounted
$ 9,920,070	1972	Discounted
$ 9,249,654	1971	Discounted
$ 8,624,546	1970	Discounted
$ 8,041,683	1969	Discounted
$ 7,498,212	1968	Discounted
$ 6,991,469	1967	Discounted
$ 6,518,973	1966	Discounted
$ 6,078,409	**1965**	**Discounted**

Note: (1) De-escalated using the actual annual increase in Source of Supply O&M costs from FY 2000 to 2009, of 6.8%.

Appendix H: Re-Calculation of Analysis using 1965 Costs

Step 3: De-escalate All Fixed Assets (2)

Original costs of Assets in Year Placed in Service (Fixed Asset Records)

Existing System

	TOTALS	< 1965	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Fixed Assets	$ 607,311,627	$ 44,989,774	$ 831,647	$ 24,169,153	$ 17,007,951	$ 769,426	$ 3,814,278	$ 5,796,147	$ -	$ 1,179,025	$ 989,115	$ 8,925,536

Predominately GW	TOTALS	< 1965	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
GW	$ 44,989,774	$ 44,989,774										
GST	$ 149,451,790		$ 16,427	$ 22,799,530	$ 74,701	$ 769,426	$ 3,814,278					
Treated mains	$ 86,507,372		$ 815,220					$ 5,796,147				
Recycled Water	$ 3,404,117											
Additional GW assets (1)	$ 325,299,325				$ 47,503,910							$ 50,178,180
Total Predominately GW	$ 609,652,379	$ 44,989,774	$ 831,647	$ 22,799,530	$ 47,578,611	$ 769,426	$ 3,814,278	$ 5,796,147	$ -	$ -	$ -	$ 50,178,180

Discounted back to 1965			1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
			0	1	2	3	4	5	6	7	8	9
			100%	95%	91%	88%	84%	80%	74%	68%	63%	53%
Existing System	**$ 196,751,498**	$ 44,989,774	$ 831,647	$ 23,070,555	$ 15,528,999	$ 673,248	$ 3,203,994	$ 4,622,244	$ -	$ 798,694	$ 623,142	$ 4,725,284
Predominatley GW Only System	**$ 246,759,366**	$ 44,989,774	$ 831,647	$ 21,763,188	$ 43,441,341	$ 673,248	$ 3,203,994	$ 4,622,244	$ -	$ -	$ -	$ 26,564,919

Note: (1) The timing of the Additional Groundwater Only System assets are based on the actual dates the treated water assets were placed in service, and are discounted back using the actual dates treated water plants were placed in service, as shown in Step 1 of Appendix H.

Note (2) All of the assets have been discounted back to 1965 using the Handy Whitman Index.

Appendix H: Re-Calculation of Analysis using 1965 Costs

Step 3: De-escalate All Fixed Assets (continued) (2)

Original costs of Assets in Year Placed in Service (Fixed Asset Records)

Existing System	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Fixed Assets	$ -	$ 365,840	$ -	$ 17,775	$ -	$ -	$ -	$ 217,447	$ -	$ -	$ 26,681,689

Predominately GW	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
GW											
GST		$ 365,840		$ 17,775				$ 217,447			$ 22,883,932
Treated mains											$ 3,797,756
Recycled Water											
Additional GW assets (1)											
Total Predominately GW	$ -	$ 365,840	$ -	$ 17,775	$ -	$ -	$ -	$ 217,447	$ -	$ -	$ 26,681,689

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Discounted back to 1965	10	11	12	13	14	15	16	17	18	19	20
	47%	45%	43%	39%	36%	32%	31%	30%	29%	28%	27%
Existing System	$ -	$ 164,628	$ -	$ 6,955	$ -	$ -	$ -	$ 64,925	$ -	$ -	$ 7,276,824
Predominatley GW Only System	$ -	$ 164,628	$ -	$ 6,955	$ -	$ -	$ -	$ 64,925	$ -	$ -	$ 7,276,824

Note: (1) The timing of the Additional Groundwater Only System assets are based on the actual dates the treated water assets were placed in service, and are discounted back using the actual dates treated water plants were placed in service, as shown in Step 1 of Appendix H.

Note (2) All of the assets have been discounted back to 1965 using the Handy Whitman Index.

Appendix H: Re-Calculation of Analysis using 1965 Costs

Step 3: De-escalate All Fixed Assets (continued) (2)

Original costs of Assets in Year Placed in Service (Fixed Asset Records)

Existing System	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Fixed Assets	$ -	$ -	$ 29,285,459	$ 60,676,102	$ 9,583,134	$ 39,378,109	$ 1,506,250	$ 1,087,664	$ 4,224,480	$ 14,670,327	$ 105,412

Predominately GW	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
GW											
GST					$ 9,583,134	$ 21,579,207	$ 89,685	$ 792,162	$ 2,477,553	$ 6,336,529	$ 91,127
Treated mains			$ 29,285,459			$ 8,019,090	$ 1,407,954	$ 282,327		$ 106,432	
Recycled Water						$ 1,681,533			$ 224		
Additional GW assets (1)				$ 227,617,235							
Total Predominately GW	$ -	$ -	$ 29,285,459	$ 227,617,235	$ 9,583,134	$ 31,279,831	$ 1,497,639	$ 1,074,490	$ 2,477,777	$ 6,442,961	$ 91,127

Discounted back to 1965	21	22	23	24	25	26	27	28	29	30	31
	27%	26%	25%	25%	24%	24%	24%	23%	22%	22%	21%
Existing System	$ -	$ -	$ 7,439,451	$ 14,990,566	$ 2,331,033	$ 9,578,459	$ 360,813	$ 250,083	$ 927,325	$ 3,165,173	$ 22,285
Predominatley GW Only System	$ -	$ -	$ 7,439,451	$ 56,234,846	$ 2,331,033	$ 7,608,607	$ 358,750	$ 247,054	$ 543,902	$ 1,390,091	$ 19,265

Note: (1) The timing of the Additional Groundwater Only System assets are based on the actual dates the treated water assets were placed in service, and are discounted back using the actual dates treated water plants were placed in service, as shown in Step 1 of Appendix H.

Note (2) All of the assets have been discounted back to 1965 using the Handy Whitman Index.

Appendix H: Re-Calculation of Analysis using 1965 Costs

Step 3: De-escalate All Fixed Assets (continued) (2)

Original costs of Assets in Year Placed in Service (Fixed Asset Records)

Existing System	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fixed Assets	$ 3,363,534	$ 14,799,062	$ 38,272,226	$ 2,424,444	$ 10,190,953	$ 850,441	$ 14,265,968	$ 3,658,341	$ 47,056,920	$ 30,339,150	$ 21,319,723	$ 112,613,061	$ 11,728,848

Predominately GW	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
GW													
GST	$ 573,051	$ 2,847,733	$ 10,632,588	$ 11,613	$ 6,436,007		$ 2,874,141	$ 961,119	$ 291,748	$ 12,777,150	$ 18,172,189	$ 15,946	$ 1,949,749
Treated mains		$ 10,156,036	$ 13,945,449		$ 1,655,072			$ 11,150	$ 171,455	$ 5,067,187		$ 3,478,893	$ 2,511,745
Recycled Water									$ 1,722,361				
Additional GW assets (1)													
Total Predominately GW	$ 573,051	$ 13,003,769	$ 24,578,036	$ 11,613	$ 8,091,079	$ -	$ 2,874,141	$ 972,269	$ 2,185,564	$ 17,844,337	$ 18,172,189	$ 3,494,838	$ 4,461,494

Discounted back to 1965	32	33	34	35	36	37	38	39	40	41	42	43	44
	20%	20%	20%	19%	19%	19%	18%	18%	17%	16%	15%	15%	14%
Existing System	$ 685,769	$ 2,988,272	$ 7,558,465	$ 467,095	$ 1,928,018	$ 158,047	$ 2,612,663	$ 641,993	$ 7,801,542	$ 4,851,184	$ 3,275,957	$ 16,460,842	$ 1,675,550
Predominatley GW Only System	$ 116,836	$ 2,625,761	$ 4,853,970	$ 2,237	$ 1,530,745	$ -	$ 526,369	$ 170,621	$ 362,343	$ 2,853,282	$ 2,792,312	$ 510,846	$ 637,356

Note: (1) The timing of the Additional Groundwater Only System assets are based on the actual dates the treated water assets were placed in service, and are discounted back using the actual dates treated water plants were placed in service, as shown in Step 1 of Appendix H.

Note (2) All of the assets have been discounted back to 1965 using the Handy Whitman Index.

APPENDIX I: District Staff's Agriculture versus M&I Water Use Analysis

Santa Clara Valley Water District

MEMORANDUM

FC 14 (01-02-07)

TO: Darin Taylor

FROM: Barbara Judd

SUBJECT: Agriculture Water Use Benefits

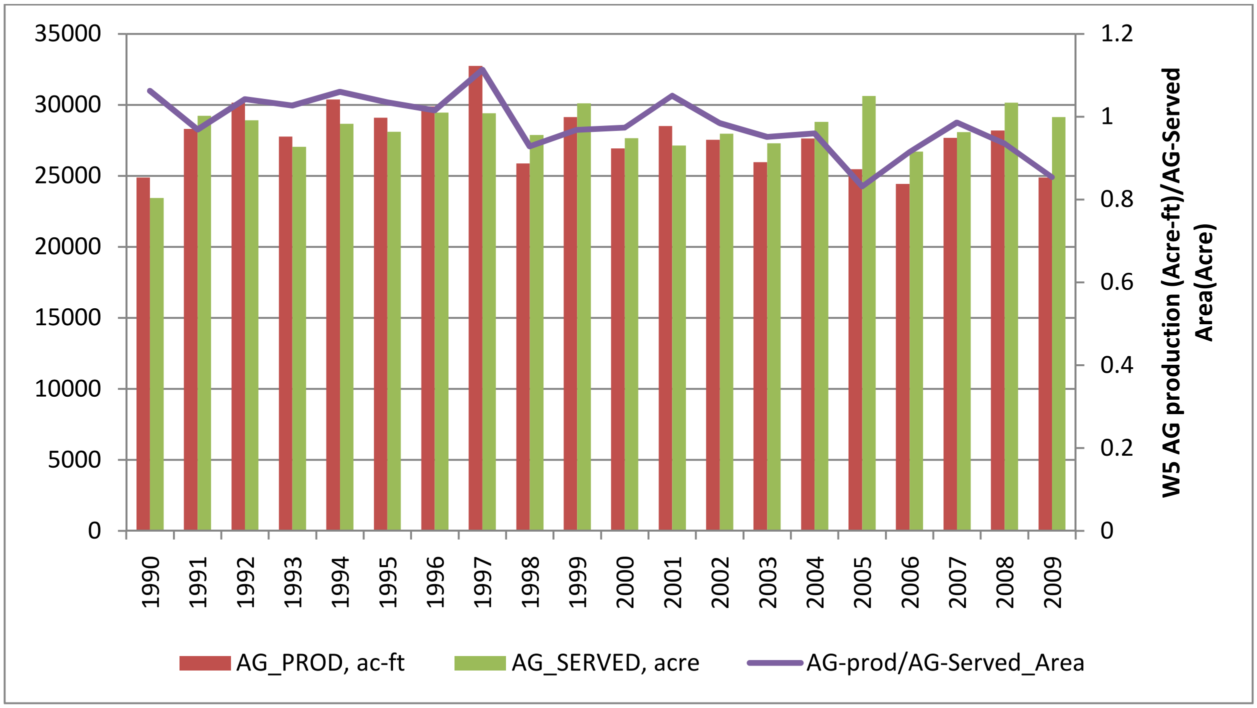
DATE: September 23, 2010

At our Conjunctive Use Benefit Study Meeting of September 10th, item 5b was discussion on how to value the benefit to M&I users of agricultural water use. This memorandum summarizes Groundwater Unit work in response to that discussion.

Approach

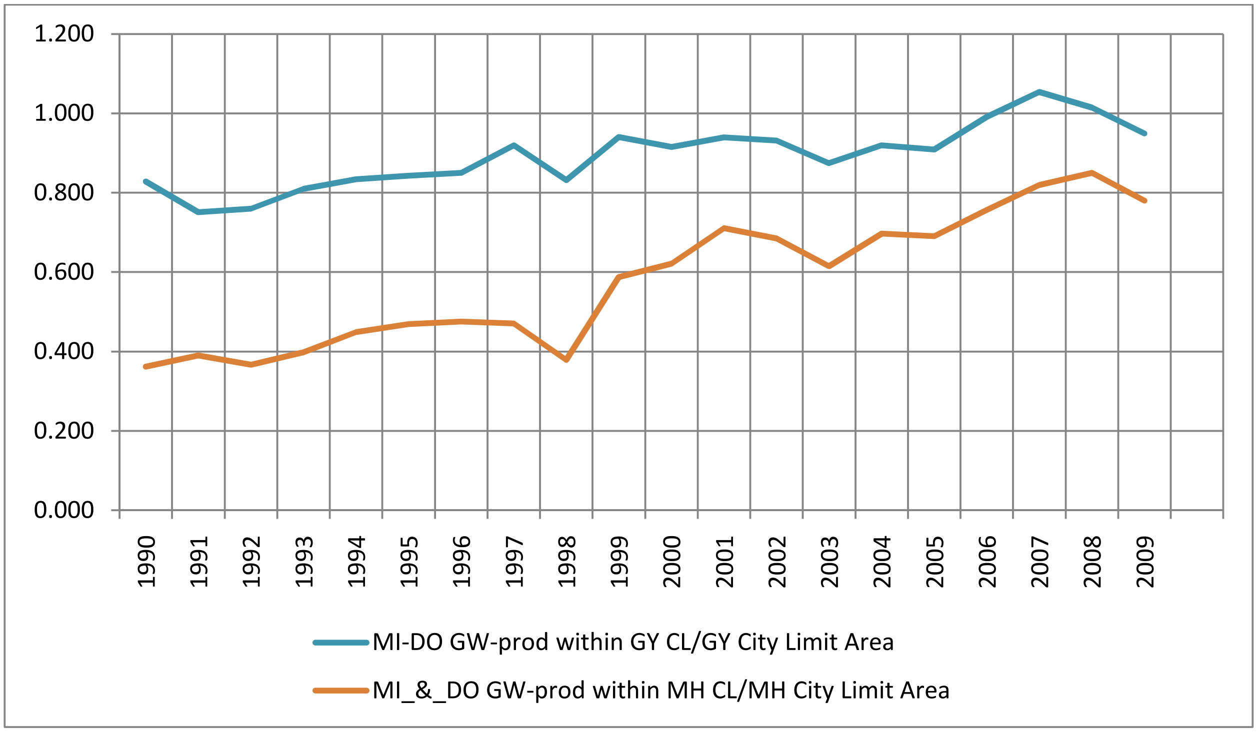
We pulled water use data for zone W-5 from the most authoritative source I know of, the District WRIS database. This system includes the groundwater production data used for customer billing. The database includes an acres-served field as well as groundwater production for each customer use record. The Zone W-5 agricultural groundwater production, acres served, and the per-unit water use coefficient (water use divided by acres served) for the past twenty years are shown in Figure 1.

Figure 1. Charge Zone W-5 Agricultural Water Use Coefficients (in acre-feet per acre)



We pulled groundwater production data for the Morgan Hill and Gilroy areas from WRIS as well. In this case, we included pumping by both the city's water retailer department as well as any "non-agricultural" water groundwater use within that city's city limit. For WRIS, non-agricultural water users are exactly as it sounds – any use other than agricultural use, such as domestic uses and other M&I uses. We used the District's GIS layer showing city limits to determine the number of acres, and then divided the groundwater production by the acres within the city limit. The per-unit water use coefficient for the past twenty years for both Morgan Hill and Gilroy are shown in Figure 2.

Figure 2. Groundwater Charge Zone W-5 M&I Water Use Coefficients (in acre-feet per acre)



<u>Computational Results</u>

The per acre water use coefficients aren't what I was expecting. Using the approach above, we came out with af/ac coefficients for Morgan Hill and Gilroy of 0.9 af/ac and 0.6 af/ac respectively. The average for both is about 0.7 af/ac. I think our quick approach to the areas served is suspect – the city limits include undeveloped land and the like. I have no feel for how much a difference that would make, but I don't think the coefficients we got are credible.

Using the WRIS agricultural water use divided by the reported agricultural acreage in WRIS gave an agricultural coefficient of about 1.0 (0.98 to be more precise). That seems off to me as well. The District's water metering program prioritizes the largest users, so most of the agricultural water use is metered even though most of the agricultural customers are not. The acreage served is self-reported, however, and I don't know how accurate those estimates are.

<u>Reality Checking</u>

I wanted to reality check our coefficients, so I looked in some commonly used references. DWR Bulletin 160-93, otherwise known as the California Water Plan, has a table of unit applied water factors for different categories of crops by Hydrologic Region (Figure 3). Llagas Subbasin, where most of our agricultural users are found, would be in the Central Coast (CC) hydrologic region. I don't know if the more recent Water Plans have updated coefficients – I doubt they would have changed significantly, and this table was easier to find in B160-93.

Figure 3. Bulletin 160-93 Ranges of Unit Applied Water for Agriculture in acre-feet/acre

Table 7-7. Ranges of Unit Applied Water for Agriculture by Hydrologic Region
(acre feet/acre per year)

Crop	NC	SF	CC	SC	SR	SJ	TL	NL	SL	CR
Grain	0.3-2.3	0.3-0.4	0.5-1.0	0.5-1.0	0.6-2.5	0.6-1.3	1.0-1.8	2.1-2.4	1.0-1.0	2.0-3.6
Rice	3.2-3.7	—	—	—	4.0-7.9	6.7-7.9	—	—	—	—
Cotton	—	—	—	—	—	3.1-3.3	3.0-3.3	—	—	4.1-5.5
Sugar beets	3.2-3.7	2.0-2.9	2.0-3.8	2.9-2.9	2.8-4.4	3.8-4.4	3.0-3.6	—	—	4.2-4.2
Corn	1.4-2.8	2.3-2.3	1.5-2.9	1.9-2.3	2.4-3.5	2.6-2.9	2.4-3.6	2.7-2.7	4.0-4.0	2.1-4.0
Other field	1.3-3.0	2.0-2.5	0.9-2.5	0.8-3.1	1.8-2.9	1.8-2.9	2.1-3.2	—	3.7-3.7	2.9-5.2
Alfalfa	2.0-3.5	2.6-3.3	2.6-4.0	4.2-4.5	2.6-4.9	3.8-4.9	3.7-4.8	3.2-3.4	5.5-8.0	6.8-9.4
Pasture	1.9-4.0	3.4-4.4	2.6-4.0	4.5-5.4	3.9-6.1	3.8-6.2	3.7-4.8	2.9-2.9	5.5-8.0	7.9-9.4
Tomatoes	—	2.4-2.4	1.7-3.3	3.0-3.0	2.6-3.5	2.7-3.5	3.1-3.4	—	—	4.3-6.4
Other truck	1.3-2.7	1.7-2.5	0.9-2.7	1.9-2.5	0.7-2.7	1.7-2.9	1.8-2.3	2.4-2.6	2.5-2.5	2.9-7.7
Almonds/pistachios	—	—	—	—	2.6-3.6	2.6-3.4	2.7-3.3	—	—	—
Other deciduous orchard	2.8-3.0	2.0-3.2	1.0-3.4	2.9-2.9	2.6-4.2	3.1-4.2	2.6-3.9	—	3.8-3.8	5.9-6.3
Subtropical orchard	—	—	1.0-2.5	2.1-2.3	2.4-2.9	2.4-2.5	1.7-2.2	—	3.5-3.5	4.2-5.9
Grapes	0.9-0.9	1.0-1.4	1.0-2.5	1.5-1.9	1.3-3.1	1.8-3.0	2.5-2.9	—	3.7-3.7	4.1-5.1

Note: Truck crops may reach higher annual unit applied water values when double or triple cropping occurs.

DWR Bulletin 113-3 also had some general applied water coefficients for the central coast as show in Figure 4. This bulletin is an often-cited source of information on agricultural water use. The South Bay subarea as defined in this document includes the Llagas subbasin.

Figure 4. Bulletin 113-3 Vegetative Water Use Applied Water Coefficients in acre-feet/acre

Table 30. ESTIMATED APPLIED WATER FOR PRINCIPAL CROPS - CENTRAL COAST, INTERIOR VALLEYS
In acre-feet/acre

Crop	Major Subarea								
	South Bay			Northern			San Luis Obispo & Santa Barbara		
	Average	High	Low	Average	High	Low	Average	High	Low
Alfalfa (Hay)	3.4	-	-	3.5	-	-	-	6.4	3.4
Barley 1/	-	-	-	-	-	-	-	1.0	0.8
Deciduous Orchard	2.8	-	-	2.5	-	-	-	3.0	2.1
Field (Misc.)	2.7	-	-	2.8	-	-	-	2.6	1.4
Pasture (Improved)	3.4	-	-	3.2	3.9	2.6	-	6.4	3.4
Subtropical Orchard	-	-	-	-	-	-	-	2.3	2.1
Sugar Beets	-	-	-	3.3	3.7	-	-	-	-
Tomatoes (Canning)	-	-	-	2.2	2.8	1.7	-	-	-
Truck (Misc.)	2.3	-	-	1.8	2.2	1.1	-	2.5	1.8
Vineyard (Wine grapes)	0.8	-	-	1.1	1.3	0.5	-	1.4	1.0

1/ Barley and small grains

As for District documents, the District's 1993 Water Needs study used 1.8 af/ac for agriculture, while the 1997 South Santa Clara County Historical Water Supply and Use Report used B113-3 coefficients for estimating historical agricultural water use.

These sources all estimate agricultural water use coefficients as on the order of 2 to 3 acre-feet per acre, not the 1.0 we got from our computations using the WRIS data. Be aware that if we were to use any of these sources computationally, I would want to be a little more thorough on sources and give more thought to which type of agricultural coefficient is most appropriate for comparing to urban water use (i.e., ET, ET of applied water, and what the assumptions should be on irrigation efficiency).

As for M&I use, *Water and Land Use : Planning Wisely for California's Future* by Johnson and Loux has a table of average unit demands for a moderate climate. Table 4-1 in that text shows 1.9 and 4.9 af/ac for medium and high density residential, respectively. They have several categories for Commercial/Industrial and Public uses too, but I want to be somewhat brief here – the range is considerably larger, from 0.5 to 4.8 or more depending on the nature of the business or public area.

Based on the quick document search, if agriculture is compared to medium density residential, it is about a wash. If it goes high density, that would be another matter, but most of W-5 is residential is medium density or lower I believe.

<u>Conclusion</u>

Based on the reality checking, I did not see a benefit in trying to refine and correct our computations of per unit water use coefficients for agriculture and M&I uses at this time. We could refine those computations, as well as prepare a more robust literature search to be sure we are extracting the most appropriate published coefficients for our analysis. However, I am not confident that doing so would produce anything substantive supporting the current agricultural groundwater charges from a cost of water service perspective.

Appendix J: Acronyms

AF – Acre Feet

AG – Agriculture

CVP – Central Valley Project

GST – Groundwater, surface water, treated water

M&I – Municipal & Industrial

O&M – Operations and maintenance

RW – Recycled water

SWP- State Water Project

T – Treatment

T&D – Transmission and distribution

WACC – Weighted average cost of capital

WTP – Water treatment plant