Santa Clara Valley Water District

2016

Infrastructure Reliability Plan

AECOM

6/30/2016

About the Santa Clara Valley Water District

The Santa Clara Valley Water District is the primary water resources agency for Santa Clara County, California. It acts not only as the county's water wholesaler, but also as its flood protection agency and is the steward for its streams and creeks, underground aquifers and District- built reservoirs.

As the county's water wholesaler, the District makes sure there is enough clean, safe water for homes, businesses and agriculture. As the agency responsible for local flood protection, the District works diligently to protect Santa Clara Valley residents and businesses from the devastating effects of flooding.

Our stream stewardship responsibilities include creek restoration and wildlife habitat project, pollution prevention efforts and a commitment to natural flood protection.

The mission of the District is to provide Silicon Valley safe, clean water for a healthy life, environment, and economy.

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Executive Summary

The Santa Clara Valley Water District (District) undertook preparation of the 2016 Infrastructure Reliability Plan (IRP) in order to identify a combination of capital and operational improvements that would provide reliable water service to present and future, raw and treated water customers in Santa Clara County during a range of emergency events. The objective of the IRP was to ensure that the District's water supply infrastructure is reliable under a range of hazards.

This report presents the findings of the IRP project with regard to existing system reliability and redundancy, potential outage scenarios, vulnerable facilities and regions, and recommended improvement projects. It summarizes a multi-year effort to review and evaluate the District's water supply system. The main body of the report summarizes major information and findings, while the appendices provide detailed supporting information. Eleven tasks, described in detail in **Chapter 1**, were executed and a technical memorandum (TM) was created to summarize the findings of each task.

This project is an update to the District's 2005 Water Infrastructure Reliability Project (2005 WIRP). The 2005 WIRP evaluated the performance of the District's system during a range of hazards, established a level of service (LOS) goal for District treated water following an emergency event, and identified potential improvement projects that would reduce system vulnerability. The purpose of this 2016 update is to:

- Review outage scenarios and update the reliability LOS goal
- Evaluate more regional, less capital intensive alternatives to the well fields proposed in the previous 2005 WIRP
- Identify projects that provide multiple benefits for added reliability, increased capacity and operational flexibility, and new treated or groundwater service connections

The general methodology that was used to identify system shortfalls and project opportunities is shown in **Figure ES-1**. Ultimately, the IRP identified projects to improve the reliability of the District system and enhance life safety for District customers. The recommended projects represent the culmination of a process that balanced capital planning methodologies, qualitative engineering judgement, quantitative analyses, customer recommendations, and stakeholder input.

Figure ES-1. Overview of 2016 IRP Process

Discussions with District management and retailers led to an understanding that high investment levels could result in system performance beyond what is needed, and may not be affordable. **There was a consensus among retailers that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level, while providing sufficient system reliability and performance.** The final recommended project portfolios meet the objectives of the IRP in a cost-effective manner, support new LOS goals identified during the project, and support other water supply interests, such as groundwater management and operational flexibility.

System Overview

The District's water supply system is comprised of storage, conveyance, recharge, treatment, and distribution facilities that include local reservoirs, groundwater sub-basins, out-of-county groundwater banking, groundwater recharge facilities, treatment plants, imported supply, and raw and treated water conveyance facilities (see **Figure 1** in **Chapter 1**). Maintaining public health and safety and ensuring the reliable operation of critical facilities following natural catastrophes and other system risks are fundamental objectives of the District. The IRP is an essential component to assessing and decreasing these risks.

The District delivers treated water to seven retail customers (retailers), and manages groundwater within the subbasin for three groundwater-only retailers. The ten retailers own and operate their own water system facilities including reservoirs, treatment plants, wells, tanks, and distribution systems. Following is the list of District retail customers:

- California Water Service Company (Cal Water)
- City of Gilroy (Gilroy)
- Great Oaks Water Company (Great Oaks)
- City of Milpitas (Milpitas)
- City of Morgan Hill (Morgan Hill)
- City of Mountain View (Mountain View)
- City of San Jose (San Jose Muni)
- San Jose Water Company (SJWC)
- City of Santa Clara (Santa Clara)
- City of Sunnyvale (Sunnyvale)

Although they do not receive District treated water or regularly use groundwater, the City of Palo Alto, Stanford University, and Purissima Hills Water District are located within the District's service area and were also included in the study.

Outage Scenarios

The goal of the IRP was to develop scenarios that captured a range of District planning objectives, and provide a reasonable "stress test" by which to measure District system performance and project improvements, and set performance goals. Outage scenarios were intended to reflect relevant hazards to the District for the purposes of measuring system performance with respect to water supply and delivery.

The selected outage scenarios were used in subsequent modeling tasks of the IRP to identify specific facility outage scenarios and to determine the impacts on potable water service. **The final selected outage scenarios include:**

- **Earthquake scenarios (two for San Andreas earthquake[1], one for Calaveras earthquake)**
- **Extreme Storm event**
- **Delta outages (6-month short-term outage, 24-month long-term outage)**
- **Regional power outage**

LOS and System Performance

For the purposes of the IRP, LOS objectives represented performance standards or targets for which the District's system may strive to reach under various outage scenarios. ***This project considered one minimum winter month demand (February) as representing basic service and the base demand target for treated water delivery after a major disaster event.*** A range of preliminary LOS objectives (water delivery targets and restoration times) were considered for potential District system performance targets under various outage scenarios. An increase in the level of performance corresponded to increases in level of investments.

Modeling and analyses were used to quantify District system capabilities and to determine the restoration time for recovery with its current baseline system and planned capital improvements in place. The analysis determined how long it would take to restore retailer demands partially (winter demands) or in full (average demands) to the East and West treated water systems, and to restore critical managed recharge operations in the three earthquake scenarios and the extreme storm scenario. Additionally, a pipe damage analysis was conducted to identify the vulnerable sections of District transmission pipeline to target for improvements. A risk exposure assessment was also carried out in order to identify the District facilities that are most susceptible to failure.

For the Earthquake and Extreme Storm outage scenarios, the results of modeling and analyses demonstrated that, in the worst case scenario, the expected outage time before the District can provide minimum treated water demands to retailers is approximately 30 days. For less severe events,

[1] *One San Andreas earthquake scenario with damages primarily on the West treated water system, one San Andreas earthquake with damages primarily on the East treated water system.*

the expected outage time before minimum demands can be restored is only approximately 4 days. The recovery times for the District to provide average treated water demands to retailers are considerably longer, ranging from approximately 14 days to approximately 75 days.

For both the short-term (6-month) and long-term (24-month) Delta outage scenarios, the results of modeling and analyses demonstrated that the District can continue limited service (with an assumed 20% reduction in demand) for the outage durations with no imported water supplies. For the regional power outage, it was determined that the District can operate facilities on backup fuel storage for an estimated 3 to 10 days, depending on the time of year and operating conditions. The District could operate on backup power for longer periods given regular external fuel deliveries.

The project analyzed the availability of backup supplies for each retailer and looked for regional redundancies. Retailer service areas that can access other supplies to replace District treated water during a service interruption were identified. ***This effort found that many retailer service areas that are primarily served by District treated water have one or more backup supplies available, such as groundwater wells, interties, and San Francisco Public Utilities Commission (SFPUC) water supply.***

Specific critical areas that may have more difficulty withstanding potential outage durations include:

- **California Water Service Company – Vallco turnout area**
- **City of Milpitas – Milpitas turnout area**
- **City of Morgan Hill – all areas**
- **City of Mountain View – Zone 3 (Miramonte) area**
- **City of San Jose – Evergreen service area**
- **City of Santa Clara – Zone 2A (Serra Tank) area**

This effort found that improvement projects that target specific service areas may efficiently address the existing reliability issues.

Building Portfolios and Recommendations

The strengths and deficiencies in system performance under each outage scenario were used to develop strategies for reliable water supply and delivery after a disaster event. Improvement projects that help address the District's system reliability needs were identified and a project evaluation methodology was developed to refine a large list of potential improvement projects and opportunities into three final recommended project portfolios:

- Operations Only
- $10 Million Capital Improvement Program (CIP)
- $100 Million CIP

Three levels of screening were conducted to determine which projects efficiently provide the greatest benefits to system reliability while also being cost-effective and feasible. The analyses included two stages of cost estimates (generic and project-specific), which aided in the portfolio refinement process. **Chapter 5** presents the results of project analyses, culminating in final recommended project portfolios.

Potential opportunities were identified and discussed throughout the project, and via meetings, workshops, and specific information gathering efforts. ***Important concepts that have been incorporated in the identification of project opportunities and are reflected in the analysis methodology are listed below.***

Table ES-1. Project Analysis Guiding Concepts

Concept	Description
Incorporate recent operational knowledge	Recent events impacting District services, such as planned and unplanned maintenance outages of District pipelines and treatment plants, and drought conditions, have led to more knowledge regarding alternate operational schemes.
Account for backup supply redundancy	Many retailer service areas have sufficient backup supply redundancy and may not require large investments in additional reliability.
Address specific vulnerable areas	There are specific retailer service areas that are more vulnerable to outages of District treated water. Reliability in these specific areas may be effectively improved with lower cost, localized solutions, rather than major infrastructure improvements.
Consider raw water and treated water system interdependencies	Strengthening the District's treated water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant raw water system damage. Likewise, the inverse applies as well, as strengthening the District's raw water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant treated water system damage.
Leverage existing investments	Where possible and beneficial, leveraging existing assets is preferred, as the District, retailers, and SFPUC have made significant investments in increasing system reliability and operational flexibility since the last 2005 WIRP study.
Favor frequently used assets	Assets, particularly groundwater wells, which can be utilized more frequently to enhance daily operations or periodic maintenance operations, are preferred over assets that would be designated as standby for infrequent use only during major emergencies.

The final recommended projects are listed in **Table ES-2**. The projects are designated as District, retailer, or joint projects depending on which agency would lead the implementation. Projects on District facilities would be implemented by the District, while projects located within retailer service areas would generally be implemented by the respective retailers. In some cases, the project can be considered a joint project, meaning that the District and retailer would share the responsibility of implementation. Joint projects benefit both retailer and District systems and provide additional operational flexibility.

Table ES-2. Recommended Projects

Portfolio	Project #	Project Name/Description
Operations Only	1	Water Wheeling Study – Interagency use of District pipelines between customer turnouts
	2	Retailer Intertie Study – Test capabilities and capacities of interagency interties
	3	Lift operational restrictions on San Jose Muni Evergreen groundwater wells
	4	Disinfection for San Jose Muni Evergreen groundwater wells
	5	Equipment to utilize existing interties between San Jose Muni Evergreen and SJWC
	6	Upgrade intertie between San Jose Muni Evergreen and Edenvale service areas
$10M CIP	7	New Great Oaks service connection on Snell Pipeline to feed excess groundwater
	8	New groundwater well near Santa Clara Serra Tank in Zone 2A
	9	New groundwater well at Mountain View Miramonte Tank in Zone 3
	10	New groundwater well(s) at existing Milpitas site(s)
	11	New groundwater well(s) at Cal Water Vallco turnout area
	12	New groundwater well(s) at Existing Cal Water sites in western service area
	13	New groundwater well(s) in Evergreen at new San Jose Muni sites
	14	New groundwater well(s) near East Pipeline at new San Jose Muni sites
	15	Develop additional and upgrade existing interties for Cal Water
	16	New intertie between San Jose Muni Evergreen and Great Oaks
	17	Upgrade two existing interties between Great Oaks and SJWC
	18	Install two new isolation valves on Milpitas Pipeline
	19	Install three new isolation valves on West Pipeline
$100M CIP	20	Replace critical and vulnerable sections (~25,000 LF) of Almaden Valley Pipeline

	District Project
	Joint Project
	Retailer Project

Additional recommendations were identified throughout the project to improve District resilience and recovery capabilities. These are not specific projects, and can be included in existing programs:

- Continue to plan recharge operations in critical areas during drought or other outages. In particular, upcoming improvements to Main and Madrone pipelines will support quicker restoration of critical recharge to the raw water turnouts in Morgan Hill.
- Continue emergency response planning
- Continue pipeline inspection and rehabilitation projects
- Address seismic and climate vulnerabilities through long-term asset replacements
- Consider practice of isolation valves immediately upstream/downstream service connections
- Continue coordination with District groundwater subcommittee to ensure appropriate practices
- Develop communications plans for water conservation messaging after hazard events

Conclusion

The District water utility system faces a variety of hazard conditions, which could lead to outages of treated water service and critical recharge. This study evaluated District system performance in several selected outage scenarios. Based on results of the analyses, the District currently meets a LOS for providing treated water at minimum demands within approximately 30 days or less, and critical recharge within approximately 75 days or less[1]. Utilizing information gathered via stakeholder meetings and workshops, this study also evaluated system capabilities with respect to regional redundancies and backup supplies. The study found that most areas of the county have sufficient backup supplies or redundancy to withstand a District service outage; however, specific service area vulnerabilities were identified. These can be more efficiently addressed by smaller localized projects, rather than major system infrastructure improvements. Project opportunities to enhance reliability for these service areas and the system overall were developed and screened. Stakeholders agreed on an investment level with corresponding recommended projects that would allow retailers to better tolerate these District service outages. These projects, shown above in **Table ES-2**, may also reduce the District service outage durations, thus improving the District's LOS. This study endorses implementation of these recommendations in the interest of enhancing District and retailer system reliabilities and life safety for their customers.

[1] *Note these are modeled outage durations based on modeling assumptions. In actual hazard events, outages may be longer or shorter depending on actual facility damage.*

Santa Clara Valley Water District

Infrastructure Reliability Plan

Chapter 1 Introduction

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1 INTRODUCTION

The Santa Clara Valley Water District (District) undertook preparation of the 2016 Infrastructure Reliability Plan (IRP) in order to identify a combination of capital and operational improvements that would provide reliable water service to present and future, raw and treated water customers in Santa Clara County during a range of emergency events. These improvements would meet the objectives of the IRP in a cost-effective manner, support new LOS goals identified during the project, and support other water supply interests, such as groundwater management and operational flexibility.

1.1. Summary

The objective of the District's 2016 IRP was to ensure that the District's water supply infrastructure is reliable under a variety of outage scenarios (emergency or hazard events). The project used hazard categories to identify specific facility outage scenarios, and to test and evaluate performance of the District system during an outage scenario. Ultimately, the IRP identified projects with the goal of improving the reliability of the District system and enhancing life safety for District customers. The recommended projects represent the culmination of a process that balanced capital planning methodologies, qualitative engineering judgement, quantitative analyses, customer recommendations, and stakeholder input.

The goal of the project was to examine and improve District water supply and service in the interest of system reliability and life safety.

This report summarizes a multi-year effort to review and evaluate the District's water supply system. The main body of the report summarizes major information and findings, while the appendices provide detailed supporting information. Throughout the report, blue text boxes reference where additional information can be found in the Appendices, and magenta text boxes are used to emphasize key information. Eleven tasks, described in detail later in this chapter, were executed and a technical memorandum (TM) was created to summarize the findings of each task.

1.2. 2005 Water Infrastructure Reliability Project

This project is an update to the District's 2005 Water Infrastructure Reliability Project (2005 WIRP). The 2005 WIRP evaluated the performance of District facilities during a range of hazard events. It found that the worst case scenario for the District's system is a magnitude

2005 WIRP LOS Goal

District potable water service at an average winter flow rate to at least one turnout per retailer in 7-14 days following a hazard event.

7.9 San Andreas earthquake in which the system could suffer up to a 60 day outage. The 2005 WIRP established a LOS goal for District potable water service following a hazard event and identified potential improvement projects that would reduce the vulnerability of the District system.

Task 3 TM includes:

- A summary of the recommended Baseline Portfolio, and Portfolios 1 and 2 from the 2005 WIRP
- The portfolio projects that have been completed by the District since the 2005 WIRP, as well as projects that are currently in progress or have been cancelled

The potential improvement projects were combined into groups of projects called "portfolios" that provided different LOSs at different costs. The project identified six different portfolios that included operational and capital improvements to meet the LOS goal (**Table 1**). The portfolios were designed to be cumulative, with a baseline portfolio and six additional portfolios that could be implemented sequentially. The Baseline Portfolio only included operational changes and reduced the outage time from 60 to 30 days. Portfolio 1 implemented programmatic elements and smaller system fixes in order to ensure life safety and allow the District to respond and communicate more efficiently after a hazard event. It would not further reduce the outage time from 30 days. Portfolio 2 increased the reliability of the system and adds an additional groundwater source, which reduces the outage time to 7 to 14 days. The Task 3 TM summarizes the portfolios from the 2005 WIRP.

Table 1. 2005 WIRP Portfolio Results

Portfolio	Purpose	Cost[3] (rounded)	Average Outage Period[4]	Controlling Event Outage Period[4]
Current System	Maintain status-quo	-	30-45 days	45-60 days
Baseline Portfolio	Stockpiling pipe and materials and emergency planning	$8 M	14 days	30 days
Portfolio 1	Life safety, programmatic elements, small fixes	$32 M	14 days	30 days
Portfolio 2	Adding one reliable source of groundwater	$150 M	1 day	7-14 days
Portfolio 3	Adding ability to use water from Lexington Reservoir	$352 M	1 day	7-14 days
Portfolio 4	Adding ability to use water from Anderson Reservoir throughout the system	$443 M	1 day	7 days
Portfolio 5	Increasing reliability of State and Federal sources	$669 M	1 day	1-3 days
Portfolio 6	Adding ability to loop treated water to link the east and west sides of the system	$1.8 B	1 day	1-2 days

[1] Portfolio 6 was not modeled, since complete recovery was achieved in other portfolios and the portfolios are cumulative in nature. Minimum achievable outage period for Portfolio 6 is kept at 1-2 days for controlling San Andreas event due to system capacity limits and inability to meet increased demands from pipe breaks in retailer systems and fire following earthquakes.

[2] One turnout on each side of system for San Jose Water Company.

[3] Costs include operations and maintenance and inflation costs.

[4] Time to restore supply to at least one turnout per retailer at average winter demand. "Average Outage Period" refers to the Southern Hayward or Central Calaveras Earthquake Event. "Controlling Event Outage Period" refers to the San Andreas Earthquake Event.

The Portfolios were evaluated based on LOS (outage period), analysis of benefit-costs, appraisal of key indicators, and assessment of rate impact**. The 2005 WIRP team recommended Portfolio 2, which also included projects identified in the Baseline Portfolio and Portfolio 1, and consisted of a total of seventeen projects grouped into seven project categories. This portfolio met the preliminary LOS goal of potable water service to at least one turnout per retailer within seven days and was projected to cost $150 million.**

Portfolio 2 Project Categories

- Stockpiled Materials (pipes)
- Life Safety
- Emergency Planning and Studies
- Agreements
- Capital Improvements
  - Groundwater Wells
  - Line Valves
- Operational Improvements
- SCADA

Most, but not all of the projects that were recommended from the 2005 WIRP have been implemented, which has reduced outage time to 30 days. One recommendation was stockpiling large diameter spare pipe and improving emergency response planning so the District is ready to repair a pipe quickly if it fails. The District implemented this recommendation in 2008 at a cost of $2.4 Million, and maintains a stockpile of large diameter spare pipe at Coyote and Vasona pump stations. The District also maintains a stockpile of internal pipeline joint seals, valves, and pipeline appurtenances. The stockpile marks a significant increase in reliability of the District's water supply system, as it helps to reduce outage time following a large earthquake from approximately 60 to 30 days.

The District also completed several emergency planning recommendations in 2014 at a cost of $150,000, to help meet the goal of reducing outage time to 30 days. These include developing a list of contractors available on standing order to use during an emergency event, improving the Water Utility Departmental Emergency Operations Center (DOC), and participating in CalWARN, a mutual aid network for water and wastewater utilities. Additional projects that were recommended in the 2005 WIRP and have been or are being implemented are listed below.

- Stabilize the SCADA system at Rinconada Water Treatment Plant (Completed in 2007 at a cost of $25,000)
- Improve the Post-Earthquake Dam Inspection Program (Ongoing, approximately $35,000 per year)
- Conduct a comprehensive SCADA study/SCADA system master plan (Completed in 2011 at a cost of $465,000)
- Seismic retrofit of the operations buildings at Rinconada, Penitencia, and Vasona Pump Station (capital project in construction, to be completed in 2017 at a cost of $21.2 Million)
- Construct a back-up raw water control center (capital project in planning, to be completed in 2025 at a cost of $6.9 Million. Note the Capital project name is SCADA Remote Architecture and Communications Upgrade)
- Install four line valves on the District's treated water pipelines to allow the District to isolate damaged portions of pipelines (Safe clean water project A3, scheduled to begin in 2025 at a cost of $13.9 Million)

The emergency well fields project in Portfolio 2 that helped reduce the outage time to 14 days were not implemented due to:

- **Reduced funding:** Board reduced funding to $20M in Fiscal Year (FY) 2012 Capital Improvement Projects (CIP) to accommodate other higher priority projects (Anderson Seismic Retrofit, Rinconada Water Treatment Plant (RWTP) Reliability Improvements).
- **District reliability improvements:** Dam seismic retrofits, pipeline air release valve upgrades, and RWTP upgrades
- **Retailer reliability improvements:** Increased storage capacity, interties with other retailers, and investments in increased reliability of San Francisco Public Utilities Commission (SFPUC) supplies
- New knowledge:
  - ***Operating with system outages:*** Some retailers have experience operating without District treated water supplies for short durations during District planned and unplanned pipeline shutdowns.
  - ***Post-disaster service levels and capabilities:*** Other recent National disasters have provided more insight regarding water use and needs following major hazard events.

The purpose of the 2016 update was to:

- **Review outage scenarios and update the reliability level of service goal**
- **Evaluate more regional, less capital intensive alternatives to the recommended well field option**
- **Identify projects that provide multiple benefits for added reliability, increased capacity and operational flexibility, and new treated or groundwater service connections.**

1.3. District System Background

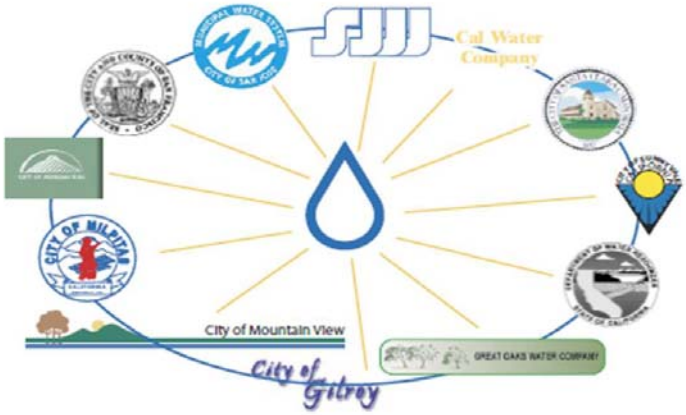
The District system includes imported water sources, ten raw water reservoirs (total storage capacity 169,000 acre-feet), 114 miles of raw and treated water pipelines, three potable water treatment plants, one recycled water treatment plant, and one District pump station (**Figure 1** on following page). In addition, there are two pump stations and 28 miles of raw water pipelines owned by the United States Bureau of Reclamation (USBR) but operated and maintained by the District, as well as a District/SFPUC intertie. More information on the District's system can be found in **Chapter 2**.

The District delivers treated water to seven retail customers (retailers), and manages groundwater within the subbasin for three groundwater-only retailers. The ten retailers own and operate their own water system facilities including reservoirs, treatment plants, wells, tanks, and distribution systems. Following is the list of District retail customers (also shown in **Figure 2**):

- California Water Service Company (Cal Water)
- City of Gilroy (Gilroy)
- Great Oaks Water Company (Great Oaks)
- City of Milpitas (Milpitas)
- City of Morgan Hill (Morgan Hill)
- City of Mountain View (Mountain View)
- City of San Jose (San Jose Muni)
- San Jose Water Company (SJWC)
- City of Santa Clara (Santa Clara)
- City of Sunnyvale (Sunnyvale)

Although they do not receive District treated water or regularly use groundwater, the City of Palo Alto, Stanford University, and Purissima Hills Water District are located within the District's service area and were also included in the study.

Figure 2. Retailer Customers and Imported Water Suppliers



The retail customers receive District treated water under the terms set forth in individual delivery agreements. Many of these agencies also extract groundwater from the groundwater basins managed by the District. More information on the retailers can be found in **Chapter 2**.

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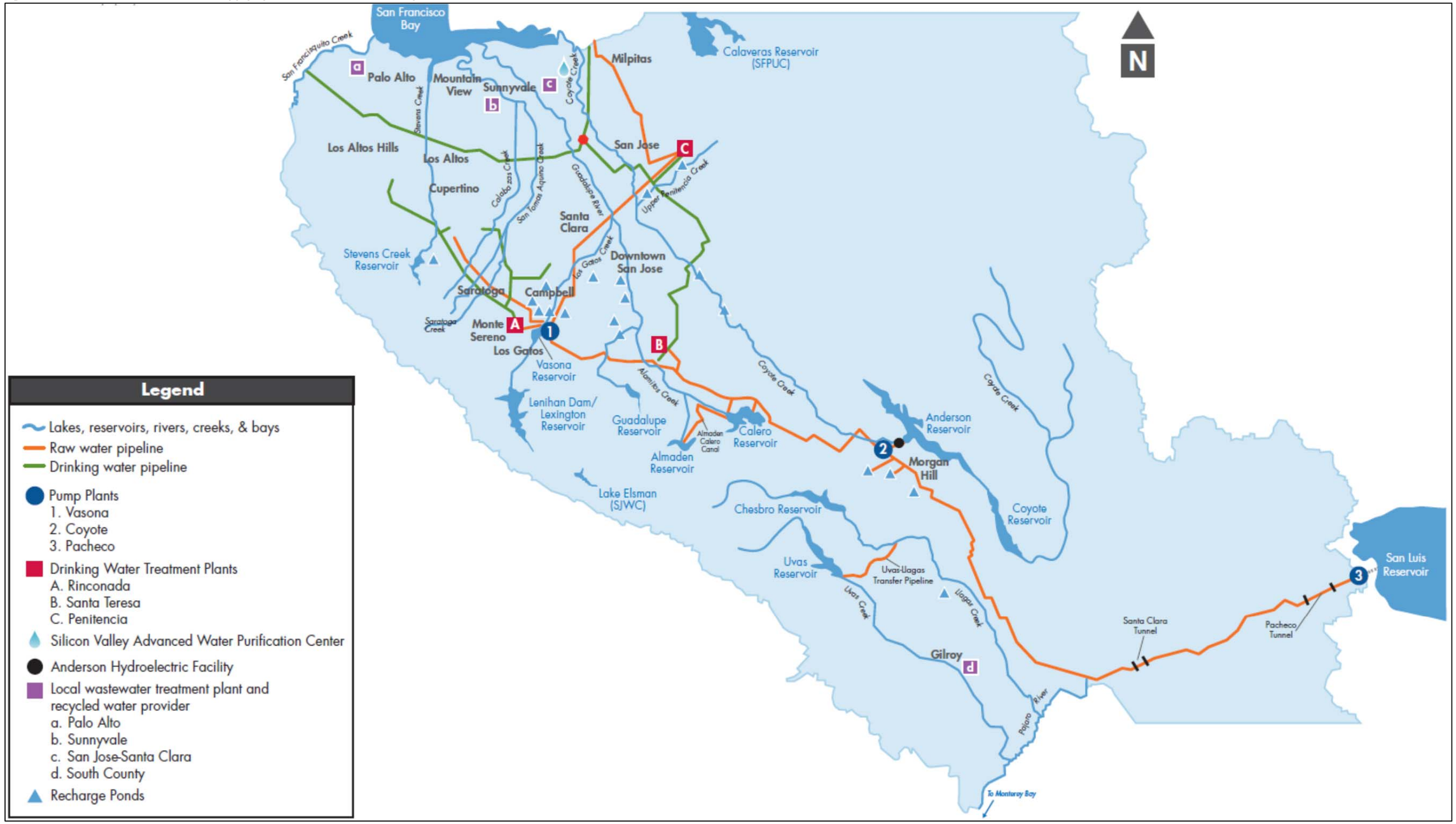
Figure 1. Overview of District's Water Supply System in Santa Clara County



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1.4. Project Methodology

The 2016 IRP quantified District system capabilities, needs and deficiencies, and potential improvement projects in order to develop LOS objectives and facilitate identification of desired District system performance. A high level assessment was performed to determine potential impacts on District facilities from different types of hazards that the region could face. Evaluation of the reliability of water supplies and facilities on a regional basis (District system, retail customer systems, and imported supply systems) was paramount to developing the most cost-effective combination of improvements or new facilities required to meet the District's system reliability goals. Strategies and projects to improve system reliability were then identified and developed. The 2016 IRP methodology is summarized in **Figure 3**.

Figure 3. Overview of 2016 IRP Process

Discussions with District management and retailers led to an understanding that high investment levels could result in system performance beyond what is needed, and may not be cost-efficient. There was a consensus among retailers that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level (i.e., $10 Million range), while providing sufficient system reliability and performance. The LOS objectives for the 2016 IRP represent performance standards or targets for which the District's system may strive to reach under various potential hazards.

2016 LOS

There was a consensus among retailers that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level ($10 Million range), while providing sufficient system reliability and performance.

The process followed the following Tasks to guide the project team in assessing the needs of the system and identifying solutions:

Task 1: Project Management
- Manage the scope of work

Task 2: Meetings
- Gather stakeholder input throughout the project

Task 3: Describe Infrastructure System
- Describe the District's and the Retailers' infrastructure systems

Task 4: Potable Water Use
- Describe District Retailers' potable water use

Task 5: Develop Outage Scenarios

- Develop hazard scenarios that represent the outages for which the District needs to plan
- Summarize the expected infrastructure damage and outage durations for different hazard types

Task 6: LOS Goals

- Set LOS goals for a range of system outages

Task 7: Potable Water Service Modeling

- Summarize modeling results and quantify impacts of outage scenarios on potable water service

Task 8: Regional Redundancy

- Analyze regional redundancies and capabilities

Task 9: Reliability Improvement Needs

- Summary of reliability improvement needs to address LOS shortfalls

Task 10: Other Improvement Needs

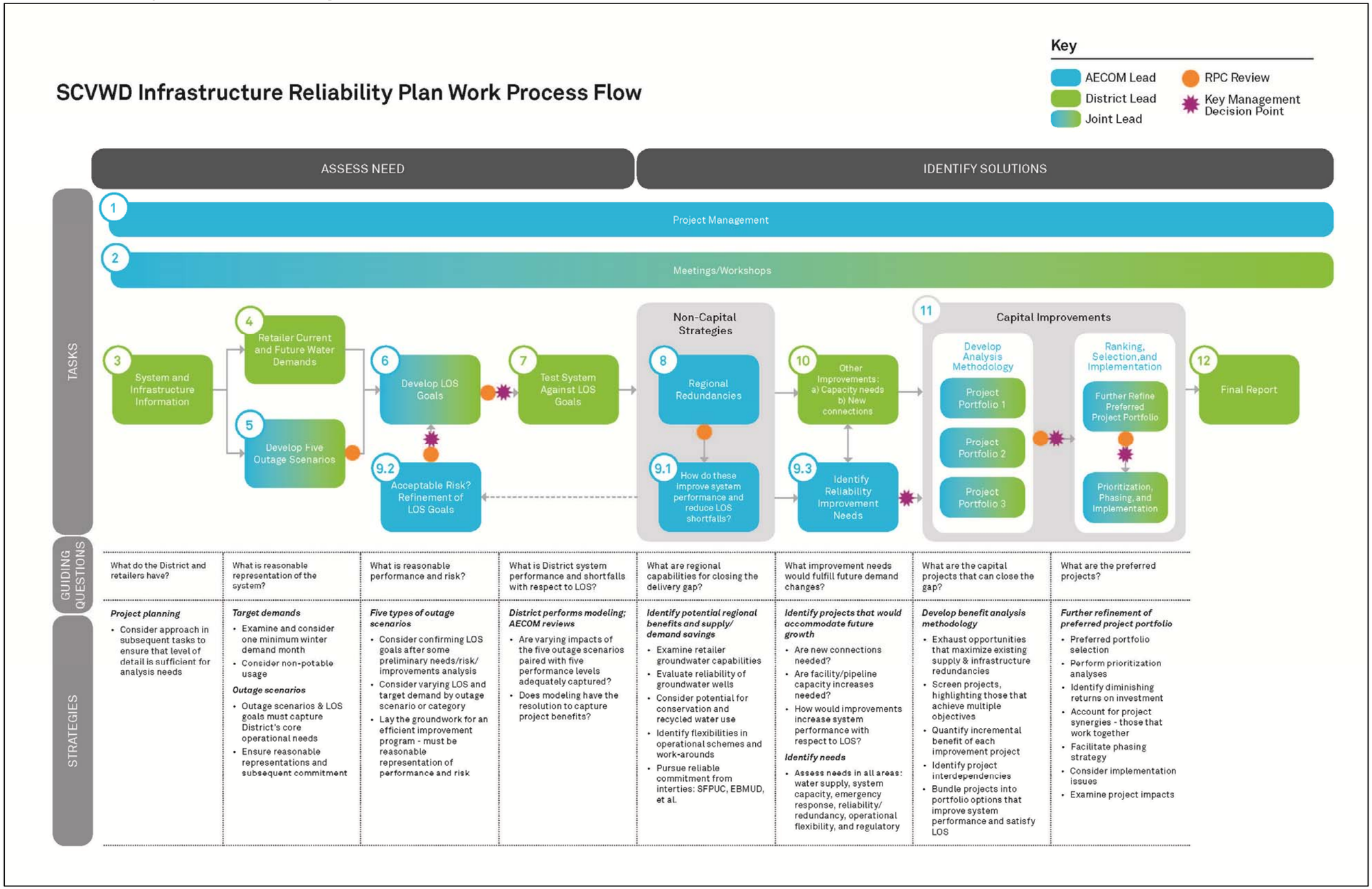
- Summary of other improvement needs to address LOS shortfalls

Task 11: Identify Projects

- Analyze and identify improvement projects to meet identified reliability needs

A flow diagram in **Figure 4** shows an iterative process that refined the LOS goals after system improvement needs had been identified.

Figure 4. SCWVD Infrastructure Reliability Plan Work Process Flow Diagram



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The work flow process allowed the project team and District to build on the knowledge gained from each task and assess the needs of the District. Task 3 efforts included gathering information on the District's system and led to an understanding of retailer systems and infrastructure as well. The average, minimum, and maximum monthly demands presented in Task 4 were used to understand desired demand and supply conditions, and to determine which retailer systems may have excess usable capacity compared to current use. Task 5 identified potential vulnerabilities and outages and developed representative scenarios based on the types of outage events for which the District needs to plan and prepare. The LOS goals developed in Task 6 addressed each of the outage scenarios selected in Task 5. The modeling efforts in Task 7 were used to determine how outage scenarios impact the District's ability to deliver potable water supplies to the retailers.

The remaining tasks allowed the District to identify solutions based on system needs. Task 8 identified the zones within each retailer service area that may be at lower risk of service outage if the District's system fails, due to the availability of excess capacity, back-up supplies, or availability of regional support. The existing system performance shortfalls were linked to specific outages and LOS goals in Task 9, and to conceptual system and/or operational needs. Information on future growth was used in Task 10 to determine if future water treatment or distribution capacity needs could be addressed by infrastructure reliability improvements. Task 11 then determined how the District can most efficiently and cost-effectively address the needs for improving system performance with respect to selected outage scenarios.

The work process flow included multiple review meetings throughout the project in order to gather input and receive feedback from retailers, internal technical staff, and District management. The project team met individually with each retailer to review and confirm the information developed throughout the project. Potential opportunities were identified and discussed via meetings, workshops, and specific information gathering efforts. These meetings are discussed further below and summarized in **Table 2**.

Table 2. Summary of Retailer Meetings

Purpose of Project Meetings	Date
▪ Explain project background ▪ Review system and infrastructure ▪ Discuss future water use ▪ Identify information needs	March 2014 one-on-one meetings
▪ Review selected outage scenarios	October 2014 workshop
▪ Develop LOS goals	December 2014 one-on-one meetings
▪ Provide updates on outage scenarios and modeling ▪ Gather input on potential opportunities and solutions	August 2015 one-on-one meetings
▪ Review initial project list	November 2015 workshop
▪ Discuss project recommendations	June 2016 workshop

A variety of relevant retailer information was gathered during the course of this project and via additional discussions at retailer meetings and workshops. This information can be found in the Retailer Information Appendix. The information has led to an understanding of retailer infrastructure (Task 3), water demands and future usage (Task 4), potential vulnerabilities and outages (Task 5), needed and

desired LOS (Task 6), and resulting outage impacts (Task 7). For the purposes of Task 8 and subsequent tasks, this information required a consolidated format to facilitate confirmation by stakeholders and further study for accomplishing project goals. A database has been developed which can generate a collection of retailer information sheets into a report.

Retailer Appendix includes:

- Retailer Database
- Updated Retailer Reports
- Retailer LOS Meeting Notes (Task 6 TM)
- Retailer Service Area Maps
- Groundwater Supply Overview Maps
- IRP Retailer Supply Source and Service Area Maps

In addition, retailer system maps have been developed showing retailer service area boundaries, geographic relation to District pipelines, locations of turnouts, and additional turnout information. These maps were useful to understand retailer service areas and facilitate discussions that helped clarify information.

1.5. Report Organization

The main objective of this report is to incorporate and document all of the information developed under the project and include recommendations for facility and operational improvements. The main body of this report provides a high level summary of the work that was performed, documents the results of the analyses, and highlights the recommended reliability improvements and implementation plan. It includes references to the detailed reports and technical memoranda which are available in the appendices. The technical reports provide more detailed discussions of specific topics including the geologic evaluation, LOS goals, retail customer coordination, baseline system reliability evaluation, portfolio development, evaluation criteria, and cost estimate assumptions. The six chapters included in the main body of this report are:

Chapter 1 – Introduction provides a background of the development of this project, lists the objectives for the report, and describes the report organization.

Chapter 2 – District System Background describes the District's water supply system, including critical facilities, and provides assumptions used for the basis of the IRP, hazard identification, LOS goals, and system hydraulics and operations.

Chapter 3 – Outage Scenarios discusses the development of the scenarios which represent the types of outages the District needs to prepare for, and identifies the expected infrastructure or facility failures in each hazard event.

Chapter 4 – Baseline System Evaluation discusses the results of the reliability evaluation of the existing District system for each retailer, and identifies existing capabilities and system performance shortfalls.

Chapter 5 – Portfolio Recommendations describes the development of project portfolios (capital and operational projects), revised LOS goals, and recommends an overall system improvement portfolio and implementation plan.

Appendices are organized by subject matter in order to simplify access to more detailed project materials. ***NOTE: SOME APPENDICES ARE CONFIDENTIAL.***

- **Project Task Support Appendix** includes all of the TMs that were developed for each task of the project
- **Infrastructure System Appendix** describes all the District's water supply system and includes District specific maps and descriptions of infrastructure
- **Climate Change Outage Appendix** includes the project work related to climate change and extreme weather evaluations
- **Maintenance Outage Appendix** contains the Maintenance Outage TM
- **Delta Levee Outage Appendix** includes all of the research and analysis of the impacts of a Delta Levee Failure including vulnerability and the status of regional repairs and upgrades
- **Earthquake Outage Appendix** describes the earthquake risks and vulnerabilities of District pipelines
- **Power Outage Appendix** contains the Fuel Analysis TM that was prepared to evaluate the impact of a regional power outage on baseline system performance
- **Retailer Information Appendix** contains retailer specific information and detailed maps and reports

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Santa Clara Valley Water District

Infrastructure Reliability Plan

Chapter 2
System Background and Use

AECOM

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2 SYSTEM BACKGROUND

The mission of the District is to provide Silicon Valley safe, clean water for a healthy life, environment, and economy.

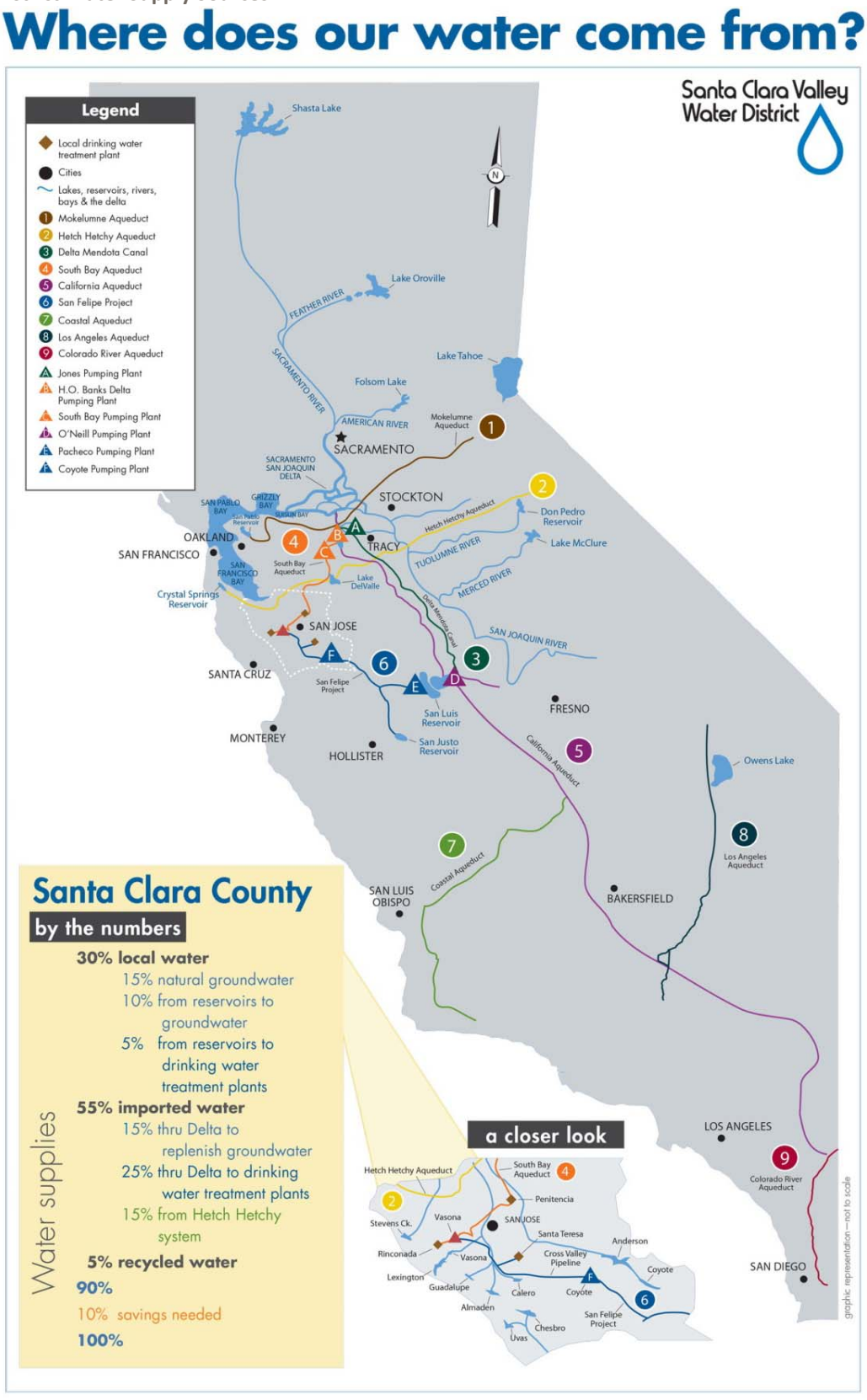
The District's water supply system is comprised of storage, conveyance, recharge, treatment, and distribution facilities that include local reservoirs, groundwater sub-basins, out-of-county groundwater banking, groundwater recharge facilities, treatment plants, imported supply, and raw, treated, and recycled water conveyance facilities. Maintaining public health and safety and ensuring the reliable operation of critical facilities following natural catastrophes and other system risks are fundamental objectives of the District. The IRP is an essential component to assessing and decreasing these risks.

This chapter describes the District's water supply system, including critical facilities, and provides assumptions used for the basis of the IRP, hazard identification, level of service goals, and system hydraulics and operations.

2.1. Santa Clara County Water Supply Sources

In addition to providing treated water in Santa Clara County, the District also manages the groundwater basin. In order to meet the county's water needs while maintaining maximum efficiency and flexibility, the District utilizes a comprehensive water supply management strategy and a variety of water supply sources. Santa Clara County's diverse water supplies include locally developed and managed water, water imported from the Sacramento-San Joaquin Delta (Delta), and recycled water, as shown in **Figure 5**. The District's comprehensive water supply management activities include the managed recharge of imported and local supplies, in-lieu groundwater recharge through the provision of treated surface water and acquisition of supplemental water supplies, and programs to protect, manage and sustain water resources. The activites augment local supplies and help to reliably meet the needs of county residents, businesses, agriculture, and the environment.

Figure 5. District Water Supply Sources



2.1.1. Local Supplies

The District collects local supplies, including rainfall and surface water runoff, in reservoirs such as Anderson and Calero, which as shown in **Figure 6**, are connected to the raw water distribution system and can supply the District's water treatment plants. Local groundwater resources make up the foundation of the county's water supply. The District also has numerous water rights to divert and store local surface water from creeks and streams. Captured local surface water is used to replenish the groundwater sub-basins through an actively managed recharge program and provides supply for the District's drinking water treatment plants.

2.1.2. Imported Supplies

In a normal year, imported water supplies account for slightly more than half of the annual supply delivered within Santa Clara County. The District imports water from the Sacramento-San Joaquin Delta (Delta) through the State Water Project (SWP) via the South Bay Aqueduct (SBA), and from the Central Valley Project (CVP) through the San Luis Reservoir (**Figure 6**). CVP and SBA imported water is sent to the District's three water treatment plants, recharge ponds or creeks, or to local reservoirs for later release to supplement groundwater recharge. Imported water is also brought into the county through the SFPUC system.

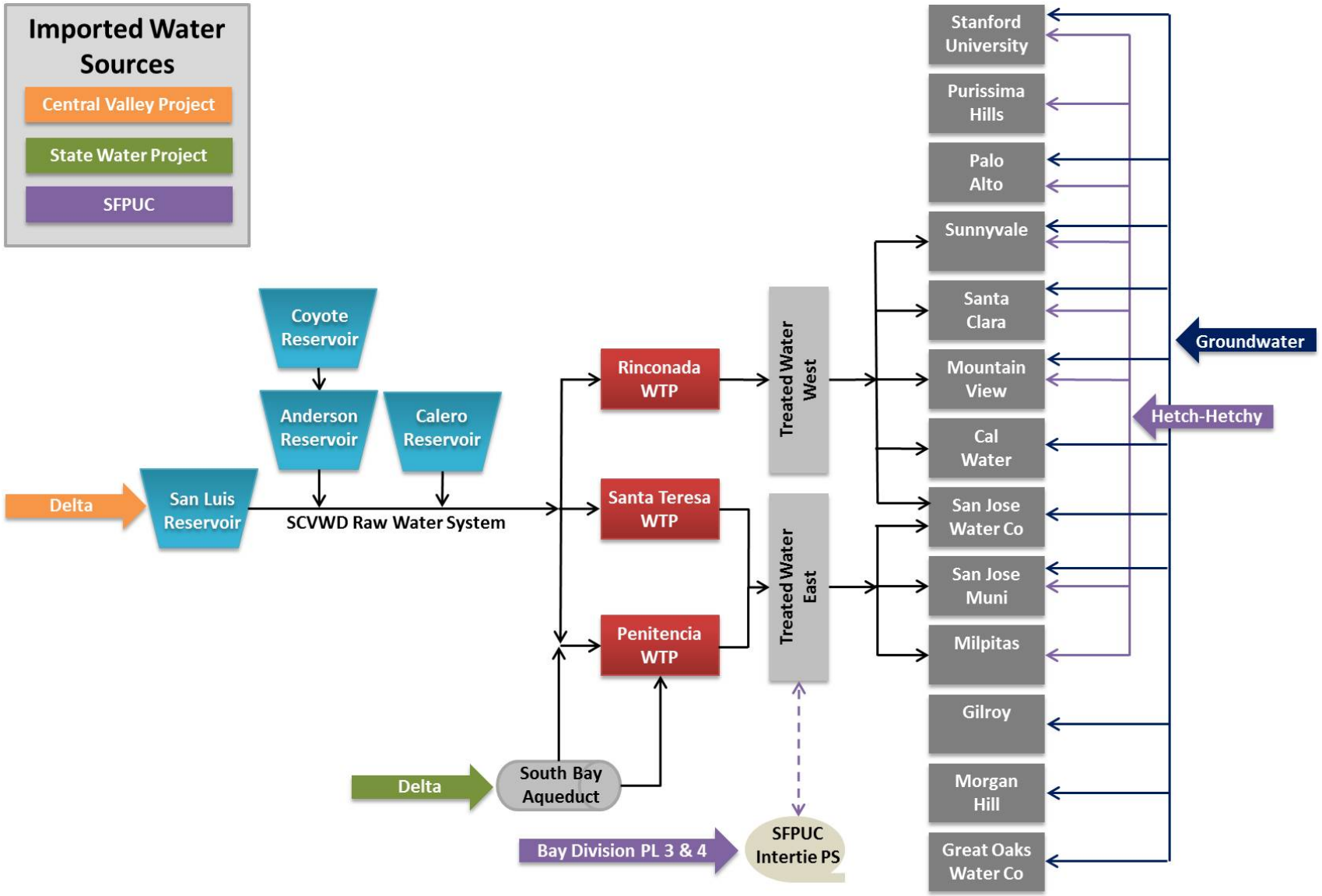
2.1.3. Recycled Water

A small, but important and growing source of water is recycled water, which is used for non-potable uses including irrigation, industry, and agriculture. Using recycled water helps conserve drinking water supplies, provides a drought-proof and locally-controlled water supply, and reduces dependency on potable supplies. Recycled water was not specifically analyzed as part of this project since current uses are non-potable. However, it is an important water supply source that will increase the resiliency of the District's system, especially if it is accepted for direct or indirect potable uses in the future. Some considerations for the Silicon Valley Advanced Water Purification Center (SVAWPC) have been documented as part of the Climate Change efforts in the Climate Change Outage Appendix.

2.1.4. Desalination

Desalination as a water supply solution was not specifically evaluated as part of this project. The high cost of implementation made it infeasible as a project alternative and was thus not considered.

Figure 6. Water Supply Sources and Treated Water Supply System Overview



2.2. District Water Supply System

Imported water from the SWP comes from the Delta through the SBA in the northern portion of Santa Clara County. The SWP water is typically treated at Penitencia Water Treatment Plant, or sent through the Central Pipeline to Rinconada Water Treatment Plant for treatment, or to managed recharge facilities.

Imported water from the CVP comes through the San Felipe Division facilities, consisting of San Luis Reservoir, Pacheco Pump Station, Pacheco Tunnel, Pacheco Conduit, Santa Clara Tunnel, Santa Clara Conduit, and Coyote Pump Station. From there, water is typically sent to Santa Teresa or Rinconada Water Treatment Plants for treatment via the Cross Valley, Calero, and Almaden Valley Pipelines, and to various managed recharge facilities throughout the county.

Four of the District's local reservoirs are connected to the transmission system and can supply the District's water treatment plants. Most notably, Anderson Reservoir feeds the Cross Valley Pipeline, and Calero Reservoir feeds the Almaden Valley Pipeline. Water from each of these reservoirs would typically be treated at Santa Teresa or Rinconada Water Treatment Plants.

The District's managed recharge facilities are used to replenish the groundwater basin so that groundwater levels are maintained, supplies are available for retailer pumping, and subsidence is avoided. The managed recharge systems allow the District to maintain groundwater levels in the groundwater basins.

A diagram of the facilities in the District's water supply system is shown in **Figure 7**. System overview maps and a more detailed system schematic map that includes retailer turnouts are available in the Infrastructure System Appendix.

Infrastructure System Appendix includes:

- System Overview Maps
- Detailed System Schematic Maps

Figure 7. Diagram of District Water Supply System

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2.2.1. District System Capacity Constraints

Information on future growth was used in Task 10 to determine if additional water treatment or distribution capacity is needed in the future in the District's system. The District's 2012 Water Supply and Infrastructure Master Plan (WSIMP) analyzed the water treatment plants and pipelines to identify constraints for existing infrastructure under future 2035 demands.

Task 10 TM includes:

- Capacity failures due to future demand increases or changes
- Recommended improvements for capacity
- Summary of constraints for each system
- Discussion of future LOS goals

The 2012 WSIMP made recommendations with regards to future capacity constraints, but did not recommend any major infrastructure projects to address future capacity. Instead, it recommended monitoring and preparing for increased pumping in the future. The Task 10 TM includes a discussion of how the WSIMP capacity recommendations relate to the IRP.

2.3. Retailer Water Supply Systems

Seven retailers receive treated water from the District's treated water system, while three retailers receive only groundwater. The District's treated water distribution system is physically separated into two separate systems, one that serves the east and one that serves the west side of Santa Clara County. The east side of the District's treated water system serves the following retailers:

- Milpitas
- San Jose Muni
- San Jose Water Company (SJWC)

Retailer Appendix includes:

- Retailer Reporting Database Sheets
- Updated Retailer TMs
- Retailer Service Area Maps

The west side of the District's treated water system serves the following retailers:

- Cal Water
- Mountain View
- Santa Clara
- Sunnyvale
- San Jose Water Company (SJWC)

Eight local water retailers in the northern portions of the county receive imported water directly from the SFPUC system. Additionally, Stanford University and the San Jose Water Company hold surface water rights, and some retailers utilize recycled water for non-potable uses.

Information on the physical capabilities and limitations of retailer supply sources was gathered and evaluated in the Retailer Reports that were developed in Task 3 and also further quantified in Task 8. Additional retailer meetings were utilized to further understand and confirm the physical capabilities and limitations of retailer supply sources. The maximum infrastructure transmission limitations of each

water supply source for each District retailer include groundwater yield, turnout capacity, and contractual limits, not necessarily reflecting available source. **Table 3** presents these results and lists the maximum capacity of each water supply source for each District retailer.

Table 3. Maximum Capacity of Retailer Water Supply (MGD)[1,2]

Retailer	Groundwater	District Treated Water	SFPUC	Local Surface Water	Total Capacity
Cal Water	13.0	6.0	n/a	n/a	19.0
Gilroy	18.8	n/a	n/a	n/a	18.8
Great Oaks	31.0	n/a	n/a	n/a	31.0
Milpitas[2]	1.7	14.4	36.0	n/a	52.1
Morgan Hill	15.3	n/a	n/a	n/a	15.3
Mountain View[2]	6.4	2.5	11.4	n/a	20.3
San Jose Muni[2]	19.6	30.0	21.6	n/a	71.2
San Jose Water Company[2]	100.0	182.0	n/a	25.0	307.0
Santa Clara[2]	54.0	5.8	10.8	n/a	70.6
Sunnyvale[2]	9.0	18.6	53.4	n/a	81.0
TOTAL	268.8	259.3	133.2	25.0	686.3

[1] This is not necessarily the amount of supply available, as capacities may be restricted by physical infrastructure limitations.
[2] MGD = millions of gallons per day
[3] Also has capacity to utilize recycled water supplies which were not included in the analysis.

Some of the retailers receive their water supply from multiple sources, while others, such as Gilroy, Great Oaks, and Morgan Hill rely solely on groundwater supplies. More information can be found in the Retailer Appendix.

2.4. Retailer Water Use

The potable water supplies used by the District's retailers were identified in the Task 4 TM. The project team gathered monthly demand data for each retailer and analyzed monthly demand by water supply source. The demands presented in the Task 4 TM were used for analysis in subsequent project tasks. For example, the average, minimum, and maximum month demands were reviewed and analyzed in setting level of service goals as part of Task 6. Retailer water demand graphs were compiled, which show the yearly and monthly demand trends and the percent of water use by supply source. The retailer demand graphs can be found in the Retailer Appendix.

Task 4 TM includes:

- Summary of planned future growth
- Summary of historical retailer demands (see the Retailer Appendix for retailer-specific demand graphs)
- Detailed demand tables and charts that include historical water usage and future growth adjustments
- Demand analysis methodology
- Future growth area map

2.4.1. Planned Future Supply Source Changes or Growth

Known future growth or supply source changes for the retailers were also identified in the Task 4 technical memorandum. The project team gathered information on future growth and supply source changes from retailer Urban Water Management Plans[1] (UWMPs), which identify the supplies water providers will use to meet future demand, and then met individually with each retailer to review and confirm the demand and growth information the team had gathered.

As confirmed through discussions with treated water retailers earlier in this project, very few new connections or areas of growth were identified. The following retailers had growth areas that were estimated and incorporated in demand calculations for the project:

- Milpitas
- San Jose Muni
- Santa Clara
- Gilroy

At this time, there are no specific recommendations for new infrastructure with regards to the identified areas of growth. All existing connections are assumed to be sufficient to address these areas.

Historical demands were compared to growth projections to determine if the water supply demand or source would be projected to change for future planning purposes. All retailers indicated that demand has either stayed the same or decreased over the past 10 years. Most retailers indicated that there are no plans to change or add supply sources in the future. In other words, they generally plan to continue utilizing the same distribution of supplies, thus utilizing relevant historical retailer demand data was appropriate.

2.4.2. Minimum Retailer Usage

The minimum retailer usage is represented by the winter demand (the average water usage for the month of February). Winter demands are a starting point for benchmarking the minimum service to provide the public in the aftermath of a major disaster. Winter demands generally do not include landscaping and other significant outdoor water use that are present during other seasons, and which may be considered extraneous during emergency situations. However, it is an amount based on historical data that can be reasonably associated with day-to-day continuity of residential and

Task 8 TM:

- Lists the maximum infrastructure transmission capacity of each water supply source for each District retailer
- Includes minimum retailer usage by source/supply utilizing historical retailer demand data

[1] *The 2010 UWMPs were used for this report. The 2015 UWMPs were not available, but are currently in progress.*

business operations and needs. **Table 4** presents the minimum usage of each water supply source for each District retailer, developed as part of Tasks 4 and 8.

Table 4. Minimum Retailer Usage by Water Supply Source (MGD)

Retailer	Groundwater	District Treated Water	SFPUC	Local Surface Water	Total Minimum Usage
Cal Water	2.0	5.2	n/a	n/a	7.2
Gilroy	4.7	n/a	n/a	n/a	4.7
Great Oaks	7.2	n/a	n/a	n/a	7.2
Milpitas	0.0	3.8	5.2	n/a	9.0
Morgan Hill	3.8	n/a	n/a	n/a	3.8
Mountain View	0.3	0.6	6.3	n/a	7.2
San Jose Muni	3.2	8.8	3.3	n/a	15.4
San Jose Water Company	27.5	46.6	n/a	10.5	84.7
Santa Clara	10.6	3.4	2.6	n/a	16.6
Sunnyvale	0.7	6.1	6.5	n/a	13.2
TOTAL	60.1	74.5	24.0	10.5	169.1

The total minimum usage (169 MGD) represents the minimum amount of water that all of the retailers have used from all sources from a historical perspective. The minimum demands were reviewed in subsequent tasks to determine if any retailer systems have excess usable capacity compared to current use. For example, a retailer may have 10 MGD of well capacity, but only uses 2 MGD typically. The excess capacity could be used in an emergency or outage scenario to meet demands.

2.5. District Infrastructure

The District's water supply system includes imported water sources, 10 dams, and raw water reservoirs (total storage capacity of 169,000 acre-feet), 152 miles of raw and treated water pipelines, three raw water pump stations, three potable water treatment plants, 400 acres of managed recharge ponds and associated systems, several in-stream diversion dams, one well field (three wells), a purified water treatment plant, and an intertie pump station with SFPUC. The physical characteristics, capacity, age, condition, and known risks or upgrades of the District's Infrastructure system were updated and documented in the District Facility Description Report included in the Infrastructure System Appendix.

The District's infrastructure summary tables that were prepared for the WSIMP were updated as part of Task 3. A summary of the District's water transmission system facilities are provided below in **Table 5.**

Task 3 TM:

- Updated the District's infrastructure summary tables that were prepared for the WSIMP

Table 5. Infrastructure Summary Table

Infrastructure	Quantity	Size/Capacity
District Service Area		1,300 sq. mi.
Imported Water Supplies	3	
SF Water Dept Bay Division[1]		77,000 ac-ft/yr (contract amt)
San Felipe Project[2]		152,500 ac-ft/yr (contract amt)
South Bay Aqueduct[3]		100,000 ac-ft/yr (contract amt)
Raw Water Pipelines	11	79.7 mi (20" to 120" diam)
Treated Water Pipelines	10	39.8 mi (20" to 84" diam)
Water Treatment Plants:	3	
Rinconada		80 MGD
Santa Teresa		100 MGD
Penitencia		40 MGD
Raw Water Pump Stations:	3	
Coyote		153,492 gpm; 12,000 hp
Pacheco		301,055 gpm; 24,000 hp
Vasona		72,000 gpm; 1,200 hp
Treated Water Pump Stations	3	
Dutard		4,000 gpm; 85 hp
Graystone		27,760 gpm; 400 hp
SFPUC Intertie		
Raw Water Reservoirs	10	169,000 ac-ft
Treated Water Reservoir	1	15 MG
Groundwater Recharge Facilities	20	393 ac
Raw Water Canals		17 mi
Tunnels	3	
Pacheco (raw water)		7.0 mi
Santa Clara (raw water)		1.4 mi
Santa Teresa (treated water)		0.34 mi
Hydroelectric Facilities	1	900 kW
Diversion Dams	9	25,000 ac-ft
Canals and Ditches	4	17.3 mi
Natural Recharge Channels		Approx. 90 mi

[1] *Owned & Operated by SFPUC*
[2] *Owned by US Bureau of Reclamation; Operated by the District*
[3] *Owned & Operated by California Department of Water Resources*

2.5.1. System Redundancy

The District's current raw water conveyance system contains a fair amount of redundancy, and has flexibility to allow changes in operations for providing service in the case of a single facility or pipeline failure. The raw water system pipelines and pump stations can convey any supply source (San Luis, Calero, or Anderson Reservoirs, or the SBA) to any water treatment plant (Rinconada, Santa Teresa, or Penitencia), with limitations on capacity in some operational scenarios.

The District's treated water system operates as two separate systems, the East and West Side systems. The East Side system can be supplied by three redundant treated water sources. The East Side System is connected to two District water treatment plants, Santa Teresa Water Treatment Plant and Penitencia Water Treatment Plant, and has a connection with the SFPUC for use in times of emergency. The District/SFPUC intertie has a pumping capacity of up to 40 MGD, and allows for the exchange of water

between the two systems in the event of planned or unplanned system outages in either system. An interruption or outage of SFPUC or other imported supplies could have significant impacts on the county's water supply reliability.

The West Side is supplied by the Rinconada Water Treatment Plant, which is currently being upgraded to provide redundancy and reliability. The District's Campbell well field provides a limited amount of back-up treated supply, approximately 2MGD, to the West side system.

2.5.2. Critical Facilities

For the purpose of this study, "critical" is defined as any facility that is essential (that must remain functional) to supplying water and to meeting the level of service demands of the District customers. Specific infrastructure includes the District's supply, transmission, and treatment facilities, the groundwater basin, and imported water facilities.

Task 3 TM:

- Summary of District Infrastructure
- Evaluation of District Critical Facilities from the 2005 WIRP
  - Asset Management Program Ranking
  - Seasonal Variation in Criticality
  - 2005 WIRP Ranking

A list of critical facilities was developed for the 2005 WIRP to identify the specific District facilities that are critical to system functions of supplying and delivering potable water. The 2005 WIRP rankings were reviewed and evaluated along with facility rankings by the Asset Management Program (*Evaluation of District Critical Facilities from the 2005 WIRP report*).

The 2005 WIRP Critical Facility list was used to identify the current District facilities that are critical to system functions of supplying and delivering potable water. The final complete list of critical facilities is included in two matrices, one matrix for raw water system and one matrix for treated water system (Infrastructure System Appendix).

This critical facilities matrix summarizes the infrastructure necessary for system performance in supplying and delivering potable water to District customers. The list was utilized to quantify impacts of hazard events by identifying the critical facilities affected and potential facility outage severities and durations.

Infrastructure System Appendix includes:

- District Facility Descriptions
- Critical Facilities Matrix
  - Facility outage durations
  - Raw water facility matrix
  - Treated water facility matrix

2.5.3. Vulnerable Facilities

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2.5.4. Infrastructure Improvements

The District monitors condition of its facilities through its Asset Management Program. As conditions worsen, the District initiates projects to rehabilitate or replace infrastructure. Some facility conditions have degraded since the 2005 WIRP, making them more vulnerable to hazard events. The District has implemented or plans to implement other projects to improve system reliability. The District has also made significant progress in improving the reliability of its pipelines through its pipeline maintenance program, which upgrades pipeline appurtenances such as air release valves and in-line valves.

The District is in the process of, or is slated to begin some significant improvement projects. Note that this is not the complete list of projects in the District's current CIP.

- Seismic retrofit of key water supply reservoirs, including Anderson and Calero Dams
- Improvements to Rinconada Water Treatment Plant, a key facility for the west treated water system
- Improvements to the Main and Madrone pipelines, which will allow the District to deliver water from Anderson reservoir to the Main and Madrone ponds

Task 3 TM includes:

- Reliability improvements to the infrastructure system that were not part of the 2005 WIRP
- List of distribution system improvement projects that are included in the District's 5-year CIP

The District's planned improvement projects were considered in the evaluation of baseline performance of the system.

2.6. Retailer Infrastructure

Retailers own and operate their own water system facilities including reservoirs, treatment plants, wells, tanks, and pipeline systems. Current information on the retailers, their supplies, and systems is a critical element of the IRP update. Task 3 included updates to Retailer System Reports (which were last prepared in 2004 for the 2005 WIRP). The updates focused on infrastructure and include detailed information on infrastructure reliability improvements made since the previous study.

Updated Retailer System Reports (Retailer Appendix):

- Summary of retailer systems
- System maps and schematics
- System descriptions
- Recommendations from 2004 Reports
- System improvements since 2004 Reports

Table 6 summarizes the conclusions of each retailer report, as well as preliminary considerations for improving the reliability of retailer systems. Specifically, the recommendations address system deficiencies or considerations with regard to a reduction or loss of District treated water deliveries.

Table 6. Retailer Report Conclusions and Considerations

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Santa Clara Valley Water District

Infrastructure Reliability Plan

Chapter 3
Outage Scenarios

AECOM

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3 OUTAGE SCENARIOS

An objective of the IRP was to develop outage scenarios that provide a reasonable "stress test" by which to measure District system performance and project improvements, and set performance goals. Outage scenarios were intended to reflect relevant hazards to the District for the purposes of measuring system performance with respect to water supply and delivery. The strengths and deficiencies in system performance under these scenarios were used to develop strategies for reliable water supply and delivery after a disaster event.

This chapter discusses these outage scenarios and evaluates the impacts to District facilities from different hazards. This chapter also presents a range of preliminary LOS objectives for potential District system performance targets under the various hazard conditions. The outage scenarios were used in subsequent modeling tasks of the IRP to identify specific facility outages and determine the impacts on potable water service.

3.1. Hazard Categories

Multiple hazard categories were considered during the selection of outage scenarios in order to encompass the range of potential impacts relevant to the District. Specific hazard categories were selected and analyzed in the Task 5 TM. Based on conceptual assessments and subsequent discussions with District staff and stakeholders, the following major hazard categories were selected for further development and evaluation:

- Climate Change and Extreme Weather
- Earthquakes
- Delta Outage
- Regional Power Outage (evaluated in Task 7)
- Maintenance Outage
- SCADA Outage
- Water Quality Event

These major hazard categories encompass a large range of potential impacts. **Table 7** summarizes the high-level assessment that was considered to determine potential impacts of each hazard category on types of District facilities.

Task 5 TM:

- Documents the evaluations and analyses performed during the planning process
- Describes the selected outage scenarios that were identified
- Includes high-level assessment of the impacts of hazard categories on District facilities

Table 7. High-Level Assessment of Hazard Categories

Hazard Category	Long-term Supply Sources (State/Federal)	Short-term Supply Sources (District Storage)	Raw Water Transmission Facilities	Water Treatment Plants	Treated Water Transmission Facilities
Extreme Weather	X	X	X	X	X
Maintenance Outage		X	X	X	X
Earthquake	X	X	X	X	X
Delta Outage	X				
Regional Power Outage			X	X	
SCADA/Controls Failure			X	X	
Water Quality Event			X	X	

Based on this conceptual assessment and discussions with District staff, all of the hazard categories were selected for further consideration and evaluation except for a SCADA/Controls Failure and a Water Quality Event. SCADA outage impacts are generally captured by other outage scenarios, and the District has some operational capabilities for manual operations of the system if necessary in case of an event that disables SCADA controls. For water quality events, minor events typically have shorter durations of impact and may be mitigated by redundancy in the raw water system, while major water quality events, such as terrorist-related events, have a low probability of occurrence.

The remaining hazard categories – Climate Change and Extreme Weather, Earthquake, Delta Outage, Regional Power Outage, and Maintenance Outage – were analyzed in more detail. Following further evaluation of each hazard category, the Maintenance Outage category was eliminated as an outage scenario (see Section 3.1.5). The following sections summarize development of the selected broad hazard categories into specific outage scenarios, by identifying the specific District facilities impacted for each. These outage scenarios were utilized in evaluating system performance in subsequent tasks.

3.1.1. Climate Change and Extreme Weather

Climate change and related extreme weather events that may result in infrastructure failure were identified in the *Infrastructure Reliability Climate Change and Extreme Weather Technical Memorandum* (Climate Change Appendix). Extreme weather in Santa Clara County includes severe storms, drought, and heat waves. These events have occurred historically and can occur at any time, but are generally not considered to be frequent or high probability events. Climate change is projected to increase the frequency and/or magnitude of the extreme weather events. The Climate Change TM considered the risk that extreme weather events pose on water utility infrastructure, regardless of whether it is an existing extreme weather event, or if it is a future event that may be exacerbated by climatic changes. The Climate Change TM evaluated how climate change and extreme weather may impact the District's water supply system infrastructure.

Climate Change Appendix:

- Evaluated how climate change and extreme weather may impact the District's water supply system infrastructure
- Includes climate change impact background and research
- Identifies infrastructure expected to be impacted
- Describes sensitivity of failed infrastructure
- Describes risk assessment methodology

Multiple types of extreme weather events were evaluated in order to determine the specific type of event that poses the greatest risk to the District's water supply system infrastructure. The first step defined the impact on District assets due to each extreme weather event. After the impacts were identified, the next step was to assess vulnerabilities in order to identify and determine exposure routes or exposure points from the extreme weather event to District facilities. The risk assessment then looked at how published climate and extreme weather projections could impact the District's vulnerable water supply system infrastructure.

It was determined that the extreme precipitation event, which causes riverine flooding, has the highest risk of impact for the District. Thus, an extreme storm was selected as the most severe and representative climate change outage scenario.

3.1.2. Earthquakes

District facilities cross three major faults that may cause considerable interruptions to water supply and delivery. The 2005 WIRP identified three likely earthquake events:

- San Andreas M7.9 (San Andreas)
- Central Calaveras M6.2 (Calaveras)
- Southern Hayward M6.7 (Hayward)

Task 5 TM includes:

- Discussion of facility probabilities of failure in earthquake scenarios
- Earthquake outage scenario refinements and final selections

Multiple preliminary outage scenarios were developed for each earthquake event and documented in the Task 5 TM. It was determined that Hayward event vulnerabilities are generally captured by San Andreas event scenarios, and therefore a specific outage scenario was not needed for Hayward. Two San Andreas scenarios and one Calaveras scenario were selected to capture the risk to District facilities in the event of a major earthquake. The final selected earthquake scenarios incorporated additional discussions with the District team, previous study information, likely facility probabilities of failure and expected pipeline breaks and leaks, and high-level considerations for probable facility outage combinations. The three final selected earthquake outage scenarios were:

- San Andreas #1 (M7.9 on the San Andreas fault with damages primarily on the West Side)
- San Andreas #2 (M7.9 on the San Andreas fault with damages primarily on the East Side)
- Calaveras (M6.2 on the Central Calaveras fault)

Earthquake Appendix includes:

- Updated information on infrastructure impacts
- Drought and earthquake recurrence interval evaluation

3.1.3. Delta Levee Failure

The District imports 40 to 45% of its water supply for customers from the Sacramento-San Joaquin Delta (Delta) via the SWP and CVP pumping plants (*see schematic in the Delta Appendix*). The Delta is extremely susceptible to catastrophic damage in the event of earthquakes, floods, and other threats in and around the Delta region. Failure of the Delta system could potentially reduce or stop water deliveries from the Delta for weeks, months, or even years (SWP Delivery Reliability Report, 2013; BDCP, 2013). A summary of the State Delivery Report can be found in the Delta Appendix.

Existing studies and findings were leveraged in the Delta Levee Failure TM to assist with evaluating and quantifying potential Delta outages, particularly the Delta Risk Management Strategy (DRMS) project conducted by the California Department of Water Resources (DWR).

Based on findings from the evaluation, it appears the geographic distance makes it unlikely that significant damage in the Delta and facility outages in the District service area would occur simultaneously as a result of selected seismic and extreme flood events. To capture risks of a Delta failure event, unique outage scenarios to capture Delta-specific failures are appropriate. As a result, two Delta outage scenarios were identified:

- Short-term/6-month Delta outage
- Long-term/24-month Delta outage

Delta Appendix includes:

- Delta import schematic
- State Delivery Report Summary TM
- Delta Status Summary TM
- Emergency Freshwater Pathway TM
- Delta Levee Failure TM:
  - Background on Delta levee failures
  - Probabilities of flood and earthquake risk
  - Estimated time to repair levees and restore water exports

These outages were defined based on the current status of the Delta, which is summarized in the Delta Status Summary TM. Because the Delta is so important

to water retailers and because it offers a multitude of other benefits to the State of California, it is likely that any necessary repairs to the Delta would be prioritized in an emergency. Numerous initiatives and programs have already been undertaken in order to protect and enhance the Delta's valuable assets and to manage the state's water resources. More information can be found in the Emergency Freshwater Pathway TM.

3.1.4. Regional Power Outage

As discussed in the Fuel Analysis Technical Memo (Joe Hill Consulting Engineers (JHCE) and AECOM), the District's capabilities with respect to a regional power outage were analyzed using two approaches:

1. The first analysis considered fuel requirements from a prolonged power outage with the assumption that all facilities are operable for the duration of the power outage and will require emergency fuel to operate. Based on historic outages in the United States, a two-week power outage was selected for the analysis.

2. The second analysis utilized the IRP outage scenarios and accounts for facility outages or lack of source water. The analysis incorporated the specific facility outage scenarios identified in this project and quantified fuel needs associated with the hazard events. In this analysis, it was assumed that fuel is only needed at a particular facility if the facility and related raw/treated water conveyance systems are operable.

Power Outage Appendix includes:

- Fuel Analysis TM
  - Backup fuel storage for critical facilities
  - Refueling requirements for backup power operations
  - Refueling requirements for recovery incorporating outage scenarios

In the case of a stand-alone regional power outage, water supply may be available and facilities may be undamaged. However, operations and water deliveries may be curtailed due to the limitations of backup power generators and fuel storage and availability. An analysis was developed to quantify reasonable power outage durations and associated reductions in operations as a result of relying on backup power and fuel capabilities. A "burn rate" analysis was performed to determine the frequency of fuel deliveries needed, assuming existing fuel storage.

3.1.5. Maintenance Outage

Impacts due to maintenance outages are captured by other hazard categories, and thus were not developed into an outage scenario

The District takes several major facilities out of service each year for maintenance. The District maintains a facility shutdown schedule that identifies when and for how long these facilities will be taken out of service for maintenance. The schedule identifies shutdowns that are required for both capital and maintenance projects. The *Planned*

Maintenance and Other Facility Outages (Maintenance TM) details the District's historical and planned outage schedules.

An evaluation of facility maintenance outages determined that potential facility impacts due to maintenance activities are covered by other more severe outage scenarios being evaluated, such as seismic events. Therefore, maintenance outages were not specifically evaluated in terms of discrete outage scenarios, and were not a main driver in analysis of system performance and goals. However, as strategies and projects were developed to increase District reliability, operational flexibilities and capabilities for performing maintenance were considered as part of evaluations.

Maintenance Appendix includes:

- Major critical facilities in the raw and treated water systems that significantly impact District operations and require significant planning and coordination
- Facilities where simultaneous outages would be most problematic
- Facilities that have not been taken out of service for maintenance

3.1.6. Selected Hazard Categories

The representative outage scenarios appropriate for evaluating performance of the District system, and identifying potential needs and improvements, were determined through preliminary evaluations of outage scenarios and discussions with District staff. The outage scenarios selected and analyzed with respect to system performance and goals are summarized in **Table 8**. Due to potentially severe impacts from earthquakes and increased reliance on groundwater sources as a result, the concern of an earthquake occurring during a major drought was deliberated. A probability analysis was performed and documented in the Earthquake Outage Appendix. It was determined that probabilistically, there is a low recurrence interval for a major seismic event occurring simultaneously with a major drought. Due to the low likelihood, a specific scenario for major earthquake combined with major drought was not considered.

Table 8. Selected Hazard Categories

Hazard Category	Outage Scenario	Scenario Description
Climate Change and Extreme Weather	Extreme Storm	This scenario analyzed impacts to District facilities due to extreme storm events
Earthquake	San Andreas M7.9 Earthquake 1	This scenario analyzed facility outages due to a San Andreas earthquake with damage focused on the District's west side treated water system
	San Andreas M7.9 Earthquake 2	This scenario analyzed facility outages due to a San Andreas earthquake with damage focused on the District's east side treated water system
	Calaveras M6.9 Earthquake	This scenario analyzed facility outages due to a Calaveras earthquake
Delta Outage	Short-term Delta Outage (6 months)	This scenario analyzed loss of all imported water to the District for 6 months due to Delta levee failure
	Long-term Delta Outage (24 Months)	This scenario analyzed loss of all imported water to the District for 24 months due to Delta levee failure
Regional Power Outage	Power Outage	This scenario analyzed loss of power at several District facilities

These selected outage scenarios were used to define specific facility impacts and evaluate District system performance, and to identify appropriate projects and operational strategies to increase District reliability for supplying and delivering water. The specific facilities impacted in each of these outage scenarios are further defined in Section 3.2 below.

3.2. Specific Facility Impacts

Detailed study was performed to attribute the selected hazard scenarios to specific District facility impacts. Research efforts included incorporating available information such as reliability data from the 2005 WIRP and also additional analyses (e.g., the DRMS report and Climate Change Vulnerability Assessment) to identify facilities most likely to fail. Discussions with District staff further refined these selections to develop the final facility outage scenarios. **Table 9** summarizes the assumed facility impacts presented as days of repair time, for each of the final selected outage scenarios. There are a number of facilities with vulnerabilities that will be addressed by upcoming improvement projects as part of the District's Capital Improvement Program (CIP). For the purposes of this study, it was assumed that these facilities will not fail, as indicated with "CIP" in the table. More details on the facility outages are included in Task 5 TM.

System schematics of the District's treated water system were produced in order to create a visual representation of the infrastructure outages caused by the extreme storm and earthquake scenarios. (Note: Delta outages do not damage the District's infrastructure and thus did not require schematics). These schematics can be found in the Task 5 TM.

Table 9. Facility Repair Time (Days) for the Final Selected Outage Scenarios

Facility	RW/ TW	Extreme Storm	San Andreas EQ #1	San Andreas EQ #2	Calaveras EQ	Delta Short-Term (6 months)	Delta Long-Term (24 months)	Regional Power Outage
Bay Delta	RW					6 months	24 months	
Pacheco PP	RW	14						14
Pacheco Conduit R1	RW				21			
Penitencia Force Main	RW	CIP	CIP	CIP	CIP			
Santa Clara Tunnel	RW	60						
Santa Clara Conduit	RW		21		21			
Anderson/Coyote Reservoir	RW	CIP	CIP	CIP	CIP			
Coyote PP	RW	60						14
Cross Valley Pipeline	RW		14	14	14			
Calero Reservoir	RW	CIP	CIP	CIP	CIP			
Almaden Pipeline	RW		14	14				
Vasona PP	RW	60						14
SBA	RW	60	30	30	30			
Central Pipeline	RW		14	14				
Rinconada WTP	WTP	14	CIP	CIP	3			14
Santa Teresa WTP	WTP	14						14
Penitencia WTP	WTP	60	60	60	60			14
Penitencia Delivery Main	TW	CIP	CIP	CIP	CIP			
West Pipeline 1	TW	14	14					
West Pipeline 2	TW	14	10					
West Pipeline 3	TW	14						
Snell Pipeline	TW			14				
East Pipeline 1	TW			10				
Milpitas Pipeline	TW			10				
District/SFPUC Intertie	TW	3	3	3	3			14
Campbell Well Field	RW							14

CIP – Indicates facility will be addressed in upcoming improvement project and is assumed to not fail for the purposes of this study.

3.3. Level of Service Goals

LOS objectives can be used to measure system performance and guide system improvement planning. For the purposes of the IRP, LOS objectives represent performance standards or targets for which the District's system may strive to reach under various outage scenarios. The Task 6 TM details the existing and proposed LOS objectives for the District's system in selected outage scenarios.

Task 6 TM includes:

- LOS benchmarking research
- Preliminary Retailer discussions on LOS and tolerable outages
- Additional Retailer demand evaluation
- Existing and proposed District LOS objectives

As a result of customer demand evaluations performed in Tasks 4 and 6, this project considered one minimum winter month (February) as representing basic service and the base demand target for treated water delivery after a major disaster event. Winter demands are a reasonable benchmark for the minimum service to provide the public in the aftermath of a major disaster. Winter demands generally do not include landscaping and other significant outdoor water use that are present during other seasons, and which may be considered extraneous during emergency situations. It represented an amount based on historical data that can be reasonably associated with day-to-day continuity of residential and business operations and needs.

Minimum LOS Target

This project considered one minimum winter month (February) as representing basic service and the base demand target for treated water delivery after a major disaster event

Recent drought conditions have also further validated the use of one minimum winter month as a valid basic service benchmark, as community outreach and conservation efforts have been successful in achieving cut-backs from typical usage patterns. In the aftermath of a major disaster, particular considerations should be given to ensuring consistent public messaging at the regional level in order to keep actual basic service demands within a reasonable range.

LOS objectives for managed recharge were also considered for this project. Recent drought conditions have resulted in loss of recharge to some areas and a better understanding of short-term impacts.

Based on LOS benchmarking research, meetings with retailers, and discussions with District staff, a range of LOS objectives were considered for potential District system performance targets under various outage scenarios. LOS objectives may vary by hazards and outage scenarios, with varying degrees of water delivery targets and restoration times. **Table 10** presents a high-level concept of LOS impacts for various levels of improvements and investments, and corresponding restoration capabilities. The purpose of this matrix is to present a general "menu" of investment levels and resulting system performance, ***in concept only***. Further evaluations performed in subsequent project tasks quantified District system capabilities, led to understanding of specific needs and deficiencies, and identified

specific improvement projects, in order to further refine the appropriate investment level and corresponding LOS goal and performance level.

Table 10. Level of Service Goals

Improvements/ Investment	Restoration Capabilities			
	Earthquake	Extreme Storm	Delta Outage Short-Term	Delta Outage Long-Term
None • No action	Winter Demands @ 30-60 days	Winter Demands @ 20-30 days	20% Reduction for 6 months	20% Reduction for 24 months
Operations only (~$1M/yr) District Enhancements • Staffing considerations • Trainings/certifications • Emerg. response planning • Contingency procedures • Coordination roles/resp. • Comm./Outreach Retailer Enhancements • Utilize backup sources • Operational config. • Increase GW/SFPUC • Increase pumping ops • Activate interconnections	Winter Demands @ 30-45 days	Winter Demands @ 14-21 days	20% Reduction for 6 months	20% Reduction for 24 months
$10+ Million CIP • PL repair capabilities • Intertie improvements • Critical isolation valves • Strategic GW wells • Increase backup power • Additional pumps at Calero Reservoir	Winter Demands @ 14-30 days	Winter Demands @ 7-14 days	20% Reduction for 6 months	20% Reduction for 24 months
$100+ Million CIP • Replace critical PLs • Redundant/parallel PLs • Redundant GW source • West-side Intertie	Winter Demands @ 7-14 days	Winter Demands @ 1-7 days	20% Reduction for 6 months	20% Reduction for 24 months
$1+ Billion CIP • New PL alignments • New TW source • New RW source	Winter Demands @ 1 day	Winter Demands @ 1 day	20% Reduction for 6 months	20% Reduction for 24 months

3.4. Retailer Tolerable Outage Considerations

Task 6 TM includes:

- Tolerable Outages
- LOS Discussion
- LOS meeting notes with each retailer

A tolerable outage for retailers was defined as the reasonable amount of time that a retailer could continue to supply basic winter demands in the absence of District treated water deliveries. Meetings with District retailers were held to understand tolerances, concerns, and objectives for withstanding outages and reduced treated water delivery and groundwater recharge in response to major disasters. The notes from these retailer meetings are available in the Task 6 TM. Due to seasonal variations, discussions differentiated between winter (low demand) conditions and summer (high demand) conditions. Tolerable outages for retailers are summarized in **Table 11.**

Table 11: Retailer Tolerable Outage Durations

Retailer	District Treated Water		Managed Groundwater Recharge
	During Winter	During Summer	
Cal Water	14 days	Hours	Unknown
Gilroy	Groundwater only system		60+ days to months
Great Oaks	Groundwater only system		2 years
Milpitas	Indefinite	Indefinite	Unknown
Morgan Hill	Groundwater only system		60 days
Mountain View	30 days	30 days	Unknown
San Jose Muni	3-5 days	Hours	3+ months
San Jose Water Company*	Indefinite	14 days	Unknown
Santa Clara	Indefinite	Indefinite	9+ months
Sunnyvale	Indefinite	7 days	Unknown

*varies by turnout and zone

Generally, a 30-day outage period/restoration goal may be tolerable for most retailers given their back up water supplies. Exceptions include Cal Water and City of San Jose (San Jose Muni), whose outage tolerances may be of shorter duration. Without District treated water supply, Cal Water would have difficulty serving specific areas of their system, particularly in the Vallco turnout area in Cupertino where there is limited groundwater capability to provide backup supply. Cal Water also has some pipeline capacity limitations that make it difficult to move water from their other areas. They could reasonably withstand a restoration period of up to two weeks. For San Jose Muni, District treated water is the only normally-available supply to their Evergreen service area. Backup groundwater wells in that area have limited capacity and state-mandated operational restrictions. As a result, restoration periods of more

than three to five days may be a hardship for San Jose Muni. Selection of recovery periods longer than these stated tolerable restoration times may prompt projects specific to these retailer areas.

With regard to managed groundwater recharge, Morgan Hill is most vulnerable to a loss of District managed recharge. Given this knowledge, it has historically been the practice of the District to prioritize recharge to areas which may benefit Morgan Hill groundwater supply over other areas which may be more tolerant to reductions or outages of recharge. Following a major disaster, the District will continue to prioritize these recharge deliveries as such.

Santa Clara Valley Water District

Infrastructure Reliability Plan

Chapter 4 Baseline System Performance

AECOM

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4 BASELINE SYSTEM PERFORMANCE

The District's ability to deliver water in the event of an outage scenario was evaluated based on the facilities that are assumed to fail as discussed in the previous chapter. Modeling and analyses were used to determine the capability of the District to restore retailer demands partially or in full, and to determine the restoration time for recovery with its current baseline system. It should be noted that planned capital improvements as discussed in the previous chapter were also assumed to be in place. Additionally, projects recommended in the District's 2012 WSIMP were assumed to be in place in evaluation of the Delta outage scenarios. The analysis quantified how long it would take to restore service to the East and West treated water systems, and to restore critical managed recharge operations in the event of an outage scenario.

This chapter presents an overview of damaged facilities and potential repair sequences necessary to restore treated water service to retail customers. The availability of treated water for each retailer at multiple time-steps following an outage is summarized. Additionally, this chapter includes an analysis of areas likely to fall below preliminary performance goals and require improvement. More detail can be found in the Task 7 TM.

4.1. Outage Scenario Modeling

For each outage scenario, the District project team analyzed the failed infrastructure and made assumptions on the priority and duration of repair activities – in other words, which facilities would be repaired first, and how long it would take to make repairs and return to operational service.

The team utilized the pipeline network model to check for hydraulic or supply constraints with specific facilities out of service. The District employs the following three models to analyze its water supply and distribution system:

Water Resource Planning Model: The Water Evaluation and Planning System (WEAP) model simulates the total management of current and future water resources in Santa Clara County.
Groundwater Models: MODFLOW models are used to evaluate groundwater storage and groundwater levels under various operational and hydrologic conditions.
Water Distribution Networks: Innovyze's H2ONet model allows staff to determine system hydraulic and capacity constraints. The District has three separate hydraulic models for its raw water and treated water east and west supply systems.

Task 7 TM:

- Presents an overview of damaged facilities and potential repair sequences necessary to restore treated water service to retail customers
- Determines which retailers experience a loss of District treated water in each outage scenario
- Summarizes the availability of treated water for each retailer at multiple time-steps following an outage

The District project team modeled a variety of operating conditions for each outage scenario to check what level of demands they are able to supply (minimum or average demands) to the water treatment plants under different pumping conditions. Using the information on repair assumptions and constraints, the team was able to determine the duration of each outage scenario to water delivery capabilities. The baseline performance of the District system was evaluated and documented in the Task 7 TM.

The following sections describe which side of the treated water system (East and West) experience loss of District treated water in each outage scenario and summarize the availability of treated water at multiple time-steps following an outage. The analysis assumed that the entire east or west side of the District's treated water delivery system would be out for the same amount of time, and restored all at once.

Recovery of critical recharge to the groundwater system is also presented. Groundwater wells are the sole source of water supply for the City of Morgan Hill, the City of Gilroy, and Great Oaks Water Company. In the case of City of Morgan Hill, prioritizing managed recharge is required to maintain groundwater levels sufficient for pumping at their wells due to their location on a shallow part of the groundwater basin. The City of Gilroy and Great Oaks Water Company are more resilient to reductions of managed recharge, due to their geographic location on a more plentiful and reliable portion of the groundwater basin.

It is important to note that this analysis only indicates availability of District supplies; availability of other treated water sources (such as groundwater or SFPUC supply) are not displayed here. More information on the retailer outages and repair sequences can be found in the Task 7 TM and Task 9 TM.

Task 9 TM:

- Depicts availability of District supplies
- Provides visual representations of system delivery status for retailers throughout the recovery period

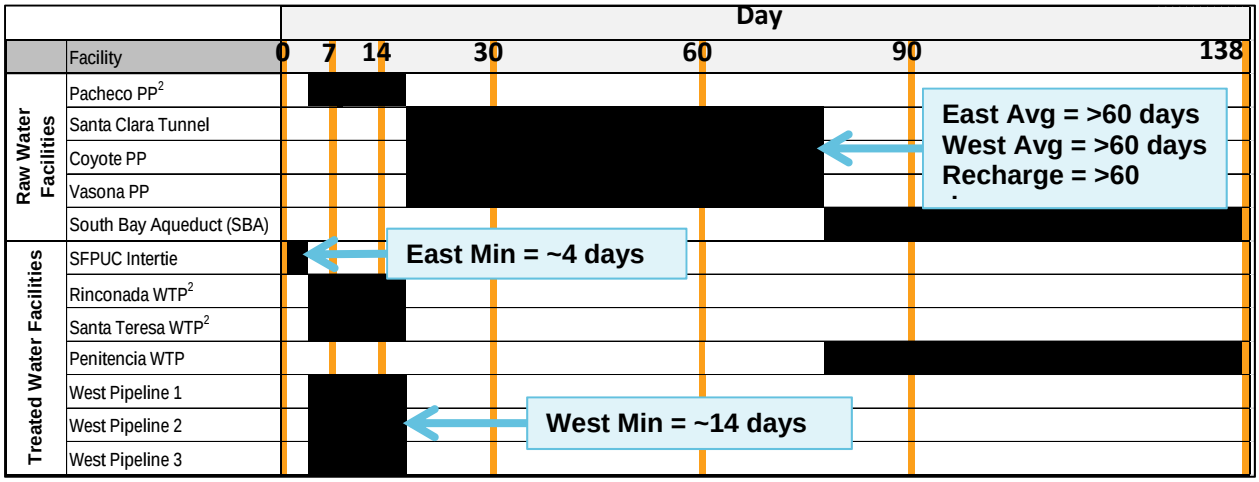
4.1.1. Extreme Storm

The District project team analyzed infrastructure outages caused by an extreme storm, and made assumptions on the priority and duration of repairs in order to determine the District's ability to restore service with its current baseline system, planned Capital improvements, and no additional improvements in place. The Extreme Storm scenario was expected to cause landslide damage to the Penitencia Water Treatment Plant and the SBA, which will likely take more than two months to repair. The H20Net model was used to confirm that the system does not have any hydraulic or supply constraints with some individual facilities out of service.

The Task 7 TM identified two repair sequences (Sequence A and B) to address the damage incurred from an extreme storm event. Both repair sequences prioritized repairing the West Pipeline first. The first repair sequence, Sequence A, then prioritized the restoration of San Felipe supplies. The second repair sequence, Sequence B, prioritized the restoration of SBA supplies. In this outage scenario, the

restoration times for both repair sequences were the same. For brevity, only Sequence A is summarized in **Table 12**, for further details on both Sequences A and B, refer to Task 7 TM. The length of the black bars represent the duration for repairing each facility. At the time-steps when infrastructure would be repaired following an extreme storm, East and West-side retailers are able to receive increased amounts of District treated water.

Table 12. Extreme Storm Repair Sequence A[1]



[1] Sequence A shown here. See Task 7 TM for more details on both Sequences A and B.
[2] Failure Mode= Power

In this scenario, minimum demands could be restored relatively quickly, and with the wet weather conditions associated with an extreme storm, winter demands would likely be sufficient. The East-side retailers receive minimum demands after approximately four days, due to the availability of the SFPUC intertie. In the Extreme Storm scenario, the West pipeline is damaged, and service to the West-side retailers cannot be restored until it is repaired after approximately 14 days. Recovery of critical recharge in the storm scenario is over 60 days due to multiple landslide failures. It was assumed that in the extreme storm scenario, managed recharge would be less critical due to excess natural infiltration and runoff.

The District/SFPUC Intertie will require backup power to operate during the associated 14-day power outage, and assumed to require refueling every three days for continued operations. Following an Extreme Storm outage scenario, other critical facilities that require backup power, such as District pumping plants and water treatment plants, are expected to fail and already assumed to be non-operational during the associated 14-day power outage. Therefore, backup power is not needed for these facilities that are otherwise non-operational.

4.1.2. Earthquake

The District project team analyzed infrastructure outages caused by each earthquake scenario and made assumptions on the priority and duration of repairs in order to determine the District's ability to restore

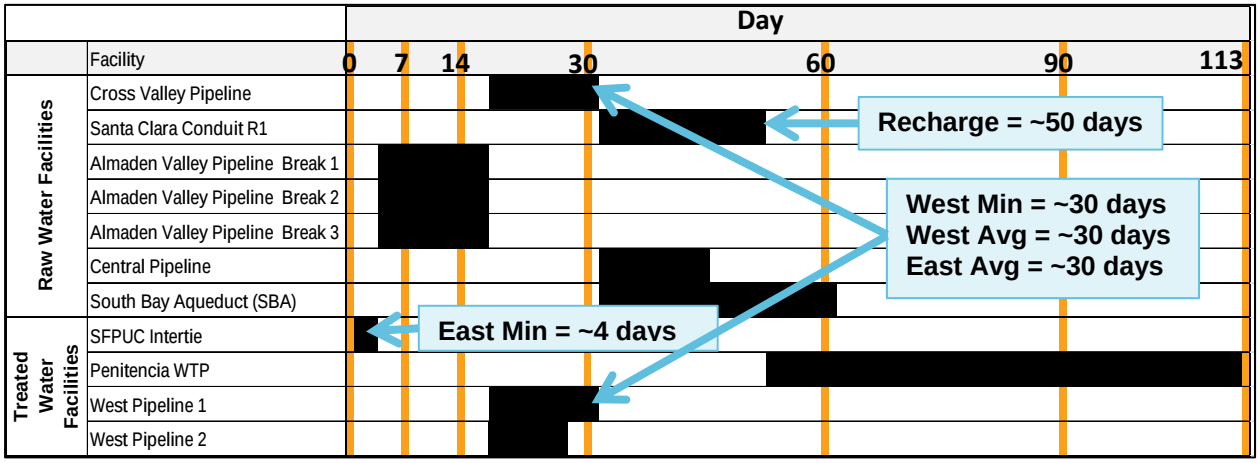
service with its current baseline system, planned Capital improvements, and no additional improvements in place. The H20Net model was used to confirm that the system does not have any hydraulic or supply constraints with some individual facilities out of service.

For each earthquake outage scenario, the Task 7 TM identified two repair sequences (Sequences A and B) to address the damage incurred from an earthquake event.

4.1.2.1. San Andreas Earthquake 1

The first repair sequence for a M7.9 San Andreas Earthquake 1, Sequence A, prioritized repairing the Almaden Valley and Cross Valley pipelines to restore local water supply sources (Calero and Anderson Reservoirs). The second repair sequence, Sequence B, prioritized repairing the SBA and Central Pipeline. Repair Sequence A resulted in superior system restoration. For brevity, only Sequence A is summarized in **Table 13**, for further details on both Sequences A and B, refer to Task 7 TM.

Table 13. San Andreas Earthquake 1 Repair Sequence A[1]



[1] Sequence A shown here. See Task 7 TM for more details on both Sequences A and B.

The East-side retailers would receive minimum demands from the District system after approximately four days once the SFPUC intertie is able to feed the East pipelines. After the breaks in West Pipeline 1 and 2 are restored, the West-side retailers would be able to meet average demands after approximately 30 days. The restoration of the Cross Valley pipeline after approximately 30 days restores average demands to the east retailers. Critical Recharge is restored after approximately 50 days upon restoration of the Santa Clara Conduit.

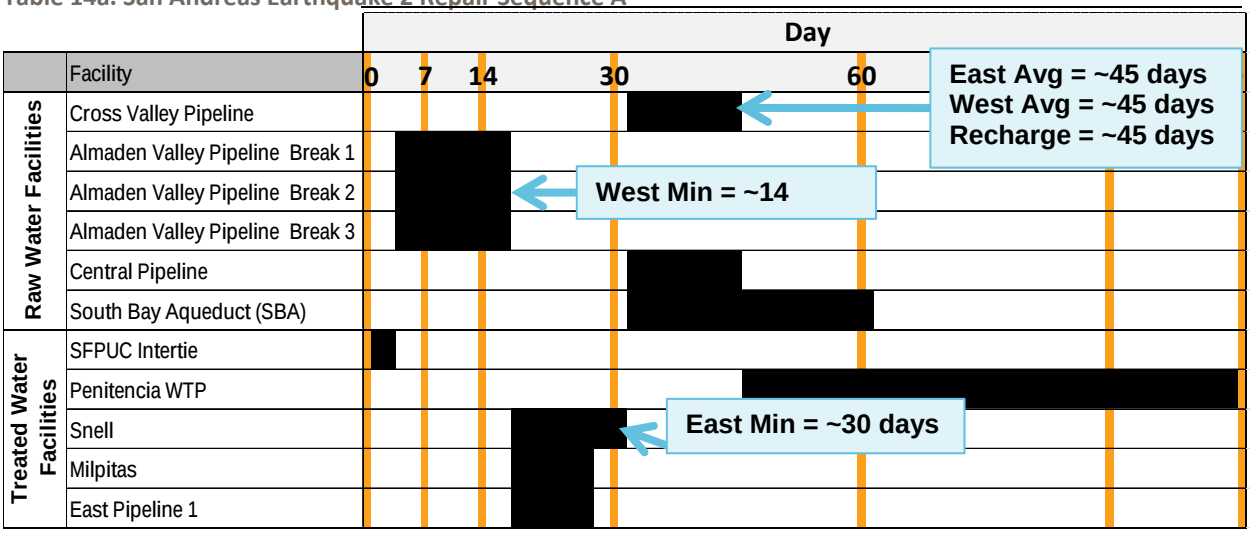
The District/SFPUC Intertie will require backup power to operate during the associated 14-day power outage, and assumed to require refueling every three days for continued operations. Following the San Andreas Earthquake 1 outage scenario, other critical facilities that require backup power, such as District pumping plants and water treatment plants, are either expected to fail or will receive no source water due to upstream facility failures, so are already assumed to be non-operational during the associated

14-day power outage. Therefore, backup power is not needed for these facilities that are otherwise non-operational.

4.1.2.2. San Andreas Earthquake 2

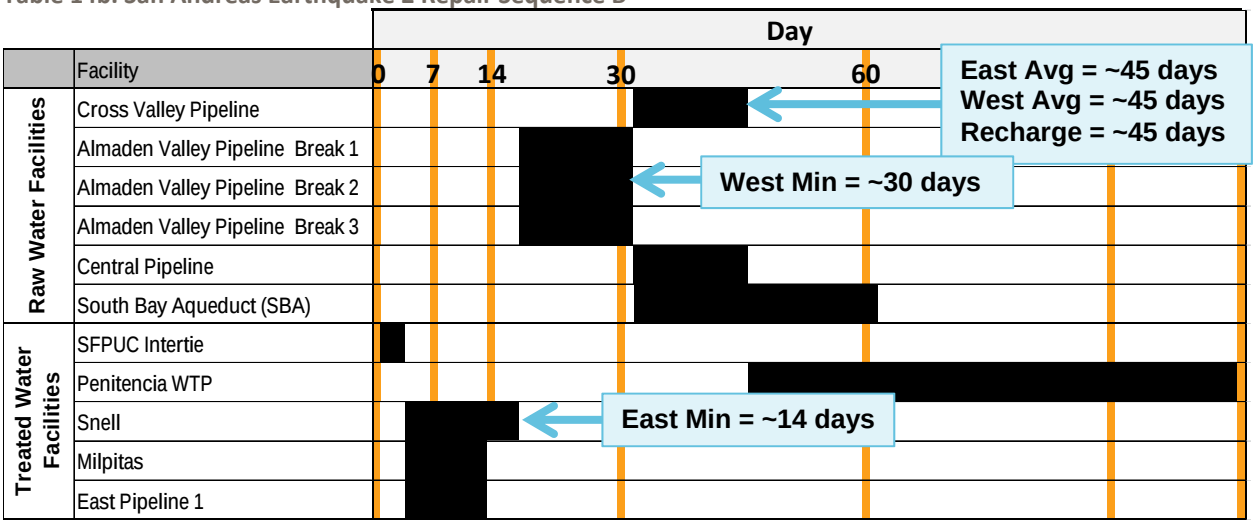
The first repair sequence for a M7.9 San Andreas Earthquake 2, Sequence A, prioritized repairing raw water pipelines to restore service to the West treated water system first. The second repair sequence, Sequence B, prioritized repairing the East treated water pipelines to restore service to the East treated water system first. Both scenarios are shown in **Table 14a** and **Table 14b**.

Table 14a. San Andreas Earthquake 2 Repair Sequence A[1]



[1] Sequence A shown here. See Task 7 TM for more details on both Sequences A and B.

Table 14b. San Andreas Earthquake 2 Repair Sequence B[1]



[1] Sequence B shown here. See Task 7 TM for more details on both Sequences A and B.

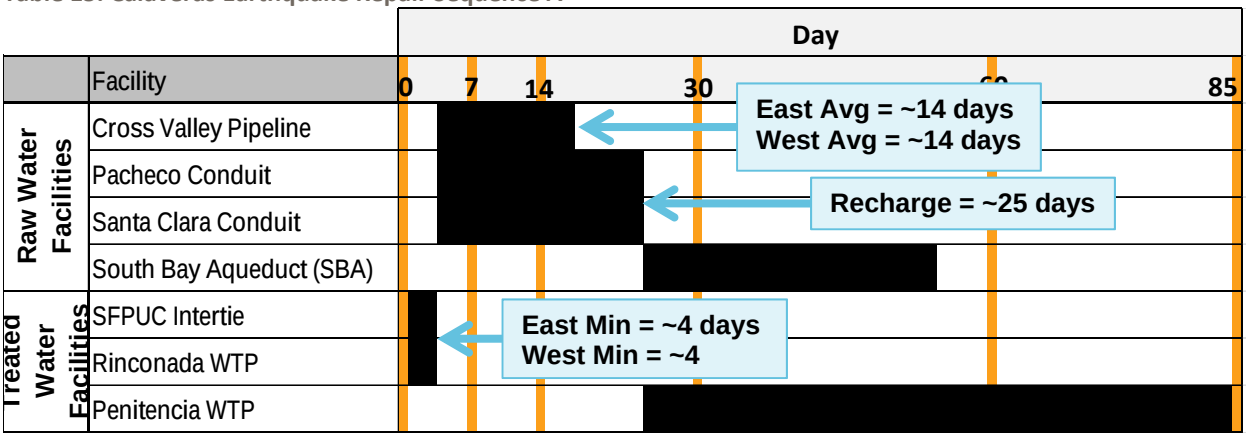
Since Sequence A prioritized West-side system repairs, the West-side retailers can meet minimum demands after approximately 14 days, while East-side retailers receive minimum demands after approximately 30 days. In Sequence B, East-side system repairs were prioritized, so the East-side retailers receive minimum demands after approximately 14 days, and West-side retailers receive minimum demands after approximately 14 days. Critical Recharge is restored after approximately 45 days in both scenarios.

After the San Andreas Earthquake 2 outage, most key facilities that require backup power (pumping plants and water treatment plants) are either expected to fail or will receive no source water due to upstream facility failures during the associated 14-day power outage, so it is assumed that backup power is not needed at those facilities. The District/SFPUC Intertie is expected to remain functional following the San Andreas 2 outage, but cannot be utilized while the Milpitas, East, and Snell Pipelines are out of service (a minimum of 14 days for repairs).

4.1.2.3. Calaveras Earthquake

The damages incurred from a M6.2 Calaveras earthquake are less significant and widespread when compared to facilities damages incurred from a M7.9 San Andreas Earthquake. Both repair sequences for a M6.9 Calaveras earthquake prioritized repairing the Cross Valley Pipeline first. The first repair sequence, Sequence A, then prioritized restoration of San Felipe supplies. The second repair sequence, Sequence B, prioritized the restoration of SBA supplies. Repair Sequence A resulted in superior system restoration. For brevity, only Sequence A is summarized in **Table 15**, for further details on both Sequences A and B, refer to Task 7 TM.

Table 15. Calaveras Earthquake Repair Sequence A[1]



[1] Scenario A shown here. See Task 7 TM for more details on both Sequences A and B

Both the East- and West-side retailers may receive minimum demands from the District system after approximately 4 days, and receive average demands after approximately 14 days. Critical Recharge is restored after approximately 25 days, once repairs to the Pacheco and Santa Clara Conduits are completed.

In the Calaveras earthquake scenario, fuel delivery to the following District facilities would be required during the associated and assumed 14-day power outage: SFPUC Intertie, Rinconada WTP and Santa Teresa WTP.

4.1.3. Delta Levee Failure

For both Delta outage scenarios (6-month and 24-month), it was assumed that all local District infrastructure will remain operational. It was assumed that an earthquake or flood event in the Delta is far enough away from Santa Clara County that it would not badly damage local infrastructure. The Delta outage evaluations looked to understand District capabilities for deliveries (treated water and groundwater recharge) in the absence of imported water and relying only on local storage. Analysis of the Delta outage scenarios in the Task 7 TM focused on whether or not the District could continue limited service for the outage duration with no imported water supplies. The WEAP and groundwater models were utilized to answer this question. The assumptions used to model the Delta outage scenarios are summarized on the left (*see textbox*).

Delta Outage Analysis:

- Utilized normal hydrology year (2002). A conscious decision was made to not combine major disasters (e.g., earthquake plus drought).
- Assumed the Governor would declare an emergency and call for 20% water use reduction. The reductions were phased over three months at a rate of 10%, 15%, 20% and then in place for remainder of outage scenario.
- Utilized 2025 water demand values from the 2010 Urban Water Management Plan
- Utilized the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) rule curves for the first six months of an outage.
- Assumed the SFPUC Intertie was available during summer months.
- Assumed the indirect potable reuse (IPR) and other WSIMP projects would be in place, with the exception of dry year options.

Analysis of 6-month and 24-month Delta outage scenarios showed that the District can continue service for both periods without any imported water supplies without causing any subsidence. The WEAP modeling results showed that there are unmet demands at the treatment plants and groundwater recharge facilities; however, the impacts of a Delta outage are largely operational as they would require retailers to supplement their supplies with groundwater via pumping and for District staff to actively manage the groundwater recharge program to meet any countywide needs.

Power outages that could impact District facilities are not expected during a Delta Levee Failure event.

4.1.4. Regional Power Outage

Fuel Analysis TM includes:
(Power Outage Appendix)

- Estimated daily fuel consumption rates by month for critical facilities

The regional power outage scenario analysis considered fuel requirements from a prolonged regional power outage with the assumption that all facilities are operable for the duration of the power outage (14 days) and will require emergency fuel storage and deliveries for continued operations. The goal of the analysis was to estimate how long the District can operate their system utilizing backup power. The analysis was limited to the District's water treatment facilities and the District/SFPUC Intertie. The District's pump stations were not specifically analyzed as they do not have generators large enough to run the pumps. The pump stations are not always required, as the District's system can operate by gravity when demands are low, which aligns with this project's LOS goal of minimum winter demands.

Existing on-site fuel storage for District facilities is limited to Rinconada WTP, Santa Teresa WTP, Penitencia WTP, and the District/SFPUC Intertie in the event of a prolonged regional power outage. Based on historic energy consumption and assumptions regarding future upgrades to Rinconada WTP, the District may be able to operate facilities on backup fuel storage for between 3 to 10 days, depending on the time of year and operating conditions. The District could operate on backup power for longer periods given regular external fuel deliveries. More details are included in the Fuel Analysis Memo.

4.2. Baseline District System Performance

After outage scenario modeling, the next step was to identify specific service areas and infrastructure that require reliability improvement projects due to a high probability of failure, large consequence of failure, or both. The purpose was to identify the shortfalls in the District's system performance with respect to the selected outage scenarios. This section identifies water system infrastructure and service area shortfalls that the District retail customers may experience in case of the selected outage scenarios.

Modeling showed that the District can continue service for both Delta outage periods without any imported water supplies without causing any subsidence, and that they are capable of preventing treated water outages to customers for a reasonable duration of time during a power outage. Therefore, the power outage scenario and the short- and long-term Delta outage scenarios are not included in the discussion on system shortfalls.

The total time that each facility will be out of service for the Extreme Storm, San Andreas 1, San Andreas 2, and Calaveras scenarios is provided in **Table 16**. These restoration times are based on assumptions regarding which facilities will fail in each scenario, assumed failure modes and repair times, suggested repair prioritization, and hydraulic model verification. The critical facilities are organized into groups that show their importance for meeting the LOS goals (minimum demands, average demands, and

critical recharge). The impacts to the treated water system and to critical recharge are discussed in the following subsections.

Table 16. Total Number of Days to Repair Each Critical Facility During Outage Scenarios[1].

Facility	Raw or Treated Water Facility	Extreme Storm[2]	San Andreas EQ #1[2]	San Andreas EQ #2[3]	Calaveras EQ[2]
District/SFPUC Intertie	TW	4	4	4	4
Rinconada WTP	WTP	18			4
West Pipeline 1	TW	18	32		
West Pipeline 2	TW	18	28		
West Pipeline 3	TW	18			
Snell Pipeline	TW			18	
East Pipeline 1	TW			14	
Milpitas Pipeline	TW			14	
Almaden Pipeline	RW		18	32	
Days to Meet Minimum Demands	East	4	4	18	4
	West	18	32	32	4
Santa Teresa WTP	WTP	18			
Cross Valley Pipeline	RW		32	46	18
Coyote PP	RW	78			
Vasona PP	RW	78			
Days to Meet Average Demands	East	78	32	46	18
	West	78	32	46	18
Pacheco PP	RW	18			
Pacheco Conduit R1	RW				25
Santa Clara Tunnel	RW	78			
Santa Clara Conduit	RW		53		25
Days to Meet Critical Recharge Demands		78	53	46	25
Central Pipeline	RW		46	46	
SBA	RW	138	62	62	55
Penitencia WTP	WTP	138	113	106	85
Days to Return to Normal Operations		138	113	106	85

[1] Estimated outage durations are approximate and intended to be planning-level assumptions only, and do not indicate actual outage durations.
[2] Repair Sequence A represented
[3] Repair Sequence B represented

The expected time to restore minimum demands for each retailer for the Extreme Storm, San Andreas 1, San Andreas 2, and Calaveras scenarios are presented in **Table 17** below.

Table 17. Restoration Time for Minimum Demands to District Treated Water Retailers

Retailer		Extreme Storm	San Andreas EQ #1	San Andreas EQ #2	Calaveras EQ
East-Side Retailers	Milpitas	~4 days	~4 days	~14 to 30 days	~4 days
	San Jose Muni				
	SJWC East				
West-Side Retailers	Cal Water	~14 days	~30 days	~14 to 30 days	~4 days
	Mountain View				
	Santa Clara				
	Sunnyvale				
	SJWC West				

The analysis showed that District treated water service may be unavailable to retailers for approximately 4 to 30 days depending on the scenario. The results of Task 7 demonstrated that, in the worst case scenario, the expected outage and recovery time for the District to provide minimum demands to retailers is approximately 30 days. For less severe events, the expected outage time before minimum demands can be restored may be as little as approximately 4 days.

Tolerable outage durations are discussed and identified in **Chapter 3**. Many retailers could tolerate a loss of District treated water for at least one month during winter demand conditions, which was agreed upon as the target demand.

4.2.1. East Treated Water System Considerations

Due to availability of the District/SFPUC intertie, service can be restored to the East treated water system immediately, or within a few days in most scenarios. The intertie can supply approximately 40 MGD while minimum winter treated water demand for the East-side retailers is 42 MGD, resulting in only a 2 MGD deficit, which could be made up with conservation efforts.

With the exception of the San Andreas 2 Earthquake outage scenario, minimum demands can be restored within approximately 4 days without any system improvements. In the San Andreas 2 earthquake scenario, the East, Snell and Milpitas pipelines are damaged and minimum demands cannot be restored to the East retailers until those pipelines are repaired after approximately 14 days. Some level of investment would be required to ensure that East-side retailers can better tolerate potential outage durations of up to approximately 30 days in the San Andreas 2 outage scenario.

Average demands can be restored to the East treated water system after approximately 14 to 75 days following an outage. The Cross Valley Pipeline must be restored in order to restore average demands in all of the earthquake outage scenarios. In an Extreme Storm outage scenario, power to the Santa Teresa WTP is more quickly restored, but the Coyote and Vasona pumping plants take up to approximately 78 days to repair and restore average demand operations.

Most East side retailers can tolerate a loss of District treated water for at least one month during winter demand conditions, which was selected as the target demand. However, San Jose Muni noted that they could potentially only tolerate loss of District treated water for less than one week in winter depending on operating conditions.

4.2.2. West Treated Water System Considerations

The range of restoration times to provide minimum demands for the West system varied by scenario, from approximately 4 days to 30 days. In the Extreme Storm scenario, the West pipeline is damaged, and service cannot be restored until it is repaired after approximately 14 days. In the San Andreas 1 Earthquake scenario, the Almaden Valley Pipeline and West pipeline are expected to fail in multiple locations. Service cannot be restored to the West system until these two pipelines are repaired, which is estimated to occur at approximately 30 days. In the San Andreas 2 earthquake scenario, the Almaden Valley Pipeline is expected to fail in multiple locations, but the West Pipeline remains intact. As such, service can be restored once the Almaden Valley Pipeline is repaired, after approximately 14 days. The Calaveras earthquake scenario is the least severe of the four outage scenarios. It does not assume damage to the West or Almaden Valley Pipelines. As such, Calero supplies would be available for treatment at Rinconada WTP, and minimum demands can be met after approximately 4 days.

The same facilities needed to restore average demands to the East treated water system are also necessary to restore average demands to the West treated water system. Depending on the earthquake outage, the Cross Valley Pipeline takes between approximately 14 to 45 days to repair and restore average demand operations to the West. In an Extreme Storm outage scenario, the Santa Teresa WTP, and the Coyote and Vasona pumping plants must be repaired to restore average demands to the West.

Some level of investment would be required to ensure that West-side retailers can better tolerate potential outage durations of up to approximately 30 days in the San Andreas outage scenarios. Although most West side retailers can tolerate a loss of District treated water for at least one week during summer and at least one month during winter, Cal Water noted that they could potentially only tolerate loss of District treated water for several hours in summer and two weeks in winter depending on operating conditions.

4.2.3. Critical Recharge Considerations

Recovery of critical recharge in the earthquake scenarios ranges from approximately 25 to 50 days. In the San Andreas 2 scenario, critical recharge is restored upon completion of repairs to the Cross Valley pipeline after approximately 45 days because the Santa Clara Conduit is not damaged in this scenario. The Santa Clara Conduit needs to be repaired in order to restore critical recharge in the San Andreas 1 and Calaveras scenarios. Recovery in the extreme storm scenario is much longer, at approximately 75 days, due to failure of several pumping plants and multiple landslide failures.

In the Delta modeling efforts in Task 7, the project team found that all retailers can sustain groundwater pumping for up to 60 days with no managed recharge. It is assumed that in the Extreme Storm scenario, managed recharge would be less critical due to excess natural infiltration and runoff.

Improvement projects already in the District CIP will enhance supply reliability to Main and Madrone ponds in support of critical recharge.

Critical recharge may be restored more quickly than the numbers presented in **Table 16**. The District is currently improving the Main and Madrone pipelines, which will allow the District to deliver water from Anderson reservoir to the Main and Madrone ponds. Additionally, the District can supply the Main and Madrone ponds by backfilling the Santa Clara Conduit using Anderson supply to reach the raw water turnouts in Morgan Hill. The ability to do so depends on various operational considerations, and would be evaluated during an emergency for feasibility and need.

4.2.4. Pipeline Considerations

The pipeline damage analysis narrowed down specific areas of vulnerability for pipelines with high probabilities of failure due to seismic hazards, pipe age, and pipe material. Note that current pipe condition was not included in the probability of failure analysis. The analysis extended and updated the work performed in the previous 2005 WIRP. By utilizing this planning-level assessment, the District may be able to focus repairs and rehabilitations, and prioritize the critical sections of pipelines expected to fail.

Critical sections of each District pipeline were identified by delineating pipeline segments with the highest number of expected potential breaks or leaks. **Table 18** summarizes the percentage of length of these critical sections compared to the total lengths of the entire pipelines. The critical section data was combined with other relevant data and displayed in comprehensive seismic hazard maps. The pipe damage analysis maps visually demonstrate the potential for District facility failure in both the San Andreas and Calaveras earthquake outage scenarios.

Pipe Damage Analysis Maps (Earthquake Appendix):

- Used to identify and assess locations of critical pipeline sections in relation to known geologic hazards
- Planning-level information that may support development of prioritization for improvements
- See Task 9 TM for pipe damage analysis methodology

The critical section maps were reviewed by a seismic expert (Don Ballantyne) for insight on the locations of likely failure points. The pipelines that have critical sections that may be considered higher priority for the District to repair are noted in **Table 18**, along with information from the Risk Exposure Analysis and the results from the Pipeline Damage Assessment. It should be noted that this analysis was not conducted with the intent of meeting the LOS Goals with respect to the selected outage scenarios. A facility might have high vulnerability and/or high priority due to geologic and seismic hazards, but the repair may not necessarily lead to achieving the LOS goals set forth in this project. More information can be found in Task 9 TM.

Table 18. Summary of Pipeline Damage Assessment

Facility	Critical Section as Percentage of Total Pipeline Length	Repair Priority Recommendation by Seismic Expert
Almaden Pipeline	41%	High
Central Pipeline	36%	High
Cross Valley Pipeline	38%	Medium
East Pipeline 1	36%	Low
Milpitas Pipeline	43%	Low
Pacheco Conduit R1	21%	Medium
Santa Clara Conduit	51%	Medium
Snell Pipeline	55%	High
SBA	39%	Medium
West Pipeline 1	44%	Medium
West Pipeline 2	32%	Medium
West Pipeline 3	10%	Medium

4.3. Risk Exposure

It would be very expensive, and may not be feasible to undertake improvement projects for all the facilities expected to fail in the outage scenarios. The next steps take a closer look at the risk exposure of each facility in order to help prioritize improvement projects. The levels of risk that the District and regional partners are willing to accept will influence the selection of level of service goals and corresponding system improvements needed.

Task 9 TM includes:

- Risk exposure methodology
- Risk exposure scores for critical facilities

Risk exposure was analyzed for each District facility. The factors contributing to risk exposure include the probability of failure and the consequence of failure. The Task 9 TM details the process for developing risk exposure scores for District facilities. **Figure 8** provides a summary of the resulting risk exposure scores for District facilities that are impacted by any of the earthquake outage scenarios (5=Highest Risk, 1= Lowest Risk). The high risk facilities were used to help inform the project screening process which is discussed in **Chapter 5**.

Figure 8. Schematic of District's System with Color Coded Risk Exposure Scores

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4.4. Regional Response Capabilities

This section discusses strategies to improve system shortfalls following an outage scenario. The project team worked with internal and external stakeholders to assess existing regional capabilities and to identify potential new regional projects for meeting level of service goals. Regional area maps were developed to better understand the general geography of how facility outages may impact the District and retailers at a regional level.

Regional Area Scenario Maps (Task 8 TM):

- Illustrates outage scenarios in schematics
- Displays specific facility outages (red)
- Presents availabilities of customer turnouts correlating with failed or intact pipelines

4.4.1. Excess Capacity

Additional efforts for Task 8 led to further understanding of capacity, minimum usage, and available excess supply by retailer and water supply type. Combining this information led to a more comprehensive regional supply versus demand picture that shows where potential excess capacity from one water supply source may be adequate or helps compensate for shortages in other water supply sources. The recovery goal is to provide the total minimum water demands (169 MGD) from the available sources for each of the outage scenarios. **Table 19** identifies where excess system capacity may be available from each source for each retailer. The purpose of this information is to determine if there is potential available excess supply for meeting the LOS goals.

Task 8 TM includes:

- Maximum infrastructure transmission capacity of each water supply source for each District retailer
- Minimum retailer usage by source utilizes historical retailer demand data
- High-level regional and retailer-specific supply and demand picture

Table 19. Excess Capacity for Retailer Water Supply Sources (MGD)[1]

Retailer	Groundwater	District Treated Water	SFPUC	Local Surface Water	Total Excess Capacity
Cal Water	11.0	0.8	n/a	n/a	11.8
Gilroy	14.1	n/a	n/a	n/a	14.1
Great Oaks Water Company	23.8	n/a	n/a	n/a	23.8
Milpitas	1.7	10.6	30.8	n/a	43.1
Morgan Hill	11.5	n/a	n/a	n/a	11.5
Mountain View	6.0	1.9	5.1	n/a	13.0
San Jose Muni	16.4	21.2	18.3	n/a	55.9
SJWC	72.5	135.4	n/a	14.5	222.3
Santa Clara	43.4	2.4	8.2	n/a	54.0
Sunnyvale	8.3	12.5	46.9	n/a	67.7
SFPUC Intertie	n/a	n/a	40	n/a	40
TOTAL	208.7	184.8	149.2	14.5	557.2

[1] Excess capacity may not be accessible to all parts of Retailer systems, as there may be system and geographical constraints on utilizing alternative supplies.

From a regional perspective, there may be potential excess capacity of more than 200 MGD in groundwater, more than 140 MGD in SFPUC, and more than 10 MGD in local supplies which may be utilized to offset shortages in District treated water supply. However, retailer systems may not necessarily have capabilities to utilize this excess capacity in all portions of their systems to replace District treated water demands, and supply may not be available when needed. The retailers have multiple pressure zones or service areas for water distribution that may be served by one or more different water supply sources.

4.4.2. Back-Up Supply

The specific zones within retailer service areas where each supply source is utilized as the primary potable water source are identified in the Task 8 TM. Retailer back-up supplies were also evaluated in order to identify specific areas which have redundant supply capabilities in case the primary water supply sources are unavailable. The retailer service areas were evaluated and summarized in **Table 20** in order to identify the locations or zones within each retailer service area that rely on primary water sources, and whether there is capability to utilize back-up supplies in case of emergency outages. This effort represented the next step in understanding how the excess capacities may be effective and further improved if needed.

Task 8 TM includes:

- Specific zones within retailer service areas where each supply source is utilized as the primary potable water source
- Detailed tables that include information on backup sources for all retailers

This effort found that many retailer zones that are primarily served by District treated water have one or more backup supplies available, such as groundwater wells, interties, and SFPUC supply. For retailers that are groundwater supply only, Morgan Hill is more sensitive to groundwater shortages, while Gilroy and Great Oaks Water Company have more plentiful groundwater conditions. These efforts provided insight to identify specific retailer service areas that can and cannot access groundwater supply to replace loss of District treated water.

Table 20. Primary Source of Supply for Each Retailer Zone and Availability of Back-Up Supply Source[1]

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4.4.3. Groundwater Supply and Demand Analysis

There is potentially over 200 MGD of total excess groundwater supply capacity among the District-served areas, and there may be opportunities to utilize this supply redundancy, and/or enhance this capability where needed. A groundwater supply and demand analysis was developed in Task 8. The purpose was to understand the groundwater supply capacity in relation to District treated water turnouts. This provided a better understanding of the capabilities and limitations of using groundwater to supply both areas that typically rely on groundwater and areas that typically rely on District treated water. Existing groundwater well capacity was assumed to be sustained after the event.

Task 8 TM includes:

- Groundwater supply and demand analysis
- Retailer groundwater well capacity summary table

Table 21 combines the minimum demands used by each retailer from groundwater and District treated water and compares it to the maximum groundwater capacity. The objective of this exercise was to identify areas where groundwater capacity alone is or is not adequate to meet total minimum demands in the event of an outage of District treated water service.

Table 21. Excess Groundwater Supply per Retailer Service Area

Retailer	Primary District Treated Water Service Areas	GW Capacity	Minimum GW Usage	Minimum Treated Water Usage	Potential GW Shortage/Excess
Cal Water	Farndon	11	2.0	4.0	+5.8
	Granger				
	Covington				
	Vallco	2		1.2	
Milpitas	Zone 1SC	1.7	0	3.8	-2.1
	Zone 2 SC				
Mountain View	Zone 3	0	0	0.6	-0.6
Santa Clara	Zone 2A	2	0	3.4	-1.4
San Jose Muni	Evergreen	8.6	6.2		+2.4
SJWC	District Turnouts (11 Zones)	100	27.5	46.6	+25.9
Sunnyvale	Zone 2	9	0.65	6.1	+2.3
	Zone 3				

In some cases, groundwater capacity alone is greater than required minimum demands, and thus may have the ability to replace loss of District treated water. In other cases, groundwater capacity is inadequate to supplant District treated water service. The analysis helped to assess where (geographically) groundwater is available to offset loss of District treated water, and also where additional enhancements are needed.

Retailer Appendix includes:

- Groundwater Supply Overview Maps for each retailer
- IRP Retailer Supply Source and Service Area Maps
  - Developed for the IRP
  - Combines information from Groundwater Supply Analysis with Retailer Service Area Maps

4.4.4. Water Transfer Considerations

This section identifies additional water transfer opportunities between retailers in order to share potential excess groundwater capacity and help tolerate outages of District treated water service in emergency events. In some cases, it may be possible to transfer excess retailer groundwater through District treated water pipelines among adjacent retailers. Retailers that can potentially provide additional groundwater to District treated water pipelines are shown in **Table 22.**

There is currently good potential for inter-retailer transfers of excess groundwater capacity from Great Oaks and San Jose Water Company. With additional enhancements or improvements, Cal Water and San Jose Muni may also be in better position to achieve inter-service area or even inter-retailer transfer of excess groundwater.

Table 22. Potential Excess Groundwater Transfers

Retailer	Zone	Excess Groundwater Capacity	Potential to Transfer to Other Retailers?
Cal Water	All District Turnouts	5.8	Yes[1]
Gilroy	Zones 1-3	14.1	No
Great Oaks	9 Zones	23.8	Yes
Milpitas	N/A	N/A	No
Morgan Hill	23 Zones	0[2]	No
Mountain View	Zone 1-2	4.9	No
Santa Clara	Zone 1, 1A, and 2	41.4	No
San Jose Muni	Evergreen	2.4	Yes[3]
	Edenvale	3.8	No
SJWC	District Turnouts (11 Zones)	25.9	Yes
Sunnyvale	Zones 2-3	2.3	No

[1] If treated water service to Vallco turnout fails, inter-retailer transfer from Cal Water may not be possible, as there are only 2 existing wells in the Vallco turnout area, and transmission capacity within the distribution system is limited.

[2] Groundwater conditions are sensitive to recharge conditions

[3] Evergreen service area has a uni-directional intertie to Edenvale service area, however there are operational restrictions on the Evergreen groundwater wells.

4.5. Reliability Improvement Needs

By integrating information on the retailer service areas that are particularly vulnerable to outages of District services, and the outage scenarios which reflect the most vulnerable District infrastructure, a clear picture of the reliability improvement needs were identified. **Table 23** describes the specific vulnerabilities of these particular retailer service areas, and identifies the critical areas to target for improvement projects. This effort found that improvement projects that target specific service areas may efficiently address the existing reliability issues. The next chapter reviews the projects and strategies to address these system needs.

Table 23. Reliability Improvement Needs

Retailer	Area	Vulnerability
Cal Water	Vallco turnout area	Limited back-up near Vallco, difficult to move water from West Pipeline turnouts to Vallco turnout area.
Milpitas	Milpitas turnout area	Requires operational and valve changes, and is more costly to operate on SFPUC water.
Morgan Hill	All	Groundwater supply is sensitive to reduction of groundwater recharge.
Mountain View	Zone 3 (Miramonte)	Requires operational and valve changes, and additional pumping costs.
San Jose Muni	Evergreen area	Back-up groundwater wells in Evergreen are not permitted for regular use.
Santa Clara	Zone 2A (Serra Tank)	One 2 MGD well in Zone 2A, which has typical demands of 3-4+ MGD. Requires booster pumps from Zone 2.

Santa Clara Valley Water District

Infrastructure Reliability Plan

Chapter 5 Portfolio Recommendations

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5 PORTFOLIO RECOMMENDATIONS

Based on results presented in the previous chapter, improvement projects that help address the District's system reliability needs were identified and evaluated. The project evaluation methodology was developed to refine a large list of potential improvement projects and opportunities into final portfolios of recommended projects. Three levels of screenings were conducted to determine which projects efficiently provide the greatest benefits to system reliability while also being cost-effective and feasible. Included in the analysis were two stages of cost estimates (generic and project-specific), which aided in the portfolio refinement process.

Task 11 TM:

- Presents the methodology and process of identifying and refining recommended project list
- Summarizes the project screening criteria and considerations
- Presents the cost estimating methodology and results
- Discusses potential implementation for the recommended projects

This chapter presents the results of project analysis, culminating in final portfolios of recommended projects. The projects recommended in this plan are incorporated by reference into the District's Local Hazard Mitigation Plan (LHMP). The methodology for identifying recommended projects and for estimating costs is also discussed throughout the chapter. Additional information regarding the project identification and screening process can be found in the Task 11 TM.

5.1. Project Identification and Screening Process

The process of identifying project opportunities and appropriate analysis methodologies incorporates important elements and information gathered throughout the project. Discussions with District management and retailers led to an understanding that high investment levels could result in system performance beyond what is needed, and may not be affordable. There was a consensus that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level, while providing sufficient system reliability and performance.

Potential opportunities were identified and discussed throughout the project, via meetings, workshops, and specific information gathering efforts. Important concepts that have been incorporated in the identification of project opportunities and reflected in the analysis methodology include:

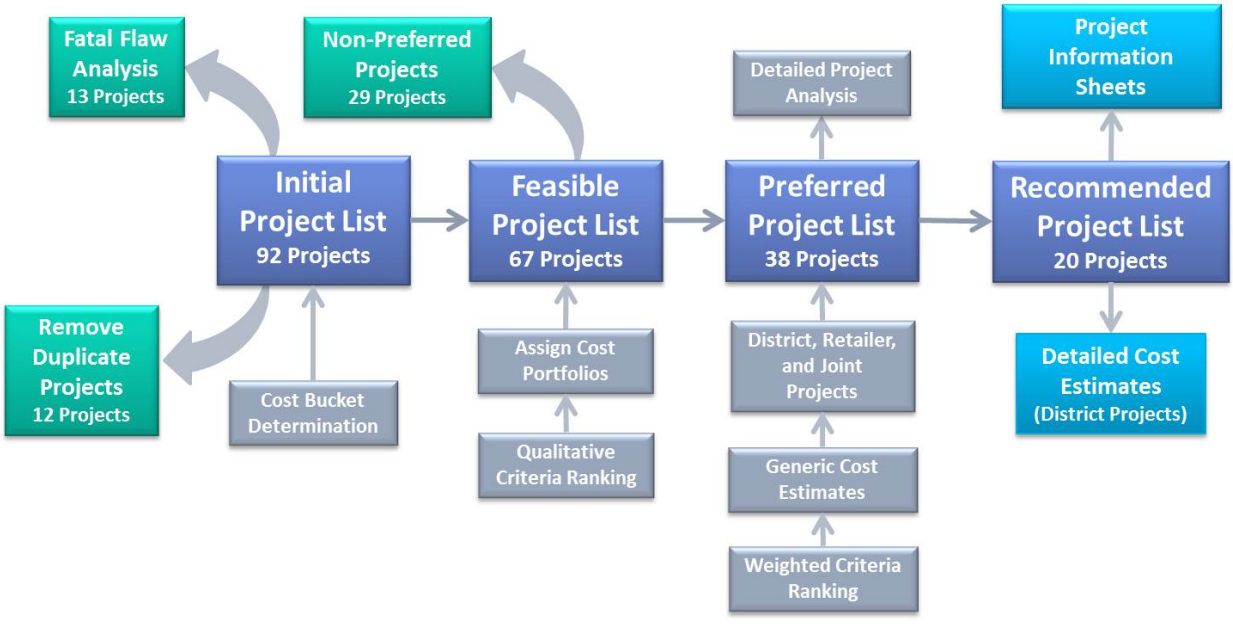
- Recent events impacting District services, such as planned and unplanned maintenance outages of District pipelines and treatment plants, and drought conditions, have led to more knowledge regarding alternate operational schemes.
- Many retailer service areas have sufficient backup supply redundancy and may not require large investments in additional reliability.

- There are specific retailer service areas that are more vulnerable to outages of District treated water. Reliability in these specific areas may be effectively improved with lower cost, localized solutions, rather than major infrastructure improvements.
- Strengthening the District's treated water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant raw water system damage. Likewise, the inverse applies as well, as strengthening the District's raw water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant treated water system damage
- Where possible and beneficial, leveraging existing assets is preferred, as both the District, retailers, and SFPUC have made significant investments in increasing system reliability and operational flexibility since the last 2005 WIRP study.
- Assets, particularly groundwater wells, which can be utilized more frequently to enhance daily operations or periodic maintenance operations, are preferred over assets that would be designated as standby for infrequent use only during major emergencies.

Project ideas were gathered based on input received from the District and retailers through several series of project meetings and workshops, and from regional master plans. The projects and opportunities were compiled into one initial project list of all potential opportunities, which contained 92 projects.

Project evaluation methodology was developed and a series of project assessment screenings was utilized to identify the recommended improvement projects. The goal was to identify the most feasible and beneficial projects that can effectively address the areas of need. This process is outlined in **Figure 9** and described in the subsequent sections. Additional documentation for all the interim project lists and analyses are provided in the Task 11 TM.

Figure 9. Overview of Project Screening Methodology



5.2. Initial Screening

The 92 potential projects were screened with an initial fatal flaw analysis to remove those that are not practical or feasible. This initial screening relied on qualitative data and engineering judgement by the project team, incorporating input from District staff, management and retailers. Considerations for classifying projects as impractical or unfeasible included recognizing projects with contractual hurdles or high costs and limited benefit. In this initial screening, 13 projects were eliminated and 12 were consolidated. A total of 67 feasible projects remained.

5.3. Secondary Screening

After the initial screening, the second round of evaluation gathered more details about the remaining 67 feasible project ideas. At this stage, additional information was collected and added to the project list. A high-level order-of-magnitude "cost bucket" was assigned to each project, as follows:

- $ = $1M range (operational improvements)
- $$ = $10M CIP range
- $$$ = $100M CIP range
- $$$$ = $1B CIP range

In general, stakeholders favored projects that would fit in an investment range of $10M to $100M. The projects in the $1B cost bucket were, for the most part, deemed too costly, and not realistic or achievable. The projects in the $1M cost bucket were viewed as minor quick fixes, or studies that would provide more information and/or increase preparedness in the event of an emergency.

The detailed rating criteria that were used to assess the feasible projects in order to identify preferred projects are described in **Table 24**. An expanded project scoring table can be found in Appendix 4 of the Task 11 TM.

Table 24. Project Rating Criteria

Rating Criteria	Description
Environmental	Projects score more points for providing specific environmental benefits. Examples of enhancements include: • Habitat restoration • Stream water quality improvement • Vegetation • Fish and wildlife support
Social/Community	Projects score more points for providing social or community benefits. Examples of enhancements include: • Reducing potential for property damage • Creating recreational opportunities
Supply/Capacity	Projects score more points for providing additional long term supply or capacity. Examples of enhancements include: • New sources of supply • Groundwater wells • Interties • Facility capacity upgrades
Operational Flexibility	Projects score more points for providing additional operational flexibility, particularly for withstanding facility shutdowns. Examples of enhancements include: • Provides supply redundancy • Facilitates wheeling or sharing water • Enables facility shutdowns
Ease of Implementation	Projects score more points for being more easily implemented. Characteristics considered include: • Land acquisition needs • Excavation requirements • Projects already in progress
Reliability	Projects score more points for increasing delivery reliability for retailers. Particular considerations are given to projects that: • Increase delivery reliability for retailers who currently cannot meet minimum demands in an outage scenario • Increase delivery reliability for retailers who currently cannot meet average demands in an outage scenario
Contribution to LOS	Projects score more points for potentially addressing one or more of the specifically identified vulnerable areas. Particular considerations are given to projects that: • Feed or wheel water through District pipelines to potentially reach vulnerable area(s) • Adds source/supply directly to vulnerable area(s)
Cost	Projects are estimated and grouped into cost categories to enable organizing into portfolios: • Operations only (less than $1 Million) • $1 to $10 Million CIP • $100 Million CIP

At this stage, the criteria were utilized to provide a qualitative analysis. Scores of "High", "Medium", and "Low" were designated and informed the screening process using engineering judgement. The feasible project list was narrowed down from 67 feasible projects to 38 preferred projects.

5.4. Final Screening

A final detailed analysis was conducted on the list of 38 preferred projects in order to develop recommended projects and opportunities, and to evaluate the portfolios against the preliminary level of service goals. Infrastructure sizes and locations, capital cost estimates, and benefits were refined in this step of the process.

5.4.1. Weighted Scores

In order to narrow down the list of preferred projects into a refined list of recommended projects, an overall weighted score was determined for each project. This quantitative analysis expanded upon the previous analysis by assigning numerical scores for each criterion, where "Low", "Medium", and "High" ratings correspond to scores of 1, 5, and 10, respectively. To calculate an overall score for each project, each of the seven criteria (excluding cost) was assigned a weight based on its relative importance. District feedback was used to finalize and weight the rating criteria. **Table 25** lists the weighting factor for each criterion and provides reasoning for the assigned weights.

Table 25. Criteria Weighting Factors

Rating Criteria	Weighting Factor	Explanation
Environmental	0.25	In an emergency, environmental concerns may be a lower priority. For example, permit violations may be preferable to serious and imminent risks to life safety.
Social/Community	0.25	In an emergency, social or community concerns may be a lower priority. For example, minor property damage may be preferable to serious and imminent risks to life safety.
Supply/Capacity	0.5	Identifies projects that provide multiple benefits, specifically enhancing the District's long-term supply and capacity capabilities during normal operations, in addition to providing benefits during emergency events.
Operational Flexibility	0.5	Identifies projects that provide multiple benefits, specifically providing day-to-day operational benefits (such as for maintenance outages), in addition to providing benefits during emergency events.
Ease of Implementation	0.5	Accounts for the feasibility of construction, which is an important consideration for the recommended projects.
Reliability	1.0	Critical criterion that identifies projects that help restore minimum or average demands to retailers in the outage scenarios.
Contribution to LOS	1.0	Critical criterion that identifies projects that improve LOS for the specific vulnerable areas, and the District's overall LOS.

Based on the weighting factors and individual scores of 1, 5, or 10, the highest total score that a project could receive is 40, while the lowest is 4. Recommended projects were selected based on a threshold total weighted score of **20 points** and above.

The project portfolios were further refined by analyzing the estimated costs of the projects. Total costs were roughly estimated for each preferred project based on generic assumptions and specifications.

Initial Generic Cost Estimates (Task 11 TM):

- Preliminary generic assumptions and specifications (Appendix 4)
- Initial generic cost estimates and methodology (Appendix 5)

Projects were also organized depending on which agency would lead the implementation. Projects on District facilities would be implemented by the District, while projects located within retailer service areas would generally be implemented by the respective retailers. In some cases, the project can be considered a joint project, meaning that the District and retailer would share the responsibility of implementation. Joint projects benefit both retailer and District systems and provide additional operational flexibility.

5.5. Recommended Portfolios

For the final recommended portfolios, 20 recommended projects were identified utilizing the weighted scores and initial cost estimates. **Table 26** includes the list of recommended projects along with the weighted scores and project-specific cost estimates for the recommended project portfolios. **Figure 10** shows the locations of the recommended projects, with labels corresponding to the project number in **Table 26**.

Project Information Sheets (Task 11 – Appendix 6):

- Description of projects and benefits
- Background information on project areas, including project location maps
- Estimated project costs

For the final 20 recommended projects, project information sheets were developed that include relevant details about the projects. In addition to a description of each project and its benefits, the project sheets include background information on the project area or retailer, the estimated project cost, and a project location map. Note that the Almaden Valley Pipeline project is not recommended for immediate implementation, but to be incorporated into the District's asset management program so that improvements are made at the same time the pipeline is rehabbed or replaced.

These recommended projects were presented and discussed at the Retailer Workshop held on June 1, 2016. Relevant comments from stakeholders were minor and have been incorporated. It is important to note that implementation of the projects included in the final recommended portfolios is dependent on other District and retailer priorities, ability to reach agreement on joint project arrangements, and other budget considerations.

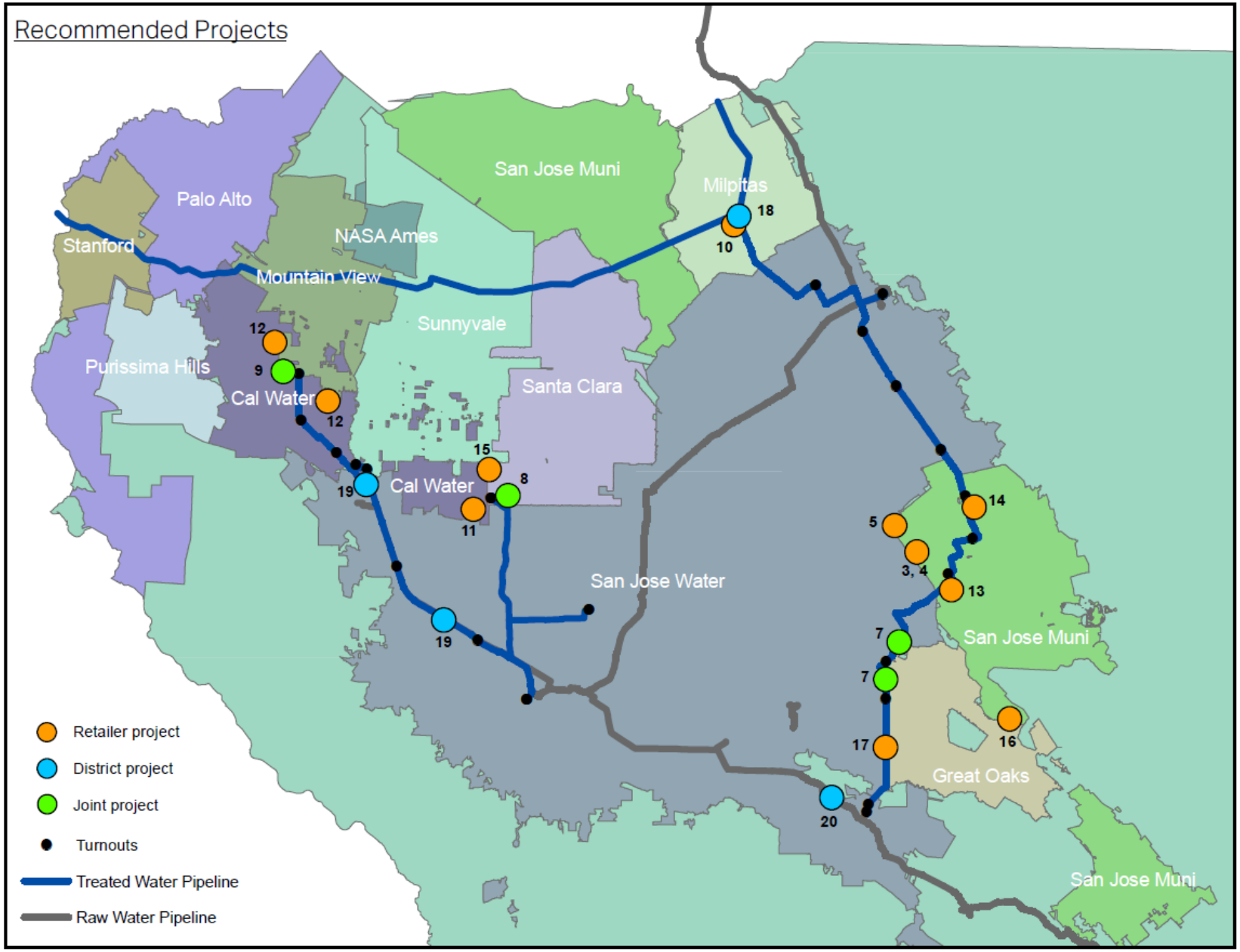
Table 26. Recommended Projects

Portfolio	Project #	Project Name	Weighted Score	Estimated District Project Cost	Estimated Retailer Project Cost[1]
Operations Only	1	Water Wheeling Study – Interagency use of District pipelines between customer turnouts	21	$0.5M	---
	2	Retailer Intertie Study – Test capabilities and capacities of interagency interties	21	District O&M budget	$0.5M
	3	Lift operational restrictions on San Jose Muni Evergreen groundwater wells	26	---	TBD
	4	Disinfection for San Jose Muni Evergreen groundwater wells	21	---	$1.0M
	5	Equipment to utilize existing interties between San Jose Muni Evergreen and SJWC	24	---	$0.5M
	6	Upgrade intertie between San Jose Muni Evergreen and Edenvale service areas	26	---	$0.2M
$10M CIP	7	New Great Oaks service connection on Snell Pipeline to feed excess groundwater	23	$1.1-1.4M[2]	TBD
	8	New groundwater well near Santa Clara Serra Tank in Zone 2A	36	$0.9M[3]	$2M[4]
	9	New groundwater well at Mountain View Miramonte Tank in Zone 3	36	$0.7M[3]	$2.8M[5]
	10	New groundwater well(s) at existing Milpitas site(s)	31	---	$2.8M[5]
	11	New groundwater well(s) at Cal Water Vallco turnout area	26	---	$2.8M[5]
	12	New groundwater well(s) at Existing Cal Water sites in western service area	21	---	$2.8M[5]
	13	New groundwater well(s) in Evergreen at new San Jose Muni sites	26	---	$2.8M[5]
	14	New groundwater well(s) near East Pipeline at new San Jose Muni sites	26	---	$2.8M[5]
	15	Develop additional and upgrade existing interties for Cal Water	21	---	$1.2M[6]
	16	New intertie between San Jose Muni Evergreen and Great Oaks	28	---	$1.2M[6]
	17	Upgrade two existing interties between Great Oaks and SJWC	23	---	$1.2M[6]
	18	Install two new isolation valves on Milpitas Pipeline	20	$1.4M	---
	19	Install three new isolation valves on West Pipeline	25	$2.2M	---
$100M CIP	20	Replace critical and vulnerable sections (~25,000 LF) of Almaden Valley Pipeline[7]	23	$135.3M	---

[1] Retailer estimated costs are planning-level estimates only, based on preliminary discussion
[2] Estimated cost depends on location of connection
[3] For connection to District pipeline
[4] Santa Clara well at Serra Tank cost estimate provided by the City of Santa Clara
[5] Estimated price per well
[6] Estimated price per intertie
[7] Not recommended for immediate implementation. To be implemented as part of long term asset replacement projects.

District Project
Joint Project
Retailer Project

Figure 10. Recommended Projects Map



The recommended project list contains 6 proposed projects in the Operations Only portfolio, 13 projects in the $10M CIP portfolio, and 1 project in the $100M CIP portfolio. Again, the one project in the $100M CIP portfolio would not be implemented immediately, but in the future as part of longer term asset management when the pipeline reaches end of life. Of these 20 projects, four would be implemented by the District and four would be implemented by the District and a retailer jointly. Detailed cost estimates were developed for the six projects in the $10M CIP and $100M CIP categories, and planning-level costs were estimated for the two studies in the operations category. The remaining projects would be implemented by individual retailers, so only planning-level costs are estimated and detailed cost estimates are not provided for these projects. It should be noted that it may not be necessary to implement all of the recommended retailer projects in order to achieve needed reliability benefits. It is up to respective retailers to determine which projects are most needed and would be most beneficial to pursue.

Detailed Cost Estimates (Task 11 – Appendix 7):

- Includes project information packages used to develop detailed cost estimates.

5.5.1. Project Descriptions

Operations Only Portfolio

Project #1 'Water Wheeling' Study: A study to assess the potential capabilities for wheeling water in District pipelines between customer turnouts could provide future benefits to the District and retailers. Specifically, it may be feasible for certain retailers with excess supply (such as SJWC and Great Oaks) to utilize District pipelines to feed water from one turnout to another in an emergency event that results in District service outages. This project is recommended due to its ease of implementation, low cost, and potentially significant enhancement to operational flexibility.

Project #2 Retailer Intertie Study: A study on the potential capabilities and capacities of retailer interties could provide valuable information on retailer systems and operations, particularly with regard to outage scenarios. Depending on the scenario, it could allow retailers with excess supply to directly feed other retailers who may experience a deficit. This should include feasibility study, as well as concepts for standardization of intertie design. This project is recommended due to its ease of implementation and potential benefits to multiple retailers within the District.

Project #3 San Jose Muni Evergreen Groundwater Well Restrictions: San Jose Muni cannot currently utilize all of their groundwater capacity due to State of California operational restrictions on groundwater wells in the Evergreen service area. The Evergreen service area was identified as particularly vulnerable to service outages, so lifting restrictions on the groundwater wells could provide an increase in system reliability and capacity.

It should be noted that it may not be necessary to implement all of the recommended San Jose Muni retailer projects in order to achieve needed reliability benefits. It is up to San Jose Muni which projects are most needed and would be most beneficial to pursue.

Project #4 San Jose Muni Evergreen Groundwater Well Disinfection: San Jose Muni cannot currently utilize all of their groundwater capacity due to State of California operational restrictions on groundwater wells in the Evergreen service area. The Evergreen service area was identified as particularly vulnerable to service outages; it was the project team's understanding that adding disinfection capabilities to the groundwater wells could help ease these operational restrictions and provide increased system reliability.

It should be noted that it may not be necessary to implement all of the recommended San Jose Muni retailer projects in order to achieve needed reliability benefits. It is up to San Jose Muni which projects are most needed and would be most beneficial to pursue.

Project #5 San Jose Muni Evergreen and SJWC Interties: New equipment, including pumps and hose or pipeline, to utilize three existing interties between San Jose Muni Evergreen service area and San Jose Water Company could enhance the resilience of the Evergreen service area at a relatively low cost.

It should be noted that it may not be necessary to implement all of the recommended San Jose Muni retailer projects in order to achieve needed reliability benefits. It is up to San Jose Muni which projects are most needed and would be most beneficial to pursue.

Project #6 San Jose Muni Evergreen and Edenvale Interties: Upgrades, including a new pump, to the existing intertie between San Jose Muni Evergreen and Edenvale service areas could allow bi-directional operations, which would provide improvements in operational flexibility and could enhance the resilience of the Evergreen service area at a relatively low cost.

It should be noted that it may not be necessary to implement all of the recommended San Jose Muni retailer projects in order to achieve needed reliability benefits. It is up to San Jose Muni which projects are most needed and would be most beneficial to pursue.

$10M CIP Portfolio

Project #7 Great Oaks Service Connection on Snell Pipeline: A new service connection from the Great Oaks system to the District's Snell Pipeline could take advantage of Great Oaks' excess groundwater capacity, estimated at up to 20 MGD depending on conditions. This project is recommended due to its reasonable cost and feasibility, and substantial increase in supply and operational flexibility for the District. There are currently two identified potential locations for the connection, located at Branham Lane or Valley Christian School.

Project #8 Santa Clara Groundwater Well: Santa Clara Zone 2A was identified as a vulnerable area with limited back up supplies. The construction of a groundwater well in Santa Clara Zone 2A near Serra Tank would increase system reliability and capacity for Santa Clara. Additionally, the well could tie into the Santa Clara Distributary near Serra Tank, improving the operational flexibility of the District's west treated water system. It is the understanding of the project team that implementation of this project is currently in progress by Santa Clara.

Project #9 Mountain View Groundwater Well: Mountain View Zone 3 was identified as a vulnerable area due to operational changes and additional pumping required to offset loss of District treated water. A new groundwater well in Mountain View Zone 3 near Miramonte Tank would increase system reliability and capacity for Mountain View. Additionally, the well could tie into the Mountain View Distributary near Miramonte Tank, improving the operational flexibility of the District's west treated water system.

Project #10 Milpitas Groundwater Well: Milpitas turnout area was identified as a vulnerable area due to operational changes and additional costs to offset loss of District treated water. A new groundwater well in Milpitas' District Zone would increase system reliability and capacity for Milpitas. Several potential sites have been identified, including Curtis Well site which has already been partially constructed, and sites located at McCandless Drive Park and former Montague Well site.

Project #11 Cal Water Groundwater Well at Vallco: Cal Water Vallco turnout area was identified as a vulnerable area due to limited availability of backup supplies to offset loss of District treated water. A new groundwater well in the Cal Water Vallco turnout area would increase system reliability and capacity for Cal Water.

Project #12 Cal Water Groundwater Well in West: Cal Water has existing sites in the western service area, including Stations #2 and #4, which have been identified as good opportunities for adding new groundwater well capacity. Additional groundwater well capacity in strategic locations would increase system reliability and capacity for Cal Water, to offset losses of West Pipeline turnouts, and also to increase the capability to move water east to the Vallco turnout area.

Project #13 San Jose Muni Evergreen Groundwater Wells: San Jose Muni Evergreen service area was identified as a vulnerable area due to operational restrictions on backup groundwater wells. New groundwater wells within Evergreen service area would increase system reliability and capacity for San Jose Muni by directly feeding the vulnerable Evergreen service areas.

Project #14 San Jose Muni East Pipeline Groundwater Wells: San Jose Muni Evergreen service area was identified as a vulnerable area due to operational restrictions on backup groundwater wells. New groundwater wells near the East Pipeline would increase system reliability and capacity for San Jose Muni by providing water near the existing District turnouts that serve the vulnerable Evergreen service areas.

Project #15 Cal Water Interties: Cal Water Vallco turnout area was identified as a vulnerable area due to limited availability of backup supplies to offset loss of District treated water. Developing additional and/or enhancing existing interties with neighboring service areas could increase system reliability and capacity for Cal Water. In particular, increasing intertie capability between Cal Water and Santa Clara could help address shortfalls near the vulnerable Vallco turnout area, and also provide operational flexibility for both retailers.

Project #16 San Jose Muni Evergreen and Great Oaks Intertie: San Jose Muni Evergreen service area was identified as a vulnerable area due to operational restrictions on backup groundwater wells. New

intertie capabilities between Evergreen service area and the Great Oaks system would increase system reliability and capacity for San Jose Muni by utilizing potential excess groundwater capacity from Great Oaks.

Project #17 SJWC and Great Oaks Interties: As the largest District retailer, SJWC spans the largest service area and has the most service connections along District treated water pipelines. As a result, SJWC may have significant impacts on the overall regional capability for wheeling water through District pipelines between retailer service connections in case of District service outages. There are currently two existing interties between SJWC and Great Oaks. Upgrades to these interties, or possibly new interties with Great Oaks, could help utilize potential excess groundwater capacity from Great Oaks and enhance operational flexibility for SJWC.

Project #18 Isolation Valves on Milpitas Pipeline: Two additional isolation valves on the Milpitas Pipeline, one on each side of the existing Milpitas turnout, could improve reliability and operational flexibility in the District's east treated water system by allowing the District to valve off potential pipeline breaks more efficiently. This may also increase operational flexibility for utilizing the District/SFPUC Intertie.

Project #19 Isolation Valves on West Pipeline: Three additional isolation valves on the West Pipeline at strategic locations could improve reliability and operational flexibility in the District's west treated water system. These valves could allow the District to valve off potential pipeline breaks more efficiently, and continue to serve as many West Pipeline service connections as possible. This may also increase operational flexibility for wheeling water on District pipelines between retailers. Proposed locations include one on each side of the existing SJWC Cox turnout, and one upstream of the existing SJWC Mann turnout.

$100M CIP Portfolio

Project #20 Almaden Valley Pipeline Improvements: The Almaden Valley Pipeline is the most critical District facility expected to fail in the assumed outage scenarios. Through pipeline damage determinations, particularly vulnerable and high-risk sections were identified which total approximately 25,000 linear feet. It is recommended that the District consider the IRP evaluations specific to this issue in considering prioritization in its long-term asset management program.

5.6. Additional Recommendations

Throughout the process of the IRP project, the project team and District staff identified additional recommendations to continuously improve the resilience and recovery capabilities of the District system. The recommendations are not specific projects, and can be included in existing District programs:

- Continue to plan for recharge operations in critical areas during drought or other outages. In particular, upcoming improvements to Main and Madrone pipelines will support quicker restoration of critical recharge to the raw water turnouts in Morgan Hill.
- Continue Emergency Response Planning
    - Develop post-earthquake inspection procedures for pipelines
    - Develop emergency response plans for each pipeline, and for other facilities that do not have up to date plans
    - Renew standing orders for equipment and contractors that have expired
    - Secure retainer agreements for equipment and contractors if feasible
    - Continue to look for mutual aid opportunities, and continue participation in California Water/Wastewater Agency Response Network (CALWARN)
- Continue planned pipeline inspection and rehabilitation projects to identify sections in need of replacement
- Address seismic and climate vulnerabilities through long-term asset replacements
    - Replace vulnerable pipe segments with earthquake resistant design
    - Consider future climate conditions (extreme heat, stronger storms, etc.) in routine equipment replacements
- Consider adopting standard practice of installing isolation valves immediately upstream and downstream of each customer service connections
- Continue coordination with District groundwater subcommittee to ensure appropriate long-term practices with respect to additional groundwater wells and proper management of the groundwater basin
- Develop or enhance communications plans for conveying the message of conserving water after an earthquake or hazard event to Santa Clara County residents

5.7. Implementation Plan

The implementation of the recommended project portfolios will depend on several factors, such as District and retailer priorities and budget allocations. This section includes a preliminary high-level implementation plan for District and joint projects, with considerations towards achieving benefits efficiently. Prioritization is not based on criteria scoring from the previous project screening process, as other factors for implementation become relevant. Other considerations include the geographic location, interdependencies, and construction feasibility of recommended projects.

Table 27 organizes the recommended District and joint projects into implementation phases. Projects are aligned into East-side and West-side, as there should be strong considerations for grouping projects with interdependencies that can provide enhanced benefits if they are implemented concurrently.

Responsibility for implementation of the remaining retailer projects would fall under each project's respective retailer. The prioritization of the retailer projects should be determined by each retailer. It should be noted that several retailer projects may provide similar benefits, so further evaluation should be conducted by the retailers to determine which projects are most feasible and cost-effective.

Table 27. Project Implementation Considerations

Area	Project	Rank	Discussion
West	West Pipeline isolation valves	1	No-regret improvement, construction only on District facility, easy to implement, no additional agreements required
	Santa Clara groundwater well	2	Construction on retailer and District facilities, planning/coordination required
	Mountain View groundwater well	2	Construction on retailer and District facilities, planning/coordination required
East	Milpitas Pipeline isolation valves	1	No-regret improvement, construction only on District facility, easy to implement, no additional agreements required
	Great Oaks connection/turnout	2	Construction on retailer and District facilities, planning/coordination required
System/ Other	Wheeling water study	1	Planning study only, no construction and no agreements needed to initiate study
	Retailer intertie study	1	Planning study only, no construction and no agreements needed to initiate study
	Almaden Valley Pipeline improvements	3	High cost and complex construction, long-term improvement project

The projects assigned a rank of 1 (shaded in green) are the highest priority and most easily initiated, and can be implemented relatively quickly. The projects assigned a rank of 2 (shaded in orange) are achievable within a reasonable timeframe but may require additional coordination efforts and formal agreements between the District and respective retailers. The project assigned a rank of 3 (shaded in magenta) is the major infrastructure project for Almaden Valley Pipeline. This project is the most

difficult to implement due to its high cost as a major infrastructure project, and will be considered in the District's long-term asset management planning.

5.8. Conclusion

The District water utility system faces a variety of hazard conditions, which could lead to outages of treated water service and critical recharge. This study evaluated District system performance in several selected outage scenarios. Based on results of the analyses, the District currently meets a LOS for providing treated water at minimum demands within approximately 30 days or less, and critical recharge within approximately 75 days or less[1]. Utilizing information gathered via stakeholder meetings and workshops, this study also evaluated system capabilities with respect to regional redundancies and backup supplies. The study found that most areas of the county have sufficient backup supplies or redundancy to withstand a District service outage; however, specific service area vulnerabilities were identified. These can be more efficiently addressed by smaller localized projects, rather than major system infrastructure improvements. Project opportunities to enhance reliability for these service areas and the system overall were developed and screened. Stakeholders agreed on an investment level with corresponding recommended projects that would allow retailers to better tolerate these District service outages. These projects may also reduce the District service outage durations, thus improving the District's LOS. This study endorses implementation of these recommendations in the interest of enhancing District and retailer system reliabilities and life safety for their customers.

[1] *Note these are modeled outage durations based on modeling assumptions. In actual hazard events, outages may be longer or shorter depending on actual facility damage.*

Santa Clara Valley Water District

Infrastructure Reliability Plan

Appendices

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Retailer Water Use

Technical Memorandum

Infrastructure Reliability Project, Task 4

Project Number: 93504001

Prepared by:
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AECOM (Jason Chen, Aaron Lee)

June 13, 2014

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Appendix 2: Map of Future Growth Areas

1. Purpose and Overview

The purpose of this memorandum is to describe the potable water supplies used by the District's retailers, and to identify any known future growth or supply source changes for these retailers. For this task, District staff compiled monthly Demand data for ten retailers: California Water Services Company (Cal Water), City of Gilroy, City of Milpitas, City of City of Morgan Hill, City of Mountain View, City of San Jose, City of Santa Clara, City of Sunnyvale, Great Oaks Water Company, and San Jose Water Company (SJWC). Demand data for the City of Palo Alto was also reviewed, although is not included in this memorandum since Palo Alto does not currently use District treated water or groundwater.

The project team gathered demand data from the sources listed below. All demand data from the noted sources is cataloged by the District and available via the District's internal website. For each retailer, the project team gathered and analyzed demand by month by water supply source.

- Monthly groundwater production data obtained from SCVWD billing data
- Monthly SCVWD treated water deliveries obtained from SCVWD billing data
- SFPUC M&I use obtained from San Francisco Public Utilities Commission (SFPUC)
- Surface M&I use obtained from SJWC

The project team gathered information on future growth and supply source changes from retailer Urban Water Management Plans (UWMPs). The California Department of Water Resources requires all water provides to publish an UWMP every five years. The plans identify the supplies water providers will use to meet future demand.

Finally, the project team met individually with each retailer to review and confirm the demand and growth information the team had gathered. During the meetings, some retailers were able to explain anomalies in demand curves, such as when an emergency shutdown had caused reduced water use in a summer month. Most retailers do not expect major growth, only in-fill development.

2. Demand Calculation Methodology

General Method

Retailer demands are based on historical averages for the last 5 years in the following categories:

- Average annual – Average water usage across all 12 months
- Minimum winter month – Average water usage for month of February
- Maximum summer month – Average water usage for month of July

Water usage breakdowns are calculated for the following water sources:

- Groundwater
- SCVWD treated water
- SFPUC treated water
- Other surface water
- Total water usage for all sources

Exceptions

There were specific incidences in which SCVWD facility shutdowns had major impacts to customer water usage characteristics. These include the following events:

Event/Shutdown	Months Affected	Customers Affected
West Pipeline	November to December 2009	• Sunnyvale • Mountain View • Cal Water Los Altos
West Pipeline	December 2010	• Cal Water Los Altos
Mountain View Distributary	January to February 2011	• Mountain View
Milpitas Pipeline	July 2012	• Milpitas
Santa Clara Distributary	July 2012	• Santa Clara
Sunnyvale Distributary	January to February 2013	• Sunnyvale

For these specific cases, unusual water usage characteristics as a result of the shutdowns were observed, and the entire historical year was omitted from the water demand calculations for the affected customer. The following table summarizes the historical year basis for each customer's water usage calculations.

Customer	Historical Year Basis
Gilroy	2009 to 2013
SJWC	2009 to 2013
San Jose Muni	2009 to 2013
Great Oaks Water Co.	2009 to 2013
Sunnyvale	2010 to 2012
Morgan Hill	2009 to 2013
Mountain View	2010, 2012, and 2013
Cal Water Los Altos	2011 to 2013
Milpitas	2009 to 2011, and 2013
Santa Clara	2009 to 2011, and 2013

Future Growth Adjustments

Historical demands were compared to 2030 projections from customer UWMPs to determine appropriateness of water usage characteristics for future planning purposes. In three particular cases, demands were adjusted to reflect projected demand increases. Adjustments were made to increase water usage to the level of at least 70% of projected 2030 demands. Details on the adjustments are included in **Appendix 1**. The adjusted water usage customers and categories include:

- San Jose Muni
  - Groundwater usage
  - SCVWD treated water usage
- Milpitas
  - SCVWD treated water usage
- Santa Clara
  - Groundwater usage
  - SCVWD treated water usage
  - SFPUC treated water usage

3. Demand Summary Table

A summary of historical retailer demands is presented in Table 1. Detailed demand tables and charts are provided in **Appendix 1**. The demands in Table 1 were calculated using the demand methodology presented in the previous section. These are based on historical water usage and are unadjusted for future growth. Table 2 includes water usage incorporating future growth adjustments.

Table 1. Historical Demand Summary

Retailer Name	Average Annual Demand (MGD)	Minimum Winter Demand (MGD)	Maximum Summer Demand (MGD)
Cal Water	11.6	7.2	17.1
City of Gilroy	7.6	4.7	10.3
City of Milpitas	9.4	7.9	11.3
City of Morgan Hill	7.1	3.8	10.9
City of Mountain View	10.3	7.2	13.5
City of San Jose Municipal Water	18.1	12.0	25.3
City of Santa Clara	18.9	15.1	23.6
City of Sunnyvale	17.9	13.2	23.9
Great Oaks Water Company	10.3	7.2	14.9
San Jose Water Company	122.5	84.7	166.3
TOTAL	233.7	163	317.1

4. Planned Future Supply Source Changes or Growth

A summary of planned future growth by retailer is provided below. All retailers indicated that demand has either stayed the same or decreased over the past 10 years. No retailers indicated any plans to change or add supply sources in the future. In other words, they plan to continue to use the same distribution of supplies. For example, San Jose Water Company does not plan to switch to taking more groundwater and less treated water.

The City of Milpitas indicated an area of major growth that will require new District infrastructure, a new treated water turnout on the Milpitas Pipeline. City of San Jose Municipal Water also indicated interest in connecting to the District's Milpitas Pipeline in its northern service area for the planned North First Street development. These growth areas are shown in the map in **Appendix 2**. In addition, the historical demands have been adjusted for planned growth, as described in the demand methodology above. The adjusted demands are provided in Table 2.

California Water Services Company

- Demand has decreased in general over the past.
- There is a potential for in-fill growth, especially in Cupertino.
- Cal Water does not anticipate any source switching, though groundwater quality rules could impact their ability to use some wells in the future.

City of Gilroy

- Demand has stayed about the same over the past 10 years.
- Gilroy's UWMP identifies growth and increasing demand through 2035. New developments include Eagle Ridge, Glen Loma Ranch, Hecker Pass, Downtown Specific Plan, Gavilan College, Shapell Industries, and Lucky Day.
- Gilroy expects to continue to rely completely on groundwater supplies in the future and has enough well capacity to meet future demand.

City of Milpitas

- Demand has decreased in general over the past.
- The major area of growth will be the new transit area, where the new BART station will be. SCVWD water is the planned future source for this growth. As such, District treated water use will increase substantially in the future, and a new turnout will be needed.

City of Morgan Hill

- Demand has stayed about the same over the past 10 years.
- Morgan Hill is expecting growth in the future, approximately 200 housing units per year. Service connections grew by 1000 in the past three years due to building incentives during the economic downturn. Growth will not continue at this high rate in the future.
- Morgan Hill expects to continue to rely completely on groundwater supplies in the future.

City of Mountain View

- Demand has decreased in general over the past.
- There is a potential for growth on the edge of the SCVWD treated zone. A preliminary meter count shows that growth would add 50% to demand. Mountain View is not sure if this could be supplied by SCVWD due to contractual limitations.
- The city is expecting to update its general plan which will likely show some growth areas. There may be growth in the NASA service area (for NASA or Google) that the City of Mountain View would provide recycled water for. NASA would provide the potable water.

City of San Jose Municipal Water

- Demand has stayed about the same over the past 10 years.
- There are some areas that are proposed for development or redevelopment in the next 25 years.
- One third of the Edenvale service area is not yet developed. This area would be served by wells in the future.
- North San Jose development: currently the area relies on SFPUC water. If the development were built, City of San Jose Municipal Water would need to run the wells there full time, and in the future, may want to bring SCVWD treated water via the future 'trade zone' turnout.
- Evergreen area has two localized properties that could be developed. These would create the need for an increase in SCVWD treated water deliveries. North San Jose and Edenvale would be developed before the Evergreen areas.

City of Santa Clara

- Demand has decreased in general over the past. Population is up 40% but demand is down 40%.
- The UWMP predicts growth, but don't know if it will actually increase as planned.
- The stadium and another large development will be coming soon. The stadium will use 85% recycled water.
- City of Santa Clara would take more treated water if it were available, just to have a more resilient water supply.
- Santa Clara has an interruptible contract with SFPUC. They have looked into buying some of Sunnyvale's supply guarantee since Sunnyvale has excess. They are pursuing becoming a permanent customer.

City of Sunnyvale

- Demand has decreased greatly over the past. Industry has moved out (cannery, chip manufacturing) and conservation is working. Gpcd has decreased to about 132 or less since a peak of 240 gpcd in 1985.
- Sunnyvale historically used wells more, however, due to take or pay limitations on both SCVWD and HH supply contracts, they use those supplies first and rarely use wells.
- City of Sunnyvale does not expect any large future growth areas or supply source changes.

Great Oaks Water Company

- Over time, demand has decreased. Customers are very good at conserving in the service area, which is mostly residential.
- Great Oaks does not expect any major growth in their service area, just in-fill.
- Great Oaks expects to continue to rely completely on groundwater supplies in the future and has enough well capacity to meet future demand.

San Jose Water Company

- The trend for max single day demand for SJWC is decreasing, going from 205 – 190 MGD in the past few years. The trend for min single day demand is also decreasing, down to about 78 MGD. Non-potable use is increasing.
- SJWC does not expect any major future growth or supply source changes.

As mentioned previously in the demand methodology subsection, future growth adjustments were applied in specific cases to better reflect 2030 demand projections from the UWMPs. Table 2 presents demands based on historical water usage and with these future growth adjustments.

Table 2. Demand Summary – Adjusted for Growth

Retailer Name	Average Annual Demand (MGD)	Minimum Winter Demand (MGD)	Maximum Summer Demand (MGD)
Cal Water	11.6	7.2	17.1
City of Gilroy	7.6	4.7	10.3
City of Milpitas	10.6	9.0	12.8
City of Morgan Hill	7.1	3.8	10.9
City of Mountain View	10.3	7.2	13.5
City of San Jose Municipal Water	22.3	15.4	30.7
City of Santa Clara	20.8	16.6	26.0
City of Sunnyvale	17.9	13.2	23.9
Great Oaks Water Company	10.3	7.2	14.9
San Jose Water Company	122.5	84.7	166.3
TOTAL	241	169	326.4

5. Summary

The demands presented in this technical memorandum will be used for analysis in subsequent project tasks. Average, lowest, and highest month demands will be reviewed and analyzed in setting level of service goals as part of Task 6.

The demands will also be reviewed in Task 8, to determine if any retailer systems have excess usable capacity compared to current use. For example, a retailer may have 10 MGD of well capacity, but only uses 2 MGD typically. The excess capacity could be used in an emergency or outage scenario to meet demands.

Information on future growth will be used in Task 10 to determine if additional water treatment or distribution capacity is needed in the future in the District's system. As of today, no retailers plan to change supply sources in the future.

Appendix 1:

Demand Tables and Charts

Summary of Customer Potable Water Use – by Water Source: Based on Historical Usage without Future Growth Adjustments

Potable Water User	Groundwater			SCVWD TW			SFPUC TW			Other			Total		
	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul
Gilroy	4.7	7.6	10.3	-	-	-	-	-	-	-	-	-	4.7	7.6	10.3
SJWC	27.5	44.4	63.4	46.6	67.7	90.1	-	-	-	10.5	10.4	12.8	84.7	122.5	166.3
San Jose Muni	0.65	0.73	0.87	8.0	13.0	19.1	3.3	4.3	5.4	-	-	-	12.0	18.1	25.3
Great Oaks	7.2	10.3	14.9	-	-	-	-	-	-	-	-	-	7.2	10.3	14.9
Sunnyvale	0.65	0.66	0.79	6.1	8.5	11.4	6.5	8.7	11.6	-	-	-	13.2	17.9	23.9
Morgan Hill	3.8	7.1	10.9	-	-	-	-	-	-	-	-	-	3.8	7.1	10.9
Mountain View	0.32	0.37	0.40	0.6	1.0	1.5	6.3	8.9	11.6	-	-	-	7.2	10.3	13.5
Cal Water Los Altos	2.0	3.3	6.8	5.2	8.2	10.2	-	-	-	-	-	-	7.2	11.6	17.1
Milpitas	0	0	0	2.7	3.0	3.6	5.2	6.4	7.7	-	-	-	7.9	9.4	11.3
Santa Clara	9.6	12.7	16.7	3.1	4.0	4.5	2.4	2.2	2.4	-	-	-	15.1	18.9	23.6
TOTAL	56.5	87.2	125.1	72.3	105.6	140.5	23.7	30.5	38.7	10.5	10.4	12.8	163.1	233.7	317.1

Summary of Customer Potable Water Use – by Water Source: Based on Historical Usage with Future Growth Adjustments

Potable Water User	Groundwater			SCVWD TW			SFPUC TW			Other			Total		
	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul
Gilroy	4.7	7.6	10.3	-	-	-	-	-	-	-	-	-	4.7	7.6	10.3
SJWC	27.5	44.4	63.4	46.6	67.7	90.1	-	-	-	10.5	10.4	12.8	84.7	122.5	166.3
San Jose Muni	3.23	3.67	4.34	8.8	14.3	21.0	3.3	4.3	5.4	-	-	-	15.4	22.3	30.7
Great Oaks	7.2	10.3	14.9	-	-	-	-	-	-	-	-	-	7.2	10.3	14.9
Sunnyvale	0.65	0.66	0.79	6.1	8.5	11.4	6.5	8.7	11.6	-	-	-	13.2	17.9	23.9
Morgan Hill	3.8	7.1	10.9	-	-	-	-	-	-	-	-	-	3.8	7.1	10.9
Mountain View	0.32	0.37	0.40	0.6	1.0	1.5	6.3	8.9	11.6	-	-	-	7.2	10.3	13.5
Cal Water Los Altos	2.0	3.3	6.8	5.2	8.2	10.2	-	-	-	-	-	-	7.2	11.6	17.1
Milpitas	0	0	0	3.8	4.3	5.1	5.2	6.4	7.7	-	-	-	9.0	10.6	12.8
Santa Clara	10.6	14.0	18.4	3.4	4.4	4.9	2.6	2.4	2.6	-	-	-	16.6	20.8	26.0
TOTAL	60.1	91.4	130.2	74.5	108.5	144.3	24.0	30.8	38.9	10.5	10.4	12.8	169.1	241.1	326.3

Backup Details on Future Growth Adjustments

Potable Water User	Groundwater			SCVWD TW			SFPUC TW			Other			Total			UWMP Projection 2030 GW Ave	UWMP Projection 2030 SCVWD Ave	UWMP Projection 2030 SFPUC Ave	UWMP Projection 2030 Other Ave	UWMP Projection 2030 Total Ave	Comparison % of 2030 UWMP Projections	Future Growth Adjustment
	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul	Feb	Ave	Jul							
Gilroy	4.7	7.6	10.3	-	-	-	-	-	-	-	-	-	4.7	7.6	10.3	8.7	-	-	-	8.7	87%	None
SJWC	27.5	44.4	63.4	46.6	67.7	90.1	-	-	-	10.5	10.4	12.8	84.7	122.5	166.3	54.2	69.5	-	10.8	134.5	91%	None
San Jose Muni	3.23	3.67	4.34	8.8	14.3	21.0	3.3	4.3	5.4	-	-	-	15.4	22.3	30.7	11.4	15.6	4.5	-	31.6	71%	GW +400% SCVWD +10%
Great Oaks	7.2	10.3	14.9	-	-	-	-	-	-	-	-	-	7.2	10.3	14.9	8.6	-	-	-	8.6	120%	None
Sunnyvale	0.65	0.66	0.79	6.1	8.5	11.4	6.5	8.7	11.6	-	-	-	13.2	17.9	23.9	0.9	11.4	8.9		21.2	84%	None
Morgan Hill	3.8	7.1	10.9	-	-	-	-	-	-	-	-	-	3.8	7.1	10.9	8.6	-	-	-	8.6	82%	None
Mountain View	0.32	0.37	0.40	0.6	1.0	1.5	6.3	8.9	11.6	-	-	-	7.2	10.3	13.5	0.2	1.2	11.3		12.7	81%	None
Cal Water Los Altos	2.0	3.3	6.8	5.2	8.2	10.2	-	-	-	-	-	-	7.2	11.6	17.1	3.0	8.8	-	-	11.8	98%	None
Milpitas	0	0	0	3.8	4.3	5.1	5.2	6.4	7.7	-	-	-	9.0	10.6	12.8	0.0	6.4	8.8	-	15.2	70%	SCVWD +40%
Santa Clara	10.6	14.0	18.4	3.4	4.4	4.9	2.6	2.4	2.6	-	-	-	16.6	20.8	26.0	20.6	4.1	4.5	-	29.2	71%	GW +10% SCVWD +10% SFPUC +10%
TOTAL	60.1	91.4	130.2	74.5	108.5	144.3	24.0	30.8	38.9	10.5	10.4	12.8	169.1	241.1	326.3	116.3	116.9	38.0	10.8	282.0	85%	

Appendix 2:

Map of Future Growth Areas

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Santa Clara Valley Water District

Infrastructure Reliability Plan

Task 5 Appendix

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Outage Scenarios

Technical Memorandum

Infrastructure Reliability Project, Task 5

Project Number: 93504001

Prepared by:
AECOM

Final Draft

June 1, 2015

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1. Purpose and Overview

This technical memorandum (TM) summarizes the work performed in Task 5 of the Santa Clara Valley Water District (SCVWD or District) Infrastructure Reliability Plan (IRP) Project. This TM describes the selected outage scenarios that were identified, and documents the evaluations and analyses performed during the planning process. Outage scenarios are intended to reflect relevant hazards to the District for the purposes of measuring system performance with respect to water supply and delivery. The strengths and deficiencies in system performance under these scenarios will be used to develop strategies for reliable water supply and delivery after a disaster event.

The purpose of Task 5 is to select specific hazard categories and identify SCVWD infrastructure that may be impacted. Using hazard categories to identify specific facility outage scenarios, SCVWD system performance will be tested and strategies and projects to improve system reliability will be identified and developed. Hazard categories considered include:

- Earthquake
- Maintenance outages
- Extreme weather events due to climate change
- Delta outage
- Water quality event
- Regional power outage
- SCADA outage

A high level assessment is performed to determine potential impact of each hazard category on SCVWD facility types, including:

- Imported supply sources – State and Federal sources
    - Central Valley Project (CVP)/San Luis Reservoir
    - South Bay Aqueduct (SBA)/State Water Project (SWP)
- Local supply sources – District raw water storage/reservoirs
- Raw water transmission facilities – raw water system pipelines, tunnels, and pumping plants
- Treatment facilities
    - Rinconada Water Treatment Plant (RWTP)
    - Santa Teresa Water Treatment Plan (STWTP)
    - Penitencia Water Treatment Plant (PWTP)
- Treated Water Transmission – treated water system pipelines

Table 1 summarizes the high-level assessment and summarizes potential impacts of hazard categories on types of District facilities.

Table 1. High-Level Assessment of Outage Types

Hazard Type/Category	Impacts				
	Imported Supply (State/ Federal)	Local Supply (District Storage)	Raw Water Transmission	Water Treatment	Treated Water Transmission
	LS	SS	RT	T	TT
Earthquake	X	X	X	X	X
District Maintenance Outage		X	X	X	X
Extreme Storm Event	X	X	X	X	X
Delta Levee Failure	X				
Regional Power			X	X	
SCADA/Controls Failure			X	X	

Based on this conceptual assessment and subsequent conversations with District staff, the following major hazard categories encompass the range of potential impacts and have been selected for further development and evaluation:

- Earthquake
- Maintenance outages
- Extreme storm events
- Delta levee failure

The following sections summarize development of these broad hazard categories into specific outage scenarios, by identifying the specific SCVWD facilities impacted for each. These outage scenarios will be utilized in evaluating system performance in subsequent tasks. The main body of this TM summarizes the planning process for each selected hazard category, while additional detailed information can be found in separate TMs which are provided as attachments.

2. Critical Facilities

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3. Climate Change Outages

The *Infrastructure Reliability Climate Change and Extreme Weather Technical Memorandum* (SCVWD, 2015), evaluates how climate change and extreme weather may impact the District's water supply system infrastructure in support of Subtask 5.2 of the IRP Project. Climate change and related extreme weather events that may result in infrastructure failure are identified, along with the infrastructure or infrastructure types expected to fail, and the vulnerability of the failed infrastructure. A risk assessment approach is used to evaluate the District's infrastructure under each extreme weather event scenario.

Extreme weather can be classified as such when thresholds or historic maximum values are exceeded during a specified time period within a specified region. Extreme weather events can occur at any time, but are generally not considered to be frequent or high probability events. Some of these events may be part of climate deviation unrelated to future climate changes due to global warming, and some may be exacerbated by climatic changes. The Climate Change TM considers the risk that extreme weather events pose on the water utility infrastructure.

Specifically, the following extreme weather events are considered in development for outage scenarios:

- Coastal flooding due to storm surges
- Extreme storm (also represents flood event)
- Extreme heat
- Drought
- Extreme cold
- Upland non-urban wildfire
- High wind

The first step towards developing extreme weather outage scenarios consists of defining the impacts on District assets due to each extreme weather event. For each event and infrastructure class, the potential for exposure to an impact is examined by subject matter experts on the District's staff. An additional analysis has been performed to determine which buried pipelines may be exposed to vulnerabilities at creek crossings, which may exacerbate some climate change impacts. The District's GIS information is used to map the pipelines and identify a preliminary list of those that cross creeks. A final list of exposed and vulnerable pipeline creek crossings has been identified and confirmed with assistance from District staff. Table 2 summarizes the final list of exposed pipeline creek crossings.

Table 2. Pipelines with Exposed Creek Crossings

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After impacts of extreme weather events on District assets are identified, the next step is a vulnerability assessment. The vulnerability assessment evaluates sensitivities of infrastructure to the particular event. The first step in the sensitivity analysis was to identify which asset classes had the potential for failure in relationship to each extreme weather impact scenario. Once the potential for failure was identified, a vulnerability analysis was conducted that looked at the time to failure and the adaptive capacity (sensitivity) of the asset class in relation to the event. The time to failure was rated from 0 (no failure) to 3 (immediate failure). The sensitivities of infrastructure classes (i.e., ability to repair or recover from failure/adaptive capacity) are also rated on a scale from 0 (low sensitivity or preventable) to 3 (high sensitivity or years to recover from failure). If an asset is exposed and cannot recover from failure due to exposure, it is scored as high sensitivity (3) to the impact. If the asset is exposed but can recover quickly, it is scored as low sensitivity (0). An infrastructure class rated as highly sensitive (3) to an extreme weather event is considered to have a high consequence of failure. Ratings of system vulnerabilities are determined by subject matter experts on District staff.

Risk is a combination of likelihood of failure and consequence of failure, which in this evaluation is represented by likelihood of an extreme weather event and facility vulnerability (described above) to that weather event. Table 3 summarizes the likelihoods of the mid-century projections of extreme weather events and also incorporates changes to local extreme weather events anticipated in Santa Clara County. Although projections for increase in intensity and frequency of extreme storm events are ranked as "Moderately Likely," when these projections are considered in combination with the exposure and consequences of an extreme storm event, it is clear that the extreme storm event has the highest risk of impact of all extreme weather events. As a result, it identifies that District infrastructure is most vulnerable to an extreme storm event, thus this hazard event has been selected for further development to represent climate change outage.

Table 3. Likelihoods of Extreme Weather Projections for Mid-Century (2050) for Santa Clara County

Extreme Weather Event	Mid-Century Projection	Likelihood Rank
Storm Surges	Increase. Will be exacerbated by sea level rise	Most Likely
Extreme Storm	Increase of precipitation intensity and frequency	Moderately Likely
Heat Wave	Increase in intensity, frequency, and duration of heat wave events	Most Likely
Drought	Increase due to increased inter-annual variability of precipitation and greater summer warming temperatures	Moderately Likely*
Extreme Cold	Reduction in severity and frequency of extreme cold events	Somewhat likely
Upland Non-Urban Wildfire	Increase in duration, frequency, and extent	Most Likely
High Wind	Increase in intensity and frequency	Somewhat likely

*Based on likelihood of precipitation and inter-annual variability

(*Source: Brown, I. and C. Thomas, 2013*)

Upon selection of the extreme storm event as the determining outage scenario, critical facilities most at risk were identified and evaluated more closely by District staff. For each critical facility ranked as "Vulnerable", subject matter experts from the District evaluated potential impacts further and assigned probabilities on the amount of function lost for each (ranging from 25% to 100% of function lost).

Table 4 summarizes the results of the extreme storm event analysis and represents the final outage scenario selected for climate change. Figure 1 highlights the critical facilities (in red) that are expected to lose 100% of function during the extreme storm event. Additional detailed analysis information is included in the *Infrastructure Reliability Climate Change and Extreme Weather Technical Memorandum* (SCVWD, 2015).

Table 4. Extreme Storm Event Facility Outage Scenario

Facility	CONFIDENTIAL	Failure Mode
Pacheco PP		Power
Santa Clara Tunnel		Landslide
Coyote PP		Flood & Power
Vasona PP		Flood & Power
SBA/SWP		Landslide
Rinconada WTP		Power
Santa Teresa WTP		Power
Penitencia WTP		Landslide & Power
West PL 1		Break at exposed section
West PL 2		Break at exposed section
West PL 3		Break at exposed section

The facilities identified in this scenario differ slightly from the extreme storm scenario described in the *Infrastructure Reliability Climate Change and Extreme Weather Technical Memorandum* (SCVWD, 2014). Additional analysis was done following the completion of the technical memorandum that resulted in modifications to the final list of facility outages for the climate change scenario. The additional analysis accounted for power outage in addition to extreme precipitation. The additional analysis also found that some facilities such as Rinconada Reservoir, Anderson, Calero, and San Luis reservoirs would not be affected by an extreme storm event. The additional analysis evaluated the likelihood of failure due to climate change for the Silicon Valley Advanced Water Purification Center (SVAWPC), as this facility could be used as a potable water supply at some point in the future. The analysis of the SVAWPC is included in the *Silicon Valley Advanced Water Purification Center Technical Memorandum* (SCVWD, 2015).

Table 5 documents and summarizes some of these additional considerations regarding specific facility vulnerabilities in an extreme storm event, incorporating input from District staff.

Table 5. Facility-Specific Considerations for Extreme Storm Event

Facility	Determination
Anderson Reservoir	Anderson Reservoir is undergoing capital improvements which include seismic retrofits to improve the dam outlet, which will allow for flood releases while supplying the distribution system. Based on discussions with District staff, this facility is expected to function during an extreme storm event.
Calero Reservoir	Calero Dam is undergoing capital improvements which include seismic retrofits to allow it to safely pass a Probable Maximum Flood scenario. Based on discussions with District staff, this facility is expected to function during an extreme storm event.
San Luis Reservoir	CONFIDENTIAL TEXT REMOVED.... an extreme storm event is not expected to impact supply capability. Based on discussions with District staff, this facility is expected to function during an extreme storm event.
Rinconada Reservoir	Original analysis mistakenly assumed the reservoir was in a flood zone. The reservoir is a covered treated water reservoir at the top of a hill.
Penitencia Force Main	The pipeline is undergoing capital improvements to improve reliability and reduce risk of failure in an earthquake or related landslide.
Penitencia Delivery Main	The pipeline is undergoing capital improvements to improve reliability and reduce risk of failure in an earthquake or related landslide.

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Figure 1. Schematic of Extreme Storm Outage Scenario

4. Maintenance Outages

Potential maintenance outages are developed utilizing historical and planned District facility outage schedules for the purposes of maintenance work. An interim summary memorandum for Subtask 5.3, *Planned Maintenance and Other Facility Outages* (SCVWD, 2014) was developed. This document details the District's historical and planned outage schedules. A summary of the interim memo is as follows:

- Major critical facilities in the raw and treated water systems that significantly impact District operations and require significant planning and coordination include: CONFIDENTIAL
- Simultaneous outages of the following facilities would be most problematic: CONFIDENTIAL
- Facilities that have not been taken out of service for maintenance include:
    - Snell Tunnel
    - Pacheco Tunnel Reach 1 (Pacheco Pumping Plant to Reservoir)
    - Anderson Force Main
    - Santa Teresa Force Main
    - Penitencia Force Main
    - Penitencia Delivery Main
    - Calero Bypass
    - Parallel East Pipeline

Based on the District's historical and planned maintenance outage schedules and discussions with District staff, specific outage combinations that would test system capabilities are identified and summarized in Table 6. As a result of considerations for these combinations and further discussions with District staff, it is determined that possible facility impacts due to maintenance outages are covered by other more severe outage scenarios being evaluated for seismic hazards. Therefore, maintenance outages will not be evaluated in terms of discrete outage scenarios, and will not be a main driver in analysis of system performance and goals. However, as strategies and projects are developed to increase District reliability, operational flexibilities and capabilities for performing maintenance will be considered as part of evaluations.

Table 4. Summary of Maintenance Outage Considerations

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5. Earthquake Outages

SCVWD facilities cross three active faults that may cause considerable interruptions to water supply and delivery. The following sections describe the process of developing the final earthquake outage scenarios for the IRP.

a. Data from 2005 Study

The 2005 IRP identifies three likely earthquake scenarios:

- San Andreas M7.9 (San Andreas)
- Central Calaveras M6.2 (Calaveras)
- Southern Hayward M6.7 (Hayward)

Based on the 2005 probability of failures for each critical facility (defined as probability of failure at time = 0), initial interpretations of outage scenarios are developed for each earthquake event. System component probabilities of failures are based on estimated fragilities due to ground motions from the 2005 IRP pipeline damage and component vulnerability models. These models use a combination of theoretical methods (e.g., American Lifelines Association pipe fragility model), empirical data, and analyses of design and observation data to determine system vulnerabilities and expected damage. The probabilities of failures are then derived from the reliability model, which employ Monte Carlo simulations using information from the pipeline damage and vulnerability models to provide a statistical representation of component failure. Details of this methodology are included in Volume 2 of the 2005 IRP Study in the "Reliability Baseline Evaluation" Technical Memorandum. Table 7 summarizes the 2005 IRP probabilities of failure for each critical facility under each earthquake scenario.

Table 5. Facility Probabilities of Failure from 2005 Study (Earthquake)

Facilities	San Andreas M7.9	Calaveras M6.2	Hayward M6.7
Pacheco Tunnel	0%	0%	0%
Pacheco Conduit R1	29%	22%	1%
Santa Clara Tunnel	0%	0%	0%
Santa Clara Conduit R1	59%	48%	2%
Santa Clara Conduit R2	29%	11%	1%
Anderson Force Main	6%	11%	0%
Cross Valley Pipeline	67%	19%	2%
Calero Pipeline	4%	0%	1%
Almaden Valley Pipeline	98%	2%	6%
Central Pipeline	94%	5%	39%
Penitencia Force Main*, [1]	3%	8%	5%
Santa Teresa Force Main	2%	0%	0%
Rinconada Force Main	32%	0%	0%
West Pipeline 1	42%	0%	0%
West Pipeline 2	32%	0%	1%
West Pipeline 3	2%	0%	1%

Facilities	San Andreas M7.9	Calaveras M6.2	Hayward M6.7
Santa Clara Distributary 1*	1%	0%	0%
Santa Clara Distributary 2*	2%	0%	0%
Campbell Distributary	2%	0%	0%
Sunnyvale Distributary	0%	0%	0%
Mountain View Distributary	1%	0%	0%
Snell Pipeline 1	65%	0%	6%
Snell Pipeline 2	6%	8%	0%
East Pipeline 1	14%	2%	3%
Parallel East Pipeline	13%	0%	4%
East Pipeline 2	7%	2%	2%
Penitencia Delivery Main*, [1]	3%	5%	4%
Milpitas Pipeline	21%	2%	12%
Raw Water Control [1]	83%	1%	1%
Treated Water Control	48%	14%	18%
Calero Reservoir	52%	0%	0%
Rinconada Reservoir	0%	0%	0%
Anderson/Coyote Reservoir*, [1]	0%	100%	0%
South Bay Aqueduct*	100%	100%	100%
SFPUC Intertie*	100%	16%	100%
Pacheco Pumping Plant	0%	0%	0%
Coyote Pumping Plant*	0%	0%	0%
Vasona Pumping Plant	36%	0%	0%
Coyote Valve Yard	7%	0%	0%
Piedmont Valve Yard	0%	0%	0%
Vasona Valve Yard	6%	0%	0%
Santa Teresa WTP	34%	2%	1%
Penitencia WTP	31%	34%	36%
Rinconada WTP*, [1]	86%	3%	2%

*- Revisions and additional clarifications on these facilities are presented in Section 5.2 (Table 11)

[1] – CIP in progress

Following discussions with District staff, initial earthquake outage scenarios were developed based on the 2005 IRP outage data. The resulting list of scenarios (12 for San Andreas and one each Calaveras and Hayward) toggle or alternate high-risk facilities depending on their probabilities of failure and based on facility function (e.g., raw water, treatment, or treated water), geographical location (e.g., east-side or west-side), and associated water source. Table 8 summarizes the preliminary combinations of impacted facilities for the San Andreas event, and Table 9 and Table 10 summarize the preliminary outage scenarios for the Calaveras and Hayward events, respectively.

Table 6. Preliminary Earthquake Outage Scenarios (San Andreas) Prior to Revision

Facility	CONFIDENTIAL	Scenario 1	2	3	4	5	6	7	8	9	10	11	12
Almaden Pipeline (Calero to STWTP)		X	X	X	X	X	X	X	X	X	X	X	X
Almaden Pipeline (Vasona to STWTP)		X	X	X	X	X	X	X	X	X	X	X	X
Central Pipeline		X	X	X	X	X	X	X	X	X	X	X	X
South Bay Aqueduct*		X	X	X	X	X	X	X	X	X	X	X	X
Santa Clara Conduit		X	X	X	X	X	X	X	X				
Cross Valley Pipeline		X	X	X	X					X	X	X	X
Calero Reservoir						X	X	X	X	X	X	X	X
Rinconada WTP*		X	X	X	X	X	X	X	X	X	X	X	X
Santa Teresa WTP		X		X		X		X		X		X	
Penitencia WTP			X		X		X		X		X		X
SFPUC Intertie*		X	X	X	X	X	X	X	X	X	X	X	X
West Pipeline 1		X			X	X			X	X			X
West Pipeline 2		X			X	X			X	X			X
Snell Pipeline			X	X			X	X			X	X	
East Pipeline 1			X	X			X	X			X	X	
Milpitas Pipeline			X	X			X	X			X	X	

*- Revisions and additional clarifications on these facilities are presented in Section 5.2 (Table 11)

X – Denotes facility outage

- Denotes no outage

Table 7. Preliminary Earthquake Outage Scenario (Calaveras) Prior to Revision

Facility	CONFIDENTIAL	Scenario 1
Pacheco Conduit R1		X
Santa Clara Conduit		X
Cross Valley Pipeline		X
Anderson Reservoir*		X
South Bay Aqueduct*		X
Penitencia WTP		X
SFPUC Intertie*		X

*- Revisions and additional clarifications on these facilities are presented in Section 5.2 (Table 11)
X – Denotes facility outage

Table 8. Preliminary Earthquake Outage Scenario (Hayward) Prior to Revision

Facility	CONFIDENTIAL	Scenario 1
Central Pipeline		X
South Bay Aqueduct*		X
Penitencia WTP		X
Milpitas Pipeline		X
SFPUC Intertie*		X

*- Revisions and additional clarifications on these facilities are presented in Section 5.2 (Table 11)
X – Denotes facility outage

b. Facility-Specific Issues and Scenario Refinements

During discussions with District staff on the preliminary scenarios, several issues were identified which prompted considerations with respect to potential failure mechanisms and future improvements of specific facilities. The results of these issues are summarized in Table 11, and details of the responses to these issues are included in the *Updated Information on Infrastructure Impacts* documentation. Questions pertaining to the facilities included:

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Table 9. Facility Specific Considerations for Seismic Event

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c. Likelihood of Earthquake During Drought

In addition to the facility specific considerations discussed in Section 5.2, an issue was raised by District management regarding the potential of a seismic event occurring concurrently during a drought. Due to potentially severe impacts from earthquakes, and possible increased reliance on groundwater sources as a result, the concern of an earthquake occurring during a major drought should be understood and addressed. As a result, an evaluation has been included to consider this additional issue, and quantify the likelihood of an earthquake occurring during a major drought period as summarized below.

The 2005 IRP study estimates recurrence intervals for specified earthquake magnitudes based on United States Geological Survey (USGS) data. Drought recurrence intervals are difficult to

estimate because they are dependent on, and sensitive to, the specific definition of a drought. A conservative 10-year recurrence interval for a drought event is assumed for this evaluation, and the resulting simultaneous probabilities of occurrence for earthquake combined with 10-year drought concurrently are summarized in Table 12. Additional detailed backup information is included in the *Drought and Earthquake Recurrence Interval Evaluation* (AECOM, 2015).

Table 10. Summary of Concurrent Earthquake and Drought Probabilities

Seismic Event	Probability of Occurrence Combined with 10-Year Drought (Any Given Year)
San Andreas M7.9	0.026%
Calaveras M6.2	0.054%
Hayward M6.7	0.034%

It is determined that due to the low recurrence interval for a major seismic event combined with 10-year drought, this particular enhancement to the hazard scenarios will not be specifically evaluated.

d. Final Earthquake Outage Scenarios

The final selected earthquake scenarios incorporate additional discussions with the SCVWD team, previous study information, and high-level considerations for probable facility outage combinations. Considerations incorporated into refinement for final scenarios include:

- Treated water pipeline outages can be consolidated into groupings for east-side and west-side scenarios
- Rinconada WTP and Penitencia WTP are the two treatment plants most likely to be impacted
- Rinconada WTP and Anderson Dam vulnerabilities are assumed to be addressed by future capital projects
- Hayward event vulnerabilities are captured by San Andreas event scenarios, and therefore a specific scenario is not needed for a Hayward event

Table 13 summarizes the final three selected earthquake outage scenarios, two for San Andreas and one for Calaveras. Figures 2, 3, and 4 utilize system schematics for visual representation of the three outages.

Table 11. Final Earthquake Outage Scenarios

		San Andreas EQ		Calaveras EQ
Facility	**CONFIDENTIAL**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Pacheco Conduit R1				X
Santa Clara Conduit R1		X		X
Anderson Dam/Reservoir				CIP
Cross Valley Pipeline		X	X	X
Calero Reservoir			CIP	
Almaden Pipeline		X	X	
SBA		X	X	X
Central Pipeline		X	X	
Rinconada WTP		CIP	CIP	
Penitencia WTP		X	X	X
West Pipeline 1		X		
West Pipeline 2		X		
Snell Pipeline 1			X	
East Pipeline 1			X	
Milpitas Pipeline			X	

X – Denotes facility outage
CIP – Denotes facility vulnerability addressed by upcoming CIP
- Denotes no outage

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Figure 2. Schematic of San Andreas Outage Scenario 1

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Figure 3. Schematic of San Andreas Outage Scenario 2

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Figure 4. Schematic of Calaveras Outage Scenario

6. Delta Levee Failure

Failure of levees in the San Francisco Bay Delta (Delta) due to flood and seismic hazards may potentially result in water export disruptions to the State Water and Central Valley projects due to inundation of the islands and subsequent water quality impacts. Significant disruptions (i.e., high duration of export interruption) to Delta water exports result when at least 10 islands are simultaneously flooded.

Existing studies and findings have been leveraged to assist with evaluating and quantifying potential Delta outages, particularly the Delta Risk Management Strategy (DRMS) project conducted by the California Department of Water Resources (DWR). Details of the information and findings evaluated are provided in the *Delta Levee Breach Summary* (AECOM, 2015). A brief summary of the evaluation is included below.

Flooding Risks

- Flood risks can potentially impact Delta water exports by causing significant degradation in Delta water quality, such as increased salinity or total organic carbon (TOC).
- The risk of at least 10 simultaneous island failures within a 100-yr planning period in the Delta due to flooding is very high (greater than 99% probability).
- Due to geographic distance, it is possible but unlikely that one major flood event or multiple simultaneous flood events would impact the Delta and the local District facilities and service area simultaneously. Therefore, the District facility outages assumed for the extreme storm event will not be combined with Delta levee failures.

Seismic Risks

- Seismic risks can potentially impact Delta water exports by causing significant degradation in Delta water quality, such as increased salinity or TOC.
- The risk of at least 10 simultaneous island failures within a 100-year planning period in the Delta due to a seismic event is very high (greater than 99% probability). However, this probability represents a cumulative risk of all possible seismic events on all relevant faults.
- When considering individual faults and respective earthquake magnitudes, expected ground motions from the San Andreas and Calaveras faults may not result in significant damage to the Delta. Therefore, the District facility outages assumed for the seismic events will not be combined with Delta levee failures.

Based on findings from the evaluation, it appears unlikely that significant damage and facility outages would occur simultaneously in the Delta and District service area as a result of selected seismic and extreme storm events. To capture risks of a Delta failure event, unique outage scenarios to capture Delta-specific failures are appropriate. As a result, two Delta outage scenarios have been identified:

- Short-term/6-month Delta outage – Loss of all imported water for 6 months

- Long-term/24-month Delta outage – Loss of all imported water for 24 months

7. Final Selected Outage Scenarios

Through preliminary evaluations of outage scenarios and discussions with District staff, it is determined that the representative outage scenarios appropriate for evaluating performance of the SCVWD system are:

- Extreme Weather (Climate Change): Extreme storm event
- Earthquake: 3 scenarios (2 for San Andreas and 1 for Calaveras)
- Delta Failure: 2 scenarios (Delta outage for (6-month) short-term and (24-month) long-term durations)

The other hazard categories are not specifically being evaluated for outage scenarios and analyzed with respect to system performance and goals due to the following considerations:

- Maintenance outages: Potential maintenance outage impacts are captured by the other scenarios
- Regional power and SCADA outages: Potential regional power and SCADA outage impacts are captured by the other scenarios
- Water quality event: Minor events have a short duration of impact and can be mitigated by redundancy in the raw water system. While a major water quality-related terrorist event is low probability of occurrence.
- Simultaneous drought and earthquake event: Low recurrence interval and low probability of occurrence.

Table 14 summarizes the assumed facility impacted for each of the final selected outage scenarios. Facility impacted under the specific hazards are a result of using available information such as reliability information from the 2005 IRP report and additional analyses (e.g., DRMS report, Climate Change Vulnerability Assessment, etc.) to identify facilities most likely impacted by the hazard event. Discussions with District staff further refined these selections to develop the final outage scenarios. These selected outage scenarios will be used to evaluate District system performance and Level of Service (LOS) goals, and to identify appropriate projects and operational strategies to increase District reliability for supplying and delivering water.

Table 12. Final Selected Outage Scenarios

Facility	CONFIDENTIAL	Extreme Storm	San Andreas EQ #1	San Andreas EQ #2	Calaveras EQ	Delta Short-Term (6 months)	Delta Long-Term (24 months)
Bay Delta						X	X
San Luis Reservoir (CVP)							
Pacheco PP		X					
Pacheco Conduit R1					X		
Penitencia Force Main		CIP	CIP	CIP	CIP		
Santa Clara Tunnel		X					
Santa Clara Conduit			X		X		
Anderson/Coyote Reservoir		CIP	CIP	CIP	CIP		
Coyote PP		X					
Cross Valley Pipeline			X	X	X		
Calero Reservoir		CIP	CIP	CIP	CIP		
Almaden Pipeline			X	X			
Vasona PP		X					
South Bay Aqueduct (SWP)		X	X	X	X		
Central Pipeline			X	X			
Rinconada WTP		X	CIP	CIP	CIP		
Rinconada Reservoir							
Santa Teresa WTP		X					
Penitencia WTP		X	X	X	X		
Penitencia Delivery Main		CIP	CIP	CIP	CIP		
West Pipeline 1		X	X				
West Pipeline 2		X	X				
West Pipeline 3		X					
Snell Pipeline				X			
East Pipeline 1				X			
Milpitas Pipeline				X			

8. References

AECOM, 2015. *Critical Facilities Matrix*.

AECOM, 2015. *Delta Levee Breach Summary.*

AECOM, 2015. *Drought and Earthquake Recurrence Evaluation*.

AECOM, 2015. *Updated Information on Infrastructure Impacts*

Brown, I. and C. Thomas, 2013. *Silicon Valley 2.0- Climate Science Review Memorandum*. Prepared for the Silicon Valley 2.0 Technical Advisory Committee Members. July 2, 2013.

SCVWD, 2015. *Infrastructure Reliability Climate Change and Extreme Weather Technical Memorandum.*

SCVWD, 2015. *Planned Maintenance and Other Facility Outages*

SCVWD, 2015. *Silicon Valley Advanced Water Purification Center Technical Memorandum*

Santa Clara Valley Water District

Infrastructure Reliability Plan

Task 6 Appendix

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Levels of Service Benchmarking and Development

Subtask 6.1
Interim Technical Memorandum

Infrastructure Reliability Project, Task 6.1

Project Number: 93504001

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Prepared by:
AECOM

Draft

June 22, 2015

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Appendices

Appendix 1 – Existing District LOS Objectives
Appendix 2 – Full List of LOS Objectives
Appendix 3 – Metropolitan Water District Information
Appendix 4 – Retailer LOS Questionnaire
Appendix 5 – Retailer LOS Meeting Notes

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1. Purpose and Overview

The purpose of this Interim Summary Technical Memo (TM) 6.1 is to summarize research and work completed to date, to develop appropriate Levels of Service (LOS) objectives for the Santa Clara Valley Water District (District) Infrastructure Reliability Plan (IRP). LOS objectives can be used to measure or quantify system performance. For the purposes of the IRP, the LOS objectives represent performance standards or targets for which the District's system may strive to reach under various hazard scenarios identified in Task 5 of the IRP. Examples of existing and prescriptive LOS objectives are sought to better understand the performance levels of other utilities and to help create a realistic performance standard for the District.

The following additional background items are attached to this memo:

- Appendix 1: Existing District LOS Objectives
- Appendix 2: Full List of LOS Objectives
- Appendix 3: Metropolitan Water District Information
- Appendix 4: Retailer LOS Questionnaire
- Appendix 5: Retailer LOS Meeting Notes

This TM 6.1 will be incorporated in an overall Task 6 LOS TM, which will detail the selection of LOS objectives for the District's existing system in selected outage scenarios, and to help develop the solutions and projects needed to meet these objectives.

2. Summary of Activities

This section summarizes the activities related to:

- 2.1 LOS Benchmarking Research
- 2.2 Preliminary Retailer Discussions on LOS
- 2.3 Additional Retailer Demand Evaluation
- 2.4 Preliminary LOS Objectives
- 2.5 Selection of LOS Objectives

a. LOS Benchmarking Research

To support development of reasonable LOS objectives, the following efforts were performed as summarized in this section:

- Existing District LOS – Compile existing documentation on District LOS goals
- Other Water Utility LOS – Research literature and benchmark with other utilities regarding other industry-accepted LOS goals

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Existing District LOS

Information regarding the District's existing service goals is documented in Appendix 1. This sub-section summarizes key findings and discusses the applicability to the current project.

Treated Water Contracts

The District's treated water retailer contracts provide LOS requirements for treated water deliveries, and states that the District will make all reasonable efforts to provide continuous service. In case of water supply shortage, the District will reduce deliveries in the following order:

1. Reduce all deliveries of untreated water for groundwater recharge
2. Reduce the total amount of water released for agriculture
3. Reduce treated water deliveries in appropriate proportions according to delivery schedules

Specific scenarios and targets for deliveries and restoration are not defined. Thus, there are no quantitative components to inform this project's LOS development. However, restoration strategy as stated above should be considered.

Water Quality Goals

The District has stringent water quality-focused LOS goals; however, they are largely applicable to normal or minor incident operations. In a major disaster such as a 7.9 San Andreas earthquake, the District would suspend water quality-focused LOS goals if necessary to maintain necessary water deliveries. This project does not consider water quality LOS goals, and is consistent with the stated mission of water delivery restoration as a priority over water quality in a major disaster event.

2005 IRP Study

LOS objective information from the 2005 IRP study have been compiled and summarized in Table 1. As shown in the table, LOS objectives are grouped into six categories:

- General – Addresses facility damage and safety, and general potable system restoration.
- Wholesale Municipal – Addresses wholesaler serviceability and restoration to point of delivery treated water turnouts for retailers.
- Industrial Use – Includes specific treated water restoration considerations for industrial customers and minimizing economic loss.
- Environmental – Includes specific raw water restoration considerations for environmental releases.
- Agricultural/Landscape – Includes specific raw water restoration considerations for agricultural/landscape customers and minimizing economic loss.
- Groundwater Recharge – Addresses raw water restoration for groundwater recharge.

As further clarified in Appendix 1, the District recognized the distinction between normal operations and emergency operations following major unplanned, multiple-outage regional events. The 2005 IRP study

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established these different service goals to address this distinction. The overall design LOS goals identified for the project was “potable water service at average winter flow rates available to a minimum of one turnout per retailer within seven days…”

The current project seeks to revisit system reliability goals and refine as necessary based on the most current information and customer landscape.

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Table 1. Existing District LOS Objectives for Maximum and Probable Events from 2005 IRP Study

Service Category	LOS Objective	
	Maximum Event	**Probable Event**
General	• Minimal property damage to District facilities that could potentially endanger general public and District staff • Temporary repairs to achieve emergency services as soon as possible • All water introduced to distribution system is potable	• Minimal property damage to District facilities and zero potential for endangerment of general public and District staff • Full service is uninterrupted to 90% of turnouts
Wholesale Municipal	• Non-potable water service (with some chlorine disinfection) available to at least one point of delivery for each retailer in affected area within 12 hours, for retailers with a reliable alternative source. Customers are expected to use storage, wells, and other services to provide water (fight fires) in the interim • Non-potable water service (with some chlorine disinfection) available to at least one point of delivery for each retailer without reliable alternate sources for fire flows within 12 hours • Potable water at average winter flow rates available to a minimum of one turnout per retailer within 7 days, with periodic 1 day interruptions for repairs • Water that meets potable water objectives at annual contract flow rates available to 90% of turnouts within 21 days • Full service to all District customers at contracted flow rates witin 45 days	• Potable water service available to 90% of turnouts at winter flow rates within 12 hours • Potable water service available to each turnout, for those retailers without reliable alternate sources, at annual contract flow rates within 12 hours • Full service to all District customers at contracted flow rates within 2 days
Industrial Users (future)	• Restoration priority based on minimizing economic loss, as determined by District in consultation with stakeholders • Non-potable water service available to affected industry within 12 hours. Customer utilizing storage, wells or other service to provide water (fight fires) in the interim • Temporary repairs to achieve full service to industrial customers at average winter demand rates within 7 days, with periodic 1 day interruptions for repairs • Full service to industrial customers within 90 days	• Temporary repairs to deliver average winter demand rates to industrial customer rates within 2 days • Full service to industrial customers within 7 days

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Service Category	LOS Objective	
	Maximum Event	**Probable Event**
Environmental Releases	• Restoration priority based on priorities set in the FAHCE agreement and other DFG MOU • Temporary raw water system repairs to achieve average annual flow releases within 21 days • Full operation of environmental releases within 90 days	• Temporary raw water system repairs to restore minimal/prioritized (as defined by FAHCE agreement and other DFG MOU) environmental releases within 2 days • Full operation of environmental releases within 7 days
Agricultural Users and Landscape Users	• Restoration priority based on minimizing economic loss, as determined by District in consultation with stakeholders • Temporary raw water system repairs to achieve average annual flow service within 30 days • Full service to agricultural customers within 90 days	• Temporary raw water system repairs to achieve average annual flow service within 2 days • Full service to agricultural customers within 15 days
Groundwater Recharge	• Temporary raw water system repairs to restore minimal/prioritized (as defined by District operations) recharge flows within 60 days • Full operation of recharge facilities within 90 days	• Temporary raw water system repairs to restore minimal/prioritized (as defined by District operations) recharge flows within 2 days • Full operation of recharge facilities within 15 days

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Other Water Utility LOS

This subtask involved researching other water utility system LOS objectives, and in particular those relevant to system performance following major disaster events. This research included industry guidelines and benchmarking with other utilities. The objective of this subtask is to determine a range of realistic and/or industry-accepted LOS targets with respect to operational levels and recovery times after disaster events. Based on the information available, most disaster event LOS objectives are formulated based on earthquake hazard scenarios. Example LOS objectives were gathered from the following sources:

- San Francisco Public Utilities Commission (SFPUC)
- Contra Costa Water District (CCWD)
- East Bay Municipal Utility District (EBMUD)
- Metropolitan Water District of Southern California
- Oregon Resilience Plan Water and Wastewater Task Group: Water and wastewater utilities serving a combined 40% of the population of western Oregon include the following utilities:
    - City of Portland
    - Tualatin Valley Water District
    - City of Bend
    - City of Gresham
    - City of Pendleton
    - City of Salem
    - Clean Water Services
    - Coos Bay – North Bend Water Board
    - Eugene Water & Electric Board
    - Rivergrove Water District
- American Society of Civil Engineers (ASCE) – Technical Council on Lifeline Earthquake Engineering
- National Institute of Standards and Technology (NIST) – Disaster Resilience Framework

Generally, LOS objectives are customized and specific to the functional system and/or components, for example whether infrastructure is for storage/supply, transmission, or distribution. Also, targets vary based on recovery timeframe and associated abilities to achieve specified operational or reliability levels after an earthquake, for example 3 days, 1 week, or 1 month following an event. In the instance of the Oregon Resilience Plan, LOS objectives vary geographically based on expected seismic-induced damage and population density throughout the study's service area. A summary of the most relevant LOS objectives is provided in Table 2. A full list of all LOS objectives considered is included in Appendix 2.

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Table 2. Summary of Most Relevant LOS Objectives

Category	LOS Objective	Timeframe	Organization
Supply/Source	20-30% operational 50-60% operational 80-90% operational	3-7 days 14-30 days 90-180 days	Oregon Resilience - Coastal Oregon
	90% restored	7-30 days	NIST - Disaster Resilience Framework
Wholesaler System	Emergency/fire Partial service Full service	2 days 10 days 30 days	CCWD
	Basic Service (Winter Day Demand/Min. month) to 70% of turnouts	1 day	SFPUC
	Average Day Demands	30 days	SFPUC
Transmission System[1]	20-30% operational 50-60% operational 80-90% operational	1-3 days 3-7 days 7-14 days	Oregon Resilience - Coastal Oregon
Distribution System[2]	Partial and sanitary demands (important facilities only)	5-15 days	CCWD
	Full demands	15-60 days	CCWD
	Minimum service to 70% of customers	10 days	EBMUD
	20-30% operational 50-60% operational 80-90% operational	7-14 days 30-90 days 90-180 days	Oregon Resilience - Coastal Oregon
	Minimum service to 70% of customers Impaired service to 90% of customers	10 days 30 days	EBMUD
	Minimum service to 70% of customers Impaired service to 90% of customers	10 days 30 days	ASCE - Technical Council on Lifeline Earthquake Engineering

[1] Transmission system refers to large-diameter pipeline networks designed and sized to carry water supply to wholesalers.
[2] Distribution system refers to smaller-diameter pipeline networks designed and sized to serve end-user retailers.

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From Table 2, the following observations regarding LOS objectives can be made:

- Disaster recovery timeframes for achieving specified performance levels vary greatly, depending on the performance level, utility, and infrastructure type
- Performance targets vary depending on system type and function, for example water supply, water treatment, transmission, distribution, etc.

It should be noted that these LOS objectives do not necessarily equate to the performance target being actually achieved by the utility. In some cases, such as the Oregon Resilience Project, LOS objectives are still under formulation and study. In other cases, they represent a desired level of performance, and not necessarily a contractual obligation.

In addition, it should be noted that the comparatively short timeframe for recovery to basic service reflected for SFPUC is a result of significant investments in an associated capital improvement program costing $4.6 billion. Specific information for Metropolitan Water District (MWD) was also gathered through an interview process. Per MWD policy, a 6-month supply of water is maintained in local reservoirs within their Southern California basin, adequate for meeting reduced water use at 50% of normal supply. MWD policy also dictates that they will maintain resources to repair any two failures of critical facilities within a 6-month period. Additional details from the MWD information gathering are provided in Appendix 3.

b. Preliminary Retailer Discussions on LOS

Meetings with District retailers were held in December 2014, to understand tolerances, concerns, and objectives for withstanding outages and reduced treated water delivery and groundwater recharge in response to major disasters. Major discussion points included:

- Longest tolerable outage or reduction of SCVWD treated water if all back-up sources (e.g., SFPUC, groundwater, other retailers, etc.) are available
- Longest tolerable outage or reduction of SCVWD treated water if only groundwater is available
- Concerns with reduced groundwater recharge operations
- Operational changes resulting from reduced or outage of SCVWD treated water

For purposes of discussion, tolerable outage was defined as the reasonable amount of time that Retailers could continue supplying basic demands using backup water supplies in the absence of District treated water deliveries. Due to seasonal variations, discussions differentiated between winter/low-demand conditions and summer/high-demand conditions. An example questionnaire in Appendix 4and full notes from the December 2014 retailer meetings are included in Appendix 5. Table 3 summarizes the results of the retailer meetings with respect to outage durations.

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Table 3. Summary of Retailer Meeting Notes – Tolerable Outage Durations

Retailer	SCVWD Treated Water		Managed Groundwater Recharge
	During Winter	During Summer	
Cal Water	14 days	Hours	Unknown
City of San Jose	3-5 days	Hours	3+ months
Gilroy	Groundwater only system		60+ days to months
Great Oaks	Groundwater only system		2 years
Milpitas	Indefinite	Indefinite	Unknown
Morgan Hill	Groundwater only system		60 days
Mountain View	30 days	30 days	Unknown
San Jose Water Company[1]	Indefinite	14 days	Unknown
Santa Clara	Indefinite	Indefinite	9+ months
Sunnyvale	Indefinite	7 days	Unknown

[1] - varies by turnout and zone, more detailed response pending

c. Additional Retailer Demand Evaluation

This subtask includes an examination of the methodology used to calculate retailer demands, and whether they are appropriate for supporting selection of LOS objectives. Task 4 defined retailer demand data for winter and summer month demands as 5-year averages of February and July months, respectively, utilizing historical water usage data from a 5-year period of 2009 to 2013. A prescriptive industry-standard demand calculation methodology is not readily available. A customized approach for examining a utility's supply and demand characteristics may be more appropriate, particularly for determining minimum demands for basic service, which may be affected by location-specific attributes such as geography, demographics, weather, and future growth projections. More details regarding the calculation methodologies for average annual, winter month, and summer month demands used for this project can be found in the Task 4 TM.

To further understand the District's water demand situation and possible variability, an evaluation was performed to compare Retailers' winter water usage, using two different calculation methods:

- Average of three winter months – Demands calculated as a 3-month average for December through February

- Average of one winter month – Demands calculated as a 1-month average for the minimum winter month of February only

Results are summarized in Table 4, split out by Retailer and by water source. As shown by this evaluation, the differences between the two calculation methods (average of 3 winter months versus average of 1 winter month) are minimal. In almost all individual cases, the difference is less than 1 MGD or 10% for a single data point. In cumulative, overall variations reduce even further. For totals of all retailers and all sources, the overall difference is less than 1 MGD. Based on results of these additional examinations, it can be concluded that the calculation methodology and basis for historical water use data is defensible. This supports the original conclusions as documented in Task 4 TM that target winter demands, calculated as a single-month of February based on latest 5 years of historical data, is appropriate and accurate for planning-level purposes.

Also, as a methodology comparison, demand targets for SFPUC's Water System Improvement Program (WSIP) were considered. The SFPUC WSIP set targets representing "Basic Service" or "Minimum Month" demands, which were calculated based on one minimum winter month, utilizing historical water usage data for the month of February. This methodology applied to wholesale and retail water customers in the East Bay, South Bay, and Peninsula; and also to the City of San Francisco's retail customers.

In addition, an evaluation of West-side versus East-side splits of SCVWD treated water demands was developed. Table 5 summarizes the West-side and East-side deliveries by Retailer for February, Average Annual, and July demands. Results show relatively little seasonal variation in the splits, averaging 44% for West-side and 56% for East-side SCVWD treated water use. The significance for breaking down West-side versus East-side demands is that treated water deliveries to the two areas are not redundant and not interchangeable. Rinconada Water Treatment Plant (WTP) solely supplies the West-side via West Pipeline, while Santa Teresa WTP and Penitencia WTP supply the East-side via East Pipeline.

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Table 4. Evaluation of Winter Demand Calculation Methodology

Retailer	Groundwater			SCVWD Treated Water			SFPUC			Other			Total		
	February (MGD)	3-Month Winter Avg (MGD)	Difference (Feb-Avg) (MGD)	February (MGD)	3-Month Winter Avg (MGD)	Difference (Feb-Avg) (MGD)	February (MGD)	3-Month Winter Avg (MGD)	Difference (Feb-Avg) (MGD)	February (MGD)	3-Month Winter Avg (MGD)	Difference (Feb-Avg) (MGD)	February (MGD)	3-Month Winter Avg (MGD)	Difference (Feb-Avg) (MGD)
Cal Water	2.0	1.9	0.1	5.2	5.0	0.1							7.2	7.0	0.3
Gilroy	4.7	4.7	0.0										4.7	4.7	0.0
GreatOaks	7.2	6.8	0.4										7.2	6.8	0.4
Milpitas				2.7	2.6	0.1	5.2	5.0	0.2				7.9	7.6	0.3
Morgan Hill	3.8	3.9	-0.1										3.8	3.9	-0.1
Mountain View	0.3	0.3	0.0	0.6	0.5	0.1	6.3	6.7	-0.4				7.2	7.5	-0.3
Santa Clara	9.6	9.1	0.5	3.1	3.1	0.1	2.4	2.2	0.2				15.1	14.4	0.7
SJ Muni	0.6	0.6	0.1	8.0	8.0	0.0	3.3	3.3	0.1				12.0	11.8	0.2
SJWC	27.5	30.1	-2.6	46.6	47.5	-0.9				10.5	7.8	2.7	84.7	85.4	-0.8
Sunnyvale	0.7	0.7	-0.1	6.1	5.1	1.0	6.5	7.3	-0.8				13.2	13.2	0.1
Total System	**56.5**	**58.3**	**-1.7**	**72.3**	**71.9**	**0.4**	**23.7**	**24.5**	**-0.7**	**10.5**	**7.8**	**2.7**	**163.1**	**162.4**	**0.7**

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Table 5. SCVWD Treated Water West-Side versus East-Side Split

Retailer	SCVWD Treated Water February (MGD)	SCVWD West-Side Split (MGD)	SCVWD East-Side Split (MGD)
Cal Water	5.2	5.2	N/A
Gilroy	N/A	N/A	N/A
GreatOaks	N/A	N/A	N/A
Milpitas	2.7	N/A	2.7
Morgan Hill	N/A	N/A	N/A
Mountain View	0.6	0.6	N/A
Santa Clara	3.1	3.1	N/A
SJ Muni	8.0	N/A	8.0
SJWC	46.6	17.3	29.4
Sunnyvale	6.1	6.1	N/A
Total System	**72.3**	**32.3**	**40.1**
		45%	**55%**

Retailer	SCVWD Treated Water Average Annual (MGD)	SCVWD West-Side Split (MGD)	SCVWD East-Side Split (MGD)
Cal Water	8.2	8.2	N/A
Gilroy	N/A	N/A	N/A
GreatOaks	N/A	N/A	N/A
Milpitas	3.0	N/A	3.0
Morgan Hill	N/A	N/A	N/A
Mountain View	1.0	1.0	N/A
Santa Clara	4.0	4.0	N/A
SJ Muni	13.0	N/A	13.0
SJWC	67.7	25.0	42.7
Sunnyvale	8.5	8.5	N/A
Total System	**105.6**	**46.9**	**58.7**
		44%	**56%**

Retailer	SCVWD Treated Water July (MGD)	SCVWD West-Side Split (MGD)	SCVWD East-Side Split (MGD)
Cal Water	10.2	10.2	N/A
Gilroy	N/A	N/A	N/A
GreatOaks	N/A	N/A	N/A
Milpitas	3.6	N/A	3.6
Morgan Hill	N/A	N/A	N/A
Mountain View	1.5	1.5	N/A
Santa Clara	4.5	4.5	N/A
SJ Muni	19.1	N/A	19.1
SJWC	90.1	33.3	56.8
Sunnyvale	11.4	11.4	N/A
Total System	**140.5**	**61.0**	**79.5**
		43%	**57%**

SJWC - Assumes a split of 37% West and 63% East based on data provided by the District
N/A – Not applicable

d. Preliminary LOS Objectives

The previous 2005 IRP study's post-seismic restoration goals are summarized in Table 6, which shows restoration goals of 7-14 days for winter demands. The calculated water demands were adjusted in 2009 due to revised demand basis. After recent discussions between the District and Retailers, it appears that an updated 30-day outage period/restoration goal after a major earthquake may be tolerable for most Retailers, depending on availability of each Retailer's back up supplies.

Table 6. Previous Post-Seismic Recovery Goals

Project	Restoration Time	Assumed System Winter Demand	Demand Basis
2005 IRP	7-14 days (1 turnout per retailer)	80 MGD	4 winter months in 2003
2009 Well Field Implementation Plan	7-14 days (1 turnout per retailer)	73 MGD	2 winter months in 2007

Based on LOS benchmarking research, meetings with retailers, and discussions with District staff, a range of preliminary LOS objectives are being considered for potential District system performance targets under various outage scenarios. Preliminary considerations for LOS objectives are summarized in Table 7, with varying hazard-specific demands and restoration times.

Table 7. Preliminary LOS Objectives

Hazard Scenario	Treated Water Delivery		Groundwater Recharge	
	Target Flow	Restoration Time	Target Flow	Restoration Time
Earthquake	Winter Demands	14 to 30 days	Average flow	60 days
Extreme Storm	Winter Demands	7 to 14 days	Average flow	60 days
Delta Outage Short-Term	Winter Demands w/20% Reduction	Immediate for 6-month duration	20% Reduction	Immediate for 6-month duration
Delta Outage Long-Term	Winter Demands w/20% Reduction	Immediate for 24-month duration	20% Reduction	Immediate for 24-month duration
Regional Power Outage	Winter Demands w/20% Reduction	Immediate for 2-week duration	20% Reduction	Immediate for 2-week duration

As shown in Table 7, LOS objectives vary by hazards and outage scenarios, with varying degrees for water delivery targets and restoration times. Generally, preliminary discussions have considered winter demands as basic service, representing the base demand target for treated water delivery after a major disaster event. Winter demands are a starting point for benchmarking the minimum service to provide the public in the aftermath of a major disaster. Winter demands generally do not include landscaping and other significant outdoor water use that are present during other seasons, and which may be considered extraneous during emergency situations. However, it is an amount based on historical data that can be reasonably associated with day-to-day continuity of residential and business operations and needs.

Modeling and analyses will determine system capabilities to restore winter demands partially or in full, and the assumed restoration time for recovery. Additional considerations and enhancements may include area-specific restoration strategies. For example, various concepts for prioritization may be evaluated, resulting in restoration objectives that could prioritize treated water and recharge flows to specific vulnerable areas.

As stated above, a 30-day outage period/restoration goal may be tolerable for most Retailers given their back up water supplies. Exceptions include Cal Water and City of San Jose (San Jose Municipal), whose outage tolerances may be of shorter duration. Without SCVWD treated water supply, Cal Water would have difficulty serving specific areas of their system, particularly in the Vallco area in Cupertino where there is limited groundwater capability to provide backup supply. Cal Water also has some pipeline capacity limitations that make it difficult to move water from their other areas. They could reasonably withstand a restoration period of up to 2 weeks. For San Jose Municipal, SCVWD treated water is the only normally-available supply to their Evergreen service area. Backup groundwater wells in that area have limited capacity and state-mandated operational restrictions. As a result, restoration periods of more than 3 to 5 days may be a hardship for San Jose Municipal. Selection of recovery periods longer than these stated tolerable restoration times may prompt projects specific to these retailer areas.

In addition, LOS objectives for managed recharge are also being considered for this project. Generally, retailers are able to withstand loss of recharge for 60 or more days without major supply impacts. In some cases, the impact of complete loss of recharge for long durations had not been previously evaluated. However, recent drought conditions have resulted in loss of recharge to some areas and a better understanding of short-term impacts.

For Delta outage scenarios (6-month and 24-month), analyses will be developed to quantify the supplies and deliveries that can be made over the outage duration, when limited to local water supplies. The Delta outage evaluations look to understand District capabilities for deliveries (treated water and groundwater recharge) in the absence of imported water and relying only on local storage. Curtailments and prioritizations are expected in these longer-term outage scenarios.

In the scenario of a regional power outage, water supply may be available and facilities may be undamaged. However, operations and water deliveries may be curtailed due to the limitations of

backup power generators and fuel availability. Analyses will be developed to quantify reasonable power outage durations and associated reductions in operations as a result of relying on backup power and fuel capabilities.

e. Selection of LOS Objectives

Subsequent phases of the current IRP Project will quantify District system capabilities, needs and deficiencies, and potential improvements; in order to further develop LOS objectives and facilitate selection of desired District system performance.

Table 8 presents a high-level concept of LOS impacts for various levels of improvements, and corresponding restoration capabilities. The purpose of this matrix is to present a general "menu" of investment levels and resulting system performance, ***in concept only***. Further evaluation performed in subsequent project tasks will develop, quantify, and refine these options. The information presented in Table 8 are rough placeholders, informed by general information gathered to date.

Table 8. Preliminary Concept of LOS Impacts

Improvements/ Investment	Restoration Capabilities			
	Earthquake	**Extreme Storm**	**Delta Outage Short-Term**	**Delta Outage Long-Term**
None • No action	Winter Demands @ 30-60 days	Winter Demands @ 20-30 days	20% Reduction for 6 months	20% Reduction for 24 months
Operations only (<$1M/yr) <u>District Enhancements</u> • Staffing considerations • Trainings/certifications • Emerg. reponse planning • Contingency procedures • Coordination roles/resp. • Comm./Outreach <u>Retailer Enhancements</u> • Utilize backup sources • Operational config. • Increase GW/SFPUC • Increase pumping ops • Activate interconnections	Winter Demands @ 30-45 days	Winter Demands @ 14-21 days	20% Reduction for 6 months	20% Reduction for 24 months
$10+ Million CIP? • PL repair capabilities • Intertie improvements • Critical isolation valves • Strategic GW wells • Increase backup power • Additional pumps at Calero Reservoir	Winter Demands @ 14-30 days	Winter Demands @ 7-14 days	20% Reduction for 6 months	20% Reduction for 24 months
$100+ Million CIP? • Replace critical PLs • Redundant/parallel PLs • Redundant GW source • West-side Intertie	Winter Demands @ 7-14 days	Winter Demands @ 1-7 days	20% Reduction for 6 months	20% Reduction for 24 months
$1+ Billion CIP? • New PL alignments • New TW source • New RW source	Winter Demands @ 1 day	Winter Demands @ 1 day	20% Reduction for 6 months	20% Reduction for 24 months

3. Anticipated Activities

Preliminary LOS objectives and concepts will be subject to further evaluation and confirmation in subsequent tasks of this project, which will determine the feasibilities of LOS objectives. The following sections represent place-holders for summarizing this anticipated work.

Task 7: Potable Water Service Modeling

- Summary of modeling results
- Preliminary considerations of outage durations and recovery capabilities

Task 8: Regional Redundancy

- Summary of regional capabilities that may support LOS selection

Task 9: Reliability Improvement Needs

- Summary of reliability improvement needs to address LOS shortfalls

Task 10: Other Improvement Needs

- Summary of other improvement needs to address LOS shortfalls

Task 11: Identify Projects

- Identify projects to meet LOS objectives

Appendix 1:
Existing District LOS Objectives

Existing Levels of Service Summary Infrastructure Reliability Project Task 6.1

The District has researched levels of service goals from available sources, including retailer contracts, Board Policy, the 2005 IRP report, retailers' Urban Water Management Plans (UWMPs), among others. The findings are presented below.

District Mission and Board Policy

The District's Mission and Board Policies provide high level direction on level of service goals for its core business areas. The mission of the District is to *"Provide Silicon Valley safe, clean water for a healthy life, environment, and economy*". The District's vision is to be a fiscally responsible water resources agency valued by the community. This is reflected in the District Act[1] that states one of the purposes of the District is "to do any and every lawful act necessary to be done that sufficient water may be available for any present or future beneficial use of uses of the lands or inhabitants within the District."

In order to achieve this mission and vision, the District's Board of Directors set policies[2] to guide District staff in managing the District's core businesses. The letter E indicates an 'Ends' policy. These are the ends to which the District works to achieve. The letter 'S' indicates a 'Strategy' for achieving the ends. The letters 'OM' indicates a desired 'Outcome Measure' for the associated ends policy.

> E-2: There is a reliable, clean water supply for current and future generations
>
> E - 2.1: Current and future water supply for municipalities, industries, agriculture and the environment is reliable.
>
> E - 2.1.3: Protect, maintain, and develop imported water.
>
> E - 2.2: Raw water transmission and distribution assets are managed to ensure efficiency and reliability.
>
> E - 2.3: Reliable high quality drinking water is delivered.
>
> S - 2.4: Develop water supplies designed to meet at least 100 percent of average annual water demand identified in the District's Urban Water Management Plan during non-drought years and at least 90 percent of average annual water demand in drought years.
>
> S - 2.1.3.1: Develop and maintain imported water contracts and water management partnerships.
>
> S - 2.2.1.1: Manage, operate, and maintain raw water transmission and distribution assets to maximize reliability, to minimize life-cycle costs and to minimize impacts to the environment.
>
> OM - 2.1.3.a: 100% of imported water identified in annual operations plan delivered to County to meet annual water needs.

[1] http://www.valleywater.org/About/DistrictAct.aspx
[2] http://www.valleywater.org/About/Board_of_Directors/Board_Governance_Policies/BAO_Interpretations.aspx

OM - 2.2.1.a: 100% of annual maintenance work plans completed for all transmission and distribution facilities.

OM 2.3.1.b: 100% of annual maintenance work plans completed for all facilities.

Treated Water Contracts

The District's treated water retailer contracts provide level of service requirements for the treated water system. The contract requirements provide guidelines for calculating future maximum daily demands for the treated water system.

Every three years the District's treated water retailers provide a delivery schedule with annual contract amounts for the three-year period. The treated water contracts require the District to provide the following:

- The total annual amount of treated water in the approved delivery schedule
- In each month, at least 15% of the total annual amount in the approved delivery schedule
- For an aggregate of 72 hours in any month, an instantaneous flow rate equivalent to 205% of the current annual amount in the approved delivery schedule expressed as an equivalent uniform flow rate over the full year (i.e., convert annual amount to MGD * 2.05)
- The district may limit the maximum flow rate to 180% of the current annual amount in the approved delivery schedule expressed as an equivalent uniform flow rate over the full year (i.e., convert annual amount to MGD * 1.80)

District will make all reasonable effort to provide continuous service to contractor but may temporarily discontinue or reduce the delivery of water to contractor for the purpose of necessary maintenance or repair of any of the facilities.

In any year in which there may occur a water shortage by reason of drought or other temporary cause in the supply of water available, the District will first reduce all deliveries of untreated water for recharge of groundwaters. If a further reduction in deliveries is needed, the District will reduce the total amount of agricultural water released to others for surface delivery by an amount equal to the following: the average of the releases of surface-delivered agricultural water during the preceding three fiscal years multiplied by the percentage of District's total receipt of water from State and Federal sources.

If any reduction in deliveries of treated water shall become necessary following the reduction of untreated water, the District will reduce deliveries of treated water in an amount that bears the same proportion to the total amount of reduction that the amount included in treated water user's approved delivery schedule bears to the total of the amount included in the approved delivery schedule for the fiscal year, determined by the district; provided the district may apportion on some other basis if such is required to meet minimum demands for domestic supply, fire protection, or sanitation during the year.

The treated water contract for the City of Mt. View is presented in Appendix One as an example of a typical treated water contract between the District and water retailers.

Water Quality Goals

The most current water quality regulations are available at http://www.swrcb.ca.gov/drinking_water/certlic/drinkingwater/Lawbook.shtml. The District has more stringent LOS goals for water quality; however, in a major disaster, like a 7.9 San Andreas earthquake, those regulations would be suspended if necessary to keep water deliveries to retailers and to the general population.

2005 WIRP LOS Goals

The 2005 Water Infrastructure Reliability Project (WIRP) study concluded that the District's water supply system could suffer up to a 60-day outage if a 7.9-magnitude earthquake on the San Andreas Fault were to occur.

The design level of service goal identified for the WIRP was "potable water service at average winter flow rates available to a minimum of one turnout per retailer within seven days…"

The District had established level of service goals for its normal operation. It was recognized that the Reliabliity Project is distinct in that it addressed District system service goals following a major unplanned, multiple outage regional event, which required different service goals than its other programs. Table 1 below lists the level of service goals established for the Reliability Project.

Table 1: Existing District Level of Service Goals

Service Category	Level of Service Goal Maximum Event	Level of Service Goal Probably Event
General	• Minimal property damage to District facilities that could potentially endanger general public and District staff • Temporary repairs to achieve emergency services as soon as possible • All water introduced to distribution system is potable	• Minimal property damage to District facilities and zero potential for endangerment of general public and District staff • Full service is uninterrupted to 90% of turnouts
Wholesale Municipal	• Non-potable water service (with some chlorine disinfection) available to at least one point of delivery for each retailer in affected area within 12 hours, for retailers with a reliable alternative source. Customers are expected to use storage, wells, and other services to provide water (fight fires) in the interim • Non-potable water service (with some chlorine disinfection) available to at least one point of delivery for each retailer without reliable alternate sources for fire flows within 12 hours • Potable water at average winter flow rates available to a minimum of one turnout per retailer within 7 days, with periodic 1 day	• Potable water service available to 90% of turnouts at winter flow rates within 12 hours • Potable water service available to each turnout, for those retailers without reliable alternate sources, at annual contract flow rates within 12 hours • Full service to all District customers at contracted flow rates within 2 days

	interruptions for repairs • Water that meets potable water objectives at annual contract flow rates available to 90% of turnouts within 21 days • Full service to all District customers at contracted flow rates witin 45 days	
Industrial Users (future)	• Restoration priority based on minimizing economic loss, as determined by District in consultation with stakeholders • Non-potable water service available to affected industry within 12 hours. Customer utilizing storage, wells or other service to provide water (fight fires) in the interim • Temporary repairs to achieve full service to industrial customers at average winter demand rates within 7 days, with periodic 1 day interruptions for repairs • Full service to industrial customers within 90 days	• Temporary repairs to deliver average winter demand rates to industrial customer rates within 2 days • Full service to industrial customers within 7 days
Environmental Releases	• Restoration priority based on priorities set in the FAHCE agreement and other DFG MOU • Temporary raw water system repairs to achieve average annual flow releases within 21 days • Full operation of environmental releases within 90 days	• Temporary raw water system repairs to restore minimal/prioritized (as defined by FAHCE agreement and other DFG MOU) environmental releases within 2 days • Full operation of environmental releases within 7 days
Agricultural Users and Landscape Users	• Restoration priority based on minimizing economic loss, as determined by District in consultation with stakeholders • Temporary raw water system repairs to achieve average annual flow service within 30 days • Full service to agricultural customers within 90 days	• Temporary raw water system repairs to achieve average annual flow service within 2 days • Full service to agricultural customers within 15 days
Groundwater Recharge	• Temporary raw water system repairs to restore minimal/prioritized (as defined by District operations) recharge flows within 60 days • Full operation of recharge facilities within 90 days	• Temporary raw water system repairs to restore minimal/prioritized (as defined by District operations) recharge flows within 2 days • Full operation of recharge facilities within 15 days

In 2007, the Distrit created a stockpile of emergency pipeline repair materials including large diameter spare pipe, internal pipeline joint seals, valves, and appurtenances, which reduced outage time following a large earthquake from 60 days to 30 days.

USBR Levels of Service

The District operates and maintains the SFR1 facilities per its agreement with US Bureau of Reclamation (USBR) for the *Transfer of the Operation and Maintenance of Certain San Felipe Division Facilities* (O&M Agreement). The O&M Agreement requires the District to operate the facilities in accordance with *Designer's Operating Criteria*. Both the O&M Agreement and Operation Criteria provide some guidance on levels of service.

Operations and Maintenance Agreement

The deisgn capacity flow rate for the SFR1 facilities is 490 cfs, and is allocated as follows:

- 330 cfs to Santa Clara County
- 93 cfs to San Benito County
- 67 cfs to future water service contractors

Designer's Operating Criteria

The District's contract with USBR requires the District to operate the San Felipe Division facilities in accordance with *Designer's Operating Criteria*. The operating criteria provide information on operating ranges and capacities for the pumps at Pacheco Pump Plant. These capacities and ranges are listed below, and can be interpreted as the level of service expected from the pumps.

- Each pump has a design capacity of 55.9 cfs at a rated total head of 240.7 ft[3].
- The twelve pumps combined must provide a discharge of 490 cfs.
- The pumps must operate over a total discharge head range of 80 to 310 feet.

The *Designer's Operating Criteria* references additional design manuals that would likely provide insight into the capacity and operating ranges of many individual SFR1 assets. This information was not researched for this plan.

The District also has an agreement with San Benito County Water District (SBCWD) for *Repayment and Management of the San Felipe Division Facilities (bilateral agreement)*. The agreement requires the two Districts to establish a condition level, which is: *"San Felipe Division Reach 1 facilities will be maintained such that, in combination with other facilities and water supplies available to the districts, each district is able to meet essential demands during unplanned outages or periods of reduced delivery capability, and in any event, such unplanned outages or periods of reduced delivery capability are not longer than two weeks."*

Water Shortage Contingency Planning (2010 UWMP's)

Santa Clara Valley Water District

Because the groundwater basins are able to store the largest amount of local reserves, the District depends on maintaining adequate storage in the basins to get through extended dry periods. In addition to working with retailers and cities to manage water use during shortages, the District augments supplies by investing in supplemental supply sources. The District has a long term agreement with Semitropic Water Storage District in Kern County that allows the District to store

[3] From Ebara Pump Field Performance Curve

up to 350,000 AF of imported water supplies in Semitropic's groundwater basins for District use in dry years. Other options may be available in any given year such as transfers, exchanges, spot markets, and the State Drought Bank. The decision on when and in which sequence supply will be utilized during different stages is managed by annual operations and planning and includes consideration of availability and cost.

The water shortage contingency actions are summarized in the Table 2 below.

Table 2: SCVWD Water Shortage Contingency Actions

Stage	Stage Title	Projected GW Reserves	Response	Suggested Reduction in Water Use[1]	Communication and outreach effort
Stage 1	Normal	Above 300,000 AF	Continue regular outreach activities in this stage to promote ongoing implementation of conservation and implementation of BMPs.		• Maintain public information and outreach focused on long term, ongoing conservation actions (e.g., water saving appliances, repairing leaks, and low-water use landscaping).
Stage 2	Alert	250,000 to 300,000 AF	This stage is meant to warn customers that current water use is tapping into groundwater reserves – a signal that groundwater levels are dropping to meet demands. Communications are needed to set the tone for the onset of shortages. Request water users to reduce water use by as much as 10%. Coordinate ordinances with cities and warn and prepare for a stage 3 situation.	0-10% demand reduction	• Expand on Stage 1 efforts • Intensify public information and advertising campaign • Focus messages on shortage situation and immediate behavioral changes
Stage 3	Severe	200,000 to 250,000 AF	Shortage conditions are worsening, requiring close coordination with retailers and cities to enact ordinances and water use restrictions. Requires significant effort and behavioral change by water users. Increase outreach campaign to save water.	10-20% demand reduction	• Expand and intensify Stage 2 activities • Further expand outreach efforts • Modify messages to reflect more severe shortage condition and need for immediate behavioral changes
Stage 4	Critical	150,000 to 200,000 AF	This is the most severe stage in a multiyear drought. Encourage retailers and cities to enforce their plans which could include fines for repeated violations.	20-40% demand reduction	• Strengthen and expand Stage 3 activities • Further expand outreach efforts • Open drought information center
Stage 5	Emergency	Below 150,000 AF	This last stage is meant to address a more immediate crisis such as a major infrastructure failure. Water supply would be available only to meet health and safety needs.	Up to 50% demand reduction	• Daily updates on water shortage emergency (media briefings, web update, social media outlets) • Activate EOC

Notes:

(1) When the District Board calls for short-term water conservation, the cities and water retailers will consider the implemention of water contingency plan actions identified in their Urban Water Management Plans in order to achieve the necessary shortage response. The District works with the water retailers and cities to help coordinate these activities.

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Appendix One – Treated Water Contract Example

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Appendix Two – 2005 WIRP Retailer LOS Questionnaires

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Appendix 2:
Full List of LOS Objectives

Source	Category	Time-Frame	System Performance Target	Notes
San Francisco Public Utilies Commission (SFPUC)	Seismic Reliability - Delivery	1 day after event	Basic Service (Winter/February)	Delivery of basic service to at least 70% of turnouts (90% reliability)
San Francisco Public Utilies Commission (SFPUC)	Seismic Recovery	30 days after event	Average Day Demands	Assumes repair capabilities
San Francisco Public Utilies Commission (SFPUC)	Maintenance Conditions	30-60 days duration depending on facility shutdown	Average Day Demands	One planned and one unplanned shutdown
San Francisco Public Utilies Commission (SFPUC)	Water Quality Event	Instantaneous	Average Day Demands at varying flow rates/severities	
San Francisco Public Utilies Commission (SFPUC)	Water Supply Outages	Instantaneous	Average Day Demands with each major source out of service	Each WTP and/or raw water source out of service
Contra Costa Water District (CCWD)	Seismic Recovery - Critical facilities	1-2 days after event	Emergency and firefighting demands	(facility reliability = 99.5% system reliability = 90%)
Contra Costa Water District (CCWD)	Seismic Recovery - Essential facilities	2-5 days after event	Emergency and critical care demands	(facility reliability = 95% system reliability = 80%)
Contra Costa Water District (CCWD)	Seismic Recovery - Important facilities	5-15 days after event	Partial and sanitary demands	(facility reliability = 90% system reliability = 50%)
Contra Costa Water District (CCWD)	Seismic Recovery - Standard facilities	15-60 days after event	Full demands (ADD?)	(facility reliability = 80% system reliability = 0-30%)
Contra Costa Water District (CCWD)	Seismic Reliability - General damage	Instantaneous	No primary damage to CCWD facilities that endangers public and staff. No direct secondary damage.	
Contra Costa Water District (CCWD)	Seismic Recovery - Repair capabilities	30 days	Temporary repairs to achieve full service within 30 days	Permanent repairs for raw water facilities within 2 years
Contra Costa Water District (CCWD)	Seismic Recovery - Wholesale municipal	2 days for emergency/fire 10 days for partial service 30 days for full service	Various	
Contra Costa Water District (CCWD)	Seismic Recovery - Industrial use	2 days for emergency/fire 10 days for partial service 30 days for full service	Various	
East Bay Municipal Utility District (EBMUD)	Seismic Reliability - General damage	Instantaneous	Limit extensive damage to system facilities. And minimal secondary damage and risk to public	
East Bay Municipal Utility District (EBMUD)	Seismic Reliability - General water quality	Instantaneous	Water introduced into distribution system minimally disinfected	
East Bay Municipal Utility District (EBMUD)	Seismic Reliability - Fire Service	Instantaneous	Sufficient portable pumps and hose to provide limited fire service in all areas	
East Bay Municipal Utility District (EBMUD)	Seismic Reliability - Fire Service	Instantaneous	All areas have minimal fire service (one reliable pumping plant and reservoir)	
East Bay Municipal Utility District (EBMUD)	Seismic Reliability - Fire Service	Instantaneous	High risk areas have improved fire service (all facilities have reliable, minimum fire reserves)	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Fire Service	100 days for maximum EQ	Normal service to all hydrants	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Hospitals/Disaster Centers	3-10 days for maximum EQ	Minimum service (near each facility)	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Hospitals/Disaster Centers	30 days for maximum EQ	Impared service (to each facility)	

Source	Category	Time-Frame	System Performance Target	Notes
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Fire Service	20 days for probable EQ	Normal service to all hydrants	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Hospitals/Disaster Centers	1 day for probable EQ	Minimum service (near each facility)	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Hospitals/Disaster Centers	3 days for probable EQ	Impared service (to each facility)	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Domestic use	3 days for maximum EQ	Potable water via distribution system or truck	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Domestic use	10 days for maximum EQ	Minimum service to 70% of customers	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Domestic use	1 day for probable EQ	Potable water via distribution system or truck	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Domestic use	3 days for probable EQ	Impaired service	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Commercial/industrial use	7 days for maximum EQ	Potable water at central locations	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Commercial/industrial use	10 days for maximum EQ	Minimum service to 70% of customers	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Commercial/industrial use	30 days for maximum EQ	Impaired service to 90% of customers	
East Bay Municipal Utility District (EBMUD)	Seismic Recovery - Commercial/industrial use	3 days for probable EQ	Impaired service	
Oregon Resilience Plan	Seismic Recovery - Potable water at supply sources	3-7 days	20-30% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Potable water at supply sources	14-30 days	50-60% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Potable water at supply sources	90-180 days	80-90% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Main transmission facilities, pipes, pump stations, and reservoirs	1-3 days	20-30% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Main transmission facilities, pipes, pump stations, and reservoirs	3-7 days	50-60% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Main transmission facilities, pipes, pump stations, and reservoirs	7-14 days	80-90% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water supply to critical facilities	3-7 days	20-30% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water supply to critical facilities	14-30 days	50-60% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water supply to critical facilities	90-180 days	80-90% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at key supply points	1-3 days	20-30% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at key supply points	7-14 days	50-60% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at key supply points	90-180 days	80-90% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at hydrants	14-30 days	20-30% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at hydrants	30-90 days	50-60% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at hydrants	90-180 days	80-90% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water at community distribution centers/points	3-7 days	20-30% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water at community distribution centers/points	7-14 days	50-60% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Water at community distribution centers/points	14-30 days	80-90% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Distribution system	7-14 days	20-30% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Distribution system	30-90 days	50-60% operational	Coastal Oregon

Source	Category	Time-Frame	System Performance Target	Notes
Oregon Resilience Plan	Seismic Recovery - Distribution system	90-180 days	80-90% operational	Coastal Oregon
Oregon Resilience Plan	Seismic Recovery - Potable water at supply sources	1 day	20-30% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Potable water at supply sources	1-3 days	50-60% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Potable water at supply sources	7-14 days	80-90% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Main transmission facilities, pipes, pump stations, and reservoirs	1 day	80-90% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Water supply to critical facilities	1 day	50-60% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Water supply to critical facilities	1-3 days	80-90% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at key supply points	1 day	80-90% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at hydrants	3-7 days	20-30% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at hydrants	7-14 days	50-60% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at hydrants	14-30 days	80-90% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Water at community distribution centers/points	1-3 days	50-60% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Water at community distribution centers/points	3-7 days	80-90% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Distribution system	1-3 days	20-30% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Distribution system	2-7 days	50-60% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Distribution system	7-14 days	80-90% operational	Oregon Valley
Oregon Resilience Plan	Seismic Recovery - Potable water at supply sources	1 day	80-90% operational	Central/Eastern Oregon
Oregon Resilience Plan	Seismic Recovery - Main transmission facilities, pipes, pump stations, and reservoirs	1 day	80-90% operational	Central/Eastern Oregon
Oregon Resilience Plan	Seismic Recovery - Water supply to critical facilities	1 day	80-90% operational	Central/Eastern Oregon
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at key supply points	1 day	80-90% operational	Central/Eastern Oregon
Oregon Resilience Plan	Seismic Recovery - Water for fire suppression at hydrants	1 day	80-90% operational	Central/Eastern Oregon
Oregon Resilience Plan	Seismic Recovery - Water at community distribution centers/points	1 day	80-90% operational	Central/Eastern Oregon
Oregon Resilience Plan	Seismic Recovery - Distribution system	1 day	80-90% operational	Central/Eastern Oregon
NIST - Disaster Resilience Framework	Seismic Recovery - Potable water at supply	7-30 days	90% restored	
NIST - Disaster Resilience Framework	Seismic Reliability - Water for fire suppression at key supply points	0 days	90% restored	
NIST - Disaster Resilience Framework	Seismic reliability - Transmission backbone system	0 days	90% restored	
NIST - Disaster Resilience Framework	Seismic Recovery - Distribution system critical facilities and emergency housing	1-3 days	90% restored	
NIST - Disaster Resilience Framework	Seismic Recovery - Community distribution centers and community recovery infrastructure	7-30 days	90% restored	
NIST - Disaster Resilience Framework	Seismic Recovery - Water for fire suppression at hydrants	7-30 days	90% restored	
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Water for fire suppression at hydrants	100 days for maximum EQ		

Source	Category	Time-Frame	System Performance Target	Notes
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Water for fire suppression at hydrants	20 days for probable EQ		
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Critical disaster facilities	10 days for maximum EQ	Minimum service (near each facility)	
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Critical disaster facilities	30 days for maximum EQ	Impaired service (at each facility)	
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Critical disaster facilities	1 day for probable EQ	Minimum service (near each facility)	
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Critical disaster facilities	3 days for probable EQ	Impaired service (at each facility)	
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Domestic and commercial/industrial	3 days for probable EQ	Impaired service	
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Domestic and commercial/industrial	10 days for maximum EQ	Minimum service to 70% of customers	
ASCE - Technical Council on Lifeline Earthquake Engineering (1999)	Seismic Recovery - Domestic and commercial/industrial	30 days for maximum EQ	Impaired service to 90% of customers	

Appendix 3:

Metropolitan Water District Information

Metropolitan Water District LOS Information

Emergency / Standby Water Supply
On average, MWD supplies approximately half of the water supply needed for Southern California. The remaining half is supplied by local sources owned and operated by MWD member agencies. With regard to emergency supplies, it is MWD's policy to maintain at least a 6-month supply of water in reservoirs that fall inside the southern California basin area of the San Andreas earthquake fault line. This 6-month supply is to be enough to meet a 6-month reduced/restricted water usage at a rate of 50% of normal supply (note that this translates into a supply of 25% of all of southern California's average day water use for 6 months).

Policy to Tier 1 Emergencies / Outages
MWD operates several Tier 1 – level facilities. These include raw water conveyance systems (with pumping stations, aqueducts and pipelines, and terminal reservoirs), water treatment plants, and main feeder treated water distribution system pipelines. It is MWD's policy that they will maintain equipment and field staffing forces such that they can respond and repair any two failures in any two Tier 1 facilities within a 6 month period. To support this work, MWD maintains a short-list of emergency contracts for assistance from outside contractors. These may include mechanical, construction, electrical, or other type contractors that may be needed to assist MWD staff in getting large facilities back on-line.

Operations Redundancies
MWD can operate facilities such that water from one WTP can be sent to another WTP, within a certain degree. Furthermore, the treatment facilities are very large and currently operate at their low-end of capacity, allowing for the possibility of them being ramped-up quite easily in case of emergency. Also, MWD provides advance notification and planning for all shutdowns of major facilities and pipeline feeders such that member agencies can engage in shutdown planning. Shutdown planning may include keeping interconnection agreements in place between various agencies, pumping groundwater from adjacent jurisdictions, or other supply amendments.

Although not necessarily a redundancy, MWD also maintains a fleet of field and construction services crews. These crews maintain heavy equipment that is owned internally and is also supported by stand-by and on-call contracts with private firms. These field services staff crews and equipment are used regularly for maintenance, support during shutdowns, and servicing of MWD's facilities. These crews are also, of course, available during the need to respond to major emergencies.

Mutual Aid / Assistance
MWD has signed/open mutual aid (MA) agreements with their wholesale Member Agency customers. These Mas are open indemnification agreements that allow MWD to assist during the event of emergencies and to not be held liable if (during assistance) something goes wrong. This allows for a more open-flow of communication and assistance when challenges arise.

MWD also operates a fully-staffed machine shop which is able to fabricate or repair large pieces of equipment from pumps, treatment facilities, and pipelines. This machine shop also operates under contract to external agencies such as the California Department of Water Resources (DWR) to conduct equipment repairs and maintenance for State Water Project pumping station pump impellers and other related equipment. During the discussion it was not known if the machine shop also did contract work for MWD MAs or other water utilities.

Participation in State/Local Emergency Programs
MWD is a California Utilities Emergency Association (CUEA) member and also participates in the California Water/Wastewater Agency Response Network (CALWARN). As a CUEA member, MWD can link to the California Governor's Office of Emergency Services (Cal OES) to obtain assistance/funding from State and Federal agencies as appropriate for specific emergencies. Also, within these links, MWD can be linked to provide assistance (and receive assistance) to/from other member utilities across the State. Within these linking capacities, MWD shares technical and other capabilities with other utilities.

Vendors and Contractors
MWD maintains a short-list of within-basin and outside-basin vendors. This list is used to supply goods and also support routine and emergency needs and business systems. This maintenance of vendors and use/implementation of business systems is assessed annually and adjusted depending on what systems are operating, what critical needs are identified, and (in the case of emergency response) what business and operating systems are on-line and/or will be needed to be brought back on-line in the event of emergency/failure.

Appendix 4:

Retailer LOS Questionnaire

Infrastructure Reliability Project

Level of Service Questionnaire – Treated Water Retailers

December 2014

Retailer:_____

Attendees:_____

1. What is the longest tolerable outage of SCVWD treated water, assuming existing back-up sources (groundwater, SFPUC, etc.) are available? Please answer the question for each turnout (if you have more than one).

2. What is the longest tolerable reduction (assume 20-50% reduction) in SCVWD treated water service, assuming existing back-up sources (groundwater, SFPUC, etc.) are available? Please answer the question for each turnout (if you have more than one).

3. What is the longest tolerable outage of SCVWD treated water, assuming existing back-up sources are unavailable? Please answer the question for each turnout (if you have more than one).

4. What is the longest tolerable reduction (assume 20-50% reduction) in SCVWD treated water service, assuming existing back-up sources (groundwater, SFPUC, etc.) are unavailable? Please answer the question for each turnout (if you have more than one).

5. Do you have any concerns about outage of groundwater recharge operations? Do you have particular areas or wells that experience drop off in production with reduced recharge operations?

Appendix 5:

Retailer LOS Meeting Notes

SCVWD Infrastructure Reliability Plan
Level of Service Goals
Meeting Notes
December 2014 to January 2015

City of San Jose

Attendees on 12/9/2014: Jeff Provenzano, Erin Baker, Metra Ulloa, Jason Chen, Bob Ward, Tracy Hemmeter

- Question from City of San Jose: Why wouldn't a wholesaler follow the same goal as SFPUC? (Basic service in 24 hrs and ADD in 30 days?) Response: There is a very high cost (>$5Billion) associated with this service level.
- Currently "no backup" capability for SCVWD treated water supplies
- Backup supply/GW wells only provide one-third of max demands
- Backup supply wells could supply minimum month demands for 3 to 5 days, but can't expect people to curtail usage. Prefer to assume maximum demands.
- 4 wells are currently classified as standby, which means usage is restricted by CDPH. Working on getting these permitted as active wells. Currently have 6-month window with wells permitted as active, but need another 6-month extension. Update received from San Jose on 1/28/2015 indicates that the State has granted permission to continue use of Evergreen wells until the end of 2015.
- 15 years ago wells were part of normal operations. Staff that knows how to operate the system with the wells has moved on. Currently the city is studying how to run the wells as part of typical operations. There is a need to test capacity with 4 wells running simultaneously.
- Chlorination not specifically required? Need to show oversight/control.
- Max day is 24 MGD, can live with one-third from GW (8 MGD) and two-thirds from SCVWD (16 MGD).
- Can tolerate down to 66% use, cannot go down to 50% because wells only provide 1/3 of max day demands.
- City has a flexible distribution system and can operate around breaks.
- No concerns with GW recharge during short-term emergencies, less than 3 months. 18 months may be a problem.
- City has SJWC Interties at 3 locations that require a 600 gpm pump and hose.
- There is a new intertie between Evergreen/Edenvale. It is only one direction, Evergreen to Edenvale, and provides 80 psi. To feed Evergreen, would need 6-inch pump to pump 200 psi and overcome pressure differential. Edenvale has three 1000 gpm wells.
- Solutions to consider:
    - Install more wells in Evergreen or East PL. San Jose Muni is short on land. Need land/easement rights near East PL to install a SJ well.
    - Joint communication on service cutbacks (such as no outdoor use)
    - Create agreements that allow for the purchase of SCVWD water through SPFUC (as back-up for north service area)
- Request to consider Evergreen Service Area as a unique situation with a unique more stringent LOS goal.

Sunnyvale

Attendees on 12/9/2014: Mansour Nasser, Erin Baker, Metra Ulloa, Jason Chen, Bob Ward, Tracy Hemmeter

- In an earthquake, Sunnyvale's distribution system is expected to be damaged.
- Can tolerate loss of SCVWD supplies if SFPUC and wells are in operation. To do so, Sunnyvale would have to open PRVs.
- Can withstand indefinite outage of SCVWD in winter, but would be difficult to go over 7 days in summer.
- Recommend reviewing the Hydroscience report provided in Task 3. The report goes through many scenarios for water supply outages for Sunnyvale's system.
- Sunnyvale receives GW supply from 7 wells. Sunnyvale cannot supply its entire service area with these wells. Most areas would drop below 20 psi.
- Could probably get by with a 50% reduction in SCVWD with no SFPUC if all wells were functioning.
- There are some capacity restrictions pumping SCVWD and well water into the north service area. Most wells are in the south and there are no areas for wells in the north.
- Can get by for 24 hours to a week without PUC supplies, but not in summer.
- Sunnyvale vulnerabilities are the distribution pipelines and GW wells.
- Sunnyvale has invested a lot in SFPUC reliability.
- Different LOS goals might be OK, but must have proper justification.
- Recommend more SFPUC interties.

San Jose Water Company

Attendees on 12/10/2014: Kurt Rayer, Erin Baker, Metra Ulloa, Jason Chen, Bob Ward, Tracy Hemmeter

- No major issues on transfer/wheeling of water between SJWC and other retailers using reverse flow.
- Interties have been upgraded – each has a "kit" w/ hose, PRV, and riser for each side.
- Max capacity of interties requires testing and further study. Hard pipe and air-gap connections. Need to evaluate size of connections for gravity and for pumping.
- Cupertino area now has groundwater backup, and interzone backup, but not enough to meet summer demands.
- In 2005 IRP, SJWC assumed they'd want to take water at More turnout near RWTP to feed their whole system. Now SCVWD could run Campbell wells to feed San Tomas turnout (Campbell Turnout).
- Need to determine if there is backup power at Campbell well field.
- The District should consider fuel and chemical contingency plans. This is part of ongoing business continuity planning for SJWC.

- Operational switch to non-SCVWD supply mode on the West Side could be accomplished within one day in an emergency but typically it takes 4-5 days to mobilize. East side is not a problem – just need to turn wells on.
- SJWC has in-house pipe repair capabilities and MSA with contractors.
- SJWC also has some repair parts, and some pipeline stockpile. Largest pipe is 48-inch to Williams Station.
- When Rinconada WTP was offline, SJWC wheeled water to themselves from Cox into District PL and into Mann Station. This may require some DDW clearance.
- Have sustained service over 2-week outage of West PL.
- Wells normally run at capacity of 100 MGD, and can go up to 110 MGD. This past summer, wells were running at up to 100 MGD, with no surface supply backup (no Montevina plant).Can consider lowering wells, and also new well sites.
- Interested in seeing information in a table on standing water level versus basin capacity, so they could plan pumping in a way to not cause subsidence.
- High benefit projects to consider:
    - Isolation valves at optimized locations
    - Interagency use of District Pipelines
    - Improving line segment reliability at strategic locations
    - Interties and turnouts
    - Backup power and fuel contingency planning (could be days or weeks before fuel is delivered)
    - New wells (suggested District owned wells, to be operated and maintained by retailer, with option to use wells as needed for non-emergency supply)
    - Research agreements for use of others pipelines, and begin DDW discussions so agreements can be in place ahead of emergency.

Great Oaks

Attendees on 12/11/2014: Tim Guster, Erin Baker, Metra Ulloa, Jason Chen, Tracy Hemmeter

- Further North in the service area is the concern. This is farther from managed recharge area.
- Most recharge is from Coyote Creek.
- Ability to sustain service without recharge is dependent on starting groundwater levels. If the basin is full (Normal condition or no drought), Great Oaks can go about 2 years without seeing impacts to service..
- Severity of concerns with outage of recharge is dependent on length of outage. Great Oaks has had to reduce pumping volume as a result of GW dropping in last 2 years.
- The priority of GW recharge as compared to deliveries to WTPs is a concern.
- Tolerable outage timeframe depends on scenario/situation, and how high GW basin is.
- Backup power is adequate for well capacity. Fuel delivery would be an issue.
- Great Oaks has 2 interties with SJWC, and these are being upgraded and tested. They have been in discussions with SJ Muni for an intertie to their Evergreen Service Area.

Cal Water

Attendees on 12/15/2014: Jim Simunovich, Ron Richardson, Erin Baker, Metra Ulloa, Aaron Lee

- A Bay Delta outage is a concern for Cal Water
    - SCVWD delta outage considerations: local reservoirs, IPR, storage, semitropic water storage, Campbell well field
- Cal Water is comfortable with varying LOS
- Under winter demand – 2 week outage is ok (recent experience with Rinconada WTP out for 2 weeks)
- Vallco turnout is the critical connection. There is limited groundwater backup in this area, and based on Cupertino's general plan, there will be more reliance on Vallco turnout in the future
- Granger/Farndon turnouts have equal priority (Cal Water can go without Covington turnout)
- Maximum groundwater use of 14-15 MGD with no restrictions. Couldn't meet max day demand with this amount in summer.
- May be able to meet 50% of max day demand with wells and can tolerate up to 50% reduction in SCVWD treated water service (based on location)
- Emergency connections to:
    - Sunnyvale, Santa Clara, San Jose Water Company, Purissima Hills
- Correlation between well production and groundwater recharge is currently unknown
    - No evaluation has been performed to determine recharge/production relationship
    - Cal Water experiences entrained air issues (tanks next to wells used to remove entrained air)
- With reduced SCVWD treated water:
    - Fire flow levels would drop – individual customers would be affected
    - Fire sprinkler systems may not receive minimum pressure needed to operate (alarms set at design pressures)
    - Vallco turnout dependent on SCVWD pressure
    - System operations are affected depending on Rinconada clearwell or treatment operations (up to 17 psi difference)

Mountain View

Attendees on 12/18/2014: Allison Turner, Will Medina, Erin Baker, Metra Ulloa, Jason Chen, Tracy Hemmeter

- Longest tolerable outage is greater than 30 days in the winter, and probably still ok in the summer.
- Can withstand seasonal variations without problems
- Miramonte PS is the main facility needed to push water up to Zone 3.
- Miramonte PS has backup power.

- Graham PS also has capability to push water from Zone 2 up to 3, but requires more manual operations.
- 2 MGD from wells (#22 and 23) have backup power.
- Wells are in Zones 1 and 2. Considering wells in Zone 3.
- Interties with SJ Muni, SJWC, Cal Water
- Wheeling water issues may need to be considered, with respect to the Raker Act, and agreements, and also water quality. Still considering two good well sites: Adjacent to Miramonte/West PL and Cuesta Park between school/freeway.
- SCVWD earthquake scenarios are San Andreas and Calaveras. For Mountain View, maybe more damage suffered in a Hayward EQ impacting SFPUC.
- SFPUC had talked to the state about non-potable water in an emergency. Can follow up with Eddie So for information.
- Could get by without SFPUC for only a day in the winter (on SCVWD and groundwater)
- Water levels have dropped 20-30 feet in wells since drought.

Santa Clara

Attendees on 12/17/2014: Chris DeGroot, Erin Baker, Metra Ulloa, Aaron Lee

- Under reduced SCVWD treated water flows, Santa Clara is likely to close turnout and rely on GW supplies. Pressure fluctuates too much with reduced flow.
- Plans for installing a new well near turnout
- During 2-week Rinconada outage – Santa Clara closed turnout and relied on its own system
    - Santa Clara can self-sustain with groundwater
- If both SFPUC and SCVWD are out:
    - Santa Clara can go 100% on groundwater for extended periods (system configuration issue – a pressure zone will be "removed")
    - Will require days to reconfigure the system
    - There are reliability plans in place if both SFPUC and SCVWD are out
- No groundwater production impacts observed since groundwater recharge has stopped (9 months of no recharge), though water levels have dropped.
    - Only impact is higher energy costs due to increased pumping
    - Most Santa Clara wells are 800-900 feet deep
    - 5-6 wells are relied on heavily – looking at alternate wells to spread reliance
- Santa Clara may be able to self sustain for one year (assuming "normal" beginning levels in ground water)
    - Water use has decreased over the last 30 years (18% of water sales is in recycled water)
- System operations are generally unaffected by SCVWD changes other than the southern part (zone 2A) near the turnout because it only has one well
    - Potential for another well at this turnout (may have 1,500-2,000 gpm capacity)
    - This additional well can be connected to the turnout to feed SCVWD system if necessary
- Suggest phasing system improvements based on varying retailer abilities to sustain service

- Potential to wheel water from STWTP/PWTP (East treated system) through San Jose Water Company system to Santa Clara (via existing intertie)
- Currently Santa Clara is using the physical capacity of the existing turnout (water going at ~15 ft/s) – future development expected in Santa Clara ($6.2 billion)

Purissima Hills

Attendees on 1/6/2015: Patrick Walter, Erin Baker, Metra Ulloa, Jason Chen, Tracy Hemmeter

- Service area is 4,600 acres, 2,200 services (~2,050 residential), and between Palo Alto and Cal Water Los Altos areas.
- Purissima Hills has an annual budget of $5M, with $1M designated for capital projects which includes R&R/pipeline replacements as needed.
- Cost of some system improvements are shared with Los Altos Hills Fire District. They are currently working to strengthen a pipeline (with DI) along the ridge that is a backbone of the system, so that tanks don't go down in an earthquake.
- System was built mostly in 1950's to 60's.
- Pipelines are 50% DI, 40% CI, and 10% AC (AC mostly at end points in residential neighborhoods, not for transmission).
- Tanks have EBAA flexible ball joints.
- Supply is 100% SFPUC supply. SFPUC water supply from two turnouts off of BDPL Nos. 3 and 4, come in at Zone 1 which has no service connections.
- Zone 1 = 0 demand, Zone 2 = 40% of demand, Zone 3 = 50% of demand, Zone 4 = 10% of demand
- There is backup power at two pump stations: Deer Creek PS has 400 kva which can power 2 pumps to pump from Zone 1 up to Zones 2 and 3. Altamont PS has backup power to pump up to Zone 4. Can maintain average demands on backup power.
- Seasonal variation/peaking is extreme, due to landscaping and horse stables.
- Storage capacity is very good, but usable storage at times is a problem. Difficult staying full due to water quality.
- Groundwater is not a good option. 2 test wells at 300' depth resulted in only 75 gpm of hard water. One near Foothill College, and one near Town Hall in Los Altos (where CalTrans has a well for irrigation).
- Two interties in the system: One with Cal Water and one with Palo Alto. Both are 1,000 gpm bi-directional.
- Would have interest in extension of West Pipeline for permanent supply and provide redundancy to SFPUC supplies.
- Would consider a partnership through Cal Water and/or Palo Alto. This idea would bring District treated or groundwater through Cal Water or Palo Alto systems to PH.
- Consider a shorter West Pipeline extension.
- The service area is mostly built out, except for a few 10 Acre lots. These may affect demands, but not by much.

Morgan Hill

Attendees on 1/7/2015: Karl Bjarke, Erin Baker, Metra Ulloa, Jason Chen, Tracy Hemmeter

- Morgan Hill has concerns with reducing managed GW recharge in Upper Coyote Creek, Main Avenue,and Madrone Ponds.
- Open to consideration of different LOS goals for different user types or source types.
- Where did the previous 60-90 day recharge goals come from?
- Morgan Hill will update/fill out the LOS questionnaire and return to the District.
- They have seen a slow degradation of the water table and production during the drought.
- Interested in status of "reverse flow" project: semi-tropic water from Kern County into SBA/San Luis Reservoir O'Neil Forebay?
- Options to look at: recycled water into the ponds, groundwater into Santa Clara Conduit.

Milpitas

Attendees on 1/8/2015: Marilyn Nickel, Tammy Qualls, Erin Baker, Metra Ulloa, Jason Chen, Tracy Hemmeter

- Milpitas can survive on only SFPUC supply. They previously operated that way.
- Intertie to ACWD was used a few years ago, to provide water to ACWD into a dead-end area resulting from construction work.
- They also have a 6" intertie with SJWC, but it hasn't been used in decades.
- Have recently experienced 10-day outages of Milpitas Pipeline. Due to construction activities, were not able to use SCVWD turnout to wheel in SFPUC supply, which didn't work well. Switching over to complete SFPUC supply requires closing all isolation valves (40+) in the system. They would prefer to use SCVWD turnout to move SFPUC water into that zone. Operationally this requires fewer manual valve adjustments. Also capacity, SFPUC turnout is 12-inch, SCVWD turnout is 16-20".
- Would strongly recommend an isolation valve on the south side of the District's existing turnout, between the existing and new/future turnout.
- Wondering about a scenario including contamination of the GW basin? District believes it would be a localized event affecting one retailer, and could be mitigated quickly.
- Fire pressure is OK without District supplies.
- Have one current GW well at Pinewood, which serves the lowest SFPUC zone.
- Have potential well, Curtis Well. This is 95% constructed (well is drilled, no pump station), but not complete. There is high iron/high manganese, and would require blending.
- The last time Pinewood Well was used was for 3 weeks in 1992.
- SFPUC agreement is for up to 9.2 MGD "maximum assured value". Supplies are more expensive, and they are required to conserve SFPUC supplies too.
- They were able to achieve 10% conservation with public outreach.

- LOS should be a standard overall goal (e.g., goal of serving 50% of population?), it's how it's achieved that is customized by customer/source.
- Regional options to consider: GW well on Snell PL or East PL to feed system on the East side for Milpitas and San Jose.

Gilroy

Attendees on 1/8/2015: Rick Smelser, ?, Erin Baker, Metra Ulloa, Aaron Lee

- Very little impact in GW production in this dry year. Comparison of Dec 2013 to Dec 2014 shows minimal differences, only a 10-ft drop in levels in GW wells.
- Can go even longer than 60+ days without recharge by the District.
- Sometimes they get Artesian wells at the south end of the basin
- Typically they run 1-2 wells for winter demands. They have 6 pump stations all with backup power.
- Well 1 was constructed in 1935 and still a good producer.
- The basin east of 101 is good, but not west.
- A groundwater contamination event would be the most threatening scenario for Gilroy. Previous studies have shown that contaminants from Morgan Hill travel at about 1 mile per year.
- Morgan Hill would be much more restrictive regarding recharge LOS.
- Storage tanks – moving more towards reinforced concrete than steel.
- For new developments and main replacements, pipelines are 8-inch minimum DI pipe.
- Recommend a GW well siting study – to study potential future well sites. Possibly to help Morgan Hill withstand variations, with better/deeper wells.
- They don't do "time of day" pumping. They pump to tanks, and then gravity flow. They try to do off peak pumping.
- Loma Prieta experience – no power loss impacts.
- Emergency backup generators at all wells, except Well #1 (no space).

Palo Alto

Attendees on 1/8/2015: Karla Dailey, Melissa Smart, Javad Gaffari, John Reinert, Erin Baker, Metra Ulloa, Jason Chen

- Backup power capabilities and fuel storage is a major problem. Would like to consider combination of options for backup power/fuel: diesel, natural gas, propane. Have 3 portable generators, not enough.
- Interested in getting SCVWD support or partnership on power & fuel problems.
- Not a lot of future growth, just small developments.
- 300 miles of pipelines, 2-inch to 30-inch. All types of materials, CI, DI, PE, PVC, AC, WS.
- $1.5M to $4M annual water capital improvements
- Currently performing a pipeline condition assessment for their PL replacement program.

- Demands as high as 15 MGD peak (June 2014), and as low as 5.5 MGD (January 2014).
- Seismic upgrades of reservoirs/storage currently in progress.
- 5 SFPUC turnouts (3 on PAPL/BD1&2, and 2 on BD3&4). Have enough operational flexibility to feed their system completely from either side/alignment.
- Palo Alto has 8 wells. 3 are new. The five others all have been rehabbed. Only one well is permitted as active, and the others are standby/inactive. Wells provide enough capacity to backup SFPUC supplies – 15 MGD total capacity.
- Have other good well sites.
- Intertie with Purissima Hills, recently used, fed Purissima Hills.
- Stanford intertie, only one direction from Stanford into Palo Alto.
- Mountain View intertie, have used years ago.
- East Palo Alto intertie is connected on PA side, but just a blind flange with no connection on East PA side.
- Have an annual O&M program for the interties.

Santa Clara Valley Water District

Infrastructure Reliability Plan

Task 7 Appendix

AECOM

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Impacts of Outages on Potable Water Service

Technical Memorandum

Infrastructure Reliability Project, Task 7

Project Number: 93504001

Prepared by:
Lisa Fleming, P.E., Associate Civil Engineer
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February 24, 2016

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Appendix 2: Water Distribution Modeling Results

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Appendix 4a: Water Resources Planning Modeling Results – 2025 IRP 6 Month Delta Outage, 20% Demand Reduction

Appendix 4b: Water Resources Planning Modeling Results – 2025 IRP 24 Month Delta Outage, 20% Demand Reduction

Appendix 5a: Groundwater Modeling Results – Project EOY Groundwater Storage

Appendix 5b: Groundwater Modeling Results – PRESS Wells in Confined Area of Santa Clara Plain Map

Appendix 5c: Groundwater Modeling Results – PRESS Wells in Unconfined Area of Santa Clara Plain Map

Appendix 5d: Groundwater Modeling Results – South County Hydrograph Map

1 Purpose and Overview

The purpose of this Technical Memo (TM) 7 is to identify impacts to the District's ability to deliver potable water in the seven outage scenarios identified for the project. This TM examines the District's abilities with its current baseline system and only planned capital improvements (no new improvements) in place.

The analysis is based on several assumptions, including assumptions on pipeline repair times. Actual repair times in an outage event may be much longer or shorter than what is assumed in this study, which would change estimated outage durations. The estimated outage durations are intended to be reasonable planning assumptions, and do not indicate actual outage durations that will occur in any of the seven outage scenarios.

The seven scenarios are summarized below, and additional detail is available in the Task 5 Outage Scenarios Technical Memorandum.

1. Extreme Storm – This scenario analyzes outages to District facilities due to extreme storm events.
2. San Andreas M7.9 Earthquake 1 – This scenario analyzes facility outages due to a San Andreas earthquake and focuses on outages to the District's west side treated water system.
3. San Andreas M7.9 Earthquake 2 – This scenario analyzes facility outages due to a San Andreas earthquake and focuses on outages to the District's east side treated water system.
4. Calaveras M6.9 Earthquake – This scenario analyzes facility outages due to a Calaveras earthquake.
5. Delta Outage, short-term – This scenario analyzes loss of all imported water to the District for 6 months due to Delta levee failure.
6. Delta Outage, long-term - This scenario analyzes loss of all imported water to the District for 24 months due to Delta levee failure.
7. Power Outage – This scenario analyzes loss of power at several District facilities.

Schematics and tables showing the infrastructure that is expected to fail in each scenario can be found in the Task 5 Outage Scenarios Technical Memorandum. In both Delta scenarios, the Delta fails, but local infrastructure does not fail.

2 System Background

The District's system includes imported water sources, ten dams and raw water reservoirs (total storage capacity 169,000 acre-feet), 152 miles of raw and treated water pipelines, three raw water pump stations, three potable water treatment plants, 400 acres of managed recharge ponds and associated systems, several in-stream diversion dams, one well field (three wells), a purified water treatment plant, and an intertie pump station with San Francisco Public Utilities Commission (SFPUC).

The District serves treated water to seven retail customers (retailers), and ensures an adequate groundwater basin for Santa Clara County. The retailers own and operate their own water system facilities including reservoirs, treatment plants, wells, tanks, and distribution systems.

In a normal year, imported water supplies account for slightly more than half of the annual supply delivered within Santa Clara County. These imported supplies are delivered through State or Federal facilities. The District imports state water through the South Bay Aqueduct in the northern portion of Santa Clara County. The state water is typically treated at Pentiencia Water Treatment Plant, or sent through the Central Pipeline to Rinconada Water Treatment Plant for treatment, or to managed recharge facilities.

The District imports federal water through the San Felipe Division facilities, consisting of San Luis Reservoir, Pacheco Pump Station, Pacheco Tunnel, Pacheco Conduit, Santa Clara Conduit, Santa Clara Tunnel, and Coyote Pump Station. From there, water is typically sent to Santa Teresa or Rinconada Water Treatment Plants for treatment via the Cross Valley, Calero, and Almaden Valley Pipelines, and to various managed recharge facilities throughout the county.

In addition, two of the District's local reservoirs, Anderson and Calero, are connected to the distribution system, and can supply the District's water treatment plants. Anderson feeds the Cross Valley Pipeline, and Calero feeds the Almaden Valley Pipeline. Water from each of these reservoirs would typically be treated at Santa Teresa or Rinconada water treatment plants.

The District's managed recharge facilities are used to replenish the groundwater basin so that groundwater levels are maintained and supplies are available for retailer pumping, and to avoid subsidence. The managed recharge systems allow for the District to maintain groundwater levels in the groundwater basins.

Managed recharge operations are considered 'critical' in areas where groundwater wells are the sole source of municipal water supply, and where managed recharge is required to maintain groundwater levels sufficient for pumping at the municipal wells. This occurs in the Southern portion of Santa Clara County, in the City of Morgan Hill. Other areas including the City of Gilroy and parts of the City of San Jose (served by Great Oaks Water Company) rely solely on groundwater supplies, but these areas are more resilient to reduction or elimination of managed recharge due to their geographic location on a more plentiful and reliable portion of the groundwater basin.

The District's treated water distribution system is physically separated into two separate systems, one that serves the east and one that serves the west side of Santa Clara County. The Santa Teresa and Penitencia Water Treatment Plants serve the east side of the county and Rinconada Water Treatment Plant serves the west side. The west side distribution system also contains one well field, the Campbell well field, which can supplement 2-4 MGD to the west system.

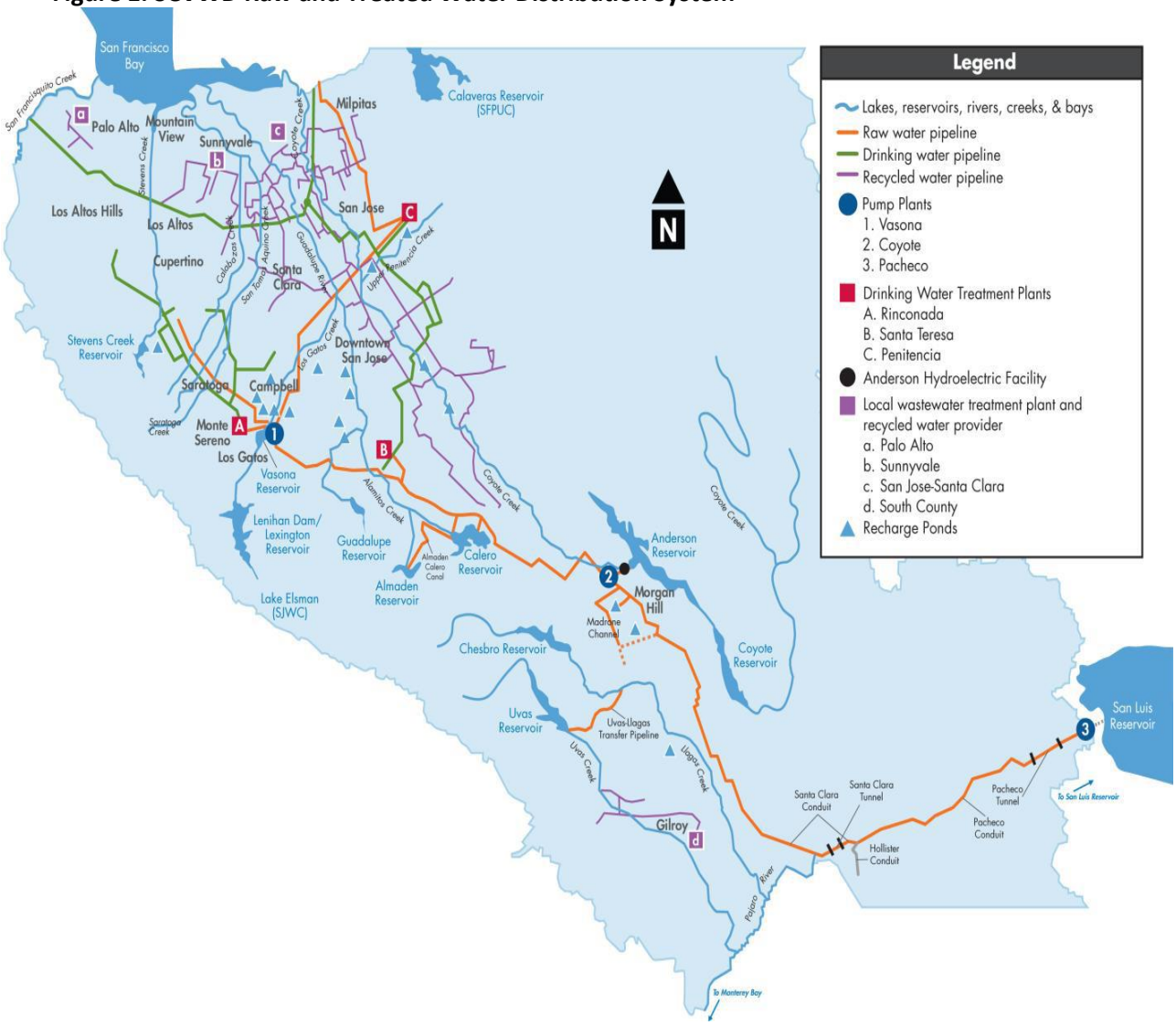
- The Santa Teresa and Penitencia WTPs supply the following retailers via the Snell, East, Parallel East, and Milpitas pipelines:

    - City of Milpitas (Milpitas Pipeline)
    - City of San Jose (East Pipeline)
    - San Jose Water Company (Snell and East Pipelines)

- The Rinconada WTP supplies the following retailers via the West Pipeline and Santa Clara, Campbell, Sunnyvale, and Mountain View Distributaries:
    - California Water Services Company (West Pipeline, Santa Clara Distributary)
    - City of Mountain View (West Pipeline, Mountain View Distributary)
    - City of Santa Clara (West Pipeline, Santa Clara Distributary)
    - City of Sunnyvale (West Pipeline, Sunnyvale Distributary)
    - San Jose Water Company (West Pipeline)

In addition, the East system has a bidirectional intertie with SFPUC, for emergency supplies. The District has one well field at the end of the Campbell Distributary that can supply that pipeline, as well as the Santa Clara Distributary. Figure 1 illustrates the SCVWD distribution system.

Figure 1. SCVWD Raw and Treated Water Distribution System



3 Model Overview

The District employs three models to analyze its water supply and distribution system, described below:

Water Resource Planning Model: The District has developed a calibrated Water Evaluation and Planning system (WEAP) model to simulate the total management of current and future water resources in Santa Clara County. It accounts for facilities that recharge the County's groundwater basins, the District's local water system including the operation of its reservoirs and creeks, the District's treatment and distribution facilities, the District's raw water conveyance system, and imported water supplies. The model also accounts for non-District sources such as imported water from San Francisco Public Utilities Commission (SFPUC), recycled water, and local water developed by others. WEAP simulates water supply conditions under a variety of future water supply scenarios. WEAP output provides information on changes in groundwater storage, reservoir storage, utilization of local and imported water supplies,

and the timing and location of water supply shortages. Information is provided by service area and by facility. The model operates on a monthly time step, and is not typically used for analysis of short durations (less than 3-6 months).

Groundwater Models: The District has developed calibrated MODFLOW models for the Santa Clara Plain, Coyote Valley, and Llagas Subbasins. The models are used to evaluate groundwater storage and groundwater levels under various operational and hydrologic conditions. The model operates on a monthly time step, and is not typically used for analysis of short durations (less than 3-6 months).

Water Distribution Networks: The District currently uses Innovyze's H2ONet software for hydraulic modeling. The District has three separate hydraulic models for its water supply system.

> Raw Water System Model: Water supply sources (San Luis Reservoir, South Bay Aqueduct Terminal Tank, Anderson and Calero Reservoirs) to the water treatment plants (WTPs) and groundwater recharge turnouts
>
> East Treated Water System Model: Santa Teresa & Penitencia WTPs to the retailer turnouts on the Snell, East & Milpitas pipelines, and the SFPUC Intertie
>
> West Treated Water System Model: Rinconada WTP to the retailer turnouts on the West Pipeline and Santa Clara, Mountain View & Campbell Distributaries.

Together, these three H2ONet models simulate the District's raw and treated water supply system. The models include the District's pipelines, major valves, surface water reservoirs, storage tanks, and pump stations. The H2ONet models simulate steady state conditions, which show a 'snapshot' in time of the water supply system and allow staff to determine system hydraulic and capacity constraints.

Table 1 below identifies which models were used to analyze each outage scenario. The modeling and analysis of individual scenarios is presented in Sections 4 and 5.

Table 1. Model Use by Scenario

Scenario	Model(s) Used for Analysis	Explanation
Extreme Storm	H2ONet Raw Water	• These scenarios cause outages with duration less than 3 months. As such the groundwater and WEAP models would not be useful. • The H20Net Raw Water model analyzes if limited supply sources (i.e., one local source such as Anderson Reservoir) can provide
San Andreas 1 EQ		

Scenario	Model(s) Used for Analysis	Explanation
San Andreas 2 EQ		required flow at sufficient pressure to the water treatment plants. • The H2ONet treated water models are not necessary in determining impacts. The treated water transmission system is typically supply-limited rather than capacity-limited, particularly at lower demands. Thus outage of treated water pipelines causes connectivity issues, not pressure issues. Once a pipeline is repaired and connectivity is restored, meeting demand is not an issue, so long as the WTP is receiving enough source water.
Calaveras EQ		
6 Month Delta Outage	WEAP and Groundwater	• These scenarios do not cause failure of District infrastructure, so H2ONet analysis is not needed. • The WEAP and groundwater models analyze how long the District can continue operations without any imported water supplies coming in to the county.
24 Month Delta Outage		
Power Outage	Excel fuel analysis spreadsheet tool	The spreadsheet tool identifies the length of time District facilities can operate with existing fuel stores, and identifies refueling needs and sequencing of facilities to be refueled.

3.1 Model Assumptions

Retailer demands for the project are described in the Task 4 Technical Memorandum. The level of service selected for the project is described in the Task 6 Technical Memorandum. In general, the project is analyzing minimum winter demands, based on the average of one lowest month for the past five years. A growth factor was added for areas of known growth.

The WEAP modeling uses a different demand set, 2025 demands from the District's Urban Water Management Plan. The WEAP modeling assumptions are described in detail in Section 4.

Outage durations for each retailer service area were not evaluated individually. The analysis assumes that the entire east or west side of the District's treated water delivery system would be out for the

same amount of time, and restored all at once. This assumption was made because it is unknown where each pipeline will fail, upstream or downstream of a particular retailer's turnout.

Section 4 presents an analysis of how long it would take to restore service to the East and West treated water systems, and to restore critical managed recharge operations in the three earthquake scenarios, and in the extreme storm scenario.

Section 5 presents an analysis of the impacts of the Delta outages, and the District's ability to deliver water throughout the duration of the outages.

The Power Outage Appendix of the Final Report presents the Fuel Analysis Summary Memo, which contains information on the power outage scenario.

4 Extreme Storm and Earthquake Scenario Modeling

Staff analyzed the extreme storm and earthquake scenarios to determine the District's ability to restore service with its current baseline system and no new improvements in place. The evaluations utilized the H2ONet distribution model to analyze impacts of each scenario. The methodology for modeling each scenario is summarized in Figure 2.

For each scenario, staff analyzed infrastructure outages, and made assumptions on the priority and duration of repairs. In other words, which facilities would be repaired first, and how long it would take to make the repairs. The mode of failure for each facility was also evaluated in determining repair time. For example, some facilities are expected to suffer severe structural damage due to landslide and take longer to repair; while some are expected to fail due to power outage, and take far less time to repair.

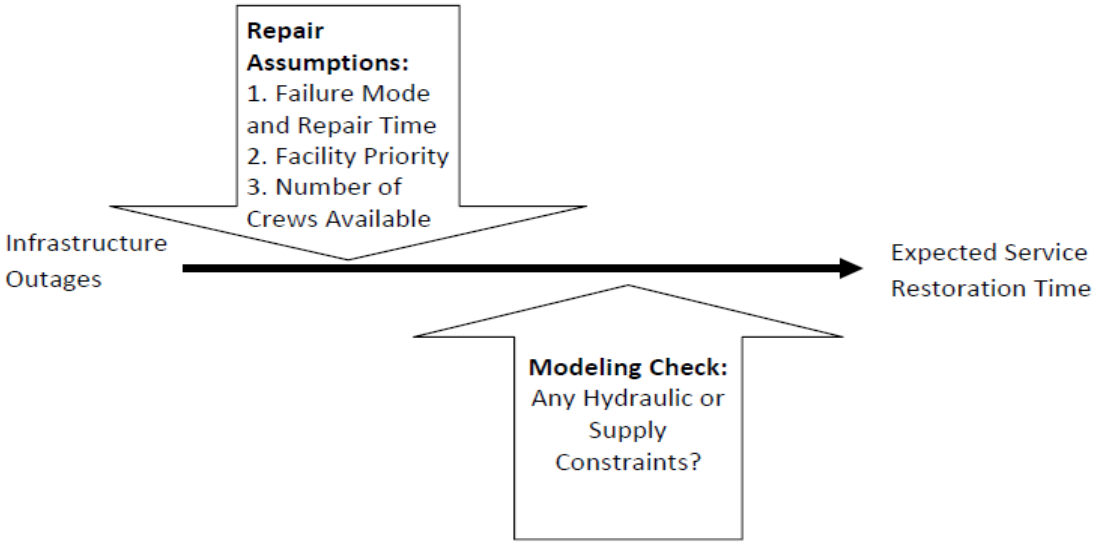
Note that the analysis is based on several assumptions, including assumptions on pipeline repair times. Actual repair times in an outage event may be much longer or shorter than what is assumed in this study, which would change the estimated outage duration. The estimated outage durations are intended to be reasonable planning assumptions, and do not indicate actual outage durations that will occur in any of the outage scenarios

Staff then used the H20Net model to check any hydraulic or supply constraints with some individual facilities out of service. For example, when the Cross Valley Pipeline is out of service, the system is only able to deliver about 35 MGD to the water treatment plants from Calero Reservoir, based on the hydraulics of the system.

Staff modeled a variety of operating conditions for each relevant outage scenario to check what level of demands was able to be supplied (minimum or average demands) to which plants (one or two) under different pumping conditions (Vasona or Coyote pumps on or off). Continuing the example above, staff checked if the 35 MGD could be delivered to RWTP or STWTP, and if more could be delivered if pumps were operating. All hydraulic modeling output is provided in Appendix 2.

Using District-specific information on repair assumptions and constraints, staff was able to estimate an expected service restoration time for each side (east and west) of the treated water system, and for critical recharge, and quantify the system water delivery capabilities. Retailers served by each of these systems are described in Section 2.

Figure 2. Modeling Methodology



4.1 Assumptions

The following assumptions were used in the modeling of the three earthquake and the storm scenarios:

1. The first three days following an event are dedicated to assessing damage, mobilizing crews, valve operations, and isolating pipeline breaks. Repair and recovery starts on day 4.

2. For earthquake events resulting in pipeline outages, the number of pipe breaks expected on each pipeline was taken from the District's 2005 Water Infrastructure Reliability Project Report (2005 Report), except for the South Bay Aqueduct (SBA). The SBA brings state water project supplies to the District and is in worse condition than documented in the 2005 Report, so this study assumes more breaks and longer duration outages than documented in the 2005 report. The SBA has failed approximately once or twice per year for the past several years, which indicates worsening condition.

3. Pipe repair and restoration durations were taken from the 2005 Report, and are summarized below:
    a. 20-30 inch diameter = 7 days
    b. 36-54 inch diameter = 10 days
    c. 60-84 inch diameter = 14 days
    d. 96-120 inch diameter = 21 days

4. The maximum number of crews mobilized at one time is three, with an assumed capability of three total pipeline break repairs concurrently. Two District crews (based on staff resource availability) plus one California Water/Wastewater Agency Response Network (CALWARN) mutual aid crew.

5. The reservoir elevation for Calero = 463 ft. and for Anderson = 580 ft. These elevations are near the historical averages.

4.2 Extreme Storm

An Extreme Storm event specifically refers to riverine flooding caused by extreme precipitation. Riverine flooding is a category of flooding, which occurs when heavy rainfall causes rivers or creeks to overtop their banks, resulting in the inundation of surrounding areas. The magnitude of riverine flooding is determined in large part by the amount of precipitation that has fallen, its duration, and its spatial distribution. The Extreme Storm scenario is expected to cause infrastructure outages identified in Table 2. More information can be found in the Task 5 Outage Scenarios Technical Memorandum.

Table 2. Extreme Storm Scenario Infrastructure Failures

Outage	Failure Mode	Repair Time (days)
Pacheco PP	Power	14
Santa Clara Tunnel	Landslide	60
Coyote PP	Flood	60
Vasona PP	Flood	60
SBA/SWP	Landslide	60
Rinconada WTP	Power	14
Santa Teresa WTP	Power	14
Penitencia WTP	Landslide	60
West PL 1	Break at exposed section	14
West PL 2	Break at exposed section	14
West PL 3	Break at exposed section	14
Penitencia Force Main	Landslide	60
Penitencia Delivery Main	Landslide	60

Two scenarios for making repairs to these facilities were analyzed. The first scenario (A) prioritizes repairing the West Pipeline, then the San Felipe Division[1] water supply source. The second scenario (B) prioritizes repairing the West Pipeline, then the South Bay Aqueduct[2] water supply source. Detailed analysis of each repair scenario, including a prioritized list of which facilities would be repaired first is provided in Appendix 1.

The expected restoration times based on these repair scenarios are shown in

Table 3. The assumed source of supply is in parenthesis below the outage duration in the table. Details on repair sequence, and operational plans during repairs is provided in Appendix 1. Associated hydraulic modeling results are provided in Appendix 2.

[1] Also known as San Luis Reservoir, Central Valley Project, or Federal supplies
[2] Also known as State Water Project or State supplies

Table 3. Extreme Storm Expected Outage Times

	Scenario A: Restore Local then San Felipe		Scenario B: Restore Local then SBA	
	Days to Min. Demands[1]	Days to Avg. Demands[1]	Days to Min. Demands[1]	Days to Avg. Demands[1]
East	4[2] (SFPUC Intertie)	78 (San Felipe)	4[2] (SFPUC Intertie)	78 (SBA)
West	18 (Anderson)	78 (San Felipe)	18 (Anderson)	78 (SBA)
Critical Recharge	78 (San Felipe)	78 (San Felipe)	78 (SBA)	78 (SBA)

[1]Minimum and average demands are from Task 4 TM. Minimum: East = 42 MGD, West = 33 MGD; Average: East = 83 MGD, West = 61 MGD.

[2]Intertie can supply approximately 40 MGD while minimum winter demand is 42 MGD. There may be a 2 MGD deficit.

4.3 San Andreas 1

The San Andreas 1 scenario is expected to cause infrastructure outages identified in Table 4.

Table 4. San Andreas 1 Scenario Infrastructure Failures

Outages (in order of probability):	# Breaks	Size (largest)	Probability of Failure	Repair Time (days)
South Bay Aqueduct	1	72"	100	28[1]
Almaden Valley Pipeline	3	78"	98	14
Central Pipeline	1	66"	94	14
Cross Valley Pipeline	1	78"	67	14
Santa Clara Conduit	1	96"	59	21
West Pipeline 1 (RWTP to Cox)	1	84"	42	14
West Pipeline 2 (Cox to Peninsular)	1	54"	32	10
Penitencia WTP	N/A	N/A	31	60[1]

[1]Landslide failures, longer duration repairs.

Two scenarios for making repairs to the facilities that are expected to fail during the San Andreas 1 outage scenario were analyzed. The first scenario (A) prioritizes repairing the Almaden Valley Pipeline and Cross Valley Pipeline to restore local water supply sources (Calero and Anderson Reservoirs). The second scenario (B) prioritizes repairing the South Bay Aqueduct water supply source and Central Pipeline. Detailed analysis of each repair scenario is provided in Appendix 1.

The expected restoration times based on these repair scenarios are shown in Table 5. The assumed source of supply is in parenthesis below the outage duration in the table. Details on repair sequence, and operational plans during repairs is provided in Appendix 1. Associated hydraulic modeling results are provided in Appendix 2.

Table 5. San Andreas 1 Expected Outage Times

	Scenario A (Restore Local First)		Scenario B (Restore SBA First)	
	Days to Min. Demands[1]	Days to Avg. Demands[1]	Days to Min. Demands[1]	Days to Avg. Demands[1]
East	4[3] (SFPUC Intertie)	32[2] (Anderson)	4[3] (SFPUC Intertie)	54 (SBA/ Anderson)
West	32 (Anderson)	32[2] (Anderson)	34 (SBA)	34 (SBA)
Critical Recharge	53 (San Felipe)	53[4] (San Felipe)	54 (Anderson)	54 (Anderson)

[1]Minimum and average demands are from Task 4 TM. Minimum: East = 42 MGD, West = 33 MGD; Average: East = 83 MGD, West = 61 MGD.
[2]Assumes Coyote Pumps available and has regional power. Without pumps, restoration at day 53.
[3]Intertie can supply approximately 40 MGD while minimum winter demand is 42 MGD (2 MGD deficit)
[4]Could be sooner if operations can backfill Santa Clara Conduit using Anderson water

4.4 San Andreas 2

The San Andreas 2 scenario is expected to cause infrastructure outages identified in Table 6 below.

Table 6. San Andreas 2 Scenario Infrastructure Failures

Outages (in order of probability):	# Breaks	Size (largest)	Probability of Failure	Repair Time per Break (days)
South Bay Aqueduct	1	72"	100	30[1]
Almaden Valley Pipeline	3	78"	98	14
Central Pipeline	1	66"	94	14
Cross Valley Pipeline	1	78"	67	14
Snell	1	72"	65	14
Penitencia WTP	N/A	N/A	31	60
Milpitas	0.2	42"	21	10
East Pipeline 1	0.2	48"	14	10

[1]Landslide failures, longer duration repairs.

Two scenarios for making repairs to the facilities that are expected to fail during the San Andreas 2 earthquake outage scenario were analyzed. The first scenario (A) prioritizes restoring raw water pipelines to restore service to the West treated water system first. The second scenario (B) prioritizes restoring the East treated water pipelines to restore service to the East treated water system first. Detailed analysis of each repair scenario is provided in Appendix 1.

The expected restoration times based on these repair scenarios are shown in Table 7. The assumed source of supply is in parenthesis below the outage duration in the table. Details on repair sequence, and operational plans during repairs is provided in Appendix 1. Associated hydraulic modeling results are provided in Appendix 2.

Table 7. San Andreas 2 Expected Outage Times

	Scenario A (Restore West First)		Scenario B (Restore East First)	
	Days to Min. Demands	Days to Avg. Demands	Days to Min. Demands	Days to Avg. Demands
East	32 (San Felipe)	53 (San Felipe)	18[1] (Intertie)	53 (San Felipe)
West	18 (Calero)	53 (San Felipe)	32 (Calero)	53 (San Felipe)
Critical Recharge	53[2] (San Felipe)	53 (San Felipe)	53[2] (San Felipe)	53 (San Felipe)

[1] Intertie can supply approximately 40 MGD while minimum winter demand is 42 MGD (2 MGD deficit)
[2] Could be sooner if operations can backfill Santa Clara Conduit using Anderson water

4.5 Calaveras

The Calaveras scenario is expected to cause infrastructure outages identified in Table 8 below.

Table 8. Calaveras Scenario Infrastructure Failures

Outages (in order of probability):	# Breaks	Size (largest)	PoF	Repair Time per Break (days)
South Bay Aqueduct	1	72"	100	30*
Santa Clara Conduit	1	96"	48	21
Penitencia	N/A	N/A	34	60
Pacheco Conduit	1	120"	22	21
Cross Valley Pipeline	1	78"	19	14

*Landslide failures, longer duration repairs.

Two scenarios for making repairs to the facilities that are expected to fail during the Calaveras earthquake outage scenario were analyzed. The first scenario (A) prioritizes repairing the Cross Valley Pipeline to restore local water supply sources, then San Felipe Division supplies. The second scenario (B) prioritizes repairing the Cross Valley Pipeline to restore local water supply sources, then SBA supplies. Detailed analysis of each repair scenario is provided in Appendix 1.

The expected restoration times based on these repair scenarios are shown in Table 9. The assumed source of supply is in parenthesis below the outage duration in the table. Details on repair sequence, and operational plans during repairs is provided in Appendix 1. Associated hydraulic modeling results are provided in Appendix 2.

Table 9. Calaveras Expected Outage Times

	Scenario A (Restore Local then San Felipe)		Scenario B (Restore Local then SBA)	
	Days to Min. Demands	**Days to Avg. Demands[1]**	**Days to Min. Demands**	**Days to Avg. Demands[1]**
East	4[2] (Intertie)	18 (Anderson)	4[2] (Intertie)	18 (Anderson)
West	4 (Calero)	18 (Anderson)	4 (Calero)	18 (Anderson)
Critical Recharge	18 (Anderson)	18 (Anderson)	18 (Anderson)	18 (Anderson)

[1] Assumes Coyote Pumps available. Without pumps, restoration at day 53.
[2] Intertie can supply approximately 40 MGD while minimum winter demand is 42 MGD (2 MGD deficit)

5 Delta Outage Scenario Modeling

For both Delta outage scenarios, it is assumed that all local District infrastructure will remain intact. An earthquake or flood event in the Delta is far enough away from Santa Clara County that it would not badly damage local infrastructure. Therefore, analysis of the Delta outage scenarios attempts to determine if the District could continue limited service for the outage duration with no imported water supplies. The WEAP and groundwater models were utilized to answer this question.

5.1 Assumptions

The following assumptions were used in the Delta outage scenarios:

1. A normal hydrology year (2002) was used for the duration of the Delta outage modeling. A conscious decision was made to not stack disaster upon disaster (i.e. earthquake plus drought, etc.)
2. The Governor would declare an emergency and call for a 20% water use reduction. The models assume the water use reduction would be phased in over three months at a rate of 10%, 15%, 20% and then in place for the remainder of the outage scenario.
3. Utilize the 2025 water demand values from the 2010 Urban Water Management Plan.
4. The FAHCE rules curves remained intact for the first six months of an outage and then turned off for the duration of the outage.
5. The San Francisco Public Utility Commission (SFPUC) - SCVWD intertie is available during summer months.
6. IPR and other WSIMP projects are turned on, except for dry year options which are turned off.

Detailed information on the Delta Outage modeling assumptions can be found in Appendix 3.

5.2 Delta Outage – 6 Months

Analysis of a six-month Delta outage scenario shows that the District can continue service for six months without any imported water supplies without causing any land subsidence. The WEAP modeling results shows there are unmet demands at the treatment plants (66,000 acre-feet) and groundwater recharge facilities (28,800 acre-feet); however, the retailers' demands are met by switching their water source from treated water to groundwater. The MODFLOW modeling results show the Santa Clara Plain, Coyote Valley, and Llagas Subbasin groundwater storage levels remain healthy, exceeding the District's established Board Outcome Measure 2.1.1, which sets goals for groundwater levels, by a total of 57,400 acre-feet. The overall countywide groundwater storage values remain within normal limits as identified as Stage 1 under the Water Storage Contingency Plan.

The impacts of a six-month Delta outage are largely operational as they would require retailers to supplement their supplies with groundwater via pumping and for District staff to actively manage the groundwater recharge program to meet any countywide needs. All of these impacts are manageable assuming the District continues with the planned investments described in the 2012 Water Supply Infrastructure Master Plan.

5.3 Delta Outage – 24 Months

Analysis of a 24-month Delta outage scenario shows that the District can continue service for 24 months without any imported water supplies without causing subsidence. The WEAP modeling results show there are unmet demands at the treatment plants (214,000 acre-feet) and groundwater recharge facilities (84,200 acre-feet); however, the retailers' demands are met by switching their water source from treated water to groundwater. The MODFLOW modeling results show the Santa Clara Plain groundwater storage level dips below the District's established Board Outcome Measure 2.1.1., which sets goals for groundwater storage levels, by 20,100 acre-feet; while the Coyote Valley and Llagas Subbasin groundwater storage levels remain healthy, exceeding the Outcome Measure 2.1.1 by a total of 28,100 acre-feet. The overall countywide groundwater storage values remain within normal limits at Stage 1 under the Water Storage Contingency Plan.

The impacts of a 24-month Delta outage are largely operational as it would require retailers to supplement their supplies with groundwater via pumping and for District staff to actively manage the groundwater recharge program to meet any countywide needs. All of these impacts are manageable assuming the District continues with the planned investments described in the 2012 Water Supply Infrastructure Master Plan.

6 Power Outage Considerations

Please see the Power Outage Appendix for the Fuel Analysis Memorandum due to a power outage.

7 Conclusions

The expected restoration times for the Extreme Storm, San Andreas 1, San Andreas 2, and Calaveras scenarios are presented in Table 10 below. These restoration times are based on assumptions regarding which facilities will fail in each scenario, assumed failure modes and repair times, suggested repair prioritization, and hydraulic model verification.

The estimated outage durations are intended to be reasonable planning assumptions, and do not indicate actual outage durations that will occur in any of the seven outage scenarios.

Table 10. Summary of Scenario Restoration Times

	Days to Min. Demands	Days to Avg. Demands
Extreme Storm		
East	4	78
West	18	78
Critical Recharge	78	78
San Andreas 1		
East	4	32
West	32	32
Critical Recharge	53	53
San Andreas 2		
East	18*	53
West	32*	53
Critical Recharge	53	53
Calaveras		
East	4	25
West	4	25
Critical Recharge	25	25

*Depends on which side of the treated water system is prioritized for repairs. If East is brought online in 18 days, West will be back in 32 days. If West is brought online in 18 days, East will be back in 32 days.

East System Conclusions

Due to the availability of the SFPUC intertie, in most scenarios, service can be restored to the East treated water system immediately, or within a few days. The SFPUC intertie is considered a highly reliable source due to the following:

- SFPUC recently completed its Water System Improvement Project (WSIP), which improved reliability of supplies from Hetch Hetchy and the East Bay, across the Sunol Valley (via Bay Division Pipelines) that feed the intertie.
- The intertie pump station was constructed in 2001, and is assumed to be seismically reliable.
- The intertie pump station has back-up generator capability to run all pumps.

- The intertie pump station contains sufficient fuel storage to run the pumps for approximately three days.

In the San Andreas 2 scenario, the East, Snell and Milpitas pipelines are damaged, and service cannot be restored to the East until those pipelines are repaired, at 18 days. If priority is given to repairing the Almaden Valley Pipeline over the East pipelines, East service wouldn't be restored until day 32.

Table 11. East Treated Water System Restoration Times

	Days to Min. Demands	Days to Avg. Demands
Extreme Storm	4	78
San Andreas 1	4	32
San Andreas 2	18*	53
Calaveras	4	25

*If repair priority is given to the West system, the restoration time is 32 days rather than 18.

West System Conclusions

The range of restoration time for the West system varies by scenario, from 4 days to 32 days. In the Extreme Storm scenario, the West pipeline is damaged, and service cannot be restored until it is repaired at 18 days.

In the San Andreas 1 Earthquake scenario, the Almaden Valley Pipeline and West pipeline are expected to fail in multiple locations. This is the worst case scenario for the West system. Service cannot be restored to the West system until these two pipelines are repaired, which is estimated at about one month.

In the San Andreas 2 earthquake scenario, the Almaden Valley Pipeline is expected to fail in multiple locations, but the West Pipeline remains intact. As such, service can be restored once the Almaden Valley Pipeline is repaired, at about 18 days. However, if priority is given to repairing the East side treated water pipelines over the Almaden Valley Pipeline, service would be restored in 32 days to the West (same as San Andreas 1 scenario). This is shown in the table below.

The Calaveras earthquake scenario is the least severe of the four. It does not damage the West or Almaden Valley Pipelines. As such, Calero supplies would be available for treatment at RWTP.

Table 12. West Treated Water System Restoration Time

	Days to Min. Demands	Days to Avg. Demands
Extreme Storm	18	78
San Andreas 1	32	32
San Andreas 2	32*	53
Calaveras	4	25

*If repair priority is given to the West system, the restoration time is 18 days rather than 32.

Critical Recharge

Recovery of critical recharge in the earthquake scenarios ranges from 25 to 53 days. Recovery in the storm scenario is much longer, 78 days, due to multiple landslide failures. ***It is assumed that in the extreme storm scenario, managed recharge would be less critical due to excess natural infiltration and runoff.*** In previous project tasks, the project team found that all retailers can sustain groundwater pumping for up to 60 days with no managed recharge.

Critical recharge would likely be restored more quickly than the numbers presented below. The District is currently improving the Main and Madrone pipelines, which will allow the District to deliver water from Anderson reservoir to the Main and Madrone ponds. Additionally, the District can supply the Main and Madrone ponds by backfilling the Santa Clara Conduit using Anderson water to reach the raw water turnouts in Morgan Hill. The ability to do so depends on various operational considerations, and would be evaluated during the emergency for feasibility and need.

Table 13. Critical Recharge Restoration Time

	Days to Min. Demands	Days to Avg. Demands
Extreme Storm	78	78
San Andreas 1	53	53
San Andreas 2	53	53
Calaveras	25	25

Average Demands

In the earthquake scenarios, average demands can be restored in one to two months. The Extreme Storm scenario is expected to cause landslide damage, which will take more than 2 months to repair. In this scenario, minimum demand can be restored relatively quickly, and with the wet weather associated with an extreme storm, winter demands would likely be sufficient.

Delta Outages

The impacts of a 6 or 24-month Delta outage are largely operational as it would require retailers to supplement their supplies with groundwater via pumping and for District staff to actively manage the groundwater recharge program to meet any countywide needs. All of these impacts are manageable assuming the District continues with the planned investments described in the 2012 Water Supply Infrastructure Master Plan (WSIMP). The investments recommended in the 2012 WSIMP are sufficient to address shorter term Delta Outages.

Power Outages

Based on historic energy consumption and assumptions regarding future upgrades to RWTP, the analysis estimates that the SCVWD could operate its treatment facilities and the SFPUC/SCVWD intertie

on backup fuel storage alone for between 3.1 to 10.5 days, depending on the time of year. RWTP is the controlling facility, using the most fuel and requiring refueling prior to other facilities. The District could operate for a longer period on backup power if fuel deliveries were initiated as part of a coordinated disaster response effort.

Appendix 1:
Scenario Modeling Detail

Scenario: Severe Storm & Flood A

Priority: Restore San Luis Source

Outages:	Failure Mode	Repair Time (days)
Pacheco PP	Power	14
Santa Clara Tunnel	Landslide	60
Coyote PP	Flood	60
Vasona PP	Flood	60
SBA/SWP	Landslide	60
Rinconada WTP	Power	14
Santa Teresa WTP	Power	14
Penitencia WTP	Landslide	60
West PL 1	Break at exposed section	14
West PL 2	Break at exposed section	14
West PL 3	Break at exposed section	14
Penitencia Force Main*	Landslide	60
Penitencia Delivery Main*	Landslide	60

*Not Expected to fail once CIP is completed.

Repair Sequence:
West Pipeline (3 breaks)
Santa Clara Tunnel
Coyote Pump Station
Vasona Pump Station
South Bay Aqueduct
Penitencia Water Treatment Plant
Penitencia Force Main
Penitencia Delivery Main

Operation Plan:
Anderson to STWTP to East at 4 days.
Anderson to STWTP and RWTP to East and West at 18 days ***(hydraulic model verified)***
At day 78, normal CVP operations restored

Conclusion:
Min Winter Demands to East at 4 days.
Min Winter Demands to West at 4 days
Average Demands to East and West and Critical Recharge restored at 78 days
Critical recharge is not likely an issue for the storm scenario.
Critical recharge could be restored more quickly than 78 days by backfilling the Santa Clara Conduit with Anderson water, if operationally feasible.
There could be difficulty switching to local sources if Calero valve yard is flooded.

Repair and Operations Plan:

Time from Event (days)	0-3	4-17	18-77	78-137
No. days	3	14	60	60
Crew 1	N/A Damage Assessment and Re-operations Period	West Pipeline Break 1	Santa Clara Tunnel	SBA
Crew 2		West Pipeline Break 2	Coyote Pump Station	PWTP
Crew 3		West Pipeline Break 3	Vasona Pump Station	
Available Sources		Anderson feeding STWTP feeding East Pipeline	RWTP to feed East and West, respectively	Normal San Luis Operations restored
Out of Service:	West Pipeline (3 breaks) Santa Clara Tunnel Coyote Pump Station Vasona Pump Station South Bay Aqueduct Penitencia Water Treatment Plant	West Pipeline (3 breaks) Santa Clara Tunnel Coyote Pump Station Vasona Pump Station South Bay Aqueduct Penitencia Water Treatment Plant	Santa Clara Tunnel Coyote Pump Station Vasona Pump Station South Bay Aqueduct Penitencia Water Treatment Plant	South Bay Aqueduct Penitencia Water Treatment Plant

Outage Duration Summary:

	Days to Min Demands	Days to Avg Demands
East	4	78
West	18	78
Critical Recharge	78	78

Scenario: Severe Storm & Flood B

Priority: Restore SBA Source

Outages:	Failure Mode	Repair Time (days)
Pacheco PP	Power	14
Santa Clara Tunnel	Landslide	60
Coyote PP	Flood	60
Vasona PP	Flood	60
SBA/SWP	Landslide	60
Rinconada WTP	Power	14
Santa Teresa WTP	Power	14
Penitencia WTP	Landslide	60
West PL 1	Break at exposed section	14
West PL 2	Break at exposed section	14
West PL 3	Break at exposed section	14
Penitencia Force Main*	Landslide	60
Penitencia Delivery Main*	Landslide	60

*Not Expected to fail once CIP is completed.

Repair Sequence:
West Pipeline (3 breaks)
South Bay Aqueduct
Penitencia Water Treatment Plant
Coyote Pump Station
Vasona Pump Station
Santa Clara Tunnel

Operation Plan:
Anderson to STWTP to East at 4 days.
Anderson to STWTP and RWTP to East and West at 18 days ***(hydraulic model verified)***
At day 78, normal SBA operations restored

Conclusion:
Min Winter Demands to East at 4 days.
Min Winter Demands to West at 4 days
Average Demands to East and West and Critical Recharge restored at 78 days
Critical recharge is not likely an issue for the storm scenario.
Critical recharge could be restored more quickly than 78 days by backfilling the Santa Clara Conduit with Anderson water, if operationally feasible.
There could be difficulty switching to local sources if Calero valve yard is flooded.

Repair and Operations Plan:

Time from Event (days)	0-3	4-17	18-77	78-137
No. days	3	14	60	60
Crew 1	N/A Damage Assessment and Re-operations Period	West Pipeline Break 1	South Bay Aqueduct	Vasona Pump Station
Crew 2		West Pipeline Break 2	Penitencia Water Treatment Plant	Santa Clara Tunnel
Crew 3		West Pipeline Break 3	Coyote Pump Station	
Available Sources		Anderson feeding STWTP feeding East Pipeline	Anderson feeding STWTP and RWTP to feed East and West, respectively	Normal San Luis Operations restored
Out of Service:	West Pipeline (3 breaks) South Bay Aqueduct Penitencia Water Treatment Plant Coyote Pump Station Vasona Pump Station Santa Clara Tunnel	West Pipeline (3 breaks) South Bay Aqueduct Penitencia Water Treatment Plant Coyote Pump Station Vasona Pump Station Santa Clara Tunnel	South Bay Aqueduct Penitencia Water Treatment Plant Coyote Pump Station Vasona Pump Station Santa Clara Tunnel	Vasona Pump Station Santa Clara Tunnel

Outage Duration Summary:

	Days to Min Demands	Days to Avg Demands
East	4	78
West	18	78
Critical Recharge	78	78

Scenario: San Andreas 1

Priority: Restore Local Reservoirs

Outages (in order of probability):	# Breaks	Size (largest)	PoF	Repair Time per Break (days)
South Bay Aqueduct	1	72"	100	30
Almaden Valley Pipeline	3	78"	98	14
Central Pipeline	1	66"	94	14
Cross Valley Pipeline	1	78"	67	14
Santa Clara Conduit	1	96"	59	21
West Pipeline 1 (RWTP to Cox)	1	84"	42	14
West Pipeline 2 (Cox to Peninsular)	1	54"	32	10
Penitencia	N/A	N/A	31	60

Repair Sequence:
Almaden Valley Pipeline (3 breaks)
West Pipeline (2 breaks)
Cross Valley Pipeline
Santa Clara Conduit
Central Pipeline
South Bay Aqueduct
Penitencia Water Treatment Plant

Operation Plan:
Intertie to East at 4 days.
Anderson or Calero to RWTP and STWTP at 32 days ***(hydraulic model verified)***
If WPL in service, Intertie to East and Calero to West at 18 days ***(hydraulic model verified)***
At day 53, normal CVP operations restored.

Conclusion:
Min Winter Demands to East at 4 days.
Calero to RWTP to West at 32 days
Average Demands to East & West at 39 days.
Critical recharge could be restored more quickly than 53 days by backfilling the Santa Clara Conduit with Anderson water, if feasible.
If more crews are available to fix WPL and AVP simultaneously (5 crews instead of 3), could get
Doesn't matter if Vasona on or off, but the current CIP to upgrade Vasona should include reliability features.
Average demands to East and West at 39 days if Coyote pumps online. Otherwise, 53 days (when CVP source is recovered) .

Repair and Operations Plan:

Time from Event (days)	0-3	4-17	18-31	32-52	53+
No. days	3	14	14	21	TBD
Crew 1	N/A Damage Assessment and Re-operations Period	Almaden Valley Pipeline Break 1	West Pipeline Break 1	Santa Clara Conduit	SBA
Crew 2		Almaden Valley Pipeline Break 2	West Pipeline Break 2	Central Pipeline	PWTP
Crew 3		Almaden Valley Pipeline Break 3	Cross Valley Pipeline	SBA	
Available Sources		Intertie feeding East Pipeline	Intertie feeding East Pipeline	Anderson or Calero feeding STWTP & RWTP	Normal San Luis operations restored
Out of Service:	Almaden Valley Pipeline (3 breaks) West Pipeline (2 breaks) Cross Valley Pipeline Santa Clara Conduit Central Pipeline South Bay Aqueduct Penitencia Water Treatment Plant	Almaden Valley Pipeline (3 breaks) West Pipeline (2 breaks) Cross Valley Pipeline Santa Clara Conduit Central Pipeline South Bay Aqueduct Penitencia Water Treatment Plant	West Pipeline (2 breaks) Cross Valley Pipeline Santa Clara Conduit Central Pipeline South Bay Aqueduct Penitencia Water Treatment Plant	Cross Valley Pipeline to day 39 Santa Clara Conduit Central Pipeline South Bay Aqueduct Penitencia Water Treatment Plant	South Bay Aqueduct Penitencia Water Treatment Plant

Outage Duration Summary:

	Days to Min Demands	Days to Avg Demands*
East	4**	32
West	32	32
Critical Recharge	53	53

*Assumes Coyote Pumps online
**40 MGD of 42 MGD available

Scenario: San Andreas 1

Priority: Restore SBA

Outages (in order of probability):	# Breaks	Size (largest)	PoF	Repair Time per Break (days)
South Bay Aqueduct (SBA)	1	72"	100	30
Almaden Valley Pipeline	3	78"	98	14
Central Pipeline	1	66"	94	14
Cross Valley Pipeline	1	78"	67	14
Santa Clara Conduit	1	96"	59	21
West Pipeline 1 (RWTP to Cox)	1	84"	42	14
West Pipeline 2 (Cox to Peninsular)	1	54"	32	10
Penitencia	N/A	N/A	31	60

Repair Sequence:
South Bay Aqueduct
Central Pipeline
West Pipeline (2 Breaks)
Almaden Valley Pipeline (3 Breaks)
Cross Valley Pipeline
Santa Clara Conduit
Penitencia Water Treatment Plant

Operations:
Intertie to East side at 4 days
SBA to RWTP to West side at 34 days
Continue intertie to East, or potentially switch SBA to PWTP & West at 34 days
SBA and Anderson blend feeding all plants at 54 days.

Conclusion:
Min Winter Demands to East at 4 days.
Min Winter or Average Demands to West at 34 days.
Recharge restored at 48 days.
Critical recharge could be restored more quickly than 48 days by backfilling the Santa Clara Conduit with Anderson water, if operationally feasible.
Average Demands to East at 48 days.
Problems: Fixing SBA in 30 days may be unrealistic. Relies on intertie for long duration.

Repair and Operations Plan:

Time from Event (days)	0-3	4-17	18-33	34-47	48+
No. days	3	14	16	14	21
Crew 1		SBA (Start)	SBA (finish)	Cross Valley Pipeline	
Crew 2		Central Pipeline	Almaden Valley Pipeline Break 1	Almaden Valley Pipeline Break 2	Santa Clara Conduit
Crew 3	N/A Damage Assessment and Re-operations Period	West Pipeline Break 1	West Pipeline Break 2	Almaden Valley Pipeline Break 3	Penitencia Water Treatment Plant
Available Sources		Intertie feeding East Pipeline	Intertie feeding East Pipeline	SBA feeding RWTP feeding West Pipeline, Intertie feeding East Pipeline or SBA feeding PWTP, feeding East PL	SBA and Anderson feeding all plants
Out of Service:	South Bay Aqueduct Central Pipeline West Pipeline (2 Breaks) Almaden Valley Pipeline (3 Breaks) Cross Valley Pipeline Santa Clara Conduit Penitencia Water Treatment Plant Penitencia WTP ongoing repairs 75+ days	South Bay Aqueduct Central Pipeline West Pipeline (2 Breaks) Almaden Valley Pipeline (3 Breaks) Cross Valley Pipeline Santa Clara Conduit Penitencia Water Treatment Plant	South Bay Aqueduct West Pipeline (1 Break) Almaden Valley Pipeline (3 Breaks) Cross Valley Pipeline Santa Clara Conduit Penitencia Water Treatment Plant	Almaden Valley Pipeline (2 Breaks) Cross Valley Pipeline Santa Clara Conduit Penitencia Water Treatment Plant	Santa Clara Conduit Penitencia Water Treatment Plant

Outage Duration Summary:

	Days to Min Demands	Days to Avg Demands
East	4*	48
West	34	34
Critical Recharge	69	69

*40 MGD of 42 MGD available

Scenario: San Andreas 2A

Priority: Restore West Service

Outages (in order of probability):	# Breaks	Size (largest)	PoF	Repair Time per Break (days)
South Bay Aqueduct	1	72"	100	30
Almaden Valley Pipeline	3	78"	98	14
Central Pipeline	1	66"	94	14
Cross Valley Pipeline	1	78"	67	14
Snell	1	72"	65	14
Penitencia	N/A	N/A	31	60
Milpitas	0.2	42"	21	10
East Pipeline 1	0.2	48"	14	10

Repair Sequence: Almaden Valley Pipeline (3 breaks)
Snell Pipeline
East Pipeline
Milpitas Pipeline
Cross Valley Pipeline
Central Pipeline
SBA
PWTP

Operation Plan: Calero to RWTP to West side at 18 days ***(hydraulic model verified)***
Intertie to East side at 32 days
Normal San Luis and Anderson operations restored at Day 46

Conclusion: Min winter demands to West at 18 days
Min winter demands to East and West at 32 days.
Critical recharge restored at 53 days
Critical recharge could be restored more quickly than 48 days by backfilling the Santa Clara Conduit with Anderson water, if operationally feasible.
If more crews are available to fix EPL, Snell, Milpitas and AVP simultaneously (6 crews instead of 3), could get min winter demands to East and West in 18 days.
Doesn't matter if Vasona on or off, but the current CIP to upgrade Vasona should include reliability features.

Repair and Operations Plan:

Time from Event (days)	0-3	4-17	18-31	32-45	46+
No. days	3	14	14	14	TBD
Crew 1	N/A Damage Assessment and Re-operations Period	Almaden Valley Pipeline Break 1	Snell Pipeline	Cross Valley Pipeline	SBA
Crew 2		Almaden Valley Pipeline Break 2	East Pipeline	Central Pipeline	PWTP
Crew 3		Almaden Valley Pipeline Break 3	Milpitas Pipeline	SBA	
Available Sources		No Service	Calero Reservoir feeding RWTP feeding West Pipeline	Intertie feeding East Pipeline Calero feeding RWTP, feeding West Pipeline	Normal San Luis operations restored
Out of Service:	Almaden Valley Pipeline (3 breaks)	Almaden Valley Pipeline (3 breaks)	Snell Pipeline	Cross Valley Pipeline	South Bay Aqueduct
	Snell Pipeline	Snell Pipeline	East Pipeline	Central Pipeline	Penitencia Water Treatment Plant
	East Pipeline	East Pipeline	Milpitas Pipeline	SBA	
	Milpitas Pipeline	Milpitas Pipeline	Cross Valley Pipeline	PWTP	
	Cross Valley Pipeline	Cross Valley Pipeline	Central Pipeline		
	Central Pipeline	Central Pipeline	SBA		
	SBA	SBA	PWTP		
	PWTP	PWTP			

Outage Duration Summary:

	Days to Min Demands	Days to Avg Demands
East	32	46
West	18	46
Critical Recharge	46	46

Scenario: San Andreas 2B

Priority: Resotre East Service

Outages (in order of probability):	# Breaks	Size (largest)	PoF	Repair Time per Break (days)
South Bay Aqueduct	1	72"	100	30
Almaden Valley Pipeline	3	78"	98	14
Central Pipeline	1	66"	94	14
Cross Valley Pipeline	1	78"	67	14
Snell	1	72"	65	14
Penitencia	N/A	N/A	31	60
Milpitas	0.2	42"	21	10
East Pipeline 1	0.2	48"	14	10

Repair Sequence:
Snell Pipeline
East Pipeline
Milpitas Pipeline
Almaden Valley Pipeline (3 Breaks)
Cross Valley Pipeline
SBA
Central Pipeline
PWTP

Operation Plan:
Intertie only to East at 18 days
Calero to RWTP to West at 32 days ***(hydraulic model verified)***
Normal San Luis operations restored at 46 days

Conclusion:
Minimum winter demand to East at 18 days.
Minimum winter demand to West at 32 days.
Average demands to East and West and critical recharge restored at 46 days.
Critical recharge could be restored more quickly than 53 days by backfilling the Santa Clara Conduit with Anderson water, if operationally feasible.

Repair and Operations Plan:

Time from Event (days)	0-3	4-17	18-31	32-45	46+
No. days	3	14	14	14	TBD
Crew 1	N/A Damage Assessment and Re-operations Period	Snell Pipeline	Almaden Valley Pipeline Break 1	Cross Valley Pipeline	PWTP
Crew 2		East Pipeline	Almaden Valley Pipeline Break 2	SBA	SBA
Crew 3		Milpitas Pipeline	Almaden Valley Pipeline Break 3	Central Pipeline	
Available Sources		No Service	Intertie feeding East Pipeline	Calero feeding RWTP feeding West Pipeline Intertie feeding East Pipeline	Normal San Luis operations restored
Out of Service:	Almaden Valley Pipeline (3 breaks) Snell Pipeline East Pipeline Milpitas Pipeline Cross Valley Pipeline Central Pipeline SBA PWTP	Almaden Valley Pipeline (3 breaks) Snell Pipeline East Pipeline Milpitas Pipeline Cross Valley Pipeline Central Pipeline SBA PWTP	Almaden Valley Pipeline (3 breaks) Cross Valley Pipeline Central Pipeline SBA PWTP	Cross Valley Pipeline Central Pipeline SBA PWTP	South Bay Aqueduct Penitencia Water Treatment Plant

Outage Duration Summary:

	Days to Min Demands	Days to Avg Demands
East	18**	46
West	32	46
Critical Recharge	46	46

**40 MGD of 42 MGD available

Scenario: Calaveras A

Priority: Restore Anderson then San Felipe

Outages (in order of probability):	# Breaks	Size (largest)	PoF	Repair Time per Break (days)
South Bay Aqueduct	1	72"	100	30
Santa Clara Conduit	1	96"	48	21
Penitencia	N/A	N/A	34	60
Pacheco Conduit	1	120"	22	21
Cross Valley Pipeline	1	78"	19	14

Repair Sequence:
Cross Valley Pipeline
Santa Clara Conduit
Pacheco Conduit
SBA
PWTP

Operation Plan:
Intertie only to East at 4 days
Calero to RWTP to West at 4 days ***(hydraulic model verified)***
Normal San Luis operations restored at 25 days

Conclusion:
Minimum winter demand to East and West at 4 days.
Average demands to East and West and critical recharge restored at 18 days.
Critical recharge could be restored more quickly than 25 days by backfilling the Santa Clara Conduit with Anderson water, if operationally feasible.

Repair and Operations Plan:

Time from Event (days)	0-3	4-24	25+
No. days	3	21	TBD
Crew 1	N/A Damage Assessment and Re-operations Period	Cross Valley Pipeline*	SBA
Crew 2		Santa Clara Conduit	PWTP
Crew 3		Pacheco Conduit	
Available Sources		Calero to RWTP to West; Intertie to East	Normal San Luis operations
Out of Service:	Cross Valley Pipeline Santa Clara Conduit Pacheco Conduit SBA PWTP	Cross Valley Pipeline Santa Clara Conduit Pacheco Conduit SBA PWTP	SBA PWTP

*repaired at day 18, at which time Anderson source could be used to provide avg demands to East and West

Outage Duration Summary:

	Days to Min Demands	Days to Avg Demands
East	4**	18
West	4	18
Critical Recharge	25	25

**40 MGD of 42 MGD available

Scenario: Calaveras B

Priority: Restore Anderson then SBA

Outages (in order of probability):	# Breaks	Size (largest)	PoF	Repair Time per Break (days)
South Bay Aqueduct	1	72"	100	30
Santa Clara Conduit	1	96"	48	21
Penitencia	N/A	N/A	34	60
Pacheco Conduit	1	120"	22	21
Cross Valley Pipeline	1	78"	19	14

Repair Sequence:
Cross Valley Pipeline
SBA
Santa Clara Conduit
Pacheco Conduit
PWTP

Operation Plan:
Intertie only to East at 4 days
Calero to RWTP to West at 4 days ***(hydraulic model verified)***
Normal SBA operations restored at 35 days

Conclusion:
Minimum winter demand to East and West at 4 days.
Average demands to East and West and critical recharge restored at 18 days.
Critical recharge could be restored more quickly than 35 days by backfilling the Santa Clara Conduit with Anderson water, if operationally feasible.

Repair and Operations Plan:

Time from Event (days)	0-3	4-24	25-33	34-46	47+
No. days	3	21	9	12	TBD
Crew 1	N/A Damage Assessment and Re-operations Period	Cross Valley Pipeline*	Pacheco Conduit (start)	Pacheco Conduit (finish)	PWTP
Crew 2		SBA	SBA	PWTP	
Crew 3		Santa Clara Conduit	PWTP		
Available Sources		Calero to RWTP to West Intertie to East	Anderson to RWTP to West; Intertie to East, or Anderson to STWTP to East	Normal SBA operations restored	Normal SBA and San Luis operations
Out of Service:	Cross Valley Pipeline Santa Clara Conduit Pacheco Conduit SBA PWTP	Cross Valley Pipeline Santa Clara Conduit Pacheco Conduit SBA PWTP	Pacheco Conduit SBA PWTP	Pacheco Conduit PWTP	Pacheco Conduit PWTP

*repaired at day 18, at which time Anderson source could be used to provide avg demands to East and West

Outage Duration Summary:

	Days to Min Demands	Days to Avg Demands
East	4	18
West	4	18
Critical Recharge	46	46

**40 MGD of 42 MGD available

Appendix 2: Water Distribution Modeling Results

Anderson Hydraulics

Scenario: Severe Storm & Flood A, Severe Storm & Flood B

Min Demands at RWTP and STWTP, No Pumps

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	505.2	129.7
BAILEY18	0	514	521.9	3.4
BAILEY30	0	514	521.9	3.4
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	447.3	57.2
CALEROCR	0	385.4	463	33.6
GUADCREEK	0	252.6	503.9	108.9
HALFRD	0	392.7	547.7	67.1
KIRK	0	238.3	457.4	94.9
KOOSERPOND	0	245.4	503.5	111.8
LGATVPS	0	242.8	336	40.4
LOWERLG	0	168	457.4	125.4
MADRONE	0	392.7	547.7	67.1
MAINAVE	0	380	547.7	72.7
MCLELLAN	0	329	447.3	51.3
PAGE	0	233	457.4	97.2
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	447.3	44.3
RODEO	0	308	447.3	60.4
ROSSCREEK	0	272.5	501.7	99.3
RWTP	33	420.2	499.5	34.4
SANPEDRO	0	345.6	547.7	87.6
SANTOMAS	0	269	447.3	77.3
SARATOGA	0	312	447.3	58.6
SMITHCR	0	243.5	447.3	88.3
STEVCREEK	0	288	447.3	69
STWTP	42	449.2	506.7	24.9
WILDCAT	0	264	447.3	79.4

Anderson Hydraulics

Scenario: **San Andreas 1A, San Andreas 1B,**
Max Demands at RWTP and STWTP, Coyote Pumps

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	631.7	184.5
BAILEY18	0	514	687.4	75.1
BAILEY30	0	514	687.4	75.1
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	549	101.3
CALEROCR	0	385.4	463	33.6
GUADCREEK	0	252.6	627.6	162.5
HALFRD	0	392.7	773.9	165.2
KIRK	0	238.3	573.4	145.2
KOOSERPOND	0	245.4	626.3	165
LGATVPS	0	242.8	413.5	74
LOWERLG	0	168	573.4	175.6
MADRONE	0	392.7	773.9	165.2
MAINAVE	0	380	773.9	170.7
MCLELLAN	0	329	549	95.3
PAGE	0	233	573.4	147.5
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	549	88.4
RODEO	0	308	549	104.4
ROSSCREEK	0	272.5	620.6	150.8
RWTP	61	420.2	612.4	83.3
SANPEDRO	0	345.6	773.9	185.6
SANTOMAS	0	269	549	121.3
SARATOGA	0	312	549	102.7
SMITHCR	0	243.5	549	132.4
STEVCREEK	0	288	549	113.1
STWTP	83	449.2	636.2	81
WILDCAT	0	264	549	123.5

Anderson Hydraulics

Scenario: None; Operational Check Only

Max Demands at RWTP and STWTP, Vasona Pumps

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	329.9	53.8
BAILEY18	0	514	385.6	-55.6
BAILEY30	0	514	385.6	-55.6
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	357.2	18.1
CALEROCR	0	385.4	463	33.6
GUADCREEK	0	252.6	325.8	31.7
HALFRD	0	392.7	472	34.4
KIRK	0	238.3	314.6	33
KOOSERPOND	0	245.4	324.5	34.3
LGATVPS	0	242.8	269.6	11.6
LOWERLG	0	168	314.6	63.5
MADRONE	0	392.7	472	34.4
MAINAVE	0	380	472	39.9
MCLELLAN	0	329	357.2	12.2
PAGE	0	233	314.6	35.3
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	357.2	5.3
RODEO	0	308	357.2	21.3
ROSSCREEK	0	272.5	318.8	20.1
RWTP	61	420.2	398	-9.6
SANPEDRO	0	345.6	472	54.8
SANTOMAS	0	269	357.2	38.2
SARATOGA	0	312	357.2	19.6
SMITHCR	0	243.5	357.2	49.3
STEVCREEK	0	288	357.2	30
STWTP	83	449.2	334.4	-49.7
WILDCAT	0	264	357.2	40.4

Additional operational checks regarding use of Anderson Reservoir are described below:

1. **Storage:** There is enough storage in Anderson to supply minimum winter demands (total of 42 MGD East and 33 MGD West equals 75MGD) for up to 60 days. 75 MGD for 60 days is equivalent to approximately 14,000 Acre-Feet (AF). Anderson Reservoir typically contains more water than this.
2. **Elevation:** The model assumed a reservoir elevation of 580 ft. This is a reasonable assumption as the historical average is 586.5 ft.
3. **Drawdown Limitation:** Anderson has a drawdown limitation to prevent erosion of 198 AF/day net release, which is less than the supply we would need (230 AF/day). However, District can increase releases from Coyote Reservoir to re-fill Anderson and maintain the 198 AF net release.

Calero Hydraulics

Scenarios: San Andreas 2A, San Andreas 2B, Calaveras A, Calaveras B

Min Demands at RWTP only, No pumps

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	457.4	109
BAILEY18	0	514	692	77.1
BAILEY30	0	514	692	77.1
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	451.6	59
CALEROCR	0	385.4	461.3	32.9
GUADCREEK	0	252.6	456	88.1
HALFRD	0	392.7	692	129.7
KIRK	0	238.3	452.4	92.8
KOOSERPOND	0	245.4	455.6	91.1
LGATVPS	0	242.8	303.6	26.3
LOWERLG	0	168	452.4	123.2
MADRONE	0	392.7	692	129.7
MAINAVE	0	380	692	135.2
MCLELLAN	0	329	451.6	53.1
PAGE	0	233	452.4	95.1
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	451.6	46.2
RODEO	0	308	451.6	62.2
ROSSCREEK	0	272.5	453.8	78.6
RWTP	33	420.2	451.2	13.4
SANPEDRO	0	345.6	692	150.1
SANTOMAS	0	269	451.6	79.1
SARATOGA	0	312	451.6	60.5
SMITHCR	0	243.5	451.6	90.2
STEVCREEK	0	288	451.6	70.9
STWTP	0	449.2	459.2	4.3
WILDCAT	0	264	451.6	81.3

Calero Hydraulics

Scenario: None, Operational Check Only

Max Demands at RWTP only, No pumps

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	445.4	103.8
BAILEY18	0	514	457.4	-24.5
BAILEY30	0	514	457.4	-24.5
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	382.3	29
CALEROCR	0	385.4	457.8	31.4
GUADCREEK	0	252.6	441.2	81.7
HALFRD	0	392.7	580	81.2
KIRK	0	238.3	349.3	48.1
KOOSERPOND	0	245.4	440	84.3
LGATVPS	0	242.8	288.5	19.8
LOWERLG	0	168	349.3	78.6
MADRONE	0	392.7	580	81.2
MAINAVE	0	380	580	86.7
MCLELLAN	0	329	382.3	23.1
PAGE	0	233	349.3	50.4
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	382.3	16.2
RODEO	0	308	382.3	32.2
ROSSCREEK	0	272.5	434.2	70.1
RWTP	61	420.2	426.1	2.5
SANPEDRO	0	345.6	580	101.6
SANTOMAS	0	269	382.3	49.1
SARATOGA	0	312	382.3	30.5
SMITHCR	0	243.5	382.3	60.1
STEVCREEK	0	288	382.3	40.9
STWTP	0	449.2	451	0.8
WILDCAT	0	264	382.3	51.3

Calero Hydraulics

Scenario: None, Operational Check Only

Max Demands at RWTP only, Vasona On

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	445.4	103.8
BAILEY18	0	514	457.4	-24.5
BAILEY30	0	514	457.4	-24.5
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	307	-3.6
CALEROCR	0	385.4	457.8	31.4
GUADCREEK	0	252.6	441.2	81.7
HALFRD	0	392.7	580	81.2
KIRK	0	238.3	430	83.1
KOOSERPOND	0	245.4	440	84.3
LGATVPS	0	242.8	347.1	45.2
LOWERLG	0	168	430	113.5
MADRONE	0	392.7	580	81.2
MAINAVE	0	380	580	86.7
MCLELLAN	0	329	307	-9.5
PAGE	0	233	430	85.4
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	307	-16.5
RODEO	0	308	307	-0.4
ROSSCREEK	0	272.5	434.2	70.1
RWTP	61	420.2	513.4	40.4
SANPEDRO	0	345.6	580	101.6
SANTOMAS	0	269	307	16.5
SARATOGA	0	312	307	-2.2
SMITHCR	0	243.5	307	27.5
STEVCREEK	0	288	307	8.2
STWTP	0	449.2	451	0.8
WILDCAT	0	264	307	18.6

Calero Hydraulics

Scenario: None; Operational Check only

Min demands at RWTP, STWTP, No pumps

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	443.6	103.1
BAILEY18	0	514	685.6	74.4
BAILEY30	0	514	685.6	74.4
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	437.8	53.1
CALEROCR	0	385.4	455.4	30.3
GUADCREEK	0	252.6	442.3	82.2
HALFRD	0	392.7	685.6	126.9
KIRK	0	238.3	438.7	86.8
KOOSERPOND	0	245.4	441.9	85.1
LGATVPS	0	242.8	294.4	22.4
LOWERLG	0	168	438.7	117.3
MADRONE	0	392.7	685.6	126.9
MAINAVE	0	380	685.6	132.4
MCLELLAN	0	329	437.8	47.2
PAGE	0	233	438.7	89.1
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	437.8	40.2
RODEO	0	308	437.8	56.3
ROSSCREEK	0	272.5	440.1	72.6
RWTP	33	420.2	437.5	7.5
SANPEDRO	0	345.6	685.6	147.3
SANTOMAS	0	269	437.8	73.2
SARATOGA	0	312	437.8	54.5
SMITHCR	0	243.5	437.8	84.2
STEVCREEK	0	288	437.8	64.9
STWTP	42	449.2	445.1	-1.8
WILDCAT	0	264	437.8	75.3

Calero Hydraulics

Scenario: None, Operational Check Only

Min Demands at STWTP, RWTP, Vasona On

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	443.6	103.1
BAILEY18	0	514	454.8	-25.6
BAILEY30	0	514	454.8	-25.6
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	319	1.6
CALEROCR	0	385.4	455.4	30.3
GUADCREEK	0	252.6	442.3	82.2
HALFRD	0	392.7	580	81.2
KIRK	0	238.3	438.7	86.8
KOOSERPOND	0	245.4	441.9	85.1
LGATVPS	0	242.8	359.4	50.5
LOWERLG	0	168	438.7	117.3
MADRONE	0	392.7	580	81.2
MAINAVE	0	380	580	86.7
MCLELLAN	0	329	319	-4.3
PAGE	0	233	438.7	89.1
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	319	-11.3
RODEO	0	308	319	4.8
ROSSCREEK	0	272.5	440.1	72.6
RWTP	33	420.2	534.4	49.5
SANPEDRO	0	345.6	580	101.6
SANTOMAS	0	269	319	21.7
SARATOGA	0	312	319	3
SMITHCR	0	243.5	319	32.7
STEVCREEK	0	288	319	13.4
STWTP	42	449.2	445.1	-1.8
WILDCAT	0	264	319	23.8

Additional operational checks regarding use of Calero Reservoir are described below:

1. **Storage:** There is typically enough storage in Calero Reservoir to supply minimum winter demands for up to 20 days (approximately 4,600 AF).
2. **Elevation:** The model assumed a reservoir elevation of 463 ft. for Calero, which is well within the historical average.

Calero Hydraulics

Scenario: None, Operational Check Only

Max Demands at STWTP, RWTP, Vasona On

	demand (MGD)	elev (ft)	head (ft)	psi
ALAMITOSCR	0	205.8	398.4	83.5
BAILEY18	0	514	435.7	-33.9
BAILEY30	0	514	435.7	-33.9
BIF	0	261.4	632	160.6
CALABAZAS	0	315.3	279	-15.7
CALEROCR	0	385.4	437.7	22.6
GUADCREEK	0	252.6	394.3	61.4
HALFRD	0	392.7	580	81.2
KIRK	0	238.3	383.1	62.7
KOOSERPOND	0	245.4	393	64
LGATVPS	0	242.8	315.6	31.5
LOWERLG	0	168	383.1	93.2
MADRONE	0	392.7	580	81.2
MAINAVE	0	380	580	86.7
MCLELLAN	0	329	279	-21.7
PAGE	0	233	383.1	65
PENPERC	0	225	475	108.3
PWTP	0	437.9	475	16.1
REGNART	0	345	279	-28.6
RODEO	0	308	279	-12.6
ROSSCREEK	0	272.5	387.3	49.8
RWTP	61	420.2	466.5	20.1
SANPEDRO	0	345.6	580	101.6
SANTOMAS	0	269	279	4.3
SARATOGA	0	312	279	-14.3
SMITHCR	0	243.5	279	15.4
STEVCREEK	0	288	279	-3.9
STWTP	83	449.2	402.9	-20.1
WILDCAT	0	264	279	6.5

Appendix 3: Delta Outage Modeling Assumptions

IRP Delta Outage Modeling Assumptions

WEAP Water Resource Management Model:

1. Scenarios[1]:
    a) 6 month Delta outage (no imported water (IW) supplies)
    b) 24 month Delta outage (no IW supplies)

2. Hydrology:
    a) "Normal" hydrology (yr 2002) for the duration of the Delta outage. This was a project team conscious choice for the project to not pile disaster upon disaster (i.e. earthquake + drought, etc.)
    b) Start in April 2002
    c) Copy 2002 hydrology for 2 years (2013 and 2014)

3. Demands:
    a) Use a 20% demand reduction phased in over three months (10%, 15%, to 20%), then in place for the entire 6 and 24 month duration.
    b) Use 2025 demands from the 2010 Urban Water Management Plan.

4. FAHCE Rule Curves:
    a) For 6 month scenario, leave FAHCE rule curves on
    b) For 24 month scenario, turn rule curves off after 6 months (or at a month where it is easily turned off).

5. Miscellaneous:
    a) Water System Improvement Program (WSIP) San Francisco Public Utility Commission (SFPUC) projects are in place (assumes reliable PUC supply).
    b) IPR Los Gatos and other WSIMP projects are turned on, EXCEPT dry year options, which should be off.
    c) SFPUC intertie is available during summer months as a source to PWTP: full capacity (40 MGD) in July – September for both years.

MODFLOW Groundwater Model

The following two assumptions were used in the MODFLOW groundwater model:

1. Modeled groundwater conditions (water levels) at the end of 2013 will be used as the initial groundwater condition to the model. Modeled groundwater conditions (storage) at end of 2013 have been used as the initial conditions to the WEAP model, to be consistent; groundwater modeling will use the same assumption.

2. The spatial pumping distribution of three model years (2002 through 2004) is assumed to be the same as actual 2013 pumping distribution, while the pumping quantity is equal to data of WEAP model results.

[1] The modeling result does not utilize any additional carryover, banked, or unused state or federal water that may exists within the system (i.e. San Luis Reservoir) from the previous year.

Appendix 4a: Water Resources Planning Modeling Results- 2025 IRP 6 Month Delta Outage, 20% Demand Reduction

Scenario: 2025 IRP 6 Month Delta Outage, 20% Demand Reduct
Model: Master WEAP Model September 2015 v009; Model Run: 11/04/2015 10:20; Model Output: 11/04/2015 10:30; Overview: ipr new overview

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Groundwater Storage (Acre-foot)														
Coyote Subbasin	16,664	17,292	17,816	18,080	18,253	18,140	17,881	17,599	17,625	18,244		17,784	19,756	16,060
Llagas Subbasin	42,212	44,327	44,127	43,497	41,894	39,882	38,428	37,566	37,981	40,977		41,489	47,300	37,566
North County Santa Clara Sbb	327,275	325,558	314,647	303,377	292,327	283,759	277,702	267,952	268,839	267,891		294,218	327,275	267,891
Sum	**386,151**	**387,177**	**376,589**	**364,954**	**352,474**	**341,781**	**334,011**	**323,118**	**324,445**	**327,112**		353,491	387,177	323,118
	0	0	0	0	0	0	0	0	0	0				
Reservoir Storage Volume (Acre-foot)														
Almaden Reservoir	1,130	1,586	1,586	1,586	100	93	88	90	100	100		631	1,586	88
Anderson Reservoir	32,274	33,047	30,271	29,013	27,452	25,817	24,263	22,793	21,000	23,019		28,262	36,445	21,000
CVP Carryover	4	0	0	0	0	0	0	0	0	0		150	1,786	0
CVP Overflow Not Used	0	0	0	0	0	0	0	0	0	0		0	0	0
Calero Reservoir	6,889	7,105	7,061	6,642	6,510	5,248	4,014	3,941	4,000	4,020		5,818	7,740	3,941
Chesbro Reservoir	6,070	6,093	5,687	4,723	4,028	3,310	2,623	1,973	1,326	710		4,063	6,418	710
Coyote Reservoir	8,721	10,946	11,067	11,068	10,857	10,523	10,266	10,042	9,195	7,100		9,414	11,068	5,200
Guadalupe Reservoir	1,645	1,511	1,354	1,354	1,317	1,209	1,101	1,003	910	604		1,343	2,132	604
Lexington Reservoir	6,754	7,107	6,868	6,515	5,978	5,183	2,369	2,148	2,000	2,000		5,367	9,002	2,000
Pacheco Reservoir	0	0	0	0	0	0	0	0	0	0		0	0	0
SWP Overflow Not Used	0	0	0	0	0	0	0	0	0	0		0	0	0
Stevens Creek Reservoir	1,665	1,890	1,840	1,840	1,824	1,649	1,484	1,331	1,182	1,182		1,670	2,321	1,182
Uvas Reservoir	7,760	7,905	7,112	5,933	5,404	4,667	3,963	3,300	2,644	2,697		5,795	9,835	2,644
semitropic reservoir	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879		195,879	195,879	195,879
swp carryover	21	0	0	0	0	0	0	0	0	0		53	589	0
Sum	**268,813**	**273,070**	**268,727**	**264,554**	**259,350**	**253,579**	**246,050**	**242,501**	**238,236**	**237,311**		258,446	276,836	237,311
	0	0	0	0	0	0	0	0	0	0				
Unmet Demand (Acre-foot)														
Penitencia WTP	0	0	2,107	2,691	3,027	0	0	0	0	0	7,825	652	3,027	0
Rinconada WTP	0	0	3,286	4,308	4,937	5,401	3,004	5,181	0	0	26,117	2,176	5,401	0
Santa Teresa WTP	0	0	4,038	5,157	5,802	6,299	5,921	5,715	0	0	32,932	2,744	6,299	0
Sum	**0**	**0**	**9,431**	**12,156**	**13,766**	**11,700**	**8,925**	**10,896**	**0**	**0**	**66,874**	5,573	13,766	0
	0	0	0	0	0	0	0	0	0	0	0			
Supply Delivered (Acre-foot)														
Penitencia WTP	1,387	1,736	0	0	0	3,286	3,089	2,982	2,543	1,980	20,175	1,681	3,286	0
Rinconada WTP	3,235	4,050	501	528	504	506	2,548	179	5,933	4,621	30,008	2,501	5,933	179
Santa Teresa WTP	2,906	3,637	0	0	0	0	0	0	5,328	4,150	22,669	1,889	5,328	0
Sum	**7,528**	**9,423**	**501**	**528**	**504**	**3,792**	**5,637**	**3,161**	**13,804**	**10,751**	**72,852**	6,071	13,804	501
	0	0	0	0	0	0	0	0	0	0	0			
Transmission Link Flow (Acre-foot)														
Transmission Link from Hetch Hetchy Intertie to Penitencia WTP	0	0	0	0	0	3,286	3,089	2,982	0	0	9,357	780	3,286	0
	0	0	0	0	0	0	0	0	0	0	0			
Streamflow (below node or reach listed) (Acre-foot)														
CVP 3 Santa Clara Conduit Bailey 0 \ Headflow	0	0	0	0	0	0	0	0	307	0	410	34	307	0
CVP Unused to Semitropic 0 \ Headflow	0	0	0	0	0	0	0	0	51	0	51	4	51	0
CVP to Anderson 0 \ Headflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CVP to Madrone Channel 0 \ Headflow	661	0	0	0	0	0	0	0	0	0	1,398	116	737	0
cvp diversion to coyote cr 0 \ Headflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cvp to expanded calero 0 \ Headflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0				
Streamflow (below node or reach listed) (Acre-foot)														
CVP Unused to Semitropic 0 \ Headflow	0	0	0	0	0	0	0	0	51	0	51	4	51	0
CVP to Madrone Channel 0 \ Headflow	661	0	0	0	0	0	0	0	0	0	1,398	116	737	0
Coyote Creek Div 36 \ Reach	3,835	326	236	161	163	94	37	16	9	30	5,202	434	3,835	0
Los Gatos Creek Div 18 \ Reach	167	184	179	184	179	184	184	0	0	179	2,424	202	615	0
	0	0	0	0	0	0	0	0	0	0				
Key Assumptions (No Unit)														
cvp alloc	0.74	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.74	4.44	0.37	0.74	0.00
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from CVP 2 Guadalupe Creek to Guadalupe Creek	0	0	0	0	0	0	0	0	430	0	552	46	430	0
Transmission Link from CVP Release to Santa Teresa WTP to Santa Teresa WTP	2,906	3,637	0	0	0	0	0	0	3,996	3,113	20,300	1,692	3,996	0
Transmission Link from CVP Turnout to Guadalupe Ponds to Alamitos and Guadalupe	0	0	0	0	0	0	0	0	476	0	614	51	476	0
Transmission Link from CVP Turnout to Kooser Ponds to Kooser Ponds	45	0	0	0	0	0	0	0	146	0	390	32	149	0
Transmission Link from CVP Turnout to Los Cap Ponds to Los Capitancillos Ponds	0	0	0	0	0	0	0	0	244	0	294	25	244	0
Transmission Link from CVP to Butterfield to Butterfield Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from CVP to SC WTP to SC WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from CVP turnout to San Pedro Ponds to San Pedro Ponds	215	238	0	0	0	0	0	0	238	230	1,396	116	238	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from Withdrawal Node 1 to cvp to coyote ck div	0	0	0	0	0	0	0	0	0	1,675	1,675	140	1,675	0
Transmission Link from Withdrawal Node 1 to new cvp to anderson	0	2,726	0	0	0	0	0	0	0	0	2,726	227	2,726	0
Transmission Link from cvp 2 Oka and Camden Ponds Withdrawal to Oka and Camden P	0	0	0	0	0	0	0	0	310	0	620	52	310	0
Transmission Link from cvp div to lp recharge to New LP Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp to rinconada to Rinconada WTP	604	809	0	0	0	0	0	0	4,450	2,619	10,117	843	4,450	0
Transmission Link from cvp to ws1 wtp to West Side 1 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp to ws2 wtp to West Side 2 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout 2 coyote ponds to Coyote Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout 2 coyote ponds to NC Coyote Pond Recharge	0	0	0	0	0	0	0	0	205	0	205	17	205	0
Transmission Link from cvp turnout 2 coyote ponds to NC Upper Coyote Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout lg creek to Los Gatos Creek Recharge	149	0	0	0	0	0	0	0	0	0	315	26	165	0
Transmission Link from cvp turnout lg ponds to Los Gatos Ponds	515	0	0	0	0	0	0	0	0	0	1,086	90	570	0
Transmission Link from cvp turnout to NC IWRP to NC IWRP recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout to church ponds to Church Ponds Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout to lower llagas to Lower Llagas Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout to main ave to Main Ave Ponds	245	161	0	0	0	0	0	0	272	263	1,213	101	272	0
Transmission Link from cvp turnout to ross creek to Ross Creek Recharge	0	0	0	0	0	0	0	0	160	0	399	33	177	0
Transmission Link from cvp turnout to west recharge nodes to Calabazas Creek Rec	0	0	0	0	0	0	0	0	0	0	4	0	4	0
Transmission Link from cvp turnout to west recharge nodes to McClellan Pond Rech	45	0	0	0	0	0	0	0	0	0	117	10	50	0
Transmission Link from cvp turnout to west recharge nodes to Regnart Creek Recha	0	0	0	0	0	0	0	0	0	0	11	1	6	0
Transmission Link from cvp turnout to west recharge nodes to Rodeo Creek Recharg	26	0	0	0	0	0	0	0	0	0	66	5	28	0
Transmission Link from cvp turnout to west recharge nodes to San Tomas Creek Rec	0	0	0	0	0	0	0	0	0	0	4	0	4	0
Transmission Link from cvp turnout to west recharge nodes to Saratoga Creek Rech	0	0	0	0	0	0	0	0	0	0	30	3	30	0
Transmission Link from cvp turnout to west recharge nodes to Stevens Creek Recha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout to west recharge nodes to Wildcat Creek Recha	0	0	0	0	0	0	0	0	0	0	19	2	16	0
Transmission Link from cvp turnout upper coyote to Coyote Upper Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**4,750**	**7,570**	**0**	**0**	**0**	**0**	**0**	**0**	**10,927**	**7,899**	**42,152**	3,513	10,927	0
	0	0	0	0	0	0	0	0	0	0				
Streamflow (below node or reach listed) (Acre-foot)														
CVP 0 Source Supply_0 \ Headflow	5,642	6,771	0	0	0	0	0	0	11,285	7,899	44,011	3,668	11,285	0
SWP 1 Supply_0 \ Headflow	3,250	3,900	0	0	0	0	0	0	6,500	4,550	25,350	2,112	6,500	0
	0	0	0	0	0	0	0	0	0	0				
Key Assumptions (No Unit)														
swp_alloc	0.65	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.65	3.90	0.33	0.65	0.00
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from SWP 2 Guadalupe Creek to Guadalupe Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from SWP Release to Santa Teresa WTP to Santa Teresa WTP	0	0	0	0	0	0	0	0	1,332	1,038	2,370	197	1,332	0
Transmission Link from SWP Turnout to Guadalupe Ponds to Alamitos and Guadalupe	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from SWP Turnout to Kooser Ponds to Kooser Ponds	45	0	0	0	0	0	0	0	0	0	94	8	50	0
Transmission Link from SWP Turnout to Los Cap Ponds to Los Capitancillos Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp 2 Oka and Camden Ponds Withdrawal to Oka and Camden P	279	0	0	0	0	0	0	0	0	0	588	49	309	0
Transmission Link from swp 2 overfelt to Overfelt Ponds	112	0	0	0	0	0	0	0	122	0	482	40	124	0
Transmission Link from swp 2 pen ponds to Penitencia Ponds	190	0	0	0	0	0	0	0	207	0	819	68	211	0
Transmission Link from swp puts to semitropic to Semitropic Put	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp to penitencia wtp to Penitencia WTP	1,387	1,736	0	0	0	0	0	0	2,543	1,980	10,818	902	2,543	0
Transmission Link from swp to rinconada to Rinconada WTP	330	2,714	0	0	0	0	0	0	1,360	1,532	6,608	551	2,714	0
Transmission Link from swp to ws1 wtp to West Side 1 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp to ws2 wtp to West Side 2 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from swp turnout lg creek to Los Gatos Creek Recharge	149	0	0	0	0	0	0	0	496	0	1,305	109	496	0
Transmission Link from swp turnout lg ponds to Los Gatos Ponds	256	0	0	0	0	0	0	0	0	0	539	45	283	0
Transmission Link from swp turnout to NC IWRP to NC IWRP recharge	280	0	0	0	0	0	0	0	305	0	1,205	100	310	0
Transmission Link from swp turnout to penitencia recharge to Penitencia Creek Re	0	0	0	0	0	0	0	0	186	0	369	31	186	0
Transmission Link from swp turnout to ross creek to Ross Creek Recharge	0	0	0	0	0	0	0	0	0	0	62	5	62	0
Transmission Link from swp turnout to west recharge nodes to Calabazas Creek Rec	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to McClellan Pond Rech	45	0	0	0	0	0	0	0	0	0	94	8	50	0
Transmission Link from swp turnout to west recharge nodes to Regnart Creek Recha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Rodeo Creek Recharg	19	0	0	0	0	0	0	0	0	0	48	4	28	0
Transmission Link from swp turnout to west recharge nodes to San Tomas Creek Rec	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Saratoga Creek Rech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Stevens Creek Recha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Wildcat Creek Recha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**3,092**	**4,450**	**0**	**0**	**0**	**0**	**0**	**0**	**6,551**	**4,550**	**25,400**	2,117	6,551	0
	0	0	0	0	0	0	0	0	0	0				
Other Supply Inflows and Outflows (Acre-foot)														
Monthly Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflow to CVP 0 Source Supply	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflow to SWP 1 Supply	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0
	0	0	0	0	0	0	0	0	0	0				
Reservoir Inflows and Outflows (Acre-foot)														
Decrease in Storage for semitropic reservoir														
Increase in Storage for semitropic reservoir	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inflow from Upstream	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Evaporation and Local Reservoir Overflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflow to Downstream	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0
	0	0	0	0	0	0	0	0	0	0				
Key Assumptions (No Unit)														
san luis storage (Thousand AF)	1,160	1,443	1,572	1,572	1,572	1,572	1,572	1,572	185	213	13,703	1,142	1,572	185
	0	0	0	0	0	0	0	0	0	0				
Water Demand (not including loss, reuse and DSM) (Acre-foot)														
Cal Water Service Area	640	801	875	1,056	1,118	1,213	1,140	1,101	1,173	914	11,494	958	1,213	640
Coyote Ag	82	171	242	311	342	371	323	254	171	88	2,465	205	371	49
Coyote Service Area	569	712	778	938	994	1,078	1,014	978	1,043	813	10,219	852	1,078	569
Gilroy Service Area	418	524	572	690	731	794	746	720	767	598	7,517	626	794	418
Great Oaks Service Area	293	367	401	484	512	556	522	505	538	419	5,267	439	556	293
Great Oaks W5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Llagas Ag	795	1,649	2,335	2,999	3,303	3,587	3,120	2,449	1,649	854	23,800	1,983	3,587	471
Milpitas Service Area	853	1,068	1,166	1,407	1,490	1,617	1,520	1,467	1,564	1,218	15,321	1,277	1,617	853
Morgan Hill Service Area	445	557	608	734	778	844	794	766	816	636	7,997	666	844	445
Mountain View Service Area	764	957	1,045	1,261	1,334	1,449	1,362	1,314	1,401	1,091	13,726	1,144	1,449	764
NC Ag	30	62	88	112	124	134	117	92	62	32	893	74	134	18
Palo Alto Service Area	727	911	995	1,200	1,270	1,379	1,297	1,251	1,334	1,039	13,068	1,089	1,379	727
Purissima Hills Service Area	173	216	237	285	302	328	308	298	317	247	3,105	259	328	173
SJ Muni North	742	929	1,014	1,224	1,296	1,406	1,322	1,277	1,361	1,060	13,330	1,111	1,406	742
SJ Muni Service Area	965	1,208	1,320	1,593	1,686	1,831	1,721	1,661	1,771	1,379	17,345	1,445	1,831	965
SJ Muni W5	20	25	27	33	34	37	35	34	36	28	354	29	37	20
SJ Water Company	7,451	9,332	10,196	12,303	13,030	14,146	13,295	12,833	13,683	10,650	133,968	11,164	14,146	7,451
San Martin Service Area	205	256	280	337	358	388	365	352	375	292	3,676	306	388	205
Santa Clara Service Area	1,714	2,146	2,344	2,827	2,994	3,250	3,054	2,949	3,143	2,448	30,790	2,566	3,250	1,714
Stanford Moffett Field Ames	310	387	423	511	541	587	552	533	568	442	5,562	463	587	310
Sunnyvale Service Area	1,406	1,760	1,922	2,319	2,455	2,666	2,506	2,418	2,578	2,008	25,254	2,105	2,666	1,406
nonAG independent pumpers	568	711	777	937	992	1,077	1,012	977	1,042	811	10,203	850	1,077	568
Sum	**19,170**	**24,749**	**27,643**	**33,559**	**35,683**	**38,738**	**36,124**	**34,228**	**35,392**	**27,068**	**355,351**	29,613	38,738	19,170
	0	0	0	0	0	0	0	0	0	0				
Unmet Demand (Acre-foot)														
Cal Water Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coyote Ag	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Coyote Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gilroy Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Oaks Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Oaks W5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Llagas Ag	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milpitas Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Morgan Hill Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mountain View Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NC Ag	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Palo Alto Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Purissima Hills Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ Muni North	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ Muni Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ Muni W5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ Water Company	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Martin Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Santa Clara Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stanford Moffett Field Ames	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunnyvale Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nonAG independent pumpers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from IPR Coyote to Coyote Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Coyote to Ford Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Coyote to IPR Coyote to Cross Valley PL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to IPR GW injection demand	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to IPR MidBasin GW Injection	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to LG IPR to Central PL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to Los Gatos Ponds	775	0	0	1,287	1,245	1,711	1,711	1,656	1,711	1,656	14,321	1,193	1,711	0
Transmission Link from IRP Sunnyvale to IPR Sunnyvale GW Injection	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**775**	**0**	**0**	**1,287**	**1,245**	**1,711**	**1,711**	**1,656**	**1,711**	**1,656**	**14,321**	1,193	1,711	0
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from lex pl 1 to Rinconada WTP	2,301	527	501	528	504	506	2,548	179	123	470	13,283	1,107	2,548	123
Transmission Link from lex pl 10 to NC IWRP recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 2 to San Tomas Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 3 to Wildcat Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 4 to Saratoga Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 5 to Rodeo Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 6 to Calabazas Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 7 to Regnart Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 8 to McClellan Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 9 to Stevens Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**2,301**	**527**	**501**	**528**	**504**	**506**	**2,548**	**179**	**123**	**470**	**13,283**	1,107	2,548	123
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from HH to Sunnyvale to Sunnyvale Service Area	550	537	700	811	1,068	1,161	1,191	1,173	1,000	817	10,158	846	1,191	537
Transmission Link from hh to PHills to Purissima Hills Service Area	100	97	127	147	194	211	216	213	181	148	1,842	153	216	97
Transmission Link from hh to milpitas service area to Milpitas Service Area	542	529	690	799	1,052	1,144	1,174	1,156	985	805	10,010	834	1,174	529
Transmission Link from hh to moffett ames to Stanford Moffett Field Ames	186	182	237	275	362	394	404	398	339	277	3,445	287	404	182
Transmission Link from hh to mountain view to Mountain View Service Area	695	678	885	1,025	1,223	1,326	1,249	1,208	1,264	980	11,975	998	1,326	678
Transmission Link from hh to palo alto to Palo Alto Service Area	683	809	927	1,126	1,193	1,294	1,218	1,177	1,259	962	12,190	1,016	1,294	683
Transmission Link from hh to santa clara to Santa Clara Service Area	277	270	353	409	538	585	600	591	504	412	5,119	427	600	270
Transmission Link from hh to sj muni n to SJ Muni North	277	270	353	409	538	585	600	591	504	412	5,118	427	600	270
Sum	**3,310**	**3,372**	**4,272**	**5,000**	**6,169**	**6,700**	**6,652**	**6,507**	**6,036**	**4,813**	**59,857**	4,988	6,700	3,310
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from lake elsman to sjw west to SJ Water Company	591	909	825	804	778	792	705	584	427	350	7,406	617	909	237
Transmission Link from stanford water to Stanford Moffett Field Ames	11	21	58	91	119	140	117	72	28	7	681	57	140	7
Sum	**602**	**930**	**883**	**895**	**897**	**932**	**822**	**656**	**455**	**357**	**8,087**	674	932	244
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from Deliver Recycled to Gilroy to Gilroy Service Area	0	15	52	101	139	170	147	90	70	29	829	69	170	0
Transmission Link from Hecker Pass Recycled to Gilroy Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Coyote to Ford Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Coyote to IPR Coyote to Cross Valley PL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Coyote to NC Coyote Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from IPR Guadalupe to Alamitos and Guadalupe Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Guadalupe to Kooser Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Guadalupe to Los Capitancillos Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to LG IPR to Central PL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to Los Gatos Ponds	775	0	0	1,287	1,245	1,711	1,711	1,656	1,711	1,656	14,321	1,193	1,711	0
Transmission Link from IPR Penitencia to Overfelt Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Penitencia to Penitencia Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IRP Sunnyvale to IPR Sunnyvale GW Injection	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Morgan Hill Recycled to Morgan Hill Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Recycled 1 to Llagas Ag	84	100	100	100	100	100	100	100	100	100	1,172	98	100	84
Transmission Link from Recycled SBWR to Milpitas to Milpitas Service Area	49	72	116	189	237	273	261	219	167	79	1,773	148	273	49
Transmission Link from Recycled SBWR to SJ Muni Edenvale to SJ Muni Service Area	82	121	196	318	399	458	439	368	281	133	2,980	248	458	82
Transmission Link from Recycled SBWR to SJ Muni North to SJ Muni North	216	319	516	815	758	821	722	686	740	350	6,434	536	821	216
Transmission Link from Recycled SBWR to SJWC to SJ Water Company	70	104	168	296	635	781	811	602	241	114	3,982	332	811	70
Transmission Link from Recycled SBWR to Santa Clara to Santa Clara Service Area	124	184	298	483	606	697	667	560	427	202	4,531	378	697	124
Transmission Link from Recycled SV to Sunnyvale to Sunnyvale Service Area	105	115	124	176	205	239	229	193	172	131	1,900	158	239	104
Transmission Link from SCRWA to Morgan Hill to Morgan Hill Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from recycle pa to palo alto to Palo Alto Service Area	44	65	68	75	77	85	78	74	75	77	840	70	85	44
Transmission Link from recycled pa to mountain view to Mountain View Service Are	64	93	97	107	111	123	113	106	108	111	1,209	101	123	64
Sum	**1,613**	**1,188**	**1,735**	**3,946**	**4,512**	**5,458**	**5,278**	**4,655**	**4,093**	**2,982**	**39,971**	3,331	5,458	1,188
	0	0	0	0	0	0	0	0	0	0				
Supply Delivered (Acre-foot)														
Cal Water Service Area	640	801	875	1,056	1,118	1,213	1,140	1,101	1,173	914	11,494	958	1,213	640
Coyote Service Area	569	712	778	938	994	1,078	1,014	978	1,043	813	10,219	852	1,078	569
Gilroy Service Area	418	524	572	690	731	794	746	720	767	598	7,517	626	794	418
Great Oaks Service Area	293	367	401	484	512	556	522	505	538	419	5,267	439	556	293
Great Oaks W5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milpitas Service Area	853	1,068	1,166	1,407	1,490	1,617	1,520	1,467	1,564	1,218	15,321	1,277	1,617	853
Morgan Hill Service Area	445	557	608	734	778	844	794	766	816	636	7,997	666	844	445
Mountain View Service Area	764	957	1,045	1,261	1,334	1,449	1,362	1,314	1,401	1,091	13,726	1,144	1,449	764
Palo Alto Service Area	727	911	995	1,200	1,270	1,379	1,297	1,251	1,334	1,039	13,068	1,089	1,379	727
Purissima Hills Service Area	173	216	237	285	302	328	308	298	317	247	3,105	259	328	173
SJ Muni North	742	929	1,014	1,224	1,296	1,406	1,322	1,277	1,361	1,060	13,330	1,111	1,406	742
SJ Muni Service Area	965	1,208	1,320	1,593	1,686	1,831	1,721	1,661	1,771	1,379	17,345	1,445	1,831	965
SJ Muni W5	20	25	27	33	34	37	35	34	36	28	354	29	37	20
SJ Water Company	7,451	9,332	10,196	12,303	13,030	14,146	13,295	12,833	13,683	10,650	133,968	11,164	14,146	7,451
San Martin Service Area	205	256	280	337	358	388	365	352	375	292	3,676	306	388	205
Santa Clara Service Area	1,714	2,146	2,344	2,827	2,994	3,250	3,054	2,949	3,143	2,448	30,790	2,566	3,250	1,714
Stanford Moffett Field Ames	310	387	423	511	541	587	552	533	568	442	5,562	463	587	310
Sunnyvale Service Area	1,406	1,760	1,922	2,319	2,455	2,666	2,506	2,418	2,578	2,008	25,254	2,105	2,666	1,406
Sum	**17,695**	**22,156**	**24,202**	**29,201**	**30,922**	**33,568**	**31,552**	**30,457**	**32,468**	**25,282**	**317,991**	26,499	33,568	17,695
	0	0	0	0	0	0	0	0	0	0				
Groundwater Natural Recharge (Acre-foot)														
Coyote Subbasin	160	303	79	114	59	64	58	50	43	355	2,402	200	976	43
Llagas Subbasin	1,858	2,375	1,303	1,435	1,187	1,118	1,111	1,095	1,130	2,614	22,085	1,840	5,134	1,095
North County Santa Clara Sbb	0	1,127	1,692	3,173	3,276	4,264	3,690	3,414	2,253	1,773	32,271	2,689	6,973	0
Sum	**2,018**	**3,806**	**3,074**	**4,722**	**4,522**	**5,445**	**4,858**	**4,558**	**3,427**	**4,742**	**56,758**	4,730	13,083	2,018
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from North County Santa Clara Sbb to Cal Water Service Area	97	122	562	670	670	727	230	922	179	139	4,541	378	922	97
Transmission Link from North County Santa Clara Sbb to Campbell Well Field	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Great Oaks Service Area	293	367	401	484	512	556	522	505	538	419	5,267	439	556	293
Transmission Link from North County Santa Clara Sbb to Milpitas Service Area	0	131	360	419	200	0	0	0	0	0	1,203	100	419	0
Transmission Link from North County Santa Clara Sbb to Mountain View Service Are	0	148	63	128	0	0	0	0	0	0	433	36	148	0
Transmission Link from North County Santa Clara Sbb to NC Ag	30	62	88	112	124	134	117	92	62	32	892	74	134	18
Transmission Link from North County Santa Clara Sbb to Palo Alto Service Area	0	37	0	0	0	0	0	0	0	0	38	3	37	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from North County Santa Clara Sbb to Purissima Hills Service A	73	119	110	138	108	117	92	85	136	99	1,263	105	138	73
Transmission Link from North County Santa Clara Sbb to Rinconada WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from North County Santa Clara Sbb to SJ Muni North	249	340	145	0	0	0	0	0	117	298	1,778	148	377	0
Transmission Link from North County Santa Clara Sbb to SJ Muni Service Area	0	0	1,125	1,275	1,288	0	0	0	0	0	3,688	307	1,288	0
Transmission Link from North County Santa Clara Sbb to SJ Water Company	2,133	2,509	9,202	11,203	11,616	10,860	10,057	10,050	4,293	3,470	81,023	6,752	11,616	2,133
Transmission Link from North County Santa Clara Sbb to Santa Clara Service Area	837	1,096	1,505	1,793	1,794	1,948	728	1,798	1,339	1,154	15,961	1,330	1,948	728
Transmission Link from North County Santa Clara Sbb to Santa Teresa WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Stanford Moffett Field Am	113	184	128	145	60	53	31	63	201	158	1,436	120	201	31
Transmission Link from North County Santa Clara Sbb to Sunnyvale Service Area	50	231	1,098	1,332	1,182	1,266	507	1,052	121	60	7,153	596	1,332	50
Transmission Link from North County Santa Clara Sbb to nonAG independent pumpers	568	711	777	937	992	1,077	1,012	977	1,042	811	10,203	850	1,077	568
Sum	**4,443**	**6,057**	**15,562**	**18,635**	**18,546**	**16,737**	**13,297**	**15,543**	**8,028**	**6,640**	**134,879**	11,240	18,635	4,443
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from Llagas Subbasin to Gilroy Service Area	418	509	520	589	592	624	599	630	697	569	6,688	557	697	418
Transmission Link from Llagas Subbasin to Llagas Ag	711	1,549	2,235	2,899	3,203	3,487	3,020	2,349	1,549	754	22,628	1,886	3,487	371
Transmission Link from Llagas Subbasin to Morgan Hill Service Area	445	557	608	734	778	844	794	766	816	636	7,997	666	844	445
Transmission Link from Llagas Subbasin to San Martin Service Area	205	256	280	337	358	388	365	352	375	292	3,676	306	388	205
Sum	**1,779**	**2,871**	**3,643**	**4,560**	**4,931**	**5,342**	**4,777**	**4,097**	**3,437**	**2,251**	**40,988**	3,416	5,342	1,532
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from Coyote Subbasin to Coyote Ag	82	171	242	311	342	371	323	254	171	88	2,465	205	371	49
Transmission Link from Coyote Subbasin to Coyote Service Area	569	712	778	938	994	1,078	1,014	978	1,043	813	10,219	852	1,078	569
Transmission Link from Coyote Subbasin to Great Oaks W5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Coyote Subbasin to SJ Muni W5	20	25	27	33	34	37	35	34	36	28	354	29	37	20
Sum	**671**	**907**	**1,046**	**1,281**	**1,370**	**1,487**	**1,372**	**1,266**	**1,250**	**930**	**13,038**	1,086	1,487	671
	0	0	0	0	0	0	0	0	0	0				
Supply Delivered (Acre-foot)														
Alamitos Creek Recharge	168	97	180	186	180	0	0	0	2	60	1,207	101	186	0
Alamitos and Guadalupe Ponds	616	0	0	682	660	682	682	75	670	219	5,650	471	682	0
Calabazas Creek Recharge	207	72	70	103	222	122	73	94	73	102	1,403	117	229	35
Calero Creek Recharge	70	78	75	78	75	78	78	9	22	25	725	60	78	9
Ford Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guadalupe Creek	543	601	582	601	582	601	601	66	601	193	6,176	515	601	66
Kooser Ponds	90	0	0	0	0	0	0	0	146	0	484	40	149	0
Los Capitancillos Ponds	224	248	180	89	86	55	0	0	244	26	1,647	137	248	0
Los Gatos Creek Recharge	300	0	0	0	0	0	0	0	496	0	1,624	135	496	0
Los Gatos Ponds	1,546	0	0	1,287	1,245	1,711	1,711	1,656	1,711	1,656	15,945	1,329	1,711	0
McClellan Pond Recharge	90	0	0	0	0	0	0	0	0	0	211	18	99	0
NC Coyote Pond Recharge	840	930	900	0	0	0	0	0	930	900	6,360	530	930	0
NC IWRP recharge	280	0	0	0	0	0	0	0	305	0	1,205	100	310	0
NC Upper Coyote Recharge	11	0	0	0	0	0	0	0	12	12	61	5	12	0
Oka and Camden Ponds	280	0	0	0	0	0	0	0	310	0	1,210	101	310	0
Overfelt Ponds	112	0	0	0	0	0	0	0	122	0	482	40	124	0
Penitencia Creek Recharge	168	0	0	186	180	76	18	0	186	4	1,190	99	186	0
Penitencia Ponds	190	0	0	0	0	0	0	0	207	0	819	68	211	0
Regnart Creek Recharge	64	17	17	19	56	22	7	14	7	19	326	27	71	7
Rodeo Creek Recharge	77	3	3	4	10	4	1	2	1	4	189	16	77	1
Ross Creek Recharge	168	39	23	55	39	30	27	24	186	40	982	82	186	23
San Tomas Creek Recharge	84	93	90	93	90	60	0	36	33	46	732	61	93	0
Saratoga Creek Recharge	398	430	280	432	426	144	102	150	138	196	3,202	267	440	67
Silver Creek Recharge	56	62	60	62	60	62	62	60	62	60	710	59	62	42
Stevens Creek Recharge	280	310	300	162	160	133	133	129	133	171	2,531	211	310	129
Thompson Creek Recharge	84	71	46	93	90	87	55	42	40	50	728	61	93	23
Wildcat Creek Recharge	55	36	33	60	59	39	0	23	22	16	413	34	60	0
lower coyote recharge	112	124	120	0	0	0	0	0	0	120	724	60	124	0
Sum	**7,112**	**3,212**	**2,959**	**4,192**	**4,220**	**3,907**	**3,551**	**2,379**	**6,661**	**3,920**	**56,937**	4,745	7,734	2,379
	0	0	0	0	0	0	0	0	0	0				
Supply Delivered (Acre-foot)														
Coyote Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coyote Upper Recharge	500	553	536	553	536	553	553	536	553	536	6,516	543	553	500
Coyote Upper Recharge 2	614	680	955	879	948	756	502	399	680	658	8,430	703	955	399
Sum	**1,114**	**1,233**	**1,490**	**1,432**	**1,484**	**1,310**	**1,056**	**934**	**1,233**	**1,193**	**14,946**	1,246	1,490	934
	0	0	0	0	0	0	0	0	0	0				

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Supply Delivered (Acre-foot)														
Butterfield Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Church Ponds Recharge	0	0	0	283	0	0	0	0	0	0	884	74	601	0
Lower Llagas Recharge	554	614	594	614	594	614	614	594	614	594	7,227	602	614	554
Madrone Ponds	667	739	715	739	715	739	739	715	739	715	8,700	725	739	667
Main Ave Ponds	245	161	0	0	0	0	0	0	272	263	1,485	124	272	0
San Pedro Ponds	215	238	0	0	0	0	0	0	238	230	1,396	116	238	0
Uvas Recharge	776	859	832	859	832	859	859	832	859	832	10,118	843	859	776
Sum	**2,458**	**2,611**	**2,141**	**2,495**	**2,141**	**2,212**	**2,212**	**2,141**	**2,722**	**2,634**	**29,810**	2,484	3,323	2,141
	0	0	0	0	0	0	0	0	0	0				
Unmet Demand (Acre-foot)														
Alamitos Creek Recharge	0	89	0	0	0	186	186	180	184	120	983	82	186	0
Alamitos and Guadalupe Ponds	0	682	660	0	0	0	0	585	12	441	2,380	198	682	0
Calabazas Creek Recharge	0	157	152	126	0	107	156	128	156	120	1,298	108	195	0
Calero Creek Recharge	0	0	0	0	0	0	0	66	55	50	188	16	66	0
Ford Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guadalupe Creek	0	0	0	0	0	0	0	516	0	389	905	75	516	0
Kooser Ponds	45	149	144	149	144	149	149	144	2	144	1,268	106	149	0
Los Capitancillos Ponds	0	0	60	159	154	193	248	240	4	214	1,273	106	248	0
Los Gatos Creek Recharge	148	496	480	496	480	496	496	480	0	480	4,216	351	496	0
Los Gatos Ponds	0	1,711	1,656	425	411	0	0	0	0	0	4,203	350	1,711	0
McClellan Pond Recharge	45	149	144	149	144	149	149	144	149	144	1,541	128	149	45
NC Coyote Pond Recharge	0	0	0	930	900	930	930	900	0	0	4,590	383	930	0
NC IWRP recharge	0	310	300	310	300	310	310	300	5	300	2,445	204	310	0
NC Upper Coyote Recharge	0	12	15	17	17	17	17	15	0	0	111	9	17	0
Oka and Camden Ponds	0	310	300	310	300	310	310	300	0	300	2,440	203	310	0
Overfelt Ponds	0	124	120	124	120	124	124	120	2	120	978	82	124	0
Penitencia Creek Recharge	0	186	180	0	0	110	168	180	0	176	1,000	83	186	0
Penitencia Ponds	0	211	204	211	204	211	211	204	3	204	1,663	139	211	0
Regnart Creek Recharge	0	54	52	52	13	49	64	55	64	50	514	43	64	0
Rodeo Creek Recharge	0	82	79	81	72	81	84	80	84	78	811	68	84	0
Ross Creek Recharge	0	147	157	131	141	156	159	156	0	140	1,208	101	159	0
San Tomas Creek Recharge	0	0	0	0	0	33	93	54	60	44	363	30	93	0
Saratoga Creek Recharge	0	10	146	8	0	296	338	276	302	230	1,981	165	373	0
Silver Creek Recharge	0	0	0	0	0	0	0	0	0	0	20	2	20	0
Stevens Creek Recharge	0	0	0	148	140	177	177	171	177	129	1,119	93	177	0
Thompson Creek Recharge	0	22	44	0	0	6	38	48	53	40	367	31	70	0
Wildcat Creek Recharge	0	24	26	0	0	21	60	35	39	42	299	25	60	0
lower coyote recharge	0	0	0	124	120	124	124	120	124	0	736	61	124	0
Sum	**237**	**4,925**	**4,919**	**3,950**	**3,660**	**4,236**	**4,591**	**5,498**	**1,476**	**3,955**	**38,898**	3,241	5,498	237
	0	0	0	0	0	0	0	0	0	0				
Unmet Demand (Acre-foot)														
Coyote Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coyote Upper Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coyote Upper Recharge 2	0	0	0	292	185	414	668	556	0	0	2,115	176	668	0
Sum	**0**	**0**	**0**	**292**	**185**	**414**	**668**	**556**	**0**	**0**	**2,115**	176	668	0
	0	0	0	0	0	0	0	0	0	0				
Unmet Demand (Acre-foot)														
Butterfield Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Church Ponds Recharge	560	620	600	337	600	620	620	600	620	600	6,416	535	620	19
Lower Llagas Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Madrone Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Main Ave Ponds	0	110	263	272	263	272	272	263	0	0	1,715	143	272	0
San Pedro Ponds	0	0	230	238	230	238	238	230	0	0	1,404	117	238	0
Uvas Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**560**	**730**	**1,093**	**847**	**1,093**	**1,130**	**1,130**	**1,093**	**620**	**600**	**9,535**	795	1,130	19
	0	0	0	0	0	0	0	0	0	0				
Streamflow (below node or reach listed) (Acre-foot)														
Coyote Creek Div 36 \ Reach	3,835	326	236	161	163	94	37	16	9	30				
Guadalupe River Div 12 \ Reach	1,283	383	179	184	800	184	184	0	0	179				
Los Gatos Creek Div 16 \ Reach	167	184	179	184	179	184	184	0	0	179				
Penitencia Creek 4 \ Reach	1,682	260	213	30	2	0	0	0	0	0				
Stevens Creek Div 10 \ Reach	413	220	200	0	0	0	0	0	0	0				
	0	0	0	0	0	0	0	0	0	0				
Streamflow (below node or reach listed) (Acre-foot)														
4 \ Reach	619	66	23	131	161	94	37	16	9	30				
	0	0	0	0	0	0	0	0	0	0				
Streamflow (below node or reach listed) (Acre-foot)														
0 \ Headflow	2,167	570	367	817	889	695	441	339	316	400				
	0	0	0	0	0	0	0	0	0	0				
Streamflow (below node or reach listed) (Cubic Feet per Second)														
Lower Coyote Creek 0 \ Headflow	0	9	1	4	0	0	0	0	0	0				

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Lower Coyote Creek 1 \ Upper Coyote Creek Inflow	1	10	5	5	1	1	1	1	12	50				
Lower Coyote Creek 2 \ Reach	1	10	5	5	1	1	1	1	12	50				
Lower Coyote Creek 3 \ CVP to Anderson Inflow	1	55	5	5	1	1	1	1	12	50				
Lower Coyote Creek 4 \ Reach	1	55	5	5	1	1	1	1	12	50				
Lower Coyote Creek 5 \ Anderson Reservoir	26	28	36	10	10	10	10	10	27	3				
Lower Coyote Creek 6 \ Reach	26	28	36	10	10	10	10	10	27	3				
Lower Coyote Creek 7 \ Coyote Creek Div Outflow	0	0	0	0	0	0	0	0	0	0				
Lower Coyote Creek 8 \ Reach	0	0	0	0	0	0	0	0	0	0				
Upper Coyote Creek 0 \ Headflow	15	38	9	4	1	0	0	0	0	17				
Upper Coyote Creek 1 \ Coyote Reservoir	1	1	4	1	1	1	1	1	12	50				
Upper Coyote Creek 2 \ Reach	1	1	4	1	1	1	1	1	12	50				
Upper Coyote Creek 3 \ Coyote Minimum Flow	1	1	4	1	1	1	1	1	12	50				
Upper Coyote Creek 4 \ Reach	1	1	4	1	1	1	1	1	12	50				
	0	0	0	0	0	0	0	0	0	0				
Supply Delivered (Acre-foot)														
Anderson PL release	0	0	0	0	0	0	0	0	0	0				
	0	0	0	0	0	0	0	0	0	0				
Streamflow (below node or reach listed) (Acre-foot)														
Los Gatos Creek 0 \ Headflow	676	1,080	499	409	226	8	0	0	3	663				
Los Gatos Creek 1 \ Lexington Reservoir	2,370	681	659	681	659	681	2,729	179	123	643				
Los Gatos Creek 3 \ exch lex and sjwc	2,370	681	659	681	659	681	2,729	179	123	643				
Los Gatos Creek 5 \ Los Gatos Creek Div Outflow	0	0	0	0	0	0	0	0	0	0				
Los Gatos Creek Div 0 \ Headflow	2,370	681	659	681	659	681	2,729	179	123	643				
Los Gatos Creek Div 1 \ FAHCE Lexington Reservoir Operations	2,370	681	659	681	659	681	2,729	179	123	643				
Los Gatos Creek Div 3 \ Lexington Minimum Flow	2,370	681	659	681	659	681	2,729	179	123	643				
Los Gatos Creek Div 5 \ Los Gatos Creek ds Accretion Inflow	2,440	702	674	703	675	688	2,732	179	123	647				
Los Gatos Creek Div 7 \ Lexington Res Pipeline Outflow	139	175	172	175	171	182	184	0	0	177				
Los Gatos Creek Div 13 \ Los Gatos Ponds Withdrawal	168	184	179	185	179	185	185	0	0	179				
Los Gatos Creek Div 15 \ Los Gatos Creek Recharge Withdrawal	167	184	179	184	179	184	184	0	0	179				
Los Gatos Creek Div 17 \ FAHCE Los Gatos Creek SF 50	167	184	179	184	179	184	184	0	0	179				
	0	0	0	0	0	0	0	0	0	0				
Streamflow (below node or reach listed) (Acre-foot)														
0 \ Headflow	2,301	527	501	528	504	506	2,548	179	123	470				
1 \ lex pl 1	0	0	0	0	0	0	0	0	0	0				
2 \ Reach	0	0	0	0	0	0	0	0	0	0				
3 \ lex pl 2	0	0	0	0	0	0	0	0	0	0				
4 \ Reach	0	0	0	0	0	0	0	0	0	0				
5 \ lex pl 3	0	0	0	0	0	0	0	0	0	0				
6 \ Reach	0	0	0	0	0	0	0	0	0	0				
7 \ lex pl 4	0	0	0	0	0	0	0	0	0	0				
8 \ Reach	0	0	0	0	0	0	0	0	0	0				
9 \ lex pl 10	0	0	0	0	0	0	0	0	0	0				
10 \ Reach	0	0	0	0	0	0	0	0	0	0				
11 \ lex pl 5	0	0	0	0	0	0	0	0	0	0				
12 \ Reach	0	0	0	0	0	0	0	0	0	0				
13 \ lex pl 11	0	0	0	0	0	0	0	0	0	0				
14 \ Reach	0	0	0	0	0	0	0	0	0	0				
15 \ lex pl 6	0	0	0	0	0	0	0	0	0	0				
16 \ Reach	0	0	0	0	0	0	0	0	0	0				
17 \ lex pl 12	0	0	0	0	0	0	0	0	0	0				
18 \ Reach	0	0	0	0	0	0	0	0	0	0				
19 \ Tributary Inflow 4	0	0	0	0	0	0	0	0	0	0				
20 \ Reach	0	0	0	0	0	0	0	0	0	0				
21 \ lex pl 7	0	0	0	0	0	0	0	0	0	0				
22 \ Reach	0	0	0	0	0	0	0	0	0	0				
23 \ lex pl 8	0	0	0	0	0	0	0	0	0	0				
24 \ Reach	0	0	0	0	0	0	0	0	0	0				
25 \ lex pl 9	0	0	0	0	0	0	0	0	0	0				
26 \ Reach	0	0	0	0	0	0	0	0	0	0				
	0	0	0	0	0	0	0	0	0	0				
Flow Requirement Reliability (Percent)														
Almaden Minimum Flow														
Anderson Minimum Flow														
Calero Minimum Flow														
Chesbro Minimum Flow														
Coyote Minimum Flow														
FAHCE 10 cfs														
FAHCE Almaden Reservoir Operations														
FAHCE Anderson Coyote Creek Golf Dr														
FAHCE Anderson Reservoir Operations														
FAHCE Calero Reservoir Operations														
FAHCE Coyote Creek Flow to Bay														

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
FAHCE Guadalupe Creek ds Masson Dam														
FAHCE Guadalupe Flow to Bay														
FAHCE Guadalupe Reservoir Operations														
FAHCE Lexington Reservoir Operations														
FAHCE Los Gatos Creek SF 50														
FAHCE Stevens Creek Flow to Bay														
FAHCE Stevens Creek Reservoir Operations														
Guadalupe Minimum Flow														
LSAA Chesbro Reservoir Operations														
LSAA Uvas Reservoir Operations														
Lexington Minimum Flow														
Madrone Channel Minimum Flow														
Stevens Creek Minimum Flow														
Unmet Instream Flow Requirement (Acre-foot)														
Almaden Minimum Flow	0	0	0	0	0	31	31	30	29	0				
Anderson Minimum Flow	0	0	0	0	0	0	0	0	0	0				
Calero Minimum Flow	0	0	0	0	0	0	0	29	0	0				
Chesbro Minimum Flow	0	0	0	0	0	0	0	0	0	0				
Coyote Minimum Flow	0	0	0	0	0	0	0	0	0	0				
FAHCE 10 cfs	0	0	0	0	0	0	0	0	0	0				
FAHCE Almaden Reservoir Operations	0	0	0	0	12,536	29,758	44,882	57,597	74,638	86,366				
FAHCE Anderson Coyote Creek Golf Dr	0	0	0	0	0	0	0	0	0	0				
FAHCE Anderson Reservoir Operations	0	0	0	0	0	0	0	0	0	0				
FAHCE Calero Reservoir Operations	0	0	0	0	0	0	0	29	0	0				
FAHCE Coyote Creek Flow to Bay	0	0	0	0	0	0	0	0	0	0				
FAHCE Guadalupe Creek ds Masson Dam	0	0	0	0	0	0	20	58	41	0				
FAHCE Guadalupe Flow to Bay	0	0	0	0	0	0	0	0	0	0				
FAHCE Guadalupe Reservoir Operations	0	0	0	0	0	0	0	0	0	0				
FAHCE Lexington Reservoir Operations	0	0	0	0	0	0	0	0	122	0				
FAHCE Los Gatos Creek SF 50	0	0	0	0	0	0	0	0	0	0				
FAHCE Stevens Creek Flow to Bay	0	0	0	0	0	0	0	0	0	0				
FAHCE Stevens Creek Reservoir Operations	0	0	0	0	0	0	0	0	0	0				
Guadalupe Minimum Flow	0	0	0	0	0	0	0	0	0	0				
LSAA Chesbro Reservoir Operations	0	0	0	0	0	0	0	0	0	0				
LSAA Uvas Reservoir Operations	0	0	0	0	0	0	0	0	0	0				
Lexington Minimum Flow	0	0	0	0	0	0	0	0	0	0				
Madrone Channel Minimum Flow	0	0	0	0	0	0	0	0	0	0				
Stevens Creek Minimum Flow	0	0	0	0	0	0	0	0	0	0				
	0	0	0	0	0	0	0	0	0	0				
Transmission Link Flow (Acre-foot)														
Transmission Link from Almaden Reservoir to Almaden Calero Canal	19	253	0	0	0	0	0	0	0	0	3,226	269	2,201	0
Transmission Link from Anderson Reservoir to Anderson PL release	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Anderson Reservoir to Anderson to Madrone Channel	6	739	715	739	715	739	739	715	739	715	7,302	609	739	2
Transmission Link from Anderson Reservoir to Butterfield Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Anderson Reservoir to Main Ave Ponds	0	0	0	0	0	0	0	0	0	0	272	23	272	0
Transmission Link from CVP 2 Guadalupe Creek to Guadalupe Creek	0	0	0	0	0	0	0	0	430	0	552	46	430	0
Transmission Link from CVP Release to Santa Teresa WTP to Santa Teresa WTP	2,906	3,637	0	0	0	0	0	0	3,996	3,113	20,300	1,692	3,996	0
Transmission Link from CVP Turnout to Guadalupe Ponds to Alamitos and Guadalupe	0	0	0	0	0	0	0	0	476	0	614	51	476	0
Transmission Link from CVP Turnout to Kooser Ponds to Kooser Ponds	45	0	0	0	0	0	0	0	146	0	390	32	149	0
Transmission Link from CVP Turnout to Los Cap Ponds to Los Capitancillos Ponds	0	0	0	0	0	0	0	0	244	0	294	25	244	0
Transmission Link from CVP to Butterfield to Butterfield Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from CVP to SC WTP to SC WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from CVP turnout to San Pedro Ponds to San Pedro Ponds	215	238	0	0	0	0	0	0	238	230	1,396	116	238	0
Transmission Link from Calero Reservoir to Calero PL release	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Campbell Well Field to Rinconada WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Coyote Subbasin to Coyote Ag	82	171	242	311	342	371	323	254	171	88	2,465	205	371	49
Transmission Link from Coyote Subbasin to Coyote Service Area	569	712	778	938	994	1,078	1,014	978	1,043	813	10,219	852	1,078	569
Transmission Link from Coyote Subbasin to Great Oaks W5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Coyote Subbasin to SJ Muni W5	20	25	27	33	34	37	35	34	36	28	354	29	37	20
Transmission Link from Coyote Subbasin to coyote outflow losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Deliver Recycled to Gilroy to Gilroy Service Area	0	15	52	101	139	170	147	90	70	29	829	69	170	0
Transmission Link from Desal to Penitencia WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Dry Year Option to Dry Year Option	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Exchange Contract to Tributary Inflow 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from HH to Sunnyvale to Sunnyvale Service Area	550	537	700	811	1,068	1,161	1,191	1,173	1,000	817	10,158	846	1,191	537

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from Hecker Pass Recycled to Gilroy Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Hetch Hetchy Intertie to Penitencia WTP	0	0	0	0	0	3,286	3,089	2,982	0	0	9,357	780	3,286	0
Transmission Link from IPR Coyote to Coyote Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Coyote to Ford Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Coyote to IPR Coyote to Cross Valley PL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Coyote to NC Coyote Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Guadalupe to Alamitos and Guadalupe Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Guadalupe to Kooser Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Guadalupe to Los Capitancillos Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to IPR GW injection demand	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to IPR MidBasin GW Injection	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to LG IPR to Central PL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Los Gatos to Los Gatos Ponds	775	0	0	1,287	1,245	1,711	1,711	1,656	1,711	1,656	14,321	1,193	1,711	0
Transmission Link from IPR Los Gatos to NC IWRP recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Penitencia to Overfelt Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IPR Penitencia to Penitencia Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from IRP Sunnyvale to IPR Sunnyvale GW Injection	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Llagas Creek to Church Ponds Recharge	0	0	0	283	0	0	0	0	0	0	283	24	283	0
Transmission Link from Llagas Subbasin to Gilroy Service Area	418	509	520	589	592	624	599	630	697	569	6,688	557	697	418
Transmission Link from Llagas Subbasin to Llagas Ag	711	1,549	2,235	2,899	3,203	3,487	3,020	2,349	1,549	754	22,628	1,886	3,487	371
Transmission Link from Llagas Subbasin to Loss to Pajaro and Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Llagas Subbasin to Morgan Hill Service Area	445	557	608	734	778	844	794	766	816	636	7,997	666	844	445
Transmission Link from Llagas Subbasin to San Martin Service Area	205	256	280	337	358	388	365	352	375	292	3,676	306	388	205
Transmission Link from Local Uvas Flood Release to Uvas to Cross Valley PL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Los Gatos Creek Recharge Withdrawal to Los Gatos Creek Re	2	0	0	0	0	0	0	0	0	0	5	0	2	0
Transmission Link from Los Gatos Ponds Withdrawal to Los Gatos Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Madrone Channel to Madrone Ponds	667	739	715	739	715	739	739	715	739	715	8,700	725	739	667
Transmission Link from Masson Dam Diversion to Los Capitancillos Ponds	66	0	0	0	0	0	0	0	0	25	348	29	198	0
Transmission Link from Masson Dam Rediversion to Los Capitancillos Ponds	158	248	180	89	86	55	0	0	0	0	1,005	84	248	0
Transmission Link from Morgan Hill Recycled to Morgan Hill Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Cal Water Service Area	97	122	562	670	670	727	230	922	179	139	4,541	378	922	97
Transmission Link from North County Santa Clara Sbb to Campbell Well Field	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Great Oaks Service Area	293	367	401	484	512	556	522	505	538	419	5,267	439	556	293
Transmission Link from North County Santa Clara Sbb to Milpitas Service Area	0	131	360	419	200	0	0	0	0	0	1,203	100	419	0
Transmission Link from North County Santa Clara Sbb to Mountain View Service Are	0	148	63	128	0	0	0	0	0	0	433	36	148	0
Transmission Link from North County Santa Clara Sbb to NC Ag	30	62	88	112	124	134	117	92	62	32	892	74	134	18
Transmission Link from North County Santa Clara Sbb to Palo Alto Service Area	0	37	0	0	0	0	0	0	0	0	38	3	37	0
Transmission Link from North County Santa Clara Sbb to Purissima Hills Service A	73	119	110	138	108	117	92	85	136	99	1,263	105	138	73
Transmission Link from North County Santa Clara Sbb to Rinconada WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from North County Santa Clara Sbb to SJ Muni North	249	340	145	0	0	0	0	0	117	298	1,778	148	377	0
Transmission Link from North County Santa Clara Sbb to SJ Muni Service Area	0	0	1,125	1,275	1,288	0	0	0	0	0	3,688	307	1,288	0
Transmission Link from North County Santa Clara Sbb to SJ Water Company	2,133	2,509	9,202	11,203	11,616	10,860	10,057	10,050	4,293	3,470	81,023	6,752	11,616	2,133
Transmission Link from North County Santa Clara Sbb to Santa Clara Service Area	837	1,096	1,505	1,793	1,794	1,948	728	1,798	1,339	1,154	15,961	1,330	1,948	728
Transmission Link from North County Santa Clara Sbb to Santa Teresa WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Stanford Moffett Field Am	113	184	128	145	60	53	31	63	201	158	1,436	120	201	31
Transmission Link from North County Santa Clara Sbb to Sunnyvale Service Area	50	231	1,098	1,332	1,182	1,266	507	1,052	121	60	7,153	596	1,332	50
Transmission Link from North County Santa Clara Sbb to nonAG independent pumpers	568	711	777	937	992	1,077	1,012	977	1,042	811	10,203	850	1,077	568
Transmission Link from North County Santa Clara Sbb to zone exchange loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Pacheco Reservoir to Pacheco to cvp	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from Penitencia to service areas to Milpitas Service Area	262	336	0	0	0	200	85	92	412	334	2,335	195	412	0
Transmission Link from Penitencia to service areas to SJ Muni Service Area	883	1,087	0	0	0	1,372	1,282	1,293	1,490	1,246	10,677	890	1,490	0
Transmission Link from Penitencia to service areas to SJ Water Company	241	313	0	0	0	1,713	1,722	1,597	641	400	7,162	597	1,722	0
Transmission Link from Recycled 1 to Llagas Ag	84	100	100	100	100	100	100	100	100	100	1,172	98	100	84
Transmission Link from Recycled SBWR to Milpitas to Milpitas Service Area	49	72	116	189	237	273	261	219	167	79	1,773	148	273	49
Transmission Link from Recycled SBWR to SJ Muni Edenvale to SJ Muni Service Area	82	121	196	318	399	458	439	368	281	133	2,980	248	458	82
Transmission Link from Recycled SBWR to SJ Muni North to SJ Muni North	216	319	516	815	758	821	722	686	740	350	6,434	536	821	216
Transmission Link from Recycled SBWR to SJWC to SJ Water Company	70	104	168	296	635	781	811	602	241	114	3,982	332	811	70
Transmission Link from Recycled SBWR to Santa Clara to Santa Clara Service Area	124	184	298	483	606	697	667	560	427	202	4,531	378	697	124
Transmission Link from Recycled SV to Sunnyvale to Sunnyvale Service Area	105	115	124	176	205	239	229	193	172	131	1,900	158	239	104
Transmission Link from Rinconada to service areas to Cal Water Service Area	543	679	313	386	448	486	910	179	994	775	6,952	579	994	179
Transmission Link from Rinconada to service areas to Mountain View Service Area	5	38	0	0	0	0	0	0	29	0	108	9	38	0
Transmission Link from Rinconada to service areas to SJ Water Company	1,510	1,860	0	0	0	0	0	0	2,752	2,166	11,725	977	2,752	0
Transmission Link from Rinconada to service areas to Santa Clara Service Area	476	596	188	142	56	20	1,060	0	873	680	5,179	432	1,060	0
Transmission Link from Rinconada to service areas to Sunnyvale Service Area	701	877	0	0	0	0	578	0	1,285	1,000	6,043	504	1,285	0
Transmission Link from SCRWA to Morgan Hill to Morgan Hill Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from SWP 2 Guadalupe Creek to Guadalupe Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from SWP Release to Santa Teresa WTP to Santa Teresa WTP	0	0	0	0	0	0	0	0	1,332	1,038	2,370	197	1,332	0
Transmission Link from SWP Turnout to Guadalupe Ponds to Alamitos and Guadalupe	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from SWP Turnout to Kooser Ponds to Kooser Ponds	45	0	0	0	0	0	0	0	0	0	94	8	50	0
Transmission Link from SWP Turnout to Los Cap Ponds to Los Capitancillos Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Santa Teresa to service areas to SJ Muni Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Santa Teresa to service areas to SJ Water Company	2,906	3,637	0	0	0	0	0	0	5,328	4,150	22,669	1,889	5,328	0
Transmission Link from Semitropic Exchange Kern NWR withdrawal to Exchange to Ke	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Shallow GW Reuse to Mountain View Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Shallow GW Reuse to SJ Water Company	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Shallow GW Reuse to Santa Clara Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Stevens Creek Recharge Withdrawal to Stevens Creek Rechar	280	310	300	162	160	133	133	129	133	171	2,531	211	310	129
Transmission Link from Test New Supply 10K to Test New Supply 10K	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Test New Supply 10K to Test New Supply 10K Res	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Uvas Release to Llagas Recharge to Church Ponds Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Uvas Reservoir to Church Ponds Recharge	0	0	0	0	0	0	0	0	0	0	601	50	601	0
Transmission Link from Uvas Reservoir to Uvas Llagas Transfer Pipeline Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from West Side Package WTPs to SJ Water Company	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from Withdrawal Node 1 to Alamitos Creek Recharge	168	97	180	186	180	0	0	0	2	60	1,207	101	186	0
Transmission Link from Withdrawal Node 1 to Coyote Upper Recharge 2	614	680	955	879	948	756	502	399	680	658	8,430	703	955	399
Transmission Link from Withdrawal Node 1 to cvp to coyote ck div	0	0	0	0	0	0	0	0	0	1,675	1,675	140	1,675	0
Transmission Link from Withdrawal Node 1 to new cvp to anderson	0	2,726	0	0	0	0	0	0	0	0	2,726	227	2,726	0
Transmission Link from cvp 2 Oka and Camden Ponds Withdrawal to Oka and Camden P	0	0	0	0	0	0	0	0	310	0	620	52	310	0
Transmission Link from cvp div to lp recharge to New LP Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp to rinconada to Rinconada WTP	604	809	0	0	0	0	0	0	4,450	2,619	10,117	843	4,450	0
Transmission Link from cvp to ws1 wtp to West Side 1 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp to ws2 wtp to West Side 2 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from cvp turnout 2 coyote ponds to Coyote Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout 2 coyote ponds to NC Coyote Pond Recharge	0	0	0	0	0	0	0	0	205	0	205	17	205	0
Transmission Link from cvp turnout 2 coyote ponds to NC Upper Coyote Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout lg creek to Los Gatos Creek Recharge	149	0	0	0	0	0	0	0	0	0	315	26	165	0
Transmission Link from cvp turnout lg ponds to Los Gatos Ponds	515	0	0	0	0	0	0	0	0	0	1,086	90	570	0
Transmission Link from cvp turnout to NC IWRP to NC IWRP recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout to church ponds to Church Ponds Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout to lower llagas to Lower Llagas Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout to main ave to Main Ave Ponds	245	161	0	0	0	0	0	0	272	263	1,213	101	272	0
Transmission Link from cvp turnout to ross creek to Ross Creek Recharge	0	0	0	0	0	0	0	0	160	0	399	33	177	0
Transmission Link from cvp turnout to west recharge nodes to Calabazas Creek Rec	0	0	0	0	0	0	0	0	0	0	4	0	4	0
Transmission Link from cvp turnout to west recharge nodes to McClellan Pond Rech	45	0	0	0	0	0	0	0	0	0	117	10	50	0
Transmission Link from cvp turnout to west recharge nodes to Regnart Creek Recha	0	0	0	0	0	0	0	0	0	0	11	1	6	0
Transmission Link from cvp turnout to west recharge nodes to Rodeo Creek Recharg	26	0	0	0	0	0	0	0	0	0	66	5	28	0
Transmission Link from cvp turnout to west recharge nodes to San Tomas Creek Rec	0	0	0	0	0	0	0	0	0	0	4	0	4	0
Transmission Link from cvp turnout to west recharge nodes to Saratoga Creek Rech	0	0	0	0	0	0	0	0	0	0	30	3	30	0
Transmission Link from cvp turnout to west recharge nodes to Stevens Creek Recha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from cvp turnout to west recharge nodes to Wildcat Creek Recha	0	0	0	0	0	0	0	0	0	0	19	2	16	0
Transmission Link from cvp turnout upper coyote to Coyote Upper Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from desal directly to sjwc to SJ Water Company	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from desal to santa clara to Santa Clara Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from exch lex and sjwc to zz exchange lex and sjwc	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from hh to PHills to Purissima Hills Service Area	100	97	127	147	194	211	216	213	181	148	1,842	153	216	97
Transmission Link from hh to milpitas service area to Milpitas Service Area	542	529	690	799	1,052	1,144	1,174	1,156	985	805	10,010	834	1,174	529
Transmission Link from hh to moffett ames to Stanford Moffett Field Ames	186	182	237	275	362	394	404	398	339	277	3,445	287	404	182
Transmission Link from hh to mountain view to Mountain View Service Area	695	678	885	1,025	1,223	1,326	1,249	1,208	1,264	980	11,975	998	1,326	678
Transmission Link from hh to palo alto to Palo Alto Service Area	683	809	927	1,126	1,193	1,294	1,218	1,177	1,259	962	12,190	1,016	1,294	683
Transmission Link from hh to santa clara to Santa Clara Service Area	277	270	353	409	538	585	600	591	504	412	5,119	427	600	270
Transmission Link from hh to sj muni n to SJ Muni North	277	270	353	409	538	585	600	591	504	412	5,118	427	600	270
Transmission Link from lake elsman to sjw west to SJ Water Company	591	909	825	804	778	792	705	584	427	350	7,406	617	909	237
Transmission Link from lex pl 1 to Rinconada WTP	2,301	527	501	528	504	506	2,548	179	123	470	13,283	1,107	2,548	123
Transmission Link from lex pl 10 to NC IWRP recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 11 to West Side 2 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 12 to West Side 1 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 2 to San Tomas Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 3 to Wildcat Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 4 to Saratoga Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 5 to Rodeo Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 6 to Calabazas Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 7 to Regnart Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 8 to McClellan Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from lex pl 9 to Stevens Creek Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from local 2 Oka and Camden Ponds Withdrawal to Oka and Camden	1	0	0	0	0	0	0	0	0	0	3	0	1	0
Transmission Link from local 2 coyote pond recharge to Coyote Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from local 2 guad creek to Guadalupe Creek	543	601	582	601	582	601	601	66	172	193	5,624	469	601	66
Transmission Link from local 2 lower coyote recharge to lower coyote recharge	112	124	120	0	0	0	0	0	0	120	724	60	124	0
Transmission Link from local 2 overfelt to Overfelt Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from local 2 pen ponds to Penitencia Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from local 2 upper coyote to NC Upper Coyote Recharge	11	0	0	0	0	0	0	0	12	12	61	5	12	0
Transmission Link from local Uvas release to recharge to Uvas Recharge	776	859	832	859	832	859	859	832	859	832	10,118	843	859	776
Transmission Link from local anderson 2 coyote ponds to NC Coyote Pond Recharge	840	930	900	0	0	0	0	0	725	900	6,155	513	930	0
Transmission Link from local anderson res to Church Ponds Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from local anderson res to Lower Llagas Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from local calabasas creek to Calabazas Creek Recharge	207	72	70	103	222	122	73	94	73	102	1,399	117	229	31
Transmission Link from local calero creek to Calero Creek Recharge	70	78	75	78	75	78	78	9	22	25	725	60	78	9
Transmission Link from local guadalupe 2 to Alamitos and Guadalupe Ponds	616	0	0	682	660	682	682	75	195	219	5,036	420	682	0
Transmission Link from local lower Llagas recharge to Lower Llagas Recharge	554	614	594	614	594	614	614	594	614	594	7,227	602	614	554
Transmission Link from local penitencia creek to Penitencia Creek Recharge	168	0	0	186	180	76	18	0	0	4	821	68	186	0
Transmission Link from local regnart creek to Regnart Creek Recharge	64	17	17	19	56	22	7	14	7	19	314	26	65	5
Transmission Link from local release 2 ford ponds to Ford Pond Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from local release 2 upper coyote to Coyote Upper Recharge	500	553	536	553	536	553	553	536	553	536	6,516	543	553	500
Transmission Link from local rodeo creek to Rodeo Creek Recharge	32	3	3	4	10	4	1	2	1	4	76	6	32	1
Transmission Link from local ross creek recharge to Ross Creek Recharge	168	39	23	55	39	30	27	24	26	40	521	43	168	9
Transmission Link from local san tomas creek to San Tomas Creek Recharge	84	93	90	93	90	60	0	36	33	46	728	61	93	0
Transmission Link from local saratoga creek to Saratoga Creek Recharge	398	430	280	432	426	144	102	150	138	196	3,172	264	440	37
Transmission Link from local saratoga div to NC IWRP recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from local silver creek to Silver Creek Recharge	56	62	60	62	60	62	62	60	62	60	710	59	62	42
Transmission Link from local stevens creek flood release to Tributary Inflow 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from local thompson creek to Thompson Creek Recharge	84	71	46	93	90	87	55	42	40	50	728	61	93	23
Transmission Link from local wildcat creek to Wildcat Creek Recharge	55	36	33	60	59	39	0	23	22	16	394	33	60	0
Transmission Link from recycle pa to palo alto to Palo Alto Service Area	44	65	68	75	77	85	78	74	75	77	840	70	85	44
Transmission Link from recycled pa to mountain view to Mountain View Service Are	64	93	97	107	111	123	113	106	108	111	1,209	101	123	64
Transmission Link from release for bank sale to Sell Bank Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from sc wtp conduit to MH to Morgan Hill Service Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from send to Pacheco Withdrawal to send to Pacheco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from stanford water to Stanford Moffett Field Ames	11	21	58	91	119	140	117	72	28	7	681	57	140	7
Transmission Link from swp 2 Oka and Camden Ponds Withdrawal to Oka and Camden P	279	0	0	0	0	0	0	0	0	0	588	49	309	0
Transmission Link from swp 2 overfelt to Overfelt Ponds	112	0	0	0	0	0	0	0	122	0	482	40	124	0
Transmission Link from swp 2 pen ponds to Penitencia Ponds	190	0	0	0	0	0	0	0	207	0	819	68	211	0
Transmission Link from swp puts to semitropic to Semitropic Put	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp to penitencia wtp to Penitencia WTP	1,387	1,736	0	0	0	0	0	0	2,543	1,980	10,818	902	2,543	0
Transmission Link from swp to rinconada to Rinconada WTP	330	2,714	0	0	0	0	0	0	1,360	1,532	6,608	551	2,714	0
Transmission Link from swp to ws1 wtp to West Side 1 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp to ws2 wtp to West Side 2 Package WTP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout lg creek to Los Gatos Creek Recharge	149	0	0	0	0	0	0	0	496	0	1,305	109	496	0
Transmission Link from swp turnout lg ponds to Los Gatos Ponds	256	0	0	0	0	0	0	0	0	0	539	45	283	0
Transmission Link from swp turnout to NC IWRP to NC IWRP recharge	280	0	0	0	0	0	0	0	305	0	1,205	100	310	0
Transmission Link from swp turnout to penitencia recharge to Penitencia Creek Re	0	0	0	0	0	0	0	0	186	0	369	31	186	0
Transmission Link from swp turnout to ross creek to Ross Creek Recharge	0	0	0	0	0	0	0	0	0	0	62	5	62	0
Transmission Link from swp turnout to west recharge nodes to Calabazas Creek Rec	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to McClellan Pond Rech	45	0	0	0	0	0	0	0	0	0	94	8	50	0
Transmission Link from swp turnout to west recharge nodes to Regnart Creek Recha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Rodeo Creek Recharg	19	0	0	0	0	0	0	0	0	0	48	4	28	0
Transmission Link from swp turnout to west recharge nodes to San Tomas Creek Rec	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Transmission Link from swp turnout to west recharge nodes to Saratoga Creek Rech	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Stevens Creek Recha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Wildcat Creek Recha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	**37,408**	**44,946**	**35,450**	**42,946**	**44,746**	**50,697**	**49,319**	**43,558**	**60,550**	**47,956**	**544,825**	45,402	60,550	35,450
	0	0	0	0	0	0	0	0	0	0				
Key Assumptions (No Unit)														
Accretional Flows Utilization Factor	0.25	0.25	0.25	0.75	1.00	1.00	1.00	1.00	1.00	0.75				
Alamitos Creek Recharge Capacity (AF)	168	186	180	186	180	186	186	180	186	180				
Alamitos and Guadalupe Ponds Recharge Capacity (AF)	616	682	660	682	660	682	682	660	682	660				
Almaden Calero Canal Capacity (CFS)	85	85	85	85	85	85	85	85	85	85				
Almaden Flood Rule Curve (Thousand AF)	1	2	2	2	2	2	2	2	2	0				
Almaden Pulse Count	1	2	2	0	0	0	0	0	0	0				
Almaden Pulse in Period	1	1	0	0	0	0	0	0	0	0				
Almaden Reservoir Estimated Evaporation (AF)	5	9	20	21	30	7	5	4	3	3				
Almaden Reservoir Inflows 90 Exceedance (AF)	514	784	487	180	111	62	44	30	15	91				
Almaden Spill Days	0	2	2	2	1	0	0	0	0	0				
Almaden Spill Volume (AF)	0	292	290	297	171	0	0	0	0	0				
Almaden Transfer Rule Curve (AF)	1,212	1,439	1,548	500	500	500	500	500	500	500				
Anderson Cold Water Volume (AF)	0	0	0	11,536	10,921	10,326	9,711	9,096	8,501	0				
Anderson Depth to Cold Water Pool (ft)	32	32	32	32	32	32	32	32	32	32				
Anderson Flood Rule Curve (Thousand AF)	0	0	0	0	0	0	0	0	0	0				
Anderson Pulse Count	0	0	0	0	0	0	0	0	0	0				
Anderson Reservoir Estimated Evaporation (AF)	83	129	221	215	310	344	262	220	139	112				
Anderson Reservoir Inflows 90 Exceedance (AF)	67	88	205	20	5	6	8	6	0	0				
Anderson Spill Days	0	0	0	0	0	0	0	0	0	0				
Anderson Spill Volume (AF)	0	0	0	0	0	0	0	0	0	0				
Anderson prev month stg (AF)	33,751	32,274	33,047	30,271	29,013	27,452	25,817	24,263	22,793	21,000				
Average Monthly Evaporation (in)	1	2	4	5	6	6	6	4	3	1				
CVP Total Supply (AF)	6,197	7,566	0	0	0	0	0	0	11,285	7,900				
Calero Creek Recharge Capacity (AF)	70	78	75	78	75	78	78	75	78	75				
Calero Flood Rule Curve (Thousand AF)	9	10	10	10	10	10	10	10	10	4				
Calero Pulse Count	1	2	2	0	0	0	0	0	0	0				
Calero Reservoir Estimated Evaporation (AF)	35	58	99	102	147	167	104	72	48	41				
Calero Reservoir Inflows 90 Exceedance (AF)	163	185	84	18	12	12	12	12	0	0				
Calero Spill Days	0	0	0	0	0	0	0	0	0	0				
Calero Spill Volume (AF)	0	0	0	0	0	0	0	0	0	0				
Calero Transfer Rule Curve (AF)	8,186	9,199	9,579	9,579	9,579	9,579	9,579	9,579	9,579	8,640				
Campbell_Well_Field_amount (MGD)	2	2	2	2	2	2	2	2	2	2				
Chesbro Diversion Rule Curve (AF)	7,039	6,515	5,939	5,336	4,732	4,129	3,515	2,911	2,317	500				
Chesbro Flood Rule Curve (Thousand AF)	8	8	8	8	8	8	8	8	5	5				
Chesbro Reservoir Estimated Evaporation (AF)	29	48	83	77	100	103	73	54	32	21				
Chesbro Reservoir Inflows 90 Exceedance (AF)	420	355	244	36	12	1	6	10	0	0				
Chesbro Transfer Rule Curve (Thousand AF)	0	0	0	0	0	0	0	0	0	0				
Conservation 13K reduction	0	0	0	0	0	0	0	0	0	0				
Conservation 28K reduction	0	0	0	0	0	0	0	0	0	0				
Coyote Flood Rule Curve (Thousand AF)	0	0	0	0	0	0	0	0	0	0				
Coyote IPR Amount (MGD)	7	7	7	7	7	7	7	7	7	7				
Coyote Reservoir Estimated Evaporation (AF)	47	76	158	162	234	271	196	164	109	93				
Coyote Reservoir Inflows 90 Exceedance (AF)	1,170	570	936	212	44	37	33	14	0	0				
Coyote Valley Agricultural Return (AF)	8	17	24	31	34	37	32	25	17	9				
Coyote Valley Deep Percolation of Precipitation (AF)	138	268	36	59	0	0	0	0	0	325				
Coyote Valley Natural Recharge (AF)	160	303	79	114	59	64	58	50	43	355				
Coyote Valley Septic Return (AF)	14	18	19	23	25	27	25	24	26	20				
Exchange Kern NWR amount (AF)	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000				
Graywater_Use_Amount (AF)	300	300	300	300	300	300	300	300	300	300				
Guadalupe Cold Water Volume (AF)	0	0	0	526	526	526	526	526	526	0				
Guadalupe Depth to Cold Water Pool (ft)	21	21	21	21	21	21	21	21	21	21				
Guadalupe Flood Rule Curve (Thousand AF)	3	3	3	3	3	3	3	3	3	2				
Guadalupe Pulse Count	0	0	0	0	0	0	0	0	0	0				
Guadalupe Recharge Capacity (AF)	543	601	582	601	582	601	601	582	601	582				
Guadalupe Reservoir Estimated Evaporation (AF)	7	10	16	15	22	26	19	15	10	8				
Guadalupe Reservoir Inflows 90 Exceedance (AF)	312	384	307	99	49	46	20	19	4	23				
Guadalupe Reservoir Max Hydraulic Capacity (CFS)	0	0	0	0	0	0	0	0	0	0				
Guadalupe Spill Days	0	0	0	0	0	0	0	0	0	0				
Guadalupe Spill Volume (AF)	0	0	0	0	0	0	0	0	0	0				
HH\milpitas	0	0	0	0	0	0	0	0	0	0				
HH\mtView	0	0	0	0	0	0	0	0	0	0				
HH\paloAlto	0	0	0	0	0	0	0	0	0	0				
HH\purissimaHills	0	0	0	0	0	0	0	0	0	0				

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
HH\santaClara	0	0	0	0	0	0	0	0	0	0				
HH\sjMuni	0	0	0	0	0	0	0	0	0	0				
HH\stanfordMoffet	0	0	0	0	0	0	0	0	0	0				
HH\sunnyvale	0	0	0	0	0	0	0	0	0	0				
IPR MidBasin Amount (MGD)	5	5	5	5	5	5	5	5	5	5				
IPR Sunnyvale Amount (MGD)	10	10	10	10	10	10	10	10	10	10				
IPR_GW_Injection_amount (MGD)	10	10	10	10	10	10	10	10	10	10				
Kooser Ponds Recharge Capacity (AF)	134	149	144	149	144	149	149	144	149	144				
Lexington Flood Rule Curve (Thousand AF)	18	19	19	19	19	19	19	17	16	14				
Lexington Pipeline Capacity (MGD)	20	20	20	20	20	20	20	20	20	20				
Lexington Reservoir Estimated Evaporation (AF)	31	46	79	82	105	122	86	42	28	20				
Lexington Reservoir Inflows 90 Exceedance (AF)	1,038	1,404	188	250	146	104	108	78	2	83				
Llagas Subbasin Mountain Front Recharge (AF)	957	991	991	991	991	991	991	991	1,000	1,000				
Llagas Subbasin Septic Return (AF)	139	158	170	175	185	115	109	92	76	45				
Llagas Subbasin Stream Seepage (AF)	115	119	11	11	11	11	11	11	54	54				
Los Capitancillos Ponds Recharge Capacity (AF)	224	248	240	248	240	248	248	240	248	240				
Los Gatos Creek to Los Gatos Ponds Max Diversion (AF)	1,546	0	0	0	0	0	1,711	0	0	1,656				
Los Gatos Div Max Diversion (AF)	55,537	681	659	681	659	681	61,488	179	246	59,504				
Los Gatos IPR Amount (AF)	20,200	20,200	20,200	20,200	20,200	20,200	20,200	20,200	20,200	20,200				
Los Gatos Ponds Monthly Recharge Capacity (AF)	1,826	2,021	1,956	2,021	1,956	2,021	2,021	1,956	2,021	1,956				
Masson Dam Diversion Available (AF)	66	0	0	0	0	0	0	0	55	0				
Masson Dam Rediversion Available (AF)	156	246	60	89	86	89	89	86	89	60				
NC_recharge_IWRP_amount (AF)	10	10	10	10	10	10	10	10	10	10				
New WSIMP CVP Ag Transfer (AF)	0	0	0	0	0	0	0	0	0	0				
New WSIMP CVP Ag Transfer Amount (AF)	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000				
New WSIMP CVP Exchange Contract Amount (AF)	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000				
New WSIMP CVP Exchange Contract in Dry Year (AF)	0	0	0	0	0	0	0	0	0	0				
New WSIMP CVP Exchange Contract in Wet Year (AF)	0	0	0	0	0	0	0	0	0	0				
Normal Monthly Import Distribution	0	0	0	0	0	0	0	0	0	0				
Pacheco Flood Rule Curve (Thousand AF)	0	0	0	0	0	0	0	0	0	0				
Pacheco Reservoir Estimated Evaporation (AF)	0	0	0	0	0	0	0	0	0	0				
Pacheco Reservoir Inflows 90 Exceedance (AF)	0	0	0	0	0	0	0	0	0	0				
Priorities\Almaden Reservoir Storage Priority	11	11	11	11	11	11	11	11	11	11				
Priorities\Anderson Reservoir Storage Priority	94	94	94	94	94	94	94	94	94	94				
Priorities\Calero Reservoir Storage Priority	10	10	10	96	96	96	96	96	96	96				
Priorities\Chesbro Reservoir Storage Priority	98	98	98	98	98	98	98	98	98	98				
Priorities\Coyote Reservoir Storage Priority	93	93	93	93	93	93	93	93	93	93				
Priorities\FAHCE Almaden Reservoir Operations Priority	10	10	10	10	10	10	10	10	10	10				
Priorities\FAHCE Anderson Reservoir Operations Priority	9	9	9	9	9	9	9	9	9	9				
Priorities\FAHCE Calero Reservoir Operations Priority	9	9	9	9	9	9	9	9	9	9				
Priorities\FAHCE Guadalupe Reservoir Operations Priority	10	10	10	10	10	10	10	10	10	10				
Priorities\FAHCE Lexington Reservoir Operations Priority	9	9	9	9	9	9	9	9	9	9				
Priorities\FAHCE Los Gatos Creek SF 50	2	2	2	2	2	2	2	2	2	2				
Priorities\FAHCE Stevens Creek Reservoir Operations Priority	9	9	9	9	9	9	9	9	9	9				
Priorities\Guadalupe Reservoir Storage Priority	11	11	11	11	11	11	11	11	11	11				
Priorities\Lexington Reservoir Storage Priority	10	10	10	10	10	10	10	10	10	10				
Priorities\Stevens Creek Reservoir Storage Priority	10	10	10	10	10	10	10	10	10	10				
Priorities\Uvas Reservoir Storage Priority	98	98	98	98	98	98	98	98	98	98				
Project triggers\Almaden_seismic_upgrade	1	1	1	1	1	1	1	1	1	1				
Project triggers\Anderson_seismic_upgrade	1	1	1	1	1	1	1	1	1	1				
Project triggers\Calero_seismic_upgrade	1	1	1	1	1	1	1	1	1	1				
Project triggers\Campbell_Well_Field	0	0	0	0	0	0	0	0	0	0				
Project triggers\Conservation 13K	0	0	0	0	0	0	0	0	0	0				
Project triggers\Conservation 28K	0	0	0	0	0	0	0	0	0	0				
Project triggers\Coyote DPR active	0	0	0	0	0	0	0	0	0	0				
Project triggers\Coyote_seismic_upgrade	0	0	0	0	0	0	0	0	0	0				
Project triggers\DOSD_fixes	0	0	0	0	0	0	0	0	0	0				
Project triggers\Delta Outage Months	6	6	6	6	6	6	6	6	6	6				
Project triggers\Exchange Kern NWR	0	0	0	0	0	0	0	0	0	0				
Project triggers\FAHCE Scenario	2	2	2	2	2	2	2	2	2	2				
Project triggers\Guadalupe_seismic_upgrade	1	1	1	1	1	1	1	1	1	1				
Project triggers\IPR_GW_Injection	0	0	0	0	0	0	0	0	0	0				
Project triggers\IPR_MidBasin_GW_Injection	0	0	0	0	0	0	0	0	0	0				
Project triggers\IPR_Sunnyvale_GW_Injection	0	0	0	0	0	0	0	0	0	0				
Project triggers\IPR_coyote	0	0	0	0	0	0	0	0	0	0				
Project triggers\IPR_guadalupe	0	0	0	0	0	0	0	0	0	0				
Project triggers\IPR_losgatos	1	1	1	1	1	1	1	1	1	1				
Project triggers\IPR_penitencia	0	0	0	0	0	0	0	0	0	0				
Project triggers\Lex PL	1	1	1	1	1	1	1	1	1	1				
Project triggers\NC_recharge_IWRP	1	1	1	1	1	1	1	1	1	1				
Project triggers\NC_recharge_SLLP	0	0	0	0	0	0	0	0	0	0				
Project triggers\NC_recycled_regional	0	0	0	0	0	0	0	0	0	0				

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
Project triggers\New Supply 10K	0	0	0	0	0	0	0	0	0	0				
Project triggers\SC_Church_Ponds	1	1	1	1	1	1	1	1	1	1				
Project triggers\SC_recharge_Butterfield\amount_af (AF)	300	300	300	300	300	300	300	300	300	300				
Project triggers\SC_recharge_upperMadrone	0	0	0	0	0	0	0	0	0	0				
Project triggers\SC_recycled_heckerpass	0	0	0	0	0	0	0	0	0	0				
Project triggers\SC_recycled_morganhill	0	0	0	0	0	0	0	0	0	0				
Project triggers\SC_recycled_scrwa_mh	0	0	0	0	0	0	0	0	0	0				
Project triggers\SC_wtp	0	0	0	0	0	0	0	0	0	0				
Project triggers\SJWC_exchange_Lex	0	0	0	0	0	0	0	0	0	0				
Project triggers\Stevens Creek accretional flows	1	1	1	1	1	1	1	1	1	1				
Project triggers\StevensCreek_Pipeline	0	0	0	0	0	0	0	0	0	0				
Project triggers\Use Accretional Flows Utilization Factor	1	1	1	1	1	1	1	1	1	1				
Project triggers\UvasRes_Pipeline	0	0	0	0	0	0	0	0	0	0				
Project triggers\WSCP Demand Reduction Flag	1	1	1	1	1	1	1	1	1	1				
Project triggers\additional_wells	0	0	0	0	0	0	0	0	0	0				
Project triggers\anderson_expansion	0	0	0	0	0	0	0	0	0	0				
Project triggers\calero_expansion	0	0	0	0	0	0	0	0	0	0				
Project triggers\dam_seismic_upgrade	1	1	1	1	1	1	1	1	1	1				
Project triggers\dry_year_option	0	0	0	0	0	0	0	0	0	0				
Project triggers\exchange_contract	0	0	0	0	0	0	0	0	0	0				
Project triggers\graywater_use	1	1	1	1	1	1	1	1	1	1				
Project triggers\new_import_contract	0	0	0	0	0	0	0	0	0	0				
Project triggers\pacheco_expansion	0	0	0	0	0	0	0	0	0	0				
Project triggers\regional_desalination	0	0	0	0	0	0	0	0	0	0				
Project triggers\semitropic_reoperations	1	1	1	1	1	1	1	1	1	1				
Project triggers\shallow_gw_reuse	0	0	0	0	0	0	0	0	0	0				
Project triggers\sri_year_type	4	4	4	4	4	4	4	4	4	4				
Project triggers\uvas_expansion	0	0	0	0	0	0	0	0	0	0				
Project triggers\westside_intertie	0	0	0	0	0	0	0	0	0	0				
Project triggers\westside_wtps	0	0	0	0	0	0	0	0	0	0				
SWP Total Supply (AF)	3,620	4,430	0	0	0	0	0	0	6,500	4,550				
San Luis Reservoir Storage Threshold For Low Point (AF)	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000				
San Luis Storage_Annual Min (Thousand AF)	185	185	185	185	185	185	185	185	185	185				
Stevens Creek Cold Water Volume (AF)	681	681	681	791	791	791	791	791	791	791				
Stevens Creek Depth to Cold Water Pool (ft)	18.10	18.10	18.10	18.10	18.10	18.10	18.10	18.10	18.10	18.10				
Stevens Creek Flood Rule Curve (Thousand AF)	3	3	3	3	3	3	3	3	3	2				
Stevens Creek Pulse Count	0	0	0	0	0	0	0	0	0	0				
Stevens Creek Recharge Capacity (AF)	280	310	300	310	300	310	310	300	310	300				
Stevens Creek Reservoir Estimated Evaporation (AF)	9	13	24	25	36	42	31	24	16	12				
Stevens Creek Reservoir Inflows 90 Exceedance (AF)	589	505	420	159	6	0	0	0	0	21				
Stevens Creek Spill Days	0	0	0	0	0	0	0	0	0	0				
Stevens Creek Spill Volume (AF)	0	0	0	0	0	0	0	0	0	0				
Uvas Creek LSAA Calculated Summer Flow (CFS)	0.00	0.00	0.00	0.00	13.60	14.00	14.00	14.00	14.00	14.00				
Uvas Reservoir Accumulated Accretion Storage Savings (AF)	0	0	0	0	238	484	730	968	1,214	1,452				
Uvas Reservoir Estimated Evaporation (AF)	32	49	86	86	106	123	89	68	41	29				
Uvas Reservoir Inflows 90 Exceedance (AF)	1,256	1,279	662	6	6	3	4	36	0	0				
Uvas Rule Curve (Thousand AF)	10	10	10	10	10	10	10	10	10	10				
Uvas Transfer Rule Curve (AF)	9,250	9,668	9,187	7,890	6,826	5,980	5,121	4,275	3,443	7,500				
Vasona Reservoir Estimated Evaporation (AF)	0	0	0	0	0	0	0	0	0	0				
WTP Assumptions\Penitencia Demands (AF)	1,387	1,736	2,107	2,691	3,027	3,286	3,089	2,982	2,543	1,980				
WTP Assumptions\Rinconada Demands (AF)	3,235	4,050	3,787	4,836	5,441	5,907	5,552	5,360	5,933	4,621				
WTP Assumptions\Santa Teresa Demands (AF)	2,906	3,637	4,038	5,157	5,802	6,299	5,921	5,715	5,328	4,150				
Water_Evaporation (in)	1.49	2.45	4.19	4.31	6.22	7.22	5.76	4.83	3.20	2.73				
Weather Demand Factor Flag	0	0	0	0	0	0	0	0	0	0				
ag acreage multiplier	2	2	2	2	2	2	2	2	2	2				
anderson cold water pool\cold water release achieved (AF)	1,444	1,599	1,547	492	476	492	492	476	492	298				
anderson cold water pool\remaining cold pool needed (AF)	0	0	0	2,951	2,460	1,984	1,492	1,000	524	0				
anderson cold water pool\total cold water pool (AF)	16,096	15,170	15,654	13,913	13,125	12,146	11,121	10,147	9,225	8,101				
anderson ds recharge capacity\min lower water evap (AF)	81	158	258	347	417	414	351	240	153	67				
anderson ds recharge capacity\recharge release achieved (AF)	1,379	944	1,164	1,556	62	60	62	62	60	1,101				
anderson ds recharge capacity\summer evap water needed (AF)	0	0	0	1,921	1,575	1,158	744	393	153	0				
anderson ds recharge capacity\total ds recharge capacity (AF)	2,072	2,294	2,520	2,790	2,700	2,790	2,790	2,520	2,294	2,220				
anderson fahce release (CFS)	26	26	26	8	8	8	8	8	8	5				
anderson rel for tw needs (AF)	0	0	8,400	8,400	7,501	5,837	4,202	2,668	0	0				
anderson release to cvp\max monthly release to cvp (AF)	0	0	0	0	0	0	0	0	0	0				
anderson release to cvp\release to cvp achieved (AF)	0	0	0	0	0	0	0	0	0	0				
anderson_buff_coef	34	33	33	31	29	28	26	24	23	21				
anderson_drawdown_limit (Thousand AF)	6	6	6	6	6	6	6	6	6	6				
below FMRC (Thousand AF)	20	15	25	45	45	45	45	45	45	32				
cc import allocations flag	1	1	1	1	1	1	1	1	1	1				
coy current ngwy (AF)	147	287	60	92	34	37	32	28	16	340				
coy near full stop recharge level (AF)	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000				

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
coy prev gw pumping (AF)	759	671	907	1,046	1,281	1,370	1,487	1,372	1,266	1,250				
coy recharge capacity (AF)	500	553	536	553	536	553	553	536	553	536				
coy remaining stg factor	1	1	1	1	1	1	1	1	1	1				
coy_storage (AF)	16,060	16,664	17,292	17,816	18,080	18,253	18,140	17,881	17,599	17,625				
coyote drainage off	1	1	1	1	1	1	1	1	1	1				
coyote prev month stg (AF)	7,976	8,721	10,946	11,067	11,068	10,857	10,523	10,266	10,042	9,195				
cvp 5th year	0	0	0	0	0	0	0	0	0	0				
cvp allocation (CFS)	102	110	0	0	0	0	0	0	184	133				
cvp max carryover p1 (Thousand AF)	20	20	20	20	20	20	20	20	20	20				
cvp_carryover (Thousand AF)	1	1	0	0	0	0	0	0	0	0				
days in month	28	31	30	31	30	31	31	30	31	30				
dec_coy_storage (AF)	15,445	15,445	15,445	15,445	15,445	15,445	15,445	15,445	15,445	15,445				
dec_demand_red_yr_count	0	0	0	0	0	0	0	0	0	0				
dec_nc_storage (AF)	322,348	322,348	322,348	322,348	322,348	322,348	322,348	322,348	322,348	322,348				
dec_sanluis_stg (Thousand AF)	370	370	370	370	370	370	370	370	370	370				
dec_sc_storage (AF)	36,394	36,394	36,394	36,394	36,394	36,394	36,394	36,394	36,394	36,394				
dec_swp_stg (Thousand AF)	0	0	0	0	0	0	0	0	0	0				
demand_reduction_count_fctr	1	1	1	1	1	1	1	1	1	1				
demand_reduction_fctr	0.00	0.00	-0.10	-0.15	-0.20	-0.20	-0.20	-0.20	0.00	0.00				
demand_reduction_yr_count	0	0	0	0	0	0	0	0	0	0				
demand_yr	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025				
five year count	2	2	2	2	2	2	2	2	2	2				
great oaks w5 pct	0	0	0	0	0	0	0	0	0	0				
lowPointYr	0	0	0	0	0	0	0	0	0	0				
lp new recharge (AF)	0	0	0	0	0	0	0	0	0	0				
max anderson ben use\current ben use (AF)	1,444	3,043	4,590	6,145	6,621	7,113	7,605	8,081	8,573	9,674				
max anderson ben use\total annual max bu (AF)	67,930	67,930	67,930	67,930	67,930	67,930	67,930	67,930	67,930	67,930				
month	2	3	4	5	6	7	8	9	10	11				
nc constant head (AF)	0	0	0	0	0	0	0	0	0	0				
nc current ngwy (AF)	0	1,127	1,692	3,241	3,587	4,733	3,775	3,638	2,253	1,773				
nc drainage off	1	1	1	1	1	1	1	1	1	1				
nc nat recharge (AF)	0	1,127	1,692	3,173	3,276	4,264	3,690	3,414	2,253	1,773				
nc near full stop recharge level (AF)	325,000	325,000	325,000	325,000	325,000	325,000	325,000	325,000	325,000	325,000				
nc pos zone exchange (AF)	0	0	0	68	311	470	85	224	0	0				
nc prev gw pumping (AF)	6,115	4,443	6,057	15,562	18,635	18,546	16,737	13,297	15,543	8,028				
nc recharge (AF)	331	300	0	0	0	0	0	0	0	496				
nc recharge capacity (AF)	5,944	6,581	6,372	6,586	6,374	6,586	6,586	6,372	6,581	6,369				
nc recharge full buffer (AF)	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000				
nc remaining stg factor	1	1	1	1	1	1	1	1	1	1				
nc_storage (AF)	324,606	327,275	325,558	314,647	303,377	292,327	283,759	277,702	267,952	268,839				
nmbr_stages	5	5	5	5	5	5	5	5	5	5				
non_contract_tw_ok	1	1	0	0	0	0	0	0	1	1				
oka camden Ponds Monthly Recharge Capacity (AF)	280	310	300	310	300	310	310	300	310	300				
rainfall	13	13	13	13	13	13	13	13	13	13				
recycled_pct\SJWC	0	0	0	0	0	0	0	0	0	0				
recycled_pct\milpitas	0	0	0	0	0	0	0	0	0	0				
recycled_pct\mountainView	1	1	1	1	1	1	1	1	1	1				
recycled_pct\paloAlto	0	0	0	0	0	0	0	0	0	0				
recycled_pct\santaClara	0	0	0	0	0	0	0	0	0	0				
recycled_pct\sjMuni	1	1	1	1	1	1	1	1	1	1				
recycled_pct\sjMuniEdenvale	0	0	0	0	0	0	0	0	0	0				
recycled_pct\sjMuniNorth	1	1	1	1	1	1	1	1	1	1				
sc current ngwy (AF)	1,904	2,398	1,367	1,547	1,361	1,318	1,377	1,389	1,420	2,808				
sc drainage flag	0	0	0	0	0	0	0	0	0	0				
sc near full stop recharge level (AF)	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000				
sc prev gw pumping (AF)	1,767	1,779	2,871	3,643	4,560	4,931	5,342	4,777	4,097	3,437				
sc recharge capacity (AF)	3,794	4,201	4,065	4,201	4,065	4,201	4,201	4,065	4,201	4,065				
sc remaining stg factor	1	1	1	1	1	1	1	1	1	1				
sc_storage (AF)	39,675	42,212	44,327	44,127	43,497	41,894	39,882	38,428	37,566	37,981				
semitropic_variables\bank_data	171	171	171	171	171	171	171	171	171	171				
semitropic_variables\cvp alloc	1	1	0	0	0	0	0	0	1	1				
semitropic_variables\cvp_supply (AF)	5,643	6,771	0	0	0	0	0	0	11,285	7,900				
semitropic_variables\dec_semitropic_storage (AF)	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879				
semitropic_variables\max take_per Month (AF)	4,922	4,922	2,625	2,625	2,625	2,625	2,625	2,625	4,922	4,922				
semitropic_variables\max_put_af (AF)	31,675	31,675	31,675	31,675	31,675	31,675	31,675	31,675	31,675	31,675				
semitropic_variables\max_put_res_top (AF)	227,554	227,554	227,554	227,554	227,554	227,554	227,554	227,554	227,554	227,554				
semitropic_variables\max_take_af (AF)	59,063	59,063	31,500	31,500	31,500	31,500	31,500	31,500	59,063	59,063				
semitropic_variables\max_take_res_bottom (AF)	136,817	136,817	164,379	164,379	164,379	164,379	164,379	164,379	136,817	136,817				
semitropic_variables\nmbr_take_months	1	1	1	1	1	1	1	1	1	1				
semitropic_variables\prev_monthly_put (AF)	0	0	0	0	0	0	0	0	0	0				
semitropic_variables\prev_monthly_take (AF)	0	0	0	0	0	0	0	0	0	0				
semitropic_variables\san luis storage (Thousand AF)	1,160	1,443	1,572	1,572	1,572	1,572	1,572	1,572	185	213				

	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Sum	Avg	Max	Min
semitropic_variables\semitropic_storage (AF)	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879	195,879				
semitropic_variables\swp_alloc	1	1	0	0	0	0	0	0	1	1				
semitropic_variables\swp_supply (AF)	3,250	3,900	0	0	0	0	0	0	6,500	4,550				
semitropic_variables\wtp_demands (AF)	7,528	9,423	9,932	12,684	14,270	15,492	14,562	14,057	13,804	10,751				
sj muni w5 pct	0	0	0	0	0	0	0	0	0	0				
stage_all	1	1	1	1	1	1	1	1	1	1				
stage_all_1_floor (AF)	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000				
stage_all_2_floor (AF)	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000				
stage_all_3_floor (AF)	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000				
stage_all_4_floor (AF)	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000				
stage_all_5_floor (AF)	0	0	0	0	0	0	0	0	0	0				
stage_coy	1	1	1	1	1	1	1	1	1	1				
stage_nc	1	1	1	1	1	2	2	2	2	2				
stage_sc	4	4	4	4	4	4	4	4	4	4				
swp 5th year	0	0	0	0	0	0	0	0	0	0				
swp max carryover p1 (Thousand AF)	20	20	20	20	20	20	20	20	20	20				
swp_carryover (Thousand AF)	0	1	0	0	0	0	0	0	0	0				
unitconversion\af2cfs	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50				
unitconversion\afd2mgd	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33				
unitconversion\afperMonth2cfs	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02				
unitconversion\cfs2af	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98				
unitconversion\cfs2afpermonth	55.54	61.49	59.51	61.49	59.51	61.49	61.49	59.51	61.49	59.51				
unitconversion\cfs2mgd	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65				
unitconversion\cubicm2af	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
unitconversion\mgd2af	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07				
unitconversion\mgd2cfs	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55				
unitconversion\mgd2cms	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04				
weather_fctr_ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
weather_fctr_mi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
wtp 5k adjustment (AF)	248	297	396	446	545	545	545	545	495	347				
z_potable reuse ramping deduction calculation	1	1	1	1	1	1	1	1	1	1				
z cvp carryover storage begin year (AF)	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786				
z cvp carryover used (AF)	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786				
z san luis full	0	0	0	0	0	0	0	0	0	0				
z swp carryover storage begin year (AF)	589	589	589	589	589	589	589	589	589	589				
z swp carryover used (AF)	589	589	589	589	589	589	589	589	589	589				
	0	0	0	0	0	0	0	0	0	0				
Reservoir Storage Volume (Acre-foot)														
deadend cvp	0	0	0	0	0	0	0	0	0	0				

Appendix 4b: Water Resources Planning Modeling Results- 2025 IRP 24 Month Delta Outage, 20% Demand Reduction

Scenario: 2025 IRP 24 Month Delta Outage, 20% Demand Reduct

NOTE: Annual values reported may be annual totals or end-of-calendar year values

Model: Master WEAP Model September 2015 v009; Model Run: 11/04/2015 10:20; Model Output: 11/04/2015 12:30; Overview: ipr new overview

	2002	2003	2004	2005
Groundwater Storage				
Coyote Subbasin	15,445	20,257	24,693	23,383
Llagas Subbasin	36,394	46,720	54,472	63,068
North County Santa Clara Sbb	322,350	255,983	191,144	196,143
Sum	**374,189**	**322,960**	**270,310**	**282,594**
	0	0	0	0
Reservoir Storage Volume				
Almaden Reservoir	882	100	100	106
Anderson Reservoir	35,573	34,450	29,817	36,887
CVP Carryover	1,786	0	0	1,786
CVP Overflow Not Used	0	0	0	0
Calero Reservoir	4,585	5,999	6,037	7,740
Chesbro Reservoir	5,800	5,800	5,800	5,800
Coyote Reservoir	5,200	5,200	5,200	5,200
Guadalupe Reservoir	2,218	2,132	2,132	2,132
Lexington Reservoir	9,002	9,618	9,618	9,002
Pacheco Reservoir	0	0	0	0
SWP Overflow Not Used	0	0	0	0
Stevens Creek Reservoir	2,321	2,321	2,321	2,321
Uvas Reservoir	9,835	9,835	9,835	9,835
semitropic reservoir	195,879	195,879	195,879	195,879
swp carryover	589	0	0	589
Sum	**273,670**	**271,334**	**266,739**	**277,277**
	0	0	0	0
Unmet Demand (Acre-foot)				
Penitencia WTP	0	13,876	18,643	5,163
Rinconada WTP	0	33,677	34,500	2,097
Santa Teresa WTP	0	44,531	53,668	9,137
Sum	**0**	**92,084**	**106,811**	**16,397**
	0	0	0	0
Supply Delivered (Acre-foot)				
Penitencia WTP	28,000	14,124	9,357	22,837
Rinconada WTP	65,329	19,206	15,829	60,678
Santa Teresa WTP	58,669	9,989	0	48,680
Sum	**151,998**	**43,319**	**25,186**	**132,195**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from Hetch Hetchy Intertie to Penitencia WTP	0	9,357	9,357	0
	0	0	0	0
Streamflow (below node or reach listed) (Acre-foot)				
CVP 3 Santa Clara Conduit Bailey 0 \ Headflow	1,523	102	0	605
CVP Unused to Semitropic 0 \ Headflow	0	0	0	0
CVP to Anderson 0 \ Headflow	0	0	0	0
CVP to Madrone Channel 0 \ Headflow	378	1,398	0	2,050
cvp diversion to coyote cr 0 \ Headflow	0	0	0	0
cvp to expanded calero 0 \ Headflow	0	0	0	0
	0	0	0	0
Streamflow (below node or reach listed) (Acre-foot)				
CVP Unused to Semitropic 0 \ Headflow	0	0	0	0
CVP to Madrone Channel 0 \ Headflow	378	1,398	0	2,050
Coyote Creek Div 36 \ Reach	5,644	5,202	3,892	5,418
Los Gatos Creek Div 18 \ Reach	1,888	1,630	0	2,067
	0	0	0	0
Key Assumptions (No Unit)				
cvp alloc	0.74	0.00	0.00	0.74
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from CVP 2 Guadalupe Creek to Guadalupe Creek	2,260	122	0	386
Transmission Link from CVP Release to Santa Teresa WTP to Santa Teresa WTP	54,738	9,989	0	44,749
Transmission Link from CVP Turnout to Guadalupe Ponds to Alamitos and Guadalupe	1,735	138	0	408
Transmission Link from CVP Turnout to Kooser Ponds to Kooser Ponds	1,215	94	0	939
Transmission Link from CVP Turnout to Los Cap Ponds to Los Capitancillos Ponds	1,324	50	0	821
Transmission Link from CVP to Butterfield to Butterfield Recharge	0	0	0	0
Transmission Link from CVP to SC WTP to SC WTP	0	0	0	0
Transmission Link from CVP turnout to San Pedro Ponds to San Pedro Ponds	2,800	690	0	1,879
Transmission Link from Withdrawal Node 1 to cvp to coyote ck div	0	0	0	1,573
Transmission Link from Withdrawal Node 1 to new cvp to anderson	0	2,726	0	4,613
Transmission Link from cvp 2 Oka and Camden Ponds Withdrawal to Oka and Camden P	1,519	310	0	610
Transmission Link from cvp div to lp recharge to New LP Recharge	0	0	0	0
Transmission Link from cvp to rinconada to Rinconada WTP	32,332	2,183	0	29,080
Transmission Link from cvp to ws1 wtp to West Side 1 Package WTP	0	0	0	0
Transmission Link from cvp to ws2 wtp to West Side 2 Package WTP	0	0	0	0

	2002	2003	2004	2005
Transmission Link from cvp turnout 2 coyote ponds to Coyote Pond Recharge	0	0	0	0
Transmission Link from cvp turnout 2 coyote ponds to NC Coyote Pond Recharge	1,028	0	0	930
Transmission Link from cvp turnout 2 coyote ponds to NC Upper Coyote Recharge	0	0	0	12
Transmission Link from cvp turnout lg creek to Los Gatos Creek Recharge	0	315	0	0
Transmission Link from cvp turnout lg ponds to Los Gatos Ponds	4,998	1,086	0	0
Transmission Link from cvp turnout to NC IWRP to NC IWRP recharge	0	0	0	0
Transmission Link from cvp turnout to church ponds to Church Ponds Recharge	0	0	0	0
Transmission Link from cvp turnout to lower llagas to Lower Llagas Recharge	0	0	0	0
Transmission Link from cvp turnout to main ave to Main Ave Ponds	0	407	0	1,600
Transmission Link from cvp turnout to ross creek to Ross Creek Recharge	1,594	62	0	1,081
Transmission Link from cvp turnout to west recharge nodes to Calabazas Creek Rec	245	0	0	204
Transmission Link from cvp turnout to west recharge nodes to McClellan Pond Rech	661	94	0	443
Transmission Link from cvp turnout to west recharge nodes to Regnart Creek Recha	116	6	0	113
Transmission Link from cvp turnout to west recharge nodes to Rodeo Creek Recharg	316	54	0	236
Transmission Link from cvp turnout to west recharge nodes to San Tomas Creek Rec	61	0	0	115
Transmission Link from cvp turnout to west recharge nodes to Saratoga Creek Rech	346	0	0	487
Transmission Link from cvp turnout to west recharge nodes to Stevens Creek Recha	1,257	0	0	0
Transmission Link from cvp turnout to west recharge nodes to Wildcat Creek Recha	79	16	0	75
Transmission Link from cvp turnout upper coyote to Coyote Upper Recharge	538	0	0	0
Sum	**109,161**	**18,342**	**0**	**90,352**
	0	0	0	0
Streamflow (below node or reach listed) (Acre-foot)				
CVP 0 Source Supply_0 \ Headflow	112,848	18,056	0	94,792
SWP 1 Supply_0 \ Headflow	64,999	10,400	0	54,599
	0	0	0	0
Key Assumptions (No Unit)				
swp_alloc	0.65	0.00	0.00	0.65
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from SWP 2 Guadalupe Creek to Guadalupe Creek	0	0	0	0
Transmission Link from SWP Release to Santa Teresa WTP to Santa Teresa WTP	3,931	0	0	3,931
Transmission Link from SWP Turnout to Guadalupe Ponds to Alamitos and Guadalupe	0	0	0	0
Transmission Link from SWP Turnout to Kooser Ponds to Kooser Ponds	0	94	0	0
Transmission Link from SWP Turnout to Los Cap Ponds to Los Capitancillos Ponds	0	0	0	0
Transmission Link from swp 2 Oka and Camden Ponds Withdrawal to Oka and Camden P	2,130	279	0	1,539
Transmission Link from swp 2 overfelt to Overfelt Ponds	1,012	236	0	782
Transmission Link from swp 2 pen ponds to Penitencia Ponds	1,721	401	0	1,330
Transmission Link from swp puts to semitropic to Semitropic Put	0	0	0	0
Transmission Link from swp to penitencia wtp to Penitencia WTP	28,000	4,767	0	22,837
Transmission Link from swp to rinconada to Rinconada WTP	25,024	3,564	0	17,370
Transmission Link from swp to ws1 wtp to West Side 1 Package WTP	0	0	0	0
Transmission Link from swp to ws2 wtp to West Side 2 Package WTP	0	0	0	0
Transmission Link from swp turnout lg creek to Los Gatos Creek Recharge	5,783	315	0	3,438
Transmission Link from swp turnout lg ponds to Los Gatos Ponds	0	539	0	0
Transmission Link from swp turnout to NC IWRP to NC IWRP recharge	0	590	0	1,955
Transmission Link from swp turnout to penitencia recharge to Penitencia Creek Re	930	0	0	827
Transmission Link from swp turnout to ross creek to Ross Creek Recharge	0	62	0	0
Transmission Link from swp turnout to west recharge nodes to Calabazas Creek Rec	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to McClellan Pond Rech	0	94	0	0
Transmission Link from swp turnout to west recharge nodes to Regnart Creek Recha	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Rodeo Creek Recharg	0	48	0	0
Transmission Link from swp turnout to west recharge nodes to San Tomas Creek Rec	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Saratoga Creek Rech	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Stevens Creek Recha	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Wildcat Creek Recha	0	0	0	0
Sum	**68,531**	**10,989**	**0**	**54,010**
	0	0	0	0
Other Supply Inflows and Outflows (Acre-foot)				
Monthly Inflow	0	0	0	0
Outflow	0	0	0	0
Outflow to CVP 0 Source Supply	0	0	0	0
Outflow to SWP 1 Supply	0	0	0	0
Sum	**0**	**0**	**0**	**0**
	0	0	0	0
Reservoir Inflows and Outflows (Acre-foot)				
Decrease in Storage for semitropic reservoir	4,121			
Increase in Storage for semitropic reservoir	0	0	0	0
Inflow from Upstream	0	0	0	0
Net Evaporation and Local Reservoir Overflow	0	0	0	0
Outflow to Downstream	-4,121	0	0	0
Sum	**0**	**0**	**0**	**0**
	0	0	0	0
Key Assumptions (No Unit)				
san luis storage (Thousand AF)	370	1,572	1,572	370
	0	0	0	0
Water Demand (not including loss, reuse and DSM) (Acre-foot)				
Cal Water Service Area	12,920	10,935	10,336	12,480
Coyote Ag	2,465	2,465	2,465	2,465
Coyote Service Area	11,487	9,722	9,190	11,096

	2002	2003	2004	2005
Gilroy Service Area	8,450	7,152	6,760	8,162
Great Oaks Service Area	5,921	5,011	4,737	5,719
Great Oaks W5	0	0	0	0
Llagas Ag	23,800	23,800	23,800	23,800
Milpitas Service Area	17,222	14,576	13,778	16,636
Morgan Hill Service Area	8,989	7,608	7,191	8,683
Mountain View Service Area	15,429	13,059	12,343	14,904
NC Ag	893	893	893	893
Palo Alto Service Area	14,690	12,433	11,752	14,190
Purissima Hills Service Area	3,490	2,954	2,792	3,371
SJ Muni North	14,984	12,682	11,987	14,474
SJ Muni Service Area	19,497	16,502	15,598	18,833
SJ Muni W5	398	337	318	384
SJ Water Company	150,930	127,444	120,444	145,491
San Martin Service Area	4,132	3,497	3,306	3,991
Santa Clara Service Area	34,611	29,294	27,689	33,432
Stanford Moffett Field Ames	6,252	5,291	5,002	6,039
Sunnyvale Service Area	28,388	24,027	22,710	27,421
nonAG independent pumpers	11,469	9,707	9,175	11,078
Sum	**396,417**	**339,390**	**322,265**	**383,544**
	0	0	0	0
Unmet Demand (Acre-foot)				
Cal Water Service Area	0	0	0	0
Coyote Ag	0	0	0	0
Coyote Service Area	0	0	0	0
Gilroy Service Area	0	0	0	0
Great Oaks Service Area	0	0	0	0
Great Oaks W5	0	0	0	0
Llagas Ag	0	0	0	0
Milpitas Service Area	0	0	0	0
Morgan Hill Service Area	0	0	0	0
Mountain View Service Area	0	0	0	0
NC Ag	0	0	0	0
Palo Alto Service Area	0	0	0	0
Purissima Hills Service Area	0	0	0	0
SJ Muni North	0	0	0	0
SJ Muni Service Area	0	0	0	0
SJ Muni W5	0	0	0	0
SJ Water Company	0	0	0	0
San Martin Service Area	0	0	0	0
Santa Clara Service Area	0	0	0	0
Stanford Moffett Field Ames	0	0	0	0
Sunnyvale Service Area	0	0	0	0
nonAG independent pumpers	0	0	0	0
Sum	**0**	**0**	**0**	**0**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from IPR Coyote to Coyote Service Area	0	0	0	0
Transmission Link from IPR Coyote to Ford Pond Recharge	0	0	0	0
Transmission Link from IPR Coyote to IPR Coyote to Cross Valley PL	0	0	0	0
Transmission Link from IPR Los Gatos to IPR GW injection demand	0	0	0	0
Transmission Link from IPR Los Gatos to IPR MidBasin GW Injection	0	0	0	0
Transmission Link from IPR Los Gatos to LG IPR to Central PL	0	0	0	0
Transmission Link from IPR Los Gatos to Los Gatos Ponds	15,150	14,321	20,148	20,148
Transmission Link from IRP Sunnyvale to IPR Sunnyvale GW Injection	0	0	0	0
Sum	**15,150**	**14,321**	**20,148**	**20,148**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from lex pl 1 to Rinconada WTP	7,973	13,459	15,829	14,228
Transmission Link from lex pl 10 to NC IWRP recharge	0	0	0	0
Transmission Link from lex pl 2 to San Tomas Creek Recharge	0	0	0	0
Transmission Link from lex pl 3 to Wildcat Creek Recharge	0	0	0	0
Transmission Link from lex pl 4 to Saratoga Creek Recharge	0	0	0	0
Transmission Link from lex pl 5 to Rodeo Creek Recharge	0	0	0	0
Transmission Link from lex pl 6 to Calabazas Creek Recharge	0	0	0	0
Transmission Link from lex pl 7 to Regnart Creek Recharge	0	0	0	0
Transmission Link from lex pl 8 to McClellan Pond Recharge	0	0	0	0
Transmission Link from lex pl 9 to Stevens Creek Recharge	1	0	0	0
Sum	**7,974**	**13,459**	**15,829**	**14,228**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from HH to Sunnyvale to Sunnyvale Service Area	10,158	10,158	10,158	10,158
Transmission Link from hh to PHills to Purissima Hills Service Area	1,842	1,842	1,842	1,842
Transmission Link from hh to milpitas service area to Milpitas Service Area	10,010	10,010	10,010	10,010
Transmission Link from hh to moffett ames to Stanford Moffett Field Ames	3,445	3,445	3,445	3,445
Transmission Link from hh to mountain view to Mountain View Service Area	12,806	11,337	11,079	12,570
Transmission Link from hh to palo alto to Palo Alto Service Area	13,518	11,555	10,911	13,234
Transmission Link from hh to santa clara to Santa Clara Service Area	5,119	5,119	5,119	5,119
Transmission Link from hh to sj muni n to SJ Muni North	5,118	5,118	5,118	5,118

	2002	2003	2004	2005
Sum	**62,015**	**58,584**	**57,682**	**61,496**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from lake elsman to sjw west to SJ Water Company	7,406	7,406	7,406	7,406
Transmission Link from stanford water to Stanford Moffett Field Ames	681	681	681	681
Sum	**8,087**	**8,087**	**8,087**	**8,087**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from Deliver Recycled to Gilroy to Gilroy Service Area	829	829	829	829
Transmission Link from Hecker Pass Recycled to Gilroy Service Area	0	0	0	0
Transmission Link from IPR Coyote to Ford Pond Recharge	0	0	0	0
Transmission Link from IPR Coyote to IPR Coyote to Cross Valley PL	0	0	0	0
Transmission Link from IPR Coyote to NC Coyote Pond Recharge	0	0	0	0
Transmission Link from IPR Guadalupe to Alamitos and Guadalupe Ponds	0	0	0	0
Transmission Link from IPR Guadalupe to Kooser Ponds	0	0	0	0
Transmission Link from IPR Guadalupe to Los Capitancillos Ponds	0	0	0	0
Transmission Link from IPR Los Gatos to LG IPR to Central PL	0	0	0	0
Transmission Link from IPR Los Gatos to Los Gatos Ponds	15,150	14,321	20,148	20,148
Transmission Link from IPR Penitencia to Overfelt Ponds	0	0	0	0
Transmission Link from IPR Penitencia to Penitencia Ponds	0	0	0	0
Transmission Link from IRP Sunnyvale to IPR Sunnyvale GW Injection	0	0	0	0
Transmission Link from Morgan Hill Recycled to Morgan Hill Service Area	0	0	0	0
Transmission Link from Recycled 1 to Llagas Ag	1,172	1,172	1,172	1,172
Transmission Link from Recycled SBWR to Milpitas to Milpitas Service Area	1,773	1,773	1,773	1,773
Transmission Link from Recycled SBWR to SJ Muni Edenvale to SJ Muni Service Area	3,251	2,980	2,980	2,980
Transmission Link from Recycled SBWR to SJ Muni North to SJ Muni North	7,521	6,278	6,206	7,717
Transmission Link from Recycled SBWR to SJWC to SJ Water Company	2,624	4,138	4,210	2,699
Transmission Link from Recycled SBWR to Santa Clara to Santa Clara Service Area	4,531	4,531	4,531	4,531
Transmission Link from Recycled SV to Sunnyvale to Sunnyvale Service Area	1,900	1,900	1,900	1,900
Transmission Link from SCRWA to Morgan Hill to Morgan Hill Service Area	0	0	0	0
Transmission Link from recycle pa to palo alto to Palo Alto Service Area	1,056	840	840	840
Transmission Link from recycled pa to mountain view to Mountain View Service Are	994	1,209	1,209	1,209
Sum	**40,800**	**39,971**	**45,799**	**45,799**
	0	0	0	0
Supply Delivered (Acre-foot)				
Cal Water Service Area	12,920	10,935	10,336	12,480
Coyote Service Area	11,487	9,722	9,190	11,096
Gilroy Service Area	8,450	7,152	6,760	8,162
Great Oaks Service Area	5,921	5,011	4,737	5,719
Great Oaks W5	0	0	0	0
Milpitas Service Area	17,222	14,576	13,778	16,636
Morgan Hill Service Area	8,989	7,608	7,191	8,683
Mountain View Service Area	15,429	13,059	12,343	14,904
Palo Alto Service Area	14,690	12,433	11,752	14,190
Purissima Hills Service Area	3,490	2,954	2,792	3,371
SJ Muni North	14,984	12,682	11,987	14,474
SJ Muni Service Area	19,497	16,502	15,598	18,833
SJ Muni W5	398	337	318	384
SJ Water Company	150,930	127,444	120,444	145,491
San Martin Service Area	4,132	3,497	3,306	3,991
Santa Clara Service Area	34,611	29,294	27,689	33,432
Stanford Moffett Field Ames	6,252	5,291	5,002	6,039
Sunnyvale Service Area	28,388	24,027	22,710	27,421
Sum	**357,790**	**302,525**	**285,932**	**345,308**
	0	0	0	0
Groundwater Natural Recharge (Acre-foot)				
Coyote Subbasin	2,434	2,390	2,376	2,424
Llagas Subbasin	23,643	22,085	22,085	22,085
North County Santa Clara Sbb	32,271	32,271	32,271	32,271
Sum	**58,347**	**56,746**	**56,732**	**56,780**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from North County Santa Clara Sbb to Cal Water Service Area	1,972	5,319	5,743	1,636
Transmission Link from North County Santa Clara Sbb to Campbell Well Field	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Great Oaks Service Area	5,921	5,011	4,737	5,719
Transmission Link from North County Santa Clara Sbb to Milpitas Service Area	452	1,500	1,618	782
Transmission Link from North County Santa Clara Sbb to Mountain View Service Are	1,103	433	54	727
Transmission Link from North County Santa Clara Sbb to NC Ag	892	892	892	892
Transmission Link from North County Santa Clara Sbb to Palo Alto Service Area	116	38	0	115
Transmission Link from North County Santa Clara Sbb to Purissima Hills Service A	1,648	1,112	950	1,529
Transmission Link from North County Santa Clara Sbb to Rinconada WTP	0	0	0	0
Transmission Link from North County Santa Clara Sbb to SJ Muni North	2,345	1,286	663	1,639
Transmission Link from North County Santa Clara Sbb to SJ Muni Service Area	0	6,543	8,671	2,368
Transmission Link from North County Santa Clara Sbb to SJ Water Company	45,364	94,006	100,691	55,228
Transmission Link from North County Santa Clara Sbb to Santa Clara Service Area	15,352	15,714	14,037	14,175
Transmission Link from North County Santa Clara Sbb to Santa Teresa WTP	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Stanford Moffett Field Am	2,126	1,166	876	1,913
Transmission Link from North County Santa Clara Sbb to Sunnyvale Service Area	2,185	8,442	6,523	1,731
Transmission Link from North County Santa Clara Sbb to nonAG independent pumpers	11,469	9,707	9,175	11,078

	2002	2003	2004	2005
Sum	**90,946**	**151,170**	**154,631**	**99,535**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from Llagas Subbasin to Gilroy Service Area	7,621	6,323	5,931	7,333
Transmission Link from Llagas Subbasin to Llagas Ag	22,628	22,628	22,628	22,628
Transmission Link from Llagas Subbasin to Morgan Hill Service Area	8,989	7,608	7,191	8,683
Transmission Link from Llagas Subbasin to San Martin Service Area	4,132	3,497	3,306	3,991
Sum	**43,370**	**40,056**	**39,056**	**42,636**
	0	0	0	0
Transmission Link Flow (Acre-foot)				
Transmission Link from Coyote Subbasin to Coyote Ag	2,465	2,465	2,465	2,465
Transmission Link from Coyote Subbasin to Coyote Service Area	11,487	9,722	9,190	11,096
Transmission Link from Coyote Subbasin to Great Oaks W5	0	0	0	0
Transmission Link from Coyote Subbasin to SJ Muni W5	398	337	318	384
Sum	**14,350**	**12,524**	**11,973**	**13,945**
	0	0	0	0
Supply Delivered (Acre-foot)				
Alamitos Creek Recharge	1,307	1,146	611	778
Alamitos and Guadalupe Ponds	6,927	6,103	8,030	7,560
Calabazas Creek Recharge	1,643	1,399	1,399	1,602
Calero Creek Recharge	590	639	480	658
Ford Pond Recharge	0	0	0	0
Guadalupe Creek	6,838	5,382	4,027	5,490
Kooser Ponds	1,215	189	0	939
Los Capitancillos Ponds	2,035	1,272	627	2,116
Los Gatos Creek Recharge	5,840	634	50	3,470
Los Gatos Ponds	20,148	15,945	20,148	20,148
McClellan Pond Recharge	661	189	0	443
NC Coyote Pond Recharge	9,973	6,360	9,265	8,190
NC IWRP recharge	0	590	0	1,955
NC Upper Coyote Recharge	172	61	160	139
Oka and Camden Ponds	3,650	592	31	2,169
Overfelt Ponds	1,012	236	0	782
Penitencia Creek Recharge	2,117	821	1,187	2,014
Penitencia Ponds	1,721	401	0	1,330
Regnart Creek Recharge	431	320	314	427
Rodeo Creek Recharge	392	177	76	311
Ross Creek Recharge	2,115	645	521	1,601
San Tomas Creek Recharge	788	728	728	842
Saratoga Creek Recharge	3,518	3,172	3,172	3,659
Silver Creek Recharge	710	710	710	710
Stevens Creek Recharge	3,650	2,837	3,650	2,765
Thompson Creek Recharge	728	728	728	728
Wildcat Creek Recharge	472	410	394	468
lower coyote recharge	972	848	1,216	968
Sum	**79,625**	**52,531**	**57,522**	**72,263**
	0	0	0	0
Supply Delivered (Acre-foot)				
Coyote Pond Recharge	0	0	0	0
Coyote Upper Recharge	6,516	6,516	6,516	6,190
Coyote Upper Recharge 2	10,546	8,430	7,517	4,020
Sum	**17,061**	**14,946**	**14,033**	**10,211**
	0	0	0	0
Supply Delivered (Acre-foot)				
Butterfield Recharge	0	0	0	0
Church Ponds Recharge	0	884	283	283
Lower Llagas Recharge	4,704	7,227	7,227	7,227
Madrone Ponds	8,700	8,700	7,095	8,039
Main Ave Ponds	3,200	679	0	1,600
San Pedro Ponds	2,800	690	0	1,879
Uvas Recharge	10,118	10,118	10,118	10,118
Sum	**29,521**	**28,298**	**24,722**	**29,146**
	0	0	0	0
Unmet Demand (Acre-foot)				
Alamitos Creek Recharge	883	1,044	1,579	1,412
Alamitos and Guadalupe Ponds	1,103	1,927	0	470
Calabazas Creek Recharge	1,058	1,302	1,302	1,099
Calero Creek Recharge	322	274	433	255
Ford Pond Recharge	0	0	0	0
Guadalupe Creek	243	1,699	3,054	1,591
Kooser Ponds	537	1,563	1,752	813
Los Capitancillos Ponds	885	1,648	2,293	804
Los Gatos Creek Recharge	0	5,206	5,790	2,370
Los Gatos Ponds	0	4,203	0	0
McClellan Pond Recharge	1,091	1,563	1,752	1,309
NC Coyote Pond Recharge	977	4,590	1,685	2,760
NC IWRP recharge	0	3,060	3,650	1,695
NC Upper Coyote Recharge	0	111	12	32
Oka and Camden Ponds	0	3,058	3,619	1,481

	2002	2003	2004	2005
Overfelt Ponds	448	1,224	1,460	678
Penitencia Creek Recharge	73	1,369	1,003	176
Penitencia Ponds	761	2,081	2,482	1,152
Regnart Creek Recharge	409	519	525	412
Rodeo Creek Recharge	608	823	924	689
Ross Creek Recharge	75	1,545	1,669	589
San Tomas Creek Recharge	307	367	367	253
Saratoga Creek Recharge	1,665	2,011	2,011	1,524
Silver Creek Recharge	20	20	20	20
Stevens Creek Recharge	0	813	0	885
Thompson Creek Recharge	367	367	367	367
Wildcat Creek Recharge	240	302	318	244
lower coyote recharge	488	612	244	492
Sum	**12,559**	**43,303**	**38,313**	**23,572**
	0	0	0	0
Unmet Demand (Acre-foot)				
Coyote Pond Recharge	0	0	0	0
Coyote Upper Recharge	0	0	0	325
Coyote Upper Recharge 2	0	2,115	3,029	3,695
Sum	**0**	**2,115**	**3,029**	**4,020**
	0	0	0	0
Unmet Demand (Acre-foot)				
Butterfield Recharge	0	0	0	0
Church Ponds Recharge	7,300	6,416	7,017	7,017
Lower Llagas Recharge	2,523	0	0	0
Madrone Ponds	0	0	1,605	661
Main Ave Ponds	0	2,521	3,200	1,600
San Pedro Ponds	0	2,109	2,800	920
Uvas Recharge	0	0	0	0
Sum	**9,823**	**11,047**	**14,622**	**10,198**
	0	0	0	0
Streamflow (below node or reach listed) (Acre-foot)				
Coyote Creek Div 36 \ Reach	5,644	5,202	3,892	5,418
Guadalupe River Div 12 \ Reach	2,949	5,580	3,188	4,046
Los Gatos Creek Div 16 \ Reach	1,888	1,630	0	2,067
Penitencia Creek 4 \ Reach	2,095	2,461	2,095	2,095
Stevens Creek Div 10 \ Reach	819	1,533	0	1,066
	0	0	0	0
Streamflow (below node or reach listed) (Acre-foot)				
4 \ Reach	1,206	1,206	1,206	1,206
	0	0	0	0
Streamflow (below node or reach listed) (Acre-foot)				
0 \ Headflow	7,556	7,556	7,556	7,556
	0	0	0	0
Streamflow (below node or reach listed) (Cubic Feet per Second)				
Lower Coyote Creek 0 \ Headflow	7	7	7	7
Lower Coyote Creek 1 \ Upper Coyote Creek Inflow	40	30	31	30
Lower Coyote Creek 2 \ Reach	40	30	31	30
Lower Coyote Creek 3 \ CVP to Anderson Inflow	40	34	31	37
Lower Coyote Creek 4 \ Reach	40	34	31	37
Lower Coyote Creek 5 \ Anderson Reservoir	30	22	24	16
Lower Coyote Creek 6 \ Reach	30	22	24	16
Lower Coyote Creek 7 \ Coyote Creek Div Outflow	0	0	0	0
Lower Coyote Creek 8 \ Reach	0	0	0	0
Upper Coyote Creek 0 \ Headflow	26	26	26	26
Upper Coyote Creek 1 \ Coyote Reservoir	33	23	24	23
Upper Coyote Creek 2 \ Reach	33	23	24	23
Upper Coyote Creek 3 \ Coyote Minimum Flow	33	23	24	23
Upper Coyote Creek 4 \ Reach	33	23	24	23
	0	0	0	0
Supply Delivered (Acre-foot)				
Anderson PL release	0	0	0	0
	0	0	0	0
Streamflow (below node or reach listed) (Acre-foot)				
Los Gatos Creek 0 \ Headflow	16,129	16,129	16,129	16,129
Los Gatos Creek 1 \ Lexington Reservoir	9,670	14,847	15,659	16,096
Los Gatos Creek 3 \ exch lex and sjwc	9,670	14,847	15,659	16,096
Los Gatos Creek 5 \ Los Gatos Creek Div Outflow	0	0	0	0
Los Gatos Creek Div 0 \ Headflow	9,670	14,847	15,659	16,096
Los Gatos Creek Div 1 \ FAHCE Lexington Reservoir Operations	9,670	14,847	15,659	16,096
Los Gatos Creek Div 3 \ Lexington Minimum Flow	9,670	14,847	15,659	16,096
Los Gatos Creek Div 5 \ Los Gatos Creek ds Accretion Inflow	9,845	15,023	15,835	16,271
Los Gatos Creek Div 7 \ Lexington Res Pipeline Outflow	1,871	1,563	6	2,044
Los Gatos Creek Div 13 \ Los Gatos Ponds Withdrawal	1,946	1,635	50	2,099
Los Gatos Creek Div 15 \ Los Gatos Creek Recharge Withdrawal	1,888	1,630	0	2,067
Los Gatos Creek Div 17 \ FAHCE Los Gatos Creek SF 50	1,888	1,630	0	2,067
	0	0	0	0
Streamflow (below node or reach listed) (Acre-foot)				
0 \ Headflow	7,974	13,459	15,829	14,228

	2002	2003	2004	2005
1 \ lex pl 1	1	0	0	0
2 \ Reach	1	0	0	0
3 \ lex pl 2	1	0	0	0
4 \ Reach	1	0	0	0
5 \ lex pl 3	1	0	0	0
6 \ Reach	1	0	0	0
7 \ lex pl 4	1	0	0	0
8 \ Reach	1	0	0	0
9 \ lex pl 10	1	0	0	0
10 \ Reach	1	0	0	0
11 \ lex pl 5	1	0	0	0
12 \ Reach	1	0	0	0
13 \ lex pl 11	1	0	0	0
14 \ Reach	1	0	0	0
15 \ lex pl 6	1	0	0	0
16 \ Reach	1	0	0	0
17 \ lex pl 12	1	0	0	0
18 \ Reach	1	0	0	0
19 \ Tributary Inflow 4	1	0	0	0
20 \ Reach	1	0	0	0
21 \ lex pl 7	1	0	0	0
22 \ Reach	1	0	0	0
23 \ lex pl 8	1	0	0	0
24 \ Reach	1	0	0	0
25 \ lex pl 9	0	0	0	0
26 \ Reach	0	0	0	0
	0	0	0	0
Flow Requirement Reliability (Percent)				
Almaden Minimum Flow	75	75		
Anderson Minimum Flow	100	100		
Calero Minimum Flow	90	81		
Chesbro Minimum Flow	100	100		
Coyote Minimum Flow	100	100		
FAHCE 10 cfs	100	100		
FAHCE Almaden Reservoir Operations	52	52		
FAHCE Anderson Coyote Creek Golf Dr	98	98		
FAHCE Anderson Reservoir Operations	100	100		
FAHCE Calero Reservoir Operations	98	98		
FAHCE Coyote Creek Flow to Bay	100	100		
FAHCE Guadalupe Creek ds Masson Dam	81	88		
FAHCE Guadalupe Flow to Bay	100	100		
FAHCE Guadalupe Reservoir Operations	100	100		
FAHCE Lexington Reservoir Operations	98	100		
FAHCE Los Gatos Creek SF 50	100	100		
FAHCE Stevens Creek Flow to Bay	100	100		
FAHCE Stevens Creek Reservoir Operations	100	100		
Guadalupe Minimum Flow	96	92		
LSAA Chesbro Reservoir Operations	100	100		
LSAA Uvas Reservoir Operations	100	100		
Lexington Minimum Flow	100	92		
Madrone Channel Minimum Flow	100	100		
Stevens Creek Minimum Flow	100	100		
	0	0		
Unmet Instream Flow Requirement (Acre-foot)				
Almaden Minimum Flow	0	0	0	0
Anderson Minimum Flow	0	0	0	0
Calero Minimum Flow	0	18	18	0
Chesbro Minimum Flow	0	0	0	0
Coyote Minimum Flow	0	0	0	0
FAHCE 10 cfs	0	0	0	0
FAHCE Almaden Reservoir Operations	14,143	86,311	86,311	88,418
FAHCE Anderson Coyote Creek Golf Dr	0	0	0	0
FAHCE Anderson Reservoir Operations	0	0	0	0
FAHCE Calero Reservoir Operations	0	0	0	0
FAHCE Coyote Creek Flow to Bay	0	0	0	0
FAHCE Guadalupe Creek ds Masson Dam	0	0	0	0
FAHCE Guadalupe Flow to Bay	0	0	0	0
FAHCE Guadalupe Reservoir Operations	0	0	0	0
FAHCE Lexington Reservoir Operations	0	0	0	0
FAHCE Los Gatos Creek SF 50	0	0	0	0
FAHCE Stevens Creek Flow to Bay	0	0	0	0
FAHCE Stevens Creek Reservoir Operations	0	0	0	0
Guadalupe Minimum Flow	0	0	0	0
LSAA Chesbro Reservoir Operations	0	0	0	0
LSAA Uvas Reservoir Operations	0	0	0	0
Lexington Minimum Flow	0	0	0	0
Madrone Channel Minimum Flow	0	0	0	0
Stevens Creek Minimum Flow	0	0	0	0
	0	0	0	0

	2002	2003	2004	2005
Transmission Link Flow (Acre-foot)				
Transmission Link from Almaden Reservoir to Almaden Calero Canal	0	1,125	809	2,848
Transmission Link from Anderson Reservoir to Anderson PL release	0	0	0	0
Transmission Link from Anderson Reservoir to Anderson to Madrone Channel	8,322	7,302	7,095	5,989
Transmission Link from Anderson Reservoir to Butterfield Recharge	0	0	0	0
Transmission Link from Anderson Reservoir to Main Ave Ponds	3,200	272	0	0
Transmission Link from CVP 2 Guadalupe Creek to Guadalupe Creek	2,260	122	0	386
Transmission Link from CVP Release to Santa Teresa WTP to Santa Teresa WTP	54,738	9,989	0	44,749
Transmission Link from CVP Turnout to Guadalupe Ponds to Alamitos and Guadalupe	1,735	138	0	408
Transmission Link from CVP Turnout to Kooser Ponds to Kooser Ponds	1,215	94	0	939
Transmission Link from CVP Turnout to Los Cap Ponds to Los Capitancillos Ponds	1,324	50	0	821
Transmission Link from CVP to Butterfield to Butterfield Recharge	0	0	0	0
Transmission Link from CVP to SC WTP to SC WTP	0	0	0	0
Transmission Link from CVP turnout to San Pedro Ponds to San Pedro Ponds	2,800	690	0	1,879
Transmission Link from Calero Reservoir to Calero PL release	0	0	0	0
Transmission Link from Campbell Well Field to Rinconada WTP	0	0	0	0
Transmission Link from Coyote Subbasin to Coyote Ag	2,465	2,465	2,465	2,465
Transmission Link from Coyote Subbasin to Coyote Service Area	11,487	9,722	9,190	11,096
Transmission Link from Coyote Subbasin to Great Oaks W5	0	0	0	0
Transmission Link from Coyote Subbasin to SJ Muni W5	398	337	318	384
Transmission Link from Coyote Subbasin to coyote outflow losses	0	0	0	0
Transmission Link from Deliver Recycled to Gilroy to Gilroy Service Area	829	829	829	829
Transmission Link from Desal to Penitencia WTP	0	0	0	0
Transmission Link from Dry Year Option to Dry Year Option	0	0	0	0
Transmission Link from Exchange Contract to Tributary Inflow 3	0	0	0	0
Transmission Link from HH to Sunnyvale to Sunnyvale Service Area	10,158	10,158	10,158	10,158
Transmission Link from Hecker Pass Recycled to Gilroy Service Area	0	0	0	0
Transmission Link from Hetch Hetchy Intertie to Penitencia WTP	0	9,357	9,357	0
Transmission Link from IPR Coyote to Coyote Service Area	0	0	0	0
Transmission Link from IPR Coyote to Ford Pond Recharge	0	0	0	0
Transmission Link from IPR Coyote to IPR Coyote to Cross Valley PL	0	0	0	0
Transmission Link from IPR Coyote to NC Coyote Pond Recharge	0	0	0	0
Transmission Link from IPR Guadalupe to Alamitos and Guadalupe Ponds	0	0	0	0
Transmission Link from IPR Guadalupe to Kooser Ponds	0	0	0	0
Transmission Link from IPR Guadalupe to Los Capitancillos Ponds	0	0	0	0
Transmission Link from IPR Los Gatos to IPR GW injection demand	0	0	0	0
Transmission Link from IPR Los Gatos to IPR MidBasin GW Injection	0	0	0	0
Transmission Link from IPR Los Gatos to LG IPR to Central PL	0	0	0	0
Transmission Link from IPR Los Gatos to Los Gatos Ponds	15,150	14,321	20,148	20,148
Transmission Link from IPR Los Gatos to NC IWRP recharge	0	0	0	0
Transmission Link from IPR Penitencia to Overfelt Ponds	0	0	0	0
Transmission Link from IPR Penitencia to Penitencia Ponds	0	0	0	0
Transmission Link from IRP Sunnyvale to IPR Sunnyvale GW Injection	0	0	0	0
Transmission Link from Llagas Creek to Church Ponds Recharge	0	283	283	283
Transmission Link from Llagas Subbasin to Gilroy Service Area	7,621	6,323	5,931	7,333
Transmission Link from Llagas Subbasin to Llagas Ag	22,628	22,628	22,628	22,628
Transmission Link from Llagas Subbasin to Loss to Pajaro and Others	0	0	0	0
Transmission Link from Llagas Subbasin to Morgan Hill Service Area	8,989	7,608	7,191	8,683
Transmission Link from Llagas Subbasin to San Martin Service Area	4,132	3,497	3,306	3,991
Transmission Link from Local Uvas Flood Release to Uvas to Cross Valley PL	0	0	0	0
Transmission Link from Los Gatos Creek Recharge Withdrawal to Los Gatos Creek Re	57	5	50	32
Transmission Link from Los Gatos Ponds Withdrawal to Los Gatos Ponds	0	0	0	0
Transmission Link from Madrone Channel to Madrone Ponds	8,700	8,700	7,095	8,039
Transmission Link from Masson Dam Diversion to Los Capitancillos Ponds	382	323	284	383
Transmission Link from Masson Dam Rediversion to Los Capitancillos Ponds	329	899	343	912
Transmission Link from Morgan Hill Recycled to Morgan Hill Service Area	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Cal Water Service Area	1,972	5,319	5,743	1,636
Transmission Link from North County Santa Clara Sbb to Campbell Well Field	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Great Oaks Service Area	5,921	5,011	4,737	5,719
Transmission Link from North County Santa Clara Sbb to Milpitas Service Area	452	1,500	1,618	782
Transmission Link from North County Santa Clara Sbb to Mountain View Service Are	1,103	433	54	727
Transmission Link from North County Santa Clara Sbb to NC Ag	892	892	892	892
Transmission Link from North County Santa Clara Sbb to Palo Alto Service Area	116	38	0	115
Transmission Link from North County Santa Clara Sbb to Purissima Hills Service A	1,648	1,112	950	1,529
Transmission Link from North County Santa Clara Sbb to Rinconada WTP	0	0	0	0
Transmission Link from North County Santa Clara Sbb to SJ Muni North	2,345	1,286	663	1,639
Transmission Link from North County Santa Clara Sbb to SJ Muni Service Area	0	6,543	8,671	2,368
Transmission Link from North County Santa Clara Sbb to SJ Water Company	45,364	94,006	100,691	55,228
Transmission Link from North County Santa Clara Sbb to Santa Clara Service Area	15,352	15,714	14,037	14,175
Transmission Link from North County Santa Clara Sbb to Santa Teresa WTP	0	0	0	0
Transmission Link from North County Santa Clara Sbb to Stanford Moffett Field Am	2,126	1,166	876	1,913
Transmission Link from North County Santa Clara Sbb to Sunnyvale Service Area	2,185	8,442	6,523	1,731
Transmission Link from North County Santa Clara Sbb to nonAG independent pumpers	11,469	9,707	9,175	11,078
Transmission Link from North County Santa Clara Sbb to zone exchange loss	0	0	0	0
Transmission Link from Pacheco Reservoir to Pacheco to cvp	0	0	0	0
Transmission Link from Penitencia to service areas to Milpitas Service Area	4,987	1,293	377	4,071
Transmission Link from Penitencia to service areas to SJ Muni Service Area	16,246	6,979	3,947	13,485
Transmission Link from Penitencia to service areas to SJ Water Company	6,766	5,852	5,032	5,281
Transmission Link from Recycled 1 to Llagas Ag	1,172	1,172	1,172	1,172

	2002	2003	2004	2005
Transmission Link from Recycled SBWR to Milpitas to Milpitas Service Area	1,773	1,773	1,773	1,773
Transmission Link from Recycled SBWR to SJ Muni Edenvale to SJ Muni Service Area	3,251	2,980	2,980	2,980
Transmission Link from Recycled SBWR to SJ Muni North to SJ Muni North	7,521	6,278	6,206	7,717
Transmission Link from Recycled SBWR to SJWC to SJ Water Company	2,624	4,138	4,210	2,699
Transmission Link from Recycled SBWR to Santa Clara to Santa Clara Service Area	4,531	4,531	4,531	4,531
Transmission Link from Recycled SV to Sunnyvale to Sunnyvale Service Area	1,900	1,900	1,900	1,900
Transmission Link from Rinconada to service areas to Cal Water Service Area	10,948	5,616	4,593	10,844
Transmission Link from Rinconada to service areas to Mountain View Service Area	526	79	0	397
Transmission Link from Rinconada to service areas to SJ Water Company	30,101	6,054	3,104	26,197
Transmission Link from Rinconada to service areas to Santa Clara Service Area	9,609	3,930	4,002	9,607
Transmission Link from Rinconada to service areas to Sunnyvale Service Area	14,146	3,527	4,130	13,633
Transmission Link from SCRWA to Morgan Hill to Morgan Hill Service Area	0	0	0	0
Transmission Link from SWP 2 Guadalupe Creek to Guadalupe Creek	0	0	0	0
Transmission Link from SWP Release to Santa Teresa WTP to Santa Teresa WTP	3,931	0	0	3,931
Transmission Link from SWP Turnout to Guadalupe Ponds to Alamitos and Guadalupe	0	0	0	0
Transmission Link from SWP Turnout to Kooser Ponds to Kooser Ponds	0	94	0	0
Transmission Link from SWP Turnout to Los Cap Ponds to Los Capitancillos Ponds	0	0	0	0
Transmission Link from Santa Teresa to service areas to SJ Muni Service Area	0	0	0	0
Transmission Link from Santa Teresa to service areas to SJ Water Company	58,669	9,989	0	48,680
Transmission Link from Semitropic Exchange Kern NWR withdrawal to Exchange to Ke	0	0	0	0
Transmission Link from Shallow GW Reuse to Mountain View Service Area	0	0	0	0
Transmission Link from Shallow GW Reuse to SJ Water Company	0	0	0	0
Transmission Link from Shallow GW Reuse to Santa Clara Service Area	0	0	0	0
Transmission Link from Stevens Creek Recharge Withdrawal to Stevens Creek Rechar	2,393	2,837	3,650	2,765
Transmission Link from Test New Supply 10K to Test New Supply 10K	0	0	0	0
Transmission Link from Test New Supply 10K to Test New Supply 10K Res	0	0	0	0
Transmission Link from Uvas Release to Llagas Recharge to Church Ponds Recharge	0	0	0	0
Transmission Link from Uvas Reservoir to Church Ponds Recharge	0	601	0	0
Transmission Link from Uvas Reservoir to Uvas Llagas Transfer Pipeline Inflow	0	0	0	0
Transmission Link from West Side Package WTPs to SJ Water Company	0	0	0	0
Transmission Link from Withdrawal Node 1 to Alamitos Creek Recharge	1,307	1,146	611	778
Transmission Link from Withdrawal Node 1 to Coyote Upper Recharge 2	10,546	8,430	7,517	4,020
Transmission Link from Withdrawal Node 1 to cvp to coyote ck div	0	0	0	1,573
Transmission Link from Withdrawal Node 1 to new cvp to anderson	0	2,726	0	4,613
Transmission Link from cvp 2 Oka and Camden Ponds Withdrawal to Oka and Camden P	1,519	310	0	610
Transmission Link from cvp div to lp recharge to New LP Recharge	0	0	0	0
Transmission Link from cvp to rinconada to Rinconada WTP	32,332	2,183	0	29,080
Transmission Link from cvp to ws1 wtp to West Side 1 Package WTP	0	0	0	0
Transmission Link from cvp to ws2 wtp to West Side 2 Package WTP	0	0	0	0
Transmission Link from cvp turnout 2 coyote ponds to Coyote Pond Recharge	0	0	0	0
Transmission Link from cvp turnout 2 coyote ponds to NC Coyote Pond Recharge	1,028	0	0	930
Transmission Link from cvp turnout 2 coyote ponds to NC Upper Coyote Recharge	0	0	0	12
Transmission Link from cvp turnout lg creek to Los Gatos Creek Recharge	0	315	0	0
Transmission Link from cvp turnout lg ponds to Los Gatos Ponds	4,998	1,086	0	0
Transmission Link from cvp turnout to NC IWRP to NC IWRP recharge	0	0	0	0
Transmission Link from cvp turnout to church ponds to Church Ponds Recharge	0	0	0	0
Transmission Link from cvp turnout to lower llagas to Lower Llagas Recharge	0	0	0	0
Transmission Link from cvp turnout to main ave to Main Ave Ponds	0	407	0	1,600
Transmission Link from cvp turnout to ross creek to Ross Creek Recharge	1,594	62	0	1,081
Transmission Link from cvp turnout to west recharge nodes to Calabazas Creek Rec	245	0	0	204
Transmission Link from cvp turnout to west recharge nodes to McClellan Pond Rech	661	94	0	443
Transmission Link from cvp turnout to west recharge nodes to Regnart Creek Recha	116	6	0	113
Transmission Link from cvp turnout to west recharge nodes to Rodeo Creek Recharg	316	54	0	236
Transmission Link from cvp turnout to west recharge nodes to San Tomas Creek Rec	61	0	0	115
Transmission Link from cvp turnout to west recharge nodes to Saratoga Creek Rech	346	0	0	487
Transmission Link from cvp turnout to west recharge nodes to Stevens Creek Recha	1,257	0	0	0
Transmission Link from cvp turnout to west recharge nodes to Wildcat Creek Recha	79	16	0	75
Transmission Link from cvp turnout upper coyote to Coyote Upper Recharge	538	0	0	0
Transmission Link from desal directly to sjwc to SJ Water Company	0	0	0	0
Transmission Link from desal to santa clara to Santa Clara Service Area	0	0	0	0
Transmission Link from exch lex and sjwc to zz exchange lex and sjwc	0	0	0	0
Transmission Link from hh to PHills to Purissima Hills Service Area	1,842	1,842	1,842	1,842
Transmission Link from hh to milpitas service area to Milpitas Service Area	10,010	10,010	10,010	10,010
Transmission Link from hh to moffett ames to Stanford Moffett Field Ames	3,445	3,445	3,445	3,445
Transmission Link from hh to mountain view to Mountain View Service Area	12,806	11,337	11,079	12,570
Transmission Link from hh to palo alto to Palo Alto Service Area	13,518	11,555	10,911	13,234
Transmission Link from hh to santa clara to Santa Clara Service Area	5,119	5,119	5,119	5,119
Transmission Link from hh to sj muni n to SJ Muni North	5,118	5,118	5,118	5,118
Transmission Link from lake elsman to sjw west to SJ Water Company	7,406	7,406	7,406	7,406
Transmission Link from lex pl 1 to Rinconada WTP	7,973	13,459	15,829	14,228
Transmission Link from lex pl 10 to NC IWRP recharge	0	0	0	0
Transmission Link from lex pl 11 to West Side 2 Package WTP	0	0	0	0
Transmission Link from lex pl 12 to West Side 1 Package WTP	0	0	0	0
Transmission Link from lex pl 2 to San Tomas Creek Recharge	0	0	0	0
Transmission Link from lex pl 3 to Wildcat Creek Recharge	0	0	0	0
Transmission Link from lex pl 4 to Saratoga Creek Recharge	0	0	0	0
Transmission Link from lex pl 5 to Rodeo Creek Recharge	0	0	0	0
Transmission Link from lex pl 6 to Calabazas Creek Recharge	0	0	0	0
Transmission Link from lex pl 7 to Regnart Creek Recharge	0	0	0	0

	2002	2003	2004	2005
Transmission Link from lex pl 8 to McClellan Pond Recharge	0	0	0	0
Transmission Link from lex pl 9 to Stevens Creek Recharge	1	0	0	0
Transmission Link from local 2 Oka and Camden Ponds Withdrawal to Oka and Camden	1	3	31	20
Transmission Link from local 2 coyote pond recharge to Coyote Pond Recharge	0	0	0	0
Transmission Link from local 2 guad creek to Guadalupe Creek	4,578	5,259	4,027	5,104
Transmission Link from local 2 lower coyote recharge to lower coyote recharge	972	848	1,216	968
Transmission Link from local 2 overfelt to Overfelt Ponds	0	0	0	0
Transmission Link from local 2 pen ponds to Penitencia Ponds	0	0	0	0
Transmission Link from local 2 upper coyote to NC Upper Coyote Recharge	172	61	160	127
Transmission Link from local Uvas release to recharge to Uvas Recharge	10,118	10,118	10,118	10,118
Transmission Link from local anderson 2 coyote ponds to NC Coyote Pond Recharge	8,945	6,360	9,265	7,260
Transmission Link from local anderson res to Church Ponds Recharge	0	0	0	0
Transmission Link from local anderson res to Lower Llagas Recharge	0	0	0	0
Transmission Link from local calabasas creek to Calabazas Creek Recharge	1,399	1,399	1,399	1,399
Transmission Link from local calero creek to Calero Creek Recharge	590	639	480	658
Transmission Link from local guadalupe 2 to Alamitos and Guadalupe Ponds	5,191	5,964	8,030	7,152
Transmission Link from local lower Llagas recharge to Lower Llagas Recharge	4,704	7,227	7,227	7,227
Transmission Link from local penitencia creek to Penitencia Creek Recharge	1,187	821	1,187	1,187
Transmission Link from local regnart creek to Regnart Creek Recharge	314	314	314	314
Transmission Link from local release 2 ford ponds to Ford Pond Recharge	0	0	0	0
Transmission Link from local release 2 upper coyote to Coyote Upper Recharge	5,978	6,516	6,516	6,190
Transmission Link from local rodeo creek to Rodeo Creek Recharge	76	76	76	76
Transmission Link from local ross creek recharge to Ross Creek Recharge	521	521	521	521
Transmission Link from local san tomas creek to San Tomas Creek Recharge	728	728	728	728
Transmission Link from local saratoga creek to Saratoga Creek Recharge	3,172	3,172	3,172	3,172
Transmission Link from local saratoga div to NC IWRP recharge	0	0	0	0
Transmission Link from local silver creek to Silver Creek Recharge	710	710	710	710
Transmission Link from local stevens creek flood release to Tributary Inflow 4	0	0	0	0
Transmission Link from local thompson creek to Thompson Creek Recharge	728	728	728	728
Transmission Link from local wildcat creek to Wildcat Creek Recharge	394	394	394	394
Transmission Link from recycle pa to palo alto to Palo Alto Service Area	1,056	840	840	840
Transmission Link from recycled pa to mountain view to Mountain View Service Are	994	1,209	1,209	1,209
Transmission Link from release for bank sale to Sell Bank Water	0	0	0	0
Transmission Link from sc wtp conduit to MH to Morgan Hill Service Area	0	0	0	0
Transmission Link from send to Pacheco Withdrawal to send to Pacheco	0	0	0	0
Transmission Link from stanford water to Stanford Moffett Field Ames	681	681	681	681
Transmission Link from swp 2 Oka and Camden Ponds Withdrawal to Oka and Camden P	2,130	279	0	1,539
Transmission Link from swp 2 overfelt to Overfelt Ponds	1,012	236	0	782
Transmission Link from swp 2 pen ponds to Penitencia Ponds	1,721	401	0	1,330
Transmission Link from swp puts to semitropic to Semitropic Put	0	0	0	0
Transmission Link from swp to penitencia wtp to Penitencia WTP	28,000	4,767	0	22,837
Transmission Link from swp to rinconada to Rinconada WTP	25,024	3,564	0	17,370
Transmission Link from swp to ws1 wtp to West Side 1 Package WTP	0	0	0	0
Transmission Link from swp to ws2 wtp to West Side 2 Package WTP	0	0	0	0
Transmission Link from swp turnout lg creek to Los Gatos Creek Recharge	5,783	315	0	3,438
Transmission Link from swp turnout lg ponds to Los Gatos Ponds	0	539	0	0
Transmission Link from swp turnout to NC IWRP to NC IWRP recharge	0	590	0	1,955
Transmission Link from swp turnout to penitencia recharge to Penitencia Creek Re	930	0	0	827
Transmission Link from swp turnout to ross creek to Ross Creek Recharge	0	62	0	0
Transmission Link from swp turnout to west recharge nodes to Calabazas Creek Rec	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to McClellan Pond Rech	0	94	0	0
Transmission Link from swp turnout to west recharge nodes to Regnart Creek Recha	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Rodeo Creek Recharg	0	48	0	0
Transmission Link from swp turnout to west recharge nodes to San Tomas Creek Rec	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Saratoga Creek Rech	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Stevens Creek Recha	0	0	0	0
Transmission Link from swp turnout to west recharge nodes to Wildcat Creek Recha	0	0	0	0
Sum	**682,944**	**489,637**	**451,631**	**642,382**
	0	0	0	0
Key Assumptions (No Unit)				
Accretional Flows Utilization Factor	0.25	0.25	0.25	0.25
Alamitos Creek Recharge Capacity (AF)	186	186	186	186
Alamitos and Guadalupe Ponds Recharge Capacity (AF)	682	682	682	682
Almaden Calero Canal Capacity (CFS)	85	85	85	85
Almaden Flood Rule Curve (Thousand AF)	1	1	1	1
Almaden Pulse Count	0	0	0	0
Almaden Pulse in Period	0	0	0	0
Almaden Reservoir Estimated Evaporation (AF)	1	1	1	1
Almaden Reservoir Inflows 90 Exceedance (AF)	189	189	189	189
Almaden Spill Days	12	10	10	10
Almaden Spill Volume (AF)	1,878	1,578	1,578	1,578
Almaden Transfer Rule Curve (AF)	500	515	515	863
Anderson Cold Water Volume (AF)	0	0	0	0
Anderson Depth to Cold Water Pool (ft)	32	32	32	32
Anderson Flood Rule Curve (Thousand AF)	0	0	0	0
Anderson Pulse Count	0	0	0	0
Anderson Reservoir Estimated Evaporation (AF)	33	31	31	33
Anderson Reservoir Inflows 90 Exceedance (AF)	1	1	1	1
Anderson Spill Days	0	0	0	0

	2002	2003	2004	2005
Anderson Spill Volume (AF)	0	0	0	0
Anderson prev month stg (AF)	22,419	21,022	20,500	23,272
Average Monthly Evaporation (in)	1	1	1	1
CVP Total Supply (AF)	6,771	0	0	6,771
Calero Creek Recharge Capacity (AF)	78	78	78	78
Calero Flood Rule Curve (Thousand AF)	5	9	9	9
Calero Pulse Count	0	0	0	0
Calero Reservoir Estimated Evaporation (AF)	11	11	11	11
Calero Reservoir Inflows 90 Exceedance (AF)	3	3	3	3
Calero Spill Days	9	0	0	0
Calero Spill Volume (AF)	1,349	0	0	0
Calero Transfer Rule Curve (AF)	4,000	7,726	7,726	7,726
Campbell_Well_Field_amount (MGD)	2	2	2	2
Chesbro Diversion Rule Curve (AF)	500	500	500	500
Chesbro Flood Rule Curve (Thousand AF)	6	6	6	6
Chesbro Reservoir Estimated Evaporation (AF)	3	5	5	5
Chesbro Reservoir Inflows 90 Exceedance (AF)	34	34	34	34
Chesbro Transfer Rule Curve (Thousand AF)	0	0	0	0
Conservation 13K reduction	0	0	0	0
Conservation 28K reduction	0	0	0	0
Coyote Flood Rule Curve (Thousand AF)	0	0	0	0
Coyote IPR Amount (MGD)	7	7	7	7
Coyote Reservoir Estimated Evaporation (AF)	21	21	13	21
Coyote Reservoir Inflows 90 Exceedance (AF)	6	6	6	6
Coyote Valley Agricultural Return (AF)	5	5	5	5
Coyote Valley Deep Percolation of Precipitation (AF)	956	956	956	956
Coyote Valley Natural Recharge (AF)	976	973	973	976
Coyote Valley Septic Return (AF)	16	13	13	16
Exchange Kern NWR amount (AF)	10,000	10,000	10,000	10,000
Graywater_Use_Amount (AF)	0	300	300	300
Guadalupe Cold Water Volume (AF)	0	0	0	0
Guadalupe Depth to Cold Water Pool (ft)	21	21	21	21
Guadalupe Flood Rule Curve (Thousand AF)	2	2	2	2
Guadalupe Pulse Count	0	0	0	0
Guadalupe Recharge Capacity (AF)	601	601	601	601
Guadalupe Reservoir Estimated Evaporation (AF)	2	1	3	2
Guadalupe Reservoir Inflows 90 Exceedance (AF)	52	52	52	52
Guadalupe Reservoir Max Hydraulic Capacity (CFS)	0	0	0	0
Guadalupe Spill Days	0	0	5	0
Guadalupe Spill Volume (AF)	0	0	700	0
HH\milpitas	0	0	0	0
HH\mtView	0	0	0	0
HH\paloAlto	0	0	0	0
HH\purissimaHills	0	0	0	0
HH\santaClara	0	0	0	0
HH\sjMuni	0	0	0	0
HH\stanfordMoffet	0	0	0	0
HH\sunnyvale	0	0	0	0
IPR MidBasin Amount (MGD)	5	5	5	5
IPR Sunnyvale Amount (MGD)	10	10	10	10
IPR_GW_Injection_amount (MGD)	10	10	10	10
Kooser Ponds Recharge Capacity (AF)	149	149	149	149
Lexington Flood Rule Curve (Thousand AF)	14	14	14	14
Lexington Pipeline Capacity (MGD)	20	20	20	20
Lexington Reservoir Estimated Evaporation (AF)	6	6	6	6
Lexington Reservoir Inflows 90 Exceedance (AF)	203	203	203	203
Llagas Subbasin Mountain Front Recharge (AF)	1,000	1,000	1,000	1,000
Llagas Subbasin Septic Return (AF)	39	39	39	39
Llagas Subbasin Stream Seepage (AF)	54	54	54	54
Los Capitancillos Ponds Recharge Capacity (AF)	248	248	248	248
Los Gatos Creek to Los Gatos Ponds Max Diversion (AF)	1,711	1,711	1,711	1,711
Los Gatos Div Max Diversion (AF)	61,488	614,876	614,876	61,488
Los Gatos IPR Amount (AF)	20,200	20,200	20,200	20,200
Los Gatos Ponds Monthly Recharge Capacity (AF)	2,021	2,021	2,021	2,021
Masson Dam Diversion Available (AF)	0	0	0	0
Masson Dam Rediversion Available (AF)	430	500	500	430
NC_recharge_IWRP_amount (AF)	10	10	10	10
New WSIMP CVP Ag Transfer (AF)	0	0	0	0
New WSIMP CVP Ag Transfer Amount (AF)	10,000	10,000	10,000	10,000
New WSIMP CVP Exchange Contract Amount (AF)	10,000	12,000	12,000	12,000
New WSIMP CVP Exchange Contract in Dry Year (AF)	0	0	0	0
New WSIMP CVP Exchange Contract in Wet Year (AF)	0	0	0	0
Normal Monthly Import Distribution	0	0	0	0
Pacheco Flood Rule Curve (Thousand AF)	0	0	0	0
Pacheco Reservoir Estimated Evaporation (AF)	0	0	0	0
Pacheco Reservoir Inflows 90 Exceedance (AF)	0	0	0	0
Priorities\Almaden Reservoir Storage Priority	11	11	11	11
Priorities\Anderson Reservoir Storage Priority	94	94	94	94
Priorities\Calero Reservoir Storage Priority	10	10	10	10

	2002	2003	2004	2005
Priorities\Chesbro Reservoir Storage Priority	98	98	98	98
Priorities\Coyote Reservoir Storage Priority	93	93	93	93
Priorities\FAHCE Almaden Reservoir Operations Priority	10	10	10	10
Priorities\FAHCE Anderson Reservoir Operations Priority	9	9	9	9
Priorities\FAHCE Calero Reservoir Operations Priority	9	9	9	9
Priorities\FAHCE Guadalupe Reservoir Operations Priority	10	10	10	10
Priorities\FAHCE Lexington Reservoir Operations Priority	9	9	9	9
Priorities\FAHCE Los Gatos Creek SF 50	2	2	2	2
Priorities\FAHCE Stevens Creek Reservoir Operations Priority	9	9	9	9
Priorities\Guadalupe Reservoir Storage Priority	11	11	11	11
Priorities\Lexington Reservoir Storage Priority	10	10	10	10
Priorities\Stevens Creek Reservoir Storage Priority	10	10	10	10
Priorities\Uvas Reservoir Storage Priority	98	98	98	98
Project triggers\Almaden_seismic_upgrade	0	1	1	1
Project triggers\Anderson_seismic_upgrade	0	1	1	1
Project triggers\Calero_seismic_upgrade	0	1	1	1
Project triggers\Campbell_Well_Field	0	0	0	0
Project triggers\Conservation 13K	0	0	0	0
Project triggers\Conservation 28K	0	0	0	0
Project triggers\Coyote DPR active	0	0	0	0
Project triggers\Coyote_seismic_upgrade	0	0	0	0
Project triggers\DOSD_fixes	0	0	0	0
Project triggers\Delta Outage Months	0	24	24	24
Project triggers\Exchange Kern NWR	0	0	0	0
Project triggers\FAHCE Scenario	2	1	1	2
Project triggers\Guadalupe_seismic_upgrade	0	1	1	1
Project triggers\IPR_GW_Injection	0	0	0	0
Project triggers\IPR_MidBasin_GW_Injection	0	0	0	0
Project triggers\IPR_Sunnyvale_GW_Injection	0	0	0	0
Project triggers\IPR_coyote	0	0	0	0
Project triggers\IPR_guadalupe	0	0	0	0
Project triggers\IPR_losgatos	1	1	1	1
Project triggers\IPR_penitencia	0	0	0	0
Project triggers\Lex PL	1	1	1	1
Project triggers\NC_recharge_IWRP	0	1	1	1
Project triggers\NC_recharge_SLLP	0	0	0	0
Project triggers\NC_recycled_regional	0	0	0	0
Project triggers\New Supply 10K	0	0	0	0
Project triggers\SC_Church_Ponds	1	1	1	1
Project triggers\SC_recharge_Butterfield\amount_af (AF)	300	300	300	300
Project triggers\SC_recharge_upperMadrone	0	0	0	0
Project triggers\SC_recycled_heckerpass	0	0	0	0
Project triggers\SC_recycled_morganhill	0	0	0	0
Project triggers\SC_recycled_scrwa_mh	0	0	0	0
Project triggers\SC_wtp	0	0	0	0
Project triggers\SJWC_exchange_Lex	0	0	0	0
Project triggers\Stevens Creek accretional flows	1	1	1	1
Project triggers\StevensCreek_Pipeline	0	0	0	0
Project triggers\Use Accretional Flows Utilization Factor	1	1	1	1
Project triggers\UvasRes_Pipeline	0	0	0	0
Project triggers\WSCP Demand Reduction Flag	1	1	1	1
Project triggers\additional_wells	0	0	0	0
Project triggers\anderson_expansion	0	0	0	0
Project triggers\calero_expansion	0	0	0	0
Project triggers\dam_seismic_upgrade	0	1	1	1
Project triggers\dry_year_option	0	0	0	0
Project triggers\exchange_contract	0	0	0	0
Project triggers\graywater_use	0	1	1	1
Project triggers\new_import_contract	0	0	0	0
Project triggers\pacheco_expansion	0	0	0	0
Project triggers\regional_desalination	0	0	0	0
Project triggers\semitropic_reoperations	0	1	1	1
Project triggers\shallow_gw_reuse	0	0	0	0
Project triggers\sri_year_type	2	4	3	4
Project triggers\uvas_expansion	0	0	0	0
Project triggers\westside_intertie	0	0	0	0
Project triggers\westside_wtps	0	0	0	0
SWP Total Supply (AF)	3,900	0	0	3,900
San Luis Reservoir Storage Threshold For Low Point (AF)	250,000	250,000	250,000	250,000
San Luis Storage_Annual Min (Thousand AF)	123	898	1,572	123
Stevens Creek Cold Water Volume (AF)	681	791	1,605	991
Stevens Creek Depth to Cold Water Pool (ft)	18	18	18	18
Stevens Creek Flood Rule Curve (Thousand AF)	2	2	2	2
Stevens Creek Pulse Count	0	0	0	0
Stevens Creek Recharge Capacity (AF)	310	310	310	310
Stevens Creek Reservoir Estimated Evaporation (AF)	3	3	4	4
Stevens Creek Reservoir Inflows 90 Exceedance (AF)	70	70	70	70
Stevens Creek Spill Days	10	9	11	11
Stevens Creek Spill Volume (AF)	1,469	1,366	1,732	1,670

	2002	2003	2004	2005
Uvas Creek LSAA Calculated Summer Flow (CFS)	8	14	14	14
Uvas Reservoir Accumulated Accretion Storage Savings (AF)	484	1,698	1,698	1,698
Uvas Reservoir Estimated Evaporation (AF)	5	9	10	10
Uvas Reservoir Inflows 90 Exceedance (AF)	89	89	89	89
Uvas Rule Curve (Thousand AF)	10	10	10	10
Uvas Transfer Rule Curve (AF)	8,000	8,000	8,000	8,000
Vasona Reservoir Estimated Evaporation (AF)	0	0	0	0
WTP Assumptions\Penitencia Demands (AF)	1,528	1,528	1,528	1,528
WTP Assumptions\Rinconada Demands (AF)	3,566	2,747	2,747	3,566
WTP Assumptions\Santa Teresa Demands (AF)	3,202	2,929	2,929	3,202
Water_Evaporation (in)	1	1	1	1
Weather Demand Factor Flag	0	0	0	0
ag acreage multiplier	2	2	2	2
anderson cold water pool\cold water release achieved (AF)	123	123	123	615
anderson cold water pool\remaining cold pool needed (AF)	0	0	0	0
anderson cold water pool\total cold water pool (AF)	8,991	8,115	7,787	9,525
anderson ds recharge capacity\min lower water evap (AF)	45	45	45	45
anderson ds recharge capacity\recharge release achieved (AF)	833	1,290	251	1,290
anderson ds recharge capacity\summer evap water needed (AF)	0	0	0	0
anderson ds recharge capacity\total ds recharge capacity (AF)	2,294	2,294	2,294	2,294
anderson fahce release (CFS)	2	2	2	10
anderson rel for tw needs (AF)	0	6,589	6,589	0
anderson release to cvp\max monthly release to cvp (AF)	0	0	0	0
anderson release to cvp\release to cvp achieved (AF)	0	0	0	0
anderson_buff_coef	23	21	21	23
anderson_drawdown_limit (Thousand AF)	6	6	6	6
below FMRC (Thousand AF)	32	32	32	32
cc import allocations flag	1	1	1	1
coy current ngwy (AF)	946	946	946	946
coy near full stop recharge level (AF)	23,000	23,000	23,000	23,000
coy prev gw pumping (AF)	930	761	761	930
coy recharge capacity (AF)	553	553	553	553
coy remaining stg factor	1	1	1	1
coy_storage (AF)	13,933	18,619	23,734	21,871
coyote drainage off	1	1	1	1
coyote prev month stg (AF)	7,100	7,100	2,112	7,100
cvp 5th year	0	0	0	0
cvp allocation (CFS)	110	0	0	110
cvp max carryover p1 (Thousand AF)	20	20	20	20
cvp_carryover (Thousand AF)	0	0	0	0
days in month	31	31	31	31
dec_coy_storage (AF)	10,300	15,445	20,257	24,693
dec_demand_red_yr_count	0	0	0	1
dec_nc_storage (AF)	301,400	322,348	255,981	191,143
dec_sanluis_stg (Thousand AF)	370	412	1,058	1,627
dec_sc_storage (AF)	26,600	36,394	46,720	54,472
dec_swp_stg (Thousand AF)	0	0	0	0
demand_reduction_count_fctr	1	1	1	1
demand_reduction_fctr	0.00	-0.20	-0.20	0.00
demand_reduction_yr_count	0	0	1	2
demand_yr	2,025	2,025	2,025	2,025
five year count	1	2	3	4
great oaks w5 pct	0	0	0	0
lowPointYr	0	0	0	0
lp new recharge (AF)	0	0	0	0
max anderson ben use\current ben use (AF)	13,312	10,924	10,303	6,484
max anderson ben use\total annual max bu (AF)	67,930	67,930	67,930	67,930
month	12	12	12	12
nc constant head (AF)	0	0	0	0
nc current ngwy (AF)	6,973	6,973	6,973	6,973
nc drainage off	1	1	1	1
nc nat recharge (AF)	6,973	6,973	6,973	6,973
nc near full stop recharge level (AF)	325,000	325,000	325,000	325,000
nc pos zone exchange (AF)	0	0	0	0
nc prev gw pumping (AF)	6,665	12,421	12,568	6,640
nc recharge (AF)	480	1	1	0
nc recharge capacity (AF)	6,581	6,581	6,581	6,581
nc recharge full buffer (AF)	25,000	25,000	25,000	25,000
nc remaining stg factor	1	1	1	1
nc_storage (AF)	313,759	251,791	186,847	187,473
nmbr_stages	5	5	5	5
non_contract_tw_ok	1	0	0	1
oka camden Ponds Monthly Recharge Capacity (AF)	310	310	310	310
rainfall	13	13	13	13
recycled_pct\SJWC	0	0	0	0
recycled_pct\milpitas	0	0	0	0
recycled_pct\mountainView	0	1	1	1
recycled_pct\paloAlto	1	0	0	0
recycled_pct\santaClara	0	0	0	0

	2002	2003	2004	2005
recycled_pct\sjMuni	1	1	1	1
recycled_pct\sjMuniEdenvale	0	0	0	0
recycled_pct\sjMuniNorth	1	1	1	1
sc current ngwy (AF)	4,922	4,922	4,922	4,922
sc drainage flag	0	0	0	0
sc near full stop recharge level (AF)	140,000	140,000	140,000	140,000
sc prev gw pumping (AF)	2,251	1,946	1,946	2,251
sc recharge capacity (AF)	4,201	4,201	4,201	4,201
sc remaining stg factor	1	1	1	1
sc_storage (AF)	30,282	40,671	48,612	56,816
semitropic_variables\bank_data	171	171	171	171
semitropic_variables\cvp alloc	1	0	0	1
semitropic_variables\cvp_supply (AF)	6,771	0	0	6,771
semitropic_variables\dec_semitropic_storage (AF)	200,000	195,879	195,879	195,879
semitropic_variables\max take_per Month (AF)	4,922	2,625	2,625	4,922
semitropic_variables\max_put_af (AF)	31,675	31,675	31,675	31,675
semitropic_variables\max_put_res_top (AF)	231,675	227,554	227,554	227,554
semitropic_variables\max_take_af (AF)	59,063	31,500	31,500	59,063
semitropic_variables\max_take_res_bottom (AF)	140,938	164,379	164,379	136,817
semitropic_variables\nmbr_take_months	1	1	1	6
semitropic_variables\prev_monthly_put (AF)	0	0	0	0
semitropic_variables\prev_monthly_take (AF)	1,821	0	0	0
semitropic_variables\san luis storage (Thousand AF)	370	1,572	1,572	370
semitropic_variables\semitropic_storage (AF)	195,879	195,879	195,879	195,879
semitropic_variables\swp_alloc	1	0	0	1
semitropic_variables\swp_supply (AF)	3,900	0	0	3,900
semitropic_variables\wtp_demands (AF)	8,296	7,204	7,204	8,296
sj muni w5 pct	0	0	0	0
stage_all	1	1	1	2
stage_all_1_floor (AF)	300,000	300,000	300,000	300,000
stage_all_2_floor (AF)	250,000	250,000	250,000	250,000
stage_all_3_floor (AF)	200,000	200,000	200,000	200,000
stage_all_4_floor (AF)	150,000	150,000	150,000	150,000
stage_all_5_floor (AF)	0	0	0	0
stage_coy	2	1	1	1
stage_nc	2	2	3	3
stage_sc	2	4	4	4
swp 5th year	0	0	0	0
swp max carryover p1 (Thousand AF)	20	20	20	20
swp_carryover (Thousand AF)	0	0	0	0
unitconversion\af2cfs	1	1	1	1
unitconversion\afd2mgd	0	0	0	0
unitconversion\afperMonth2cfs	0	0	0	0
unitconversion\cfs2af	2	2	2	2
unitconversion\cfs2afpermonth	61	61	61	61
unitconversion\cfs2mgd	1	1	1	1
unitconversion\cubicm2af	0	0	0	0
unitconversion\mgd2af	3	3	3	3
unitconversion\mgd2cfs	2	2	2	2
unitconversion\mgd2cms	0	0	0	0
weather_fctr_ag	0	0	0	0
weather_fctr_mi	0	0	0	0
wtp 5k adjustment (AF)	297	297	297	297
z_potable reuse ramping deduction calculation	1	1	1	1
z cvp carryover storage begin year (AF)	0	1,786	0	0
z cvp carryover used (AF)	0	1,786	0	0
z san luis full	0	0	0	0
z swp carryover storage begin year (AF)	0	589	0	0
z swp carryover used (AF)	0	589	0	0
	0	0	0	0
Reservoir Storage Volume (Acre-foot)				
deadend cvp	0	0	0	0

Appendix 5a: Groundwater Modeling Results- Project EOY Groundwater Storage

Water Supply Division
Projected EOY Groundwater Storage
Projected as of: October 2015 (Revised)

Scenario [a]	Hydrology	Initial	2002	2003	2004
		Actual	Actual	Actual	Actual
Santa Clara Plain	**W-2 Water Use, AF**	0	336,600	284,700	325,000
	GW pumping	0	90,900	151,400	99,500
	Treated Water	0	152,000	43,000	132,300
	Hetch Hetchy	0	62,000	58,600	61,500
	Miscellaneous	0	8,100	8,100	8,100
	Recycled Water	0	23,600	23,600	23,600
	Surface Water	0	0	0	0
	Total Recharge (Model)	0	103,400	80,900	100,700
	Facility Recharge (Ops plan)	0	75,400	56,500	73,600
	Natural (Model)	0	28,000	24,400	27,100
	EOY Groundwater Storage [b]	**301,400**	**312,400**	**257,900**	**262,700**
W-5 Water Use, AF		0	59,700	54,600	58,500
Coyote Valley	GW Pumping	0	14,300	12,500	13,900
	Surface Water	0	0	0	0
	Total Recharge (Model)	0	19,500	17,300	17,500
	Facility Recharge(Model)	0	17,100	14,900	15,100
	Natural Recharge (Model)	0	2,400	2,400	2,400
	EOY Groundwater Storage [c]	**10,300**	**11,200**	**11,600**	**10,900**
Llagas Subbasin	GW pumping	0	43,400	40,100	42,600
	Recycled Water	0	2,000	2,000	2,000
	Surface Water	0	0	0	0
	Total Recharge (Model)	0	51,400	49,800	51,900
	Facility Recharge (Ops plan)	0	29,500	27,900	30,000
	Natural (Model)	0	21,900	21,900	21,900
	EOY Groundwater Storage [d]	**26,600**	**33,800**	**38,500**	**40,600**
County	**Pumping**	**0**	**148,600**	**204,000**	**156,000**
	Managed Recharge	**0**	**122,000**	**99,300**	**118,700**
	Total Use W2 and W5	**0**	**396,300**	**339,300**	**383,500**
	District Water [e]	**0**	**334,300**	**280,700**	**322,000**
	Total Groundwater Storage	**338,300**	**357,400**	**308,000**	**314,200**
	GW Storage Change from Previous Year		19,100	(49,400)	6,200

[a] IRP_1511_1 Water Use

[b] Accumulated since 1970

[c] Accumulated since Sep 1991 with 7,000 AF in reserve as of Sep 1991

[d] Accumulated since Sep 1990

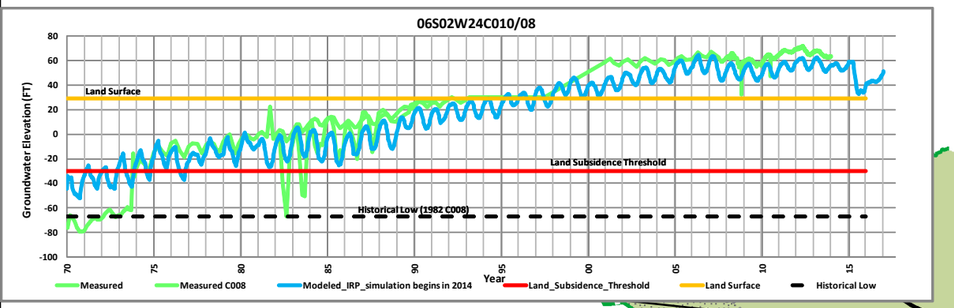
[e] Including recycled water, excluding Hetch Hetchy deliveries and other private local surface supplies

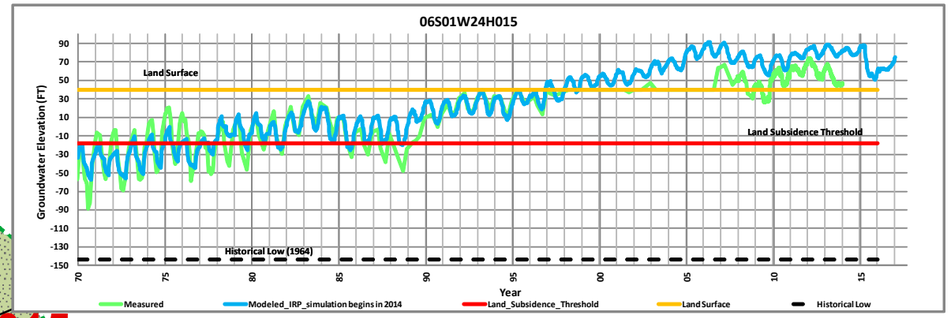
Color code for Outcome Measures (BAO Interpretations): **Black**: meets and **Purple**: does not meet

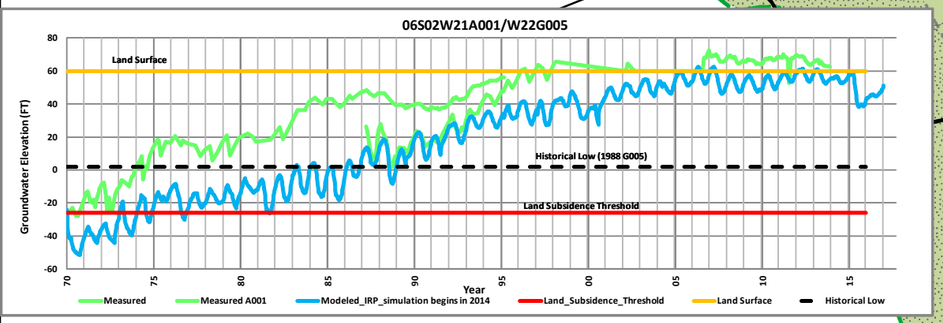
Color code for Water Shortage Contingency Plan: **Green fill**: Stage 1 (Normal or above 300,000 AF), **Blue fill**: Stage 2 (Alert or 250,000-300,000 AF), **Yellow fill**: Stage 3 (Severe or 200,000-250,000 AF), **Orange fill**: Stage 4 (Critical or 150,000-200,000 AF), and **Red fill**: Stage 5 (Emergency or Below 150,000 AF)

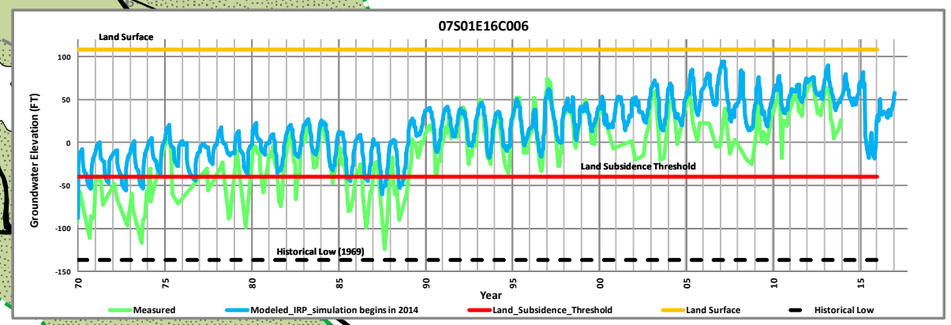
Appendix 5b: Groundwater Modeling Results- PRESS Wells in Confined Area of Santa Clara Plain Map

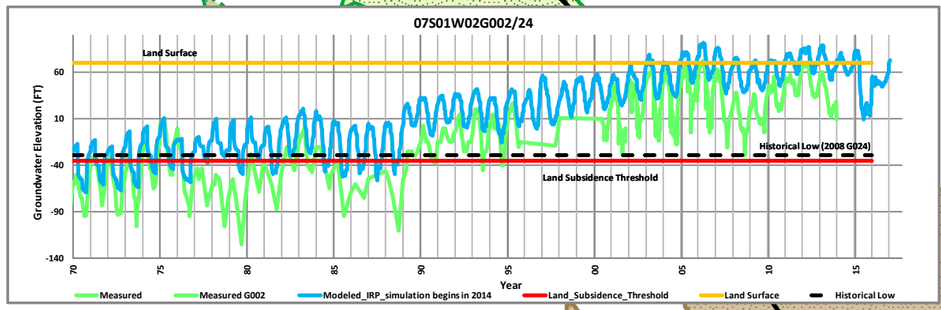
PRESS Wells in Confined Area of Santa Clara Plain

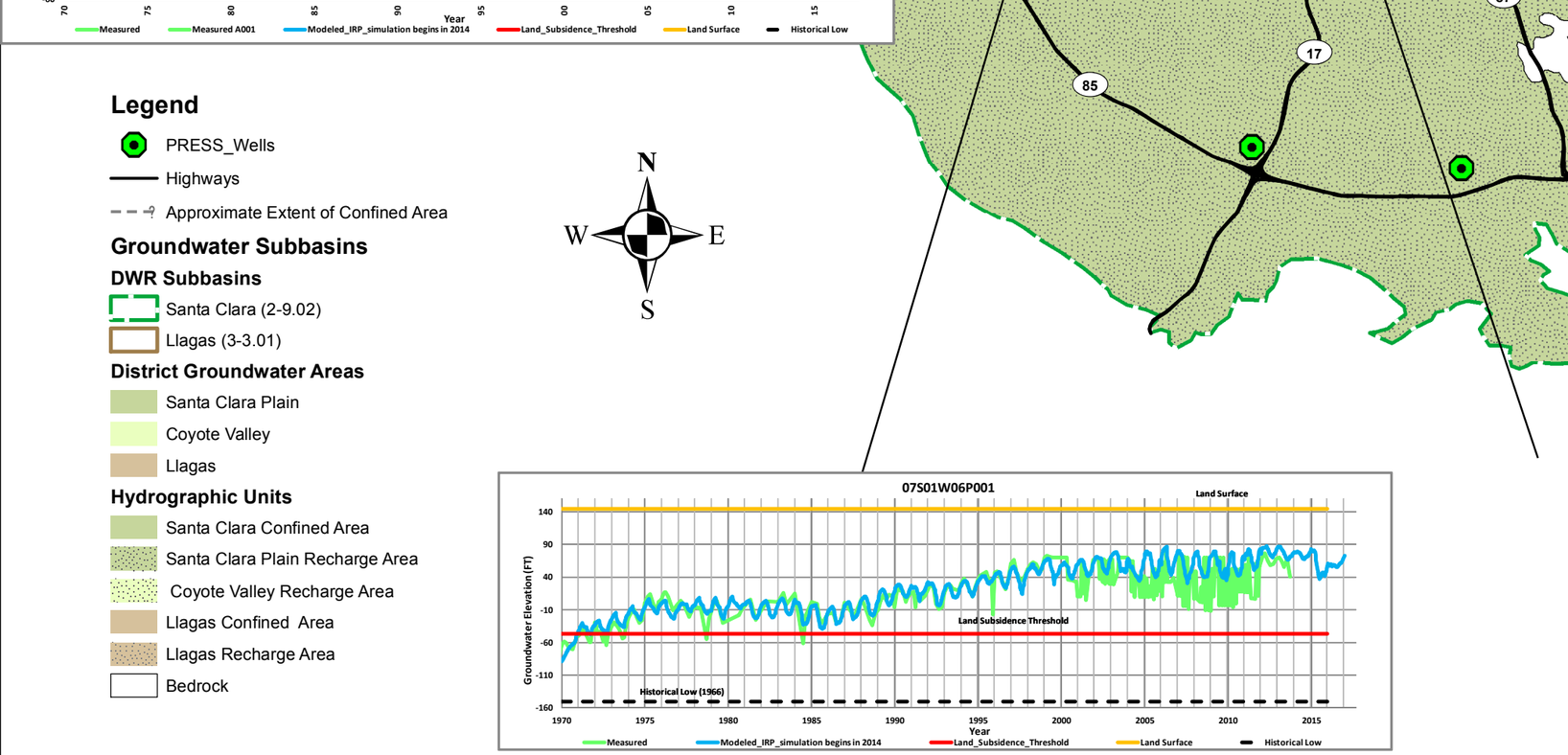












Legend

- PRESS_Wells
- Highways
- Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

- Santa Clara (2-9.02)
- Llagas (3-3.01)

District Groundwater Areas

- Santa Clara Plain
- Coyote Valley
- Llagas

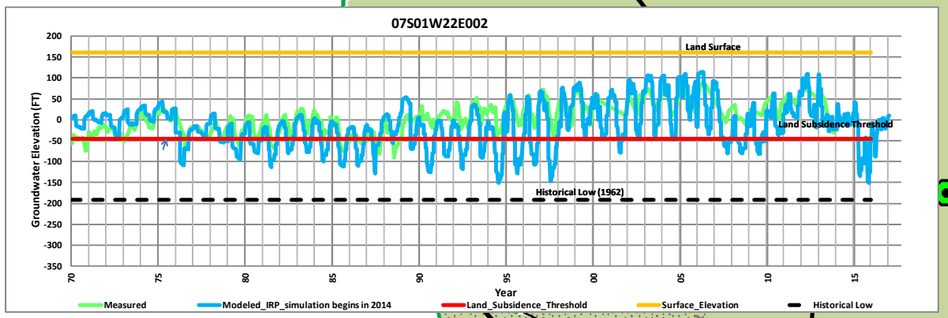
Hydrographic Units

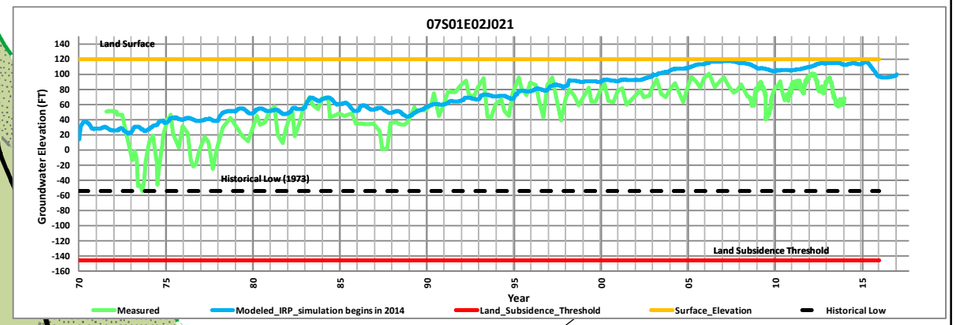
- Santa Clara Confined Area
- Santa Clara Plain Recharge Area
- Coyote Valley Recharge Area
- Llagas Confined Area
- Llagas Recharge Area
- Bedrock

N W E S

Appendix 5c: Groundwater Modeling Results- PRESS Wells in Unconfined Area of Santa Clara Plain Map

PRESS Wells in Unconfined Area of Santa Clara Plain





07S01E02J021

07S01W22E002

08S01W03K013

08S01E05N002

Legend

- PRESS_Wells
- Highways
- Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

- Santa Clara (2-9.02)
- Llagas (3-3.01)

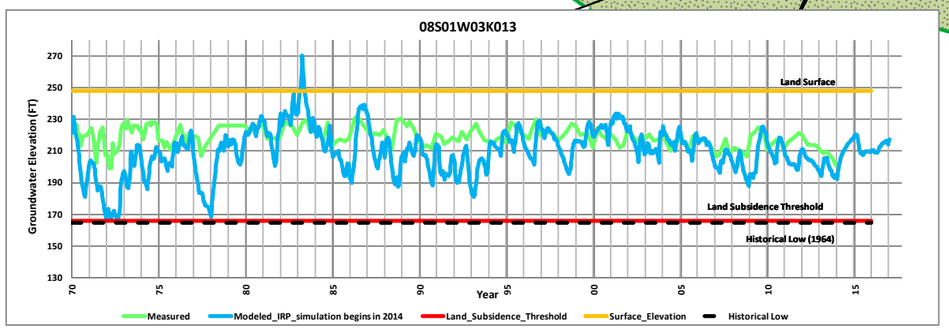
District Groundwater Areas

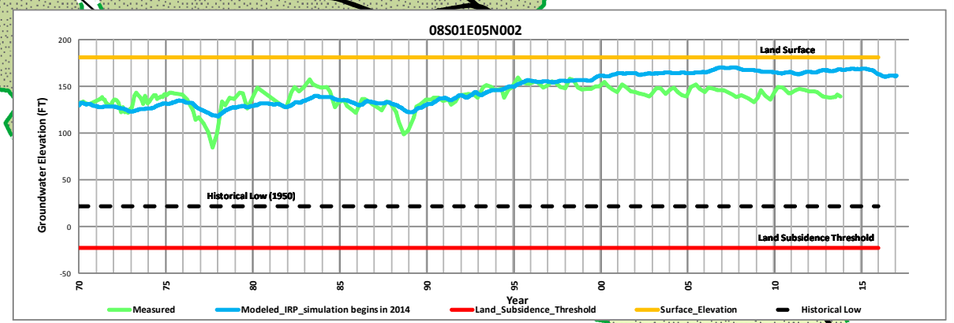
- Santa Clara Plain
- Coyote Valley
- Llagas

Hydrographic Units

- Santa Clara Confined Area
- Santa Clara Plain Recharge Area
- Coyote Valley Recharge Area
- Llagas Confined Area
- Llagas Recharge Area
- Bedrock

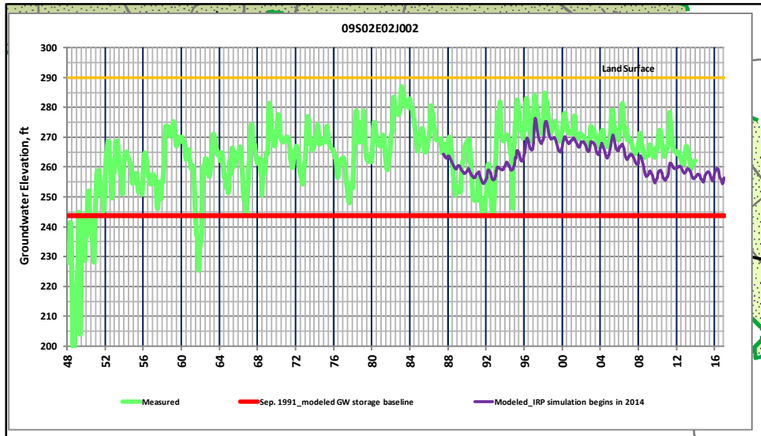
N W E S

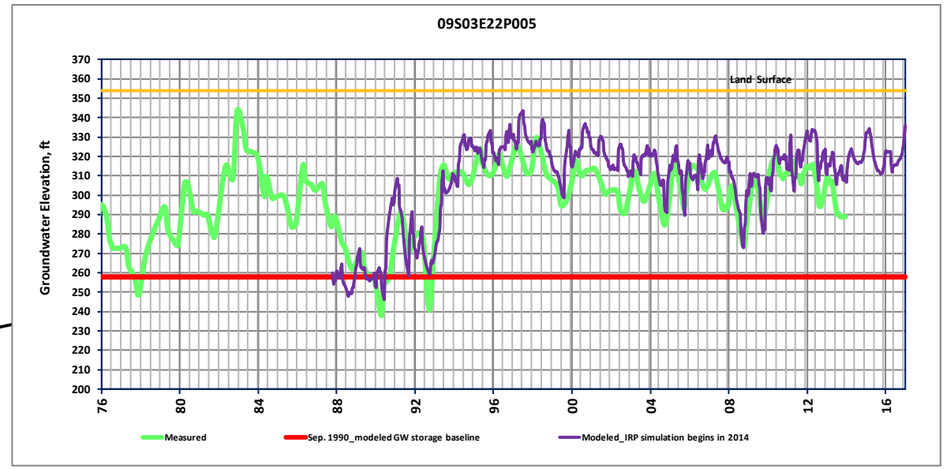


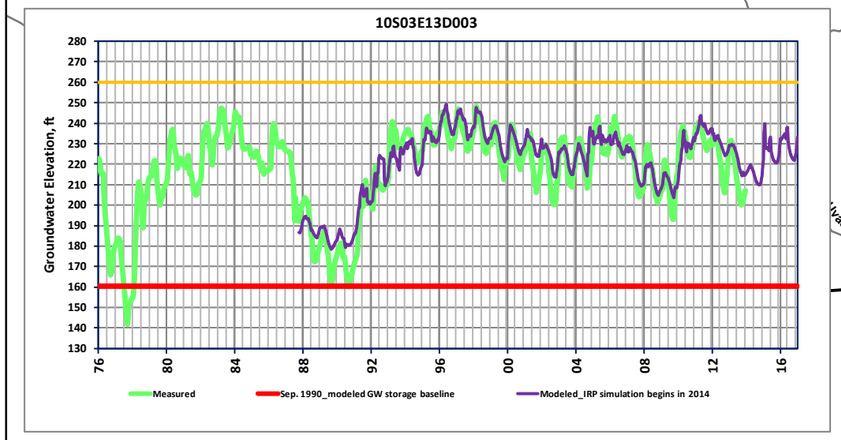


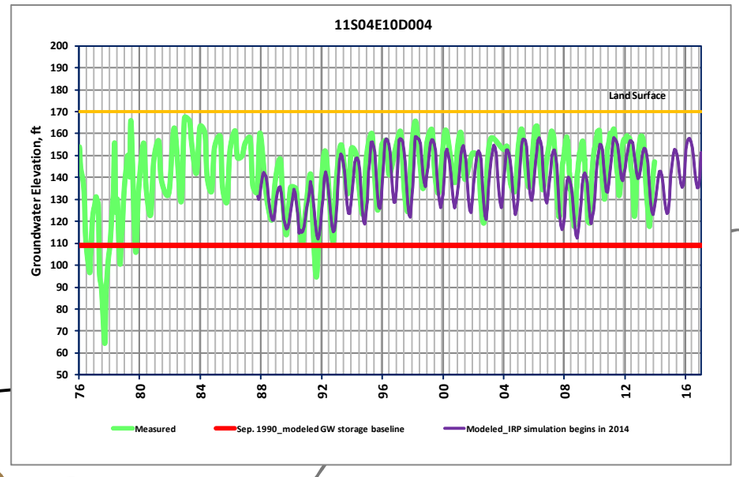
Appendix 5d: Groundwater Modeling Results- South County Hydrograph Map

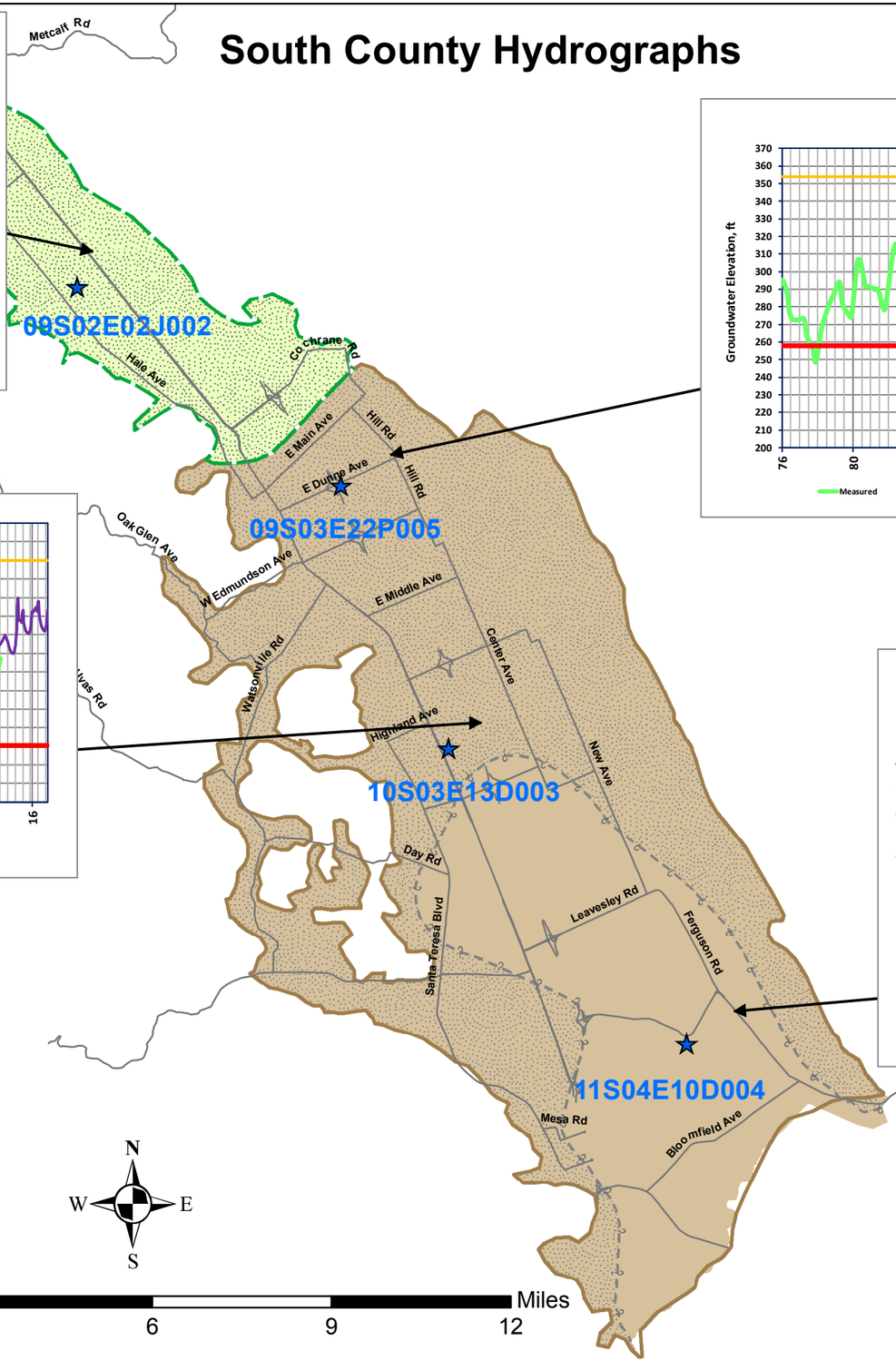
South County Hydrographs











Legend

- Groundwater Monitoring Index Wells
- Major Roads
- Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

- Santa Clara (2-9.02)
- Llagas (3-3.01)

District Groundwater Areas

- Santa Clara Plain
- Coyote Valley
- Llagas

Hydrographic Units

- Santa Clara Plain Recharge Area
- Coyote Valley Recharge Area
- Llagas Confined Area
- Llagas Recharge Area
- Bedrock

Santa Clara Valley Water District

Infrastructure Reliability Plan

Task 8 Appendix

AECOM

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Task 8 Regional Redundancy

Technical Memorandum

Infrastructure Reliability Project, Task 8

Project Number: 93504001

Prepared by:

AECOM

DRAFT

May 31, 2016

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Appendices

Appendix 1: District Regional Area Maps by Outage Scenario

Appendix 2: Groundwater Supply Overview Maps

Appendix 3: Retailer Groundwater Well Capacity

1. Purpose

The purpose of this Technical Memo (TM) for Task 8 is to identify and determine availability of excess supply capacity and back-up supplies for Santa Clara Valley Water District (District) retail customers (retailers). The task is organized into three sections:

Task 8.1 – Determine Excess Potable Water Delivery Capacity: This subtask presents a comparison of the physical capacity of retailers' supply sources versus their minimum usage for those sources. The difference represents the potential excess potable water delivery that may be available for each retailer.

Task 8.2 – Identify Back-up Supplies for District Sources: This subtask presents an assessment of retailers' service areas and identifies availabilities of primary and backup potable water sources. The purpose is to gain an understanding of the areas that have one or more redundant supply options and areas that have no supply redundancy.

Task 8.3 – Identify Existing and Potential Regional Response Capabilities: During the course of gathering information for Tasks 8.1 and 8.2, and gaining understanding retailers' supply situations and demand characteristics, regional capabilities for meeting demands have been noted, along with potential new projects that may enhance capabilities at a customer or system level.

2. Retailer Information

A variety of relevant retailer information has been gathered during the course of this project and via additional discussions at retailer meetings and workshops. The information has led to an understanding of retailer infrastructure (Task 3), water demands and future usage (Task 4), potential vulnerabilities and outages (Task 5), needed and desired level of service (Task 6), and resulting outage impacts (Task 7). For the purposes of Task 8 and subsequent tasks, this information required a consolidated format to facilitate confirmation by stakeholders and further study for accomplishing project goals. A database has been developed which can generate a collection of retailer information sheets into a report. This report has been included in the *Retailer Reporting Database Sheets* (AECOM, 2015).

In addition, retailer system maps have been developed showing retailer service area boundaries, geographic relation to District pipelines, locations of turnouts, and additional turnout information. These maps were useful in understanding retailer service areas and facilitating discussions that helped clarify information for subsequent efforts as described in this Task 8 TM. The Retailer Service Area Maps are included in the Final Report.

3. Excess Potable Water Delivery Capacity

3.1 Maximum Supply Capacity

The District manages the groundwater basin for Santa Clara County, and serves treated water directly to seven retailers. Information on system infrastructure was gathered and Retailer Reports were developed in Task 3. Additional retailer meetings were utilized to further understand and confirm the physical capabilities and limitations of retailer supply sources. **Table 1** presents these results and lists the maximum infrastructure transmission capacity of each water supply source for each District retailer. It should be noted that capacity limitations include groundwater yield, turnout capacity, and contractual limits, not necessarily reflecting available source.

Table 1. Maximum Capacity of Retailer Water Supply (MGD)

Retailer	Groundwater	SCVWD Treated Water	SFPUC	Local Surface Water	Total Capacity
City of Gilroy	18.8	n/a	n/a	n/a	18.8
San Jose Water Company	100.0	182.0		25.0	307.0
City of San Jose	19.6	30.0	21.6	n/a	71.2
Great Oaks Water Company	31.0	n/a	n/a	n/a	31.0
City of Sunnyvale	9.0	18.6	53.4	n/a	81.0
City of Morgan Hill	15.3	n/a	n/a	n/a	15.3
City of Mountain View	6.4	2.5	11.4	n/a	20.3
California Water Service Company	13.0	6.0	n/a	n/a	19.0
City of Milpitas	1.7	14.4	36.0	n/a	52.1
City of Santa Clara	54.0	5.8	10.8	n/a	70.6
TOTAL	**268.8**	**259.3**	**133.2**	**25.0**	**686.3**

Note*:* This is not necessarily the amount of supply available, capacities may be restricted by physical infrastructure limitations.

The retailers' capacity to utilize groundwater supply (268.8 million gallons per day) is greater than the capacity to utilize District treated water (259.3 MGD). In some cases, such as City of San Jose, the groundwater capacity is less than capacity for District treated water, and thus may not be adequate to supplant District supplies. In other cases, such as City of Santa Clara, the groundwater capacity is greater than capacity for District treated water, and thus may have the ability to replace a loss of District treated water.

3.2 Minimum Usage

Minimum retailer usage by source/supply utilizes retailer demand data developed in Task 4 and is summarized in **Table 2**. The minimum usage represents the average water usage for the month of February based on historical data from the 5 year period of 2009 to 2013. It also incorporates 2030 projections from customer Urban Water Management Plans (UWMPs), adjusting for future growth and supply source changes where appropriate. Additional retailer meetings were utilized to further understand and confirm usage/demand characteristics. The purpose of this information is to compare to supply capacities and determine potential available excess supply as shown in Section 3.3.

Table 2. Minimum Retailer Usage by Water Supply Source (MGD)

Retailer	Groundwater	SCVWD Treated Water	SFPUC	Local Surface Water	Total Minimum Usage
City of Gilroy	4.7	n/a	n/a	n/a	4.7
San Jose Water Company	27.5	46.6	n/a	10.5	84.7
City of San Jose	3.2	8.8	3.3	n/a	15.4
Great Oaks Water Company	7.2	n/a	n/a	n/a	7.2
City of Sunnyvale	0.7	6.1	6.5	n/a	13.2
City of Morgan Hill	3.8	n/a	n/a	n/a	3.8
City of Mountain View	0.3	0.6	6.3	n/a	7.2
California Water Service Company	2.0	5.2	n/a	n/a	7.2
City of Milpitas	0.0	3.8	5.2	n/a	9.0
City of Santa Clara	10.6	3.4	2.6	n/a	16.6
TOTAL	**60.1**	**74.5**	**24.0**	**10.5**	**169.1**

The recovery goal is to provide 169 MGD from the available sources for each of the outage scenarios. For the earthquake scenario, the need may be to fulfill minimum demands without District treated water, using only groundwater, local surface water, and SFPUC supply. It should be noted that the minimum usage in **Table 2** represents the smallest amount of water that each retailer has used from each source from a historical perspective. However, in some cases, this may be influenced by source water preferences, and may not fully represent retailer infrastructure capabilities to replace loss of supply. For example, in the case of City of Santa Clara, the minimum usage of SCVWD treated water may be represented by 3.4 MGD historically. However, in case of emergency, it may be possible to replace that 3.4 MGD usage with their groundwater capacity.

3.3 Excess Capacity

Maximum supply/delivery capacities were compared to minimum usage/demands in order to identify where excess system capacity may be available.

Table 3 summarizes the excess capacity available from each source for each retailer.

Table 3. Excess Capacity for Retailer Water Supply Sources (MGD)

Retailer	Groundwater	SCVWD Treated Water	SFPUC	Local Surface Water	Total Excess Capacity
City of Gilroy	14.1	n/a	n/a	n/a	14.1
San Jose Water Company	72.5	135.4		14.5	222.3
City of San Jose	16.4	21.2	18.3	n/a	55.9
Great Oaks Water Company	23.8	n/a	n/a	n/a	23.8
City of Sunnyvale	8.3	12.5	46.9	n/a	67.7
City of Morgan Hill	11.5	n/a	n/a	n/a	11.5
City of Mountain View	6.0	1.9	5.1	n/a	13.0
California Water Service Company	11.0	0.8	n/a	n/a	11.8
City of Milpitas	1.7	10.6	30.8	n/a	43.1
City of Santa Clara	43.4	2.4	8.2	n/a	54.0
TOTAL	**208.7**	**184.8**	**109.2**	**14.5**	**517.2**

As can be noted from **Table 3**, there may be potential excess capacity of more than 200 MGD in groundwater, more than 100 MGD from SFPUC (retailer turnouts), and more than 10 MGD in local supplies. Additionally, the SFPUC-SCVWD intertie in Milpitas has a capacity of 40 MGD which can be considered excess capacity. Retailer systems may not necessarily have capabilities to utilize this excess capacity in all portions of their systems to replace District treated water demands. The next steps will include evaluating capabilities to deliver excess supplies to the portions of retailers' distribution systems that need it, and to back-feed the District's treated water transmission system.

For example, City of Santa Clara shows potential excess groundwater capacity of 43.4 MGD, but only a portion of that capacity is available for replacing loss of District treated water from the turnout on Santa Clara Distributary. Another issue to be noted is that retailer systems may not necessarily have the capability to utilize excess capacities simultaneously, either due to infrastructure limitations or permitted restrictions.

Table 4 below presents all three components: total capacity, minimum usage, and available excess by retailer and water supply type. By combining this information, this table provides a regional supply versus demand picture that shows where potential excess capacity from one water supply source may be adequate or help compensate shortages in other water supply sources. Most notably from a system-wide perspective, in certain situations excess groundwater capacity may be utilized to offset shortages in District treated water supply. As can be inferred from the table, minimum water usage for retailers as whole may be approximately 170 MGD, and minimum District treated water usage has historically been as low as approximately 75 MGD. When comparing to excess quantities for groundwater supply of over 200 MGD as a whole, there may be opportunities to utilize this supply redundancy, and/or enhance this capability where needed.

Table 4. Excess Capacity by Source Type

Retailer	Groundwater (MGD)			SCVWD TW (MGD)			SFPUC TW (MGD)			Local Surface Water (MGD)			Total (MGD)		
	Capacity	Usage	Excess	Capacity	Usage	Excess	Capacity	Usage	Excess	Capacity	Usage	Excess	Capacity	Usage	Excess
Gilroy	18.8	4.7	14.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18.8	4.7	14.1
SJWC	100.0	27.5	72.5	182.0	46.6	135.4	n/a	n/a	n/a	25.0	10.5	14.5	307.0	84.7	222.3
San Jose Muni	19.6	3.2	16.4	30.0	8.8	21.2	21.6	3.3	18.3	n/a	n/a	n/a	71.2	15.4	55.9
Great Oaks	31.0	7.2	23.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	31.0	7.2	23.8
Sunnyvale	9.0	0.7	8.3	18.6	6.1	12.5	53.4	6.5	46.9	n/a	n/a	n/a	81.0	13.2	67.7
Morgan Hill	15.3	3.8	11.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15.3	3.8	11.5
Mountain View	6.4	0.3	6.0	2.5	0.6	1.9	11.4	6.3	5.1	n/a	n/a	n/a	20.3	7.2	13.0
Cal Water Los Altos	13.0	2.0	11.0	6.0	5.2	0.8	n/a	n/a	n/a	n/a	n/a	n/a	19.0	7.2	11.8
Milpitas	1.7	0.0	1.7	14.4	3.8	10.6	36.0	5.2	30.8	n/a	n/a	n/a	52.1	9.0	43.1
Santa Clara	54.0	10.6	43.4	5.8	3.4	2.4	10.8	2.6	8.2	n/a	n/a	n/a	70.6	16.6	54.0
TOTAL	**268.8**	**60.1**	**208.7**	**259.3**	**74.5**	**184.8**	**133.2**	**24.0**	**109.2**	**25.0**	**10.5**	**14.5**	**686.3**	**169.1**	**517.2**

Notes:

1. Usage is based on minimum (winter) demands as developed in Task 4 of the project, and represents planning goals for IRP.
2. Capacity represents infrastructure transmission capacity, not supply availability. Available supplies are typically less than infrastructure capacity.
3. Excess capacity may not be accessible to all parts of Retailer systems, as there may be system and geographical constraints on utilizing alternate supplies.
4. Acronyms: TW = Treated Water, MGD = Million Gallons per Day

4. Supply Source Availability

This task involves an in-depth evaluation of retailer service areas, identifying the primary water sources used in specific locations or zones within retailer service areas, and noting whether there is capability to utilize back-up supplies in case of outages. This effort represents the next step in understanding how the excess capacities presented in Section 3 may be effective and further improved if needed. The following issues were clarified as part of this task:

> Primary Sources: Retailers have multiple pressure zones or service areas for water distribution that may be served by one or more different water supply sources. Based on information developed in Tasks 3 and 4, and further clarifications received during discussions at retailer meetings, the primary water source used in each specific zone within retailer services areas is identified.
>
> Back-Up Supply Availability: Retailer back-up supplies were evaluated to identify areas which have redundant supply capabilities in case primary water supply sources are unavailable. This section summarizes the back-up supply sources that are available for each retailer's primary source.

Table 5 summarizes the primary supply sources, backup supply sources, capacities, and availabilities of backup water supply for each retailer. The table also includes additional insight on availability of existing interconnections between retailers.

As seen in the table, retailers have unique situations with respect to primary and backup supply availability. Generally, there are two categories of backup supply availability; however, it should be noted that this analysis considers only the availability of backup supply and does not address the adequacy of capacity to fulfill the demands needed.

- No backup supply: Gilroy, Great Oaks, and Morgan Hill supply consists of only groundwater, and normally have groundwater capacity beyond their typical needs. The resiliency of the supply needs to be evaluated for the scenarios.
- One or two backup supplies: San Jose Municipal, Cal Water, Santa Clara, San Jose Water Company, Sunnyvale, Mountain View, and Milpitas have supply redundancy and are able to serve all areas with one or two backup supply sources in case of primary source failure.

Table 6 illustrates a high-level regional and retailer-specific supply and demand picture, combining and summarizing information on capacity and excess supply (Table 4), and primary versus backup supply sources (Table 5).

Table 5. Existing Supply Source Availability

Customer	Groundwater Supplies			SCVWD Supplies			SFPUC Supplies		
	Pressure Zones as Primary Supply	Backup Supply Available?	Description and Notes	Pressure Zones as Primary Supply	Backup Supply Available?	Description and Notes	Pressure Zones as Primary Supply	Backup Supply Available?	Description and Notes
Gilroy	All 3 pressure zones	N	- GW well capacity of 18.8 MGD provides redundancy, for average demands of 7.6 MGD	None	N/A	N/A	None	N/A	N/A
SJWC	Most of 90 pressure zones	Y (SCVWD TW, surface TW)	- GW well capacity of 100 MGD meets winter demands - Surface TW capacity of 25 MGD (dependant on local rainfall)	10 of 90 pressure zones	Y (GW wells, surface TW)	- Interties with Cal Water, Cupertino, Great Oaks, Milpitas, and SJ Muni	None	N/A	N/A
San Jose Muni	2 of 8 pressure zones: Edenvale and Coyote	Partial (Edenvale w/SCVWD TW)	- GW well capacity of 19.6 MGD (8.6 MGD in Evergreen meets winter) - Need to confirm permitted status of inactive wells	5 of 8 pressure zones: Evergreen service area	Y (GW wells)	- Interties with SJWC (Evergreen)	1 of 8 pressure zones: NSJ service area	Y (GW wells)	- SFPUC TW capacity of 21.6 MGD (NSJ/Alviso only) - Interties with Santa Clara (NSJ/Alviso)
Great Oaks	All 9 pressure zones	N	- GW well capacity of 31 MGD provides redundancy - Two 6-inch interties with SJWC; capacity and condition unknown	None	N/A	N/A	None	N/A	N/A
Sunnyvale	None	N/A	N/A	2 of 3 pressure zones: Zones 2 and 3	Y (SFPUC TW, GW wells)	- GW well capacity of 10 MGD meets Zones 2 and 3 demands - Able to supply entire service with SCVWD - Interties with Santa Clara, Mt.View, Cupertino, and Cal Water	1 of 3 pressure zones: Zone 1	Y (SCVWD TW, GW wells)	- SFPUC TW capacity of 53.4 MGD (Zone 1), able to supply entire service area with SFPUC - Distribution system capacity limitations - Interties with Santa Clara, Mt.View, and Cal Water
Morgan Hill	All 23 pressure zones	N	- GW well capacity of 15.3 MGD meets maximum demands	None	N/A	N/A	None	N/A	N/A
Mountain View	None	N/A	N/A	1 of 3 pressure zones: Zone 3	Y (SFPUC TW, GW wells)	- GW well capacity of 6.35 MGD provides some backup - Interties with Palo Alto and Sunnyvale	2 of 3 pressure zones: Zones 1 and 2	Y (SCVWD TW, GW wells)	- GW well capacity of 6.35 MGD provides some backup - SFPUC TW capacity of 11.4 MGD (contract max) - Interties with Palo Alto and Sunnyvale
Cal Water Los Altos	Sunnyvale service areas	Y (SCVWD TW)	- GW well capacity of 13 MGD meets winter and average demands - Some operational difficulties supplying entire system with GW	Most of the 18 pressure zones	Y (GW)	- Interties with Santa Clara, Sunnyvale, Purissima Hills, SJWC, and Mt.View	None	N/A	N/A
Milpitas	None	N/A	N/A	2 of 6 pressure zones: Zones 1SC and 2 SC	Y (SFPUC TW)	- Using SFPUC to replace SCVWD significantly increases operational costs	4 of 6 pressure zones: Zones 1SF, 2SF, 3SF, and 4SF	Y (SCVWD TW, Pinewood Well)	- GW well capacity of 1.7 MGD provides some backup - SFPUC TW capacity of 71 MGD (4 zones typically, all zones possible) - Interties with SJWC and ACWD in SF zones
Santa Clara	2 of 4 pressure zones: Zones 1 and 2	Y (SCVWD TW, SFPUC TW)	- GW well capacity of 54 MGD provides redundancy	1 of 4 pressure zones: Zone 2A	Y (GW wells)	- Interties with Sunnyvale, SJ Muni, SJWC, and Cal Water	1 of 4 pressure zones: Zone 1A	Y (SCVWD TW, GW wells)	- SFPUC TW capacity of 10.8 MGD (Zone 1 and 1A) - Interties with Sunnyvale, SJ Muni, SJWC, and Cal Water

Acronyms: TW = Treated Water, GW = Ground Water, MGD = Million Gallons per Day

Table 6. Excess Capacity and Backup Supply by Source Type

Customer	Groundwater (MGD)					SCVWD TW (MGD)					SFPUC TW (MGD)					Total (MGD)		
	Max. Capacity	Min. Usage	Excess	Primary Source?	Backup Avail.?	Max. Capacity	Min. Usage	Excess	Primary Source?	Backup Avail.?	Max. Capacity	Min. Usage	Excess	Primary Source?	Backup Avail.?	Max. Capacity	Min. Usage	Excess
Gilroy	19	5	14	All 3 zones	None	N/A					N/A					19	5	14
SJWC	100	28	72	Most of 90 zones	SCVWD TW Surface TW	182	47	135	10 of 90 zones	GW wells Surface TW	N/A					307	85	222
San Jose Muni	20	3	17	2 of 8 areas	Edenvale: SCVWD TW	30	9	21	5 of 8 areas	GW wells	22	3	18	1 of 8 areas	GW wells	72	15	56
Great Oaks	31	7	24	All 9 zones	None	N/A					N/A					31	7	24
Sunnyvale	9	1	8	N/A		19	6	13	2 of 3 zones	SFPUC TW GW wells	53	6	47	1 of 3 zones	SCVWD TW GW wells	81	13	68
Morgan Hill	15	4	11	All 23 zones	None	N/A					N/A					15	4	11
Mountain View	6	0	6	N/A		3	1	2	1 of 3 zones	SFPUC TW GW wells	11	6	5	2 of 3 zones	SCVWD TW GW wells	20	7	13
Cal Water Los Altos	13	2	11	Sunnyvale svc area	SCVWD TW	6	5	1	Most of 18 zones	GW wells	N/A					19	7	12
Milpitas	2	0	2	N/A		14	4	11	2 of 6 zones	SFPUC TW Curtis Well	36	5	31	4 of 6 zones	SCVWD TW GW wells ACWD	52	9	43
Santa Clara	54	11	43	2 of 4 zones	SCVWD TW SFPUC TW	6	3	2	1 of 4 zones	GW wells	11	3	8	1 of 4 zones	SCVWD TW GW wells	71	17	54
TOTAL RETAILERS	**269**	**60**	**209**			**259**	**75**	**185**			**133**	**24**	**109**			**687**	**169**	**518**

5. Existing and Potential Regional Response Capabilities

The project team worked with retailers and SFPUC to identify existing regional capabilities and to identify potential new regional projects for meeting level of service goals.

5.1 District Regional Area Scenario Maps

Regional area maps were developed to better understand how facility outages from Tasks 5 and 7 may impact the District and retailers at a regional level. To create an efficient visual format, the maps are split into East and West sides, show the treated water system geographically, and represent the raw water system as a schematic in an inset. These maps illustrate the four outage scenarios with specific facility outages shown in red, and the turnouts which correlate with failed or intact pipelines:

- San Andreas Earthquake 1
- San Andreas Earthquake 2
- Calaveras Earthquake
- Extreme Storm

The maps are included in **Appendix 1**. The intent of this tool is to overlay scenario outages to better understand the retailer service areas impacted. It should be noted that this is an interim evaluation tool, and is not intended to illustrate specific service deficiencies, shortfalls, needs, and solutions. Enhanced tools for those purposes are part of Task 9 Improvement Needs and Task 11 Projects to Meet Needs.

5.2 Groundwater Supply and Demand Overview

A groundwater supply and demand overview has been developed to understand the groundwater supply capacity in relation to District turnouts and zones within retailer service areas that are normally served by District treated water and groundwater. The purpose of this effort is to further quantify and begin correlating where (geographically) groundwater is available to offset loss of District treated water via the turnout, and where additional enhancements are needed. More information can be found in **Appendix 2**, while the Groundwater Supply Overview Maps are included in the Final Report.

Retailer groundwater well capacities are provided for individual wells where available, or by groups of wells where logical or necessary. The groundwater capacity is compared to retailer winter usage for District treated water and groundwater supply only. The purpose is to better understand the capabilities and limitations of using groundwater to supply both areas that typically rely on groundwater, plus areas that typically rely on District treated water. This section summarizes general findings of the groundwater supply and demand overview by retailer.

A summary of individual retailer groundwater well capacities are included in **Appendix 3**.

- California Water Service Company: Total groundwater supply capacity is 13 MGD, with approximately 11 MGD in the Farndon/Granger/Covington area and 2 MGD in the Vallco area. Winter demands total 7.2 MGD, with approximately 4 MGD of District treated water demand at the Farndon/Granger/Covington turnouts, and 1.2 MGD at the Vallco turnout. There is potential that up to 5.8 MGD excess groundwater capacity may be available to offset loss of District treated water.

Cal Water	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
Farndon	11	2.0	4.0	Up to 5.8
Granger				
Covington				
Vallco	2		1.2	
Total	13	2.0	5.2	

- Gilroy: Total groundwater supply capacity is 18.7 MGD, and winter demands are 4.7 MGD. There is potential for up to 14 MGD of excess groundwater capacity. Gilroy is not in close proximity to District treated water pipelines and is currently not able to supply excess groundwater into the District treated water system.

Gilroy	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
Total	18.7	4.7	n/a	Up to 14

- Great Oaks: Total groundwater supply capacity is 31 MGD, and winter demands are 7.2 MGD. There is potential for up to 23.8 MGD of excess groundwater capacity. However, to determine how much excess supply may be utilized in the District treated water system, further confirmation may be needed to identify the quantity that can reach Snell Pipeline. Initial understanding is that the Great Oaks distribution system has adequate flexibility to supply 20 MGD of groundwater to the Snell Pipeline.

Great Oaks	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
Total	31	7.2	n/a	Up to 23.8

- Milpitas: Total groundwater supply capacity is 1.7 MGD. District treated water winter demands are 2.7 MGD existing, and 3.8 MGD with future growth adjustments (see Task 4). The Pinewood Well serves SFPUC zones, and no groundwater capabilities currently exist in SCVWD zones. Milpitas has a shortage of 2.1 MGD in the event of loss of treated water. Completion of the Curtis Well or wheeling water between turnouts may be a viable solution.

Milpitas	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential GW Shortage (MGD)
Total	1.7	0	3.8	(2.1)

- Morgan Hill: Total groundwater supply capacity is 15.3 MGD, and winter demands are 3.8 MGD. The potential for 11.5 MGD excess groundwater may be unreliable because groundwater levels are dynamic and less stable than that of Gilroy and Great Oaks, and there is heavier reliance on regular groundwater recharge. Morgan Hill is not connected to the District treated water system.

Morgan Hill	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
Total	15.3	3.8	0	unreliable

- Mountain View: Total groundwater supply capacity is 5.2 MGD, all of which is in Zones 1 and 2, which have typical groundwater usage of 0.3 MGD. Zone 3, which is served by District treated water, has winter demands of 0.6 MGD. There is no currently no groundwater capability to offset District treated water demands in Zone 3. There may be good potential sites for new groundwater wells to serve Zone 3.

Mountain View	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
Zone 1 and 2	5.2	0.3	0	4.9
Zone 3	0	0	0.6	0
Total	5.2	0.3	0.6	4.3

- San Jose Municipal: Total groundwater supply capacity is 19.6 MGD, with approximately 8.6 MGD in the Evergreen service area which is served by the District. Total winter demands are 8.0 MGD existing, and 8.8 MGD with future growth adjustments (see Task 4). Although the minimum demands in the Evergreen area (6.2 MGD) are lower than the groundwater capacity in Evergreen, the Evergreen wells are currently under operational restrictions and may not be able to replace a loss of District treated water. More enhancements may be needed to provide capability to offset loss of District treated water, either within Evergreen or from Edenvale which has excess groundwater capacity. The excess 3.8 MGD in the Edenvale service area could potentially be supplied to Evergreen due to a new intertie between service areas. Pumping improvements would be required.

San Jose Muni	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
North San Jose	3.4	2.0	0	Not available to District
Evergreen	8.6	6.2		2.4
Edenvale	4.2	0.4	0	3.8
Coyote	3.4	0.2	0	Not available to District
Total	19.6	8.8		10.8

- San Jose Water Company: Total groundwater supply capacity is 100 MGD. During favorable conditions, there is adequate groundwater capacity to satisfy winter demands estimated at 84.7 MGD. There is potential for up to 25.9 MGD of excess groundwater capacity, however, to determine how much excess supply may be utilized in the District treated water system, further confirmation is needed to identify the quantities that can reach San Jose Water Company's various District turnouts.

San Jose Water company	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
Total	100	27.5	46.6	Up to 25.9

- Santa Clara: Total groundwater supply capacity is 54 MGD; however, only one well (2 MGD) is located in Zone 2A that is served by the District treated water turnout which typically provides 3.4 MGD winter flows. The system does have the ability to pump groundwater from the other zones into Zone 2A. An additional well in Zone 2A could be located near the Serra Tank and the District turnout, potentially with the ability to provide excess groundwater supply into the District treated

water system. Further evaluation is needed to determine the benefits of additional groundwater capacity in Zone 2A.

Santa Clara	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
Zone 1	52	10.6	-	41.4
Zone 1A				
Zone 2				
Zone 2A	2	-	3.4	0
Total	54	10.6	3.4	Up to 40

- Sunnyvale: Total groundwater supply capacity is 9 MGD, located in Zones 2 and 3 which are served by District treated water at typical winter demands of 6.1 MGD. It should be noted that only Westmoor Well (0.7 MGD) is located in Zone 3, where the District treated water turnouts are. There may be concern with Sunnyvale's distribution system and its post-earthquake capabilities for inter-zone distribution.

Sunnyvale	GW capacity (MGD)	GW Demand (MGD)	District TW Demand (MGD)	Potential Excess GW (MGD)
Zone 1	0	0	0	-
Zone 2	9	0.65	6.1	Up to 2.25
Zone 3				
Total	9	0.65	6.1	Up to 2.25

6. Potential Regional Projects

Retailer meetings were held to gather specific information on interties, operational schemes, and other available regional response mechanisms currently available or requiring enhancements. During the series of meetings, various ideas on potential new regional connections or projects to improve system supply reliability were identified and discussed. Generally, retailers favor cost-efficient solutions, and prefer to leverage existing infrastructure and supplies where beneficial and reasonable. Retailers are also open to, and often prefer, solutions that provide supply closer to the point-of-use (such as within retailer service areas) and may provide benefits regularly, not only for the purpose of catastrophic emergencies. These solutions include new and/or enhancements to existing interconnections between retailers, groundwater well improvements (including backup power and fuel storage), and additional groundwater capacity at existing sites/pipelines. **Table 7** summarizes some of these specific potential regional response projects. It should be noted that subsequent tasks, such as Task 11 Identify Projects to Meet Needs, will provide a more comprehensive and detailed overview of potential projects.

Table 7. Potential Retailer Projects

Retailer	Project Description
California Water Service	Install intertie with City of Mountain View (stub-outs approximately 50 feet apart)
	Develop additional and/or enhance existing interties with neighboring service areas
	Develop additional groundwater wells in northern portion of the county which may allow back-feeding into West Pipeline
	Develop connection to SFPUC BDPL 3 and 4 pipelines
	Tie in Bear Gulch service area into Los Altos service area to gain flexibility in using SFPUC supplies
City of Gilroy	Construct pipeline to share water with Morgan Hill
	Construct connection to Santa Clara Conduit so that Gilroy can feed into SCVWD system
City of Milpitas	Develop additional interties and enhance existing interties
	Install isolation valves on Milpitas Pipeline both north and south of existing turnout, particularly between the SCVWD turnouts near Piper/Montague
	Develop groundwater well on Snell Pipeline or East Pipeline to feed system on East side for Milpitas and San Jose
City of Morgan Hill	Construct pipeline to share water from Gilroy
	Develop capabilities to feed recycled water into recharge ponds as backup
	Develop options for feeding groundwater into Santa Clara Conduit as backup
City of Mountain View	Construct groundwater wells in Zone 3, such as at Bryant and/or Miramonte. May be able to back-feed Mountain View Distributary.
	Construct intertie in Zone 3 to neighboring service area(s), such as Sunnyvale
	Work with CalWater to construct interties, currently stub-outs are 50-feet apart
	Construct additional larger intertie with Palo Alto
	Consider west-side intertie with SFPUC, which would provide additional west-side connections to BDPL 3 and 4
City of San Jose	Purchase equipment, pumps, hose/piping for three intertie locations with SJWC in Evergreen
	Construct additional groundwater wells near East Pipeline
	Construct intertie with Great Oaks in Evergreen
	Joint communication on service cutbacks
	Create agreements that allow for the purchase of SCVWD water through SPFUC (as back-up for North service area)

Retailer	Project Description
City of Santa Clara	Install additional intertie(s) with City of San Jose
	Install additional well near Serra Tank in Zone 2A, which could be tied into the Santa Clara Distributary to back-feed District system. May require upgrade at existing turnout.
Great Oaks Water Company	Construct turnout/intertie to SCVWD Snell Pipeline at Branham Lane to back-feed excess groundwater supply
	Construct turnout/intertie to SCVWD Snell Pipeline at Valley Christian School to back-feed excess groundwater supply
	Construct additional wells in different locations of the GW basin to provide reliable excess GW supply
	Install intertie(s) with San Jose Municipal in Evergreen area
	Upgrade and test two existing interties with SJWC
San Jose Water Company	Increase intertie capabilities, including construction of new interties and improvements to existing interties
	Test capacities of interties (by gravity and pumping)
	Develop ability to wheel water through SCVWD system from Cox turnout to other West PL turnouts (such as Mann Station)
	Study groundwater standing water level versus groundwater basin capacity, to avoid subsidence
	Construct isolation valves at optimized locations, such as upstream of Mann, and both sides of Cox.
	Interagency use of SCVWD pipelines for wheeling water
Santa Clara Valley Water District	Enhance emergency preparedness
	Evaluate fuel and chemical contingencies
	Consider utilization/integration of indirect potable reuse, particularly for groundwater recharge
	Replace/retrofit/harden critical and vulnerable pipeline sections

7. References

AECOM, 2015. *Retailer Reporting Database Sheets*.

Appendix 1

District Regional Area Maps by Outage Scenario

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Appendix 2

Groundwater Supply Overview Analysis

Groundwater Supply Overview Analysis

AECOM received GIS shapefiles from the District which included the locations of 50,396 wells within the boundaries of its service area. Based on initial review, these wells are categorized into 12 categories as listed below as listed in the "Status" field:

Status	Count/No. of Wells
A	17,131
A01	7,561
A02	808
B	2,640
D	21,274
I	1
I02	3
IS01	364
P	1
Pending	63
S	155
Undet	395
Total	50,396

The majority of the wells are not retailer groundwater extraction wells. In order to identify retailer groundwater extraction wells and their geographic relation to District turnouts, a preliminary effort was made to correlate via Well ID using information collected in Task 3 and retailer meetings. Where Well ID is not available, geographic estimation methods are used to correlate wells in the same geographic location. This initial screening led to the determination and assumption that many of the active retailer groundwater extraction wells utilize a status field of "A01" or "A02". This was used to filter and narrow down the number of wells for the purposes of geographic correlation.

Appendix 3

Retailer Groundwater Well Capacity

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Santa Clara Valley Water District

Infrastructure Reliability Plan

Task 9 Appendix

AECOM

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System Reliability Improvement Needs

Technical Memorandum

Infrastructure Reliability Project, Task 9

Project Number: 93504001

Prepared by:

AECOM

DRAFT

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Appendices

Appendix 1: Outage Schematic Repair Sequence

Appendix 2: Restoration Schematics

Appendix 3: Risk Exposure Assessment

1. Purpose

The purpose of this Technical Memo (TM) for Task 9 is to identify specific service areas and infrastructure that require reliability improvement projects due to a high probability of failure, large consequence of failure, or both. This task further clarifies treated water service shortfalls that the Santa Clara Valley Water District (District) retail customers may experience following the selected outage scenarios. The task is organized into the following sections:

Task 9.1 – Assess Existing Performance and Identify Shortfalls: This subtask was combined with Task 9.3 (Identify System Reliability Needs) to assess the existing performance of the District's system. The purpose of this task is to identify the shortfalls in the District's system performance with respect to the seven selected outage scenarios. Additionally, the task includes an analysis of areas likely to fall below preliminary performance goals and require improvement. This task builds on the results of Task 8 by determining if the existing regional redundancies identified in Task 8 improve the District's system performance and provide a reduction in performance shortfalls.

Task 9.2 – Risk Exposure: This subtask presents an assessment of service failures with the highest risk exposure. High risk could occur due to a high probability of failure, large consequence of failure, or both. The purpose is to present information on level of service shortfalls and risk. The levels of risk that the District and regional partners are willing to accept will influence the selection of level of service goals and corresponding system improvements needed.

Additional Task – Pipe Damage Assessment: Based on an in-depth analysis of seismic vulnerability from the 2005 IRP, this analysis attempts to identify pipe segments where a majority of the vulnerability is contained in a smaller stretch of pipeline. Pipeline improvements are recommended based on the results.

2. Existing System Performance

The Task 7 TM identified impacts to the District's ability to deliver potable water in the seven outage scenarios identified for the project with its current baseline system and only planned capital improvements (no new improvements) in place. Task 7 presented an overview of damaged facilities and potential repair sequences necessary to restore treated water service to retail customers. Based on the results of Task 7, this section determines which retailers experience a loss of District treated water in each outage scenario and summarizes the availability of treated water for each retailer at multiple time-steps following an outage.

For each outage scenario, two repair sequences were developed by the District in Task 7. The Task 7 TM identified the days at which critical infrastructure would be repaired following each outage scenario. At these critical time-steps, East and West-side retailers are able to receive increased amounts of SCVWD treated water. **Table 2** through **Table 5** depict the availability of SCVWD supplies and provide a visual representation of the status of retailers throughout the recovery period using the color code shown in **Table 1**. Red boxes indicate that no SCVWD treated water is available; yellow boxes indicate that minimum demands can be met with SCVWD treated water; and green boxes indicate that average demands can be met with SCVWD treated water. These tables only indicate that the retailer cannot utilize District treated water supplies; they do not include any information on other sources of available treated water (such as groundwater or SFPUC treated water).

The repair sequence for each outage scenario from the Task 7 TM is also presented on outage schematics in **Appendix 1**.

Table 1. Color Code for Repair Sequence Tables

Color	Legend
	No SCVWD TW Supply Available
	Minimum Demands Met
	Average Demands Met

2.1 Assumptions and Considerations

It is important to note that the time-steps used in the following tables do not represent exact days, but rather a range of days. For example, the Day 0 time-step represents the first few days after an outage and the Day 60+ time-step represents days in the range of 50 to 80. This simplifying assumption has been made in order to ensure consistency among the analyses of each outage scenario. Additionally, the original time-steps presented in the Task 7 TM were based on several assumptions and intended to provide a realistic stress test on the District's system. Actual outage durations in any single event will likely be different from modeled results.

A major assumption carried over from Task 7 is the availability of the SFPUC Intertie, which has a capacity of around 40 MGD. In every outage scenario, the intertie is assumed to be available immediately (within a few days) following the event. Although the intertie capacity is approximately 2 MGD lower than the winter demands of East-side retailers, it is assumed that East-side retailers can meet their minimum demands from the intertie alone.

2.2 San Andreas Earthquake 1

The Task 7 TM identified two repair sequences to address the damages incurred from a M7.9 San Andreas earthquake in which damage is centered on West-side facilities. The first repair sequence, Scenario A, prioritizes repairing the Almaden Valley and Cross Valley Pipelines. The second repair sequence, Scenario B, prioritizes repairing the South Bay Aqueduct and Central Pipeline.

The retailer outages for both repair sequences are summarized in **Table 2** below.

Table 2. San Andreas Earthquake 1 Expected Outage Times

San Andreas EQ 1 – Scenario A

Retailer		Day			
		0	14	30	60+
East	SJWC				
	San Jose Muni				
	Milpitas				
West	SJWC				
	Cal Water				
	Sunnyvale				
	Mountain View				
	Santa Clara				

San Andreas EQ 1 – Scenario B

Retailer		Day			
		0	14	30	60+
East	SJWC				
	San Jose Muni				
	Milpitas				
West	SJWC				
	Cal Water				
	Sunnyvale				
	Mountain View				
	Santa Clara				

In both Scenarios A and B, the East-side retailers receive minimum demands from the SCVWD system at approximately Day 4, while West-side is unable to meet winter demands until after approximately 30 days at which point they can supply average demands. In Scenario A, both East- and West-side retailers are able to meet average demands after approximately 30 days. In Scenario B, however, only West-side retailers can meet average demands after approximately 30 days.

2.3 San Andreas Earthquake 2

The Task 7 TM identified two repair sequences to address damage incurred from a M7.9 San Andreas earthquake in which damage is centered on East-side facilities. The first repair sequence, Scenario A, prioritizes restoring treated water service to the West-side retailers first, by prioritizing repairs of the Almaden Valley Pipeline. The second repair sequence, Scenario B, prioritizes restoring service to the East-side retailers first, by prioritizing repairs of East-side treated water pipelines including Snell, East, and Milpitas Pipelines.

The retailer outages for both repair sequences are summarized in **Table 3** below.

Table 3. San Andreas Earthquake 2 Expected Outage Times

San Andreas EQ 2 – Scenario A

Retailer		Day			
		0	14	30	60+
East	SJWC				
	San Jose Muni				
	Milpitas				
West	SJWC				
	Cal Water				
	Sunnyvale				
	Mountain View				
	Santa Clara				

San Andreas EQ 2 – Scenario B

Retailer		Day			
		0	14	30	60+
East	SJWC				
	San Jose Muni				
	Milpitas				
West	SJWC				
	Cal Water				
	Sunnyvale				
	Mountain View				
	Santa Clara				

Since Scenario A prioritizes West-side system repairs, the West-side retailers can meet minimum demands after approximately 14 days, while East-side retailers do not have any available treated water until after approximately 30 days. In Scenario B, East-side system repairs are prioritized, so the East-side retailers receive minimum demands after approximately 14 days, and West-side retailers receive minimum demands after approximately 30 days.

2.4 Calaveras Earthquake

The Task 7 TM identified two repair sequences to address damage incurred from a M6.9 Calaveras earthquake. Both repair sequence prioritize repairing the Cross Valley Pipeline first. The first repair sequence, Scenario A, then prioritizes the restoration of San Felipe supplies. The second repair sequence, Scenario B, prioritizes the restoration of South Bay Aqueduct supplies. The end result for both repair sequences is similar, as Calero Reservoir is able to supply Rinconada WTP for the West-side after approximately Day 4, and Santa Teresa WTP and SFPUC Intertie is able to supply the East-side after approximately Day 4, regardless of the repair sequences affecting South Bay Aqueduct, Cross Valley Pipeline, and Santa Clara and Pacheco Conduits.

The retailer outages for both repair sequences are summarized in **Table 4** below.

Table 4. Calaveras Earthquake Expected Outage Times
Calaveras EQ – Scenario A/B

Retailer		Day			
		0	14	30	60+
East	SJWC				
	San Jose Muni				
	Milpitas				
West	SJWC				
	Cal Water				
	Sunnyvale				
	Mountain View				
	Santa Clara				

Retailers are able to meet minimum and average demands on the same days for both Scenarios A and B. In either case, minimum demands can be met after approximately Day 4, due to relatively minor infrastructure damage.

2.5 Extreme Storm

The Task 7 TM identified two repair sequences to address damage incurred from an extreme storm event. Both repair sequence prioritize repairing the West Pipeline first. The first repair sequence, Scenario A, then prioritizes the restoration of San Felipe supplies. The second repair sequence, Scenario B, prioritizes the restoration of South Bay Aqueduct supplies. The end result for both repair sequences is similar, as Calero Reservoir is able to supply Rinconada WTP for the West-side after approximately 14 days, and SFPUC Intertie is able to supply the East-side after approximately Day 4, regardless of the repair sequences affecting upstream facilities such as Pacheco PP, Santa Clara Tunnel, and Coyote PP.

The retailer outages for both repair sequences are summarized in **Table 5** below.

Table 5. Extreme Storm Expected Outage Times
Extreme Storm – Scenario A/B

Retailer		Day			
		0	14	30	60+
East	SJWC				
	San Jose Muni				
	Milpitas				
West	SJWC				
	Cal Water				
	Sunnyvale				
	Mountain View				
	Santa Clara				

For both Scenarios A and B, East-side retailers receive minimum demands after approximately Day 4, and West-side retailers receive minimum demands beginning after approximately 14 days.

2.6 Delta Outages

Based on findings from the evaluation in the Task 5 TM, it appears unlikely that an event significant enough to disrupt the export of water from the Delta would also impact local District infrastructure. An earthquake or flood event in the Delta is far enough away from Santa Clara County that it would not badly damage local infrastructure. Therefore, the analysis of the Delta outage scenarios in the Task 7 TM focused on whether or not the District could continue limited service for the outage duration with no imported water. Two Delta outage scenarios were analyzed in Task 7, a 6-month and a 24-month Delta outage.

Analysis of both Delta outage scenarios show that the District can continue service without any imported water supplies. The impacts of a 6 or 24-month Delta outage are largely operational as it would require retailers to supplement their supplies with groundwater via pumping and for District staff to actively manage the groundwater recharge program to meet any county-wide needs.

2.7 Power Outages

As discussed in the SCVWD Fuel Analysis Memo, prepared by Joe Hill Consulting Engineers (JHCE) and AECOM, there are two approaches to analyzing District capabilities with respect to power outages. The first analysis considers fuel requirements to compensate for a prolonged power outage. The second analysis considers the IRP outage scenarios and accounts for facility outages or lack of source water.

In a prolonged power outage, the District can operate all facilities on existing backup fuel storage alone for around 3 to 10 days. The length of time can be extended if the District schedules storage tank refueling deliveries. For example, to meet summer demands, the District would need to refuel storage tanks at the water treatment plants every 3 days. During the winter, fuel deliveries to water treatment plants would be required less frequently. In both seasons, fuel delivery to the SFPUC Intertie would be required every 3 days if the intertie were being utilized to its maximum capacity (40 MGD).

With regard to the selected outage scenarios, fuel requirements were calculated for the Extreme Storm event, the San Andreas and Calaveras earthquakes. In both San Andreas earthquakes, key facilities are rendered non-operational, so backup power is irrelevant. In the Extreme Storm scenario, fuel delivery to the SFPUC Intertie would be necessary. In the Calaveras earthquake scenario, fuel delivery to the following facilities would be required: SFPUC Intertie, Rinconada WTP, Santa Teresa WTP, Coyote Pump Station, and Vasona Pump Station.

The fuel analysis exercise does not indicate any significant shortfalls in the District's system. The District is capable of responding to power outages and preventing treated water outages to customers for a reasonable duration of time. The Fuel Analysis Memo includes the following recommended actions to improve system reliability:

1. Confirm that refueling procedures are established and followed to maintain initial fuel storage levels at facilities in the event of an emergency.
2. Identify off-site fuel storage possibilities and confirm that adequate staff and equipment are available to make fuel deliveries between off-site and facilities.
3. Continue discussions with regional agencies to coordinate regional fuel storage/supply efforts.
4. Develop emergency operations strategies for the SCVWD system and specific facilities (especially the RWTP) which seek to minimize fuel consumption.

2.8 Summary

The analysis from Task 8 determined the availability of excess supply capacity and back-up supplies for each retailer. The results discussed in Sections 2.2 through 2.7 were combined with the results from Task 8 and summarized in **Table 6**. Schematics of the facilities during restoration are available in **Appendix 2**.

Table 6. Days to Restore Minimum Demands to SCVWD Treated Water and Backup Water Supply Sources

Retailer	Minimum Demand	SCVWD TW System Outages	Days to Minimum SCVWD TW Demands				Backup Water Supply Sources	
			Extreme Storm	San Andreas EQ 1	San Andreas EQ 2	Calaveras EQ	Available Sources	Available Supply
Gilroy	5 MGD	None					Groundwater	19 MGD
SJWC	85 MGD	West	14	30	30[1]	0	Groundwater	100 MGD
		East	0	0	14[1]	0		
San Jose Muni	15 MGD	East	0	0	14[1]	0	Groundwater, SFPUC treated water	47 MGD[2]
Great Oaks	7 MGD	None					Groundwater	31 MGD
Sunnyvale	13 MGD	West	14	30	30[1]	0	Groundwater, SFPUC treated water	63 MGD
Morgan Hill	4 MGD	None					Groundwater	15 MGD
Mountain View	7 MGD	West	14	30	30[1]	0	Groundwater, SFPUC treated water	17 MGD
Cal Water	7 MGD	West	14	30	30[1]	0	Groundwater	18 MGD
Milpitas	9 MGD	East	0	0	14[1]	0	Groundwater, SFPUC treated water	39 MGD
Santa Clara	17 MGD	West	14	30	30[1]	0	Groundwater, SFPUC treated water	69 MGD
Palo Alto	6 MGD	None					Groundwater, SFPUC treated water	35 MGD
Purissima Hills	1 MGD	None					SFPUC treated water	4 MGD

[1] Depends on which side of the treated water system is prioritized for repairs. If East is brought online after approximately 14 days, West will be back after approximately 30 days. If West is brought online after approximately 14 days, East will be back after approximately 30 days.

[2] 22 MGD is from SFPUC, which does not serve San Jose Muni's District treated water service areas.

Based on the results presented in Sections 2.2 through 2.7, shown in **Table 6**, the turnouts that provide SCVWD treated water to retailers may not be able to provide sufficient water supply to meet winter demands under the following scenarios:

- San Andreas Earthquake 1
- San Andreas Earthquake 2
- Extreme Storm

Most retailers will need to supplement their supplies with groundwater supply to meet their winter demands during District treated water outages. The following section identifies the retailer service areas that will have potential water supply shortfalls when SCVWD treated water cannot be utilized.

It should be noted that the physical reliability of groundwater wells has not been specifically studied as part of this project. According to studies conducted by USGS and the Lawrence Livermore National Lab that investigated the effects of earthquakes on groundwater supply, significant infrastructure damage to groundwater wells was not documented in those studies (Morgan, et al. 2014; Sneed et al, 2003). Another issue would be availability of backup power to operate groundwater wells in case of power outages. Some retailers have made significant improvements to their backup power capabilities and fuel supplies in order to better prepare for a power outage. Based on these considerations, for the purposes of this project's evaluations, existing groundwater wells are assumed to be available.

3. Shortfalls and Opportunities for Improvement

This section identifies areas where there is a potential for a deficit in treated water supply following an outage and discusses strategies to improve system shortfalls.

3.1 West Treated Water Network

Table 7 identifies retailers that rely on District treated water from the West Pipeline and may experience shortfalls due to the San Andreas earthquake scenarios and the Extreme Storm scenario before District treated water service is restored, and lists where there is opportunity for improvement.

Table 7. Shortfalls and Opportunities for Improvement of West Treated Water Network

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3.2 East Treated Water Network

Table 8 identifies retailers that rely on District treated water from the East Pipeline that may experience shortfalls due to the San Andreas earthquake scenarios before District treated water service is restored, and lists where there is opportunity for improvement.

Table 8. Shortfalls and Opportunities for Improvement of East Treated Water Network

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4. Risk Exposure

Risk exposure was analyzed for each District facility. The factors contributing to risk exposure include the probability of failure (PoF) and the consequence of failure (CoF). Probabilities of failure for district facilities in three earthquake scenarios (along the San Andreas, Calaveras, and Hayward fault lines) were calculated and discussed in the Task 5 TM. Data for the Hayward earthquake is not included in this TM due to the Hayward earthquake not being selected as one of the final outage scenarios.

The risk exposure score for each District facility was calculated following the methodology shown in **Appendix 3.** The process determines risk exposure scores by determining the maximum amount of water that would be unavailable to each facility in the SCVWD system for each outage scenario and multiplying it by the probability of failure for both the San Andreas and Calaveras earthquake scenarios. The final values were then ranked from largest to smallest and given a risk exposure score between 0 and 5 (5 = Highest Risk, 0 = Lowest Risk). Finally, the facilities are sorted from highest to lowest risk exposure score. **Table 9** lists the sorted risk exposure scores for all District facilities, with facilities that are expected to fail during each outage scenario marked with an X.

Table 9. Risk Exposure Scores

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5. Pipe Damage Analysis

The pipe damage analysis narrows down specific areas of improvement for pipelines with high probabilities of failure. The analysis extends and updates the work done in the previous 2005 IRP. It is recommended that with limited budget and resources, the District may be able to focus repairs and rehabilitations, and prioritize the critical sections of the pipelines expected to fail.

5.1 2005 IRP Analysis

In the 2005 IRP analysis, the District assigned each component of the SCVWD distribution network a fragility or likelihood of failure for each outage scenario. Fragilities are a function of the pipe type, hazard intensity, and geologic hazard zones where they are located including: surface ground rupture due to faulting, liquefaction, landslide, and proximity to river/stream. Pipeline earthquake fragilities are particularly critical in determining the expected post event performance of the system.

The probabilities of failures were then derived from the SCVWD Reliability Model, which employed Monte Carlo simulations using the pipeline fragility and vulnerability information to provide a statistical representation of component failure. The SCVWD Reliability Model is composed of several interconnected elements which when combined allow the estimation of the response of the SCVWD water system and the ability of the network to provide water following a major stress event. Details of this methodology are included in Volume 2 of the 2005 IRP Study in the "Reliability Baseline Evaluation" Technical Memorandum.

The pipeline damage model in the 2005 IRP study provided the following information:

- Map identifying the dominant hazard for each individual pipeline link
- Probability that each individual link remains in service
- Total number of repairs (leaks + breaks) on each individual link

The total number of breaks and leaks represent the total number of repairs likely to be required for each pipeline. The segments that have a higher number of repairs are more likely to fail after an outage scenario. The 2005 IRP summarizes the number of pipeline leaks and breaks, as well as the estimated probability of pipeline failure, by pipeline for each earthquake outage scenarios.

5.2 Critical Section Identification

The pipe damage model from 2005 was updated based on the most recent geological data in 2015. The number of pipe repairs for each segment was found to be similar to the 2005 study. The number of pipe repairs is used to identify the critical pipeline sections that will potentially fail in the modeled earthquake scenarios. Groups of short pipe segments that have significantly higher propensity to fail are categorized as Critical Sections. Critical sections are identified by visually selecting pipe segments of the entire pipeline, but have the highest number of potential breaks or leaks. **Table 10** summarizes the lengths of these critical sections compared to the total lengths of the pipelines. It should be noted, these lengths are based on ArcGIS and may be considered planning-level estimations.

Table 10. Critical Section Identification

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As shown in the table above, identification of critical sections may significantly reduce the linear footage of pipeline to focus and prioritize rehabilitations. The figure below is an example of a critical section in the Almaden Pipeline. Based on the pipe damage model, while the total length of pipeline is over 60,000 linear feet, only a small portion has the highest repair number, which represents the section that is most likely to fail after an earthquake.

Figure 1. Almaden Pipeline Critical Section

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5.3 Critical Section Mapping

The critical section data presented in Section 5.2 has been combined with other relevant data in comprehensive seismic hazard maps. The maps visually demonstrate the potential for District facility failure in both the San Andreas and Calaveras earthquake outage scenarios. The seismic hazard maps include the following information:

- SCVWD infrastructure (treated and raw water pipelines, turnouts, line valves)
- Natural features (streams, fault lines, liquefaction hazard boundaries)
- Retailer boundaries
- Pipeline damage data, as pipeline maximum repair number
- Critical section analysis tables, when applicable (see Section 4.2)

The maps were created in ArcGIS, using District-provided data when available. The following map layers were provided by the District: treated and raw water pipeline network, turnouts, line valves, fault lines, streams, and retailer boundaries.

As discussed in Section 5.2, the pipeline damage data was developed by AECOM staff. Detailed pipeline damage analysis tables were created for each critical section (15 critical sections in total, on 12 pipelines).

The liquefaction hazard data was developed by the Association of Bay Area Governments Resilience Program and made available for local governments to perform vulnerability analyses. For the Calaveras outage scenario, the liquefaction hazard layer corresponds to a M6.4 earthquake along the Calaveras fault. For the San Andreas outage scenario, the liquefaction hazard layer corresponds to a M7.8 earthquake along the San Andreas fault.

The entire set of seismic hazard maps, for both earthquake scenarios, can be found in the *Pipe Damage Analysis Maps* (AECOM, 2016). The maps are used to assess the locations of critical sections in relation to known geologic hazards and to provide recommendations for specific areas of improvement. These are planning-level tools intended to assist in prioritization of pipeline improvements. It does not imply that non-critical sections will not suffer damage.

5.4 Recommendations

The critical section maps (**Appendix C**) were reviewed by seismic expert Don Ballantyne who was also involved with the 2005 IRP. He provided his professional judgement and insight on the locations of likely failure points. This is a planning-level analysis. Prior to investment in pipeline replacement or rehabilitation, further efforts to verify critical pipeline sections are recommended. The following pipelines were identified and categorized as high priority and medium priority.

<u>High priority:</u>

1. **Almaden Pipeline** – The critical section is located mainly in a moderate to high liquefaction zone. There are three areas of high lateral spread where it crosses the Guadalupe River and where it crosses Alamitos Creek twice. The other area of high lateral spread is located at the junction with Santa Teresa Force Main. Towards the eastern end of the critical section, the pipeline crosses the Shannon Fault Zone. It is unknown how active the fault zone is at this time.
    - **Recommendation:** Replace the entire critical section between Alamitos Creek and Santa Teresa Force Main because of the close proximity of multiple hazards. Replace

the section that crosses the Guadalupe River or evaluate ground improvements in this small segment. Trench the Shannon Fault zone to determine if pipe replacement is necessary along the fault zone.

2. **Central Pipeline** – The Central Pipeline is very vulnerable in Critical Section 2, where the pipe connects with the Almaden Valley Pipeline. The pipeline here follows Los Gatos Creek and is in a high liquefaction zone. Critical Section 1 is most vulnerable at the creek crossings where there is high lateral spread.
    - **Recommendation:** Replace the entire Critical Section 2 section. Further study in Critical Section 1 is recommended to determine if it is more cost effective to replace the entire section, or just use ground improvements at the creek crossings.
3. **Rinconada Force Main –** This was a pipeline of concern in the 2005 IRP. The previous study recommended adding a parallel line because there is no redundancy in the system here, and because the pipeline material is concrete cylinder, which is more vulnerable than other materials. There are three areas of high lateral spread due to high liquefaction at the following creek crossings: Wildcat Creek, San Tomas Aquino Creek, and Los Gatos Creek. The pipeline also crosses the Monte Vista fault which has unknown seismic activity. For the updated pipeline vulnerability analysis, no other specific critical sections were identified.
    - **Recommendation:** Replace or add a parallel line due to high vulnerability and criticality. Trench along the Monte Vista fault to determine seismic activity levels.
4. **Snell Pipeline** – Critical Section 1 is in an area of moderate liquefaction and has an area of high lateral spread at the Thompson Creek crossing. Critical Section 2 lies in an area of high liquefaction, but there are no particularly vulnerable spots in this section.
    - **Recommendation:** Replace or make ground improvements at the Thompson Creek crossing. Critical Section 2 is not considered a high priority at this time.

<u>Medium priority:</u>

1. **Cross Valley Pipeline** – The majority of the Cross Valley Pipeline is located in an area with high liquefaction susceptibility, not just the critical section.
    - **Recommendation:** Evaluate the pipeline further and conduct geotechnical and borings tests to determine if the entire pipeline should be replaced or if there are areas of greater vulnerability.
2. **Pacheco Conduit** – The Critical section identified is in a high liquefaction susceptibility area and in area with moderate landslide hazards.
    - **Recommendation:** Replace the entire critical section.
3. **Santa Clara Conduit** – The Critical Section identified on the Santa Clara Conduit is in an area of high liquefaction susceptibility and crosses multiple creeks, although the creeks have low lateral spread soils. The connection with the Santa Clara Tunnel on the eastern end of the pipeline was not identified as a critical section, but the 2005 IRP identified a landslide hazard at the connection.
    - **Recommendation:** Because most of the pipeline is in an area of high liquefaction susceptibility and crosses multiple creeks, further studies are recommended to evaluate the vulnerabilities to this pipeline. Further evaluation of the connection with the Santa Clara conduit is also recommended.

4. **West Pipeline** – The critical sections identified on West Pipeline 1 and 2 both contain narrow areas of high liquefaction susceptibility, and they both are in or near the Monte Vista fault zone. The Critical Section in West Pipeline 1 has an area of high lateral spread where it crosses Saratoga Creek. The critical section identified on West Pipeline 3 does not appear to be in a vulnerable area, but there is an area of high lateral spread where the pipeline crosses Stevens Creek.

    - **Recommendation:** Trench along the Monte Vista fault zone in the critical sections identified for West Pipeline 1 and 2 and replacement or ground improvements at Saratoga Creek. No recommendations for the critical section on West Pipeline 3; however, further evaluation of possible pipe replacement or ground improvements at the Stevens Creek crossing is recommended.

5. **South Bay Aqueduct** – Critical Section 1 on the South Bay Aqueduct is in an area of high landslide hazard. Critical Section 2 is at the Penitencia Treatment Plant, and is also in an area of high landslide hazard potential.

    - **Recommendation:** The pipeline in both of these sections should be replaced with materials that are designed to withstand landslide hazards.

6. Additional Water Transfer Considerations

Initial recommendations for reliability improvements, to address system shortfalls, were discussed in Section 3. This section identifies additional water transfer opportunities to improve the performance of the District's treated water system in emergency events.

Water Transfer Considerations between Retailers

In some cases, it may be possible to transfer excess retailer groundwater through existing District treated water pipelines among adjacent agencies. This initial study considers excess water supply only. Further study is needed to determine specific infrastructure improvements that may be required. According to the Task 8 TM, agencies that can potentially provide additional groundwater to District treated water pipelines include:

1. **California Water Service Company:** Up to 5.8 MGD could be available to be transferred to the turnouts that serve nearby agencies such as Mountain View, Sunnyvale and Santa Clara, either through the District treated water pipeline or smaller diameter interties. If the Vallco turnout fails after an earthquake, inter-agency transfer from the California Water Service Company may be difficult, as there are only 2 existing wells in the Vallco turnout area, and there is limited transmission capacity to the rest of the service area.

2. **Great Oaks:** Up to 23.8 MGD can be transferred to San Jose Municipal Water Service or San Jose Water Company. If the East Pipeline and Milpitas Pipeline are intact after an earthquake, groundwater from Great Oaks can potentially be transferred all the way to Milpitas if additional pumping capacity is available. This option would require constructing new intertie(s), either between Great Oaks and the District, or between retailers.

3. **San Jose Municipal Water Service:** The City has 2.4 MGD additional groundwater extraction capacity in Evergreen and 3.8 MGD additional capacity in Edenvale area. While the Evergreen area has the potential to transfer water through the District treated water pipeline, the Edenvale wells are not able to transfer outside of their immediate service area, as there are no treated water pipeline turnouts directly to the Edenvale service area. San Jose Muni has an

intertie between the two service areas that, with some minor improvements, could be used to transfer water bi-directionally.

4. **San Jose Water Company:** Up to 25.9 MGD of groundwater can be used to support adjacent retailers. In general, there is more excess groundwater available for the East Pipeline than for the West Pipeline, and the groundwater demand may also be higher on the eastern side. San Jose Water Company may need to provide more detailed data regarding their demand and groundwater supply in order to identify inter-retailer transfer opportunities.

5. **Santa Clara:** There is currently up to 41.4 MGD of additional groundwater capacity in the service area. However, the excess capacity is not located in Zone 2A, which is the service zone closest to the District's treated water pipeline turnout. Therefore, the additional flow cannot be used to support the demands of nearby retailers, via the District pipelines. Direct interties between Santa Clara and other retailers may enable use of the excess supplies.

6. **Sunnyvale:** There is currently up to 2.25 MGD of additional groundwater capacity. Most of the groundwater wells are located in Zone 2 at a lower elevation. Only Westmoor Well (with a capacity of 0.7 MGD) is located in Zone 3, in close proximity to the District treated water turnouts. Therefore, similar to Santa Clara, most of the additional flow cannot be used to support the demands of nearby retailers, via the District pipelines. Direct interties between Sunnyvale and other retailers may enable use of the excess supplies.

7. References

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SCVWD Fuel Analysis Memo, prepared by Joe Hill Consulting Engineers (JHCE)

Pipe Damage Analysis Maps (AECOM, 2016)

Appendix 1

Outage Schematic Repair Sequence

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Appendix 2
Restoration Schematics

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Appendix 3
Risk Exposure Assessment

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Risk Exposure

Risk exposure was analyzed for each District facility. The factors contributing to risk exposure include the probability of failure (PoF) and the consequence of failure (CoF). Probabilities of failure for district facilities in three earthquake scenarios (along the San Andreas, Calaveras, and Hayward fault lines) were calculated and discussed in Task 5. Data for the Hayward earthquake is not included in this TM due to the Hayward earthquake not being selected as one of the final outage scenarios.

The consequence of failure value was determined for each District facility. Consequence of failure is defined as the maximum amount of water that would be unavailable to each facility in the SCVWD system for each outage scenario (and represented as a flow in MGD in **Table 1**). It is important to note that the consequence of failure values do not indicate supply shortages within the District. For example, as seen in **Table 1**, the consequence of failure for a South Bay Aqueduct outage is 89.2 MGD. However, this does not mean that the District will experience an 89.2 MGD deficit, as the District could utilize water from the San Luis Reservoir, Anderson/Coyote Reservoirs, or Calero Reservoir instead.

The following assumptions were made in determining the consequence of failure in MGD:

1) The available imported water supply (from the South Bay Aqueduct and San Felipe systems) is limited to the annual contractual amount.
2) The available local reservoir supply (from Anderson/Coyote and Calero Reservoirs) is limited to the maximum reservoir flow rates, found in the Task 7 Scenario Modeling spreadsheet.
3) The available flow on each treated water pipeline is equal to the sum of maximum demands from all turnouts along the pipeline. Maximum turnout demands (corresponding to July 2013 data) were provided by the District.
4) The capacity of the pumping plants is the smaller of upstream pipeline capacity or pumping plant design capacity.

The consequence of failure and probabilities of failure for both the San Andreas and Calaveras earthquake scenarios from Task 5 are shown in **Table 1**.

Table 1. Maximum flow values for each facility along with the probability of failure for both the San Andreas and Calaveras earthquake scenarios

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Next, the flow values for each facility were multiplied by the probability of failure for both the San Andreas and Calaveras earthquake scenarios (**Table 3**). In many cases, the probability of failure for the facility is 0% for one or both earthquakes. After calculating PoF * CoF for both earthquakes, the higher value was taken for each facility to assess the potential risk. This method accounts for the maximum probability and consequence of failure for all District facilities.

The final PoF * CoF values were then ranked from largest to smallest and sorted into 6 groups, as shown in **Table 2**.

Table 2. Risk Exposure Scoring

Score	Loss of Supply (MGD)
5	100.1 +
4	50.1 – 100.0
3	10.1 – 50.0
2	5.1 – 10.0
1	0.1 – 5.0
0	0

Table 3. Maximum Probability and Consequence of Failure for District Facilities

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In **Table 4**, the facilities are sorted from highest to lowest risk exposure score and the facilities that fail during selected earthquake scenarios are marked with an X.

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Table 4. Risk Exposure Score, Outages in Earthquake Scenarios

Facilities	Risk Exposure Score	San Andreas EQ 1 Outages	San Andreas EQ 2 Outages	Calaveras EQ Outages
Almaden Valley Pipeline	5	X	X	
Cross Valley Pipeline	4	X	X	X
South Bay Aqueduct*	4	X	X	X
Central Pipeline	4	X	X	
Santa Clara Conduit R1	4	X		X
Anderson/Coyote Reservoir*, 1	4			
Rinconada WTP*, 1	4			
SFPUC Intertie*	3			
Pacheco Conduit R1	3			X
Santa Clara Conduit R2	3			
Santa Teresa WTP	3			
Vasona Pumping Plant	3			
Rinconada Force Main	3			
Calero Reservoir	3			
West Pipeline 1	3	X		
Penitencia WTP	3	X	X	X
West Pipeline 2	2	X		
Coyote Valve Yard	2			
Anderson Force Main	2			
Vasona Valve Yard	2			
Snell Pipeline 1	2		X	
Calero Pipeline	2			
Milpitas Pipeline	1		X	
East Pipeline 1	1		X	
Penitencia Force Main*, 1	1			
East Pipeline 2	1			
Santa Teresa Force Main	1			
Snell Pipeline 2	1			
West Pipeline 3	1			
Santa Clara Distributary 2*	1			
Penitencia Delivery Main*, 1	1			
Santa Clara Distributary 1*	1			
Campbell Distributary	0			

Facilities	Risk Exposure Score	San Andreas EQ 1	San Andreas EQ 2	Calaveras EQ Outages
Mountain View Distributary	0			
Pacheco Tunnel	0			
Santa Clara Tunnel	0			
Sunnyvale Distributary	0			
Parallel East Pipeline	0			
Raw Water Control 1	0			
Treated Water Control	0			
Rinconada Reservoir	0			
Pacheco Pumping Plant	0			
Coyote Pumping Plant*	0			
Piedmont Valve Yard	0			

Santa Clara Valley Water District

Infrastructure Reliability Plan

Task 10 Appendix

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Santa Clara Valley Water District Infrastructure System Improvement Needs

Technical Memorandum

Infrastructure Reliability Project, Task 10

Project Number: 93504001

Prepared by:
Erin Baker, P.E., Engineering Unit Manager

January 25, 2016

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2. Capacity Constraints 1
3. New Connections 3
4. Level of Service Requirements 3

1. Purpose

The purpose of this task is to identify system improvements needed to address capacity constraints, new connections for existing customers, or changing levels of service for existing customers.

This tech memo identifies capacity failures due to future demand increases or changes, proposed new connections for existing customers (treated water or groundwater wells), and proposed level of service changes. Lastly, this tech memo identifies recommended improvements for capacity, new connections, or changing level of service requirements. The memo also evaluates new regulations or legislation that may impact level of service goals.

Information for this memo was taken from the 2012 Water Supply and Infrastructure Master Plan (WSIMP), and from interviews with retailer customers in Task 4 of this project.

2. Capacity Constraints

The District's 2012 Water Supply and Infrastructure Master Plan (WSIMP) analyzed the water treatment plants and pipelines to identify constraints for existing infrastructure under future 2035 demands. The LOS goals for the IRP are based upon historic average February demands while the WSIMP is anticipating maximum daily demand. A summary of constraints for each system (raw, east, west) is provided below.

Raw Water System

The raw water system has sufficient capacity to meet demands through 2035. Hydraulic modeling did not show any infrastructure constraints for the existing raw water system under future demands for typical operations. As future demands increase, the District may have to run the Coyote (and possibly Vasona) pumps more often.

East Treated Water System

The system is adequately sized for average demands through 2035 but does not have sufficient treatment plant capacity to meet maximum daily demands through 2035. Maximum daily demands are projected to exceed treatment plant capacity starting in 2030. The east treated water pipelines, however, have sufficient capacity to carry projected future maximum daily flows through 2035.

West Treated Water System

The west side treated water system has sufficient treatment plant capacity to meet maximum daily demands through 2035. The Rinconada Water Treatment Plant (RWTP) capacity is currently being increased from 80 to 100 MGD. The west treated water pipelines are capable of carrying the maximum flow planned for RWTP, and have sufficient capacity to carry projected future maximum daily flows through 2035.

3. Recommendations

Recommendations with regards to future capacity increases as recommended in the 2012 WSIMP are listed below, with discussion of how these recommendations pertain to the IRP.

WSIMP Recommendation 1:

Monitor east side demands and consider operational or contractual solutions before investing in new infrastructure to expand plant capacity in the east treated water system to meet contract flow requirements.

How this relates to IRP:

Any project recommended for the IRP that provides additional capacity to the East treated water system should be assigned an additional benefit of providing more capacity in the project benefit cost analysis.

WSIMP Recommendation 2:

Consider increasing the capacity of the Vasona pump station. Although not required for typical operations, an increased capacity would allow the District to deliver 100% SBA water to the newly expanded RWTP.

How this relates to IRP:

If any projects are proposed for the Vasona pump station as part of the IRP, consider increasing plant capacity as part of the project.

WSIMP Recommendation 3:

Be prepared to run the Vasona and Coyote pumps more often in the future. Running the pumps more often will add operational and maintenance costs. The pumps will use more power and require more frequent maintenance.

How this relates to IRP:

The IRP is planning based on minimum winter demands. The pump stations are not required for minimum winter demands.

WSIMP Recommendation 4:

Perform surge analyses of District pipelines to further ensure system reliability throughout the future. Additionally, continue to inspect and maintain District pipelines so they continue to be available and reliable for future use.

How this relates to IRP:

The IRP will also recommend continuing to inspect and maintain District pipelines so they continue to be available and reliable for future use. The IRP will also recommend additional valving and may recommend hardening of some pipelines.

4. New Connections

In discussions with treated water retailers earlier in this project, very few new connections or areas of growth were identified. These are listed below, and have been accounted for in demand calculations for the project. For a more detailed discussion of future areas of growth, see the Task 4 Technical Memorandum, Retailer Water Use.

1. City of Milpitas – The city has requested and the District has constructed a new turnout that will serve the area surrounding the new Bay Area Rapid Transit (BART) station.
2. City of San Jose – There are some areas that are proposed for development or redevelopment in the next 25 years, though none of these would require new SCVWD infrastructure.
    - One third of the Edenvale service area is not yet developed. This area would be served by groundwater in the future.
    - North San Jose area currently relies on SFPUC water. If a new development were built, the City would need to run the wells there full time, and in the future, may want to bring SCVWD treated water via the existing 'trade zone' turnout.
    - Evergreen area has two localized properties that could be developed. These would create the need for an increase in SCVWD treated water deliveries. North San Jose and Edenvale would be developed before the Evergreen areas.
3. City of Santa Clara – The city's UWMP predicts substantial growth, but currently don't know if it will actually increase as planned. The stadium has been completed and the area is continuing to develop. Another large development will be coming soon, but will not require a new District connection.

In addition, there is some in-fill growth expected in the city of Gilroy, but the specific area and extent is unknown at this time. At this time, there are no specific recommendations for new infrastructure with regards to the identified areas of growth. All existing connections are sufficient to address these areas. It is recommended that the District confirm these findings as part of the upcoming 2015 Urban Water Management Plan and subsequent 2017 Water Supply and Infrastructure Master Plan.

5. Level of Service Requirements

At this time, the District is not aware of any new regulations or legislation that may impact service levels, such as new treated water or groundwater quality regulations, contractual requirements, or laws. Greater public and regulatory acceptance of direct potable reuse (DPR) and expansion of indirect potable reuse (IPR) has potential to be a source of additional local supply. It is not anticipated that DPR and IPR will significantly impact the service levels.

The District will likely be required to adjust its raw water operations due to a lawsuit regarding its water rights (the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) and three creeks settlement agreement). This settlement is currently in progress, and the raw water operations unit plans to make operational adjustments to meet any new requirements. The FAHCE settlement may result in some infrastructure changes or improvements, but these have not yet been identified. Once the FAHCE projects are identified, the District could choose to combine them with IRP recommended projects if it makes sense to do so. The District routinely combines capital improvement projects affecting the same facility.

Santa Clara Valley Water District

Infrastructure Reliability Project

Task 11 Appendix

AECOM

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Projects to Meet Needs

Technical Memorandum

Infrastructure Reliability Project, Task 11

Project Number: 93504001

Prepared by:

AECOM

June 2, 2016

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Appendices

Appendix 1: Initial Project Screening

Appendix 2: Preferred Project List

Appendix 3: Non-Preferred Project List

Appendix 4: Expanded Project Scoring Table

Appendix 5: Generic Costs Preliminary Specifications and Assumptions

Appendix 6: Generic Cost Estimate Report

Appendix 7: Project Information Sheets

Appendix 8: Detailed Cost Estimate Project Info Packages

Appendix 9: Detailed Cost Estimate Report (AACE Class 4)

1. Purpose

The purpose of this Technical Memo (TM) for Task 11 is to identify improvement projects that help address Santa Clara Valley Water District (District) system reliability needs identified in previous tasks. The TM is organized into the following sections:

Section 2 (Task 11.2) – Compile Planned and Potential Projects and Opportunities: This subtask presents potential project ideas that have been collected throughout this project including relevant planned projects from existing District plans, culminating in a list of all initial project ideas.

Section 3 (Task 11.3) – Develop Information for Feasible Projects: In this subtask, the list of projects developed in subtask 11.2 was screened qualitatively for fatal flaws. Projects that are considered impractical or infeasible were removed from further consideration and evaluation. The remaining projects were analyzed in greater detail, using project information templates, scoring criteria, and cost-benefit methodology.

Section 4 (Task 11.4) – Identify Preferred Projects and Opportunities: This subtask presents the preferred projects identified using qualitative analyses of the screening criteria from subtask 11.1, and additional input from District staff. The selection of preferred projects reflects overall qualitative cost-benefit information, criteria ratings, and regional retailer input collected throughout the project.

Section 5 (Task 11.5) – Identify Recommended Projects and Opportunities: In this subtask, the preferred projects identified in subtask 11.4 were further refined and finalized based on capital cost estimates and benefit-cost analysis, and a quantitative evaluation of the screening criteria.

Section 6 (Task 11.6) – Develop Implementation Plan: This subtask identifies a phasing schedule for implementation of the recommended projects. The prioritization of recommended projects is based on factors such as feasibility, geographic location, and the level of external coordination and planning required. This section includes identifying the lead agency responsible for each recommended project.

Task 11 also includes subtask 11.1, the development of project evaluation methodology. Project evaluation methodology includes screening and rating criteria, cost estimating methodology, benefit analysis methodology, cost-benefit calculation methodology, and project information templates. The project analysis methodology is described throughout this TM, in Sections 3 through 5.

2. Planned and Potential Projects and Opportunities

The process of identifying project opportunities and appropriate analysis methodologies began in previous project tasks, and incorporates important elements and information gathered throughout the project.

Tolerable outage durations were discussed and identified in Task 6. Among the findings of Task 6 were that most retailers could tolerate a loss of SCVWD treated water for at least one week during summer (high demand months), and at least one month during winter (low demand months). Notable exceptions were parts of two retailers' systems, Cal Water and San Jose Muni, where tolerable outage durations are several hours in summer and less than two weeks in winter. All retailers could tolerate a period of 60 days or longer without managed groundwater recharge. Additionally, Task 6 included discussion regarding varying levels of service attributed to investment levels. Discussions with District management and retailers led to an understanding that high investment levels could result in system performance beyond what is needed, and may not be affordable. There was a consensus that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level, while providing sufficient system reliability and performance.

The baseline performance of the SCVWD system was evaluated and documented by the District in Task 7. The results of Task 7 demonstrate that, in the worst case scenario, the expected outage time before the District can provide minimum demands to retailers is 30 days. For less severe events, the expected outage time before minimum demands can be restored is only 4 days. The recovery times for the District to provide average demands to retailers are considerably longer, ranging from 18 days to nearly 80 days.

Regional redundancies and backup supply availabilities for each retailer were identified and documented in Task 8. These efforts helped identify retailer service areas that can access other supplies to replace District treated water during a service interruption. Detailed tables that include information on backup sources for all retailers were developed and included in the Task 8 TM. This effort found that many retailer zones that are primarily served by District treated water have one or more backup supplies available, such as groundwater wells, interties, and SFPUC treated water supply.

Specific areas in need of improvements were identified and documented in Task 9. This task identified critical areas that may have more difficulty withstanding potential outage durations. Table 1 lists the retailer areas that are particularly vulnerable to service outages. This effort found that improvement projects that target specific service areas may efficiently address the existing reliability issues. Task 9 also examined the most vulnerable sections of District transmission pipelines, identifying the critical sections to target for replacements.

Table 1. Reliability Improvement Needs

Retailer	Area	Vulnerability
Cal Water	Vallco turnout area	Limited back-up near Vallco, difficult to move water from West Pipeline turnouts to Vallco turnout area.
Mountain View	Zone 3 (Miramonte)	Requires operational and valve changes, and additional pumping costs.
Santa Clara	Zone 2A (Serra Tank)	One 2 MGD well in Zone 2A, which has typical demands of 3-4+ MGD. Requires booster pumps from Zone 2.
Milpitas	Milpitas turnout area	Requires operational and valve changes, and is more costly to operate on SFPUC water.
San Jose Muni	Evergreen area	Back-up groundwater wells in Evergreen are not permitted for regular use.
Morgan Hill	All	Groundwater supply is sensitive to reduction of groundwater recharge.

Potential opportunities were identified and discussed throughout the project, particularly during the evaluation process for Tasks 6 through 9 (as discussed above), and via meetings, workshops, and specific information gathering efforts. Important concepts that have been incorporated in the identification of project opportunities and reflected in the analysis methodology include:

- Recent events impacting District services, such as planned and unplanned maintenance outages of District pipelines and treatment plants, and drought conditions, have led to more knowledge regarding alternate operational schemes.
- Many retailer service areas have sufficient backup supply redundancy and may not require large investments in additional reliability.
- There are specific retailer service areas that are more vulnerable to outages of District treated water. Reliability in these specific areas may be effectively improved with lower cost, localized solutions, rather than major infrastructure improvements.
- Strengthening the District's treated water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant raw water system damage. Likewise, the inverse applies as well, as strengthening the District's raw water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant treated water system damage
- Where possible and beneficial, leveraging existing assets is preferred, as both the District and retailers have made significant investments in increasing system reliability and operational flexibility since the last IRP study.

- Assets, particularly groundwater wells, which can be utilized more frequently to enhance daily operations or periodic maintenance operations, are preferred over assets that would be designated as standby for infrequent use only during major emergencies.

As previously discussed, the potential improvement opportunities that were identified throughout the project largely reflect these overall concepts.

Project ideas from various sources were compiled into one initial project list of all potential opportunities. This initial list contained 92 potential projects. The projects and opportunities in the initial list were gathered based on input received from the District and retailers through several series of meetings and workshops. Additionally, several planned or potential projects from other District or regional master plans were added to this initial project list. The initial list of 92 projects is provided in Appendix 1.

The initial list of 92 potential projects was presented to District managers and retailers and received concurrence and approval to proceed with evaluation. A series of project assessment screenings and project evaluation methodology were developed and utilized to identify the recommended improvement projects. The goal was to identify the most feasible and beneficial projects that can effectively address the areas of need. This process is described in the subsequent sections.

3. Feasible Projects

After compiling the initial 92 potential projects and opportunities into one master list, the projects were screened with an initial fatal flaw analysis to remove those that are not practical or feasible. This initial screening relied on qualitative data and engineering judgement by the project team, incorporating input from District staff, management and retailers. Appendix 1 includes the 13 projects that were discarded based on the initial screening criteria. The criteria used to classify projects as impractical or unfeasible included the following:

- Contractual hurdles
- High cost and limited benefit

12 additional projects were eliminated based on consolidation of similar or duplicate projects. The remaining 67 projects that qualified as feasible were sorted into the following categories:

- Plan/study/coordination
- Equipment
- Backup power/fuel
- Connection/turnout
- Groundwater well
- Intertie
- Isolation valve
- Treatment
- Infrastructure

The categorical project list of 67 feasible projects is included in Appendix 1. At this stage, additional information was collected and added to the project list. The customer or originator (i.e., the retailer that identified the project) was listed for each project or opportunity. For each project, it was noted if construction would be required on a District facility. Finally, a high-level order-of-magnitude "cost bucket" was assigned to each project, as follows:

- $ = $1M range (operational improvements)
- $$ = $10M Capital Improvement Plan (CIP) range
- $$$ = $100M CIP range
- $$$$ = $1B CIP range

In general, retailers favored projects that would fit in an investment range of $10M to $100M. The projects in the $1B cost bucket were, for the most part, deemed too costly, and not realistic or achievable. The projects in the $1M cost bucket were viewed as minor quick fixes, or studies that would provide more information and/or increase preparedness in the event of an emergency.

4. Preferred Projects and Opportunities

After the initial screening, the second round of evaluation gathered more details about the remaining 67 feasible project ideas. Detailed rating criteria were used to assess the feasible projects in order to identify preferred projects. The eight rating criteria were developed at the start of Task 11, and are described in Table 2. At this stage, the criteria were utilized to provide a qualitative analysis. Scores of "High", "Medium", and "Low" were designated and informed the screening process using engineering judgement.

Table 2. Project Rating Criteria

Criteria	Description
Environmental	Project provides environmental benefits *e.g., supports sustainable groundwater basin*
Social/Community	Project provides social or community benefits *e.g., limits impacts of pipeline breaks leading to property damage*
Supply/Capacity	Project provides additional long term supply or capacity *e.g., adds new source that can feed District treated water system*
Operational Flexibility	Project provides additional operational flexibility *e.g., facilitates wheeling water between turnouts during shutdowns*
Ease of Implementation	Project is easy to implement *e.g., does not require major excavation and/or land acquisition*
Reliability	Project helps restore min. or avg. demands in hazard outages *e.g., new well satisfies winter demand in San Andreas EQ scenario*
Contribution to LOS	Project improves level of service to identified vulnerable areas *e.g., intertie improves supply availability to vulnerable area*
Cost	Project cost in current dollars *used to facilitate organizing into cost categories*

The 67 feasible projects were analyzed qualitatively based on the above rating criteria. A list of preferred projects was developed based on the overall qualitative ranking of each project, with additional consideration of District and retailer preferences. The feasible project list was narrowed down from 67 feasible projects to 38 preferred projects. The initial preferred project portfolios are provided in Appendix 2. The list of 29 non-preferred projects is included in Appendix 3, along with detailed explanations of why each project was discarded at this stage. The 38 preferred projects were divided into the three cost categories that retailers expressed interest in pursuing: $1M projects (operational improvements only), $10M capital improvement projects, and $100M capital improvement projects. At this stage, preferred projects were assigned to preliminary portfolios based on cost levels.

5. Recommended Projects and Opportunities

A final detailed analysis was conducted on the list of 38 preferred projects in order to develop recommended projects and opportunities. The purpose of this final analysis is to develop the projects in each preferred portfolio in more detail and to evaluate the portfolios against the preliminary level of service goals. To this end, the infrastructure sizes and locations, capital cost estimates, and benefits were refined.

5.1 Weighted Scores

In order to narrow down the list of 38 preferred projects into a refined list of recommended projects, an overall weighted score was determined for each project. This quantitative analysis expanded upon the previous analysis by assigning numerical scores for each criterion, where "Low", "Medium", and "High" ratings correspond to scores of 1, 5, and 10, respectively. To calculate an overall score for each project, each of the seven criteria (excluding cost) was assigned a weight based on its relative importance. District feedback was used to finalize and weight the rating criteria. Table 3 lists the weighting factor for each criterion and provides reasoning for the assigned weights. An expanded project scoring table can be found in Appendix 4.

Table 3. Criteria Weighting Factors

Criteria	Weighting Factor	Explanation
Environmental	0.25	In an emergency, environmental concerns may be a lower priority. For example, permit violations may be preferable to serious and imminent risks to life safety.
Social/Community	0.25	In an emergency, social or community concerns may be a lower priority. For example, minor property damage may be preferable to serious and imminent risks to life safety.
Supply/Capacity	0.5	Identifies projects that provide multiple benefits, specifically enhancing the District's long-term supply and capacity capabilities during normal operations, in addition to providing benefits during emergency events.
Operational Flexibility	0.5	Identifies projects that provide multiple benefits, specifically providing day-to-day operational benefits (such as for maintenance outages), in addition to providing benefits during emergency events.
Ease of Implementation	0.5	Accounts for the feasibility of construction, which is an important consideration for the recommended projects.
Reliability	1.0	Critical criterion that identifies projects that help restore minimum or average demands to retailers in the outage scenarios.
Contribution to LOS	1.0	Critical criterion that identifies projects that improve LOS for the specific vulnerable areas, and the District's overall LOS.

Based on the weighting factors and individual scores of 1, 5, or 10, the highest total score that a project could receive is 40, while the lowest is 4. Recommended projects were selected based on a threshold total weighted score of 20 points and above.

5.2 Initial Generic Cost Estimates

The project portfolios were further refined by analyzing the estimated costs of the projects. Total costs were roughly estimated for each preferred project. Although the projects included in the operations only portfolio did not require construction cost estimates, planning-level cost estimates were developed for each. Projects included in the $10M CIP and $100M CIP portfolios fit into the following five generic project categories:

- Groundwater well
- Intertie
- Isolation valve
- Service connection/turnout
- Pipeline replacement

The initial generic cost estimates by category were developed using preliminary specifications and assumptions. Appendix 5 contains the Generic Costs Preliminary Specifications and Assumptions document, provided to the M Lee Corporation and used in the development of the initial generic cost estimates.

The initial generic cost estimates served as place-holders for initial evaluation, prior to developing more detailed cost estimates in later phases. The first step in determining total capital cost for each project was to estimate the direct construction costs. Next, a multiplier was applied to account for relevant contingencies. Table 4 presents a description of the contingencies and markups added to calculate total construction hard cost. Soft costs were calculated for each project using methodology provided by the District. The total soft costs, including planning, design, construction management, and project close out/commissioning, amount to 55% of the total construction costs. The total capital cost (hard cost and soft cost) of each preferred project is then equal to 155% of the total construction costs.

The initial generic cost estimates and methodology are included in Appendix 6 and summarized in Table 5. These planning-level estimates are considered equivalent to AACE Estimated Classification Class 5.

Table 4. Construction Markups

	Item	Total Cost	Explanation
1	**Direct Cost = Base** **(Detailed itemized pricing for construction work)**	**$100.00**	Equivalent to subcontractor's bid to general contractor. This includes costs for materials, labor & equipment and subcontractor's markups for overhead and profit.
2	**Markups are added to the above for the following:**		
3	General Contractor's General Conditions, Overhead and Profit	15.50%	Includes 10% for General Contractor's General Conditions compounded with 5% for General Contractor's OH&P
4		---	
5	Subtotal A	$115.50	
6	Contingency for Design and Estimating	30.0%	Allowance to cover costs that may result from design changes, items not fully itemized in the estimate, errors or omissions in the estimate, or unpredictable conditions or risks that experience shows are likely to occur during the design or bidding phase of the project.
7		---	
8	Subtotal B - Construction Hard cost	$150.15	This is the estimated fair -market construction bid submitted by general contractor
9	Construction Contingency	10.0%	This is an allowance to cover change orders during construction
10		---	
11	**Total Construction Hard cost**	**$165.17**	This is the estimated construction cost for contractors at the end of the construction project
9	Soft Cost - Excluded		To be carried separately by Client
10		---	
11	Subtotal C	$165.17	This is the estimated construction cost for contractors at the end of the construction project
9	Project Contingency/Reserve - Excluded		To be carried separately by Client
10		---	
11	**Total Project Cost**	$165.17	This is the estimated construction cost for contractors at the end of the construction project
12	Total Multiplier from Direct Cost (Subcontractor's Cost) to Construction Hard Cost	1.65	This is the multiplier added to Direct Cost to come up with total construction hard cost

Table 5. Generic Cost Estimates Overview

Category	Unit	Direct Construction Cost	Total Construction Hard Cost	Total Soft Cost	Total Capital Cost
Groundwater Well	EA	$1,355,150	$2,236,000	$1,229,800	$3,465,800
Pipeline Replacement - Suburban	LF	-	-	-	-
48" diameter		$1,509	$2,490	$1,370	$3,860
66" diameter		$2,106	$3,475	$1,911	$5,386
72" diameter		$2,321	$3,830	$2,107	$5,937
78" diameter		$2,718	$4,485	$2,467	$6,952
Pipeline Replacement - Urban	LF	-	-	-	-
48" diameter		$2,017	$3,328	$1,830	$5,158
66" diameter		$2,858	$4,716	$2,594	$7,310
72" diameter		$3,366	$5,554	$3,055	$8,609
78" diameter		$3,809	$6,285	$3,457	$9,742
Intertie	EA	$457,600	$755,000	$415,250	$1,170,250
Isolation Valve	EA	$224,800	$371,000	$204,050	$575,050
Service Connection/Turnout	EA	$532,700	$879,000	$483,450	$1,362,450

EA = each; LF = linear foot

5.3 Project Information Sheets

For each recommended project, project information sheets were developed that include relevant details about the projects. In addition to a description of each project and its benefits, the project sheets include background information on the project area or retailer, the estimated project cost, and a project location map. Appendix 7 contains project information sheets.

5.4 District, Retailer, and Joint Projects

In the process of developing final recommended project portfolios, the projects were organized depending on which agency facilities are impacted and would lead the implementation. Projects on District facilities would be implemented by the District, while projects located within retailer service areas would generally be implemented by the respective retailers. In some cases, the project can be considered a joint project, meaning that the District and retailer would share the responsibility of implementation. For example, a groundwater well that ties into a District treated water pipeline is considered a joint project, due to construction occurring on both retailer and District-owned facilities and land. Joint projects benefit both retailer and District systems and provide additional operational flexibility.

It is important to note that implementation of the projects included in the final recommended portfolios is dependent on other District and retailer priorities, ability to reach agreement on joint project arrangements, and other budget considerations.

5.5 Recommended Projects

20 recommended projects were identified utilizing the weighted scores and initial cost estimates of the preferred projects. Of these 20 projects, 4 would be implemented by the District and 3 would be implemented by the District and a retailer jointly. Detailed cost estimates were developed for the 7 projects that would require District implementation (full or joint). The remaining 13 projects would be implemented by individual retailers, so detailed cost estimates are not provided for these projects. It should be noted that it may not be necessary to implement all of the 13 retailer projects in order to achieve needed benefits. For example, there are multiple strategies for San Jose Muni to enhance reliability for the Evergreen service area. It is up to the retailer to decide which ones are most needed and would be most beneficial to pursue.

Detailed project information packages (Appendix 8) were compiled for the 7 District and joint projects, and used to develop detailed cost estimates. These packages expand upon the previously developed specifications and assumptions document, and contain additional design parameters (e.g., existing facility as-builts) and specific project location maps. AACE Estimated Classification Class 4 cost estimates for these 7 projects have been completed and are included in Appendix 9. Methodologies and assumptions, including direct cost to construction hard cost markup of 59%, and soft cost markup of 55%, are detailed in the cost estimate report.

The recommended project list contains 6 proposed projects in the Operations Only portfolio, 13 projects in the $10M CIP portfolio, and 1 project in the $100M CIP portfolio. Table 6 includes descriptions, weighted scores, and cost estimates for the recommended project portfolios. Figure 1 shows the location of the recommended projects within Santa Clara County, with labels corresponding to the project number in Table 6.

These recommended projects were presented and discussed at the Retailer Workshop held on June 1, 2016. Relevant comments from stakeholders were minor and have been incorporated.

Table 6. Recommended Projects

Portfolio	#	Category	Description	Weighted Score	District Project Cost	Retailer Project Cost[1]
Operations Only	1	Plan/Study/ Coordination	Coordinate interagency use of SCVWD pipelines for wheeling water between customer turnouts (e.g., via WPL from Cox to Mann).	26	$500,000 for study only	TBD
	2	Plan/Study/ Coordination	Study and test capabilities and capacities of retailer interties, by gravity and pumping. Included in this study should be the feasibility and concept for standardization of design.	21	Included in District O&M budget	TBD estimated $500K
	3	Plan/Study/ Coordination	Work with SWRCB/CDPH to lift operational restrictions on SJ Muni Evergreen wells and achieve normal operational status (in progress).	31	None	TBD
	4	Equipment	Install disinfection capabilities for groundwater supply in SJ Muni Evergreen (not currently required by the state, groundwater not under influence of surface water). May help lift operational restrictions.	21	None	TBD estimated $1M
	5	Equipment	New pumps and hose/pipe for utilizing three existing interties between SJ Muni Evergreen and SJWC.	24	None	TBD estimated $500K
	6	Equipment	Upgrade intertie between SJ Muni Evergreen and Edenvale to be bi-directional, and install pump and required equipment.	26	None	TBD estimated $200K
$10M CIP	7	Connection/ Turnout	Construct turnout/intertie to SCVWD Snell Pipeline to feed up to 20 mgd excess groundwater capacity from Great Oaks to SCVWD, connection located at Branham Lane or Valley Christian School.	23	$1,136,000 (school) or $1,438,000 (Branham)	TBD
	8	Groundwater Well	New groundwater well near Santa Clara Serra Tank in Zone 2A, which could tie into Santa Clara Distributary to feed SCVWD system. Planning and design already under way.	36	$890,000 for connection	TBD - estimated $2M per well
	9	Groundwater Well	New groundwater well at Mountain View Miramonte Tank site for Zone 3, which could tie into Mountain View Distributary to feed SCVWD system.	36	$654,000 for connection	TBD - estimated $2.8M per well
	10	Groundwater Well	New groundwater well at existing Milpitas site, such as completion of Curtis Well (Parc Metro Park). Other potential opportunities may include McCandless Drive Park and former Montague Well site.	31	None	TBD - estimated $2.8M per well
	11	Groundwater Well	New groundwater wells at new sites for the Cal Water Vallco turnout area near Santa Clara Distributary, which is currently difficult to reach with only groundwater.	24	None	TBD - estimated $2.8M per well
	12	Groundwater Well	New groundwater wells at existing Cal Water sites (e.g., Stations #2 and #4).	26	None	TBD - estimated $2.8M per well
	13	Groundwater Well	New groundwater well(s) in Evergreen on new SJ Muni sites.	28	None	TBD - estimated $2.8M per well
	14	Groundwater Well	New groundwater well(s) near East Pipeline on new SJ Muni sites (need land/easement rights near East PL).	28	None	TBD - estimated $2.8M per well
	15	Intertie	Develop additional and/or enhance existing interties for Cal Water with neighboring service areas. In particular, upgrade existing or install new intertie between Cal Water and Santa Clara.	21	None	TBD - estimated $1.2M per intertie
	16	Intertie	New intertie between SJ Muni (Evergreen) and Great Oaks.	28	None	TBD - estimated $1.2M per intertie
	17	Intertie	Upgrade two existing interties between Great Oaks and SJWC.	23	None	TBD - estimated $1.2M per intertie
	18	Isolation Valve	Install two new isolation valves on Milpitas Pipeline, north and south of existing turnout, particularly between the current and future proposed SCVWD turnouts near Piper/Montague.	20	$1,361,000	None
	19	Isolation Valve	Install three new isolation valves at strategic locations on West Pipeline, located both sides of Cox and upstream of Mann, to facilitate potential wheeling of water.	25	$2,241,000	None
$100M CIP	20	Infrastructure	Replace critical and vulnerable sections of Almaden Valley Pipeline.	23	$135,315,000 (for 25,000 LF)	None

	District project
	Joint project
	Retailer project

Footnote
1. Retailer costs are planning-level estimates only, based on preliminary discussion. Cost estimate for Santa Clara well at Serra Tank provided by City of Santa Clara.

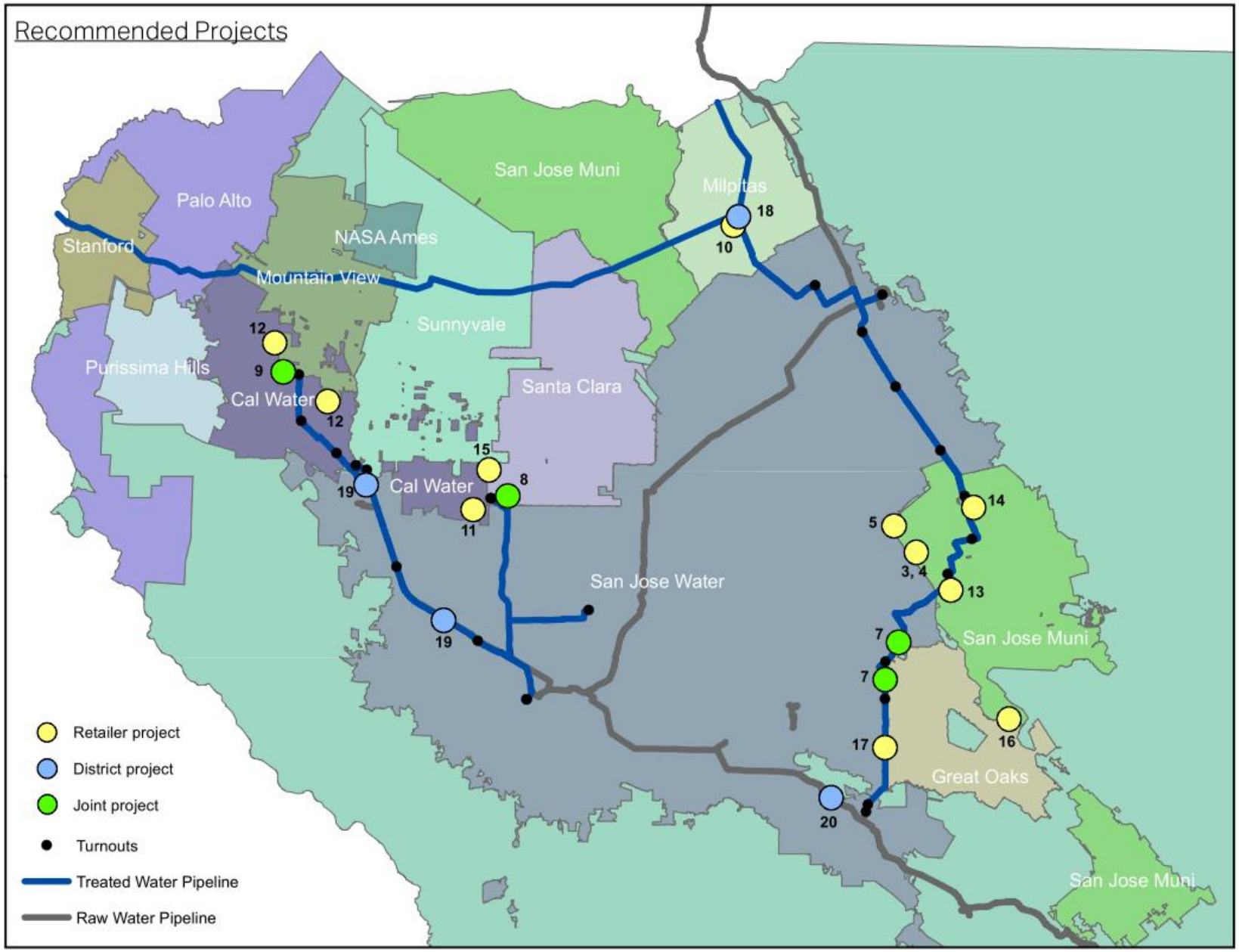

Figure 1. Recommended Projects Map

6. Implementation Plan

As previously discussed, implementation of the recommended project portfolio will depend on several factors, such as District and retailer priorities and budget allocations. This section includes a preliminary high-level implementation plan for District and joint projects, with considerations towards achieving benefits efficiently. Other considerations include the geographic location and construction feasibility of recommended projects.

Table 7 organizes the recommended District and joint projects based on geographic location and rank, which identifies the order in which projects should be implemented. Projects are aligned into East-side and West-side, as there should be strong considerations for grouping projects that can provide enhanced benefits if they are implemented concurrently, due to project interdependencies.

Responsibility for implementation of the remaining retailer projects would fall under each project's respective retailer. The prioritization of the retailer projects should be determined by each retailer. It should be noted that several retailer projects may provide similar benefits, so further evaluation should be conducted by the retailers to determine which projects are most feasible and cost-effective. For example, there are four projects in the Operations Only portfolio that could improve San Jose Muni's system, but San Jose Muni may be able to significantly improve their reliability by implementing only one or two of the recommended projects.

Table 7. Project Implementation Considerations

Area	#	Project	Rank	Discussion
West	19	West Pipeline isolation valves	1	No-regret improvement, construction only on District facility, no additional agreements required
	8	Santa Clara groundwater well	2	Construction on retailer and District facilities, planning/coordination required
	9	Mountain View groundwater well	2	Construction on retailer and District facilities, planning/coordination required
East	18	Milpitas Pipeline isolation valves	1	No-regret improvement, construction only on District facility, no additional agreements required
	7	Great Oaks connection/turnout	2	Construction on retailer and District facilities, planning/coordination required
System/ Other	1	Study on wheeling water via District pipelines	1	Planning study only, no construction and no agreements needed to initiate study
	2	Study on capabilities and capacities of retailer interties	1	Planning study only, no construction and no agreements needed to initiate study
	20	Almaden Valley Pipeline critical section replacement	3	High cost and complex construction, long-term improvement project

The projects assigned a rank of 1 are the most feasible and most easily initiated, and should be implemented first. The projects assigned a rank of 2 are achievable, but require additional coordination efforts and formal agreements between the District and respective retailers. The project assigned a rank of 3 is the most difficult to implement due to its high cost as a major infrastructure improvement project.

Appendix 1:
Initial Project Screening

SCVWD IRP - Project List (by Category) - INITIAL SCREENING

#	Category	Customer/ Originator	Item	Construction on District facility	Description/Comments	Cost Category
1	Plan/Study/ Coordination	All	Coordinate emergency planning efforts with all retailers		Emergency response and operations needs to be emphasized, coordinated, and improved	$
2		Morgan Hill	Develop documentation for prioritizing GW recharge deliveries to Madrone Channel and Upper Coyote		District prioritizes deliveries to Madrone Channel and Upper Coyote equally with TW deliveries. Recommend institutionalizing and documenting this concept.	$
3		Morgan Hill	Consider recycled water project options		Consider options and costs from the Recycled Water Master Plan, for developing recycled water capabilities for Morgan Hill.	$
4		Morgan Hill	Morgan Hill water supply study		Recommend that Morgan Hill continue current water supply study and planning efforts and reliability measures.	$
5		Palo Alto	Coordinate backup power and fuel planning efforts with Palo Alto and all retailers		Palo Alto is interested in working with SCVWD on backup power and fuel contingencies. This could apply to all retailers.	$
		Purissima Hills	Develop partnerships to supply emergency SCVWD water to Purissima Hills through existing interties with Cal Water (and/or Palo Alto)		Would consider partnership with Cal Water and/or Palo Alto to bring emergency District TW or GW through existing bi-directional interties	$
6		San Jose Muni	Coordinate public outreach and communication efforts		Joint communication on service cutbacks (such as no outdoor use)	$
7		San Jose Muni	Study on sustainable yield of SJ Muni Evergreen wells		Further study on sustainable capacities of GW wells in Evergreen, and also WQ impacts on disinfected system.	$
8		San Jose Muni	Work with SWRCB to lift operational restrictions on SJ Muni Evergreen wells (in progress)		Coordinate with CDPH to lift operational restrictions of groundwater wells in Evergreen, and achieve normal operational status (in progress)	$
9		SJWC	Study on sustainable yield of wells		Interested in further study on GW standing water level versus GW basin capacity, to avoid pumping causing subsidence (applies to all retailers)	$
10		SJWC	Study and testing of capabilities and capacities of interties		More study and testing on maximum capacities of interties, by gravity and pumping (applies to all retailers)	$
11		SJWC	Develop plan for wheeling Lexington water to Montevina Treatment Plant		Evaluate capabilities, coordination, and requirements for wheeling Lexington water to Montevina Treatment Plant	$
12		SJWC	Coordinate interagency use of SCVWD pipelines for wheeling water between turnouts or customers (e.g., via WPL from Cox to Mann)		Interagency use of SCVWD pipelines for wheeling water between turnouts or customers (applies to all retailers)	$
13		SCVWD	Evaluate and upgrade backup power, fuel, and chemical capabilities		Evaluate and upgrade fuel and chemical contingencies	$
14		SCVWD	Enhance SCVWD emergency planning and preparedness		Enhance SCVWD's emergency preparedness	$
15	Equipment	San Jose Muni	Disinfection capabilities for SJ Muni wells		Install disinfection capabilities for groundwater supply in Evergreen (not currently required by the state, GW not under influence of surface water)	$
16		San Jose Muni	New pumps and hose/pipe for utilizing existing interties between SJ Muni (Evergreen) and SJWC		Three intertie locations with SJWC in Evergreen require 600-gpm pumps and hose/piping	$
17		San Jose Muni	Upgrade intertie between SJ Muni Evergreen and Edenvale (bi-directional) and purchase pump		Modify intertie between Evergreen and Edenvale to operate bi-directionally, requires 6-inch pump to pump 100 psi	$
18	Backup Power/ Fuel	All	Backup power capabilities and additional fuel storage		Enhance backup power capabilities, such as for groundwater wells; and increase fuel storage capacity	$$
19	Connection/ Turnout	Great Oaks	New emergency Great Oaks connection on Snell Pipeline at Branham Lane, to feed excess well capacity to SCVWD Snell Pipeline	Y	Construct turnout/intertie to SCVWD Snell Pipeline at Branham Lane (up to 20 mgd excess capacity from Great Oaks to SCVWD)	$$
20		Great Oaks	New emergency Great Oaks connection on Snell Pipeline at Valley Christian School, to feed excess well capacity to Snell Pipeline	Y	Construct turnout/intertie to SCVWD Snell Pipeline at Valley Christian School (up to 20 mgd excess capacity from Great Oaks to SCVWD)	$$
21		Morgan Hill	Consider groundwater supply as backup for Santa Clara Conduit raw water	Y	Consider options for GW into Santa Clara Conduit as backup	$$
22		Gilroy	Pipeline to connect Gilroy to feed Santa Clara Conduit with groundwater	Y	Construct connection to SCVWD pipeline so that Gilroy can feed into SCVWD system.	$$$
23	Groundwater Well	Cal Water	New Cal Water wells on existing sites		Install additional wells (Stations #2 and #4 have good water quality, would have to destroy existing well and construct a new one)	$$
24		Cal Water	New site and Cal Water well near Vallco turnout/Santa Clara Distributary area	Y	Develop additional groundwater wells, particularly around the Vallco turnout area (need land) near Santa Clara Distributary which is currently difficult to reach with only GW	$$
25		Cal Water	New site and Cal Water well in northern area where it can back-feed into West Pipeline	Y	Installation of additional GW wells at key locations (if land is available), such as in northern portion of the county, may allow Cal Water to provide water into the SCVWD system by back-feeding into West Pipeline	$$
26		Great Oaks	New Great Oaks wells		Construct additional wells in different locations of the GW basin to provide reliable excess GW supply	$$
27		Milpitas	New Milpitas well at existing site (completion of Curtis Well)		Develop additional groundwater wells to serve SCVWD pressure zones. Specific opportunity for Curtis Well. Other additional wells possible.	$$
28		Milpitas	New Milpitas wells on Snell PL and/or East PL	Y	Consider GW well on Snell PL or East PL to feed system on East side for Milpitas and San Jose	$$
29		Morgan Hill	Lower existing Morgan Hill wells		Lowering existing GW wells to access lower elevations of the GW basin	$$
30		Morgan Hill	New Morgan Hill wells		Additional GW wells to access different hydrological portions of the GW basin	$$
31		Mountain View	New Mountain View well at Bryant		New well for Zone 3 - 2nd choice: Bryant - at old tank site where elevated tank was removed	$$
32		Mountain View	New Mountain View well at Miramonte, with new turnout/feed on Mountain View Distributary	Y	New well for Zone 3 - 1st choice: Miramonte well at Miramonte Tank site, could feed tank and also feed into MV Distributary. MV would own/operate/maintain well. Well could help with THM issues	$$
33		San Jose Muni	New site and SJ Muni well		Construct GW wells near East PL (San Jose Muni is short on land, need land/easement rights near East PL to install a SJ well	$$
34		San Jose Muni	New site and SJ Muni wells in Evergreen		Construct additional groundwater wells in Evergreen	$$
35		SJWC	New SJWC wells, such as at Alum Rock		Construct additional GW wells at key locations. Potential location for additional well: Alum Rock by school?	$$
36		SJWC	Lower existing SJWC wells		Lower existing wells	$$
37		Santa Clara	New Santa Clara well at Serra Tank, with new turnout/feed on Santa Clara Distributary	Y	Install additional well near Serra Tank in Zone 2A, which could be tied into the Santa Clara Distributary to feed SCVWD system. Planning and design of a well at Serra Tank may begin in next fiscal year. Opportunity for cost-sharing.	$$
38		Sunnyvale	Rehabilitate existing Sunnyvale well (Westmoor well)		Rehabilitating Westmoor Well to increase well capacity near SCVWD turnouts	$$
39	Intertie	Cal Water	New intertie between Cal Water and Mountain View		Install intertie with City of Mountain View (stub outs 50-feet apart)	$$
40		Cal Water	Upgrade existing or new intertie between Cal Water and Santa Clara		Develop additional and/or enhance existing interties with neighboring service areas	$$
41		Great Oaks	Upgrade two existing interties between Great Oaks and SJWC		Upgrade and test two existing interties with SJWC	$$
42		Milpitas	Upgrade existing or new intertie between Milpitas and SJWC		Develop additional interties and enhance existing interties	$$
43		Mountain View	New intertie between Mountain View and Sunnyvale		Intertie in Zone 3 to neighboring service area(s), such as Sunnyvale	$$
44		Mountain View	New intertie between Mountain View and Palo Alto		Construct additional larger intertie with Palo Alto (16-inch)	$$
45		San Jose Muni	New intertie between SJ Muni (Evergreen) and Great Oaks		Construct intertie with Great Oaks in Evergreen	$$
46		SJWC	Upgrade existing or new SJWC interties (various). Santa Clara, Milpitas, SJ Muni, Cal Water, Great Oaks.		Increase intertie capabilities, including new interties and improvements to existing interties	$$
47		Santa Clara	New intertie between Santa Clara and SJ Muni (North SJ)		Install additional intertie(s) with City of San Jose	$$
48		SCVWD	West-side intertie with SFPUC BDPL 3 & 4	Y	Construct west-side intertie with SFPUC. Options include: - West Pipeline extension - Sunnyvale Distributary extension - Mountain View Distributary extension - Santa Clara Distributary extension	$$$$
49	Isolation Valve	Milpitas	New isolation valves on Milpitas Pipeline near Milpitas turnout	Y	Install isolation valves on Milpitas Pipeline both north and south of existing turnout, particularly between the current and future proposed SCVWD turnouts near Piper/Montague	$$
50		SCVWD	Additional Line Isolation Valves	Y	Add isolation valves at strategic locations, such as on West Pipeline near Cox and Mann. These would be in addition to 4 line valves in District's current CIP.	$$
51	Treatment	Morgan Hill	Purchase package water treatment plant for Morgan Hill to treat raw water from Santa Clara Conduit		Purchase package water treatment plant that could be brought online and tied into Morgan Hill system	$$
52	Infrastructure	Morgan Hill	Repair/upsize Main Avenue and Madrone Pipelines	Y	Implement current project to repair and/or upsize Main Avenue and Madrone Pipelines for Main Avenue and Madrone recharge ponds. Also, considering extension to Butterfield channel. (District WSIMP recommendation)	$$
53		SJWC	District pipeline replacement/rehabilitation at critical locations	Y	Improve line segment reliability at strategic locations	$$
54		SCVWD	Calero Siphons or Pump Station	Y	Repair siphons or construct pump station to increase flows from Calero Reservoir	$$
55		SCVWD	Treated water storage tank(s)	Y	Add treated water storage, such as East Reservoir site	$$
56		SCVWD	Harden: Pacheco Conduit	Y	Harden Pacheco Conduit (Reach 1) - Calaveras EQ scenario	$$$
57		SCVWD	Harden: Santa Clara Conduit	Y	Harden Santa Clara Conduit (Reach 1) - San Andreas EQ1 and Calaveras EQ	$$$
58		SCVWD	Harden: Cross Valley Pipeline	Y	Harden Cross Valley Pipeline - San Andreas EQ1, EQ2, and Calaveras EQ	$$$
59		SCVWD	Harden: Almaden Pipeline	Y	Harden Almaden Pipeline - San Andreas EQ1 and EQ2	$$$
60		SCVWD	Harden: South Bay Aqueduct	Y	Harden South Bay Aqueduct - San Andreas EQ1, EQ2, and Calaveras EQ	$$$
61		SCVWD	Harden: Central Pipeline	Y	Harden Central Pipeline - San Andreas EQ1 and EQ2	$$$
62		SCVWD	Harden: West Pipeline 1	Y	Harden West Pipeline (Reach 1) - San Andreas EQ1	$$$
63		SCVWD	Harden: West Pipeline 2	Y	Harden West Pipeline (Reach 2) - San Andreas EQ1	$$$
64		SCVWD	Harden: Snell Pipeline 1	Y	Harden Snell Pipeline (Reach 1) - San Andreas EQ2	$$$
65		SCVWD	Harden: East Pipeline 1	Y	Harden East Pipeline (Reach 1) - San Andreas EQ2	$$$
66		SCVWD	Harden: Milpitas Pipeline	Y	Harden Milpitas Pipeline - San Andreas EQ2	$$$
67		SCVWD	Treated water East-West link	Y	Construct pipeline connecting the East-side and West-side TW systems	$$$$

							Initial Screening	Comments
1	Cal Water	Connection/Turnou	New Cal Water contract and connection/ turnout to SFPUC BDPL 3 & 4		Develop connection to SFPUC BDPL 3 and 4 pipelines (BDPL 3 &4 pass through CalWater parcel)	$$$	Project or Opportunity Not Defined	Contractual hurdles
2		Connection/Turnou	Connect Bear Gulch service area into Los Altos service area to gain SFPUC supply for Cal Water.		Tie in Bear Gulch service area (which is supplied by SFPUC) into Los Altos service area to gain flexibility in using SFPUC supplies. Also interest in developing a banking system. But there is no excess contractual supply to accomplish this.	?	Project or Opportunity Not Defined	Contractual hurdles
3	Gilroy	Groundwater Well	New Gilroy wells		Additional GW wells to access most plentiful portions of the GW basin	$$	High Cost/Low Benefit	Already have excess capacity
3	Milpitas	Connection/Turnou	New Milpitas turnout for SFPUC system at Los Cochas next to Calaveras		Additional turnout to the SFPUC system (Los Cochas next to Calaveras) (approximately 3 years)	$$	Project or Opportunity Not Defined	Plan with SFPUC
4	Morgan Hill	Connection/Turnou	New Morgan Hill turnout on Santa Clara Conduit	Y	Construct turnout for Morgan Hill on Santa Clara Conduit, the closest SCVWD raw water pipeline	$$	Does not Meet Study Goals	Already 3 turnouts
5		Infrastructure	Pipeline to connect Gilroy with Morgan Hill		Construct pipeline to share water from Gilroy. Cost may be too high due to 8-mile distance.	$$$	High Cost/Low Benefit	High cost with limited need
6		Recycled Water	Develop recycled water capabilities for backup groundwater recharge for Morgan Hill		Would like to consider options for bringing recycled water into recharge ponds as backup	$$$	Project or Opportunity Not Defined	Long-term water supply planning
7	Mountain View	Recycled Water	Develop recycled water capabilities in Mountain View		Recycled water projects	$$$	Project or Opportunity Not Defined	Long-term water supply planning
8	Purissima Hills	Connection/Turnou	West Pipeline extension and intertie with SFPUC BDPL 3 & 4; and new Purissima Hills turnout/connection	Y	Interested in extension of SCVWD West PL for supply redundancy	$$$	Project or Opportunity Not Defined	Long-term water supply planning (new customer)
10	San Jose Muni	Equipment Groundwater Well	Security measures and equipment at SJ Muni wells		Increase security measures, particularly at wells (e.g., lights, cameras, motion detectors, etc.)	$	Retailer Project	Retailer Project
11		n/Study/Coordinat	Develop partnerships to supply SCVWD water through SFPUC as backup for SJ Muni (North SJ)		Create agreements that allow for the purchase of SCVWD water through SPFUC (as back-up for North service area)	$	Project or Opportunity Not Defined	Contractual hurdles
12	San Jose WC	Infrastructure	Infrastructure upgrades to SJWC distribution system, to improve conveyance of well water		System enhancements to alleviate GW supply conveyance limitations, including booster pumps and distribution pipelines	$$	Retailer Project	Retailer Project
13	Sunnyvale	Infrastructure	Infrastructure upgrades to Sunnyvale distribution system, to enable transfer of SCVWD or well water to Zone 1 as backup to SFPUC		Improving capacity of the distribution system to enable movement of SCVWD treated or well water to Zone 1 in case of an SFPUC outage	$$	Retailer Project	Retailer Project

Appendix 2:
Preferred Project List

Preferred Project Scoring

								Weighting 0.25	Weighting 0.25	Weighting 0.5	Weighting 0.5	Weighting 0.5	Weighting 1.0	Weighting 1.0		Scoring System 1 - 5 - 10		
Portfolio	**#**	**Category**	**Customer/ Originator**	**Item**	**Description/Comments**	**District Project**	**Retailer Project**	**Environmental**	**Social/ Community**	**Supply/ Capacity**	**Operational Flexibility**	**Ease of Implementation**	**Reliability**	**Contribution to LOS**	**LOS Notes**	**Weighted Score**	**Preliminary Cost Estimate**	**Score/Cost Index**
Operations Only	1	Plan/Study/ Coordination	San Jose Muni	Study on sustainable yield of SJ Muni Evergreen wells	Further study on sustainable capacities of GW wells in Evergreen, and also WQ impacts on disinfected system.		X	5	1	5	1	10	5	1		15.5	$ 100,000	155
	2		San Jose Muni	Work with SWRCB to lift operational restrictions on SJ Muni Evergreen wells (in progress)	Coordinate with CDPH to lift operational restrictions of groundwater wells in Evergreen, and achieve normal operational status (in progress)		X	1	1	5	5	10	10	10	SA2: SJ Muni (Evergreen) could meet demands without District water at **Day 0**	30.5	$ 50,000	610
	3		SJWC	Study on sustainable yield of wells	Interested in further study on GW standing water level versus GW basin capacity, to avoid pumping causing subsidence (applies to all retailers)	X	X	5	1	5	1	5	1	1		9	$ 250,000	36
	4		SJWC	Study and testing of capabilities and capacities of interties	More study and testing on maximum capacities of interties, by gravity and pumping (applies to all retailers)		X	1	1	1	10	10	5	5		21	$ 150,000	140
	5		SJWC	Develop plan for wheeling Lexington water to Montevina Treatment Plant	Evaluate capabilities, coordination, and requirements for wheeling Lexington water to Montevina Treatment Plant		X	1	1	1	5	5	1	1		8	$ 100,000	80
	6		SJWC	Coordinate interagency use of SCVWD pipelines for wheeling water between turnouts or customers (e.g., via WPL from Cox to Mann)	Interagency use of SCVWD pipelines for wheeling water between turnouts or customers (applies to all retailers)	X	X	1	1	1	5	5	10	10	SA1: Could help West-side retailers meet demands at **Day 14** SA2: Could help West-side retailers meet demands at **Day 0** Extreme Storm: Could help West-side retailers meet demands at **Day 14** Note: Ability to wheel water depends on location of pipeline breaks. West PL has 3 breaks in Extreme Storm, 2 breaks in SA1.	26	$ 250,000	104
	7	Equipment	San Jose Muni	Disinfection capabilities for SJ Muni wells	Install disinfection capabilities for groundwater supply in Evergreen (not currently required by the state, GW not under influence of surface water)		X	1	1	1	5	5	5	10	SA2: SJ Muni (Evergreen) could meet demands without District water at **Day 0**	21	$ 200,000	105
	8		San Jose Muni	New pumps and hose/pipe for utilizing existing interties between SJ Muni (Evergreen) and SJWC	Three intertie locations with SJWC in Evergreen require 600-gpm pumps and hose/piping		X	1	1	5	1	10	5	10	SA2: SJ Muni (Evergreen) could meet demands without District water at **Day 0**	23.5	$ 200,000	118
	9		San Jose Muni	Upgrade intertie between SJ Muni Evergreen and Edenvale (bi-directional) and purchase pump	Modify intertie between Evergreen and Edenvale to operate bi-directionally, requires 6-inch pump to pump 100 psi		X	1	1	5	5	10	5	10	SA2: SJ Muni (Evergreen) could meet demands without District water at **Day 0**	25.5	$ 200,000	128
	10	Backup Power/ Fuel	All	Backup power capabilities and additional fuel storage	Enhance backup power capabilities, such as for groundwater wells; and increase fuel storage capacity	X	X	1	1	1	1	5	1	1		6	$ 500,000	12
$10M CIP	1	Connection/ Turnout	Great Oaks	New emergency Great Oaks connection on Snell Pipeline at Branham Lane, to feed excess well capacity to SCVWD Snell Pipeline	Construct turnout/intertie to SCVWD Snell Pipeline at Branham Lane (up to 20 mgd excess capacity from Great Oaks to SCVWD)	X	X	1	1	10	10	5	5	5	SA2: Could help East-side retailers meet demands if Snell/East Pipeline repairs are prioritized (**Day 14**)	23	$ 1,318,500	17
	2		Great Oaks	New emergency Great Oaks connection on Snell Pipeline at Valley Christian School, to feed excess well capacity to Snell Pipeline	Construct turnout/intertie to SCVWD Snell Pipeline at Valley Christian School (up to 20 mgd excess capacity from Great Oaks to SCVWD)	X	X	1	1	10	10	5	5	5	SA2: Could help East-side retailers meet demands if Snell/East Pipeline repairs are prioritized (**Day 14**)	23	$ 1,318,500	17
	3	Groundwater Well	Cal Water	New Cal Water wells on existing sites	Install additional wells (Stations #2 and #4 have good water quality, would have to destroy existing well and construct a new one)		X	1	1	5	1	5	10	10	All outages: Cal Water could meet demands without District water at **Day 0**	26	$ 3,354,000	8
	4		Cal Water	New site and Cal Water well near Vallco turnout/Santa Clara Distributary area	Develop additional groundwater wells, particularly around the Vallco turnout area (need land) near Santa Clara Distributary which is currently difficult to reach with only GW		X	1	1	5	1	1	10	10	All outages: Cal Water could meet demands without District water at **Day 0**	24	$ 3,354,000	7
	5		Milpitas	New Milpitas well at existing site (completion of Curtis Well)	Develop additional groundwater wells to serve SCVWD pressure zones. Specific opportunity for Curtis Well. Other additional wells possible.		X	1	1	5	5	10	10	10	SA2: Milpitas could meet demands without District water at **Day 0**	30.5	$ 2,520,000	12
	6		Mountain View	New Mountain View well at Miramonte, with new turnout/feed on Mountain View Distributary	New well for Zone 3 - 1st choice: Miramonte well at Miramonte Tank site, could feed tank and also feed into MV Distributary. MV would own/operate/maintain well. Well could help with THM issues	X	X	1	1	10	10	10	10	10	All outages: MV Zone 3 could meet demands without District water at **Day 0** Possibility of backfeeding to other retailers (Cal Water, Sunnyvale) would depend on location of pipeline breaks	35.5	$ 3,354,000	11
	7		San Jose Muni	New site and SJ Muni well	Construct GW wells near East PL (San Jose Muni is short on land, need land/easement rights near East PL to install a SJ well		X	1	1	5	5	5	10	10	SA2: SJ Muni (Evergreen) could meet demands without District water at **Day 0**	28	$ 3,354,000	8
	8		San Jose Muni	New site and SJ Muni well(s) in Evergreen	Construct additional groundwater wells in Evergreen		X	1	1	5	5	5	10	10	SA2: SJ Muni (Evergreen) could meet demands without District water at **Day 0**	28	$ 3,354,000	8
	9		SJWC	New SJWC wells, such as at Alum Rock	Construct additional GW wells at key locations. Potential location for additional well: Alum Rock by school?		X	1	1	5	5	5	5	1		14	$ 3,354,000	4
	10		Santa Clara	New Santa Clara well at Serra Tank, with new turnout/feed on Santa Clara Distributary	Install additional well near Serra Tank in Zone 2A, which could be tied into the Santa Clara Distributary to feed SCVWD system. Planning and design of a well at Serra Tank may begin in next fiscal year. Opportunity for cost-sharing.	X	X	1	1	10	10	10	10	10	All outages: Santa Clara could meet demands without District water at **Day 0** Possibility of backfeeding to other West-side retailers, would depend on location of pipeline breaks	35.5	$ 3,354,000	11
	11		Sunnyvale	Rehabilitate existing Sunnyvale well (Westmoor well)	Rehabilitating Westmoor Well to increase well capacity near SCVWD turnouts		X	1	1	5	1	10	1	1		10.5	$ 1,500,000	7
	12	Intertie	Cal Water	New intertie between Cal Water and Mountain View	Install intertie with City of Mountain View (stub outs 50-feet apart)		X	1	1	1	5	5	5	5		16	$ 885,750	18
	13		Cal Water	Upgrade existing or new intertie between Cal Water and Santa Clara	Develop additional and/or enhance existing interties with neighboring service areas		X	1	1	1	5	5	5	10		21	$ 885,750	24
	14		San Jose Muni	New intertie between SJ Muni (Evergreen) and Great Oaks	Construct intertie with Great Oaks in Evergreen		X	1	1	5	5	5	10	10	SA2: SJ Muni (Evergreen) could meet demands without District water at **Day 0**	28	$ 1,132,500	25
	15		SJWC	Upgrade existing or new SJWC interties (various). Santa Clara, Milpitas, SJ Muni, Cal Water, Great Oaks.	Increase intertie capabilities, including new interties and improvements to existing interties		X	1	1	5	5	5	5	5		18	$ 885,750	20
	16		Great Oaks	Upgrade two existing interties between Great Oaks and SJWC	Upgrade and test two existing interties with SJWC		X	1	1	5	5	5	10	5		23	$ 885,750	26
	17		Milpitas	Upgrade existing or new intertie between Milpitas and SJWC	Develop additional interties and enhance existing interties		X	1	1	5	5	5	5	1		14	$ 885,750	16
	18		Mountain View	New intertie between Mountain View and Sunnyvale	Intertie in Zone 3 to neighboring service area(s), such as Sunnyvale		X	1	1	1	5	5	1	1		8	$ 885,750	9
	19		Mountain View	New intertie between Mountain View and Palo Alto	Construct additional larger intertie with Palo Alto (16-inch)		X	1	1	1	5	5	5	1		12	$ 885,750	14
	20		Santa Clara	New intertie between Santa Clara and SJ Muni (North SJ)	Install additional intertie(s) with City of San Jose		X	1	1	1	1	5	1	1		6	$ 885,750	7
	21	Isolation Valve	Milpitas	New isolation valves on Milpitas Pipeline near Milpitas turnout	Install isolation valves on Milpitas Pipeline both north and south of existing turnout, particularly between the current and future proposed SCVWD turnouts near Piper/Montague	X		1	5	1	10	5	5	5	SA2: Inherent uncertainty in locations of pipeline breaks. Three pipeline breaks in East results in minimum of 14 days for recovery. Isolation valves may not reduce recovery time. Even if priority is fixing Snell and East PLs first, service still restored at **Day 14.**	19.5	$ 556,500	35
	22		SCVWD	Additional Line Isolation Valves on West Pipeline	Add isolation valves at strategic locations, such as on West Pipeline near Cox and Mann. These would be in addition to 4 line valves in District's current CIP.	X		1	5	1	10	5	5	5	LOS dependent on location of valves	19.5	$ 556,500	35
	23	Infrastructure	SJWC	District pipeline replacement/rehabilitation at critical locations	Improve line segment reliability at strategic locations	X		1	5	1	1	1	5	5		13	$ 10,000,000	1
	24		SCVWD	Calero Siphons or Pump Station	Repair siphons or construct pump station to increase f1s from Calero Reservoir	X		1	1	10	5	1	5	1		14.5	$ 10,000,000	1
$100M CIP	1	Infrastructure	SCVWD	Harden: Cross Valley Pipeline	Harden Cross Valley Pipeline - San Andreas EQ1, EQ2, and Calaveras EQ	X		1	5	1	1	1	5	5		13	$ 112,153,500	0.12
	2		SCVWD	Harden: Almaden Pipeline	Harden Almaden Pipeline - San Andreas EQ1 and EQ2	X		1	5	1	1	1	10	10	SA1: Would potentially only need to fix 2 breaks on West PL, resulting in restoration of West at **Day 14** SA2: Would potentially result in restoration of West at **Day 0.** Would need to fix 3 breaks in East but can restore East at **Day 14.**	23	$ 158,500,000	0.15
	3		SCVWD	Harden: South Bay Aqueduct	Harden South Bay Aqueduct - San Andreas EQ1, EQ2, and Calaveras EQ	X		1	5	1	1	1	5	10		18	$ 171,109,500	0.11
	4		SCVWD	Harden: Central Pipeline	Harden Central Pipeline - San Andreas EQ1 and EQ2	X		1	5	1	1	1	5	10		18	$ 168,375,000	0.11

Appendix 3:
Non-Preferred Project List

Non-Preferred Projects

#	Category	Customer/ Originator	Item	Description/Comments	Cost Category	Env.	Social/Community	Supply/ Capacity	Op. Flexibility	Ease of Imp.	Reliability	Cost	Rationale for Non-Preference
Operations Only													
1	Plan/Study/ Coordination	All	Coordinate emergency planning efforts with all retailers	Emergency response and operations needs to be emphasized, coordinated, and improved	$	Low	Low	Low	Low	Medium	Low	Low	Emergency planning efforts that were well-defined during the study have been included in the preferred project list in the 'operations' category. This project is meant to cover other general efforts that were not defined, and therefore not considered in the IRP study. SCVWD is committed to continuous improvement in emergency planning, and will consider other specific recommendations or actions as they are identified in the future.
2		Morgan Hill	Develop documentation for prioritizing GW recharge deliveries to Madrone Channel and Upper Coyote	District prioritizes deliveries to Madrone Channel and Upper Coyote equally with TW deliveries. Recommend institutionalizing and documenting this concept.	$	Low	Low	Low	Low	Medium	Low	Low	This would require opening treated water contracts for negiotion, and therefore, is not recommended. However, SCVWD does account for these deliveries in its supply models, and has continued making deliveries despite the current drought.
3		Morgan Hill	Consider recycled water project options	Consider options and costs from the Recycled Water Master Plan, for developing recycled water capabilities for Morgan Hill.	$	Medium	Low	Low	Low	Medium	Low	Low	Recycled water project options are being studied as part of SCVWD's long-term supply planning projects.
4		Morgan Hill	Morgan Hill water supply study	Recommend that Morgan Hill continue current water supply study and planning efforts and reliability measures.	$	Low	Low	Low	Low	High	Medium	Low	This is a project that Morgan Hill would do for long term supply planning. It would not be an SCVWD or IRP effort.
5		Palo Alto	Coordinate backup power and fuel planning efforts with Palo Alto and all retailers	Palo Alto is interested in working with SCVWD on backup power and fuel contingencies. This could apply to all retailers.	$	Low	Low	Low	Low	Medium	Medium	Low	SCVWD is supportive of regional emergency fuel planning efforts; however, the IRP study did not evaluate fuel and power at the regional level. This project would need additional scoping and identification of key participants to pursue further.
6		Purissima Hills	Develop partnerships to supply emergency SCVWD water to Purissima Hills through existing interties with Cal Water (and/or Palo Alto)	Would consider partnership with Cal Water and/or Palo Alto to bring emergency District TW or GW through existing bi-directional interties	$	Low	Low	Low	Low	Medium	Low	Low	Purissima Hills already has interties with Cal Water and Palo Alto. Cal Water and Palo Alto will provide water if available and needed in an emergency.
7		San Jose Muni	Coordinate public outreach and communication efforts	Joint communication on service cutbacks (such as no outdoor use)	$	Low	Low	Low	Low	Medium	Low	Low	No specific project or action was identified as part of the IRP study to carry forward. SCVWD is supportive of continuing improvement to joint communication efforts.
8		SCVWD	Evaluate and upgrade backup power, fuel, and chemical capabilities	Evaluate and upgrade fuel and chemical contingencies	$	Low	Low	Low	Low	Medium	Low	Low	Preliminary fuel need and burn rate study was developed as part of the IRP.
9		SCVWD	Enhance SCVWD emergency planning and preparedness	Enhance SCVWD's emergency preparedness	$	Low	Low	Low	Low	Medium	Medium	Low	This project is meant to cover general enhancements to emergency planning; however, no specific recommendations were identified in this IRP study. Previous studies including the 2005 IRP and IRP Baseline Improvements Project identified several emergency planning projects that have been implemented. SCVWD is committed to continuous improvement in emergency planning, and will consider other specific recommendations or actions as they are identified in the future.
$10 CIP													
1	Connection/ Turnout	Morgan Hill	Consider groundwater supply as backup for Santa Clara Conduit raw water	Consider options for GW into Santa Clara Conduit as backup	$$	Low	Low	Medium	Low	Medium	Low	Medium	Morgan Hill currently relies on groundwater. If groundwater were available to feed the Santa Clara Conduit, Morgan Hill would presumably have sufficient groundwater supplies from its wells. Also refer to project #1 below on $100M CIP list.
2	Groundwater Well	Cal Water	New site and Cal Water well in northern area where it can back-feed into West Pipeline	Installation of additional GW wells at key locations (if land is available), such as in northern portion of the county, may allow Cal Water to provide water into the SCVWD system by back-feeding into West Pipeline	$$	Low	Low	High	High	Medium	High	Medium	Site was not defined. Other defined well sites for Cal Water are included on the preferred project list.
3		Great Oaks	New Great Oaks wells	Construct additional wells in different locations of the GW basin to provide reliable excess GW supply	$$	Low	Low	Medium	Low	Medium	Low	Medium	Great Oaks already has well capacity in excess of their demands.
4		Milpitas	New Milpitas wells on Snell PL and/or East PL	Consider GW well on Snell PL or East PL to feed system on East side for Milpitas and San Jose	$$	Low	Low	High	High	Medium	High	Medium	Site was not defined. Other defined well sites for Milpitas/East pipeline are included on the preferred project list.
5		Morgan Hill	Lower existing Morgan Hill wells	Lowering existing GW wells to access lower elevations of the GW basin	$$	Medium	Low	Low	Low	Medium	Low	Medium	IRP outage scenarios resulted in expected outage durations of groundwater recharge of about 60 days. Lowering wells would be beneficial for a longer term outage of groundwater recharge, such as in a drought.
6		Morgan Hill	New Morgan Hill wells	Additional GW wells to access different hydrological portions of the GW basin	$$	Medium	Low	Low	Low	Medium	Low	Medium	Morgan Hill already has well capacity in excess of their demands. New wells may help in a drought scenario if wells can be located in an area where the aquifer is less sensitive to changes in recharge.
7		Mountain View	New Mountain View well at Bryant	New well for Zone 3 - 2nd choice: Bryant - at old tank site where elevated tank was removed	$$	Low	Low	Medium	Medium	Medium	Low	Medium	A preferred well location at Miramonte Reservoir is included on the preferred project list.
8		SJWC	Lower existing SJWC wells	Lower existing wells	$$	Medium	Low	Low	Low	Medium	Low	Medium	IRP outage scenarios resulted in expected outage durations of groundwater recharge of about 60 days. Lowering wells would be beneficial for a longer term outage of groundwater recharge, such as in a drought.
9	Treatment	Morgan Hill	Purchase package water treatment plant for Morgan Hill to treat raw water from Santa Clara Conduit	Purchase package water treatment plant that could be brought online and tied into Morgan Hill system	$$	Low	Low	High	Medium	Low	Low	Medium	Morgan Hill currently relies on groundwater. If raw water is available in the Santa Clara Conduit, SCVWD would be able to recharge the aquifer in Morgan Hill, and Morgan Hill would presumably have sufficient groundwater supplies from its wells.
10	Infrastructure	Morgan Hill	Repair/upsize Main Avenue and Madrone Pipelines	Implement current project to repair and/or upsize Main Avenue and Madrone Pipelines for Main Avenue and Madrone recharge ponds. Also, considering extension to Butterfield channel. (District WSIMP recommendation)	$$	Medium	Low	Low	Low	Low	Low	Medium	This project is being done by SCVWD and is in the CIP.
11		SCVWD	Treated water storage tank(s)	Add treated water storage, such as East Reservoir site	$$	Low	Low	Medium	Medium	Medium	Low	Medium	Storage tanks are a preferred solution for operational flexibility for managing peak demands; however, for earthquake scenarios, tanks are less reliable than wells, and therefore not pursed as part of the IRP.
$100 CIP													
1	Connection/Turnout	Gilroy	Pipeline to connect Gilroy to feed Santa Clara Conduit with groundwater	Construct connection to SCVWD pipeline so that Gilroy can feed into SCVWD system.	$$$	Low	Low	Medium	Medium	Low	Medium	High	This project would provide the ablity to use groundwater from Gilroy for recharge in the Morgan Hill area. It has limited benefits for the high cost, and the long distance of pipe the water would have to travel does not make it a reliable solution for earthquake hazards.
2	Intertie	SCVWD	West-side intertie with SFPUC BDPL 3 & 4	Construct west-side intertie with SFPUC. Options include: - West Pipeline extension - Sunnyvale Distributary extension - Mountain View Distributary extension - Santa Clara Distributary extension	$$$$	Low	Low	High	High	Low	High	High	This project does not provide sufficient benefit to justify the high cost. This project would provide the ability for SCVWD treated water retailers along the West Pipeline to use SFPUC water in place of SCVWD treated water if the Rinconada Water Treatment Plant or portions of the West Pipeline were damaged in an earthquake or storm event. The findings of the analysis done for the IRP are that all retailers already have sufficient alternate supplies available to back-up SCVWD treated water supplies at winter demand levels for the expected outage durations for a seismic or storm event, with the exception of a few localized areas. In addition, SCVWD is currently improving the reliability of its Rinconada Water Treatment Plant, and plans to add two isolation valves on the West Pipeline to further improve reliability. Three of five retailers on the West Pipeline (Cities of Mountain View, Sunnyvale, and Santa Clara) already receive SFPUC water into their systems. The cities of Mountain View and Sunnyvale can move their SFPUC supplies within their systems to the zones served by SCVWD treated water supplies, and also have some groundwater well backup supplies. The City of Santa Clara cannot move SFPUC water to the zone served by SCVWD treated water, but has sufficient groundwater supply to back-up SCVWD treated supplies. The remaining two retailers, San Jose Water Company and Cal Water, do not receive SFPUC supplies, but have sufficient groundwater capacity to back-up SCVWD treated water supplies within their systems. The IRP also evaluated a Delta outage. Modeling and analysis show that retailers could use their groundwater or SFPUC supplies to replace any shortage of treated water from Rinconada Water Treatment Plant, with an assumption of 20% demand reduction/conservation efforts in place, as well as future planned recycled water projects in place. There are two retail customers that do not currently receive SCVWD treated water from the West Pipeline, Purissima Hills Water District and the City of Palo Alto. The IRP found that these two retailers also have back-up supplies and interties available to back-up their current system supplies in an outage event. However, each of these entities has expressed interest in a West Pipeline extension to receive SCVWD treated water for additional supply reliability for the short term or long term. As mentioned above, the West Pipeline extension does not provide sufficient benefit to justify the cost as a project to improve short term reliability due to earthquake or storm since all retailers already have sufficient backup supplies to meet winter demands. The IRP did not analyze long term supply reliability. The addition of the City of Palo Alto and Purissima Hills Water District as regular or new treated water customers for improved long term supply reliability can be evaluated as part of SCVWD's long term water supply planning process.
3	Infrastructure	SCVWD	Harden: Pacheco Conduit	Harden Pacheco Conduit (Reach 1) - Calaveras EQ scenario	$$$	Low	Low	Low	Low	Low	High	High	The calculated risk exposure for the Pacheco Conduit is lower than that of other pipelines. See TM 9 analysis. However, SCVWD may choose to improve the pipeline as part of its long term asset management program.
4		SCVWD	Harden: Santa Clara Conduit	Harden Santa Clara Conduit (Reach 1) - San Andreas EQ1 and Calaveras EQ	$$$	Low	Low	Low	Low	Low	High	High	The calculated risk exposure for the Santa Clara Conduit is lower than that of other pipelines. See TM 9 analysis. However, SCVWD may choose to improve the pipeline as part of its long term asset management program.
5		SCVWD	Harden: West Pipeline 1	Harden West Pipeline (Reach 1) - San Andreas EQ1	$$$	Low	Low	Low	Low	Low	High	High	The calculated risk exposure for the West Pipeline is lower than that of other pipelines. See TM 9 analysis. However, SCVWD may choose to improve the pipeline as part of its long term asset management program.
6		SCVWD	Harden: West Pipeline 2	Harden West Pipeline (Reach 2) - San Andreas EQ1	$$$	Low	Low	Low	Low	Low	High	High	The calculated risk exposure for the West Pipeline is lower than that of other pipelines. See TM 9 analysis. However, SCVWD may choose to improve the pipeline as part of its long term asset management program.
7		SCVWD	Harden: Snell Pipeline 1	Harden Snell Pipeline (Reach 1) - San Andreas EQ2	$$$	Low	Low	Low	Low	Low	High	High	The calculated risk exposure for the Snell Pipeline is lower than that of other pipelines. See TM 9 analysis. However, SCVWD may choose to improve the pipeline as part of its long term asset management program.
8		SCVWD	Harden: East Pipeline 1	Harden East Pipeline (Reach 1) - San Andreas EQ2	$$$	Low	Low	Low	Low	Low	High	High	The calculated risk exposure for the East Pipeline is lower than that of other pipelines. See TM 9 analysis. However, SCVWD may choose to improve the pipeline as part of its long term asset management program.
9		SCVWD	Harden: Milpitas Pipeline	Harden Milpitas Pipeline - San Andreas EQ2	$$$	Low	Low	Low	Low	Low	High	High	The calculated risk exposure for the Milpitas Pipeline is lower than that of other pipelines. See TM 9 analysis. However, SCVWD may choose to improve the pipeline as part of its long term asset management program.
10		SCVWD	Treated water East-West link	Construct pipeline connecting the East-side and West-side TW systems	$$$$	Low	Low	High	High	Low	High	High	This project does not provide sufficient benefit to justify the high cost. The findings of the analysis done for the IRP are that all retailers already have sufficient alternate supplies available to back-up SCVWD treated water supplies at winter demand levels for the expected outage durations for a seismic or storm event, with exception of a few localized areas.

Appendix 4:
Expanded Project Scoring Table

Rating Criteria	Low = 1 pt	Medium = 5 pts	High = 10 pts
Environmental	Does not provide any specific environmental benefit and/or does not address a specific environmental concern. Examples of enhancements include habitat restoration, stream water quality, vegetation, and fish and wildlife support.	Could provide some environmental benefit and/or addresses a specific environmental concern. Examples of enhancements include habitat restoration, stream water quality, vegetation, and fish and wildlife support.	Directly provides significant environmental benefot and/or addresses specific environmental concerns. Examples of enhancements include habitat restoration, stream water quality, vegetation, and fish and wildlife support.
Social/Community	Does not provide any specific social or community benefits	Could provide some social or community benefit - Reduce property damage impacts due to pipeline breaks, such as via isolation valves or pipeline hardening - Enhance recreational opportunities	Directly provides significant social and/or community benefits
Supply/Capacity	Does not provide increase in supply or capacity - Coordination studies - Isolation valves - Hardening pipelines	Provides increase in supply or capacity within retailer service areas - Groundwater well and/or intertie within retailer distribution system	Provides increase in supply or capacity to District system directly - New source of supply directly into the District system
Operational Flexibility	Does not increase operational flexibility - Hardening pipelines	Could provide some increase in operational flexibility for one service area - Interties - Wells within retailer distribution system	Significantly increases operational flexibility for multiple service areas and allows retailers to withstand pipeline outages - Key isolation valves - Projects that feed or wheel water in District pipelines
Ease of Implementation	Difficult to implement - Requires land acquisition for sites for new groundwater wells - Requires significant excavation for large pipeline work	Moderate implementation effort - Study with significant coordination or modeling - Moderate excavation work for isolation valves, interties, connections, and groundwater wells at existing sites	Easily implemented - Study without significant coordination or modeling needed - Minor excavation work or minor equipment needed - Project that is already in progress
Reliability	Does not increase reiability for retailers to meet demands	May increase reliability for retailers who currently cannot meet average demands in an outage scenario	May increase reliability for retailers who currently cannot meet minimum demands in an outage scenario
Contribution to LOS	Does not directly address a specifically identified vulnerable area	Could help address one or more of the specifically identified vulnerable areas, but still relies on other dependencies - Feeding or wheeling water through District pipelines could potentially reach a vulnerable area	Directly addresses one or more of the specifically identified vulnerable areas - Adds source or supply directly to vulerable area, such as key groundwater well or intertie
Cost	$100+ Million Project cost categories to enable grouping into porfolios	$1 - $10 Million Project cost categories to enable grouping into porfolios	< $1 Million Project cost categories to enable grouping into porfolios

Appendix 5:

Generic Costs Preliminary Specifications and Assumptions

Groundwater Well

Specifications:

- 2-3 MGD capacity
- 500 foot depth
- 300 foot casing, 200 foot perforation
- 8-10” diameter
- 500 foot connection to distribution system (ductile iron pipe)
- 220-330 horsepower pump required
- On-site disinfection (chlorine injection)
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Land is already owned by the retailer
- Open space with easy access
- Close proximity to high voltage power and existing water lines

Pipeline Replacement

Suburban/Rural Location *Almaden Valley and Cross Valley Pipelines, SBA*	**Urban Location** *Central Pipeline*

<u>Specifications:</u>
• Welded steel pipeline
  ○ 48” diameter
  ○ 66” diameter
  ○ 72” diameter
  ○ 78” diameter
• Total length of ~25,000 linear feet
• Parallel alignment, 20 foot tie-in
 	
<u>Assumptions:</u>
• Few utility conflicts
• Jack and bore every ~3000 feet
• Abandon existing pipeline in place
• Possibility of creek crossings (up to 4 locations)
• Liquefaction zone
	<u>Specifications:</u>
	• Welded steel pipeline
	  ○ 48” diameter
	  ○ 66” diameter
	  ○ 72” diameter
	  ○ 78” diameter
	• Total length of ~25,000 linear feet
	• Parallel alignment, 20 foot tie-in
	
	<u>Assumptions:</u>
	• Congested utilities
	• Jack and bore every ~1000 feet
	• Abandon existing pipeline in place
	• Possibility of creek crossings (up to 4 locations)
	• Traffic control required
	• Possibility of hazardous soil/dewatering required/earthwork
	• Liquefaction zone

Intertie

Specifications:

- 12” diameter ductile iron pipeline
- ~800 foot length
- 2 isolation valves
- 600 gpm, 8-inch, 100+ psi pump

Assumptions:

- Portable pump on a trailer
- Possible creek crossing

CONFIDENTIAL

Isolation Valve

Specifications:

- 48” or 60” diameter butterfly valve
- Valve vault
    - 17’ by 17’ vault size
    - 2’ 9” by 8’ clear opening
    - Aluminum roof scuttle
    - Access by stairs (2’ wide)
    - 2’ 6” by 6’ hatch opening
    - Valve support concrete base
- SCADA
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Few utility conflicts
- Standard vault design

Service Connection/Turnout

Specifications:

- 20” diameter turnout
- Isolation valve
- Valve vault
    - 13’ by 15’ vault size
    - 2’ 9” by 8’ clear opening
    - Aluminum roof scuttle
    - Access by stairs (2’ wide)
    - 4’ by 4’ hatch opening
    - Valve support concrete base
- ~500 foot connection
- SCADA
- Mag meter
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Few utility conflicts
- Standard vault design
- Must be able to transfer 20 MGD in excess supply

Appendix 6:
Generic Cost Estimate Report

SCVWD RELIABILITY STUDY

PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COSTS (AN OPINION OF PROBABLE CONSTRUCTION COST) BASED ON RELIABILITY STUDY CONCEPT

Owner:
SANTA CLARA VALLEY WATER DISTRICT

Prepared for
AECOM
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Prepared by
M LEE CORPORATION
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3/16/2016 Progress Draft

MLC: 1203 SCVWD Reliability Generic Estimate

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COSTS
(AN OPINION OF PROBABLE CONSTRUCTION COST)

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SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)

PREAMBLE (BASIS OF ESTIMATE)

3/16/2016 Progress Draft

1 Outline

1.1 The preliminary construction cost estimate, which represents our opinion of probable construction costs, is comprised of the following integral parts:

a) Preamble
b) Estimate Summaries
c) Estimate Details
Please see Table of Contents for details.

1.2 The preparation of this estimate is based on the following:
a) Generic Costs Preliminary Specifications and Assumptions prepared by AECOM for M Lee Corporation received by us on Mar 8, 2016 (5 pages)
b) Discussion during a kick-off meeting between AECOM and M Lee Corp on Mar 2, 2016.

1.3 This conceptual estimate is equivalent to AACE Estimating Classification Class 5.

2 Assumptions & Qualifications

2.1 The estimate specifically excludes the following:
Real Estate/ Right of Way Acquisition, if any
Legal fees
Finance costs
Cost escalation from the date of this estimate. It is recommended to include 5.0% per year for the
It is assumed that the above items, if needed, are included elsewhere in the owner's overall project budget.

2.2 Based on a single general contract using prevailing wage rates current for the County of Santa Clara.

2.3 The estimate is based on all work to be performed during regular working hours. No premium allowance is included for overtime, working at nights or weekends.

2.4 The estimate is based on estimated prices current as of March 2016, with four to six responsible and responsive bids under a competitive bidding environment for a fixed price lump sum contract.

Experience indicates that fewer bidders may result in higher bids, and conversely more bidders may result in more competitive bids. Therefore it is important to obtain as many bids as possible.

2.5 The unit costs used in the detailed estimates are composite construction unit costs including costs for material including sales tax, labor, and equipment. Contractors' markups for general conditions, overhead and profits and plan check fee are added to the direct construction cost.

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)

PREAMBLE (BASIS OF ESTIMATE)

2.6 Items potentially affecting the cost estimate:
Modifications to the scope of work included in this estimate
Unforeseen sub-surface conditions
Special phasing requirements
Restrictive technical specifications or excessive contract conditions
Any specified item of equipment, material, or product that cannot be obtained from at least three different sources
Any other non-competitive bid situations

2.7 The estimate has been prepared using generally accepted estimating practices and it represents our opinion of probable construction costs. It is intended to be a determination of fair market value for the project construction. Since we have no control over market conditions and other factors which may affect the bid prices, we cannot and do not warrant nor guarantee that bids or ultimate construction costs will not vary from the cost estimate. It should also be noted that the estimate is a "snapshot in time" and that the reliability of this opinion of probable construction cost will inherently degrade over time.

2.8 Please note this estimate is based on very preliminary design information and assumptions, and it should be used as a general guideline for more specific and detailed studies going forward.

2.9 Abbreviations used in the estimate:
CY = cubic yard
DIP = ductile iron pipe
(E) = existing
EA = each
GSF = gross square feet
LB = pound
LF = linear foot
LS = lump sum
NIC = Not In Contract
SF = square foot
WSP = Welded Steel Pipe

SCVWD RELIABILITY STUDY

PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AACE Class 5)

BASED ON RELIABILITY STUDY CONCEPT

MARKUPS 3/16/2016 Progress Draft

	Item	Total Cost	Explanation
1	**Direct Cost = Base**	**$100.00**	Equivalent to subcontractor's bid to general contractor. This includes costs for materials, labor & equipment and subcontractor's markups for overhead and profit.
	(Detailed itemized pricing for construction work)		
2	**Markups are added to the above for the following:**		
3	General Contractor's General Conditions, Overhead and Profit	15.50%	Includes 10% for General Contractor's General Conditions compounded with 5% for General Contractor's OH&P
4		---	
5	Subtotal A	$115.50	
6	Contingency for Design and Estimating	30.0%	Allowance to cover costs that may result from design changes, items not fully itemized in the estimate, errors or omissions in the estimate, or unpredictable conditions or risks that experience shows are likely to occur during the design or bidding phase of the project.
7		---	
8	Subtotal B - Construction Hard cost	$150.15	This is the estimated fair -market construction bid submitted by general contractor
9	Construction Contingency	10.0%	This is an allowance to cover change orders during construction
10		---	
11	**Total Construction Hard cost**	**$165.17**	This is the estimated construction cost for contractors at the end of the construction project
9	Soft Cost - Excluded		To be carried separately by Client
10		---	
11	Subtotal C	$165.17	This is the estimated construction cost for contractors at the end of the construction project
9	Project Contingency/Reserve - Excluded		To be carried separately by Client
10		---	
11	**Total Project Cost**	$165.17	This is the estimated construction cost for contractors at the end of the construction project
12	Total Multiplier from Direct Cost (Subcontractor's Cost) to Construction Hard Cost	1.65	This is the multiplier added to Direct Cost to come up with total construction hard cost

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
BASED ON RELIABILITY STUDY CONCEPT
ESTIMATE SUMMARY

3/16/2016 Progress Draft

ALL COSTS ARE IN 2016 DOLLARS

COMPONENT		UNIT	TOTAL CONSTRUCTION HARD COST
GROUNDWATER WELL		EA	$2,236,000
PIPELINE REPLACEMENT UNIT PRICES - SUBURBAN			
	48” diameter	LF	$2,490
	66” diameter	LF	$3,475
	72” diameter	LF	$3,830
	78” diameter	LF	$4,485
PIPELINE REPLACEMENT UNIT PRICES - URBAN			
	48” diameter	LF	$3,328
	66” diameter	LF	$4,716
	72” diameter	LF	$5,554
	78” diameter	LF	$6,285
INTERTIE		EA	$755,000
ISOLATION VALVE		EA	$371,000
SERVICE CONNECTION		EA	$879,000

Please read attached "Preamble" and "Estimate Details" for a complete scope of work including basis of estimate, exclusions, assumptions and qualifications.

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
GROUNDWATER WELL

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Groundwater Well**				
3	**Specification**				
4	2-3 MGD capacity				
5	500 foot depth				
6	300 foot casing, 200 foot perforation				
7	8-10" diameter				
8	500 foot connection to distribution system (ductile iron pipe)				
9	220-330 horsepower pump required				
10	On-site disinfection (chlorine injection)				
11	Backup power (on-site generator/fuel storage)				
12					
13	**Assumptions:**				
14	Land is already owned by the retailer				
15	Open space with easy access				
16	Close proximity to high voltage power and existing water lines				
17					
18	**Preliminary Estimate**				
19	Install conductor casing w/sand cement seal	1	ea	20,000.00	20,000
20	Drill pilot hole	500	lf	98.00	49,000
21	Perform geophysical surveys	1	ea	5,000.00	5,000
22	Perform sieve grain size analysis on 10 samples	1	ea	1,500.00	1,500
23	Ream pilot hole	500	lf	100.00	50,000
24	Perform caliper survey of reamed borehole	1	ea	3,250.00	3,250
25	Furnish & install 10-inch nominal diameter Type 304 stainless steel blank casing, and appurtenances	300	lf	300.00	90,000
26	Furnish & install 10-inch nominal diameter Type 304 stainless steel sump	10	lf	400.00	4,000
27	Furnish & install 10-inch nominal diameter type 304 stainless steel wire-wrapped screen	200	lf	220.00	44,000
28	Furnish & install nominal 2-inch nominal diameter type 304 stainless steel sounding tube.	350	lf	52.00	18,200
29	Furnish & install nominal 2-inch diameter type 304 stainless steel gravel feed pipe	350	lf	46.00	16,100
30	Furnish & install nominal 2-inch diameter type 304 stainless steel vent pipe	1	ea	1,500.00	1,500
31	Furnish & emplace filter pack in annular space	300	lf	80.00	24,000
32	Furnish & emplace fine sand in annular space	5	lf	90.00	450
33	Furnish & emplace sand-cement seals in annular space	200	lf	50.00	10,000
34	Furnish, install, & remove temporary piping to convey development and pumping test waters to discharge & setting tanks	1	ea	10,000.00	10,000
35	Furnish, install, operate & remove pump system & transducers for well development & pump tests	1	ea	7,000.00	7,000
36	Develop well by swabbing & bailing	40	hr	150.00	6,000
37	Develop well by pumping	40	hr	150.00	6,000
38	Step-drawdown test	12	hr	150.00	1,800
39	Constant rate pump test	48	hr	150.00	7,200

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
40	Perform water quality analysis of completed well	1	ea	2,500.00	2,500
41	Provide NPDES sample bottles and analysis	1	ea	2,500.00	2,500
42	Perform plumbness and alignment test	1	ea	1,500.00	1,500
43	Well disinfection	1	ea	2,000.00	2,000
44	Provide final well color down-hole video	1	ea	1,000.00	1,000
45	Pump pad	1	ea	2,000.00	2,000
46	Submersible Pump, 220-330 HP	1	ea	200,000.00	200,000
47	Variable frequency drive	1	ea	50,000.00	50,000
48	One main line, 8"	500	lf	381.95	190,975
49	Mag meter, 8"	1	ea	4,500.00	4,500
50	BFV, 8"	2	ea	10,000.00	20,000
51	Pump control valve	1	ea	5,000.00	5,000
52	One pump to waste line	20	lf	100.00	2,000
53	Allow for electrical, instrumentation and control	1	ls	50,000.00	50,000
54	Allow for grading and paving	1	ls	15,000.00	15,000
55					
56	**Groundwater Well - Total**				923,975
57	Add markups			65%	600,584
57					
58	Total construction cost (hardcost)				1,524,559
60				**rounded-off**	**1,525,000**
61					
62					
63	**Building with Chemical Treatment for One Well**				
64					
65	Building, assumed 1000 SF	1,000	sf		
66	Site formation	1,000	sf	3.00	3,000
67	Slab on grade & foundation	1,000	sf	20.00	20,000
68	Exterior wall	1,700	sf	39.00	66,300
69	Roof deck/Roofing	1,000	sf	26.00	26,000
70	Interior partition	470	sf	20.00	9,400
71	Exterior door/frame/hardware, pair	3	ea	2,600.00	7,800
72	Exterior door/frame/hardware, single	3	ea	1,950.00	5,850
73	Interior door/frame/hardware, single	1	ea	1,560.00	1,560
74	Removable hatch	1	ea	1,040.00	1,040
75	Trench with grates	14	lf	156.00	2,184
76	Grating over pit	120	sf	98.00	11,760
77	Equipment locker	1	ea	2,600.00	2,600
78	Plumbing	1,000	sf	20.00	20,000
79	Mechanical ventilation	1,000	sf	10.00	10,000
80	Electrical & lighting	1,000	sf	26.00	26,000
81	SCADA	1	ea	20,000.00	20,000
82					
83	Subtotal A				233,494
84					
85	Sitework				
86	Clearing & grubbing	1	ls	6,500.00	6,500
87	Grading	1	ls	6,500.00	6,500

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
GROUNDWATER WELL

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
88	Landscaping	1	ls	3,900.00	3,900
89	Traffic bollards	5	ea	1,040.00	5,200
90	Site cleanup & disinfection	1	ls	3,900.00	3,900
91	Sewer storm drain, & water line connections	1	ls	26,000.00	26,000
92	Connect to (E) electrical power supply	1	ls	15,000.00	15,000
93	Connect to (E) water supply line	1	ls	20,000.00	20,000
94	Connect to (E) sewer line	1	ls	10,000.00	10,000
95					
96	Subtotal B				97,000
97	Disinfection for 500 GPM:				
98	Metering pumps	2	ea	2,000	4,000
99	Metering pumps, redundant	2	ea	2,000	4,000
100	Chemical drums	2	ea	750	1,500
101	Process piping	1	ls	10,000	10,000
102	Electrical	1	ls	7,500	7,500
103					
104	Subtotal C				27,000
105					
106	Backup Power:				
107	Generator, say 100 KW	1	ea	50,000	50,000
108	ATS, say 225 A	1	ea	6,000	6,000
109	Diesel fuel storage, above ground, say 1000 Gal	1	ea	10,000	10,000
110	Misc. items	1	ls	7,500	7,500
111					
112	Subtotal D				73,500
113					
114	**Total - Building with Chemical Treatment for One Well**	**A+B+C+D**			430,994
115	Add markups			65%	280,146
115					
116	Total construction cost (hardcost)	A+B+C+D			711,140
118				**rounded-off**	**711,000**
119					
120	**Ground Total Above (Groundwater Well, Building & Associated Work)**				**2,236,000**
121					

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
PIPELINE REPLACEMENT UNIT PRICES - SUBURBAN

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
1	**Suburban/Rural Location**				
2	**Almaden Valley and Cross Valley Pipelines, SBA**				
3				**SUMMARY**	
4					
5	Specifications:				Total Hard cost
6	**Welded steel pipeline, cement mortar lining**			Direct U.C. $/LF	Total U. C. (includes markups 65%), $/LF
7	**48" diameter**		LF	1,509.00	**2,490.00**
8	**66" diameter**		LF	2,106.00	**3,475.00**
9	**72" diameter**		LF	2,321.00	**3,830.00**
10	**78" diameter**		LF	2,718.00	**4,485.00**
11					
12	Total length of ~25,000 linear feet				
13	Parallel alignment, 20 foot tie				
14					
15	Assumptions:				
16	Few utility conflicts				
17	Jack and bore every ~3000 feet				
18	Abandon existing pipeline in place				
19	Possibility of creek crossings (up to 4 locations)				
20	Liquefaction zone				
21					

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AACE Class 5)
PIPELINE REPLACEMENT UNIT PRICES - SUBURBAN

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
22					
23	**Preliminary Cost Estimate**			UNIT COST BUILD-UP	
24					
25	**48" Welded steel pipeline**	25,000	lf		
26	Trenching/Excavation	45,370	cy	25.00	1,134,250
27	Haul-off excavated material	11,630	cy	30.00	348,900
28	Backfill	33,740	cy	35.00	1,180,900
29	Temporary shoring	350,000	sf	15.00	5,250,000
30	Pipe material & installation	25,000	lf	280.00	7,000,000
31	Fittings, add 20%	20%			1,400,000
32	Testing & inspection	25,000	lf	5.00	125,000
33	Jack & bore every 3000 ft/ea	8	ea	150,000.00	1,200,000
34	Creek crossings	4	ea	500,000.00	2,000,000
35	Avoid utility conflicts	25,000	lf	10.00	250,000
36	Abandon existing pipeline in place	25,000	lf	25.00	625,000
37	Remove & then restore paving	175,000	sf	12.00	2,100,000
38	Traffic control/traffic management	25,000	lf	10.00	250,000
39					
40	Direct cost	25,000	lf	914.56	22,864,050
41	Add Markups			65%	14,861,633
42					
43	Total construction cost (hardcost)	25,000	LF	**1,509.00**	37,725,683
44					
45					
46	**66" Welded steel pipeline**	25,000	lf		
47	Trenching/Excavation	66,898	cy	25.00	1,672,450
48	Haul-off excavated material	21,987	cy	30.00	659,610
49	Backfill	44,911	cy	35.00	1,571,885
50	Temporary shoring	425,000	sf	15.00	6,375,000
51	Pipe material & installation	25,000	lf	420.00	10,500,000
52	Fittings, add 20%	20%			2,100,000
53	Testing & inspection	25,000	lf	7.00	175,000
54	Jack & bore every 3000 ft/ea	8	ea	250,000.00	2,000,000
55	Creek crossings	4	ea	750,000.00	3,000,000
56	Avoid utility conflicts	25,000	lf	12.00	300,000
57	Abandon existing pipeline in place	25,000	lf	30.00	750,000
58	Remove & then restore paving	212,500	sf	12.00	2,550,000
59	Traffic control/traffic management	25,000	lf	10.00	250,000
60					
61	Direct cost	25,000	lf	1,276.16	31,903,945
62	Add Markups			65%	20,737,564
63					

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AACE Class 5)
PIPELINE REPLACEMENT UNIT PRICES - SUBURBAN

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
64	Total construction cost (hardcost)	25,000	LF	**2,106.00**	52,641,509
65					
66					
67	**72" Welded steel pipeline**	25,000	lf		
68	Trenching/Excavation	75,000	cy	25.00	1,875,000
69	Haul-off excavated material	26,167	cy	30.00	785,010
70	Backfill	48,833	cy	35.00	1,709,155
71	Temporary shoring	450,000	sf	15.00	6,750,000
72	Pipe material & installation	25,000	lf	490.00	12,250,000
73	Fittings, add 20%	20%			2,450,000
74	Testing & inspection	25,000	lf	9.00	225,000
75	Jack & bore every 3000 ft/ea	8	ea	350,000.00	2,800,000
76	Creek crossings	4	ea	1,000,000.00	4,000,000
77	Avoid utility conflicts	25,000	lf	15.00	375,000
78	Abandon existing pipeline in place	25,000	lf	35.00	875,000
79	Remove & then restore paving	225,000	sf	12.00	2,700,000
80	Traffic control/traffic management	25,000	lf	10.00	250,000
81					
82	Direct cost	25,000	lf	1,406.77	35,169,165
83	Add Markups			65%	22,859,957
84					
85	Total construction cost (hardcost)	25,000	LF	**2,321.00**	58,029,122
86					
87					
88	**78" Welded steel pipeline**	25,000	lf		
89	Trenching/Excavation	83,565	cy	25.00	2,089,125
90	Haul-off excavated material	30,709	cy	30.00	921,270
91	Backfill	52,856	cy	35.00	1,849,960
92	Temporary shoring	475,000	sf	15.00	7,125,000
93	Pipe material & installation	25,000	lf	560.00	14,000,000
94	Fittings, add 20%	20%			2,800,000
95	Testing & inspection	25,000	lf	10.00	250,000
96	Jack & bore every 3000 ft/ea	8	ea	450,000.00	3,600,000
97	Creek crossings	4	ea	1,000,000.00	4,000,000
98	Avoid utility conflicts	25,000	lf	18.00	450,000
99	Abandon existing pipeline in place	25,000	lf	40.00	1,000,000
100	Remove & then restore paving	237,500	sf	12.00	2,850,000
101	Traffic control/traffic management	25,000	lf	10.00	250,000
102					
103	Direct cost	25,000	lf	1,647.41	41,185,355
104	Add Markups			65%	26,770,481
105					

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
PIPELINE REPLACEMENT UNIT PRICES - SUBURBAN

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
106	Total construction cost (hardcost)	25,000	LF	**2,718.00**	67,955,836
107					

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
PIPELINE REPLACEMENT UNIT PRICES - URBAN

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
1	**Urban Location**				
2	**Central Pipeline**				
3				**SUMMARY**	
4					
5	Specifications:				
6	**Welded steel pipeline, cement mortar lining**			Direct U.C. $/LF	Total U. C. (includes markups 65%), $/LF
7	**48" diameter**			2,017.00	**3,328.00**
8	**66" diameter**			2,858.00	**4,716.00**
9	**72" diameter**			3,366.00	**5,554.00**
10	**78" diameter**			3,809.00	**6,285.00**
12	Total length of ~25,000 linear feet				
13	Parallel alignment, 20 foot tie				
14					
15	Assumptions:				
16	Congested utilities				
17	Jack and bore every ~1000 feet				
18	Abandon existing pipeline in place				
19	Possibility of creek crossings (up to 4 locations)				
20	Traffic control required				
21	Possibility of hazardous soil/dewatering required				
22	Liquefaction zone				
23					

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AACE Class 5)
PIPELINE REPLACEMENT UNIT PRICES - URBAN

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
24					
25	**Preliminary Cost Estimate**			UNIT COST BUILD-UP	
26					
27	**48" Welded steel pipeline**	25,000	lf		
28	Trenching/Excavation	45,370	cy	25.00	1,134,250
29	Haul-off excavated material	11,630	cy	30.00	348,900
30	Backfill	33,740	cy	35.00	1,180,900
31	Temporary shoring	350,000	sf	16.00	5,600,000
32	Pipe material & installation	25,000	lf	280.00	7,000,000
33	Fittings, add 20%	20%			1,400,000
34	Testing & inspection	25,000	lf	5.00	125,000
35	Jack & bore every 1000 ft/ea	25	ea	150,000.00	3,750,000
36	Creek crossings	4	ea	500,000.00	2,000,000
37	Avoid utility conflicts	25,000	lf	20.00	500,000
38	Abandon existing pipeline in place	25,000	lf	25.00	625,000
39	Remove & then restore paving	175,000	sf	15.00	2,625,000
40	Traffic control/traffic management	25,000	lf	20.00	500,000
41	Contaminated soil removal, say 50%	22,685	cy	150.00	3,402,750
42	Dewatering	25,000	lf	15.00	375,000
43					
44	Direct cost	25,000	lf	1,222.67	30,566,800
45	Add Markups			65%	19,868,420
46					
47	Total construction cost (hardcost)	25,000	LF	**2,017.00**	50,435,220
48					
49					
50	**66" Welded steel pipeline**	25,000	lf		
51	Trenching/Excavation	66,898	cy	25.00	1,672,450
52	Haul-off excavated material	21,987	cy	30.00	659,610
53	Backfill	44,911	cy	35.00	1,571,885
54	Temporary shoring	425,000	sf	16.00	6,800,000
55	Pipe material & installation	25,000	lf	420.00	10,500,000
56	Fittings, add 20%	20%			2,100,000
57	Testing & inspection	25,000	lf	7.00	175,000
58	Jack & bore every 1000 ft/ea	25	ea	250,000.00	6,250,000
59	Creek crossings	4	ea	750,000.00	3,000,000
60	Avoid utility conflicts	25,000	lf	25.00	625,000
61	Abandon existing pipeline in place	25,000	lf	30.00	750,000
62	Remove & then restore paving	212,500	sf	15.00	3,187,500
63	Traffic control/traffic management	25,000	lf	20.00	500,000
64	Contaminated soil removal, say 50%	33,449	cy	150.00	5,017,350
65	Dewatering	25,000	lf	20.00	500,000

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
PIPELINE REPLACEMENT UNIT PRICES - URBAN

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
66					
67	Direct cost	25,000	lf	1,732.35	43,308,795
68	Add Markups			65%	28,150,717
69					
70	Total construction cost (hardcost)	25,000	LF	**2,858.00**	71,459,512
71					
72					
73	**72" Welded steel pipeline**	25,000	lf		
74	Trenching/Excavation	75,000	cy	25.00	1,875,000
75	Haul-off excavated material	26,167	cy	30.00	785,010
76	Backfill	48,833	cy	35.00	1,709,155
77	Temporary shoring	450,000	sf	16.00	7,200,000
78	Pipe material & installation	25,000	lf	490.00	12,250,000
79	Fittings, add 20%	20%			2,450,000
80	Testing & inspection	25,000	lf	9.00	225,000
81	Jack & bore every 1000 ft/ea	25	ea	350,000.00	8,750,000
82	Creek crossings	4	ea	1,000,000.00	4,000,000
83	Avoid utility conflicts	25,000	lf	30.00	750,000
84	Abandon existing pipeline in place	25,000	lf	35.00	875,000
85	Remove & then restore paving	225,000	sf	15.00	3,375,000
86	Traffic control/traffic management	25,000	lf	20.00	500,000
87	Contaminated soil removal, say 50%	37,500	cy	150.00	5,625,000
88	Dewatering	25,000	lf	25.00	625,000
89					
90	Direct cost	25,000	lf	2,039.77	50,994,165
91	Add Markups			65%	33,146,207
92					
93	Total construction cost (hardcost)	25,000	LF	**3,366.00**	84,140,372
94					
95					
96	**78" Welded steel pipeline**	25,000	lf		
97	Trenching/Excavation	83,565	cy	25.00	2,089,125
98	Haul-off excavated material	30,709	cy	30.00	921,270
99	Backfill	52,856	cy	35.00	1,849,960
100	Temporary shoring	475,000	sf	16.00	7,600,000
101	Pipe material & installation	25,000	lf	560.00	14,000,000
102	Fittings, add 20%	20%			2,800,000
103	Testing & inspection	25,000	lf	10.00	250,000
104	Jack & bore every 1000 ft/ea	25	ea	450,000.00	11,250,000
105	Creek crossings	4	ea	1,000,000.00	4,000,000
106	Avoid utility conflicts	25,000	lf	35.00	875,000
107	Abandon existing pipeline in place	25,000	lf	40.00	1,000,000

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
PIPELINE REPLACEMENT UNIT PRICES - URBAN

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
108	Remove & then restore paving	237,500	sf	15.00	3,562,500
109	Traffic control/traffic management	25,000	lf	20.00	500,000
110	Contaminated soil removal, say 50%	41,783	cy	150.00	6,267,450
111	Dewatering	25,000	lf	30.00	750,000
112					
113	Direct cost	25,000	lf	2,308.61	57,715,305
114	Add Markups			65%	37,514,948
115					
116	Total construction cost (hardcost)	25,000	LF	**3,809.00**	95,230,253
117					

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
INTERTIE

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Intertie**				
3	**Specification**				
4	12” diameter ductile iron pipeline				
5	~800 foot length				
6	2 isolation valves				
7	600 gpm, 8-inch, 100+ psi pump				
8					
9	**Assumptions:**				
10	Portable pump on a trailer				
11	Possible creek crossing				
12					
13					
14	**Preliminary Estimate**				
15					
16	**12” diameter ductile iron pipeline**	800	lf		
17	Trenching/Excavation	474	cy	25.00	11,850
17	Haul-off excavated material	23	cy	30.00	690
18	Backfill	451	cy	35.00	15,785
19	Temporary shoring	6,400	sf	15.00	96,000
20	Pipe material & installation	800	lf	150.00	120,000
21	Fittings, add 20%	20%			24,000
22	Isolation valve, 12" dia butterfly valve	2	ea	5,000.00	10,000
23	Portable pump on a trailer, 600 gpm, 8", 100 psi	1	ea	15,000.00	15,000
24	Connect to (E) stub-out	2	ea	5,000.00	10,000
25	Testing & inspection	800	lf	5.00	4,000
26	Creek crossings	1	ea	100,000.00	100,000
27	Avoid utility conflicts	800	lf	5.00	4,000
28	Remove & then restore paving	3,200	sf	12.00	38,400
29	Traffic control/traffic management	800	lf	10.00	8,000
30					
31	**One Intertie-Total**				457,725
33	Add markups			65%	297,521
33					
34	Total construction cost (hardcost)				755,246
35				**rounded-off**	**755,000**

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
ISOLATION VALVE

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Isolation Valve**				
3					
4	Specifications:				
5	48” or 60” diameter butterfly valve				
6	Valve vault				
7	17’ by 17’ vault size				
8	2’ 9” by 8’ clear opening				
9	**Aluminum roof scuttle**				
10	Access by stairs (2’ wide)				
11	2’ 6” by 6’ hatch opening				
12	Valve support concrete base				
13	SCADA				
14	Backup power (on-site generator/fuel storage)				
15	Automatic switch				
16	Premium efficiency				
17	Diesel fuel				
18	Air pollution control				
19					
20	Assumptions:				
21	Few utility conflicts				
22	Standard vault design				
23					
24	**Preliminary Estimate**				
25					
25	48" Butterfly valve	1	ea	35,000.00	35,000
26	Valve vault, 17'x17'	1	ea	130,050.00	130,050
27	SCADA	1	ea	20,000.00	20,000
28	Backup power, on-site generator:				
29	Generator, say 50 KW	1	ea	28,000.00	28,000
30	ATS, say 100 A	1	ea	3,500.00	3,500
31	Diesel fuel storage, above ground, say 500 Gal	1	ea	5,000.00	5,000
32	Misc. items	1	ls	3,000.00	3,000
33					
34	**One Isolation Valve-Total**				224,550
36	Add markups			65%	145,958
36					
37	Total construction cost (hardcost)				370,508
38				**rounded-off**	**371,000**

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
SERVICE CONNECTION

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Service Connection/Turnout**				
3					
4	**Specifications:**				
5	20" diameter turnout				
6	Isolation valve				
7	Valve vault				
8	13' by 15' vault size				
9	2' 9" by 8' clear opening				
10	Aluminum roof scuttle				
11	Access by stairs (2' wide)				
12	4' by 4' hatch opening				
13	Valve support concrete base				
14	~500 ft connecting				
15	SCADA				
16	Mag meter				
17	Backup power (n-site generator/fuel storage)				
18	Automatic switch				
19	Premium efficiency				
20	Diesel fuel				
21	Air pollution control				
22					
23	**Assumptions:**				
24	Few utility conflicts				
25	Standard vault design				
26	Must be able to transfer 20 MGD in excess supply				
27					
28	**Preliminary Estimate**				
29					
30	20" turnout	1	ea	35,000.00	35,000
31	20" Butterfly valve	1	ea	35,000.00	35,000
32	Valve vault, 13'x15'	1	ea	97,500.00	97,500
33	SCADA	1	ea	20,000.00	20,000
34	Mag meter	1	ea	5,000.00	5,000
35	Backup power, on-site generator:				
36	Generator, say 50 KW	1	ea	28,000.00	28,000
37	ATS, say 100 A	1	ea	3,500.00	3,500
38	Diesel fuel storage, above ground, say 500 Gal	1	ea	5,000.00	5,000
39	**20" diameter ductile iron pipeline**	500	lf		
40	Trenching/Excavation	404	cy	25.00	10,100
40	Haul-off excavated material	41	cy	30.00	1,230
41	Backfill	363	cy	35.00	12,705
42	Temporary shoring	4,670	sf	15.00	70,050
43	Pipe material & installation, 20" DIP	500	lf	250.00	125,000
44	Fittings, add 20%	20%			25,000
45	Connect to (E) stub-out	1	ea	10,000.00	10,000
46	Testing & inspection	500	lf	8.00	4,000
47	Avoid utility conflicts	500	lf	5.00	2,500

SCVWD RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST (AAEC Class 5)
SERVICE CONNECTION

3/16/2016 Progress Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
48	Remove & then restore paving	2,335	sf	12.00	28,020
49	Traffic control/traffic management	500	lf	10.00	5,000
51	Misc. items	1	ls	10,000.00	10,000
52					
53	**Service Connection-Total**				532,605
54	Add markups			65%	346,193
54					
55	Total construction cost (hardcost)				878,798
57				rounded-off	879,000

Appendix 7:
Project Information Sheets

Project	**Almaden Valley Pipeline Improvements**
Portfolio	**$100M CIP**
Projected Cost	**$146.3M**
Project Contact Information	

BACKGROUND

The Almaden Valley Pipeline is a 72-inch to 78-inch diameter raw water pipeline extending 12.3 miles between the Calero Valve Yard and the Vasona Pump Station. The Almaden Valley Pipeline is the only pipeline that can transmit water to the Santa Teresa Water Treatment Plant from any source, and the only pipeline that can supply the Rinconada Water Treatment Plant with local or Central Valley Project water. It is considered a Tier 1 critical facility. The pipeline is anticipated to fail in a major earthquake, and one critical section has been identified that is particularly susceptible to failure in a seismic event.

PROJECT DESCRIPTION

Replace the critical section of Almaden Valley Pipeline (25,409 linear feet).

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☐Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Pipeline with high level of risk – significant increase in system reliability
- Will allow faster recovery path following an earthquake outage scenario by providing local water supplies (Calero Reservoir) to the system
- High cost and disruptive construction (major infrastructure improvement project)

PROJECT COSTS

Capital Cost Estimate	$146.3M
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**Cal Water Interties**
Portfolio	**$10M CIP**
Estimated Retailer Cost	**$1.2M**
Project Contact Information	

BACKGROUND

The California Water Service Company serves the City of Los Altos and portions of Cupertino, Sunnyvale, Mountain View, and Los Altos Hills. Cal Water supplies its system with a combination of groundwater and SCVWD treated water. Additional interties to neighboring retailers and/or improvements to existing interties within the Cal Water service area could address system shortfalls and increase resilience.

PROJECT DESCRIPTION

Upgrade existing or new intertie between Cal Water and Santa Clara, or between Cal Water and Mountain View. Develop additional and/or enhance existing interties with neighboring service areas.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability, supply, and operational flexibility within the Cal Water service area; improves system redundancy in outage scenarios
- Moderate construction costs and disruption

PROJECT COSTS

Capital Cost Estimate	$1.2M per intertie
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**Cal Water Wells**
Portfolio	**$10M CIP**
Estimated Retailer Cost	**$2.7M**
Project Contact Information	

BACKGROUND

The California Water Service Company serves the City of Los Altos and portions of Cupertino, Sunnyvale, Mountain View, and Los Altos Hills. A shortfall was identified in the Cal Water retailer service area, specifically in the area near the Vallco turnout. The area surrounding the Vallco turnout is heavily reliant on District treated water, so additional groundwater wells could improve system reliability.

PROJECT DESCRIPTION

Option 1: New Cal Water wells on existing sites. Install additional wells (Stations #2 and #4 have good water quality, would have to destroy existing well and construct a new one).

Option 2: New site and Cal Water well near Vallco turnout/Santa Clara Distributary area. Develop additional groundwater wells, particularly around the Vallco turnout area (would need land) near Santa Clara Distributary, which is currently difficult to reach with only groundwater.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☐Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

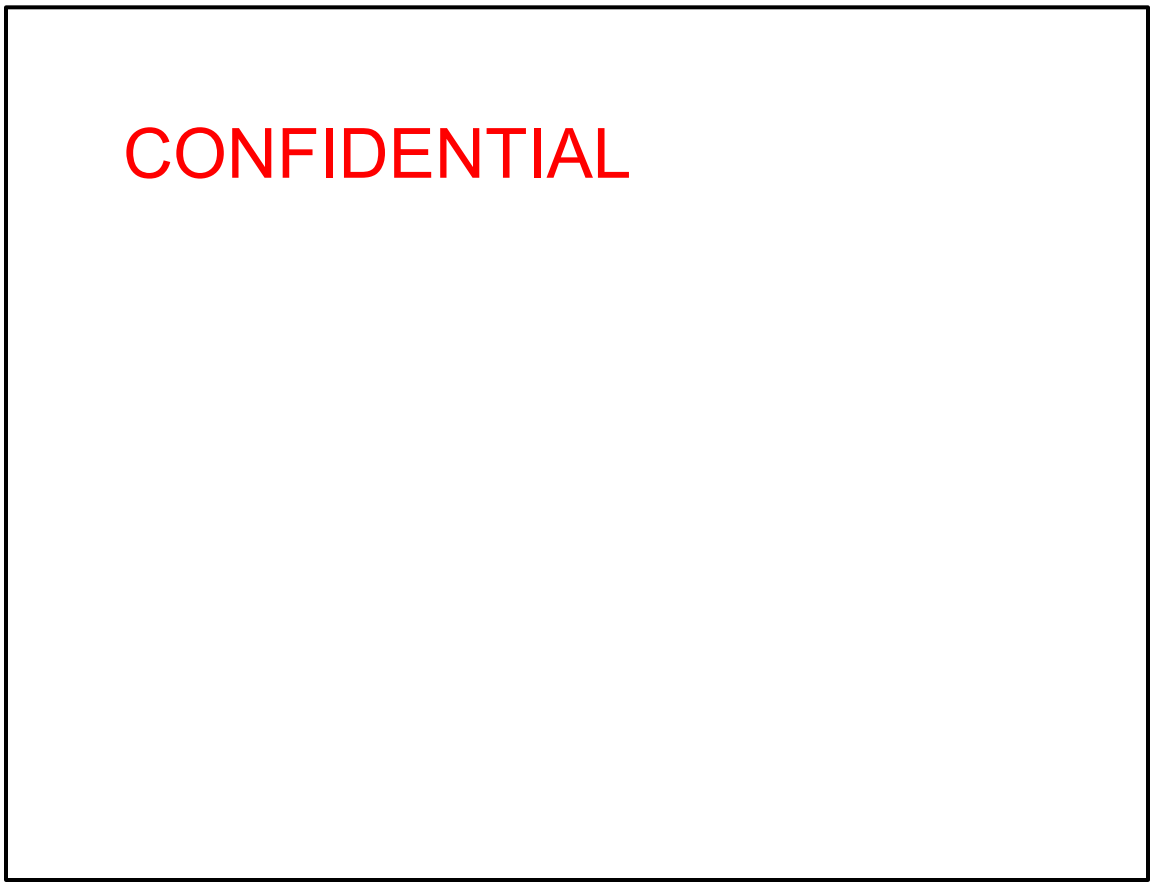
Explanation:

- Significant increase in system reliability and supply within the Cal Water service area, improves system redundancy in outage scenarios
- Moderate cost and fairly simple construction, but Option 2 would require acquisition of additional land

PROJECT COSTS

Capital Cost Estimate	Option 1: $2.7M per well Option 2: $2.7M per well
Annual Costs	Option 1: TBD Option 2: TBD
Estimated Useful Life	Option 1: TBD Option 2: TBD

PROJECT LOCATION



Project	**Great Oaks Connection/Turnout**
Portfolio	**$10M CIP**
Projected District Cost	**$1.3M**
Project Contact Information	

BACKGROUND

Great Oaks Water Company serves treated water to several communities within the City of San Jose. Great Oaks currently relies entirely on groundwater to meet customer demands; all wells can serve all portions of the Great Oaks service area. Constructing a new connection from the Great Oaks service area to the Snell Pipeline could feed into the District's system and take advantage of excess groundwater supply from Great Oaks.

PROJECT DESCRIPTION

Option 1: New emergency Great Oaks connection on Snell Pipeline at Branham Lane, to feed excess well capacity to SCVWD Snell Pipeline (up to 20 MGD excess capacity from Great Oaks to SCVWD).

Option 2: New emergency Great Oaks connection on Snell Pipeline at Valley Christian School, to feed excess well capacity to Snell Pipeline (up to 20 MGD excess capacity from Great Oaks to SCVWD).

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability, supply, and operational flexibility; improves system redundancy in outage scenarios
- Moderate construction costs and disruption

PROJECT COSTS

Capital Cost Estimate	Option 1: $1.4M Option 2: $1.1M
Annual Costs	Option 1: TBD Option 2: TBD
Estimated Useful Life	Option 1: TBD Option 2: TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**Milpitas Isolation Valves**
Portfolio	**$10M CIP**
Projected Cost	**$1.1M**
Project Contact Information	

BACKGROUND

Additional isolation valves on the Milpitas Pipeline would improve reliability and operational flexibility in the District's east treated water system. This project has a moderate ease of implementation and a wide range of benefits for both everyday operations and emergency events.

PROJECT DESCRIPTION

New isolation valves on Milpitas Pipeline near Milpitas turnout. Install two isolation valves on Milpitas Pipeline both north and south of existing turnout, particularly between the current and future proposed SCVWD turnouts near Piper/Montague.

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Increase in system reliability and operational flexibility within the Milpitas service area and District's east treated water system
- Moderate cost and ease of implementation

PROJECT COSTS

Capital Cost Estimate	$1.1M
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**Milpitas Well**
Portfolio	**$10M CIP**
Estimated Retailer Cost	**$2.7M**
Project Contact Information	

BACKGROUND

The City of Milpitas owns, operates, and maintains the treated water distribution system for Milpitas. The City normally meets customer demands using SFPUC and SCVWD treated water, but can utilize groundwater in an emergency. The total groundwater capacity is less than the City's demand for District treated water. This shortfall could be addressed by completing construction of the Curtis Well (or additional wells) so the City could replace a loss of District treated water with groundwater supply.

PROJECT DESCRIPTION

New Milpitas well at existing site (possible completion of Curtis Well, or other potential sites identified) to serve SCVWD pressure zones.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability and supply within the Milpitas service area, improves system redundancy in outage scenarios
- Moderate cost and fairly simple construction, especially given that the Curtis Well has already been drilled

PROJECT COSTS

Capital Cost Estimate	$2.7M
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**Mountain View Well**
Portfolio	**$10M CIP**
Projected District Cost	**$0.8M**
Project Contact Information	

BACKGROUND

The City of Mountain View provides treated water to all of the City's customers, except those located in Cal Water service areas. Less than 5% of the City's water supply comes from groundwater, with the remaining supply purchased from SFPUC and SCVWD. Mountain View's Zone 3 cannot utilize groundwater to replace District treated water in an emergency. This shortfall could be addressed by constructing groundwater wells in Zone 3, which could also feed into the Mountain View Distributary.

PROJECT DESCRIPTION

New Mountain View well at Miramonte, with new turnout/feed on Mountain View Distributary. New well for Zone 3 - 1st choice: Miramonte well at Miramonte Tank site, could feed tank and also feed into MV Distributary. MV would own/operate/maintain well.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability and supply within the Mountain View Zone 3 service area, improves system redundancy in outage scenarios
- Moderate cost and fairly simple construction

PROJECT COSTS

Capital Cost Estimate	$0.8M
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**Retailer Intertie Study**
Portfolio	**Operations Only**
Projected Cost	**Included in District O&M Budget**
Project Contact Information	

BACKGROUND

Within the SCVWD system, many interties between two neighboring service areas currently exist, but many are rarely used or have never been used. A study on the capabilities and capacities of retailer interties could provide valuable information on the resilience of retailer systems in the case of a District treated water outage.

PROJECT DESCRIPTION

Study and test capabilities and capacities of retailer interties, by gravity and pumping. Included in this study should be the feasibility and concept for standardization of design.

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☒Easy to Implement

Explanation:

- Potential increase in resilience and operational flexibility for the District and retailers
- Low cost, easy to implement

PROJECT COSTS

Capital Cost Estimate	Included in District O&M Budget
Annual Costs	TBD
Estimated Useful Life	N/A

PROJECT LOCATION

N/A

Project	**Upgrade San Jose Muni Interties**
Portfolio	**Operations Only**
Estimated Retailer Cost	**$0.2M-0.5M**
Project Contact Information	

BACKGROUND

San Jose Municipal Water Service provides treated water to four different areas in the City of San Jose. San Jose Muni utilizes SFPUC and SCVWD treated water in addition to groundwater. In the Evergreen service area, the four groundwater wells are designated for emergency use only and are under operating restrictions. Upgrading/enhancing existing interties between Evergreen and Edenvale or Evergreen and SJWC could improve the system reliability in Evergreen.

PROJECT DESCRIPTION

Option 1: Equipment to utilize existing interties between SJ Muni Evergreen and SJWC.

Option 2: Upgrade intertie between SJ Muni Evergreen and Edenvale.

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☐Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☒Easy to Implement

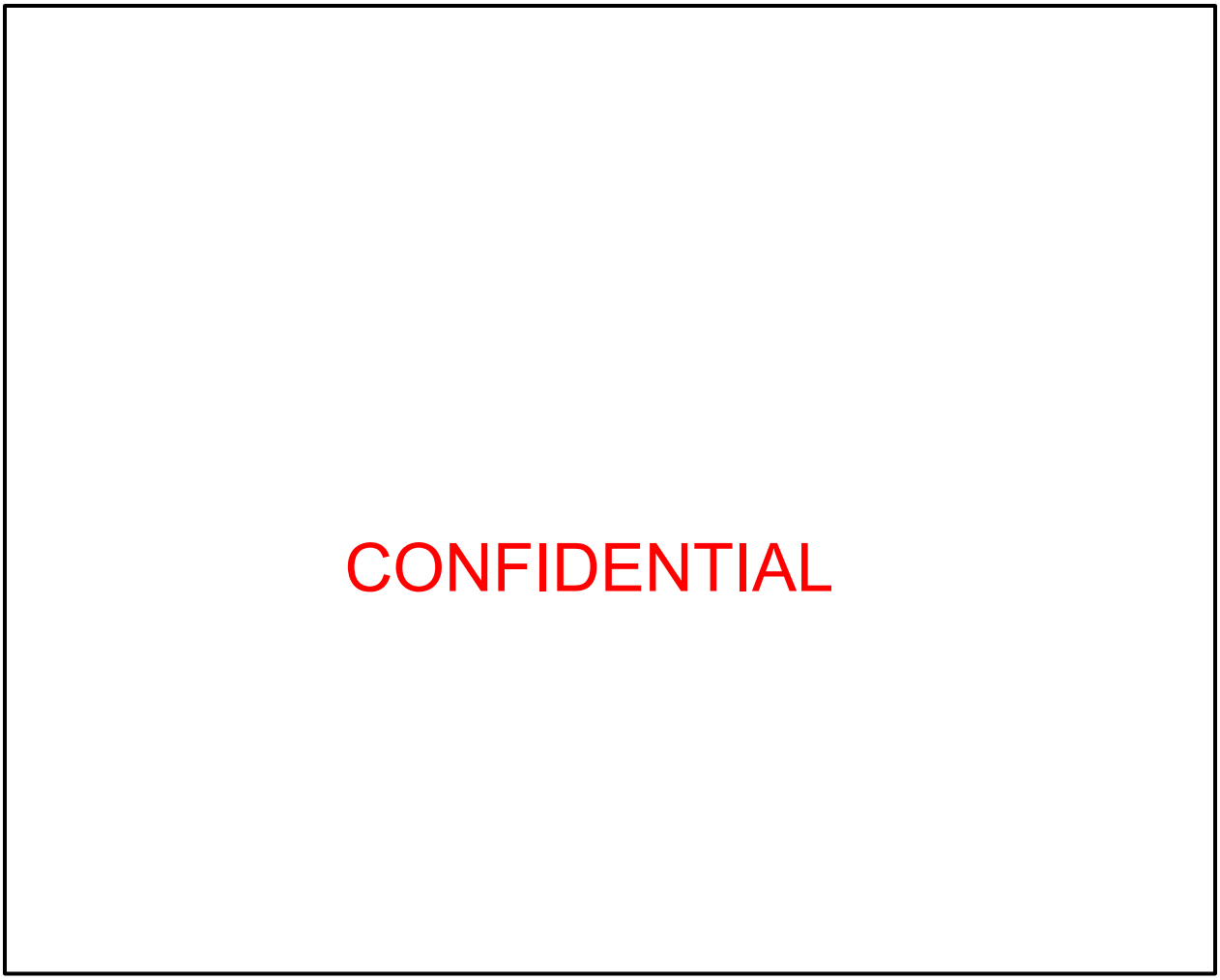
Explanation:

- Increase in resilience for Evergreen service area, utilizing existing infrastructure with minor improvements

PROJECT COSTS

Capital Cost Estimate	Option 1: $0.5M Option 2: $0.2M
Annual Costs	Option 1: TBD Option 2: TBD
Estimated Useful Life	Option 1: TBD Option 2: TBD

PROJECT LOCATION



Project	**San Jose Muni Intertie**
Portfolio	**$10M CIP**
Estimated Retailer Cost	**$1.2M**
Project Contact Information	

BACKGROUND

San Jose Municipal Water Service provides treated water to four different areas in the City of San Jose. San Jose Muni utilizes SFPUC and SCVWD treated water in addition to groundwater. In the Evergreen service area, the four groundwater wells are designated for emergency use only and are under operating restrictions. Constructing a new intertie between the Evergreen service area and Great Oaks could address shortfalls in the Evergreen area by taking advantage of excess groundwater capacity in Great Oaks.

PROJECT DESCRIPTION

New intertie between San Jose Muni (Evergreen) and Great Oaks.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability, supply, and operational flexibility within the San Jose Muni Evergreen service area; improves system redundancy in outage scenarios
- Moderate construction costs and disruption

PROJECT COSTS

Capital Cost Estimate	$1.2M
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**San Jose Muni Wells**
Portfolio	**$10M CIP**
Estimated Retailer Cost	**$2.7M**
Project Contact Information	

BACKGROUND

San Jose Municipal Water Service provides treated water to four different areas in the City of San Jose. San Jose Muni utilizes SFPUC and SCVWD treated water in addition to groundwater. In the Evergreen service area, the four groundwater wells are designated for emergency use only and are under operating restrictions. This shortfall could be addressed by constructing additional groundwater wells and/or lifting restrictions on the existing wells.

PROJECT DESCRIPTION

Option 1: New site and SJ Muni well. Construct GW wells near East PL (San Jose Muni is short on land, need land/easement rights near East PL to install a SJ well).

Option 2: New site and SJ Muni wells in Evergreen.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

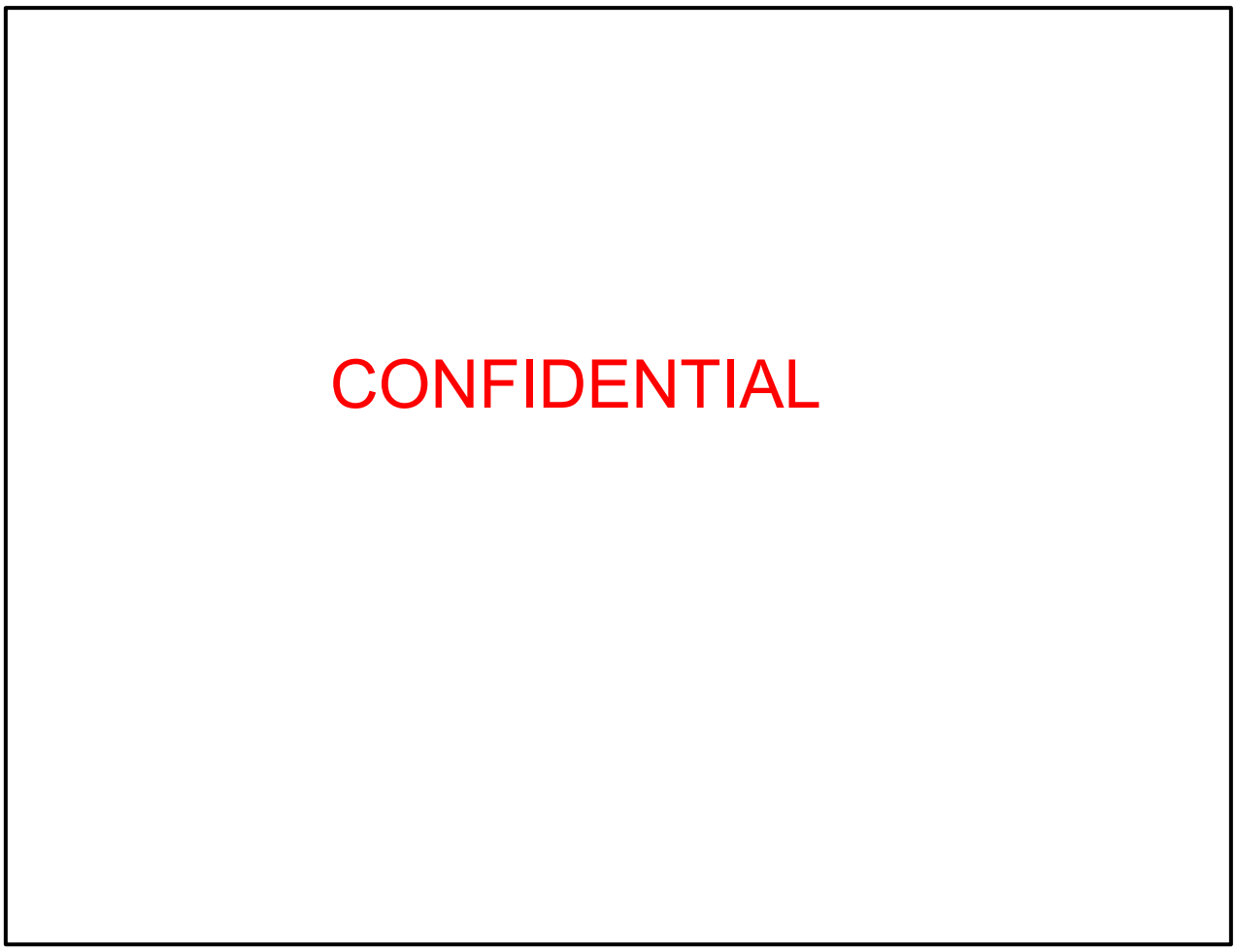
Explanation:

- Significant increase in system reliability and supply within the Evergreen service area, improves system redundancy in outage scenarios
- Moderate cost and fairly simple construction, but Option 1 would require acquisition of additional land

PROJECT COSTS

Capital Cost Estimate	Option 1: $2.7M per well Option 2: $2.7M per well
Annual Costs	Option 1: TBD Option 2: TBD
Estimated Useful Life	Option 1: TBD Option 2: TBD

PROJECT LOCATION



Project	**Santa Clara Well**
Portfolio	**$10M CIP**
Projected District Cost	**$0.7M**
Project Contact Information	

BACKGROUND

The City of Santa Clara provides potable water service to all customers in Santa Clara. Most of the City's water supply comes from 29 groundwater wells, with the remainder purchased from SCVWD and SFPUC. The Zone 2A service area only has one groundwater well which may not be able to replace District treated water in an outage scenario. This shortfall could be addressed by constructing an additional well at Serra Tank, which could be tied into the Santa Clara Distributary.

PROJECT DESCRIPTION

New Santa Clara well at Serra Tank, with new turnout/feed on Santa Clara Distributary. Install additional well near Serra Tank in Zone 2A, which could be tied into the Santa Clara Distributary to feed SCVWD system. Planning and design of a well at Serra Tank may begin in next fiscal year. Opportunity for cost-sharing.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

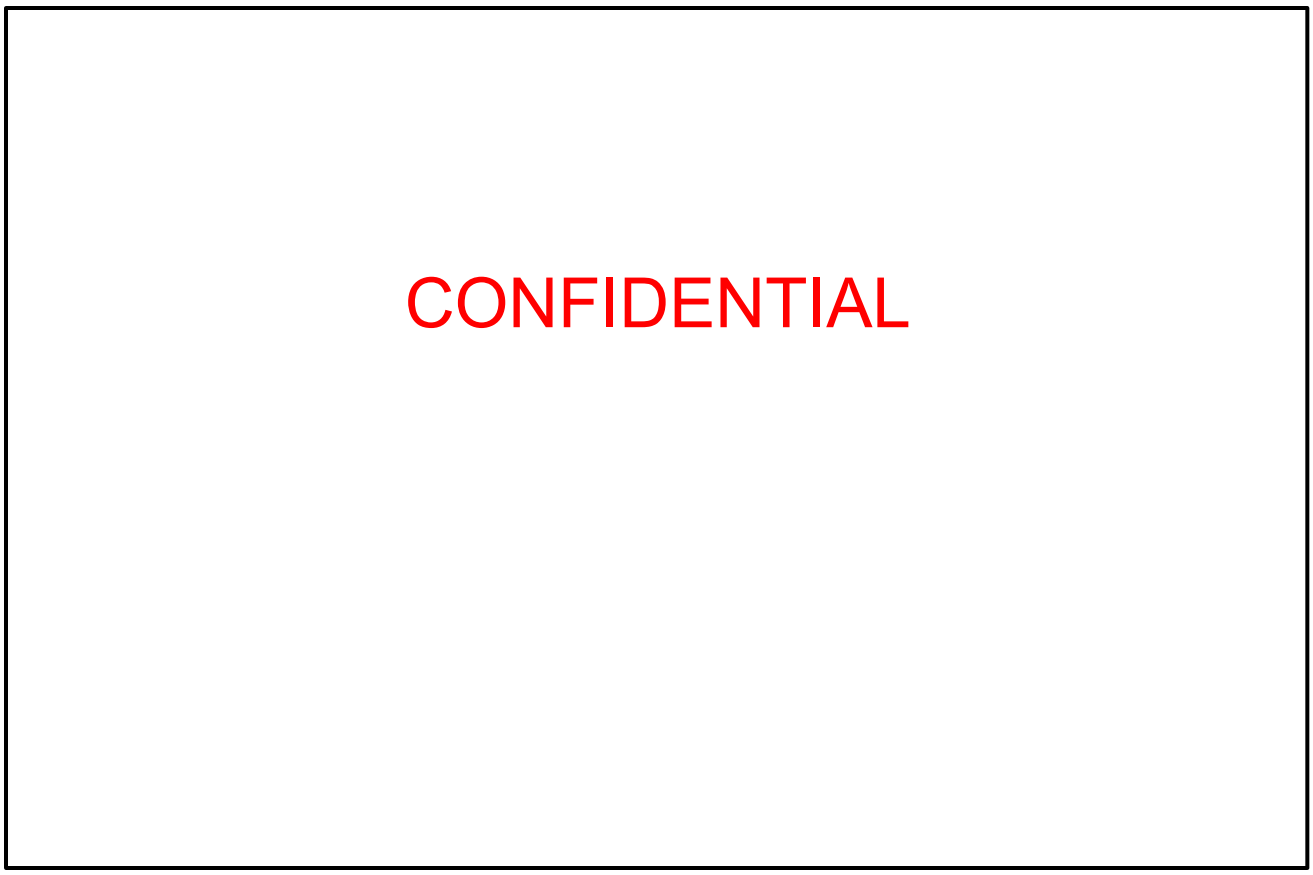
Explanation:

- Increase in system reliability and supply within Santa Clara's Zone 2A service area, improves system redundancy in outage scenarios
- Moderate cost and fairly simple construction

PROJECT COSTS

Capital Cost Estimate	$0.7M
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION



Project	**Enhance San Jose Muni Wells**
Portfolio	**Operations Only**
Estimated Retailer Cost	**$1M**
Project Contact Information	

BACKGROUND

The San Jose Muni Evergreen area was identified as being particularly vulnerable to service outages. There are currently four groundwater wells in the Evergreen area that are not permitted for normal usage. In order to increase the reliability of San Jose Muni's system in Evergreen, San Jose Muni could work to lift the operational restrictions on the wells or install disinfection capabilities.

PROJECT DESCRIPTION

Option 1: Lift operational restrictions on San Jose Muni Evergreen groundwater wells.

Option 2: Install disinfection capabilities for San Jose Muni Evergreen groundwater wells.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☐Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Increase in system reliability and supply for San Jose Muni's Evergreen area
- Moderate ease of implementation

PROJECT COSTS

Capital Cost Estimate	Option 1: TBD Option 2: $1M
Annual Costs	Option 1: TBD Option 2: TBD
Estimated Useful Life	Option 1: TBD Option 2: TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**San Jose Water Company Intertie**
Portfolio	**$10M CIP**
Estimated Retailer Cost	**$1.2M**
Project Contact Information	

BACKGROUND

San Jose Water Company has the ability to wheel water between turnouts and interties within their system. Upgraded or new interties with Great Oaks would take advantage of Great Oaks' excess groundwater capacity and provide enhanced operational flexibility for San Jose Water Company and other neighboring retailers.

PROJECT DESCRIPTION

Upgrade two existing interties or construct new intertie between Great Oaks and SJWC.

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in operational flexibility within San Jose Water Company's system, and possibly in neighboring service areas
- Moderate ease of implementation

PROJECT COSTS

Capital Cost Estimate	$1.2M per new intertie
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Project	**Water Wheeling Study**
Portfolio	**Operations Only**
Projected Cost	**$0.5M**
Project Contact Information	

BACKGROUND

In the event of an emergency, the District may be able to wheel water between customer turnouts to provide treated water supplies to its retailers. A study on the feasibility of wheeling water could provide future enhanced operational flexibility for the District.

PROJECT DESCRIPTION

Coordinate interagency use of SCVWD pipelines for wheeling water between customer turnouts (e.g. via West Pipeline from Cox to Mann).

PROJECT BENEFITS

☐Improves System Reliability

☐Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☒Easy to Implement

Explanation:

- Potential increase in resilience and operational flexibility for the District and retailers
- Low cost, easy to implement

PROJECT COSTS

Capital Cost Estimate	$0.5M
Annual Costs	TBD
Estimated Useful Life	N/A

PROJECT LOCATION

N/A

Project	**West Pipeline Isolation Valves**
Portfolio	**$10M CIP**
Projected Cost	**$1.8M**
Project Contact Information	

BACKGROUND

Additional isolation valves on the West Pipeline would improve reliability and operational flexibility in the District's west treated water system. This project has a moderate ease of implementation and a wide range of benefits for both everyday operations and emergency events.

PROJECT DESCRIPTION

Construct three additional isolation valves at strategic locations, such as on West Pipeline near Cox and Mann. These would be in addition to 4 line valves in District's current CIP.

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability and operational flexibility within the West treated water network; improves redundancy and reliability for West-side retailers
- Moderate cost and ease of implementation

PROJECT COSTS

Capital Cost Estimate	$1.8M
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Appendix 8:

Detailed Cost Estimate Project Info Packages

Project	**Great Oaks Connection/Turnout**
Portfolio	**$10M CIP**
Projected Cost	
Project Contact Information	

BACKGROUND

Great Oaks Water Company serves treated water to several communities within the City of San Jose. Great Oaks currently relies entirely on groundwater to meet customer demands; all wells can serve all portions of the Great Oaks service area. Constructing a new connection from the Great Oaks service area to the Snell Pipeline could feed into the District's system and take advantage of excess groundwater supply from Great Oaks.

PROJECT DESCRIPTION

Option 1: New emergency Great Oaks connection on Snell Pipeline at Branham Lane, to feed excess well capacity to SCVWD Snell Pipeline. Construct turnout/intertie to SCVWD Snell Pipeline at Branham Lane (up to 20 MGD excess capacity from Great Oaks to SCVWD).

Option 2: New emergency Great Oaks connection on Snell Pipeline at Valley Christian School, to feed excess well capacity to Snell Pipeline. Construct turnout/intertie to SCVWD Snell Pipeline at Valley Christian School (up to 20 MGD excess capacity from Great Oaks to SCVWD).

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability, supply, and operational flexibility; improves system redundancy in outage scenarios
- Moderate construction costs and disruption

PROJECT COSTS

Capital Cost Estimate	Option 1: TBD Option 2: TBD
Annual Costs	Option 1: TBD Option 2: TBD
Estimated Useful Life	Option 1: TBD Option 2: TBD

PROJECT LOCATION

CONFIDENTIAL

Service Connection/Turnout

Specifications:

- 20” diameter turnout
- Isolation valve
- Valve vault
    - 13’ by 15’ vault size
    - 2’ 9” by 8’ clear opening
    - Aluminum roof scuttle
    - Access by stairs (2’ wide)
    - 4’ by 4’ hatch opening
    - Valve support concrete base
- ~500 foot connection
- SCADA
- Mag meter
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Few utility conflicts
- Standard vault design
- Must be able to transfer 20 MGD in excess supply

Project	**Almaden Valley Pipeline Improvements**
Portfolio	**$100M CIP**
Projected Cost	
Project Contact Information	

BACKGROUND

The Almaden Valley Pipeline is a 72-inch to 78-inch diameter raw water pipeline extending 12.3 miles between the Calero Valve Yard and the Vasona Pump Station. The Almaden Valley Pipeline is the only pipeline that can transmit water to the Santa Teresa Water Treatment Plant from any source, and the only pipeline that can supply the Rinconada Water Treatment Plant with local or Central Valley Project water. It is considered a Tier 1 critical facility. The pipeline is anticipated to fail in a major earthquake, and one critical section has been identified that is particularly susceptible to failure in a seismic event.

PROJECT DESCRIPTION

Replace the critical section of Almaden Valley Pipeline (25,409 linear feet).

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☐Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Pipeline with high level of risk – significant increase in system reliability
- Will allow faster recovery path following an earthquake outage scenario by providing local water supplies (Calero Reservoir) to the system
- High cost and disruptive construction (major infrastructure improvement project)

PROJECT COSTS

Capital Cost Estimate	TBD
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Pipeline Replacement

Suburban/Rural Location *Almaden Valley and Cross Valley Pipelines, SBA*	**Urban Location** *Central Pipeline*

<u>Specifications:</u>
• Welded steel pipeline
  ○ 48” diameter
  ○ 66” diameter
  ○ 72” diameter
  ○ 78” diameter
• Total length of ~25,000 linear feet
• Parallel alignment, 20 foot tie-in
 	
<u>Assumptions:</u>
• Few utility conflicts
• Jack and bore every ~3000 feet
• Abandon existing pipeline in place
• Possibility of creek crossings (up to 4 locations)
• Liquefaction zone
	<u>Specifications:</u>
	• Welded steel pipeline
	  ○ 48” diameter
	  ○ 66” diameter
	  ○ 72” diameter
	  ○ 78” diameter
	• Total length of ~25,000 linear feet
	• Parallel alignment, 20 foot tie-in
	
	<u>Assumptions:</u>
	• Congested utilities
	• Jack and bore every ~1000 feet
	• Abandon existing pipeline in place
	• Possibility of creek crossings (up to 4 locations)
	• Traffic control required
	• Possibility of hazardous soil/dewatering required/earthwork
	• Liquefaction zone

Project	**Milpitas Well**
Portfolio	**$10M CIP**
Projected Cost	
Project Contact Information	

BACKGROUND

The City of Milpitas owns, operates, and maintains the treated water distribution system for Milpitas. The City normally meets customer demands using SFPUC and SCVWD treated water, but can utilize groundwater in an emergency. The total groundwater capacity is less than the City's demand for District treated water. This shortfall could be addressed by completing construction of the Curtis Well (or additional wells) so the City could replace a loss of District treated water with groundwater supply.

PROJECT DESCRIPTION

New Milpitas well at existing site (completion of Curtis Well) to serve SCVWD pressure zones.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability and supply within the Milpitas service area, improves system redundancy in outage scenarios
- Moderate cost and fairly simple construction, especially given that the Curtis Well has already been drilled

PROJECT COSTS

Capital Cost Estimate	TBD
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Attachment 1: Initial Specifications and Assumptions

Groundwater Well

Specifications:

- 2-3 MGD capacity
- 500 foot depth
- 300 foot casing, 200 foot perforation
- 8-10" diameter
- 500 foot connection to distribution system (ductile iron pipe)
- 220-330 horsepower pump required
- On-site disinfection (chlorine injection)
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Land is already owned by the retailer
- Open space with easy access
- Close proximity to high voltage power and existing water lines

Project	**Mountain View Well**
Portfolio	**$10M CIP**
Projected Cost	
Project Contact Information	

BACKGROUND

The City of Mountain View provides treated water to all of the City's customers, except those located in Cal Water service areas. Less than 5% of the City's water supply comes from groundwater, with the remaining supply purchased from SFPUC and SCVWD. Mountain View's Zone 3 cannot utilize groundwater to replace District treated water in an emergency. This shortfall could be addressed by constructing groundwater wells in Zone 3, which could also feed into the Mountain View Distributary.

PROJECT DESCRIPTION

New Mountain View well at Miramonte, with new turnout/feed on Mountain View Distributary. New well for Zone 3 - 1st choice: Miramonte well at Miramonte Tank site, could feed tank and also feed into MV Distributary. MV would own/operate/maintain well.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability and supply within the Mountain View Zone 3 service area, improves system redundancy in outage scenarios
- Moderate cost and fairly simple construction

PROJECT COSTS

Capital Cost Estimate	TBD
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Groundwater Well

Specifications:

- 2-3 MGD capacity
- 500 foot depth
- 300 foot casing, 200 foot perforation
- 8-10” diameter
- 500 foot connection to distribution system (ductile iron pipe)
- 220-330 horsepower pump required
- On-site disinfection (chlorine injection)
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Land is already owned by the retailer
- Open space with easy access
- Close proximity to high voltage power and existing water lines

Project	**Santa Clara Well**
Portfolio	**$10M CIP**
Projected Cost	
Project Contact Information	

BACKGROUND

The City of Santa Clara provides potable water service to all customers in Santa Clara. Most of the City's water supply comes from 29 groundwater wells, with the remainder purchased from SCVWD and SFPUC. The Zone 2A service area only has one groundwater well which may not be able to replace District treated water in an outage scenario. This shortfall could be addressed by constructing an additional well at Serra Tank, which could be tied into the Santa Clara Distributary.

PROJECT DESCRIPTION

New Santa Clara well at Serra Tank, with new turnout/feed on Santa Clara Distributary. Install additional well near Serra Tank in Zone 2A, which could be tied into the Santa Clara Distributary to feed SCVWD system. Planning and design of a well at Serra Tank may begin in next fiscal year. Opportunity for cost-sharing.

PROJECT BENEFITS

☒Improves System Reliability

☒Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Increase in system reliability and supply within Santa Clara's Zone 2A service area, improves system redundancy in outage scenarios
- Moderate cost and fairly simple construction

PROJECT COSTS

Capital Cost Estimate	TBD
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Groundwater Well

Specifications:

- 2-3 MGD capacity
- 500 foot depth
- 300 foot casing, 200 foot perforation
- 8-10” diameter
- 500 foot connection to distribution system (ductile iron pipe)
- 220-330 horsepower pump required
- On-site disinfection (chlorine injection)
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Land is already owned by the retailer
- Open space with easy access
- Close proximity to high voltage power and existing water lines

Project	**Milpitas Isolation Valve**
Portfolio	**$10M CIP**
Projected Cost	
Project Contact Information	

BACKGROUND

The City of Milpitas owns, operates, and maintains the treated water distribution system for Milpitas. The City normally meets customer demands using both SFPUC and SCVWD treated water. Installing additional line valves along the District's Milpitas Pipeline could enhance system reliability in an emergency event.

PROJECT DESCRIPTION

New isolation valves on Milpitas Pipeline near Milpitas turnout. Install isolation valves on Milpitas Pipeline both north and south of existing turnout, particularly between the current and future proposed SCVWD turnouts near Piper/Montague.

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Increase in system reliability and operational flexibility within the Milpitas service area
- Moderate cost and ease of implementation

PROJECT COSTS

Capital Cost Estimate	TBD
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Isolation Valve

Specifications:

- 48” or 60” diameter butterfly valve
- Valve vault
    - 17’ by 17’ vault size
    - 2’ 9” by 8’ clear opening
    - Aluminum roof scuttle
    - Access by stairs (2’ wide)
    - 2’ 6” by 6’ hatch opening
    - Valve support concrete base
- SCADA
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Few utility conflicts
- Standard vault design

Project	**SCVWD Isolation Valves**
Portfolio	**$10M CIP**
Projected Cost	
Project Contact Information	

BACKGROUND

The Santa Clara Valley Water District provides treated water to seven retail customers in Santa Clara County. Within the District's West treated water system, additional isolation valves on the West Pipeline could increase system resilience in an emergency situation.

PROJECT DESCRIPTION

Additional Line Isolation Valves. Add isolation valves at strategic locations, such as on West Pipeline near Cox and Mann. These would be in addition to 4 line valves in District's current CIP.

PROJECT BENEFITS

☒Improves System Reliability

☐Improves System Supply/Capacity

☒Improves Operational Flexibility

☐Provides Environmental Benefits

☐Provides Social/Community Benefits

☐Easy to Implement

Explanation:

- Significant increase in system reliability and operational flexibility within the West treated water network; improves redundancy and reliability for West-side retailers
- Moderate cost and ease of implementation

PROJECT COSTS

Capital Cost Estimate	TBD
Annual Costs	TBD
Estimated Useful Life	TBD

PROJECT LOCATION

CONFIDENTIAL

Isolation Valve

Specifications:

- 48” or 60” diameter butterfly valve
- Valve vault
    - 17’ by 17’ vault size
    - 2’ 9” by 8’ clear opening
    - Aluminum roof scuttle
    - Access by stairs (2’ wide)
    - 2’ 6” by 6’ hatch opening
    - Valve support concrete base
- SCADA
- Backup power (on-site generator/fuel storage)
    - Automatic switch
    - Premium efficiency
    - Diesel fuel
    - Air pollution control

Assumptions:

- Few utility conflicts
- Standard vault design

Appendix 9:

Detailed Cost Estimate Report (AACE Class 4)

SCVWD INFRASTRUCTURE RELIABILITY STUDY

PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COSTS
(AN OPINION OF PROBABLE CONSTRUCTION COST)
AACE CLASS 4 LEVEL
BASED ON RELIABILITY STUDY CONCEPT

Owner:
SANTA CLARA VALLEY WATER DISTRICT
5750 Almaden Expy
San Jose, CA 95118
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5/25/2016 Draft

MLC: 1203 SCVWD Reliability Estimate

SCVWD INFRASTRUCTURE RELIABILITY STUDY
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COSTS
(AN OPINION OF PROBABLE CONSTRUCTION COST)
AACE CLASS 4 LEVEL

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5/25/2016 Draft

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Based on Reliability Study Concept
Preamble (Basis Of Estimate)

5/25/2016 Draft

1 Outline

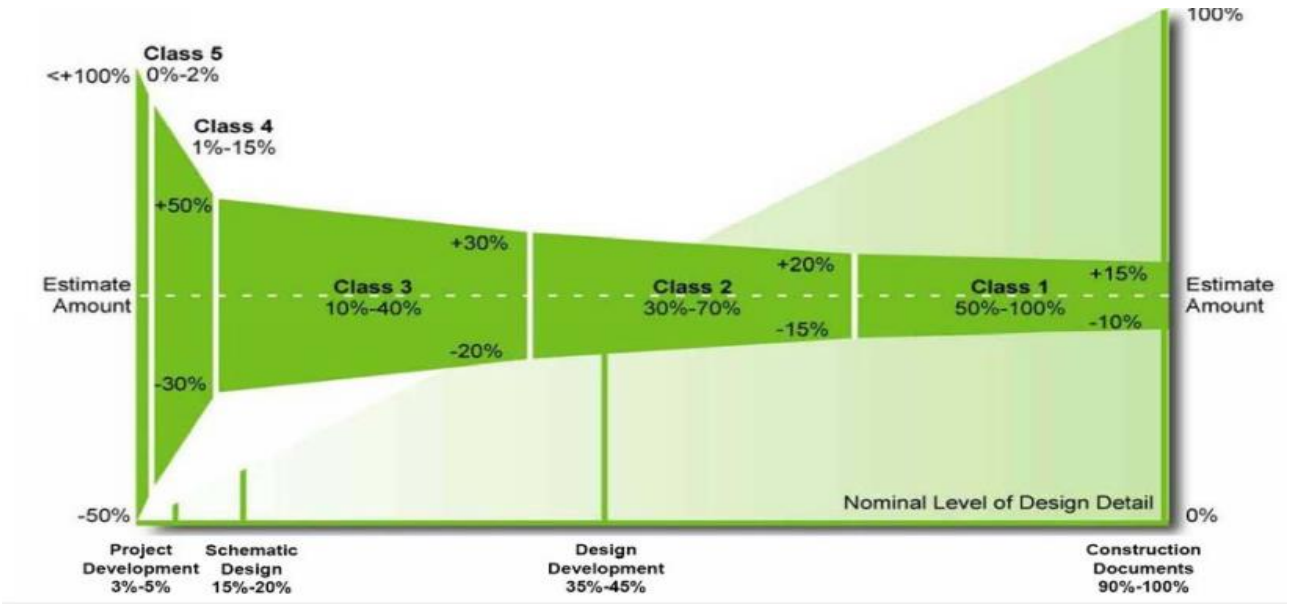
1.1 The preliminary construction cost estimate, which represents our opinion of probable construction costs, is comprised of the following integral parts:

a) Preamble
b) Estimate Summary
c) Estimate Details
Please see Table of Contents for details.

1.2 The preparation of this estimate is based on the following:
a) Generic Costs Preliminary Specifications and Assumptions prepared by AECOM for M Lee Corporation received by us on Mar 8, 2016 (5 pages)
b) Discussion during a kick-off meeting between AECOM and M Lee Corp on Mar 2, 2016.
c) SCVWD IRP Cost Estimating Short List for Mlee dated 2016-04-08
d) Proposed Project Information 20160412
e) As built plans for Almaden Valley Pipeline, Unit I, Unit II Phase I and Unit II Phase II, a total of 311 sheets of PDF file
f) Incorporation of relevant comments from AECOM's QA/QC Review dated May 10, 2016

1.3 This conceptual estimate is equivalent to AACE Estimating Classification Class 4. Such estimates are used for detailed strategic planning, business development, project screening, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval.

Per AACE the expected accuracy ranges for this class of estimate are -15 to -30 percent on the low end and +20 to +50 percent on the high end. Typical range of accuracies for estimate Class 1 through 5 are illustrated in the Figure below:



2 Assumptions & Qualifications

2.1 The estimate specifically excludes the following:
Hazardous material and contaminated soil abatement
Real Estate/ Right of Way Acquisition, if any
Legal fees
Finance costs
Cost escalation from the date of this estimate. It is recommended to include 5.0% per year for the next two years.
It is assumed that the above items, if needed, are included elsewhere in the owner's overall project budget.

2.2 The estimate is based on a single general contract using prevailing wage rates current for the County of Santa Clara.

2.3 The estimate is based on all work to be performed during regular working hours. No premium allowance is included for overtime, working at nights or weekends.

2.4 The estimate is based on estimated prices current as of May 2016, with four to six responsible and responsive bids under a competitive bidding environment for a fixed price lump sum contract.

Experience indicates that fewer bidders may result in higher bids, and conversely more bidders may result in more competitive bids. Therefore it is important to obtain as many bids as possible.

2.5 The unit costs used in the detailed estimates are composite construction unit costs including costs for material including sales tax, labor, and equipment. Contractors' markups for general conditions, overhead and profits and plan check fee are added to the direct construction cost.

2.6 Items potentially affecting the cost estimate:
Modifications to the scope of work included in this estimate
Unforeseen sub-surface conditions
Special phasing requirements
Restrictive technical specifications or excessive contract conditions
Any specified item of equipment, material, or product that cannot be obtained from at least three different sources
Any other non-competitive bid situations

2.7 The estimate has been prepared using generally accepted estimating practices and it represents our opinion of probable construction costs. It is intended to be a determination of fair market value for the project construction. Since we have no control over market conditions and other factors which may affect the bid prices, we cannot and do not warrant nor guarantee that bids or ultimate construction costs will not vary from the cost estimate. It should also be noted that the estimate is a "snapshot in time" and that the reliability of this opinion of probable construction cost will inherently degrade over time.

2.8 Please note this estimate is based on very preliminary design information and assumptions, and it should be used as a general guideline for more specific and detailed studies going forward.

2.9 Abbreviations used in the estimate:
CY = cubic yard
DIP = ductile iron pipe
(E) = existing
EA = each
GSF = gross square feet
LB = pound
LF = linear foot
LS = lump sum
NIC = Not In Contract
SF = square foot
WSP = Welded Steel Pipe

SCVWD Infrastructure Reliability Study

Preliminary Estimate Of Probable Construction Cost (AACE Class 4)

Based On Reliability Study Concept

Markups 5/25/2016 Draft

	Item	Total Cost	Explanation
1	**Direct Cost (Detailed itemized pricing for construction work)**	**$100.00**	Equivalent to subcontractor's bid to general contractor. This includes costs for materials, labor & equipment, sales tax and subcontractor's markups for overhead and profit.
2	**Markups are added to the above for the following:**		
3	General Contractor's General Conditions, Overhead and Profit	15.50%	Includes 10% for General Contractor's General Conditions compounded with 5% for General Contractor's OH&P.
4		---	
5	Subtotal A	$115.50	
6	Design Phase Estimating Contingency	25.0%	Allowance to cover costs that may result from design changes, items not fully itemized in the estimate, errors or omissions in the estimate, or unpredictable conditions or risks that experience shows are likely to occur during the design or bidding phase of the project.
7		---	
8	Subtotal B - Construction Hard Cost	$144.38	This is the estimated fair-market construction cost at the time of bidding.
9	Construction Contingency	10.0%	This is an allowance to cover change orders during construction.
10		---	
11	Total Construction Hard Cost	$158.81	This is the estimated construction cost paid to contractors at the end of the construction project.
12			
13	Total Multiplier from Direct Cost (Subcontractor's Cost) to Construction Hard Cost	1.59	This is the total multiplier added to direct cost to come up with total construction hard cost.
14	Total Markup % from Direct Cost to Construction Hard Cost	**59%**	This is the total markup percentage added to direct cost to come up with total construction hard cost.

Note: An allowance of 55% for soft costs (per SCVWD) is added at the estimate summary level to the Total Construction Hard Cost to come up with the Total Estimated Project Cost.

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Based on Reliability Study Concept
Summary of Capital Cost Estimates **5/25/2016 Draft**

ALL COSTS ARE IN 2016 DOLLARS

Component	Total Construction Hard Cost $	Soft Cost $ at 55%	Total Present Capital Cost $
1 Service Connection/Turnout			
1.1 Great Oaks Connection on Snell Pipeline at Branham Lane	928,000	510,000	1,438,000
1.2 Great Oaks Connection on Snell Pipeline at Valley Christian School	733,000	403,000	1,136,000
2 Groundwater Well & Building with Chemical Treatment			
2.1 New Milpitas Well	2,057,000	1,131,000	3,188,000
2.2 New Mountain View Well	2,215,000	1,218,000	3,433,000
2.3 New Santa Clara Well	2,368,000	1,302,000	3,670,000
3 Isolation Valve			
3.1 Two New Isolation Valves on Milpitas Pipeline near Milpitas Turnout, 42" dia	878,000	483,000	1,361,000
3.2 Three Additional Line Isolation Valves on West Pipeline at Cox Turnout & Mann Turnout, 60" dia	1,446,000	795,000	2,241,000
4 Infrastructure			
4.1 SCVWD Harden: Almaden Pipeline (25,409 ft)	87,300,000	48,015,000	135,315,000

Please read attached "Preamble", Markups" and "Estimate Details" for a complete scope of work including basis of estimate, exclusions, assumptions and qualifications.

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Connection/Turnout
Great Oaks on Snell Pipeline at Braham Lane **5/25/2016 Draft**

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Service Connection/Turnout**				
3					
4	**Specifications:**				
5	20” diameter turnout				
6	Isolation valve				
7	Valve vault				
8	13’ by 15’ vault size				
9	2’ 9” by 8’ clear opening				
10	Aluminum roof scuttle				
11	Access by stairs (2’ wide)				
12	4’ by 4’ hatch opening				
13	Valve support concrete base				
14	~300 ft connecting pipe				
15	SCADA				
16	Mag meter				
17	Backup power (on-site generator/fuel storage)				
18	Automatic switch				
19	Premium efficiency				
20	Diesel fuel				
21	Air pollution control				
22					
23	**Assumptions:**				
24	Few utility conflicts				
25	Standard vault design				
26	Must be able to transfer 20 MGD in excess supply				
27					
28	**Preliminary Estimate**				
29					
30	**20” diameter ductile iron pipeline**	300	lf		
30	Temporary shoring, 11 ft deep, sheet piling	6,600	SF	13.00	85,800
32	Trenching/Excavation, 11 ft deep	611	CY	25.00	15,275
32	Haul-off all excavated material	611	CY	30.00	18,330
33	Backfill, imported, compacted	587	CY	55.00	32,285
34	Pipe material & installation, 20" DIP	300	LF	250.00	75,000
35	Fittings, add 20%	20%			15,000
37	20" Butterfly valve	1	EA	13,000.00	13,000
38	Valve vault, 15'x13'x11' H internal dimension	1	ea		
38	Temporary shoring	936	SF	15.00	14,040
39	Excavation	156	CY	30.00	4,680
40	Haul-off excavated material	79	CY	30.00	2,370
41	Backfill	77	CY	35.00	2,695
42	CIP bottom slab, 1 ft thick, extend 1 ft beyond wall	323	SF	37.00	11,951
43	CIP Walls, 1 ft thick	704	SF	74.00	52,096
44	CIP Top slab, 1 ft thick	195	SF	56.00	10,920
45	Aluminum roof scuttle , 2'-9"x8'-0"	1	EA	2,000.00	2,000
46	Access by stairs (2’ wide)	1	EA	2,000.00	2,000
47	Sump with grating	1	EA	3,000.00	3,000
48	Electrical & lighting	1	LS	10,000.00	10,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Connection/Turnout
Great Oaks on Snell Pipeline at Braham Lane **5/25/2016 Draft**

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
49	Mechanical	1	LS	5,000.00	5,000
50	Sump discharge pipe & roof drain	1	EA	2,000.00	2,000
52	Mag meter	1	EA	5,000.00	5,000
52	Connect to (E) 66" Snell Pipeline, 11 ft deep, including combination manhole	1	EA	50,000.00	50,000
53	Connect to (E) stub-out	1	EA	10,000.00	10,000
54	Testing & inspection	1	LS	5,000.00	5,000
56	**Associated Items**				
57	Generator, say 50 KW	1	EA	45,000.00	45,000
58	ATS, say 100 A	1	EA	4,500.00	4,500
59	Diesel fuel storage, above ground, say 500 Gal	1	EA	5,000.00	5,000
60	SCADA	1	EA	20,000.00	20,000
60	Protect existing conflicting underground utilities	1	LS	3,000.00	3,000
61	Remove & then restore paving	2,595	SF	15.00	38,925
62	Traffic control/traffic management	1	LS	10,000.00	10,000
64	Misc. items	1	LS	10,000.00	10,000
65					
66	**Service Connection-Total Direct Cost**				583,867
67	Add markups			59%	344,482
67					
68	**Total Construction Cost (Hardcost)**				928,349
70				rounded-off	928,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Connection/Turnouts
Great Oaks on Snell Pipeline at Valley Christian School **5/25/2016 Draft**

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Service Connection/Turnout**				
3					
4	**Specifications:**				
5	20” diameter turnout				
6	Isolation valve				
7	Valve vault				
8	13’ by 15’ vault size				
9	2’ 9” by 8’ clear opening				
10	Aluminum roof scuttle				
11	Access by stairs (2’ wide)				
12	4’ by 4’ hatch opening				
13	Valve support concrete base				
14	~200 ft connecting pipe				
15	SCADA				
16	Mag meter				
17	Backup power (on-site generator/fuel storage)				
18	Automatic switch				
19	Premium efficiency				
20	Diesel fuel				
21	Air pollution control				
22					
23	**Assumptions:**				
24	Few utility conflicts				
25	Standard vault design				
26	Must be able to transfer 20 MGD in excess supply				
27					
28	**Preliminary Estimate**				
29					
30	**20” diameter ductile iron pipeline**	200	lf		
30	Temporary shoring, 9 ft deep, sheet piling	3,600	SF	13.00	46,800
32	Trenching/Excavation, 9 ft deep	333	CY	25.00	8,325
32	Haul-off all excavated material	333	CY	30.00	9,990
33	Backfill, imported, compacted	317	CY	55.00	17,435
34	Pipe material & installation, 20" DIP	200	LF	250.00	50,000
35	Fittings, add 20%	20%			10,000
37	20" Butterfly valve	1	EA	13,000.00	13,000
38	Valve vault, 15'x13'x11' H internal dimension	1	ea		
38	Temporary shoring	936	SF	15.00	14,040
39	Excavation	156	CY	30.00	4,680
40	Haul-off excavated material	79	CY	30.00	2,370
41	Backfill	77	CY	35.00	2,695
42	CIP bottom slab, 1 ft thick, extend 1 ft beyond wall	323	SF	37.00	11,951
43	CIP Walls, 1 ft thick	704	SF	74.00	52,096
44	CIP Top slab, 1 ft thick	195	SF	56.00	10,920
45	Aluminum roof scuttle, 2'-9"x8'-0"	1	EA	2,000.00	2,000
46	Access by stairs (2’ wide)	1	EA	2,000.00	2,000
47	Sump with grating	1	EA	3,000.00	3,000
48	Electrical & lighting	1	LS	10,000.00	10,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Connection/Turnouts
Great Oaks on Snell Pipeline at Valley Christian School **5/25/2016 Draft**

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
49	Mechanical	1	LS	5,000.00	5,000
50	Sump discharge pipe & roof drain	1	EA	2,000.00	2,000
52	Mag meter	1	EA	5,000.00	5,000
52	Connect to (E) 66" Snell Pipeline, 11 ft deep, including combination manhole	1	EA	45,000.00	45,000
53	Connect to (E) stub-out	1	EA	10,000.00	10,000
54	Testing & inspection	1	LS	3,000.00	3,000
56	**Associated Items**				
57	Generator, say 50 KW	1	EA	45,000.00	45,000
58	ATS, say 100 A	1	EA	4,500.00	4,500
59	Diesel fuel storage, above ground, say 500 Gal	1	EA	5,000.00	5,000
60	SCADA	1	EA	20,000.00	20,000
60	Protect existing conflicting underground utilities	1	LS	3,000.00	3,000
61	Remove & then restore paving	1,795	SF	15.00	26,925
62	Traffic control/traffic management	1	LS	5,000.00	5,000
64	Misc. items	1	LS	10,000.00	10,000
65					
66	**Service Connection-Total Direct Cost**				460,727
67	Add markups			59%	271,829
67					
68	**Total Construction Cost (Hardcost)**				732,556
70				rounded-off	733,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Milpitas

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Groundwater Well, Curtis Well in Milpitas**				
3	**Specification**				
4	2-3 MGD capacity				
5	500 foot depth				
6	300 foot casing, 200 foot perforation				
7	8-10” diameter				
8	220-330 horsepower pump required				
9	On-site disinfection (chlorine injection)				
10	Backup power (on-site generator/fuel storage)				
11					
12	**Assumptions:**				
13	Partially constructed, with well drilled already but no casing installed				
14	Open space with easy access				
15	200 LF distribution line requires railroad crossing				
16	Connect distribution to existing 42" pipe, which is 10 ft deep.				
17					
18	**Ground Well, Pumping & Connection Pipeline:**				
19	**Well Construction:**				
20	Install conductor casing w/sand cement seal	Completed			
21	Drill pilot hole	Completed			
22	Perform geophysical surveys	Completed			
23	Perform sieve grain size analysis on 10 samples	Completed			
24	Ream pilot hole	Completed			
25	Perform caliper survey of reamed borehole	Completed			
26	10-inch nominal diameter Type 304 stainless steel blank casing, and appurtenances	300	LF	300.00	90,000
27	10-inch nominal diameter Type 304 stainless steel sump	10	LF	400.00	4,000
28	10-inch nominal diameter type 304 stainless steel wire-wrapped screen	200	LF	220.00	44,000
29	2-inch nominal diameter type 304 stainless steel sounding tube	350	LF	52.00	18,200
30	2-inch nominal diameter type 304 stainless steel gravel feed pipe	350	LF	46.00	16,100
31	2-inch nominal diameter type 304 stainless steel vent pipe	1	EA	1,500.00	1,500
32	Filter pack in annular space	300	LF	80.00	24,000
33	Fine sand in annular space	5	LF	90.00	450
34	Sand-cement seals in annular space	200	LF	50.00	10,000
35	Furnish, install, & remove temporary piping to convey development and pumping test waters to discharge & setting tanks	1	EA	10,000.00	10,000
36	Furnish, install, operate & remove pump system & transducers for well development & pump tests	1	EA	7,000.00	7,000
37	Develop well by swabbing & bailing	40	HR	150.00	6,000
38	Develop well by pumping	40	HR	150.00	6,000
39	Step-drawdown test	12	HR	150.00	1,800
40	Constant rate pump test	48	HR	150.00	7,200

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Milpitas

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
41	Perform water quality analysis of completed well	1	EA	2,500.00	2,500
42	Provide NPDES sample bottles and analysis	1	EA	2,500.00	2,500
43	Perform plumbness and alignment test	1	EA	1,500.00	1,500
44	Well disinfection	1	EA	2,000.00	2,000
45	Provide final well color down-hole video	1	EA	1,000.00	1,000
46					
47	Subtotal W1				255,750
48					
49	**Pump:**				
50	Pump pad	1	EA	2,000.00	2,000
51	Submersible Pump, 220-330 HP	1	EA	250,000.00	250,000
52	Variable frequency drive including electrical hookup	1	EA	50,000.00	50,000
53					
54	Subtotal W2				302,000
55					
56	**8" diameter ductile iron pipeline**	200	lf		
56	Temporary shoring, sheet piling	3,600	SF	10.00	36,000
58	Trenching/Excavation, ave 9 ft deep	267	CY	25.00	6,675
58	Haul-off all excavated material	267	CY	30.00	8,010
59	Backfill, imported, compacted	264	CY	55.00	14,520
60	Pipe material & installation, 8" DIP	200	LF	100.00	20,000
62	Mag meter, 8"	1	EA	2,000.00	2,000
63	BFV, 8"	2	EA	2,800.00	5,600
64	Pump control valve	1	EA	5,000.00	5,000
64	Connect to (E) 42" Pipeline, 10 ft deep	1	EA	40,000.00	40,000
65	Horizontal boring under railroad crossing	1	LS	20,500.00	20,500
66	Testing & inspection	1	LS	3,000.00	3,000
68					
69	Subtotal W3				161,305
70					
71	**Associated Items**				
72	Allow for electrical, instrumentation and control	1	LS	30,000.00	30,000
73	Allow for paving removal & restoration	800	SF	15.00	12,000
74	Allow for utility impacts due to proximity to existing	1	LS	25,000.00	25,000
75	Misc. items	1	LS	10,000.00	10,000
76					
77	Subtotal W4				77,000
78					
79					
80	Total Direct Cost above, W1+W2+W3+W4				796,055
81	Add markups			59%	469,672
81					
82	Ground Well, Pumping & Connection Pipeline				1,265,727
84		**W**		**rounded-off**	**1,266,000**
85					
86					
87	**Building with Chemical Treatment for One Well**				
88	Building, assumed 1000 SF:	1,000	sf		
89	Site formation	1,000	SF	3.00	3,000
90	Slab on grade & foundation	1,000	SF	20.00	20,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Milpitas

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
91	Exterior wall	1,700	SF	40.00	68,000
92	Roof deck/Roofing	1,000	SF	25.00	25,000
93	Interior partition	470	SF	20.00	9,400
94	Exterior door/frame/hardware, pair	3	EA	2,600.00	7,800
95	Interior door/frame/hardware, single	1	EA	1,560.00	1,560
96	Removable hatch	1	EA	1,040.00	1,040
97	Trench with grates	20	LF	150.00	3,000
98	Grating over pit	120	SF	100.00	12,000
99	Equipment locker	1	EA	2,600.00	2,600
100	Plumbing	1,000	SF	35.00	35,000
101	Mechanical ventilation	1,000	SF	25.00	25,000
102	Electrical & lighting	1,000	SF	30.00	30,000
103	SCADA	1	EA	20,000.00	20,000
104					
105	Subtotal B1				263,400
106	Sitework:				
107	Clearing & grubbing	1	LS	6,500.00	6,500
108	Grading	1	LS	6,500.00	6,500
109	Landscaping	1	LS	4,000.00	4,000
110	Traffic bollards	5	EA	900.00	4,500
111	Site cleanup & disinfection	1	LS	3,900.00	3,900
112	Sewer storm drain, & water line connections	1	LS	26,000.00	26,000
113	Connect to (E) electrical power supply	1	LS	15,000.00	15,000
114	Connect to (E) water supply line	1	LS	20,000.00	20,000
115	Connect to (E) sewer line	1	LS	10,000.00	10,000
116					
117	Subtotal B2				96,400
118	Disinfection for 500 GPM:				
119	Metering pumps	2	EA	2,000.00	4,000
120	Metering pumps, redundant	2	EA	2,000.00	4,000
121	Chemical drums	2	EA	750.00	1,500
122	Process piping	1	LS	10,000.00	10,000
123	Electrical	1	LS	7,500.00	7,500
124					
125	Subtotal B3				27,000
126					
127	Backup Power:				
128	Generator, say 100 KW	1	EA	85,000.00	85,000
129	ATS, say 225 A	1	EA	8,000.00	8,000
130	Diesel fuel storage, above ground, say 1000 Gal	1	EA	10,000.00	10,000
131	Misc. items	1	LS	7,500.00	7,500
132					
133	Subtotal B4				110,500
134					
135					
136	Total Direct Cost above, B1+B2+B3+B4				497,300
137	Add markups			59%	293,407
137					
138	**Building with Chemical Treatment for One Well**				790,707
140		**Subtotal B**		**rounded-off**	**791,000**

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Milpitas

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
141					
142	**Total Above (Groundwater Well, Building & Associated Work) - Construction Cost**				**2,057,000**

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Mountain View, at Miramonte Tank Site

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Ground Water Well, Mountain View, at Miramonte Tank Site**				
3	**Specification**				
4	2-3 MGD capacity				
5	500 foot depth				
6	300 foot casing, 200 foot perforation				
7	8-10” diameter				
8	220-330 horsepower pump required				
9	On-site disinfection (chlorine injection)				
10	Backup power (on-site generator/fuel storage)				
11					
12	**Assumptions:**				
13	Partially constructed, with well drilled already but no casing installed				
14	Open space with easy access				
15	500 LF distribution line				
16	Connect distribution to existing to pipe at Miramonte Ave and tank				
17					
18	**Ground Well, Pumping & Connection Pipeline:**				
19	**Well Construction:**				
20	Install conductor casing w/sand cement seal	1	EA	15,000.00	15,000
21	Drill pilot hole	500	LF	50.00	25,000
22	Perform geophysical surveys	1	EA	3,000.00	3,000
23	Perform sieve grain size analysis on 10 samples	1	EA	1,500.00	1,500
24	Ream pilot hole	500	LF	50.00	25,000
25	Perform caliper survey of reamed borehole	1	EA	3,250.00	3,250
26	10-inch nominal diameter Type 304 stainless steel blank casing, and appurtenances	300	LF	300.00	90,000
27	10-inch nominal diameter Type 304 stainless steel sump	10	LF	400.00	4,000
28	10-inch nominal diameter type 304 stainless steel wire-wrapped screen	200	LF	220.00	44,000
29	2-inch nominal diameter type 304 stainless steel sounding tube	350	LF	52.00	18,200
30	2-inch nominal diameter type 304 stainless steel gravel feed pipe	350	LF	46.00	16,100
31	2-inch nominal diameter type 304 stainless steel vent pipe	1	EA	1,500.00	1,500
32	Filter pack in annular space	300	LF	80.00	24,000
33	Fine sand in annular space	5	LF	90.00	450
34	Sand-cement seals in annular space	200	LF	50.00	10,000
35	Furnish, install, & remove temporary piping to convey development and pumping test waters to discharge & setting tanks	1	EA	10,000.00	10,000
36	Furnish, install, operate & remove pump system & transducers for well development & pump tests	1	EA	7,000.00	7,000
37	Develop well by swabbing & bailing	40	HR	150.00	6,000
38	Develop well by pumping	40	HR	150.00	6,000
39	Step-drawdown test	12	HR	150.00	1,800
40	Constant rate pump test	48	HR	150.00	7,200

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Mountain View, at Miramonte Tank Site

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
41	Perform water quality analysis of completed well	1	EA	2,500.00	2,500
42	Provide NPDES sample bottles and analysis	1	EA	2,500.00	2,500
43	Perform plumbness and alignment test	1	EA	1,500.00	1,500
44	Well disinfection	1	EA	2,000.00	2,000
45	Provide final well color down-hole video	1	EA	1,000.00	1,000
46					
47	Subtotal W1				328,500
48					
49	**Pump:**				
50	Pump pad	1	EA	2,000.00	2,000
51	Submersible Pump, 220-330 HP	1	EA	250,000.00	250,000
52	Variable frequency drive including electrical hookup	1	EA	50,000.00	50,000
53					
54	Subtotal W2				302,000
55					
56	**8" diameter ductile iron pipeline**	500	lf		
56	Temporary shoring, 5 ft deep	5,000	SF	8.00	40,000
58	Trenching/Excavation, 5 ft deep	370	CY	25.00	9,250
58	Haul-off all excavated material	370	CY	30.00	11,100
59	Backfill, imported, compacted	351	CY	55.00	19,305
60	Pipe material & installation, 8" DIP	500	LF	100.00	50,000
62	Mag meter, 8"	1	EA	2,000.00	2,000
63	BFV, 8"	2	EA	2,800.00	5,600
64	Pump control valve	1	EA	5,000.00	5,000
64	Connect to existing water tank	1	LS	20,000.00	20,000
65	Testing & inspection	1	LS	3,000.00	3,000
67					
68	Subtotal W3				165,255
69					
70	**Associated Items**				
71	Allow for electrical, instrumentation and control	1	LS	30,000.00	30,000
72	Allow for paving removal & restoration, at street & at park	2,000	SF	15.00	30,000
73	Allow for landscape restoration	1	LS	5,000.00	5,000
74	Allow for utility impacts due to proximity to existing	1	LS	25,000.00	25,000
75	Misc. items	1	LS	10,000.00	10,000
76					
77	Subtotal W4				100,000
78					
79					
80	Total Direct Cost above, W1+W2+W3+W4				895,755
81	Add markups			59%	528,495
81					
82	Ground Well, Pumping & Connection Pipeline				1,424,250
84		**W**		**rounded-off**	**1,424,000**
85					
86					
87	**Building with Chemical Treatment for One Well**				
88	Building, assumed 1000 SF:	1,000	sf		
89	Site formation	1,000	SF	3.00	3,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Mountain View, at Miramonte Tank Site

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
90	Slab on grade & foundation	1,000	SF	20.00	20,000
91	Exterior wall	1,700	SF	40.00	68,000
92	Roof deck/Roofing	1,000	SF	25.00	25,000
93	Interior partition	470	SF	20.00	9,400
94	Exterior door/frame/hardware, pair	3	EA	2,600.00	7,800
95	Interior door/frame/hardware, single	1	EA	1,560.00	1,560
96	Removable hatch	1	EA	1,040.00	1,040
97	Trench with grates	20	LF	150.00	3,000
98	Grating over pit	120	SF	100.00	12,000
99	Equipment locker	1	EA	2,600.00	2,600
100	Plumbing	1,000	SF	35.00	35,000
101	Mechanical ventilation	1,000	SF	25.00	25,000
102	Electrical & lighting	1,000	SF	30.00	30,000
103	SCADA	1	EA	20,000.00	20,000
104					
105	Subtotal B1				263,400
106	Sitework:				
107	Clearing & grubbing	1	LS	6,500.00	6,500
108	Grading	1	LS	6,500.00	6,500
109	Landscaping	1	LS	4,000.00	4,000
110	Traffic bollards	5	EA	900.00	4,500
111	Site cleanup & disinfection	1	LS	3,900.00	3,900
112	Sewer storm drain, & water line connections	1	LS	26,000.00	26,000
113	Connect to (E) electrical power supply	1	LS	15,000.00	15,000
114	Connect to (E) water supply line	1	LS	20,000.00	20,000
115	Connect to (E) sewer line	1	LS	10,000.00	10,000
116					
117	Subtotal B2				96,400
118	Disinfection for 500 GPM:				
119	Metering pumps	2	EA	2,000.00	4,000
120	Metering pumps, redundant	2	EA	2,000.00	4,000
121	Chemical drums	2	EA	750.00	1,500
122	Process piping	1	LS	10,000.00	10,000
123	Electrical	1	LS	7,500.00	7,500
124					
125	Subtotal B3				27,000
126					
127	Backup Power:				
128	Generator, say 100 KW	1	EA	85,000.00	85,000
129	ATS, say 225 A	1	EA	8,000.00	8,000
130	Diesel fuel storage, above ground, say 1000 Gal	1	EA	10,000.00	10,000
131	Misc. items	1	LS	7,500.00	7,500
132					
133	Subtotal B4				110,500
134					
135	Total Direct Cost above, B1+B2+B3+B4				497,300
136	Add markups			59%	293,407
136					
137	Building with Chemical Treatment for One Well				790,707
139		**Subtotal B**		**rounded-off**	**791,000**

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Mountain View, at Miramonte Tank Site

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
140					
141	**Total Above (Groundwater Well, Building & Associated Work) - Construction Cost**				**2,215,000**
142					

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Santa Clara, at Vallco Turnout & Serra Tank

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Ground Water Well, Santa Clara, at Vallco Turnout & Serra Tank**				
3	**Specification**				
4	2-3 MGD capacity				
5	500 foot depth				
6	300 foot casing, 200 foot perforation				
7	8-10" diameter				
8	220-330 horsepower pump required				
9	On-site disinfection (chlorine injection)				
10	Backup power (on-site generator/fuel storage)				
11					
12	**Assumptions:**				
13	Partially constructed, with well drilled already but no casing installed				
14	Open space with easy access				
15	500 LF distribution line				
16	Connect distribution to existing tank				
17					
18	**Ground Well, Pumping & Connection Pipeline:**				
19	**Well Construction:**				
20	Install conductor casing w/sand cement seal	1	EA	15,000.00	15,000
21	Drill pilot hole	500	LF	50.00	25,000
22	Perform geophysical surveys	1	EA	3,000.00	3,000
23	Perform sieve grain size analysis on 10 samples	1	EA	1,500.00	1,500
24	Ream pilot hole	500	LF	50.00	25,000
25	Perform caliper survey of reamed borehole	1	EA	3,250.00	3,250
26	10-inch nominal diameter Type 304 stainless steel blank casing, and appurtenances	300	LF	300.00	90,000
27	10-inch nominal diameter Type 304 stainless steel sump	10	LF	400.00	4,000
28	10-inch nominal diameter type 304 stainless steel wire-wrapped screen	200	LF	220.00	44,000
29	2-inch nominal diameter type 304 stainless steel sounding tube	350	LF	52.00	18,200
30	2-inch nominal diameter type 304 stainless steel gravel feed pipe	350	LF	46.00	16,100
31	2-inch nominal diameter type 304 stainless steel vent pipe	1	EA	1,500.00	1,500
32	Filter pack in annular space	300	LF	80.00	24,000
33	Fine sand in annular space	5	LF	90.00	450
34	Sand-cement seals in annular space	200	LF	50.00	10,000
35	Furnish, install, & remove temporary piping to convey development and pumping test waters to discharge & setting tanks	1	EA	10,000.00	10,000
36	Furnish, install, operate & remove pump system & transducers for well development & pump tests	1	EA	7,000.00	7,000
37	Develop well by swabbing & bailing	40	HR	150.00	6,000
38	Develop well by pumping	40	HR	150.00	6,000
39	Step-drawdown test	12	HR	150.00	1,800
40	Constant rate pump test	48	HR	150.00	7,200
41	Perform water quality analysis of completed well	1	EA	2,500.00	2,500

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Santa Clara, at Vallco Turnout & Serra Tank

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
42	Provide NPDES sample bottles and analysis	1	EA	2,500.00	2,500
43	Perform plumbness and alignment test	1	EA	1,500.00	1,500
44	Well disinfection	1	EA	2,000.00	2,000
45	Provide final well color down-hole video	1	EA	1,000.00	1,000
46					
47	Subtotal W1				328,500
48					
49	**Pump:**				
50	Pump pad	1	EA	2,000.00	2,000
51	Submersible Pump, 220-330 HP	1	EA	250,000.00	250,000
52	Variable frequency drive including electrical hookup	1	EA	50,000.00	50,000
53					
54	Subtotal W2				302,000
55					
56	**8" diameter ductile iron pipeline**	500	lf		
56	Temporary shoring, 10 ft deep	10,000	SF	10.00	100,000
58	Trenching/Excavation, 10 ft deep	741	CY	25.00	18,525
58	Haul-off all excavated material	741	CY	30.00	22,230
59	Backfill, imported, compacted	722	CY	55.00	39,710
60	Pipe material & installation, 8" DIP	500	LF	100.00	50,000
62	Mag meter, 8"	1	EA	2,000.00	2,000
63	BFV, 8"	2	EA	2,800.00	5,600
64	Pump control valve	1	EA	5,000.00	5,000
64	Connect to (E) 36" Pipeline	1	EA	35,000.00	35,000
65	Connect to existing water tank	1	LS	10,000.00	10,000
66	Testing & inspection	1	LS	3,000.00	3,000
68					
69	Subtotal W3				291,065
70					
71	**Associated Items**				
72	Allow for electrical, instrumentation and control	1	LS	30,000.00	30,000
73	Allow for paving removal & restoration at tank site	2,000	LF	15.00	30,000
74	Misc. items	1	LS	10,000.00	10,000
75					
76	Subtotal W4				70,000
77					
78					
79	Total Direct Cost above, W1+W2+W3+W4				991,565
80	Add markups			59%	585,023
80					
81	**Ground Well, Pumping & Connection Pipeline**				1,576,588
83		**W**		**rounded-off**	**1,577,000**
84					
85					
86	**Building with Chemical Treatment for One Well**				
87	Building, assumed 1000 SF:	1,000	sf		
88	Site formation	1,000	SF	3.00	3,000
89	Slab on grade & foundation	1,000	SF	20.00	20,000
90	Exterior wall	1,700	SF	40.00	68,000
91	Roof deck/Roofing	1,000	SF	25.00	25,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Ground Water Well, Santa Clara, at Vallco Turnout & Serra Tank

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
92	Interior partition	470	SF	20.00	9,400
93	Exterior door/frame/hardware, pair	3	EA	2,600.00	7,800
94	Interior door/frame/hardware, single	1	EA	1,560.00	1,560
95	Removable hatch	1	EA	1,040.00	1,040
96	Trench with grates	20	LF	150.00	3,000
97	Grating over pit	120	SF	100.00	12,000
98	Equipment locker	1	EA	2,600.00	2,600
99	Plumbing	1,000	SF	35.00	35,000
100	Mechanical ventilation	1,000	SF	25.00	25,000
101	Electrical & lighting	1,000	SF	30.00	30,000
102	SCADA	1	EA	20,000.00	20,000
103					
104	Subtotal B1				263,400
105	Sitework:				
106	Clearing & grubbing	1	LS	6,500.00	6,500
107	Grading	1	LS	6,500.00	6,500
108	Landscaping	1	LS	4,000.00	4,000
109	Traffic bollards	5	EA	900.00	4,500
110	Site cleanup & disinfection	1	LS	3,900.00	3,900
111	Sewer storm drain, & water line connections	1	LS	26,000.00	26,000
112	Connect to (E) electrical power supply	1	LS	15,000.00	15,000
113	Connect to (E) water supply line	1	LS	20,000.00	20,000
114	Connect to (E) sewer line	1	LS	10,000.00	10,000
115					
116	Subtotal B2				96,400
117	Disinfection for 500 GPM:				
118	Metering pumps	2	EA	2,000.00	4,000
119	Metering pumps, redundant	2	EA	2,000.00	4,000
120	Chemical drums	2	EA	750.00	1,500
121	Process piping	1	LS	10,000.00	10,000
122	Electrical	1	LS	7,500.00	7,500
123					
124	Subtotal B3				27,000
125					
126	Backup Power:				
127	Generator, say 100 KW	1	EA	85,000.00	85,000
128	ATS, say 225 A	1	EA	8,000.00	8,000
129	Diesel fuel storage, above ground, say 1000 Gal	1	EA	10,000.00	10,000
130	Misc. items	1	LS	7,500.00	7,500
131					
132	Subtotal B4				110,500
133					
134	Total Direct Cost above, B1+B2+B3+B4				497,300
135	Add markups			59%	293,407
135					
136	**Building with Chemical Treatment for One Well**				790,707
138		**Subtotal B**		**rounded-off**	**791,000**
139					
140	**Total Above (Groundwater Well, Building & Associated Work) - Construction Cost**				**2,368,000**

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Isolation Valves (2 Each) on Milpitas Pipeline
Near Milpitas Turnout **5/25/2016 Draft**

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Isolation Valve**				
3					
4	Specifications:				
5	42” diameter butterfly valve				
6	Valve vault				
7	17’ by 17’ vault size , internal dimension				
8	2’ 9” by 8’ clear opening				
9	Aluminum roof scuttle				
10	Access by stairs (2’ wide)				
11	2’ 6” by 6’ hatch opening				
12	Valve support concrete base				
13	SCADA				
14	Backup power (on-site generator/fuel storage)				
15	Automatic switch				
16	Premium efficiency				
17	Diesel fuel				
18	Air pollution control				
19					
20	Assumptions:				
21	Pipe diameter = 42" dia				
22	Pipe depth = 10 ft				
23					
24	**Preliminary Estimate**				
25	**For One Valve, 42" dia:**				
25	Coordinate shut-down of pipeline	1	EA	2,000.00	2,000
26	Valve vault, 17'x17'x10' internal dimensions				
27	Temporary shoring	924	SF	15.00	13,860
28	Excavation	212	CY	30.00	6,360
29	Haul-off excavated material	147	CY	30.00	4,410
30	Backfill	65	CY	35.00	2,275
31	CIP bottom slab, 1 ft thick, extend 1 ft beyond wall	441	SF	37.00	16,317
32	CIP Walls, 1 ft thick	720	SF	74.00	53,280
33	CIP Top slab, 1 ft thick	289	SF	56.00	16,184
34	Aluminum roof scuttle	1	EA	2,000.00	2,000
35	Access by stairs (2’ wide)	1	EA	2,500.00	2,500
36	4’ by 4’ hatch opening	1	EA	3,000.00	3,000
37	Sump with grating	1	EA	3,000.00	3,000
38	Sump discharge pipe & roof drain	1	EA	2,000.00	2,000
39	Electrical & lighting	1	LS	10,000.00	10,000
40	Mechanical	1	LS	5,000.00	5,000
41	Remove & restore street paving	418	SF	17.00	7,106
42	Traffic control/management	1	LS	2,500.00	2,500
43	42" Butterfly valve, with electric actuator, to (E) pipeline	1	EA	47,000.00	47,000
44	SCADA	1	EA	20,000.00	20,000
45	Backup power, on-site generator:				
46	Generator, say 50 KW	1	EA	45,000.00	45,000
47	ATS, say 100 A	1	EA	4,500.00	4,500
48	Diesel fuel storage, above ground, say 500 Gal	1	EA	5,000.00	5,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Isolation Valves (2 Each) on Milpitas Pipeline
Near Milpitas Turnout **5/25/2016 Draft**

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
49	Misc. items	1	LS	3,000.00	3,000
50					
51	**One Isolation Valve-Total**				276,292
53	Add markups			59%	163,012
53					
54	Total construction cost (hardcost)				439,304
55	**For One Isolation Valve:**				439,000
	For Two Valves, Total Construction Cost	**2**	**ea**	439,000	**878,000**

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Isolation Valves (3 Each) on West Pipeline
At CoxTurnout **5/25/2016 Draft**

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
1					
2	**Isolation Valve**				
3					
4	Specifications:				
5	Butterfly valves, total 3 each				
	54" dia & 66" dia at Cox Turnout				
	36" at Mann Turnout				
8	Valve vault , one for each valve				
9	17' by 17' vault size , internal dimension				
10	2' 9" by 8' clear opening				
11	Aluminum roof scuttle				
12	Access by stairs (2' wide)				
13	2' 6" by 6' hatch opening				
14	Valve support concrete base				
15	SCADA				
16	Backup power (on-site generator/fuel storage)				
17	Automatic switch				
18	Premium efficiency				
19	Diesel fuel				
20	Air pollution control				
21					
22	Assumptions:				
23	Pipe diameter = 54" dia, 66" dia and 36" dia, Use 60" dia for Estimating Purpose				
24	Pipe depth = 9 ft				
25					
26	**Preliminary Estimate**				
27	**For One Valve, 60" dia:**				
27	Coordinate shut-down of pipeline	1	EA	2,000.00	2,000
28	Valve vault, 17'x17'x10'				
29	Temporary shoring	924	SF	15.00	13,860
30	Excavation	212	CY	30.00	6,360
31	Haul-off excavated material	147	CY	30.00	4,410
32	Backfill	65	CY	35.00	2,275
33	CIP bottom slab, 1 ft thick, extend 1 ft beyond wall	441	SF	37.00	16,317
34	CIP Walls, 1 ft thick	720	SF	74.00	53,280
35	CIP Top slab, 1 ft thick	289	SF	56.00	16,184
36	Aluminum roof scuttle	1	EA	2,000.00	2,000
37	Access by stairs (2' wide)	1	EA	1,500.00	1,500
38	4' by 4' hatch opening	1	EA	3,000.00	3,000
39	Sump with grating	1	EA	3,000.00	3,000
40	Sump discharge pipe & roof drain	1	EA	2,000.00	2,000
41	Electrical & lighting	1	LS	10,000.00	10,000
42	Mechanical	1	LS	5,000.00	5,000
43	Remove & restore street paving	418	SF	17.00	7,106
44	Traffic control/management	1	LS	2,500.00	2,500
45	60" Butterfly valve, with electric actuator, to (E) pipeline	1	EA	75,000.00	75,000
46	SCADA	1	EA	20,000.00	20,000
47	Backup power, on-site generator:				
48	Generator, say 50 KW	1	EA	45,000.00	45,000

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Isolation Valves (3 Each) on West Pipeline
At CoxTurnout **5/25/2016 Draft**

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Estimated Cost $
49	ATS, say 100 A	1	EA	4,500.00	4,500
50	Diesel fuel storage, above ground, say 500 Gal	1	EA	5,000.00	5,000
51	Misc. items	1	LS	3,000.00	3,000
52					
53	**One Isolation Valve-Total**				303,292
55	Add markups			59%	178,942
55					
56	Total construction cost (hardcost)				482,234
57	For One Valve:				482,000
	For Three Valves, Total Construction Cost	**3**	**ea**	482,000	**1,446,000**

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Almaden Valley Pipeline (One Critical Section of 25,409 feet)

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
	Scope:				
	Replacement of a critical section of the Almaden Valley Pipeline of approximately 25,409 ft (4.8 miles) from Coleman Rd to Harry Rd in San Jose which was previously constructed under Unit II Phase 1 and partially under Unit II Phase 2.				
	Specifications:				
	72" Welded steel pipeline, with flexible (polyurethane) lining/coating, 0.375" wall , in 50 ft sections				
	Assumptions:				
	New pipeline parallel to existing pipeline				
	Parallel alignment, 20 foot tie				
	Suburban/urban location with few utility conflicts				
	Jack and bore at busy street intersections				
	Abandon existing pipeline in place and filled with lean concrete grout				
	Creek crossings needed				
	Liquefaction zone				
	Preliminary Cost Estimate				
	72" Welded steel pipeline	25,409	lf		
	Temporary shoring, sheet piling	559,300	SF	15.00	8,389,500
	Trenching/Excavation	93,200	CY	25.00	2,330,000
	Haul-off excavated material	93,200	CY	30.00	2,796,000
	Backfill, imported, compacted	66,600	CY	55.00	3,663,000
	Embankment	6,580	CY	50.00	329,000
	72" dia Pipe material & installation	25,409	LF	942.00	23,935,278
	Reinforced concrete encasement to pipe, 980 lf	2,240	CY	450.00	1,008,000
	Jack & bore, 3 locations: Coleman Rd, Meridian Ave & Almaden Expy, say 60 ft long with driving pit and receiving pit	3	EA	612,000.00	1,836,000
	Creek crossings	4	EA	350,000.00	1,400,000
	Manhole & Air Release Assembly	27	EA	35,000.00	945,000
	Air release assembly	7	EA	25,000.00	175,000
	Telemetry pull box	36	EA	10,000.00	360,000
	2" steel conduit	25,409	LF	20.00	508,180
	Cathode protection	25,409	LF	10.00	254,090
	Connect to existing system	2	EA	150,000.00	300,000
	Testing & inspection	25,409	LF	15.00	381,135
	Avoid utility conflicts at intersections	3	EA	250,000.00	750,000
	Abandon existing pipeline in place, filled with lean concrete grout	25,409	LF	157.00	3,989,213

SCVWD Infrastructure Reliability Study
Preliminary Estimate Of Probable Construction Cost (AACE Class 4)
Almaden Valley Pipeline (One Critical Section of 25,409 feet)

5/25/2016 Draft

Item #	Description of Work	Quantity	Unit	Unit Cost $ (Direct Cost)	Total Direct (Trade) Cost $
				Total	**Total $**
39	Remove & then restore paving	5,000	SF	17.00	85,000
40	Clear & grub existing	254,090	SF	1.00	254,090
41	Restore impacted planting/landscape	1	LS	250,000.00	250,000
42	Dewatering, allow	25,409	LF	15.00	381,135
43	Traffic control/traffic management, minimal	1	LS	150,000.00	150,000
44	System disinfection & testing	1	LS	100,000.00	100,000
45	Phased shut-down connection & start-up of pipeline	4	EA	80,000.00	320,000
46					
47	Direct cost	25,409	LF	2,160.24	54,889,621
48	Add Markups			59%	32,384,876
49					
50	**Total Construction Cost (Hardcost)**	25,409	LF	**3,435.00**	87,274,497
51					
52				rounded-off	**87,300,000**

Santa Clara Valley Water District

Infrastructure Reliability Plan

Infrastructure System Appendix

AECOM

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Infrastructure System Appendix:

SCVWD Facilities and Descriptions Database

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Appendix Three
CANALS AND DITCHES

Canal or Ditch	System	Purpose	Canal Construction	Capacity	Condition Information	Reliability Improvements Since 2005	Expected Future Upgrades	Year Complete	2015 Facility Age
Almaden-Calero Canal	Guadalupe River Water Supply and Recharge	Conveys water from Almaden Reservoir to Calero Reservoir. Water right for 6,000 AF transfer water at Calero Reservoir	4.4 mi concrete lined canal	120 cfs	Canal is in poor condition. Does not hold baseline capacity. Leakage, seepage, drainage, landslide and maintenance road access issues.		Restore operational capacity; stabilize and improve maintenance access. Expected construction 2015.	1930	85
Coyote Canal	Upper Coyote Creek Water Supply and Recharge	Conveys water from a point on Coyote Creek d/s of Anderson Dam to a point on Coyote Creek u/s of Coyote Pond.	9 mi natural channel runs parallel to Coyote Creek	125 cfs			FAHCE settlement agreement may require improvements to the canal.		
Kirk Ditch	Los Gatos Water Supply and Recharge	Conveys water from Los Gatos Creek or the Central Pipeline (SBA source) to the Oka and McGlincey Ponds	1.9 mi open channel and pipeline	35 cfs				1960	55
Page Ditch	Los Gatos Water Supply and Recharge	Conveys water from Los Gatos Creek or the Central Pipeline (SBA source)to the Camden, Page, Sunnyoaks, and Budd ponds	2 mi natural channel	50 cfs				1967	48
Vasona Canal	Los Gatos Water Supply and Recharge	Conveys water from Vasona Reservoir to Smith Creek, the Vasona Pump Station, and San Tomas Creek. Can supply Stevens Creek Pipeline from the Vasona Valve Yard at Vasona Pump Station.	1.7 mi reinforced concrete pipe; 0.8 mi open channel	75 cfs	Canal is in poor condition and barely operational.		Current capital project will look at canal improvements as part of a comprehensive west side raw water system analysis (Stevens Creek & Vasona Raw Water Distribution)	1930	85

NOTES: Canals no longer in operation: Coyote-Alamitos, Coyote Extension, Evergreen Canal & Distribution System

SCVWD Technical Memorandum - Appendix Three

DIVERSION DAMS

Diversion Dam	System	Purpose	Dam Construction	Associated Water Right Licensed Amount & Resource	Associated Infrastructure	Past Major Upgrades	Condition Information	Reliability Improvements Since 2005	Expected Future Upgrades	Year Complete	2015 Facility Age
Alamitos	Guadalupe River Water Supply and Recharge	Diverts water from the Alamitos Creek to the Alamitos Ponds	Wood paneled flashboard dam	3,302 AF Percolation; Guadalupe Creek	Fish Ladder	Drop structure added in 1960s. Fish ladder added in 1999.	Current construction & operations pose saftey and flood risk		Current capital project to replace dam is scheduled for completion in 2018	1932	83
Church	Lower Llagas Water Supply and Recharge	Diverts water from Llagas Creek to the Church Ponds	Rock/earthen diversion dam	None		Dam raised 10 ft. in 1985, added 231,000 cubic yards of material. Included seismic retrofits.	Poor Condition - not functioning		Need CIP to upgrade Diversion Dam. Assumed to be in place for future projections.		
Coyote Canal Diversion	Upper Coyote Creek Water Supply and Recharge	Diverts water from Coyote Creek to the Coyote Canal	Wood paneled flashboard dam	None	Fish Screen	Fish screen added in 1999				1950	65
Coyote Percolation Dam*	Upper Coyote Creek Water Supply and Recharge	Stores water for recharge in Coyote Pond	Steel paneled flashboard dam, 9.5 ft. high and 110 ft. long	5,000 AF Surface Storage and Recharge; Coyote Creek	Fish Ladder	Fish ladder added in 1999	Current construction & operations pose saftey and flood risk		Current capital project to replace dam is scheduled for completion in 2018	1934	81
Kirk	Los Gatos Water Supply and Recharge	Diverts water from Los Gatos Creek to the Kirk recharge system (Kirk Ditch, Oka Ponds, and McGlincey Ponds)	Steel paneled flashboard dam	9,090 AF Underground Storage; Los Gatos Creek		Relocated in 1993	Current construction & operations pose saftey and flood risk	Replaced dam and added fish screen in 2014		1937	78
Masson	Guadalupe River Water Supply and Recharge	Diverts water from Guadalupe Creek to the Los Capitancillos Ponds	Steel paneled flashboard dam	557 AF Beneficial Use - no storage; Guadalupe River	Fish screen and ladder	Fish facilities added in 1999				1964	51
Maybury	Upper Penitencia Creek Water Supply and Recharge	Diverts water from Penitencia Creek to the Overfelt Gardens and Maybury Ponds	Steel paneled flashboard dam	3,500 AF Recharge; Penitencia Creek (Split with Noble Diversion)	Fish screen and ladder	Fish facilities added in 1999				1975	40
Noble	Upper Penitencia Creek Water Supply and Recharge	Diverts water from Penitencia Creek to the Penitencia (Bob Gross), Piedmont, Helmsley, and Capitol Ponds	Steel paneled flashboard dam	3,500 AF Recharge; Penitencia Creek (Split with Maybury Diversion)	Wier type fish ladder					1977	38
Smith	West Side and Stevens Creek Water Supply and Recharge			None							

*FERC Regulated Dam

SCVWD Technical Memoradum - Appendix Three
IMPORTED WATER FACILITIES

Facility	System	Purpose	General Condition	Past Upgrades	Future Upgrades
Delta-Mendota Canal	CVP	Distributes water from the Delta to O'Neill Pumping Plant and other federal water contractors farther South	(See note 1)		
Delta	CVP-SWP	Stores fresh water flowing from the Sacramento and San Joaquin Rivers	Existing Delta levees unstable, underlying seismic risks, increasing threats of altered hydrology and sea level rise due to climate change, and ongoing regulatory uncertainty and concerns over Delta's environmental health		
Jones Pumping Plant	CVP	Pumps water from the Sacramento-San Joaquin River Delta into the Delta Mendota Canal	(See note 1)		
O'Neill Pumping Plant	CVP	Pumps water from the Delta Mendota Canal into O'Neill Forebay	(See note 1)		
O'Neill Forebay	CVP	Storage facility that serves as a hydraulic junction point for State and Federal project water			
Gianelli Pumping Plant	CVP	Pumps water from O'Neill Forebay to San Luis Reservoir	For January through December 2013, OA was 57.5% (see note 2)		
San Luis Reservoir	CVP	Major water storage facility that directly feeds the San Felipe Division and stores water for other contractors farther South	Potential low-point issues in San Luis Reservoir can compromise water quality for SCVWD and/or curtail water deliveries to SCVWD		
Banks Pumping Plant	SWP	Pumps water from the Delta (Clifton Court Forebay) to the California Aqueduct	For January through December 2013, OA was 75.0% (see note 2)		
California Aqueduct	SWP	Distributes water from the Delta to state water contractors			
Bethany Reservoir	SWP	Stores water from the California Aqueduct, starts South Bay Aqueduct			
South Bay Pumping Plant	SWP	Pumps water from Bethany Reservoir into the South Bay Aqueduct	For January through December 2013, OA was 69.2% (see note 2)		
Del Valle Pumping Plant	SWP	Pumps water from South Bay Aqueduct into Del Valle Reservoir	For January through December 2013, OA was 99.6% (see note 2)		
Del Valle Reservoir	SWP	Off stream storage for water traveling to state water contractors along the South Bay Aqueduct			

Facility	System	Purpose	General Condition	Past Upgrades	Future Upgrades
South Bay Aqueduct	SWP	Distributes water from Bethany Reservoir to state water contractors along the SBA, terminating at the SBA terminal tank at PWTP	Poor; three leaks occurred in 2013 causing interruption of service to SCVWD; DWR and SBA contractors in early stages of SBA vulnerability assessment	SBA improvement and enlargement project (DWR) to address adequacy of existing facilities to deliver contractual design flow and increase SBA design capacity from 300 cfs to 430 cfs (completed 2013)	As of 02/27/2014, DWR and SBA contractors in early stages of SBA vulnerability assessment; may result in future improvements on SBA
Delta-Mendota Canal/California Aqueduct Intertie	CVP-SWP	Pumps water from Delta-Mendota Canal to California Aqueduct or distributes water from California Aqueduct to Delta-Mendota Canal by gravity	Fair	Construction completed 2012	
Bay Division Pipelines No. 3 and 4	SFPUC	Distributes water from the Sierra Nevada or Calaveras Reservoir to retailers in Northern Santa Clara County			
SFPUC Intertie Pump Station	SFPUC	Transfers water between SFPUC bay division pipelines no. 3 and 4 and SCVWD for emergency use			Good, some coating damage
Possible Major Projects:		1. San Luis Reservoir Low Point Solution: Combination (Wells/Recharge), DAF Treatment, New Reservoir, Lower Intake Alternatives still being evaluated (5/10)			
	2. Bay Delta Conservation Plan (BDCP)	The BDCP is a long-term (50-year) conservation strategy being developed to meet the permit requirements of a Natural Communities Conservation Plan (NCCP) and Habitat Conservation Plan (HCP) under State and federal Endangered Species Acts (ESA) for operation of the State Water Project and Central Valley Project. Initiated under a collaborative planning agreement in 2006 by the Department of Water Resources (DWR), Bureau of Reclamation (Reclamation), other State and federal agencies, water contractors and environmental stakeholders, the BDCP is designed to contribute to the recovery of 56 species that depend on the Delta ecosystem. It includes a total of 22 conservation measures (CMs), including CM1 (Delta Conveyance), which calls for new north Delta diversion facilities with state-of-the-art fish screens that would reduce pumping levels in the south Delta, and help restore more natural flow patterns for fish. Water would be conveyed from the north Delta in two parallel tunnels with a total capacity of 9,000 cubic feet per second (cfs). Public draft versions of the BDCP and associated environmental documentation were released 12/13/2013 and is scheduled to conclude 06/13/2014 (as of 02/27/2014).			

Notes:

1. Per D. Mody's 02/27/2014 conversation w/San Luis & Delta-Mendota Water Authority (SLDMWA), Reclamation prepares a report every three years for Delta-Mendota Canal, Jones PP, and O'Neill PP; SLDMWA to send the most recent report to D. Mody.

2. DWR prepares a monthly service rate report for its plants; recommend using operating availability (OA) parameter (i.e., operational readiness of equipment or percentage of time the unit was operated or could be operated) for January through December 2013; for perspective, OA for entire SWP during this timeframe was 79.1%

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NATURAL CHANNELS

Creek	System	Source of Water (In addition to local run-off)	Sub-basin Recharged	Reliability Improvements Since 2005	Planned Future Upgrades
Alamitos	Guadalupe Water Supply and Recharge	Almaden Reservoir, Calero Creek, Almaden Valley Pipeline (San Felipe, Anderson, or Calero sources)	Santa Clara Valley		
Calabazas	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Pipeline (San Felipe, SBA, Anderson, or Calero sources), Rodeo Creek, Regnart Creek	Santa Clara Valley	Improvements to achieve 1% flood protection, includes widening Bollinger Bridge; Saratoga-Sunnyvale Road culvert widening.	
Calero	Guadalupe Water Supply and Recharge	Calero Reservoir	Santa Clara Valley		
Corrallitos	Upper Llagas Water Supply and Recharge	Tennant Creek, San Felipe	Llagas		
Coyote (Lower)	Lower Coyote Creek Water Supply and Recharge	Silver Creek, Thompson Creek, Upper Penitencia Creek, various other creek inflow	Santa Clara Valley		Mid-coyote improvements to achieve 1% flood protection for Montague to I-280
Coyote (Upper)	Upper Coyote Creek Water Supply and Recharge	Anderson Reservoir, Coyote Pumping Plant (San Felipe Source Water), various creek inflow	Santa Clara Valley		
East Little Llagas	Upper Llagas Water Supply and Recharge	Madrone Channel, Corrallitos Creek	Llagas		
Guadalupe Creek	Guadalupe Water Supply and Recharge	Guadalupe Reservoir, Almaden Valley Pipeline (San Felipe, Anderson, or Calero sources), various creek inflow	Santa Clara Valley		
Guadalupe River	Guadalupe Water Supply and Recharge	Alamitos Creek, Ross Creek, Canoas Creek	Santa Clara Valley	Improvements to achieve 1% flood protection on lower and upper reaches	Improvements to achieve 1% flood protection on Upper Guad. River from I-280 to Blossom Hill Rd.
Llagas	Lower Llagas Water Supply and Recharge	Chesbro Reservoir, East Little Llagas Creek, Uvas-Llagas Transfer Pipeline (Uvas Reservoir source) various creek inflow	Llagas		Improvements to achieve 1% flood protection on both lower and upper reaches
Los Gatos	Los Gatos Water Supply and Recharge	Lexington Reservoir, Vasona Reservoir, various creek inflow, Central Pipeline (SBA source water)	Santa Clara Valley		
Penitencia	Upper Penitencia Water Supply and Recharge	Cherry flat reservoir (City of SJ), SBA terminal tank, various creek inflow	Santa Clara Valley		Improvements to achieve 1% flood protection on both lower and upper reaches
Regnart	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Pipeline (San Felipe, SBA, Anderson, or Calero sources)	Santa Clara Valley		Erosion repairs and WQ improvements
Rodeo	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Pipeline (San Felipe, SBA, Anderson, or Calero sources)	Santa Clara Valley		
Ross	Guadalupe Water Supply and Recharge	Almaden Valley Pipeline (San Felipe, Anderson, or Calero sources), various creek inflow	Santa Clara Valley		
San Tomas	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Pipeline or Vasona Canal (San Felipe, SBA, Anderson, Calero, Vasona sources), Wildcat Creek, Smith Creek, San Tomas Injection Well, Saratoga Creek, and Calabazas Creek	Santa Clara Valley		Two bridge improvements for flood protection
Saratoga	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Pipeline (San Felipe, SBA, Anderson, or Calero sources)	Santa Clara Valley		
Sierra	Upper Penitencia Water Supply and Recharge	Penitencia (Gross) Ponds	Santa Clara Valley		
Silver	Lower Coyote Creek Water Supply and Recharge	Various creek inflow	Santa Clara Valley	Lower Silver CIP Reaches 3, 4, 5, and 6 capacity improvements to achieve 1% flood protection	
Smith	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Pipeline (San Felipe, SBA, Anderson, or Calero sources), Vasona Canal (Vasona Reservoir source)	Santa Clara Valley		
Stevens	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Reservoir, Stevens Creek Pipeline (San Felipe, SBA, Anderson, or Calero sources)	Santa Clara Valley		
Tennant	Upper Llagas Water Supply and Recharge	San Felipe (Santa Clara Conduit T/O)	Llagas		
Thompson	Lower Coyote Creek Water Supply and Recharge	Various creek inflow	Santa Clara Valley		Improvements for water quality, riparian habitat and erosion
Uvas	Lower Llagas Water Supply and Recharge	Uvas Reservoir, various creek inflow	Llagas		
Wildcat	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Pipeline (San Felipe, SBA, Anderson, or Calero sources)	Santa Clara Valley		

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PIPELINES

Pipeline	System	Purpose	Service	Primary Material	Size	Approx Total Length (Miles)	Past Major Upgrades	Condition Information	Reliability Improvements Since 2005	Planned Future Upgrades	Planned Future Inspect. Dates	Year Complete	Expected Life (Years)	2015 Facility Age (Years)	Major Rehab Date	2040 Life Remain	Future Turnouts	Irrigators - Exact Location Unknown
East Pipeline	East Treated Water Distribution	Distributes treated water from PWTP via the PWTP Delivery Main to SJWC and San Jose Municipal service areas in the north eastern portion of north county	Treated	WSP	33", 36", 42", 48"	6.39	1995 as part of the PEP construction, Patt Avenue Line Valve and vault were installed and a buried service valve at Aborn Turnout was added	March 2010 inspection shows pipeline is in good condition. Inspection found multiple cracks, but no major repairs were needed. Approx. 40% of pipeline could not be inspected due to thick biofilm. Ocala line valve replaced.	Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	IRP2 Line Valves - 1 line valve proposed near piedmont valve yard to isolate pipeline in earthquake	2011, 2012	1974	90	41	2064	24		N/A
Milpitas Pipeline	East Treated Water Distribution	Distributes treated water from PWTP via the PWTP Delivery Main to SJWC service areas in the north eastern portion of north county, and to the City of Milpitas service area.	Treated	WSP	42"	4.60	1999 re-alignment on Capitol between I-680 and Cropley, new pipe and line valve in this area	Has not been inspected		City has requested a second turnout for the area near the VTA and Bart Extension. Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2013	1993	90	22	2083	43	New turnout requested by City to be installed by 2013 - In TW Transmission Small Caps Project. Future Trade Zone Turnout d/s Hostetter	N/A
Parallel East Pipeline	East Treated Water Distribution	Adds capacity to the system and allows for STWTP water to be delivered north of Ocala in the event the EPL is out of service	Treated	WSP	54"	2.35		March 2010 inspection of small section of pipe near Ocala line valve - pipeline in good condition		Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2015	1995	90	20	2085	45	Future Norwood and Ocala turnouts near existing EPL turnouts	N/A
Penitencia Delivery Main	East Treated Water Distribution	Distributes treated water from PWTP to the East and Milpitas Pipelines	Treated	PCCP	66"	0.49	Penitencia Mod-Valve and vault was added in late 90s. Pipeline was rehabbed at that time.	Has not been inspected			2012	1974	100	41	2074	34		N/A
Santa Teresa Tunnel	East Treated Water Distribution	Distributes treated water from STWTP to SJWC and San Jose Municipal service areas in the south eastern portion of north county	Treated	PCCP	72"	0.34		Has not been inspected; Two known leakage events; Spare PVC conduit in tunnel has failed and caused flooding in vault where conduit terminates			none	1989	100	26	2089	49		
Snell Pipeline	East Treated Water Distribution	Distributes treated water from STWTP to SJWC and San Jose Municipal service areas in the south eastern portion of north county	Treated	PCCP	60", 66", 72"	8.51		Has not been inspected		IRP2 Line Valves - 1 line valve proposed near Skyway Turnout to isolate pipeline following earthquake. Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2016, 2017	1989	100	26	2089	49	Future 18" between Pinos and Skyway turnouts	N/A
Alamitos Pipeline	Guadalupe River Water Supply and Recharge	Distributes water from the Los Capitancillos Ponds to the Alamitos Ponds	Raw	RCCP	24"	0.17	Extended by 450 ft. in 1970					1964	90	51	2054	14		
Almaden Valley Pipeline	Guadalupe River Water Supply and Recharge	Distributes raw water from Calero Pipeline or Calero Reservoir to the Santa Teresa Water Treatment Plant, to Vasona Valve Yard/Rinconada Force Main, or to recharge	Raw	PCCP	72", 78"	12.25		Pipeline is in good condition for pipe of its age. 2007/2008 inspections found leak in 1 pipe , scheduled for repair in Jan 2011. 80 total distressed of 1886 pipes inspected = 4.2%. Section from Santa Teresa Force Main (454+83) to Coleman Line Valve (271+50) has not been inspected.	Recoated inside lining; repaired leaking joints		2018	1974	100	41	2074	34		
Calero Pipeline	Guadalupe River Water Supply and Recharge	Distributes raw water from the Cross Valley Pipeline to the Almaden Valley Pipeline, bypassing Calero Reservoir	Raw	PCCP	78"	2.62		Has not been inspected			2015	1990	100	25	2090	50		One - Approx 100 GPM
Calero Standpipe	Guadalupe River Water Supply and Recharge	Standpipe at start of Calero Pipeline to maintain pressure in the pipeline	Raw	WSP	54"	0.16		Has not been inspected			2015	1990	75	25	2065	25		
Guadalupe Pipeline	Guadalupe River Water Supply and Recharge	Distributes water from the Alamitos Ponds to the Guadalupe Ponds	Raw	RCCP	30" - 18"	1.08	Partially re-located at Guadalupe River in 1997					1993	90	22	2083	43		
Kooser Pipeline	Guadalupe River Water Supply and Recharge	Distributes water from the Almaden Valley Pipeline to the Kooser Ponds	Raw											2015	0	-2040		
Masson Pipeline	Guadalupe River Water Supply and Recharge	Distributes water from the Masson Diversion on Guadalupe Creek to the Guadalupe Water Treatment Facilities and Los Capitancillos Ponds	Raw	RCCP	30"	0.25						1964	90	51	2054	14		
Meridian Pipeline	Guadalupe River Water Supply and Recharge	Distributes water from the U/S Los Capitancillos Ponds to the D/S Los Capitancillos Ponds	Raw	RCCP	27"	0.22						1964	90	51	2054	14		
Santa Teresa Force Main	Guadalupe River Water Supply and Recharge	Distributes raw water from the Almaden Valley Pipeline (San Felipe Division, Anderson, or Calero Sources) to the STWTP	Raw	PCCP	78"	0.41		January 2008 inspection found pipeline to be in excellent condition with no distressed pipes			2018	1989	100	26	2089	49		
Central Pipeline	Los Gatos Water Supply and Recharge	Distributes raw water from the South Bay Aqueduct to recharge and the Vasona Valve Yard	Raw	PCCP	66"	12.64	Pipeline has undergone two relocations near Guadalupe Line Valve as part of flood control projects (HWY 87)	Pipeline is in good condition for pipe of its age. 2005 inspections found 59 total distressed pipes of 2066 inspected = 2.86%. One additional pipe became distressed and three had additional wire breaks since 2001 inspection. Total 4.6 of 13.1 miles not yet inspected. Relocation at HWY87 was inspected in 2004 due to concerns that contractor hit the		Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2017	1965	100	50	2065	25		
Rinconada Force Main	Los Gatos Water Supply and Recharge	Distributes raw water from Vasona Valve Yard to the RWTP and irrigation	Raw	WSP	72"	1.62	Mid 90s, pipeline was re-aligned to accommodate HWY 85, New vault was added at Wedgewood Dr.	Pipeline is in good condition. December 2005 inspection found areas with spalling and cracking, which were repaired.		Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2017	1966	90	49	2056	16		One - Approx 400 GPM
Sunnyoaks Pipeline	Los Gatos Water Supply and Recharge	Distributes water from the Page Ditch to the Sunnyoaks and Budd Ponds	Raw	WSP	24"	0.47						1963	90	52	2053	13		
Uvas-Llagas Transfer Pipeline	Lower Llagas Water Supply and Recharge	Distributes water from Uvas Reservoir to Llagas Creek for recharge	Raw	RCCP	36"	3.33						1957	90	58	2047	7		

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PIPELINES

Pipeline	System	Purpose	Service	Primary Material	Size	Approx Total Length (Miles)	Past Major Upgrades	Condition Information	Reliability Improvements Since 2005	Planned Future Upgrades	Planned Future Inspect. Dates	Year Complete	Expected Life (Years)	2015 Facility Age (Years)	Major Rehab Date	2040 Life Remain	Future Turnouts	Irrigators - Exact Location Unknown
Pacheco Conduit Sec. 1 & 2	San Felipe Division Imported Water	Distributes raw water from the Pacheco Tunnel Reach 2 (San Luis Reservoir source water) to the Santa Clara and Hollister Conduits	Raw	PCCP	120"	7.91		Pipeline is in good condition. Dec 2007 inspection found 12 total distressed of 1407 pipes inspected = 0.85%. Portions of pipeline could not be inspected due to high water or poor air quality. Potential for 8 additional distressed pipes in uninspected sections.		Inspect and rehabilitate conduit	2014, 2018	1985	100	30	2085	45		
Pacheco Tunnel Reach 1	San Felipe Division Imported Water	Distributes raw water from the San Luis Reservoir intake structures to the Pacheco Pump Station	Raw	Reinfor. Concrt Tunnel	156"	1.83		Portion of tunnel was inspected in 2007, approximately PPP to tunnel island		Survey for cathodic protection; inspect and rehabilitate tunnel.	none	1968	90	47	2058	18		
Pacheco Tunnel Reach 2	San Felipe Division Imported Water	Distributes raw water from the Pacheco Pump Station (San Luis Reservoir source water) to the Pacheco Conduit	Raw	Reinfor. Concrt Tunnel	114"	5.22		Known leakage in tunnel			2014, 2018	1984	90	31	2074	34		
Santa Clara Conduit	San Felipe Division Imported Water	Distributes water from the Pacheco Conduit (San Luis Reservoir source water) to the Coyote Pumping Plant	Raw	PCCP	96"	23.52		Pipeline is in good condition. March 2009 inspection found 31 total distressed pipes of 2250 inspected = 1.38%. None in Calaveras fault crossing section were distressed. Sections that have not yet been inspected include 0+00 (BIF) to 47+98 (partial tunnel) and 219+73 (Sectionalizing Valve #1) to 386+20 (CPP).	Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2014, 2018	1985	100	30	2085	45	5 Future Turnout Locations - Watsonville to Pajaro Valley 1.5 mi d/s fault crossing, Furlong Ave u/s SV-1, Future 42" near SV-2, Future 36" and Future 42" u/s Maple	BIF to County Line: Three - Approx 4000 GPM total for all 3; County Line to CPP: One - rarely used
Santa Clara Tunnel	San Felipe Division Imported Water	Distributes water from the Pacheco Conduit (San Luis Reservoir source water) to the Coyote Pumping Plant	Raw	Reinfor. Concrt Tunnel	117"	0.96	2002 landslide repair at tunnel	Known leakage in tunnel, not determined to be the cause of the landslide		Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2014, 2018	1985	90	30	2075	35		
Gilroy Reclamation Pipeline	South County Recycled Water	Distributes water from the South County Regional Wastewater Authority Treatment Plant to customers	Reclaimed	WSP	12"	8.75	3,000 feet added as part of South County Recycled Water Master Plan (SCRWMP) Immediate Term Projects	Pipeline has experienced several leaks associated with recent construction and installation issues. 2009 Cathodic protection system inspection shows system is functioning acceptably.		7.5 miles to be added as part of short-term projects and 2.5 miles to be added as part of long-term projects in SCRWMP	2016	1978	60	37	2038	-2	13 service connections to be added as part of SCRWMP	
Anderson Force Main	Upper Coyote Creek Water Supply and Recharge	Distributes raw water to Anderson Reservoir from the Coyote Pump Station or from Anderson Reservoir to the Coyote Pump Station or Cross Valley Pipeline	Raw	RCCP	54"	0.81		Has not been inspected		Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2014	1984	90	31	2074	34		One - Approx 760 GPM
Cross Valley Pipeline	Upper Coyote Creek Water Supply and Recharge	Distributes raw water from Coyote Pump Station or Anderson Force Main to the Calero Pipeline	Raw	PCCP	78"	8.13	Most threaded connections were replaced in 2004/05 due to severe corrosion	Has not been inspected but has known corrosion issues. Pipeline had several threaded connection leaks after a relatively short life of 10-15 years		Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	2014	1987	100	28	2087	47		Ten - Approx 2400 GPM total for all 10
Madrone Pipeline	Upper Llagas Water Supply and Recharge	Distributes raw water from the San Felipe Division to the Madrone Channel for recharge	Raw	RCCP	24"	2.00		Pipeline is in poor condition. Capital project to repair PL will be completed in March 2012.		Main/Madrone Repair/Replacement project to be completed in 2018		2012	90	3	2102	62		
Main Avenue Pipeline	Upper Llagas Water Supply and Recharge Systems	Distributes raw water from Anderson Reservoir and San Felipe Division to the Main Avenue Ponds for recharge	Raw	WSP	16", 24"	2.03		Pipeline is in poor condition. Section from Anderson to Santa Clara Conduit is not operational. Capital project to repair PL will be completed in March 2012.		Main/Madrone Repair/Replacement project to be completed in 2018		2012	75	3	2087	47		
Helmsley Pipeline	Upper Penitencia Creek Water Supply and Recharge	Distributes water from Piedmont Ponds to Helmsley and Upper Capitol Ponds	Raw									1964	90	51	2054	14		
Penitencia Force Main	Upper Penitencia Creek Water Supply and Recharge	Distributes raw water from the South Bay Aqueduct (Imported SWP source) to the SBA terminal tank or PWTP	Raw	PCCP	66"	0.52		Has not been inspected		Seismic improvements to delivery main and force main juction	2012	1974	100	41	2074	34		
San Tomas Pipeline	West Side and Stevens Creek Water Supply and Recharge	Distributes water from the Campbell Distributary to the San Tomas Injection Well	Treated	PVC	12"	0.33						1999	75	16	2074	34		
Stevens Creek Pipeline	West Side and Stevens Creek Water Supply and Recharge	Distributes raw water from the Rinconada Force Main/Vasona Valve Yard to recharge on the west side of the county	Raw	WSP	30", 36"	7.8	In past 15 years, 2 sections have been replaced: behind school on Pollard & just d/s of Quito	Has not been inspected; Known to have accelerated corrosion issues. ARVs replaced in late 90s failed in 2004.	Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	Stevens Creek Vasona Raw Water Distribution study may result in upgrades or changes to the pipeline.	2013	1966	75	49	2041	1		
Sunnyvale Distributary	West Treated Water Distribution	Distributes treated water from RWTP via the West Pipeline to the Cal Water Los Altos service area and to the City of Sunnyvale service area	Treated	WSP	33"	0.46		December 2008 video inspection found minor cracking. No repairs were made. Pipeline is in good condition.			beyond 2019	1967	75	48	2042	2		N/A
West Pipeline	WestTreated Water Distribution	Distributes treated water from RWTP to treated water contractors on the west side of the county	Treated	WSP	30", 33", 48", 54", 66", 78", 84"	9.17		RWTP to Cox turnout was inspected in 2004, several areas with mortar lining cracks and breaks were found and repaired. Severely corroded appurtenances were replaced. Remainder was inspected in November 2009. Several areas with mortar lining cracks and breaks were found and repaired. One area with deteriorated lining & rust near Rainbow TO could not be repaired in the time allowed for shutdown.	Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.	IRP2 Line Valves - 2 line valves proposed to isolate the Monte Vista Fault Zone; 1 u/s of Santa Clara Distributary junction and 1 u/s of Mann Turnout.	2018	1967	90	48	2057	17	Side outlet between Mann & Rainbow	N/A
Campbell Distributary	West Treated Water Distribution	Distributes treated water from RWTP to SJWC service area or the San Tomas Injection Well for recharge via the West Pipeline and the Santa Clara Distributary	Treated	WSP	20"	2.07	2.07	2004 shutdown included replacement of corroded appurtenances.	Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.		2013	1967	75	48	2042	2		N/A

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PIPELINES

Pipeline	System	Purpose	Service	Primary Material	Size	Approx Total Length (Miles)	Past Major Upgrades	Condition Information	Reliability Improvements Since 2005	Planned Future Upgrades	Planned Future Inspect. Dates	Year Complete	Expected Life (Years)	2015 Facility Age (Years)	Major Rehab Date	2040 Life Remain	Future Turnouts	Irrigators - Exact Location Unknown
Mountain View Distributary	West Treated Water Distribution	Distributes treated water from RWTP via the West Pipeline to the Cal Water Los Altos service area and to the City of Mountain View service area	Treated	WSP	24"	1.15		Has not been inspected	Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.		2014	1990	75	25	2065	25		N/A
Santa Clara Distributary	West Treated Water Distribution	Distributes treated water from RWTP via the West Pipeline to the Cal Water Cupertino/Santa Clara service area and to the City of Santa Clara service area	Treated	WSP	30", 36"	4.12		2004 inspection for damage due to overgrowth of trees. Pipeline was in acceptable condition. 2004 shutdown included replacement of corroded appurtenances	Inspect pipeline; replace valves, flow meters, piping, and appurtenences as needed.		2012	1967	75	48	2042	2	City of Santa Clara requested a new turnout to help with their system pressures. Request was not carried forward.	N/A

NOTES:

CIPs for all Pipelines: Cathodic Protection (broken into USBR vs. District owned) - project may increase life of pipelines, if system is maintained
Pipeline Hydraulic Reliability analysis - project is starting off by creating accurate GIS coverage and updated model. Per results of inspections to date, surge analysis is needed on all District pipelines
(POTENTIAL) Sea Level Rise flood protection of vaults, turnouts, etc.

No Longer In-Service: Half Road Pipeline and Irrigation System

Expected Life Info: ICAM and KANEW software programs were used to determine pipeline expected life.

Type of Pipe	Life
PCCP	100
RCCP	90
WSP > 36"	90
WSP< 36"	75
Tunnels	90
Gilroy Reclamation	60

Pipeline	Expected Replacement Date
Gilroy Reclamation	2038
Stevens Creek	2041
Sunnyvale Distributary	2042
Santa Clara Distributary	2042
Campbell Distributary	2042
30% WPL	2042
16% of EPL	2047
Uvas-Llagas Transfer	2047

Tunnels: Have known leakage, but tunnels by nature leak. Leakage may need to be addressed sometime before 2040.

Pipes Not Included: Dam outlet pipes are included with Dam infrastructure summary
Pond inlet & outlet pipes are included with Pond infrastructure summary

Pipeline Locations: Attached for several pipelines

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PONDS

Pond	System	Source of Water	Sub-basin Recharged	Size	Past Major Upgrades	Current Condition	Reliability Improvements Since 2005	Planned Future Upgrades	Year Complete	2015 Facility Age
Alamitos	Guadalupe River Water Supply and Recharge	Guadalupe & Alamitos Creeks; Almaden Valley Pipeline (San Felipe, Anderson, or Calero Source)	Santa Clara Valley	2 ponds; 11 Acres; avg 5 ft. deep	Reconstructed in 1963				1932	83
Budd	Los Gatos Water Supply and Recharge	Los Gatos Creek or Central Pipeline (SBA Source) via Page Ditch and Sunnyoaks Pipeline	Santa Clara Valley	3 ponds; 9 Acres; avg 11 ft. deep					1967	48
Camden	Los Gatos Water Supply and Recharge	Los Gatos Creek or Central Pipeline (SBA Source) via Page Ditch	Santa Clara Valley	3 ponds; 62 Acres; large pond avg 17 ft. deep; 2 smaller pond avg 6 ft. deep					1962	53
Capitol	Upper Penitencia Water Supply and Recharge	Penitencia Creek via Helmsley Pipeline and Pond	Santa Clara Valley	7 narrow linear ponds formed by check dams					1964	51
Church	Lower Llagas Water Supply and Recharge	Chesbro and Uvas Reservoirs via Llagas Creek	Llagas	3 ponds; 42 Acres; avg 17 ft. deep					1978	37
Coyote	Upper Coyote Creek Water Supply and Recharge	Coyote Creek (San Felipe or Anderson Source)	Santa Clara Valley	1 pond; 30 Acres; avg 5 ft. deep					1934	81
Ford Road	Upper Coyote Creek Water Supply and Recharge	Coyote Creek (San Felipe or Anderson Source)	Santa Clara Valley	4 ponds; 34 Acres; avg 5 ft. deep					1964	51
Guadalupe	Guadalupe River Water Supply and Recharge	Guadalupe & Alamitos Creeks; Almaden Valley Pipeline (San Felipe, Anderson, or Calero Source)	Santa Clara Valley	4 ponds; 31 Acres; avg 14 ft. deep					1967	48
Helmsley	Upper Penitencia Water Supply and Recharge	Penitencia Creek via Helmsley Pipeline	Santa Clara Valley	1 pond; 1.1 Acres					1964	51
Kooser	Guadalupe River Water Supply and Recharge	Almaden Valley Pipeline (San Felipe, Anderson, or Calero Source) via Kooser Pipeline	Santa Clara Valley	4 ponds; 2 Acres; avg 9 ft. deep					1962	53
Los Capitancillos	Guadalupe River Water Supply and Recharge	Guadalupe Creek; Almaden Valley Pipeline (San Felipe, Anderson, or Calero Source) via Masson Pipeline	Santa Clara Valley	10 ponds; 63 Acres; avg 5-10 ft. deep	Reconstructed in 1964				1962	53
Madrone Channel	Upper Llagas Water Supply and Recharge	San Felipe via Madrone Pipeline	Santa Clara Valley	Excavated Channel with 10 dams avg 3 ft. deep; 6.5 Acres					1975	40
Main Avenue	Upper Llagas Water Supply and Recharge	San Felipe or Anderson via Main Avenue Pipeline	Llagas	5 ponds; 6 Acres; avg 4 ft deep	Reconstructed in 1961				1955	60
Maybury	Upper Penitencia Water Supply and Recharge	Penitencia Creek via Maybury Diversion	Santa Clara Valley	1 pond; 1.2 Acres		Recharge capability of pond is questionable and being studied.		District may stop using the pond for recharge based on study results.	1964	51
McClellan	West Side and Stevens Creek Water Supply and Recharge	Stevens Creek Pipeline (San Felipe, SBA, Anderson, or Calero sources)	Santa Clara Valley	2 ponds; 2.5 Acres; avg 13 ft. deep					1976	39
McGlincey	Los Gatos Water Supply and Recharge	Los Gatos Creek or Central Pipeline (SBA Source) via Kirk Ditch	Santa Clara Valley	6 ponds; 7 Acres; avg 7 ft. deep					1959	56
Oka Lane	Los Gatos Water Supply and Recharge	Los Gatos Creek or Central Pipeline (SBA Source) via Kirk Ditch	Santa Clara Valley	3 ponds; 17 Acres; large pond avg 12 ft. deep; 2 smaller ponds avg 6 ft. deep					1958	57

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PONDS

Pond	System	Source of Water	Sub-basin Recharged	Size	Past Major Upgrades	Current Condition	Reliability Improvements Since 2005	Planned Future Upgrades	Year Complete	2015 Facility Age
Overfelt Gardens	Upper Penitencia Water Supply and Recharge	Penitencia Creek via Maybury Pond	Santa Clara Valley	4 ponds; 6 acres; avg 13 ft. deep		Recharge capability of pond is questionable and being studied.		District may stop using the pond for recharge based on study results.	1976	39
Page	Los Gatos Water Supply and Recharge	Los Gatos Creek or Central Pipeline (SBA Source) via Page Ditch	Santa Clara Valley	8 ponds; 14 Acres; avg 10 ft. deep	Reconstructed in 1961 and 1964				1935	80
Penitencia (Gross)	Upper Penitencia Water Supply and Recharge	Penitencia Creek via Noble Diversion; SBA terminal tank overflow	Santa Clara Valley	4 ponds; 20 Acres; avg 7 ft. deep	Reconstructed in 1964	Pond 1A needs fish screen on outlet pipe		Current capital project to install fish screen expected completion in June 2012	1958	57
Piedmont	Upper Penitencia Water Supply and Recharge	Penitencia Creek via Penitencia (Gross) Ponds	Santa Clara Valley	4 ponds					1964	51
San Pedro	Upper Llagas Water Supply and Recharge	San Felipe via Santa Clara Conduit	Llagas	7 ponds; 20 Acres; avg 16 ft. deep					1996	19
Sunnyoaks	Los Gatos Water Supply and Recharge	Los Gatos Creek or Central Pipeline (SBA Source) via Page Ditch and Sunnyoaks Pipeline	Santa Clara Valley	4 ponds; 3 Acres; avg 9 ft. deep					1967	48

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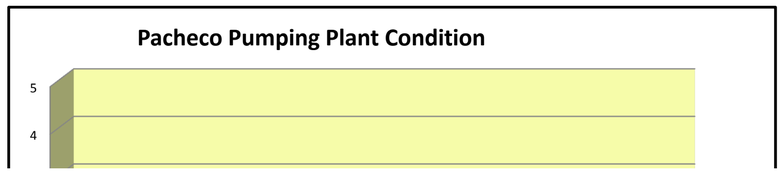
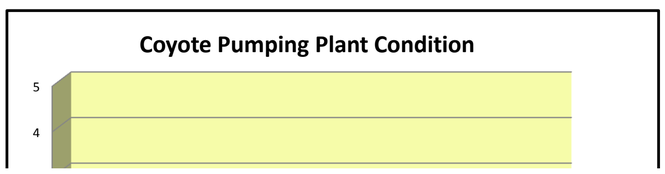
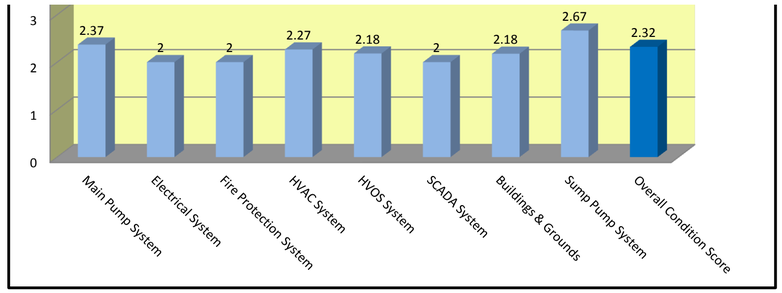
PUMPING PLANTS

Plant	System	Purpose	Capacity	Associated Systems/Facilities	Past Major Upgrades	Current Condition	Reliability Improvements Since 2005	Planned Future Upgrades	Year Constructed
Pacheco	San Felipe Division	Lifts water from San Luis Reservoir into the Pacheco Tunnel for distribution to San Benito and Santa Clara Counties	Twelve 2,000 hp variable speed vertical turbine pumps; 301,055 gpm or 360 MGD design capacity	Building, surface roads, overhead cranes, regulating tank, HVAC, Sump Pumps	Regulating Tank was re-coated in 2009; Pumps are continually re-built	No Issues	ASD drives and associated equipment was replaced in 2013. Seismic retrofit, recoating, and modification of cathodic protection on regulating tank in 2011.	Pump replacements will begin in approximately 2035: Current cost for pump & motor is about $1.55M each ($18.6M equipment cost for all pumps); Regulating Tank re-coating in 2024 and replacement in 2049; Eventually Ops building will require major rehab; Electrical substation replacement in 2027	
Coyote	San Felipe Division	Lifts water from the San Felipe Division (San Luis Reservoir via Pacheco and Santa Clara Tunnels and Conduits) or into or from Anderson Reservoir for distribution through the Cross Valley Pipeline; Not always needed as system typically flows by gravity.	Six 2,000 Hp variable speed centrifugal pumps; 153,492 gpm or 184 MGD design capacity	Building, surface roads, fuel island, hydraulic press, HVAC	IRP spare pipe stored here, as well as other buried spare pipe.	Grounds are littered with spare parts from several projects.	Backup power (generator) was provided.	Electrical substation replacement in 2022; Eventually Ops building will require major rehab	
Vasona	West Side and Stevens Creek Supply and Recharge	Lifts water from the Central Pipeline (SBA) or Almaden Valley Pipeline (San Felipe, Anderson, or Calero Sources) to the Rinconada Force Main for treatment at RWTP, or to the Stevens Creek Pipeline for recharge. Can also pump water to the Central or Almaden Valley Pipelines. Not always needed as system typically flows by gravity.	Two 200 Hp and two 400 HP electric driven horizontal centrifugal pumps, 72,000gpm or 86 MGD design capacity	Buildings, surface roads, meter shop, bridge crane	Meter shop restrooms added in 2000s; Electrical systems recently upgraded	Pumps are in poor condition, beyond re-buildable stage; Pump station and meter shop buildings may require seismic upgrades	Voice and Data systems were upgraded in 2010.	Pumps need to be replaced ASAP, but first determine future capacity needs - dependent on RWTP or West PL expansion, Stevens Creek/Vasona Study, and indirect potable re-use planning. Seismic retrofit of Pump Building and Meter Shop.	
Dutard	East Treated Water	Pumps water from PWTP to San Jose Water Company's System (operated by SJWC). Boosts water pressure during peak service hours.	Two 25 Hp Pumps, 4,000 gpm or 4.8 MGD design capacity	n/a	Pumps and electrical systems recently upgraded	No Issues		Ops building will eventually require rehab	
Graystone	East Treated Water	Pumps water from STWTP to San Jose Water Company's System (operated by SJWC). Boosts water pressure during peak service hours to feed the Graystone Pipeline	Two 200 Hp variable speed turbine pumps, 27,760 gpm or 33 MGD design capacity	n/a	Pumps recently upgraded	No Issues		Ops building will eventually require rehab	
Anderson Hydroelectric	Upper Coyote Creek Supply and Recharge	Hydroelectric facility near the base of Anderson Dam where water from the reservoir powers two 50 kW turbines to generate energy. Facility is rarely used, but in the future the District may be able to sell energy to PG&E as a 'clean' energy source.		Two generators, turbines, discharge vault and valves	Turbines have been re-built multiple times since original construction, most recently in 2010. This is linked to the over speeding issues. ($60k + each turbine)	District is not able to regulate influent to the turbines due to a faulty manual buried butterfly valve that is used to control flow. When inflow is not controlled, the turbines over-speed and fail. Floor slope has caused poor drainage and resulted in expedited corrosion.		Overall facility is in need of re-coating, which may include lead abatement. Building will eventually require rehab.	1989

Condition Detail (as of April 2010):



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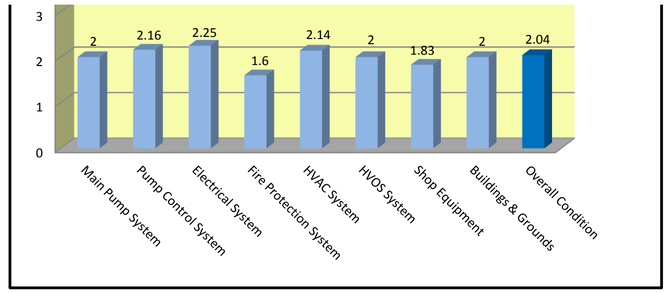
Electrical System
Fire Protection System
HVAC System
HVOS System
SCADA System
Buildings & Grounds
Sump Pump System
Overall Condition Score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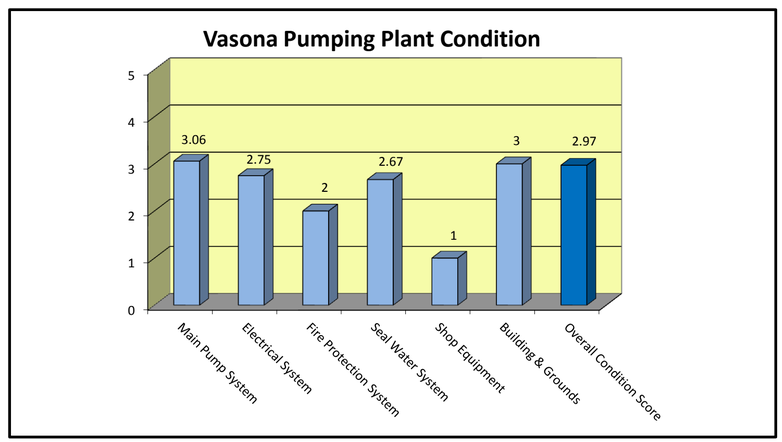
Pump Control System
Electrical System
Fire Protection System
HVAC System
HVOS System
Shop Equipment
Buildings & Grounds
Overall Condition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3
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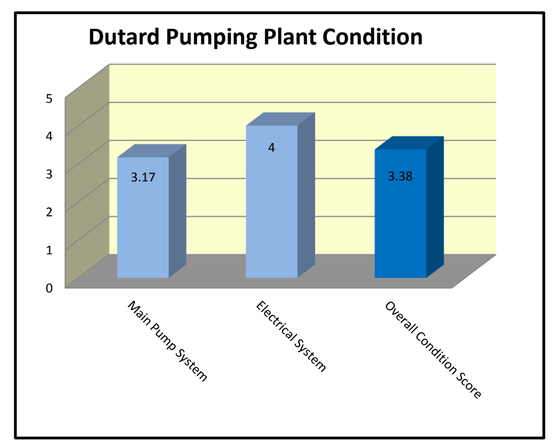
Electrical System
Fire Protection System
Seal Water System
Shop Equipment
Building & Grounds
Overall Condition Score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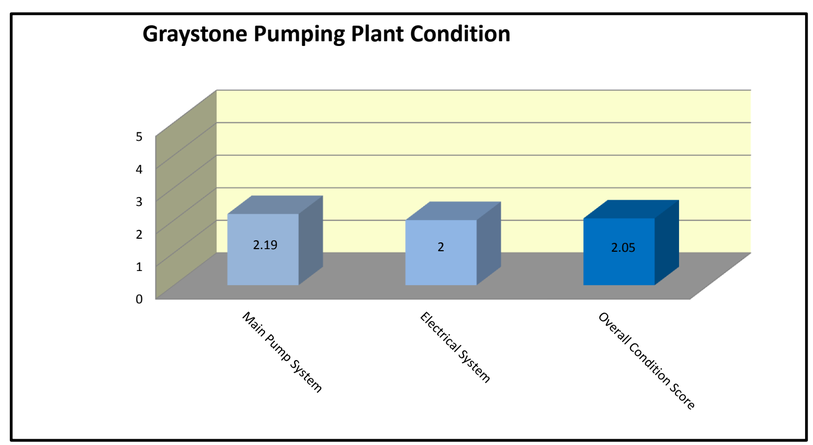
Main Pump System
Electrical System
Overall Condition Score


Graystone Pumping Plant Condition
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2.05
Main Pump System
Electrical System
Overall Condition Score

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PENITENCIA WATER TREATMENT PLANT

Plant Overview: PWTP treats water from the SBA. The treated water is delivered to water retailers on the east side of Santa Clara County via the East and Milpitas Pipelines.
System: East Treated Water
Process: Flow-through flocculation/sedimentation, ozone disinfection, and multi-media filtration. See plant flow diagram for additional process information.
Capacity: 40 MGD
Year Constructed: 1975

System	Purpose	Major Components	Date Constructed, Added, or Rehabbed	Current Condition	Reliability Improvements Since 2005	Planned Future Upgrades
Air Wash	Circulates air to filters for backwash	Valves (to each filter), actuators		No issues		
Alum	Coagulant	3 storage tanks, pumps, mixer, piping, feed building	TWIP I	No backup application point, issues with flushing feed lines, chemical tanks in direct sun		
Ammonia	Disinfection, helps maintain residual	1 storage tank, pumps, piping, water softener	TWIP I	Long run of piping, inadequate mixing, only one storage tank		Ammonia System Relocation and Upgrades CIP
Anionic Poly	Coagulant added at belt press	1 storage tank, 2 batch tanks, pumps, piping		Tank size issues, product coagulates		
Backwash	Pumps water back through filters for cleaning	Backwash pump, motor, valves (to each filter), actuators		Entrained air, bed expansion and depth issues; no back-up pump or spare parts	Replaced backwash pump in 2010	Backwash Pump Replacement Project currently replacing pump and motor and addressing bed expansion issues
Belt Press	Processes sludge from sed basins	Building, conveyor belt, pumps, surge blend tank		SCADA interface and control strategy not ideal, water demand issues		2020 major rehab/replacement, may warrant technology change (centrifuge, gravity thickeners, similar to RWTP)
Buildings and Grounds	Facilities required for housing plant employees	Operations building, surface roads, security gates		Seismic stability of operations building, space shortage in operations building and throughout site	Standby power system upgrade in 2010. Improvements made to security.	IRP2 Seismic Study will address seismic issues with ops building; 2024 building rehab for dom. water, HVAC, lighting, etc.
Carbon	Can improve taste and odor	2 tanks, building, dust collection, pumps, mixers, piping	TWIP I	Issues with flushing pumps and dosing at filters		
Cat Poly	Coagulant	1 storage tank, 2 batch tanks, pumps, piping		No sump pump alarm		
Caustic (Sodium Hydroxide)	Balances pH (raises) if water is acidic	1 storage tank, pumps, piping		Only 1 tank, tanks need heating for better operability		
Clearwell	Stores treated water prior to distribution	Clearwell tank, valves		Corrosion and mixing issues, clearwell bypass vault issues		Clearwell Coating CIP to address corrosion issues ; 2022 clearwell rehab or replacement - date could be extended by coating CIP
EPL	Plant outflow to EPL	Valve and vault		Issues with vault structure stability and vault sump pump		
Exhaust Fans	Cools/heats buildings and equipment	Exhaust fans		No issues		
Filters	Filters settled water	6 filters, filter media, filter cones, valves	2005 – Filter Media Replaced	GAC media is not used for absorption due to short life. Media has approx. 10 year life - 2015 replacement. Filter re-coating should be included with this work if possible. Algae growth and turbidity are issues		2015 filter media replacement, 2019 basin recoating, valve replacements (on-going) could all be done at once. Basin re-coating every 15-20 years. Filter Basin Cover CIP to address Algae growth issue, suggest delaying to Filter Media replacement.
Fire Protection	Fire Protection	Sprinklers		Operations building may not be adequately protected		
Hydrogen Peroxide	Can improve taste and odor	1 storage tank, pumps, piping	2006	Issues with off-gassing, feed pump capacity, and off-loading due to site/space issues		
Liquid Oxygen	Feeds ozone generation system	2 storage tanks, pressure regulating valves, vaporizers	2006	Issues with blow-offs		
Non-Ionic Polymer	Coagulant	1 storage tank, 2 batch tanks, mixer, pumps, piping		Dosing, tank location, and sump pump alarm issues		
OCL (Sodium Hypochlorite)	Disinfection	3 storage tanks, pumps, piping	Toxic Gas Ord Project	SCADA controls and metering pumps issues, Storage tank issues related to site/space planning		
Ozone Cooling	Cooling system (water) for ozone generation equipment	Valves, piping	2006	Cooling water pump issues related to plant water system		Water Pump Mods CIP to address cooling water pumps issue (add issues from Needs Assessment)
Ozone Destruction	Destructs ozone that is not dissolved into water	2 ozone destructors, blowers	2006	No issues		
Ozone Generation & Contactors	Generates ozone	Ozone generation building, 3 ozone generators, PSUs, ozone contactor building, contactor basins, diffusers, monitors, analyzers	2006	Instrumentation issues - unnecessary shutdowns and alarms		2019 major system rehab

Ozone Quenching	Limits bromate production by quenching dissolved ozone once ct has been met (calcium thiosulfate)	2 storage tanks, pumps, piping	2006	System capacity issues		
Phosphoric Acid	Corrosion inhibitor	1 storage tank, pumps, piping		Issues with tank spill containment, pump reliability, metering pumps, sump pump, access stairs and level indicator. All issues are related to site/space planning.		Chemical Systems Upgrade CIP to address system issues (suggest delay to follow space/site planning)
Plant Air	Provides air to plant processes	2 compressors, piping		No issues		
Plant Water & Domestic Water	Provides water to plant processes and facilities	Pumps, piping		Issues with domestic system usefulness, old system redundancy, new system capacity		Water Pump Mods CIP to address new system capacity issue
Potassium Permanganate	Pre-oxidant	Building, dissolver tanks, pumps, piping		System is inefficient		
SBA	SBA source water into plant	Terminal Tank, valve, actuator		No issues		
Sedimentation Basins	Forms large flocs and settles the flocs out of water	3 flocculation basins, 3 sedimentation basins, floc drives, mixers, chain & flight/rakes		Floc and sed basins need re-coating. Basin access, rapid mixer, sludge removal, and settled water turbidity issues.		2019 recoating, then every 15-20 years; valve replacements (on-going) could be combined with this
Sludge	Receives sludge from sed basins for drying	Pumps, valves, actuators		No issues		
Sulfuric Acid	Limits bromate production by reducing pH of water entering ozone facilities	1 storage tank, spill tank, pumps, piping,	2006	No issues		
Sump pumps	Sump pumps to sanitary sewer drains for most systems	Sump and underdrain pumps		Some issues identified in specific systems		
Supplemental Nitrogen	Adds nitrogen to oxygen feed to increase ozone generation efficiency	2 compressors, piping	2006	Issue with feed control		
Washwater Recovery	Receives used washwater from filter backwashes and sludge drying beds	2 ponds, pumps, valves		Issues with high turbidity, pond capacity, and belt press water		

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RECHARGE TREATMENT FACILITIES

Treatment Facility	System	Purpose	Description of Facilities/Process	Associated Infrastructure	Condition Information	Reliability Improvements Since 2005	Year Complete	2015 Facility Age
Kirk	Los Gatos Water Supply and Recharge	Reduces turbidity of water prior to recharge in Oka and McGlincey Ponds to improve recharge rates.	Cationic Polymer is injected into Kirk Ditch, then water is diverted through the detention pond	Blockhouse with 300 gal chemical storage tank; Detention pond	Chemical feed is not automated - efficiency could be improved		1961	54
Page	Los Gatos Water Supply and Recharge	Reduces turbidity of water prior to recharge in Camden, Page, Sunnyoaks, and Budd Ponds to improve recharge rates.	Cationic Polymer is injected into Page Ditch, then water is diverted through the detention pond	Blockhouse with 300 gal chemical storage tank; Detention pond	Chemical feed is not automated - efficiency could be improved		1965	50
Guadalupe	Guadalupe River Water Supply and Recharge	Reduces turbidity of water prior to recharge in Los Capitancillos Ponds to improve recharge rates.	Cationic Polymer is injected into the Masson Pipeline, then water is diverted through the detention pond	Blockhouse with small chemical storage tank; Detention pond			1962	53
Vasona Chemical Storage	Los Gatos Water Supply and Recharge	Stores cationic polymer for transfer to smaller 300 gallon tanks at Kirk and Page Ditch block houses, at the head of the Kirk and Page treatment facilities.	Staff manually fills totes and drives the chemical from Vasona to smaller tanks at Kirk and Page Ditch blockhouses.	Two 6000 gallon cationic polymer storage tanks				

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RINCONADA WATER TREATMENT PLANT

Plant Overview: RWTP treats water from the SBA (Delivered via the Central Pipeline and Rinconada Force Main) and from the San Felipe Division, Anderson Reservoir or Calero Reservoir (delivered via the Almaden Valley Pipeline and Rinconada Force Main). The treated water is delivered to water retailers on
System: West Treated Water
Process: Up-flow Clarifier Flocculation, Dual Media Filtration, Chlorine Disinfection. See plant flow diagram for additional process information.
Capacity: 80 MGD
Date Constructed: 1965

System	Purpose	Major Components	Date Constructed, Added, or Rehabbed	Current Condition	Reliability Improvements Since 2005	Planned Future Upgrades
Airwash	Circulates air to filters for backwash	2 blowers, valves (to each filter)	Valve Replacement CIP - 2009	Valves, actuators, and corroded piping were just replaced in Valve Replacement CIP		None
Alum/Ferric	Coagulant	3 storage tanks, pumps, mixer, piping		Routine contract work needed - clean & inspect tanks, etc.		Chemical Storage CIP will add seismic upgrades to storage area (breezeway wall)
Ammonia	Disinfection, helps maintain residual	1 storage tank, pumps, water softener, piping		Routine contract work needed - clean & inspect tanks, etc.		None
Backwash	Pumps water back through filters for cleaning	1 pump, VFD, valves (to each filter), actuators	Valve Replacement CIP - 2009	Valves and actuators were just replaced in Valve Replacement CIP		Chemical System Upgrade CIP will replace pump ASD
Belt Press	Processes sludge from sludge drying beds, sends filtrate to lower ponds	Pumps, valves, piping, anionic polymer system, conveyor belt and building		Poor condition		Residuals Management CIP will upgrade or rehab entire system
Buildings & Grounds	Facilities required for housing plant employees	Operations building (domestic water, elevator, windows, lighting, etc), roads, security gates, fuel station, trailers		Ops building needs remodel - plumbing, ADA, HVAC, windows, doors, etc.	Primary electrical, standby power, and truck cables were upgraded. Upgrades were made to voice and data systems. Improvements made to security.	FRP Site Improvements will repair roads & gates; IRP2 Seismic Retrofits will upgrade ops building for life safety and may include ADA or other building improvements; TW Small Caps will address lab space allocation.
Carbon (PAC)	Can improve taste and odor	2 storage tanks, feed pumps, dust collection	TWIP I	No issues to note		None
Cationic Polymer	Coagulant	2 storage tanks, pumps, piping		No issues to note		None
Caustic	Balances pH if water is acidic	1 storage tank, pump, piping		Tanks, containment, and storage structure need rehab	Chemical System Upgrade CIP upgraded tanks and containment areas; including seismic retrofits to storage area. Caustic Soda Feed System was replaced.	
Clarifiers (Flocculators)	Forms large flocs and settles those flocs out of water	4 upflow clarifier structures, mechanisms (drives, rakes, motors)		Clarifier Mechanisms are being rebuilt under Clarifier Rehab CIP; Seismic Upgrades are needed	All clarifiers were replaced and a fifth clarifier basin was added. Seismic retrofits were made to system.	
Clearwells & Treated Water Reservoir*	Stores treated water prior to distribution	2 clearwells w/ roofs, valves; 1 treated water reservoir w/ enclosure structure & valves		Have never been inspected; Roofs, guardrails, hatches, weir gates, need rehab		Clearwell Upgrade CIP for seismic upgrades to clearwells and roof rehab - included in IRP2 Seismic Retrofits Project
Filter Poly (Non-Ionic)	Coagulant (filter aid)	1 storage tank, 2 batch tanks, pumps, piping		No local control system		Filter Polymer Upgrade Project scheduled for future for control system improvements
Filters	Filters settled water	6 filters w/ sand/anthracite media, cones, valves		Filter Media and Cones need to be replaced; Filter Basins need rehab for seismic and for structural cracks		Reliability Improvements and/or Advanced Treatment CIPs will impact filters - upgrades will be addressed at that time
Fire Protection	Fire protection	Fire pump and piping		No issues to note		None
Floc Poly (Non-Ionic)	Coagulant (floc aid)	2 storage tanks, pumps, piping		No issues to note		None
HVAC	Cools/heats building and equipment	Boiler, chiller, circulation pumps		HVAC system is in poor condition and in need of major overhaul (contract/maint work)		None
Main Pumps	Pumps finished water to treated water reservoirs	More Avenue pump station, 2 booster pumps, valves		Several valves leak	Valves replaced in 2011	
OCL	Disinfection	3 storage tanks, pumps, piping		Routine contract work needed - clean & inspect tanks, etc.		TW Small Caps will improve OCL tanks
Plant Air	Provides air for plant processes	3 air compressors, motors		Some corroded piping		None
Plant Water	Provides water for plant processes	3 plant water pumps, piping	System Rehab in 2000s	No issues to note		None
Potassium Permanganate	Pre-oxidant	Skid, building, pumps, analyzer	TWIP I	No issues to note		None
Sludge	Receives sludge from clarifiers and washwater recovery ponds for drying prior to belt press process	8 sludge drying beds, 2 lower ponds, pumps		Poor condition		Residuals Management CIP will upgrade or rehab entire system

Washwater Recovery	Settles used washwater from plant filter backwashes, sent back to plant inflow, sludge to drying beds	2 ponds, pumps		Poor condition		Residuals Management CIP will upgrade or rehab entire system
Zinc/Phosphoric Acid	Corrosion inhibitor	2 storage tanks, pumps, piping		Poor condition		Chemical System Upgrade Project will upgrade storage and metering

Notes: *FERC Regulated Dam

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SOUTH COUNTY REGIONAL WASTEWATER AUTHORITY (SCRWA)

System: South County Regional Wastewater Authority (SCRWA)

Overview: Treats waste water and delivers recycled water for agricultural irrigation. The distribution system is owned by the District and operated and maintained by CH2MHill OMI. The WWTP is owned by joint powers authority (Morgan Hill & Gilroy). South County Recycled Water Master Plan (SCRWMP, 2004) detailed future improvements for the SCRWA system.

Year Constructed: 1978

Facility	Description	Current Condition	Reliability Improvements Since 2005	Planned Future Upgrades
Wastewater Treatment Plant	Capacity of 7.5 MGD, 6 MGD for tertiary treatment; tertiary effluent suitable for landscape and agricultural irrigation	No Issues		
On-site Pump Station	Located at WWTP, three 125 hp pumps, 3,475 gpm or 5 MGD design capacity. Recently added 3 MGD capacity as part of SCRWMP	No Issues		SCRWMP Short Term - expand pump capacity by 6 MGD to a total of 14 MGD
On-site Reservoir	3 MGD; added as part of SCRWMP	No Issues		SCRWMP Short Term - add a second 3 MGD on-site reservoir
Booster Pump Station	Located west of Christmas Hill park, three pumps, 3,100 gpm or 4.5 MGD design capacity	No Issues		SCRWMP Long Term - expand pump capacity by 2 MGD
Storage Tank	1.5 MGD	No Issues		

Notes: Pipeline information is included in 'pipeline summary'; SCRWMP plans to add 10 miles of pipeline

Dam, Reservoir	System	Purpose	Dam Construction	Current Reservoir Capacity (AF)	Spillway Elevation (ft)	Associated Water Right Licensed Amount & Resource	Past Major Upgrades	Reliability Improvements Since 2005	Expected Future Upgrades	Condition Issues not included in Dam Assessment Report	Year Complete	2040 Age
Almaden	Guadalupe River Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Feeds Alamitos Creek.	105 ft. high compacted earth; 250,000 cubic yards of material	1,586	608.7	2,500 AF Surface Storage & Recharge; Almaden Creek	2007 Dam Instrumentation Project added instrumentation		Modify or construct new intake structure; modigy outlet dissipation structure, piping and valves.	DSOD storage restriction to 6.1 ft. below spillway crest (326 AF loss)	1935	105
Anderson	Upper Coyote Creek Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Also stores water to supply the water treatment plants. Feeds the Anderson Force Main, Main Avenue Pipeline, or Coyote Creek.	240 ft. high compacted earth and rock; 3,320,000 cubic yards of material	90,373	625	1. 20,180 AF Surface Storage; Coyote Creek 2. 71,100 AF Surface Storage; Coyote Creek	1987-88 reconstruction increased the spillway capacity, restored dam to original height, upgraded outlet works; 2007 Dam Instrumentation Project added instrumentation		Improve seismic stability of dam; restore lost capacity due to operation restrictions.	DSOD storage restriction to 20.5 ft. below spillway crest (23,546 AF loss)	1950	90
Calero	Guadalupe River Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Also stores water to supply the water treatment plants. Feeds the Almaden Valley Pipeline or Calero Creek.	98 ft. high compacted earth; 550,000 cubic yards of material	9,934	483.5	1. 3,500 AF Surface Storage Recharge; Calero Creek 2. 6,000 AF Transfer Water from Almaden; Almaden Creek	2007 Dam Instrumentation Project added instrumentation		Improve seismic stability of dam; possible outlet modification.	DSOD storage restriction to 2 ft. below spillway crest for dam (688 AF loss); 5.9 ft. below spillway crest for dike (1949 AF loss)	1935	105
Chesbro	Lower Llagas Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Feeds Llagas Creek.	95 ft. high compacted earth; 467,000 cubic yards of material	7,945	525	1. 7,500 AF Percolation; Llagas Creek 2. 7,200 AF Percolation; Llagas Creek					1955	85
Coyote	Upper Coyote Creek Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Feeds into Anderson Reservoir.	120 ft. high compacted earth and rock-filled; 1,060,000 cubic yards of material	23,244	777.2	24,560 AF Surface Storage; Coyote Creek				DSOD storage restriction to 19.2 ft. below spillway crest (10,862 AF loss)	1936	104
Guadalupe	Guadalupe River Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Feeds Guadalupe Creek.	129 ft. high compacted earth; 520,000 cubic yards of material	3,415	617.3	3,500 AF Surface Storage; Guadalupe Creek	2007 Dam Instrumentation Project added instrumentation		Improve seismic stability of dam; possible outlet modification.	DSOD storage restriction to 7.5 ft. below spillway crest (512 AF loss) from 4/1 to 2/15, and to 9.8 ft. below spillway crest (677 AF loss) from 2/16 to 3/31	1935	105
Lenihan, Lexington	Los Gatos Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Feeds Los Gatos Creek.	195 ft. high compacted earth; 2,124,000 cubic yards of material	19,044	649.9	30,000 AF Surface Storage; Los Gatos Creek	Spillway capacity increased and original dam height restored in 1997. Outlet works rehabilitated in 2010.	Improved seismic stability to dam; outlet modifications; inlet structure modifications; tunnel built to house outlet pipe		Outlet tunnel has known leakage that may require monitoring or repair	1952	88
Stevens Creek	West Side and Stevens Creek Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Feeds Stevens Creek.	120 ft. high compacted earth; 530,000 cubic yards of material	3,138	535	4,000 AF Surface Storage Recharge; Stevens Creek	Dam raised 10 ft. in 1985, added 231,000 cubic yards of material. Included seismic retrofits.		Reduce deformation and cracking after Maximum Creditble Earthquake; reduce potential failure of dam at toe from piping and uplifting.		1935	105
Uvas	Lower Llagas Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Feeds Uvas Creek.	118 ft. high compacted earth; 377,000 cubic yards of material	9,835	487.5	10,000 AF Surface Storage, 14,400 AF Underground Storage; Uvas Creek					1957	83
Vasona	Los Gatos Water Supply and Recharge	Stores water for recharge and environmental flows in the system. Feeds Los Gatos Creek.	30 ft. high composite unit with concrete slab and buttress center and two side sections of compacted earth that contain 70,000 cubic yards of material	495	294.83	1,684 AF Surface Storage; Los Gatos Creek	New gates installed in 1997				1935	105

NOTES:
Dam condition information and expected major projects were summarized in 'Dam Assessment Team Final Memo' in Appendix D
See page 2 for detailed dam system components. The Dam Assessment Team Final Memo discusses some of these components.
Other Regulated Dams: Rinconada Treated Water Reservoir - included in RWTP information, Coyote Percolation Dam - included in Diversion Dam information

ALMADEN DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - SIGNS
- *SPILLWAY*
  - SPILLWAY STRUCTURE
  - ENERGY DISSIPATOR STILLING POND
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SYSTEM
    - VALVE CONTROL STRUCTURE
    - HYDRAULIC VALVE OPERATING SYSTEM
    - HYDRAULIC LINES
    - INLET STRUCTURE
    - INLET TRASH RACK
    - INLET SLUICE GATE VALVE
  - OUTLET PIPE
  - DOWNSTREAM VALVE SYSTEM
    - OUTLET STRUCTURE
    - OUTLET BUTTERFLY VALVE
    - OUTLET BUTTERFLY VALVE ACTUATOR
    - ALMADEN/CALERO CANAL VALVE
  - ELECTRICAL SYSTEM
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - INCLINOMETERS
  - SURVEY MONUMENTS
  - SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE
  - RESERVOIR LEVEL GUAGE STRUCTURE

ANDERSON DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - SIGNS
- *SPILLWAY*
  - CONCRETE SPILLWAY STRUCTURE
  - ENERGY DISSIPATOR
  - SPILLWAY STRUCTURE
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SYSTEM
    - VALVE CONTROL STRUCTURE
    - ELECTRICAL VALVE OPERATING SYSTEM
    - GASOLINE POWER VALVE OPERATING SYSTEM
    - HYDRAULIC VALVE OPERATING SYSTEM
    - NITROGEN CYLINDER SYSTEM
    - HYDRAULIC LINES
    - AIR VENT SYSTEM
    - UTILITY TRENCH
    - INLET STRUCTURE
    - INLET TRASH RACK #1 (LOWER)
    - INLET TRASH RACK #2 (MIDDLE)
    - INLET TRASH RACK #3 (UPPER)
    - INLET SLUICE GATE VALVE #1 (LOWER)
    - INLET SLUICE GATE VALVE #2 (MIDDLE)
    - INLET SLUICE GATE VALVE #3 (UPPER)
  - OUTLET PIPE
  - OUTLET CHANNEL
  - DOWNSTREAM VALVE SYSTEM
    - OUTLET STRUCTURE
    - OUTLET ENERGY DISSIPATOR
    - OUTLET 42" BUTTERFLY VALVE
    - OUTLET 42" BUTTERFLY VALVE ACUTATOR
  - ELECTRICAL SYSTEM
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - INCLINOMETERS
  - SURVEY MONUMENTS
  - SPILLWAY SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE
  - RESERVOIR LEVEL GUAGE REFERENCE POINTS

CALERO DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - SIGNS
- *CALERO DAM AUXILARY STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - SIGNS
- *SPILLWAY*
  - SPILLWAY STRUCTURE
  - ENERGY DISSIPATOR STILLING POND
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SYSTEM
    - VALVE CONTROL STRUCTURE
    - HYDRAULIC VALVE OPERATING SYSTI
    - HYDRAULIC LINES
    - VALVE INLET STRUCTURE
    - INLET SLUICE GATE VALVE
    - INLET TRASH RACK
  - OUTLET PIPE
  - DOWNSTREAM VALVE SYSTEM
    - OUTLET STRUCTURE
    - OUTLET VALVE - 30" BUTTERFLY VAL
    - OUTLET 30" BUTTERFLY VALVE ACUT
  - ELECTRICAL SYSTEM
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - AUXILARY STRUCTURE PIEZOMETERS
  - INCLINOMETERS
  - AUXILARY STRUCTURE SURVEY MONUMENTS
  - SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE
  - RESERVOIR LEVEL GUAGE STRUCTURE
- *SIPHON SYSTEM*
  - SIPHON SYSTEM INTAKE PIPES
  - SIPHON SYSTEM VACUUM PUMP
  - SIPHON SYSTEM OUTLET PIPES

COYOTE DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - SIGNS
- *SPILLWAY*
  - SPILLWAY STRUCTURE
  - PLUNGE POOL
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SYSTEM
    - INLET STRUCTURE
    - 42" INLET SLUICE GATE TRASH RACK
    - 60" INLET SLUICE GATE TRASH RACK
    - 42" INLET SLUICE GATE VALVE
    - 60" INLET SLUICE GATE VALVE
    - 12" INLET PIPE
    - 48" INLET PIPE
    - OUTLET 6" BALL VALVE
    - OUTLET 48" FIXED CONE VALVE
    - FLOWMETER 12" LINE
    - FLOWMETER 48" LINE
    - OUTLET TUNNEL FACILITY STRUCTURE
    - FACILITY CONTROL STRUCTURE
    - CONTROL SYSTEM LINES
    - INLET ELECTRICAL SYSTEM
    - OUTLET GENERATOR
    - HYDRAULIC VALVE OPERATING SYSTEM
    - HYDRAULIC LINES
    - SOLAR SYSTEM
    - OUTLET AIR BLOWER SYSTEM
    - 24" VENTILATION LINE
    - VENT FAN
  - DOWNSTREAM VALVE SYSTEM
    - CONCRETE OUTLET CHANNEL
    - OUTLET SECURITY GRILL
    - OUTLET PLUNGE POOL
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - INCLINOMETERS
  - SURVEY MONUMENTS
  - SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE

GUADALUPE DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - UPSTREAM FACE BERM
  - DOWNSTREAM FACE
  - CREST WALL
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - DAM SIGNS
- *SPILLWAY*
  - SPILLWAY STRUCTURE
  - ENERGY DISSIPATOR STILLING POND
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SYSTEM
    - VALVE CONTROL STRUCTURE
    - HYDRUALIC VALVE OPERATING SYSTEM
    - SLUICE GATE VALVE
    - HYDRAULIC LINES
    - INLET TRASH RACK
  - OUTLET PIPE
  - DOWNSTREAM VALVE SYSTEM
    - OUTLET STRUCTURE
    - OUTLET BUTTERFLY VALVE
    - OUTLET ENERGY DISSIPATOR
    - OUTLET BUTTERFLY VALVE ACTUATOR
  - ELECTRICAL SYSTEM
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - INCLINOMETERS
  - SURVEY MONUMENTS
  - SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE
  - RESERVOIR LEVEL GUAGE STRUCTURE

STEVENS CREEK DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - SIGNS
- *SPILLWAY*
  - SPILLWAY STRUCTURE
  - ENERGY DISSIPATOR STILLING POND
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SYSTEM
    - INLET STRUCTURE
    - INLET SLUICE GATE #1
    - INLET SLUICE GATE #2
    - HYDRAULIC VALVE OPERATING SYSTEM
    - HYDRAULIC LINES
    - INLET TRASH RACK #1
    - INLET TRASH RACK #2
  - 50" OUTLET PIPE
  - DOWNSTREAM VALVE SYSTEM
    - VALVE OULET STRUCTURE
    - OUTLET BUTTERFLY VALVE #1
    - OUTLET BUTTERFLY VALVE ACTUATOR #1
    - OUTLET BUTTERFLY VALVE #2
    - OUTLET BUTTERFLY VALVE ACTUATOR #2
    - OUTLET ENERGY DISSIPATOR
  - ELECTRICAL SYSTEM
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - INCLINOMETERS
  - SURVEY MONUMENTS
  - SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE
  - RESERVOIR LEVEL GUAGE STRUCTURE

VASONA DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - DAM SIGNS
- *SPILLWAY*
  - SPILLWAY STRUCTURE
  - CATWALK STRUCTURE
- *UPSTREAM RADIAL GATE SYSTEM*
  - GATE #1 (EAST)
  - GATE #2 (WEST)
  - FLASHBOARD PANEL #1 (UPPER SECTION)
  - FLASHBOARD PANEL #2 (LOWER SECTION)
  - CONTROLS
  - CONTROLS PLATFORM
  - LUBRICATION SYSTEM
- *42" SLUICE GATE OUTLET VALVE SYSTEM*
  - VALVE CONTROL STRUCTURE
  - TRASH RACK
  - 42" SLUICE GATE VALVE
  - OUTLET PIPE
  - 42" SLUICE GATE VALVE ACTUATOR
- *VASONA CANAL VALVE SYSTEM*
  - SLUICE GATE TRASH RACK
  - SLUICE GATE VALVE
  - SLUICE GATE OUTLET PIPE
- *ELECTRICAL SYSTEM*
- *DAM SCADA*
- *INSTRUMENTATION*
  - PIEZOMETERS
  - SURVEY MONUMENTS
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE

UVAS DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - SIGNS
- *SPILLWAY*
  - SPILLWAY STRUCTURE
  - ENERGY DISSIPATOR STILLING POND
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SYSTEM
    - INLET VALVE CONTROL STRUCTURE
    - INLET SLUICE GATE VALVE
    - INLET TRASH RACK
    - HYDRUALIC VALVE OPERATING SYSTEM
    - HYDRAULIC LINES
  - OUTLET PIPE
  - DOWNSTREAM VALVE SYSTEM
    - OUTLET VALVE STRUCTURE
    - OUTLET BUTTERFLY VALVE
    - OUTLET BUTTERFLY VALVE ACTUATOR
    - OUTLET ENERGY DISSIPATOR
  - ELECTRICAL SYSTEM
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - INCLINOMETERS
  - SURVEY MONUMENTS
  - SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE
  - RESERVOIR LEVEL GUAGE STRUCTURE

CHESBRO DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - SIGNS
- *SPILLWAY*
  - SPILLWAY STRUCTURE
  - ENERGY DISSIPATOR STILLING POND
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SYSTEM
    - VALVE CONTROL STRUCTURE
    - SLUICE GATE VALVE #1
    - SLUICE GATE VALVE #2
    - INLET TRASH RACK #1
    - INLET TRASH RACK #2
    - HYDRAULIC VALVE OPERATING SYSTEM
    - UPSTREAM HYDRAULIC LINES
  - OUTLET PIPE
  - DOWNSTREAM VALVE SYSTEM
    - OUTLET VALVE STRUCTURE
    - BUTTERFLY VALVE
    - OUTLET BUTTERFLY VALVE ACTUATOR
    - OUTLET ENERGY DISSIPATOR
  - ELECTRICAL SYSTEM
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - INCLINOMETERS
  - SURVEY MONUMENTS
  - SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE
  - RESERVOIR LEVEL GUAGE STRUCTURE

LENIHAN DAM & RESERVOIR
- *DAM STRUCTURE*
  - UPSTREAM FACE
  - DOWNSTREAM FACE
  - ACCESS ROADS
  - FENCES AND GATES
  - LOG BOOM
  - SIGNS
  - BIKE PATH
  - DRAINAGE SYSTEMS
- *SPILLWAY*
  - SPILLWAY STRUCTUR
  - CLIFF FACE
  - ENERGY DISSIPATOR
- *OUTLET SYSTEM*
  - UPSTREAM VALVE SY
    - INTAKE STRUC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - INTAKE SLUIC
    - 54" to 8" BY-P
    - INTAKE STRUCTURE TRASH RACK #1
    - INTAKE STRUCTURE TRASH RACK #2
    - INTAKE STRUCTURE TRASH RACK #3
    - INTAKE STRUCTURE TRASH RACK #4
    - INTAKE STRUCTURE TRASH RACK #5
    - CONTROL STRUCTURE
    - BACKUP GENERATOR
    - PORTABLE POWER PACK
    - UTILITY TRENCH
    - HYDRAULIC VALVE OPERATING SYSTEM
    - HYDRAULIC LINES

LENIHAN DAM & RESERVOIR
- *OUTLET SYSTEM, CONTINUED*
  - TUNNEL SYSTEM
    - TUNNEL VENTILATION SYSTEM
    - 54" OUTLET PIPE
    - 8" OUTLET PIPE
  - DOWNSTREAM VALVE SYSTEM
    - OUTLET STRUCTURE
    - 36" FIXED CONE VALVE #1 (HIGHEST)
    - 36" GUARD VALVE #1
    - 36" FIXED CONE VALVE #2 (LOWEST)
    - 36" GUARD VALVE #2
    - 16" FIXED CONE VALVE
    - 16" GUARD VALVE
    - 8" GUARD VALVE
    - 6" FIXED CONE VALVE
    - DOWNSTREAM OUTLET ENERGY DISSIPATOR
  - ELECTRICAL SYSTEM
  - SCADA
- *INSTRUMENTATION*
  - PIEZOMETERS
  - INCLINOMETERS
  - SURVEY MONUMENTS
  - SEEPAGE COLLECTION SYSTEM
  - TUNNEL SEEPAGE COLLECTION SYSTEM
  - AUTOMATED DATA AQUISTION SYSTEM ADAS
  - ADAS SEISMOGRAPH
  - RESERVOIR LEVEL GUAGE
  - RESERVOIR LEVEL GUAGE STRUCTURE

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SANTA TERESA WATER TREATMENT PLANT

Plant Overview: STWTP treats water from the San Felipe Division, Anderson Reservoir, or Calero Reservoir. The treated water is delivered to water retailers on the east side of Santa Clara County via the Snell and East Pipelines.
System: East Treated Water
Process: Dual train flow-through flocculation/sedimentation, ozone disinfection, and multi-media filtration. See plant flow diagram for additional process information.
Capacity: 100 MGD
Year Constructed: 1989

System	Purpose	Major Components	Date Constructed, Added, or Rehabbed	Current Condition	Reliability Improvements Since 2005	Planned Future Upgrades
Air Wash	Circulates air to filters for backwash	2 blowers, valves (to each filter), actuators		Blowers are old, but reliable		
Alum	Coagulant	3 storage tanks, pumps, piping	TWIP I	Some tank issues	Tanks rehabbed	
Ammonia	Disinfection, helps maintain residual	1 storage tank, pumps, piping	TWIP I	Some tank issues	Tanks rehabbed	
Backwash	Pumps water back through filters for cleaning	2 backwash pumps, valves (to each filter), actuators		Pumps are old, but have been re-built. VFDs could be added in future.		
Buildings and Grounds	Facilities required for housing plant employees	Operations building, surface roads, security gates		Security gates are becoming obsolete, could be part of water protection project. Operations building roof leaks.	Re-routed and separated east and west chemical feed piping system to application points. Single walled piping replaced with double walled piping. Improvements to security.	
Carbon	Can improve taste and odor	2 tanks, building, dust collection, pumps, mixers	TWIP I	Good, but system is obsolete. Storage of un-used chemical on-site is an issue. Space could be used for other future plant improvements.		
Cat Poly	Coagulant	1 storage tank, 2 batch tanks, pumps, piping	TWIP I added mixers	Some tank issues		
Caustic	Balances pH (raises) if water is acidic	1 storage tank, pumps, piping		Some tank and operability issues	Heating added to tank and piping; tank rehabbed	
Clearwell	Stores treated water prior to distribution	2 Clearwells, sluice gates		Condition is unknown. Eventually will need re-coating and inspection. Valves are not exercised.		
Filters	Filters settled water	6 east filters, 6 west filters, filter media, filter cones, valves	2005 – Filter Media Replaced	GAC media is not used for absorption due to short life. Media has approx. 10 year life, but filters are loosing approx. 1" of media per year. Filter valve rehab and re-coating should be included with this work if possible.		Need to submit filter media replacement project (from AMP) to CIP by July 2013 to be done by 2015.
Fire Protection	Fire protection	Sprinkler, alarms		Good		
HVAC	Cools/heats buildings and equipment	Boiler, chiller, exhaust fans, air handling units		Unknown		
Hydrogen Peroxide	Can improve taste and odor	1 storage tank, pumps, piping	2006	New, not used		
Liquid Oxygen	Feeds ozone generation system	2 storage tanks, pressure regulating valves, vaporizers	2006	New		
Non-Ionic Polymer	Coagulant	Day tank, mixer, pumps, piping		Good		
OCL	Disinfection	3 storage tanks, pumps, piping	Toxic Gas Ord Project	Tanks require frequent maintenance		
Ozone Cooling	Cooling system (water) for ozone generation equipment	Valves, piping	2006	System is new, but runs off plant water system, which is in poor condition		
Ozone Destruction	Destructs ozone that was not dissolved into water	4 ozone destructors (2 east, 2 west)	2006	Blowers are unreliable and require frequent maintenance		
Ozone Generation & Contactors	Generates ozone	Ozone generation building, 3 ozone generators, PSUs, east and west ozone contactor buildings, contactor basins, diffusers, monitors, analyzers	2006	Not currently doing any maintenance on facility		Ozone Generation equipment requires replacement in 2019
Ozone Quenching	Limits bromate production by quenching dissolved ozone once ct has been met (calcium thiosulfate)	2 storage tanks, pumps, piping	2006	New, not used		
Phosphoric Acid	Corrosion inhibitor	1 storage tank, pumps, piping		Some tank issues	Tank rehabbed	
Plant Air	Provides air to plant processes	2 compressors, piping		Good		

Plant Water	Provides water to plant processes	Hydro tank, pumps, piping		System is critical to plant operations and has operability issues. Pumps and piping have been rehabbed, but system has operating problems. Unknown if hydro tank or VFD controls are needed.		
Potassium Permanganate	Pre-oxidant	Building, skid, 2 dissolver tanks, pumps, piping		Good, but has not been used in 5 years. Storage of un-used chemical on-site is an issue. Space could be used for other future plant improvements.		
Raw Water	Chemicals added at head of plant are mixed prior to sedimentation to form flocs	Static mixer, vault, chemical diffusers, valves		Unknown if inlet valve is operational and condition is unknown.		
Sedimentation Basins	Forms large flocs and settles the flocs out of water	4 flocculation basins (2 east, 2 west), 4 sedimentation basins (2 east, 2 west), mixers (chain & flight/rakes part of sludge system)		Eventually will need re-coating.		Re-coating & valve replacement near 2020
Sludge	Receives sludge from sed basins for drying	Sedimentation basin rake assemblies, pumps, valves, actuators		Cleaning beds is large maintenance project.		
Spare Chemical	Spare feed system for additional chemical	Mixing tank, mixer, pumps, piping		N/A	Unused piping was removed from system	
Sulfuric Acid	Limits bromate production by reducing pH of water entering ozone facilities	1 storage tank, spill tank, pumps, piping,	2006	New, not used		
Sump pumps	Sump pumps to sanitary sewer drains for most systems	Sump and underdrain pumps		Filter gallery sumps drain into creek and could cause regulated discharge problem. Could plumb these into filter to waste pipe to avoid discharge problems.		
Supplemental Nitrogen	Adds nitrogen to oxygen feed to increase ozone generation efficiency	2 compressors, piping	2006	System is unreliable and causes frequent maintenance		
Washwater Clarification	Receives water from washwater recovery ponds, further clarifies the waste water, and sends it back to the head of the plant	Mixers, pumps, structure, wet well	2006	New, no issues		
Washwater Recovery	Receives used washwater from filter backwashes and sludge drying beds, water is settled then sent to washwater clarification	2 ponds (1 east, 1 west), pumps, valves		Old, but pumps have been re-built. No issues.		

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WELLS

Facility	Purpose	Description	Current Condition	Reliability Improvements Since	Planned Future Projects
Campbell Well Field	Water production well that provides water to the West Pipeline	3 wells, pumping range per well is 350 gpm in summer/fall to 1250 gpm in winter/spring or 0.5 to 1.8 MGD. (1.5 to	Power has been supplied and well scheduled to be online June 2014.		
San Tomas Injection Well	Injects treated water from RWTP via the West Pipeline and Campbell Distributary into the groundwater basin for recharge	1 injection well, design capacity of 410 - 470 gpm; 570 ft. deep	New, constructed in 1999		
Groundwater Monitoring Wells	Monitor groundwater levels and quality in Santa Clara County	Groundwater Level: 227 wells are monitored; Approx 130 are owned by the District; 77 on District land. 136 wells in Santa Clara Valley Subbasin, 17 wells in Coyote Subbasin, 72 wells in Llagas Subbasin. 13 are monitored bi-weekly for groundwater level, another 165 are used for groundwater modeling. Quality: a	Some older wells have accumulated silt. Staff is reviewing the monitoring network to ensure it meets our needs.		Probable future project to rehabilitate the monitoring network: add some new wells & decommission some older wells. On-going maintenance work to de-silt wells
Land Subsidence Monitoring Wells	Monitor land subsidence in Santa Clara County	11 wells are used to model land subsidence (press model). 2 well sites (5 total wells) have compaction recorders.			

Notes:

See maps of monitoring network locations and frequencies on page 2

ISMP Water Resources Information System CIP: project to replace the WRIS database

IRP2 Well Fields project will construct well fields throughout the county to add reliability to the District's treated water distribution system

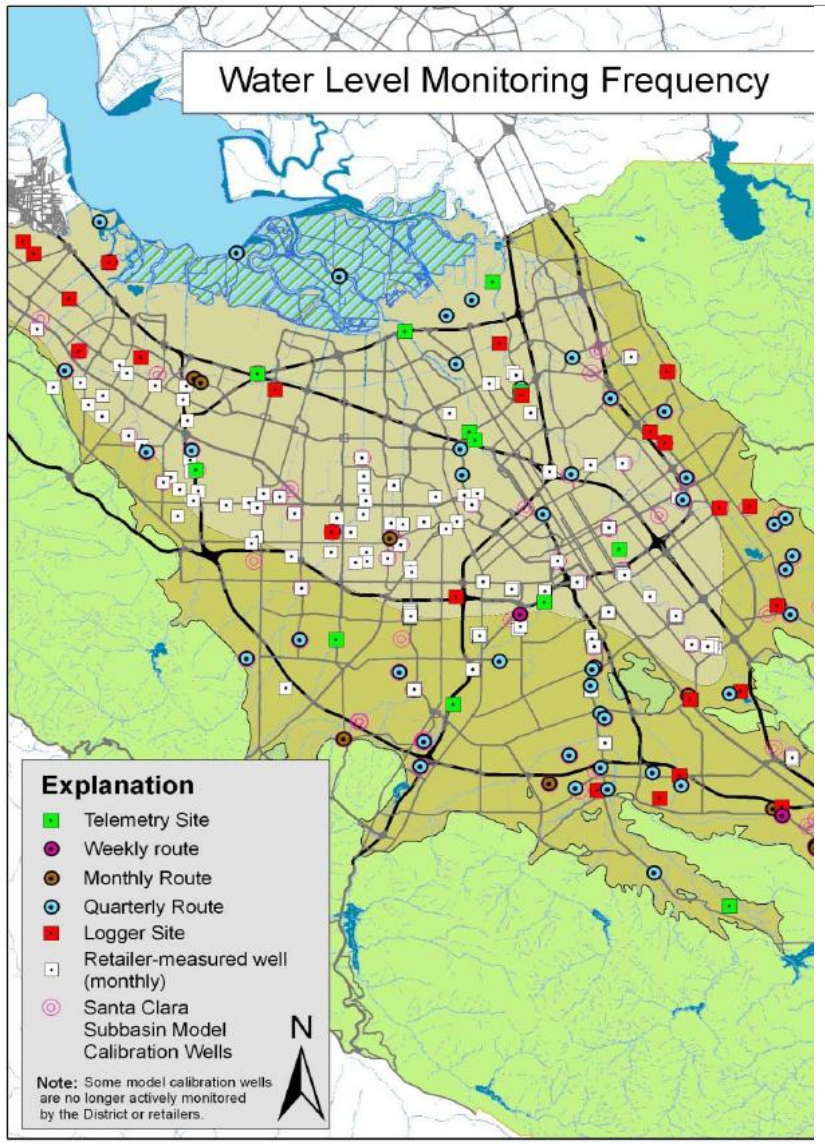


Figure 1a – Locations and Frequencies of District Water Level Monitoring in 2008: Santa Clara Groundwater Subbasin (logger and telemetry sites collect continuous data; weekly routes were changed to bi-monthly)

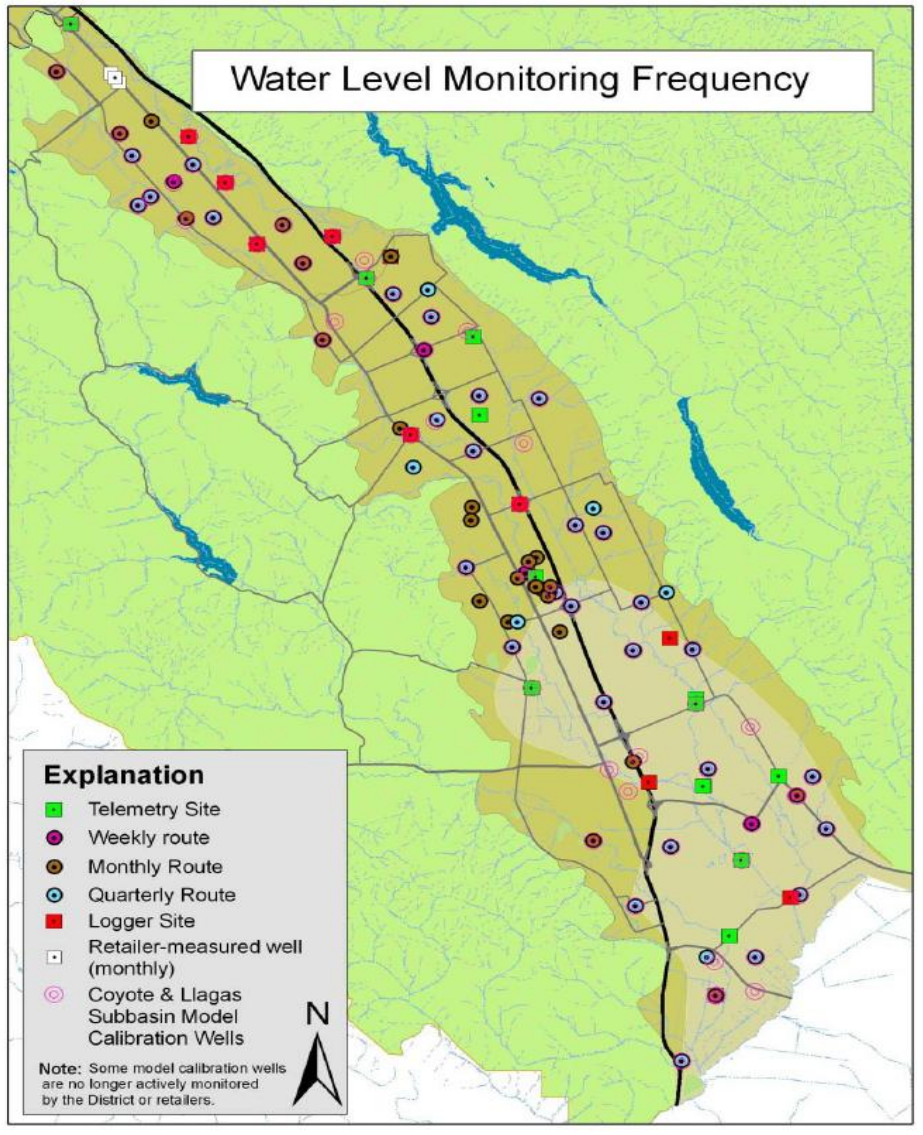


Figure 1b – Locations and Frequencies of District Water Level Monitoring in 2008: Coyo Llagas Groundwater Subbasins (logger and telemetry sites collect continuous data; in 2009, weekl were changed to bi-monthly)

Infrastructure System Appendix:

Critical Facility Matrix

Raw Water System 544
Treated Water System 545

SCVWD IRP Plan
Critical Facility Matrix - Raw Water

Item No.	Facility Name	Outages and Duration (Days)								Functions						
										RW from SBA - SWP/Delta (North)			RW from CVP/San Luis Res (South)			
		SA EQ Sc 1 - 50%	SA EQ Sc 2 - 90%	HAY EQ Sc 1 - 50%	HAY EQ Sc 2 - 90%	CAL EQ Sc 1 - 50%	CAL EQ Sc 2 - 90%	Flood	Regional Power Outage	Penitencia WTP	Rinconda WTP	Santa Teresa WTP (Not Typical)	Penitencia WTP (Not Typical)	Rinconda WTP	Santa Teresa WTP	To Recharge Facility
1	RW Control System	2	3	-	-	-	-	-	-	X	X	X	X	X	X	
2	Pacheco PS	-	-	-	-	-	-	-	7				X	X	X	
3	Pacheco Tunnel	-	-	-	-	-	-	-	-				X	X	X	
4	Pacheco Conduit	-	30	-	-	-	21	14	-				X	X	X	
5	Santa Clara Tunnel	-	-	-	-	-	-	-	-				X	X	X	
6	Santa Clara Conduit	21	30	-	-	-	21	21	-				X	X	X	X
7	Coyote PS	-	-	-	-	-	-	-	7				demand dependent	demand dependent	demand dependent	
8	Coyote Valve Yard	-	-	-	-	-	-	-	-				X	X	X	
9	Anderson Dam	-	-	-	-	>60	>60	-	-				X	X	X	
10	Anderson Force Main	-	-	-	-	-	7	14	-				X	X	X	
11	Cross Valley Pipeline	21	30	-	-	-	14	14	-				X	X	X	X
12	Calero Dam	>60	>60	-	-	-	-	-	-				supply dependent	supply dependent	supply dependent	
13	Calero Pipeline	-	-	-	-	-	-	-	-				X	X	X	
14	Calero Valve Yard	-	-	-	-	-	-	-	-				X	X	X	
15	Almaden Valley Pipeline - Calero to STWTP	14	21	-	-	-	-	14	-			X			X	X
16	Almaden Valley Pipeline - Vasona to STWTP	14	21	-	-	-	-	14	-			X	X	X		X
17	Vasona PS	-	3	-	-	-	-	14	7		demand dependent	X	X	demand dependent		X
18	Vasona Valve Yard	-	-	-	-	-	-	-	-		X	X	X	X		
19	Central Pipeline	21	21	-	14	-	-	14	-		X	X	X			X
20	South Bay Aqueduct	7	7	21	30	14	21	7	7	X	X	X				
21	Piedmont Valve Yard	-	-	-	-	-	-	-	-		X	X	X			
22	Penitencia Force Main	-	-	-	-	-	-	-	-	X			X			
23	Penitencia WTP	-	7	-	7	-	7	-	7	X			X			
24	Rinconada Force Main	-	14	-	-	-	-	-	-		X			X		
25	Rinconada WTP	0.5	30	-	-	-	-	-	-		X			X		
26	Stevens Creek Pipeline	-	-	-	-	-	-	-	-							X
27	Santa Teresa Force Main	-	-	-	-	-	-	-	-			X			X	
28	Santa Teresa WTP	-	0.5	-	-	-	-	-	-			X			X	
29	Almaden-Calero Canal	-	-	-	-	-	-	-	-							
30	Coyote Canal	-	-	-	-	-	-	-	-							X
31	Almaden Dam	-	-	-	-	-	-	-	-							

SCVWD IRP Plan
Critical Facility Matrix - Treated Water

Item No.	Facility Name	Outage Durations (Days)								Functions														
										TW from Penitencia WTP				TW from Santa Teresa WTP			TW from Rinconada WTP						
		SA EQ Sc 1 - 50%	SA EQ Sc 2 - 90%	HAY EQ Sc 1 - 50%	HAY EQ Sc 2 - 90%	CAL EQ Sc 1 - 50%	CAL EQ Sc 2 - 90%	Flood	Regional Power Outage	Milpitas	SJWC via Milpitas	SJWC via East PL	SJ Muni	Milpitas	SJWC	SJ Muni	Sunnyvale	Mt View	Cal Water via Mt View	Cal Water via Campbell	Santa Clara	SJWC	TW to/from SFPUC
1	TW Control System	-	-	-	3	-	3	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	
2	Rinconada WTP	0.5	30	-	-	-	-	-	-								X	X	X	X	X	X	
3	Rinconada Reservoir	-	-	-	-	-	-	-	-								X	X	X	X	X	X	
4	West Pipeline - RWTP to Cox Turnout	-	30	-	-	-	-	-	-								X	X	X	X	X	X	
5	West Pipeline - Cox TO DS	-	30	-	-	-	-	-	-								X	X	X			X	
6	Mountain View Distributary	-	-	-	-	-	-	-	-									X	X				
7	Sunnyvale Distributary	-	-	-	-	-	-	-	-								X						
8	Santa Clara Distributary	-	-	-	-	-	-	-	-											X	X	X	
9	Campbell Distributary	-	-	-	-	-	-	-	-											X		X	
10	Penitencia WTP	-	7	-	7	-	7	-	7	X	X	X	X										
11	Penitencia Delivery Main	-	-	-	-	-	-	-	-	X	X	X	X										
12	Piedmont Valve Yard	-	-	-	-	-	-	-	-	X	X			X									
13	Milpitas Pipeline	-	-	-	-	-	-	-	-	X	X			X									
14	Santa Teresa WTP	-	0.5	-	-	-	-	-	-					X	X	X							
15	Snell Pipeline	21	30	-	-	-	-	-	-					X	X	X							
16	East Pipeline	-	21	-	-	-	-	-	-			X	X	X	X	X							
17	Parallel East	-	21	-	-	-	-	-	-			X	X	X	X	X							
18	SFPUC Intertie Pipeline	-	-	-	-	-	-	-	-														X
19	SFPUC Intertie PS	-	-	-	-	-	-	?	?														X
20	Bay Division Pipelines 3 & 4	>60	>60	>60	>60	-	14	1	?														X

Infrastructure System Appendix:

System Overview Maps

Raw Water System 547
Treated Water System 548

CONFIDENTIAL

Infrastructure System Appendix:

System Schematic Maps

CONFIDENTIAL

Santa Clara Valley Water District

Infrastructure Reliability Plan

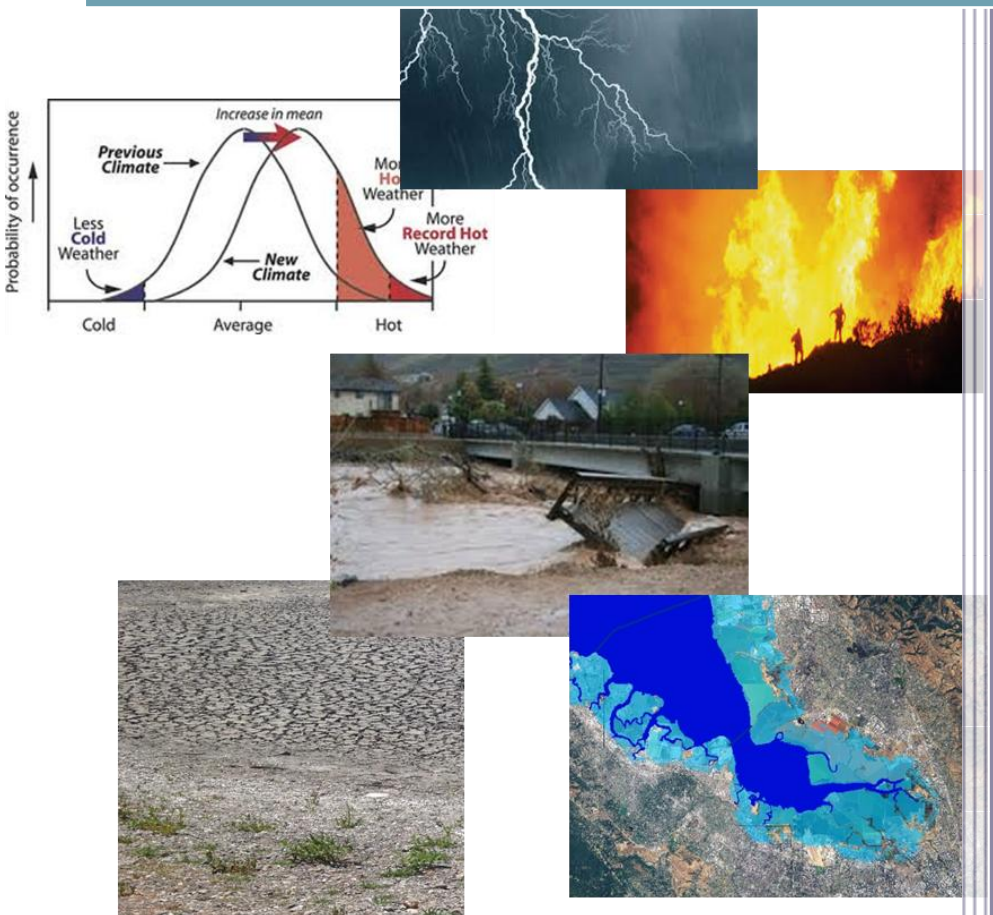
Climate Change Appendix

AECOM

Climate Change Appendix 551
Infrastructure Reliability Climate Change and Extreme Weather Risk Assessment 553
Silicon Valley Advanced Water Purification Center Hazard Impacts 609

2015

Infrastructure Reliability Climate Change and Extreme Weather Risk Assessment – Tech Memo



Cris Tulloch
Santa Clara Valley Water District
3/12/2015

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INTRODUCTION

This technical memorandum (TM) provides an overview of climate change and extreme weather and evaluates the vulnerability of climate change on the Santa Clara Valley Water District's water utility infrastructure. [It is not the purpose of this TM or the IRP to address the long-term impacts of climate change on water supply.] This analysis was conducted because previous disaster and risk analysis of the district's water utility infrastructure did not consider future climate change or extreme weather impacts; and, as with any agency or municipality, the district's infrastructure is at risk of damage or failure from many natural disasters or other catastrophic events.

This TM is Subtask 5.2 of the District's Infrastructure Reliability Plan (IRP) Project. The climate and weather vulnerabilities in this TM will be evaluated along with the other outage scenarios developed in other tasks of the IRP to determine impacts on potable water service. Subtasks 5.1 and 5.3 of the IRP identify and analyze the infrastructure outages and durations of those outages caused by a Hazard Event and for a Planned Maintenance Event, respectively.

Based on review of the most likely climate change and extreme weather scenarios for this region, the following weather events are evaluated:

- Sea Storm Surges
- Flooding (due to Extreme Precipitation)
- Drought/Drying or Expansive Soils
- Extreme Heat
- Extreme Cold spans
- Upland Non-Urban Wildfire
- High Wind

These weather events can be associated with climate change or extreme weather events. Some of the current potential extreme weather conditions are expected to increase in frequency or magnitude as the earth warms. Global warming is also expected to result in increased frequency and magnitude of some weather conditions. Extreme weather (severe storms, severe drought, etc) can occur anytime, but are not considered to be frequent or high probability events. This TM considers the effects of these extreme weather risks and climate change, regardless of the cause.

The first part of this TM provides climate change and extreme weather background information and describes some of the more likely impacts. Later in this TM, the impacts are evaluated against the Water Utility major asset classes in order to assess the relative vulnerability (exposure, sensitivity and adaptive capacity) to these threats. The first part of the analysis determined if there was an exposure route or exposure point to the asset. If so, the evaluation then included an assessment of the vulnerability, specifically the time to failure (sensitivity) and capacity of the asset failure to be avoided or mitigated (adaptive capacity).

SECTION 1: CLIMATE CHANGE AND EXTREME WEATHER: PROJECTIONS AND EFFECTS

Global Warming and Climate Change Overview

Global warming is caused by a phenomenon known as the Greenhouse Effect, which slowly warms the planet. The Greenhouse Effect is caused by an increase in the quantity of certain atmospheric gases, most notably carbon dioxide (CO_2), which reduces the ability of heat to escape from the atmosphere (much like the effect of a greenhouse that traps heat). This phenomenon appears to be an increasing problem since the industrial revolution, and is caused by everyday activities such as burning fossil fuels (e.g., oil, coal, natural gas), certain agricultural practices, and clearing forests. These activities have released large amounts of heat trapping greenhouse gases into the atmosphere in a short period of time. The earth's average temperature has risen by 1.4°F over the past century, and is projected to rise another 2°F to 11.5°F over the next hundred years. Small changes in the average temperature of the planet can translate to large shifts in climate and weather. This is what is referred to as **climate change**: significant changes in climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer[i].

The sometimes large variance in projected **climate change** effects are due to inputs from different GHG emission scenarios and which Global Climate Models (GCMs) are used. Figure 2 illustrates the effects of the two most prominent GHG emissions scenarios have on projected global temperatures. In this comparison, it is easy to see the difference in the GHG scenario have on the potential range of temperature increases. However, this study does not make any conclusions regarding the most likely GHG scenario or climate change outcome. Since it is not the purpose of this study to make a determination regarding the most probable or likely scenario, the entire range or magnitude of effects have been considered in the basis of the risk evaluation.

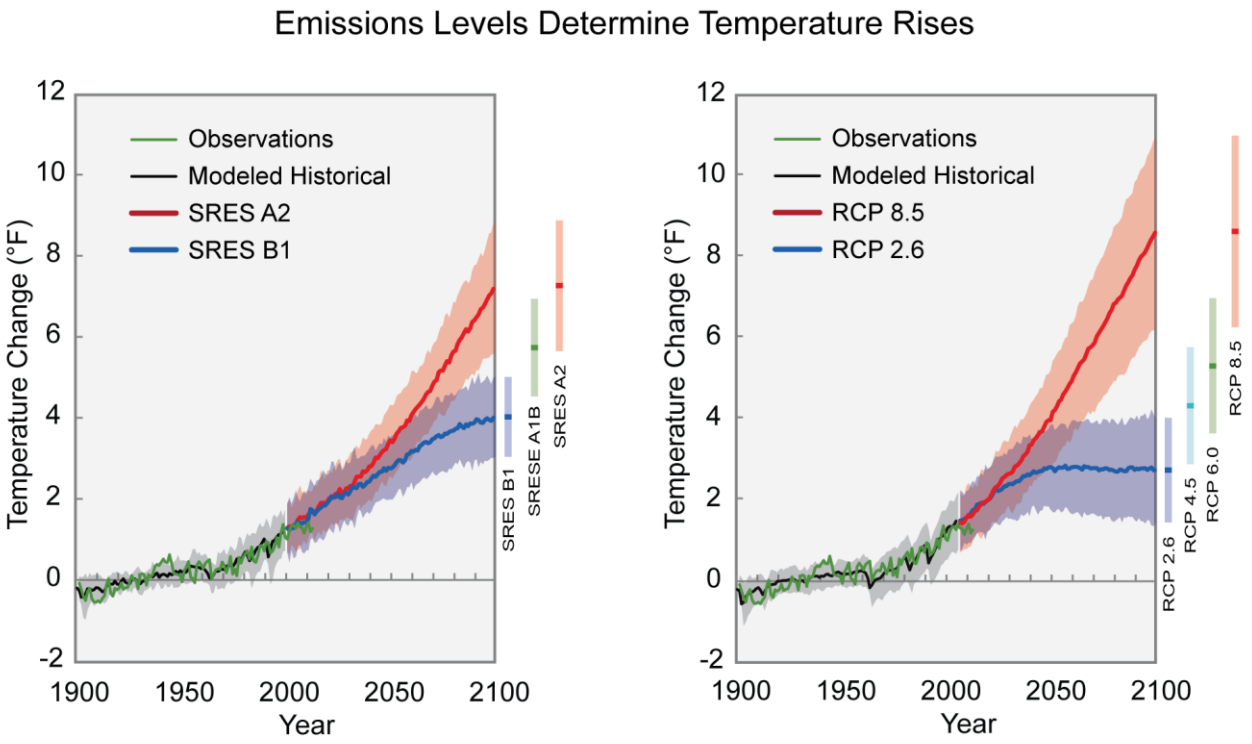


Figure 1 Emissions Scenarios[ii]

In Figure 2, each line represents a central estimate of global average temperature rise (relative to the 1901-1960 average) for a specific GHG emissions scenario. Shading indicates the range (5th to 95th percentile) of results from a suite of climate models. In all cases, temperatures are expected to rise, although the difference between lower and higher emissions pathways is substantial. The panel on the left illustrates the two main scenarios (SRES – Special Report on Emissions Scenarios; 2000). A2 assumes continued increases in emissions throughout this century, and B1 assumes much slower increases in emissions. The right panel shows a more recent analyses RCPs – Representative Concentration Pathways (IPCC 2013). The newest set includes both lower and higher pathways than did the previous set.

Climate Change Effects

This section provides a high level review of future climate projections of temperature, precipitation and sea level rise and related effects. This information was used to determine the potential for exposure to the assets from change.

Evidence of climate change is already being observed in California. In the last century, the California coast has seen almost eight inches of sea level rise. The average April 1 snow-pack in the Sierra Nevada region has decreased in the last half century. As a result of the changing climate, wildfires are becoming more frequent, longer, and more wide-spread[iii]. Historic precipitation data for California's central coast region shows a trend toward decreasing rainfall during the November to January period and a trend toward increasing rainfall during the February to April period. Temperature projections for the Bay Area show a shift in the timing of spring and summer heat extremes to begin earlier and extend later into September[iv], as well as an increase in the frequency and intensity of heat waves.

Locally, the study area is expected to see increasing temperatures. Increased temperatures could result in more extreme heat and drought events, and an increased wildfire risk (especially when combined with reduce precipitation). Future projections of precipitation are not as clear. However, there are some studies that indicate storms could become more intense and rainfall patterns could change, but not necessarily have a large impact on average annual rainfall amounts. More severe storms could result in increase flood risk and less precipitation and change in patterns could challenge local water supply operations. Sea level rise is also projected to continue to increase and this also increases flood potential. The future effects of climate change and extreme weather are discussed in more detail below.

Also evaluated are extreme weather events, which may occur outside of climate changes. Extreme weather events can be classified as such when thresholds or historic maximum values are exceeded during a specified time period or region. Extreme weather systems such as increased hurricane systems, Super Storm Sandy and other acute events have had significant and costly impacts to water utilities in recent years, and therefore, are being evaluated under the IRP.

Sea Level Rise

The frequency and duration of sea level extremes is expected to increase as sea level rises, with the potential to exceed coastal and San Francisco Bay-Delta flood defenses designed for historical conditions (Cayan et al., 2006a[v]). In addition, climate change increases the potential for more intense storms, further threatening coastal and floodplain areas.

Many models project sea level rise in the San Francisco Bay up to 55 inches by the end of the century, with the potential for even higher increases. Average trends in sea level rise projections do not take into account the exacerbating factors such as astronomical tides, changes in atmospheric pressure, wind stress, floods, or the El Niño/Southern Oscillation. The combined effects of these fluctuations with sea level rise can lead to extreme high water events. The evaluation conducted for the district's IRP evaluated published maps depicting the coastal base flood (existing extent of 100 year coastal flood), plus 55" sea level rise

scenario in 2100, even thought the study duration does not extend to the end of the century. According to a recent study[vi], there is a 1 in 6 chance that sea level could increase 4 feet by 2060, when the combination of sea level rise, storm surges and tide are taken into effect. Therefore, utilizing the year 2100 maps of 55" of sea level rise is appropriate even though the IRP study does not look out to 2100. Since increased storm surges are not specific to climate change, this risk event is also discussed in Section 3 Extreme Weather.

Precipitation

Many climate models suggest a drying tendency and a decline in the frequency of precipitation events, but not a clear change in the intensity of precipitation events. For instance, studies indicate the potential for an increase in the frequency of heavy precipitation events in Northern California, even if overall precipitation does not change (Cayan et al., 2006b). Also, empirical weather data is showing a shift in precipitation patterns.

However, future precipitation is complicated and difficult to project in this region. Review of recent literature and local modeling efforts does not indicate significant increases in future annual precipitation amounts. From a broad perspective, the overall projection is that dry areas become drier. On the other hand, much of the literature and climate models support the theory that with increased temperatures, storms may retain more moisture. Therefore, heavy downpour increases are expected in many areas in the continental US, even in southwest where total precipitation is projected to decrease. While the County's year to year rainfall amounts may not differ significantly from historic year to year changes, there is a potential for increased frequency, change in timing and increased magnitude of precipitation events. Unfortunately, that cannot be adequately projected.

Projected Precipitation Change by Season

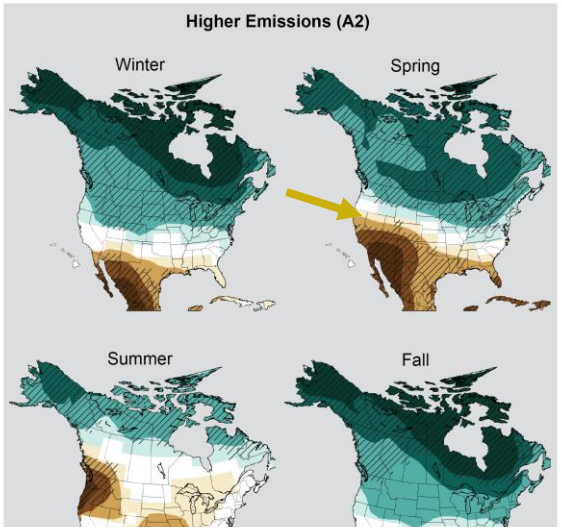


Figure 2.2 Projected Precipitation Change by Season

Figure 2.2 illustrates continental U.S. scale projected changes in precipitation by season, under a higher emissions scenario. The only observable projected change for this region is drier during the spring. Figure 2.3 shows the locally projected precipitation over time by season. Here, there appears to be some increase in the trend line in the winter scenario.

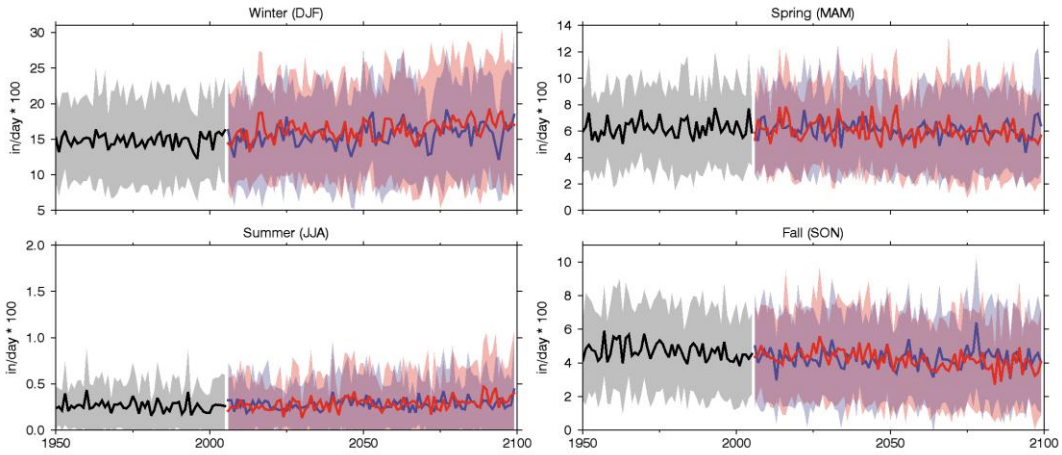


Figure 2.3: Figure 2.3 Season Rainfall Projections Overtime[viii] Seasonal average time series of precipitation for historical (black), RCP4.5 (blue) and RCP8.5 (red). The average of 30 CMIP5 models is indicated by the solid lines and their standard deviations are indicated by the respective shaded envelopes.

Local Temperature Projections

Statewide, the number of days per year above the "climatological" (1961 to 1990) 90th percentile temperature (meaning only 10 percent of daily temperatures exceed this level) is projected to increase from a current average of around six weeks per year to an average of 15 to 19 weeks per year under the higher emissions scenario, and to an average of 10 to 12 weeks per year under the lower emissions scenario (Dreschler et al., 2006). Additionally, the length of individual events is expected to increase (from a few days to as much as a few weeks). The amount by which this threshold is exceeded is expected to increase considerably, with significant implications for public health, fire risk, air quality, agricultural production, and natural ecosystems. Preliminary analysis of historic weather data for San Jose performed by District staff is showing similar trends; this analysis is continuing. Table 2 depicts the range of future average temperature increases projected for two areas in the County, under two different emissions scenarios. What is important to recognize is the considerable increase in temperatures under the higher emissions scenario. Maximum daily temperatures would exceed these values.

Table 2. Projected Temperature -viiviii

	San Jose Temp	San Jose Increase	Gilroy Temp	Gilroy Increase
Historical Average	61.2 °F		56.8 °F	
Low-Emissions Scenario:	64.5 °F	+3.3 °F	60.4 °F	+3.6 °F
High-Emissions Scenario:	66.9 °F	+5.7 °F	62.8 °F	+6.0 °F

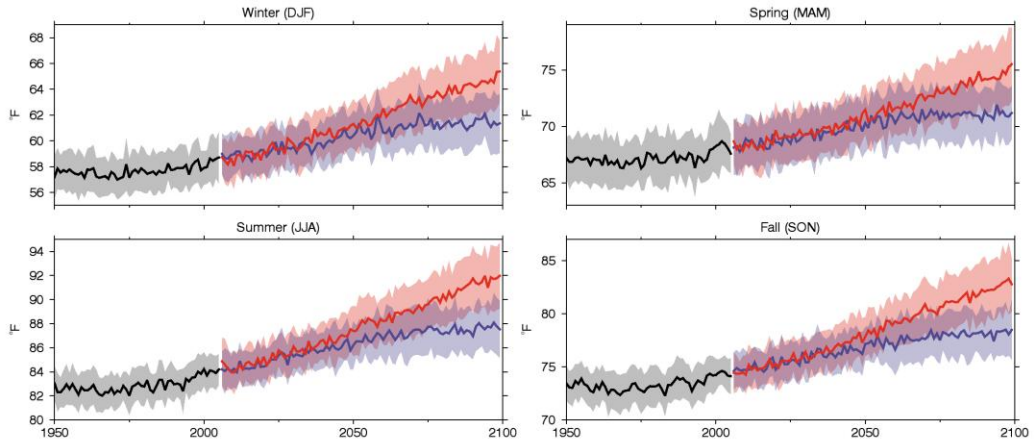


Figure 2.4 Maximum 2-m Air Temperature[ix] Seasonal average time series of maximum 2-m air temperature for historical (black), RCP4.5 (blue) and RCP8.5 (red). The historical period ends in 2005 and the future periods begin in 2006. The average of 30 CMIP5 models is indicated by the solid lines and their standard deviations are indicated by the respective shaded envelopes.
Figure 2.4 illustrates projections for maximum temperatures for each of the four seasons under the same two emissions scenarios. This is important because impacts from extreme heat need to be evaluated under the maximum temperature conditions, rather than averaged over a year.

Drought

Most climate models project that future dry years will include summer temperatures above and beyond the current warming trend. With increased temperatures, extreme temperature and heat waves, with little change in precipitation projections, droughts may increase. "Short-term (seasonal or shorter) droughts are expected to intensify in most U.S. regions. Longer-term droughts are expected to intensify in large areas of the Southwest..."[x] Droughts will increase in frequency and intensity according to another study. http://www.ldeo.columbia.edu/~bc9z/cook_pdsi_clidyn_REV_v01.pdf. Projected warming and increased evapotranspiration will cause droughts to become more severe. http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf

Increases in drought occurrence or magnitude may be caused by many climatic changes, such as: reduced or changed precipitation amounts and patterns. During extreme droughts, the deficit in soil moisture grows larger. http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf. Also, increased temperatures lead to greater evaporation of soil moisture, and in doing so increases the intensity and duration of drought. http://climatecommunication.org/wp-content/uploads/2011/09/Extreme-Weather-and-Climate-Change.pdf

Extreme Weather Effects

This section describes extreme weather events. Some of these events may be part of climate deviation unrelated to future climate changes due to global warming, and some may be exacerbated by climatic changes. However, since causation does not affect the risk of impact, it is not discussed here (although climate change causation could influence timing of events).

Climate change effects such as changes in average temperature, precipitation and sea level are likely to occur gradually. However, with extreme weather, the frequency and intensity of events such as heat waves, droughts and floods, can change substantially with even small average changes in global temperatures. Changes in extreme events are very likely to be some of the earliest impacts experienced from anthropogenic climate change. This implies that changes in extreme events are among the most immediate climate challenges to threaten infrastructure.

Not only may changes in climate alter the frequency and magnitude of individual extreme events, but these changes may also alter the likelihood of extreme climate events occurring concurrently. Vulnerability to, and impacts of, repeated and coincident extreme events are generally expected to be higher than similar events occurring individually (e.g., Hallegatte et al. 2007). However, it should be noted that extreme events will occur regardless of global warming influences.

Storm Surge and Extreme Storms with Sea Level Rise

Extreme weather events coinciding with sea level rise is a significant concern for the San Francisco (SF) Bay Area, much of which is below or barely above sea level, and is a highly urbanized metropolitan area. A major storm surge, coupled with high tides and future elevated sea levels, increases risks to communities, infrastructure systems and property. The vulnerable region in SF Bay Area scenario consists of ~140,000 homes, 800 miles of roadways, and $30 billion worth of assets, including the Port of Oakland, San Francisco International Airport, Caltrain, numerous world-class companies, and critical wastewater treatment facilities.[xi]

Coastal floods are larger and result in more damage today due to sea level rise that has already occurred. Climate Central concluded that a moderate future sea level rise projection results in a "better than even chances of historically unprecedented coastal flooding within the next 10 to 30 years throughout California, Oregon and Washington's Puget Sound. A fast scenario means near certainty in the same time frame".

Super Storm Sandy

In review of Super Storm Sandy, the most significant risks to the drinking water system associated with this kind of event, is the potential for runoff from heavy storm events affecting water quality in the surface water reservoirs; in particular, high pathogen levels, contaminants and high turbidity. This was the most significant climate change impact (major risk) identified for the 2050 scenario for the water supply system (in New York). The drinking water system was not significantly affected, and most localized impacts were repaired within hours. Most significant impacts were associated with the wastewater system. 42 of 96 pump stations (37 located within the 100 year flood plain) were damaged in NY due to Sandy. Half the impacts were due to power lost, the other to storm surge inundation. Repair due to inundation was not limited just to removing flood water, but also repairing damage associated with corrosive impact of the seawater.[xii] Fortunately, very little district water utility infrastructure is threatened by Sea Level Rise. However, the imported water infrastructure in and around the SF Bay Delta, which we are dependent on, is threatened.

Extreme Precipitation, Atmospheric Rivers and Flood

Atmospheric Rivers

This study area and much of the Southwestern U.S. is within reach of an important class of Pacific storms that are often referred to as "atmospheric rivers" (ARs). Atmospheric Rivers (AR) are storms carrying large amounts of water vapor over the Pacific Ocean in long and narrow corridors. While not specifically a result of climate change, ARs are the only type of extreme precipitation that is significant enough to be adequately modeled by global climate models (GCMs). Some GCMs project that ARs will be more extreme and occur more frequently. The effects of ARs are also discussed under Section 3, Extreme Weather.

Using a set of seven GCMs (Dettinger 2011), ARs are projected to contain more water vapor, be more intense than any simulated (or observed), AR days may increase by 30%, and twice as many years will see more than historical numbers of ARs xi. Studies project that the resultant risks of storm and floods may increase under the changing climate of the twenty-first century (however, the studies note that the understanding of historical ARs are still preliminary and warrant further investigation). Dettinger 2011; Ralph and Dettinger 2011"[xiii]

[The ability of climate models to reproduce extreme high-frequency precipitation is a key uncertainty in projections. Dynamical models typically overestimate the frequency of precipitation and underestimate precipitation intensity [v].]

ARkStorm[vii]:

ARkStorm stands for an atmospheric river with 1 in 1000 year precipitation levels. ARkStorm projected impacts are discussed in Section 2. "" In an ARkStorm scenario, a month's worth of rain dumps as much as 10 feet of water on the state…ARkStorm rainfall totals in some places would overwhelm" the flood protection system in many areas, USGS says. The Central Valley would experience a "hypothetical" flood 300 miles long and 20 miles wide, while Orange County, Los Angeles County, San Diego and the Bay Area would all be hit with serious flooding.""[xiv]

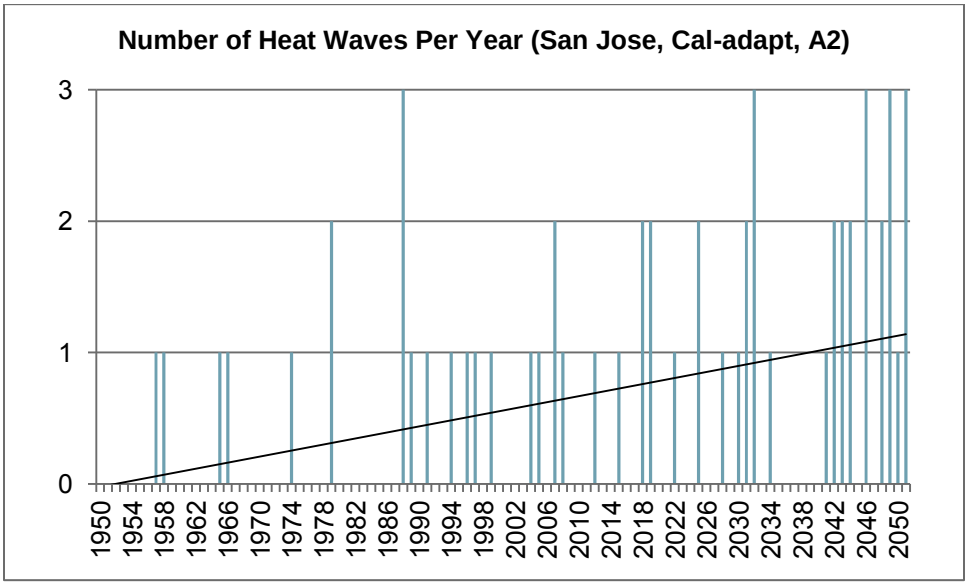
Extreme Heat/Heat Waves

While it can be helpful to use average yearly and seasonal temperature projections, incorporation of discrete events, including extreme heat conditions are more critical for this IRP study. "The number of extremely hot days is projected to continue to increase over much of the United States, especially by late century. Summer temperatures are projected to continue rising, and a reduction of soil moisture, which exacerbates heat waves, is projected for much of the western U.S.. Climate models project that the same summertime temperatures that ranked among the hottest 5% in 1950-1979 will occur at least 70% of the time by 2035-2064 in the U.S. if global emissions of heat-trapping gases continue to grow (as in the A2 emissions scenario). By the end of this century, what have previously been once-in-20-year extreme heat days (1-day events) are projected to occur every two or three years over most of the nation. In other words, what now seems like an extremely hot day will become commonplace."[xv] Locally, the Cal-adapt Extreme Heat tool projects an increasing number of extreme heat days in San Jose under the moderate-high emissions scenario (A2; model: gfdl)[xvi]

Decade Ending	Ave #Extreme Heat Days/Year	Max #Extreme Heat Days in 1 Yr
1959	6	14
1969	4	8
1979	5	15
1989	4	13
1999	9	15
2009	12	20
2019	12	20
2029	13	22
2039	17	32
2049	17	33

Extreme heat occurs as part of the existing climatic conditions. However, with climate change, the frequency or magnitude of these events could increase. This climate change influenced extreme heat effect is discussed in Section 2. The U.S. Environmental Protection Agency defines extreme heat events as "periods of summertime weather that is substantially hotter and/or more humid than typical for a given location at that time of year."

Heat waves are similar in definition to extreme heat: daily maximum temperature of more than five consecutive days exceeds the average maximum temperature by 5 °C (World Meteorological Organization). In California, heat waves are likely to occur earlier and later into the season than normal and summer events may become more frequent and more intense.[xvii] According to data from Cal-adapt model for San Jose under the A2 emissions scenario, the number and frequency of heat waves will increase in the future.



Extreme Cold Snaps

"Summertime heat waves and wintertime cold snaps are among the extremes most directly affected by climate change as well as the ones with the greatest impacts." http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf

In the report, Assessment of Climate Change in the Southwest United States, they define cold outbreaks as when temperature drops below the local levels defining the coldest 5% of winter days or nights, and are measured by how far they drop below those levels over the entire region. The occurrence of cold waves in the Southwest has lessened during the period of 2001 to 2010 when compared to the twentieth century, and are projected to continue to lessen. However, natural interannual variability will still influence their occurrence and occasional extreme cold spell will likely persist, which is agreement with recent results for California. Even though winter cold events are projected to diminish in their frequency, their intensity may not lessen into late century and some of the future cold snaps will be nearly as cold as those in the past. http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf Between 2003-2012, 59 percent of weather-related outages were caused by storms and severe weather (Figure 6). Nearly 20 percent of weather-related outages were caused by cold weather and ice storms http://assets.climatecentral.org/pdfs/PowerOutages.pdf

Wildfire

In the California Climate Change Center's 2009 'Climate Change, Growth, and California Wildfire' paper, the study found a majority of the modeled scenarios "indicated significant increases in large wildfire occurrence and burned area are likely to occur by mid-century". http://www.energy.ca.gov/2009publications/CEC-500-2009-046/CEC-500-2009-046-D.PDF

Wildfire risk is governed by many factors. Increased heat and dryness would increase risk. Changes in precipitation other than increased dryness would also have an effect. For example, increases in precipitation with higher temperatures were expected to result in increased wildfires in the "grasslands and chaparral ecosystems of southern California…by approximately 30 percent toward the end of the century because more winter rain will stimulate the growth of more plant "fuel" available to burn in the fall". Conversely, the study also indicated as expected that "a hotter, drier climate could promote up to 90 percent more northern California fires by the end of the century by drying out and increasing the flammability of forest vegetation". The study concluded that the "risk of large wildfires in California could increase by as much as 55 percent". http://meteora.ucsd.edu/cap/pdffiles/CA_climate_Scenarios.pdf

Another paper suggested a 50% increase wildfire risk by the end of the century, with a 20% increase by mid century under a medium range warming scenario (almost twice as much under the lower warming range scenario). It also recognizes the effect of precipitation, which is difficult to predict. In a drier climate, large wildfire risk in northern California could increase by 90% due to the increase in the flammability of vegetation. "A hotter, wetter climate would also lead to an increase in wildfires in northern California by about 40%" by the end of the century. http://www.ucsusa.org/assets/documents/global_warming/ucs-ca-wildfires-1.pdf

SECTION 2: POTENTIAL IMPACTS OF EXTREME WEATHER AND CLIMATE CHANGE

This section describes the character and severity of impacts from climate change and extremes. This analysis was used to support the vulnerability analyses for water utility infrastructure classes summarized in Table 4-6.

The 2012 IPCC report "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" states that adverse impacts are considered disasters when they produce widespread damage and cause severe alterations in the normal functioning of communities or societies. In the context of this IRP study, impacts are considered if there is a potential to produce widespread damage (such as flooding), or to impact the functioning of water utility infrastructure.

Many of the water utility related impacts described in this section were modeled for the ARkStorm study. This is not intended to imply that extreme storms would necessarily represent these specific damage scenarios in this study area. Instead, this can be used to ensure a wide variety and wide range of storm impact severity is considered.

ARkStorm Scenarios Related to District Infrastructure

Several significant damage modes were identified in the ARkStorm study with respect to water supply.

- Loss of water transmission from northern to southern California because of damage from overtopping of levees in the Sacramento Delta or aqueduct damage caused by flash flooding
- Greatly increased turbidity in surface water because of runoff carrying sediments into reservoirs and because of erosion of the banks of reservoirs
- Landslides could damage tanks on hillsides (or in the case of the Water District, damage to treatment plants and pipelines)
- Pipes collocated on bridges could be damaged if the bridges are damaged, for example, by foundation scour.
- Flood damage to electrical equipment serving pumps
- Flooding damage to electrical and other equipment at water treatment plants (WTP)

Sea Level Rise/Extreme Storm

The district does not have drinking water infrastructure assets vulnerable to direct impacts from Sea Level Rise or storm surges in the San Francisco Bay. However, the district's delivery of drinking water is dependent on imported water that is delivered through the San Francisco Bay Delta, which is vulnerable to sea level rise and storm surges.

> *"The consequences of a major levee outage that could happen … could be catastrophic. Depending on the number of levee breaches, pumping operations from the Tracy and Banks pumping plants could be halted due to high salinity concentrations at the pumps intakes."*
> *JULY 2006 CEC-500-2006-004*

As described at the November 14, 2013, District Board workshop ("Delta Risks and Overview of the Bay Delta Conservation Plan"), an important risk to reliable water supply conveyance through the Delta is the condition of the 1,100 miles of levees in the Delta, and their vulnerability to seismicity and climate change. With the interior of many Delta islands more than 20 feet below sea level, the non-engineered levees built on fragile soils act as dams that will be under increasing pressure with sea level rise. Although unrelated to extreme weather, geologic experts estimate that there is a 63 percent chance of a major seismic event affecting the Delta by 2036. Sea level rise and extreme storms exacerbate this potential. Modeling shows that such a seismic event could cause levee failures and flooding of multiple islands, with sea water intrusion into the central and south Delta interrupting Delta exports for up to two years or more. For Santa Clara County, these scenarios could result in shortages of up to 170,000 acre-feet a year, depending on local hydrology and groundwater basin conditions. A key point is that water shortages and the risk of shortages related to a Delta outage can continue well past the time that normal deliveries of imported water are restored if the County's groundwater reserves are depleted in response to the outage. Until these reserves are replenished, the County is more vulnerable to subsequent dry periods. Flooding of the west and southwest Delta is also more likely to interfere with conveyance of freshwater to export pumps (DWR 2007:17). For additional information, see IRP Technical Memo 5.4.

Extreme Precipitation

Increased magnitude and occurrence of precipitation events can cause flooding and water quality impacts.

Flooding

Flooding occurs frequently in Santa Clara County. The valley's streams can be very flashy and floods can occur quickly with even smaller or localized storms. Flooding can damage nearby infrastructure as a result of creek channel scouring or impacts from large debris flow. Locally, many flooding impacts have been correlated with atmospheric rivers (AR). ARs are storms in which enormous amounts of water vapor are delivered to the region from over the Pacific Ocean.

ARs are severe storms in this study region and are expected to persist outside of climate change influence. One recent local example of atmospheric river storms, is the 'Pineapple Express' storm system encountered New Year 1996/1997; the storm's "bull's eye" in Santa Clara County was Uvas Reservoir, where 9.5 inches of rain fell in 48 hours. Less than one month later, a late January 1997 "…storm caused flooding, mud and rock slides, and forced evacuation around the state. A portion of Highway 101 in San Jose was closed due to flooding. Highway 152 remained closed due to rock and mud slides from the New Year's storm. The amount of rainfall recorded in Santa Clara County ranged from 1 to 5 inches in 48 hours. Rainfall intensities varied up to a 13-year return period. Estimated damages exceeded $6 million for the county."[xviii]

Dam Damage Scenario

"The ARkStorm, therefore, does not posit any dam overtopping failure to DSOD regulated dams. Minor spillway damage and downstream erosion is plausible, however, as well as occurrences similar to

detention-basin damage, or similar to the 1997 landslide near the Franklin Canyon reservoir. Because of the extremely sensitive nature of a dam-damage scenario, the selection of a particular dam to imagine as hypothetically damaged in such a way is left to emergency planners". (ArkStorm)[xix]

Water Quality Scenario

Increased magnitude and occurrence of precipitation can result in increased turbidity of watershed runoff into drinking water reservoirs, which result in water treatment challenges. While these water quality changes may be met by operational and treatment process improvements, rainfall events can challenge treatment systems by increasing turbidity and sedimentation, or cause direct flood damage to above-ground utility facilities and buried infrastructure.

Extreme Heat

Extreme heat could affect generators, electrical, HVAC equipment, and others. Materials specified for the Bay Area are not typically designed for constant high temperatures. This should be factored into the asset management program. Equipment replacements should be done keeping potential future high temperatures in mind.

Extreme heat for prolonged periods, or periods of extreme or unprecedented drought, can affect buried infrastructure also. "… buried pipes become more prone to cracking as a result of greater soil movement due to flooding and droughts. This results in leaking pipes, which causes unnecessary water loss while compromising water quality…."[xx]

Extreme heat and drought conditions both contribute to increased wildfire risk.

Drought and Drying or Expansive Soils

"Southwestern droughts have been exacerbated by unusually warm summer temperatures. This tendency could worsen in future decades: several twenty-first-century climate model simulations suggest that dry years will include anomalously warm summer temperatures even above and beyond the warming trend in the Southwest (Cayan et al. 2010). During extreme droughts, the deficit in soil moisture grows larger, and also grows in comparison to the deficit in precipitation. Although projected precipitation anomalies during dry spells do not change markedly from observed past conditions, other hydrologic measures—including soil moisture—become more depleted." http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf

Drought, extended drying of subsurface soil, can have a negative effect on buried infrastructure or foundations where under normal situations, some residual soil moisture may keep soil more stable. With extensive drying, expansive soils can dry and crack due to soil shrinkage.

"Each year in the United States, expansive soils cause billions of dollars in damage to buildings, roads, pipelines, and other structures. This is more damage than that caused by floods, hurricanes, tornadoes, and earthquakes combined"[xxi]

Water-supply ditches that remain dry for extended periods of time can be prone to animal damage such as burrowing and plant overgrowth.[xxii]

Of course, water supplies are also at risk with increased drought. "The SWP and CVP are expected to be more vulnerable to operational interruption under climate change. It is expected that a water shortage worse than the one during the 1977 drought could occur in 1 out of every 6-8 years by mid-century and 1 out of every 3-4 years at the end of the century. http://www.water.ca.gov/pubs/climate/using_future_climate_projections_to_support_water_resoures_decision_making_in_california/usingfutureclimateprojtosuppwater_jun09_web.pdf

Extreme Cold Snaps

Extreme cold snaps occur even in this moderate Mediterranean climate. Climate change is not expected to increase occurrences of extreme cold snaps. However, taken in combination with higher temperatures during the colder winter periods, it is possible that temperature fluctuation extremes could cause stress on buried infrastructure.

Non-Urban Wildfire

Increasing temperatures and drier conditions as a result of climate change, contribute to increased wildfire severity and frequency. Furthermore, changes in other weather systems, such as seasonal shifts of precipitation and temperatures and lightening, can contribute to increased wildfire risk and longer fire seasons[xxiii].

Wildfire can damage above ground infrastructure, such as water treatment plants located in the upper watersheds, and power distribution infrastructure. Wildfire can also have a negative effect on the upper watersheds above drinking water reservoirs. Runoff from storms after wildfires can carry increased amounts of sediment.

High Winds

The study area is not expected to have hurricane force winds. At very high winds, there may be the potential for structural damage such as roof damage. Damage to water utility infrastructure is not expected at moderate wind speeds. More discussion on wind effects is in the section Lifeline Interaction Involving Power, below.

San Francisco Bay Delta Levee Damage and Repair Scenario

"In the event that a major flood in the Delta, occurs, the number and specific islands that may experience a levee breach and flooding is potentially quite varied. Given the number of islands (referred to as analysis zones) in the Delta, there are many possible combinations of levee breach/island flooding sequences that could occur (involving varying numbers of islands and varying combinations of islands) for a given flood. In the Delta Risk Management Strategy project, thousands of levee breach/island flooding sequences were generated to model the randomness in levee response during floods. In the study, a single levee breach/island flooding scenario was generated for the ARkStorm flooding. The characterization of the

projected flooding in the Delta is not based on an event-specific hydrologic analysis. Rather, this characterization is a result of a general assessment based largely on the FEMA Digital Flood Insurance Rate Maps. As a result, the input to this assessment does not provide an event-specific characterization of the spatial distribution of flooding that might occur in the Delta during a major hydrologic event. Another input to this analysis was the projected number of flooded islands as a result of levee failure". The resultant analysis suggested the following timeframes for significant repairs:

- Time to Close All Breaches (Days) 440
- Time to Dewater All Islands (Days) 580

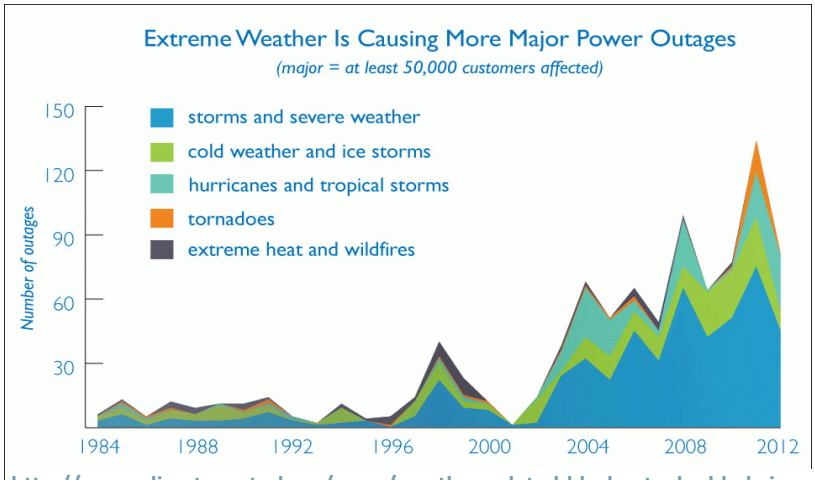
There was no analysis of recovery of the delta system as a water supply conveyance system. ((SWP Reliability Report 2013 Public Draft: If 20 islands were flooded as a result of a major earthquake, the export of freshwater from the Delta could be interrupted by about a year and a half (DWR 2009:5-15). Water supply losses of up to 8 million acre-feet would be incurred by SWP (and CVP) contractors and local water districts. Also, non-delta SWP flood potential….Occasionally, during very wet periods, flood flows can enter the California Aqueduct and contribute to SWP supply south of the Delta.))) For additional detail, see IRP Technical Memo 5.4

Lifeline Interaction Involving Transportation Corridors

"…some water-supply pipelines are on roadway or railway bridges, so bridge damage or failure (from scour) could interrupt water transmission. Furthermore, treatment facilities isolated by roadway or rail damage or flooding can run out of chlorine; some facilities receive chlorine shipments every 3-4 days. Many water treatment plants (WTPs) have onsite emergency generators, often elevated above grade, typically with 3-4 day supply of fuel (if not running on piped natural gas). These WTPs are, therefore, somewhat resistant to offsite (utility) power failure (see more below). Pumps in well fields, however, are generally not equipped with emergency generators, so water supply to communities that rely on ground water or on water that requires pumping may be susceptible to loss of water resulting from power failure."

Lifeline Interaction Involving Power

In addition to the ARkStorm analysis below, the 2014 report: Blackout: Extreme Weather, Climate Change and Power Outages states that "...an increase in severe weather has led to a doubling of major power outages across the country in the past decade. Heat waves are hotter, heavy rain events are heavier, and winter storms have increased in both frequency and intensity,…To date, these kinds of severe weather are among the leading causes of large-scale power outages in the United States."



http://www.climatecentral.org/news/weather-related-blackouts-doubled-since-2003-report-17281

Transportation

"…damage to other lifelines can impact the restoration of power. As examples, roadway damage can hinder electric utilities from getting to affected areas and performing repairs. Telecommunications failure can hinder the reporting of any damage to the utilities, as well as hindering repair coordination".

Flood

The ARkStorm Power Damage and Restoration Scenario estimated the percentage of customers initially without power after the storm. 10% of customers in Santa Clara County could be without power following the flood event.

Extreme Heat

Extreme heat scenarios are also expected to have an effect on electricity reliability. "Delivery of electricity may become more vulnerable to disruption due to climate induced extreme heat and drought events as a result of:

-– increased demand for home and commercial cooling,
-– reduced thermal power plant efficiencies due to high temperatures,
-– reduced transmission line, substation, and transformer capacities due to elevated temperatures,
-– potential loss of hydropower production
-– threatened thermoelectric generation due to limited water supply
---– the threat of wildfire to transmission infrastructure.

Wind

No such outage was noted for a wind event. However, the study did indicate power supply vulnerabilities in the wind speed analysis. While the ARkStorm study did not indicate that the Bay Area would be subject to hurricane force winds (above 75 mph), there may still be room for some wind damage to power systems.

> *"According to panel participants, wooden crossbars and pole- mount transformers on distribution-voltage utility poles can be damaged by wind speeds as low as 60 miles per hour (mph). Moderate winds also can cause lines to sway, touch, and cause cross- phase shorting. Another common cause of wind damage is moderate wind speeds with windborne debris such as palm fronds blown onto lines causing shorts. Where winds are stronger, damage is more severe. Hurricane-force winds (75 mph and higher) can cause transmission lines to sway and cause cross-phase shorting, or cause electrical transmission towers or poles to collapse."*

Since wind speeds are not expected at hurricane force in the study area, moderate, yet severe, winds are more likely to cause power failure as a result of windborne debris than direct impact to above ground electrical infrastructure. http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf

SECTION 3: RISK ASSESSMENT METHODOLOGY

Sections 1 and 2 describe climate change and summarize climate change projections and potential extreme weather scenarios for the study area. The following sections then provide the basis for a vulnerability-risk based evaluation of these threats and potential impacts. The flow chart in Figure 1 outlines the vulnerability assessment approach and the related sections within this memo.

The risk and vulnerability analysis in Section 6 contains the list of infrastructure classes considered and combines the potential for impact with the adaptive capacity of the infrastructure classes. After that analysis, a summary of the available and published probabilities (likelihood) of climate threats is provided.

The components of the risk assessment evaluation can be summarized as follows:

Impact = climate and extreme weather projections + exposed assets
Vulnerability = exposure of the asset to threat + time to impact (sensitivity) + adaptive capacity (can threat be stopped or failure easily fixed)
Probability = Likelihood of impact

Risk Assessment Methodology

The goal of the analysis performed for Subtask 5.2 was to identify if any extreme weather events should be included as an outage scenario analyzed in the overall project. The analysis identifies which extreme weather events would pose the greatest risk to the District's water supply system infrastructure. The analysis included three components: an impact analysis (climate events and infrastructure inventory), a vulnerability analysis (sensitivity and adaptive capacity), and a probability analysis (likelihood of the event occurring).

Impact Analysis - Methodology

The first steps are to define the climate or extreme weather scenarios to be considered and the infrastructure asset classes that may be threatened. A literature review was conducted to analyze the most likely climate change and extreme weather scenarios that may impact this region. These are described in Sections 2 and 3. This review and understanding of the potential impacts were valuable in the following vulnerability analysis. The following tools provided a concise overview and summary of local impacts as modeled by others.

Cal Adapt Local Climate Snapshots
http://cal-adapt.org/tools/factsheet/
National Climate Change Viewer
http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp

Vulnerability Analysis - Methodology

After defining the climate events and infrastructure classes to be considered, the potential for an impact pathway to exist is examined. Once a potential for impact is determined, the risk analysis identifies which asset classes have the potential for failure in relationship to each extreme weather impact scenario. Once the potential for failure was identified, a vulnerability analysis was conducted that looked at the time to failure and the adaptive capacity (sensitivity) of the asset class in relation to the event.

Each facility was analyzed to determine if and how it would be affected by each type of extreme weather event. This analysis included four steps, described below:

- Exposure Pathway Analysis: Can the infrastructure be exposed to the extreme weather event?
- Failure Analysis: If the infrastructure can be exposed, can it fail due to the extreme weather event? (could be a partial failure)
- Time to Failure: If the infrastructure can fail, what is the duration from the extreme event to failure? The time to failure was rated from 0 (no failure) to 3 (immediate failure).
- Adaptive Capacity: If the infrastructure can fail, how long does it take to repair? The sensitivities of infrastructure classes (i.e., ability to repair or recover from failure/adaptive capacity) are also rated on a scale from 0 (low sensitivity or preventable) to 3 (high sensitivity or years to recover from failure). If an asset is exposed and cannot recover from failure due to exposure, it is scored as high sensitivity (3) to the impact. If the asset is exposed but can recover quickly, it is scored as low sensitivity (0).

Exposure/Pathway

The climate change risks identified for the study area were listed in a matrix with the generalized infrastructure classes considered in the overall IRP framework. The infrastructure classes are considered the exposure points. If exposure pathways are identified, the infrastructure classes may be broken down into smaller classification or particular components, such as was done for pipeline creek crossings. But since the focus here is to broadly identify exposure potential, the broad classifications are considered to be sufficient for most of the analysis.

For each threat and infrastructure class, the potential for a pathway to exist was examined by subject matter experts on district staff. If it was considered possible for the climate threat to contact a component of the infrastructure class, the pathway was considered complete and given a Y (for yes) in the matrix. With the exception of geographically expanded climate impacts, all climate threats were considered to have an exposure pathway to the infrastructure in the future as it does now. For instance, the pathway of heat, rain, cold, and wind to infrastructure in the future is the same as today. The only climate risks considered to have an expanded geographic influence under climate change were sea level rise and floods. Buried infrastructure was considered to have some exposed components. If the exposed points are within the climate footprint, the pathway is complete.

Failure Potential

In an attempt to eliminate more risks from the evaluation, the next step was to make to make a subjective evaluation of whether the infrastructure class under each climate scenario had a potential to fail. This was a simple Yes/No evaluation.

Vulnerability

For the remaining infrastructure classes with a failure potential, the next step was to rate the vulnerability of that class to the climate threat. Two vulnerability conditions were applied: the sensitivity to the threat (time to failure) and the adaptive capacity of the class (ability to rebound or repair from the failure mode). These were each rated on a scale from 0 to 3.

Sensitivity

The information known about each extreme weather or climate change impact scenario was used to subjectively evaluate how much time it would take negatively impact each asset class. This was evaluated with the following relative scale:

- ✓ Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3

For instance, a moderate impact sensitivity ranking of 2 from an impact from flooding can be described as follows:

> *Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure*

Adaptive Capacity

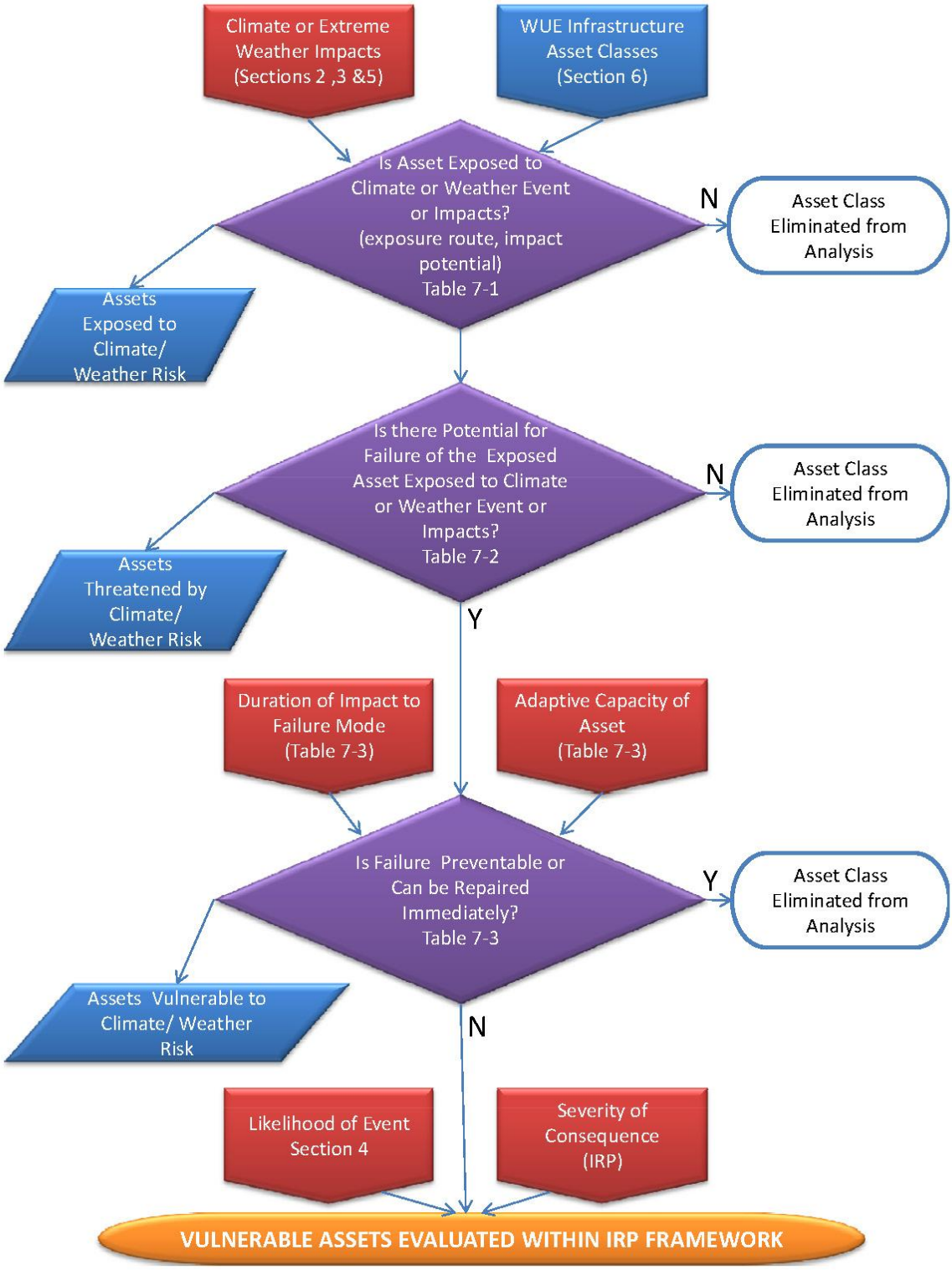
Then the information known about the asset class and the potential type of failure that might be possible was used to determine the adaptive capacity or ability to repair and the timeframe to do so. This was evaluated with the following relative scale:

- ✓ Can Failure Mode be Stopped or easily fixed at failure: Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4

For example, a low adaptive capacity (high risk) ranking of 3 from flooding can be described as follows:

> *In the event of flood, infrastructure may not be accessible for a long period of time,*

Figure 2: Vulnerability Assessment Framework



SECTION 4: RISK ANALYSIS

The Risk Assessment methodology was described in Section 5. This section presents the results of the analysis and begins with a summary of the infrastructure asset classes considered in this analysis. This is followed by a brief summary of the climate/weather impacts, then the results of the vulnerability assessment.

Impact Analysis -Infrastructure Inventory

Santa Clara Valley Water District Infrastructure Classes

Table 4-1 Infrastructure Classes

Infrastructure	Amount	Size/Capacity
Imported Water Supplies	3	
SF Water Dept Bay Division[1]		77,000 ac-ft/yr (contract amt)
San Felipe Project[2]		152,500 ac-ft/yr (contract amt)
South Bay Aqueduct[3]		100,000 ac-ft/yr (contract amt)
Raw Water Pipelines	11	79.7 mi (20" to 120" diam)
Treated Water Pipelines	10	39.8 mi (20" to 84" diam)
Water Treatment Plants:	3	
Rinconada		80 MGD
Santa Teresa		100 MGD
Penitencia		40 MGD
Raw Water Pump Stations:	3	
Coyote		153,492 gpm; 12,000 hp
Pacheco		301,055 gpm; 24,000 hp
Vasona		72,000 gpm; 1,200 hp
Treated Water Pump Stations	3	
Dutard		4,000 gpm; 85 hp
Graystone		27,760 gpm; 400 hp
SFPUC Intertie		
Raw Water Reservoirs	10	169,000 ac-ft
Treated Water Reservoir	1	15 MG
Groundwater Recharge Facilities	20	393 ac
Raw Water Canals	3	17 mi
Tunnels	3	
Pacheco (raw water)		7.0 mi
Santa Clara (raw water)		1.4 mi
Santa Teresa (treated water)		0.34 mi
Hydroelectric Facilities	1	900 kW
Diversion Dams	9	25,000 ac-ft
Canals and Ditches	4	17.3 mi
Natural Recharge Channels		Approx. 90 mi

The pipelines were further divided for the analysis, depending on if they are exposed or buried. Pipelines can be exposed if they are tied to a trestle and span across a bridge, or if located in a large shallow creek

[1] Owned & Operated by City of San Francisco Public Utilities Commission
[2] Owned by US Bureau of Reclamation; Operated by SCVWD
[3] Owned & Operated by California Department of Water Resources

bed because they are at risk of undermining during a flood event. District staff identified the pipelines that are exposed or potentially exposed at a creek crossing, and these are listed in Table 6-2 below.

Table 4-2. List of Pipelines that are or are potentially exposed to Open Air Spans

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Impact Analysis - Climate Change and Extreme Weather Effects and Impact Overview The climate change and extreme weather events and effects are described in more detail in Sections 2 and 3. This section summarizes that analysis.

Effects Summary

Sea Level Rise

Extreme high water events and impacts from coastal storm surges are expected to increase when sea level rise is combined with factors such as astronomical tides, changes in atmospheric pressure, wind stress, floods, or the El Niño/Southern Oscillation. The potential for more intense storms threatens coastal and floodplain areas. A major storm surge, coupled with high tides and future elevated sea levels, increases risks to communities, infrastructure systems and property.

Extreme Precipitation or Flood

Heavy downpour increases are expected in many areas in the continental US, even in southwest where total precipitation is projected to decrease. Atmospheric Rivers (AR) (storms carrying large amounts of water vapor over the Pacific Ocean in long and narrow corridors) may become more extreme and occur more frequently. Both of these potential changes can increase flood threat and impacts.

Extreme Heat

The number of extremely hot days is projected increase and high temperatures are projected to continue increase. Extremely hot day will become commonplace in the future with projected climate change.

Drought/Drying or Expansive Soil

Drought, extended drying of subsurface soil, can have a negative effect on buried infrastructure or foundations where under normal situations, some residual soil moisture may keep soil more stable. With extensive drying, expansive soils can dry and crack due to soil shrinkage.

Extreme Cold Snaps

The occurrence of cold waves in the Southwest has lessened during the period of 2001 to 2010 when compared to the twentieth century, and are projected to continue to lessen. However, natural interannual variability will still influence their occurrence and occasional extreme cold spell will likely persist.

Non-Urban Wildfire

Increasing temperatures and drier conditions increase the severity and frequency of wildfire. Changes in precipitation, temperatures and lightening can also produce changes in risks of wildfire and longer fire seasons.

High Wind

The study area is not expected to have hurricane force winds. Damage to water utility infrastructure is not expected at moderate wind speeds. However there could continue to have increased risk to power supply transmission systems and infrastructure.

Impact Summary

A detailed analysis of the possible climate change impacts for each infrastructure class is presented in in Appendix A. Table 4-3 below summarizes the effects and impacts identified in the vulnerability study.

Table 4-3 Climate Change Effects Summary

Summary of Climate/Weather Impacts on District Infrastructure
SLR OR STORM SURGE
In the event of a storm surge, damage could be immediate and without warning because it is impossible to know which levee might fail (Imported Water infrastructure only)
In the event of a storm surge, levee damage could be immediate and without warning because it is impossible to know which levee might fail (Imported Water infrastructure only)
EXTREME PRECIP OR FLOOD
Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected large debris flow (i.e. downed trees), unexpected levee erosion/washout, and unexpected submersion of exposed assets in flood zones.
In the event of an extreme storm or flood, damage could be immediate and without warning because it is impossible to know which levee might fail
EXTREME HEAT
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
DROUGHT DRYING OR EXPASIVE SOILS.
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
EXTREME COLD, COLD SNAPS
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
UPLAND NONURBAN WILD FIRE
This could affect water quality. Fire is immediate. Downstream water quality effects wouldn't be realized for a few days
Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.
HIGH WIND
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.

Vulnerability Analysis Results

The methodology for the vulnerability analysis was described in Section 3. The approach used was to determine where exposure routes existed from the climate change effect to the asset classes. Where an exposure route exists, the next step was to determine whether a potential for failure of the asset exists. Once the exposure route and susceptibility were established, the actual vulnerability of the asset class from the climate or weather effect was ranked. All analyses were conducted by district subject matter experts.

Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3

Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4

The following three tables summarize the results of the vulnerability assessment.

The first table 4.4 summarizes the exposure route analysis

The second table 4.5 summarizes the Failure Potential analysis

The third table 4.6 is the culmination of the vulnerability analysis that combines the sensitivity and adaptive capacity rankings from the Vulnerability Analysis. Appendix X Includes Table App 1 that provides the rational of how the vulnerability rankings were determined for each asset class and impact scenario.

A summary of the effects and impacts and vulnerability is shown in this summary matrix. In this high level summary, extreme precipitation and flood is shown as the highest number of impacts with the highest vulnerability rankings.

Type of Effect	Number of Asset Classes with Impact Potential	Range of Vulnerability Rankings			
SLR OR STORM SURGE	3	3,4	3,3		
EXTREME PRECIP OR FLOOD	19	3,4	3,3	3,2	2,3
EXTREME HEAT	13	2,2			
DROUGHT DRYING OR EXPASIVE SOILS.	12	1,3	1,2		
EXTREME COLD, COLD SNAPS	19	3,2	2,3	2,2	
UPLAND NONURBAN WILD FIRE	6	3,3	2,1		
HIGH WIND	8	3,2			

This next summary matrix illustrates the range of vulnerability rankings and which climate or weather impacts fall in each range. The color coding matches the table in Appendix A.

Vulnerability Ranking and Types of Effect
3,4
EXTREME PRECIP OR FLOOD
SLR OR STORM SURGE
3,3
EXTREME PRECIP OR FLOOD
SLR OR STORM SURGE
UPLAND NONURBAN WILD FIRE
3,2
EXTREME COLD, COLD SNAPS
EXTREME PRECIP OR FLOOD
HIGH WIND
2,3
EXTREME COLD, COLD SNAPS
EXTREME PRECIP OR FLOOD
2,2
EXTREME COLD, COLD SNAPS
EXTREME HEAT
2,1
UPLAND NONURBAN WILD FIRE
1,3
DROUGHT DRYING OR EXPASIVE SOILS.
1,2
DROUGHT DRYING OR EXPASIVE SOILS.

Table 4-4 Exposure Route Analysis

DIRECT IMPACT POTENTIAL via EXPOSURE ROUTES: DOES EXPOSURE ROUTE EXIST? This does not examine likelihood of impact, only if a pathway from the event to the exposure point exists. This does not include supply chain impacts.							
Exposure Point= Infrastructure Class	**SLR OR STORM SURGE**	**EXTREME PRECIP OR FLOOD**	**EXTREME HEAT**	**DROUGHT DRYING OR EXPASIVE SOILS.**	**EXTREME COLD, COLD SNAPS**	**UPLAND NONURBAN WILD FIRE**	**HIGH WIND**
Imported Water-Bay Delta (Levees)	Y	Y	Y	Y	Y	N	Y
Imported Water – Pump Stations (Banks, Tracy)	Y	Y	Y	Y	Y	N	Y
Imported Water – Canals (Delta Mendota, CA Aqueduct)	Y	Y	Y	Y	Y	N	Y
SF Water Dept Bay Division[4] Pipelines	N	N	Y	Y	Y	N	N
SF Water Dept Hetch Hetchy Reservoir	N	Y	Y	Y	Y	Y	Y
CVP San Felipe Project – San Luis Reservoir[5]	N	Y	Y	Y	Y	Y	Y
SWP South Bay Aqueduct[6]	N	Y	Y	Y	Y	?	Y
Raw Water Pipelines – Buried	N	N	Y	Y	Y	N	N
Raw Water Pipelines – Exposed or at Crossings	N	Y	Y	N	Y	Y	Y
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	N	Y	Y	Y	Y	Y	N
Treated Water Pipelines-Buried	N	N	N	Y	Y	N	N
Treated Water Pipelines - Exposed or at Crossings	N	Y	Y	N	Y	Y	Y
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	N	Y	Y	Y	Y	Y	N

SLR = Sea Level Rise 3 meters
[4] Owned & Operated by City of San Francisco Public Utilities Commission
[5] Owned by US Bureau of Reclamation; Operated by SCVWD
[6] Owned & Operated by California Department of Water Resources

Cathodic Protection Components	N	N	Y	Y	Y	?	Y
Water Treatment Plants:							
Rinconada	N	Y	Y	Y	Y	Y	Y
Santa Teresa	N	Y	Y	Y	Y	Y	Y
Penitencia	N	Y Landslide	Y	Y	Y	Y	Y
Raw Water Pump Stations:							
Coyote	N	Y	Y	Y	Y	Y	Y
Pacheco	N	Y	Y	Y	Y	Y	Y
Vasona	N	Y	Y	Y	Y	?	Y
Treated Water Pump Stations							
Dutard	N	Y	Y	N	Y	?	Y
Graystone	N	Y	Y	N	Y	Y	Y
SFPUC Intertie	N	Y	Y	N	Y	Y	Y
Raw Water Dams/Reservoirs	N	Y	Y	Y	Y	Y	Y
Treated Water Reservoir	N	Y	Y	Y	Y	Y	Y
Groundwater Recharge Facilities	N	Y	Y	Y	Y	N	Y
Raw Water Canals & Ditches	N	Y	Y	Y	Y	Y	Y
Tunnels							
Pacheco (raw water)	N	Y	N	N	N	N	N
Santa Clara (raw water)	N	Y	N	N	N	N	N
Santa Teresa (treated water)	N	Y	Y	N	N	N	N
Hydroelectric Facilities	N	Y	Y	Y	Y	Y	Y
Diversion Dams	N	Y	Y	Y	Y	N	Y
Natural Recharge Channels	N	Y	Y	Y	Y	Y	Y

Table 4-5 Failure Potential Analysis

Failure Potential Y/N							
Infrastructure	**SLR OR STORM SURGE**	**EXTREME PRECIP OR FLOOD**	**EXTREME HEAT**	**DROUGHT DRYING OR EXPASIVE SOILS.**	**EXTREME COLD, COLD SNAPS**	**WILD FIRE**	**HIGH WIND**
Imported Water-Bay Delta (Levees)	**Y**	**Y**		**Y**			
Imported Water – Pump Stations (Banks, Tracy)	Y	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Imported Water – Canals (Delta Mendota, CA Aqueduct)		**?**		**Y**			
SF Water Dept Bay Division[7] Pipelines				**Y**	**Y**		
SF Water Dept Hetch Hetchy Reservoir		?		Y (dam)		Y	
CVP San Felipe Project – San Luis Reservoir[8]		?		Y (dam)		Y	
SWP South Bay Aqueduct[9]				Y	Y		
Raw Water Pipelines – Buried				Y	Y		
Raw Water Pipelines – Exposed or at Crossings		Y	Y		Y		
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)		Y	Y	Y	Y		
Treated Water Pipelines-Buried				Y	Y		
Treated Water Pipelines - Exposed or at Crossings		Y	Y		Y		
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)		Y	Y	Y	Y		
Cathodic Protection Components		Y	Y		Y		Y

SLR = Sea Level Rise 3 meters
[7] Owned & Operated by City of San Francisco Public Utilities Commission
[8] Owned by US Bureau of Reclamation; Operated by SCVWD
[9] Owned & Operated by California Department of Water Resources

Failure Potential Y/N							
Infrastructure	**SLR OR STORM SURGE**	**EXTREME PRECIP OR FLOOD**	**EXTREME HEAT**	**DROUGHT DRYING OR EXPASIVE SOILS.**	**EXTREME COLD, COLD SNAPS**	**WILD FIRE**	**HIGH WIND**
Water Treatment Plants:							
Rinconada			Y	Y	Y	Y	Y
Santa Teresa			Y	Y	Y	Y	Y
Penitencia		Y	Y	Y	Y	Y	Y
Raw Water Pump Stations:							
Coyote		Y	Y		Y	Y	Y
Pacheco			Y		Y	Y	Y
Vasona		Y	Y		Y	Y	Y
Treated Water Pump Stations							
Dutard			Y		Y	Y	Y
Graystone			Y		Y	Y	Y
SFPUC Intertie			Y		Y	Y	Y
Raw Water Dams/Reservoirs		Y		Y (dams)		Y	
Treated Water Reservoir		Y		Y		Y	Y
Groundwater Recharge Facilities		Y		Y			
Raw Water Canals & Ditches		Y		Y		Y	
Tunnels							
Pacheco (raw water)		Y					
Santa Clara (raw water)		Y					
Santa Teresa (treated water)		Y					
Hydroelectric Facilities		Y	Y		Y	Y	Y
Diversion Dams		Y		Y			
Natural Recharge Channels		Y					

Table 4-6 Vulnerability Analysis

VULNERABILITY POTENTIAL: WHERE EXPOSURE ROUTE EXISTS, IS INFRASTRUCTURE VULNERABILE? **Time=** Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3 **Adaptive Capacity =** Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4							
Infrastructure Class	**SLR OR STORM SURGE**	**EXTREME PRECIP OR FLOOD**	**EXTREME HEAT**	**DROUGHT DRYING OR EXPANSIVE SOILS**	**EXTREME COLD, COLD SNAPS**	**UPLAND NON-URBAN WILD FIRE**	**HIGH WIND**
Imported Water-Bay Delta (Levees)	3,4	3,4		0			
Imported Water – Pump Stations (Banks, Tracy)	3,3	3,3	2,2	1,3	2,2		3,2
Imported Water – Canals (Delta Mendota, CA Aqueduct)	3,3	3,3		0			
SF Water Dept Bay Division[10] Pipelines				1,3	2,3		
SF Water Dept Hetch Hetchy Reservoir		NA		NA		NA	
CVP San Felipe Project – San Luis Reservoir[11]		2,3		0		NA	
SWP South Bay Aqueduct[12]				1,3	2,3	0	
Raw Water Pipelines – Buried				1,3	2,3		
Raw Water Pipelines – Exposed or at Crossings		3,3	0	0	2,2	0	
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)		3,2	2,2	1,2	2,2		
Treated Water Pipelines- Buried		3,3		1,3	2,3		
Treated Water Pipelines - Exposed or at Crossings		3,3	0	0	2,2		
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)		3,2	2,2	1,2	2,2		
Cathodic Protection Components		3,2	2,2		2,2		

SLR = Sea Level Rise 3 meters and 1 in 100 year flood

[10] Owned & Operated by City of San Francisco Public Utilities Commission

[11] Owned by US Bureau of Reclamation; Operated by SCVWD

[12] Owned & Operated by California Department of Water Resources

VULNERABILITY POTENTIAL: WHERE EXPOSURE ROUTE EXISTS, IS INFRASTRUCTURE VULNERABILE? **Time=** Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3 **Adaptive Capacity =** Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4							
Infrastructure Class	**SLR OR STORM SURGE**	**EXTREME PRECIP OR FLOOD**	**EXTREME HEAT**	**DROUGHT DRYING OR EXPANSIVE SOILS**	**EXTREME COLD, COLD SNAPS**	**UPLAND NON-URBAN WILD FIRE**	**HIGH WIND**
Water Treatment Plants:							
Rinconada			2,2	1,3	2,2	0	3,2
Santa Teresa			2,2	1,3	2,2	3,3	3,2
Penitencia		3,3	2,2	0	2,2	0	3,2
Raw Water Pump Stations:							
Coyote		2,3	2,2		3,2	3,3	3,2
Pacheco			2,2		3,2	3,3	3,2
Vasona		3,3	2,2		3,2		3,2
Treated Water Pump Stations							
Dutard			2,2		3,2	3,3	3,2
Graystone			2,2		3,2	0	3,2
SFPUC Intertie			2,2		3,2		3,2
Raw Water Dams		0		0		0	
Raw Water Reservoirs		1,3		0		2,1	
Treated Water Reservoir		3,3		1,3		3,3	3,2
Groundwater Recharge Facilities		0		0			
Raw Water Canals & Ditches		2,3		0		0	
Tunnels							
Pacheco (raw water)		2,3					
Santa Clara (raw water)		2,3					
Santa Teresa (treated water)		2,3					
Diversion Dams		0		0			
Natural Recharge Channels		3,3					

NA = Not Analyze or Unknown
0 = After more detailed review, no reasonable impact is expected;
Black = No exposure route

Relative Ranking Coding for Ease of Reference

Combined Score
6 (3,3)
5 (3,2)
4 (2, 2)
3 or 4 (1,3 or 1,2)

Climate or Weather Effects on Asset Classes

The sensitivity (as ranked in the previous table, Table 4.6) of the asset classes to climate or weather impacts are described in this list.

Table 4-7: Effects Summary

Climate/Weather Effects on Asset Classes
Cathodic Protection Components
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.
Coyote Pump Station
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.
Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.
Dutard Pump Station
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.
Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.
Graystone Pump Station
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude

Climate/Weather Effects on Asset Classes
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.
Imported Water – Canals (Delta Mendota, CA Aqueduct)
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
In the event of a storm surge, levee damage could be immediate and without warning because it is impossible to know which levee might fail
In the event of an extreme storm or flood, levee damage could be immediate and without warning because it is impossible to know which levee might fail
Imported Water – Pump Stations (Banks, Tracy)
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.
In the event of a storm surge, damage could be immediate and without warning because it is impossible to know which levee might fail
In the event of an extreme storm or flood, damage could be immediate and without warning because it is impossible to know which levee might fail
Imported Water- Bay Delta Levees
In the event of an extreme storm or flood, levee damage could be immediate and without warning because it is impossible to know which levee might fail
Imported Water- Bay Delta Levees
In the event of a storm surge, levee damage could be immediate and without warning because it is impossible to know which levee might fail
Natural Recharge Channels
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected levee erosion/washout.
Pacheco (raw water)
Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure

Climate/Weather Effects on Asset Classes
Pacheco Pump Station
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.
Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.
Penitencia
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Raw Water Canals & Ditches
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected levee erosion/washout.
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.
Raw Water Pipelines – Buried
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude

Climate/Weather Effects on Asset Classes
Raw Water Pipelines – Exposed or at Crossings
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected large debris flow (i.e. downed trees).
Raw Water Reservoirs
Wildfire could affect water quality. Fire is immediate. Downstream water quality effects wouldn't be realized for a few days
Rinconada
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Santa Clara (raw water)
Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure
Santa Teresa
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.
Santa Teresa (treated water)
Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure
SF Water Dept Bay Division[1] Pipelines
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude

Climate/Weather Effects on Asset Classes
SFPUC Intertie Pump Station
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.
SWP South Bay Aqueduct
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.
Treated Water Pipelines - Exposed or at Crossings
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected large debris flow (i.e. downed trees).
Treated Water Pipelines- Buried
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure

Climate/Weather Effects on Asset Classes
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Treated Water Reservoir
Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.
Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.
Vasona Pump Station
Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude
Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.
High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.

Likelihood of Climate Change and Extreme Weather Events

This section lists some of the available and published probability estimates (confidence levels and likelihood) of certain extreme climatic event occurring within the Southwest, California or the San Francisco Bay Area. The probability scoring is relative and is based on the published confidence levels for each event as shown below.

Table 4-8: Likelihood Summary

IRP Probability Score	CLIMATE/WEATHER RELATED EVENT	CONFIDENCE LEVEL	RETURN PERIOD
5	**Sea Level Rise** will continue to rise and that this will entail major damage to coastal regions in the Southwest.	Very High Confidence[ix]	
5	**Sea Level Rise**: Based on the National Research Council's mid-range Pacific coast sea level rise projections, Climate Central (2014) projects 2.9 feet of sea level rise locally by 2100, from a 2012 baseline.	7 percent cumulative risk of at least one flood exceeding 3 feet by 2030, a 76 percent risk by midcentury, and a 100 percent risk by 2100[xxiv]	1 in 100 Yr flood height
2	**Enhanced precipitation extremes**: • More frequent and more intense in the wintertime, even if annual precipitation declines. • "a significant increase (of 13% to14% on average by mid-century) in the intensity of wintertime extremes with 20- and 50-year return periods under the high-emissions scenario (Dominguez et al. 2012)	Medium-Low Confidence[v]	1 in 20 Yr or 1 in 50 Yr
2	**Atmospheric Rivers Enhanced Precipitation:** specifically associated with a wintertime phenomenon typically yielding extreme precipitation. Projected by most current climate models. • "…geologic evidence shows that atmospheric rivers containing extraordinary volumes of water vapor strike California about every 200 years".[1] • "ARs are projected to increase by an average of about 30%per year [xi]"	Medium-Low Confidence[v]	1 in 200 Yr
2	**Extreme Storm/Precipitation Dam Damage** The ARkStorm, therefore, does not posit any dam overtopping failure to DSOD regulated dams. Minor spillway damage and downstream erosion is plausible (ArkStorm)[xxv]	Not Conceivable for Dam Overtopping[vii] Downstream damage plausible[vii]	1 in 1000 Yr
4	**Floods** that cause severe property damage and loss of life in populous regions are predominantly caused by severe precipitation events on already saturated soils. The Southwest is likely to experience increased flood risk from short-duration extreme atmospheric river precipitation events.[v]	Likely[v]	
2	**Extreme Heat** Extreme heat events, projected to increase during the course of the next 100 years, can shorten the life of pavements. Roadway deterioration will have an impact on all	Medium-low confidence	

IRP Probability Score	CLIMATE/WEATHER RELATED EVENT	CONFIDENCE LEVEL	RETURN PERIOD
	trade—including local trade circulation—that occurs between the Southwest and other U.S. regions, and trade between the Southwest and Mexico. http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf		
2	**Heat Waves**: more humid and therefore expressed relatively more strongly in nighttime rather than daytime temperatures, with associated stronger impacts on the energy sector	Medium-Low Confidence[v]	
4	Longer-term **droughts** are expected to intensify in large areas of the Southwest	High Confidence[xxvi]	
3	**Wintertime cold snaps**: diminish in their frequency, but not necessarily in their intensity	Medium-High Confidence[v]	
4	More **wildfire** and increased risks to communities across extensive areas.	High Confidence[ix]	
1	**High Wind**	Low	

Risk Analysis

In the overall risk analysis, all other analysis is synthesized into one analysis. The last several sections summarized the vulnerability of certain infrastructure classes to specific climatic event scenarios.

The vulnerability analysis included identifying where there are complete impact pathways from the event to the infrastructure class. Then where the pathway is complete, staff identified where failure potential exists. Then the time to failure and adaptive capacity was analyzed for each scenario and infrastructure class. The last part of the risk factors assess was the probability of the event occurring.

- Time= Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3
- Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4
- Probability= Ranked 1 to 5, 5 most probable

To identify the overall risk, each climate event probability of occurrence was combined with the vulnerability results from the previous analyses.
This analysis results in the overall risk score for each scenario . For instance, the time for impact to Bay Delta levees from Sea Level Rise impacts was scored as 3, and the adaptive capacity was scored 4 for a combined ranking of (3,4). SLR and the resulting storm surge impacts were given a high probability event score of 5

- Risk = (Probability x Time to Impact) + (Probability x Adaptive Capacity infrastructure class)
- Risk Score: **35** = (5x3) + (5x4)

CLIMATE IMPACT Probability Score ➔	SLR OR STORM SURGE
Infrastructure Class ↓	5

This table summarizes the results of the combined vulnerability and probability analysis and provides relative ranking of risk among the weather and climate scenarios to various infrastructure classes.

Table 4-9: Risk Table

RISK TABLE: PROBABILITY COMBINED WITH VULNERABILITY POTENTIAL

Risk = (Probability x Time) + (Probability x Adaptive Capacity)

Probability= Ranked 1 to 5, 5 most probable

Time= Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3

Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4

CLIMATE IMPACT Probability Score ➔ / Infrastructure Class ↓	SLR OR STORM SURGE 5	EXTREME PRECIP OR FLOOD 3	EXTREME HEAT 2	DROUGHT DRYING OR EXPANSIVE SOILS 4	EXTREME COLD, COLD SNAPS 3	UPLAND NON-URBAN WILD FIRE 3	HIGH WIND 1
Imported Water- Bay Delta (Levees)	35 3,4	21 3,4		0			
Imported Water – Pump Stations (Banks, Tracy)	30 3,3	18 3,3	8 2,2	16 1,3	12 2,2		6 3,2
Imported Water – Canals (Delta Mendota, CA Aqueduct)	30 3,3	18 3,3		0			
SF Water Dept Bay Division[13] Pipelines				16 1,3	15 2,3		
SF Water Dept Hetch Hetchy Reservoir		NA		NA		NA	
CVP San Felipe Project – San Luis Reservoir[14]		15 2,3		0		NA	
SWP South Bay Aqueduct[15]				16 1,3	15 2,3	0	
Raw Water Pipelines – Buried				16 1,3	15 2,3		
Raw Water Pipelines – Exposed or at Crossings		18 3,3	0	0	12 2,2	0	
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)		15 3,2	8 2,2	12 1,2	12 2,2		
Treated Water Pipelines- Buried		18 3,3		16 1,3	15 2,3		
Treated Water Pipelines - Exposed or at Crossings		18 3,3	0	0	12 2,2		

SLR = Sea Level Rise 3 meters and 1 in 100 year flood

[13] Owned & Operated by City of San Francisco Public Utilities Commission

[14] Owned by US Bureau of Reclamation; Operated by SCVWD

[15] Owned & Operated by California Department of Water Resources

Infrastructure Class ↓	SLR OR STORM SURGE	EXTREME PRECIP OR FLOOD	EXTREME HEAT	DROUGHT DRYING SOILS	EXTREME COLD, COLD SNAPS	UPLAND NON-URBAN WILD FIRE	HIGH WIND
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)							
Cathodic Protection Components		15 3,2	8 2,2		12 2,2		
Water Treatment Plants:							
Rinconada			8 2,2	16 1,3	12 2,2	0	5 3,2
Santa Teresa			8 2,2	16 1,3	12 2,2	24 3,3	5 3,2
Penitencia		18 3,3	8 2,2	0	12 2,2	0	5 3,2
Raw Water Pump Stations:							
Coyote		15 2,3	8 2,2		15 3,2	24 3,3	5 3,2
Pacheco			8 2,2		15 3,2	18 3,3	5 3,2
Vasona		18 3,3	8 2,2		15 3,2		5 3,2
Treated Water Pump Stations							
Dutard			8 2,2		15 3,2	24 3,3	5 3,2
Graystone			8 2,2		15 3,2	0	5 3,2
SFPUC Intertie			8 2,2		15 3,2		5 3,2
Raw Water Dams		0		0		0	
Raw Water Reservoirs		12 1,3		0		12 2,1	
Treated Water Reservoir		18 3,3		16 1,3		24 3,3	5 3,2
Groundwater Recharge Facilities		0		0			
Raw Water Canals & Ditches		15 2,3		0		0	
Tunnels							
Pacheco (raw water)		15 2,3					
Santa Clara (raw water)		15 2,3					
Santa Teresa (treated water)		15 2,3					
Diversion Dams		0		0			
Natural Recharge Channels		18 3,3					

CONCLUSIONS AND RECOMMENDATIONS

The matrixes in Section 4 identify the vulnerable or at risk infrastructure classes for each of the climate threats evaluated. The vulnerability was then combined with the severity and likelihood of the climate effect to produce a risk evaluation.

Some of the most likely and severe threats such as sea level rise (5) and drought (4), have less overall risks due to fewer exposure routes and lower vulnerability. Conversely, some of the infrastructure classes are at risk, but the likelihood of the climatic event being severe or frequent is low.
It is recommended that the results of this vulnerability and risk analysis be applied to the larger IRP risk analyses to determine if extreme weather or climate change have the potential for infrastructure failure modes not incorporated in the larger analysis.

Also, the analysis of the climate and weather risks summarized in this tech memo, are applicable to risk analyses for other water supply, flood or ecological resource evaluations that may be conducted across the district. Therefore, it may be appropriate to have the climate change framework team work from this analysis, come to agreement on the threat descriptions, and prepare a final tech memo for use across the district to ensure consistency.

Also, the vulnerability framework used in this analysis, may also be appropriate for other core service areas at the district. There is potential for improvement and a broader concurrence on this approach. There is also easy application to other receptors or impact analyses, with minor adjustments to the framework.

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APPENDIX A
VULNERABILITY ASSESMENT RANKING ASSUMPTIONS

Infrastructure	CLIMATE EVENT	Score (Time, Adapt Capac)	Time= Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3	Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4
Imported Water- Bay Delta Levees	SLR OR STORM SURGE	3,4	In the event of a storm surge, levee damage could be immediate and without warning because it is impossible to know which levee might fail	Infrastructure reliability studies and past experience indicate it could take months (year or more, 18 months) to restore service or fix levees in bay delta
Imported Water- Bay Delta Levees	EXTREME PRECIP OR FLOOD	3,4	In the event of an extreme storm or flood, levee damage could be immediate and without warning because it is impossible to know which levee might fail	Infrastructure reliability studies and past experience indicate it could take weeks or months to restore service or fix levees in bay delta (year or more, 18 months)
Imported Water- Bay Delta Levees	DROUGHT DRYING OR EXPASIVE SOILS.	0	No failure, not expected to dry out.	No failure, not expected to dry out.
Imported Water – Pump Stations (Banks, Tracy)	SLR OR STORM SURGE	3,3	In the event of a storm surge, damage could be immediate and without warning because it is impossible to know which levee might fail	In the event of flood, infrastructure may not be accessible for a long period of time, particularly if levee failure
Imported Water – Pump Stations (Banks, Tracy)	EXTREME PRECIP OR FLOOD	3,3	In the event of an extreme storm or flood, damage could be immediate and without warning because it is impossible to know which levee might fail	In the event of flood, infrastructure may not be accessible for a long period of time, particularly if levee failure
Imported Water – Pump Stations (Banks, Tracy)	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Failure of extreme heat will likely be related to electrical or pump failures. Unless planned for, it may take days to replace failed components.
Imported Water – Pump Stations (Banks, Tracy)	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Unless failure is foreseen, it may take days to replace failed components or repair structures and foundations.
Imported Water – Pump Stations (Banks, Tracy)	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Imported Water – Pump Stations (Banks, Tracy)	HIGH WIND	3,2	High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.	Failure unlikely to be foreseen. It may take days to replace failed components
Imported Water – Canals (Delta Mendota, CA Aqueduct)	SLR OR STORM SURGE	3,3	In the event of a storm surge, levee damage could be immediate and without warning because it is impossible to know which levee might fail	In the event of flood, infrastructure may not be accessible for a long period of time, particularly if levee failure
Imported Water – Canals (Delta Mendota, CA Aqueduct)	EXTREME PRECIP OR FLOOD	3,3	In the event of an extreme storm or flood, levee damage could be immediate and without warning because it is impossible to know which levee might fail	In the event of flood, infrastructure may not be accessible for a long period of time, particularly if levee failure
Imported Water – Canals (Delta Mendota, CA Aqueduct)	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Unless failure is foreseen, it may take days to replace failed components or repair structures and foundations.
SF Water Dept Bay Division[1] Pipelines	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Based on SFPUC earthquake analysis. Pipeline repair 40 days maximum.
SF Water Dept Bay Division[1] Pipelines	EXTREME COLD, COLD SNAPS	2,3	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Based on SFPUC earthquake analysis. Pipeline repair 40 days maximum.
SF Water Dept Hetch Hetchy Reservoir	EXTREME PRECIP OR FLOOD	Unk	Not Analyzed	Not Analyzed
SF Water Dept Hetch Hetchy Reservoir	DROUGHT DRYING OR EXPASIVE SOILS.	Unk	Not Analyzed	Not Analyzed
SF Water Dept Hetch Hetchy Reservoir	UPLAND NONURBAN WILD FIRE	Unk	Not Analyzed	Not Analyzed
CVP San Felipe Project – San Luis Reservoir	EXTREME PRECIP OR FLOOD	0	No failure expected	No failure expected
CVP San Felipe Project – San Luis Reservoir	DROUGHT DRYING OR EXPASIVE SOILS.	0	No failure expected	No failure expected
CVP San Felipe Project – San Luis Reservoir	UPLAND NONURBAN WILD FIRE	Unk	Unk	Unk
SWP South Bay Aqueduct	EXTREME PRECIP OR FLOOD	2,3	Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. (Estimated 17 days. Previous District Reliability Study)
SWP South Bay Aqueduct	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. (Estimated 17 days. Previous District Reliability Study)

Infrastructure	CLIMATE EVENT	Score (Time, Adapt Capac)	Time= Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3	Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4
SWP South Bay Aqueduct	EXTREME COLD, COLD SNAPS	2,3	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. (Estimated 17 days. Previous District Reliability Study)
SWP South Bay Aqueduct	UPLAND NONURBAN WILD FIRE	0	No failure expected	No failure expected
Raw Water Pipelines – Buried	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. (Estimated 17 days. Previous District Reliability Study)
Raw Water Pipelines – Buried	EXTREME COLD, COLD SNAPS	2,3	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. (Estimated 17 days. Previous District Reliability Study)
Raw Water Pipelines – Exposed or at Crossings	EXTREME PRECIP OR FLOOD	3,3	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected large debris flow (i.e. downed trees).	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. Estimated 17 days. Previous District Reliability Study. Although pipe is easily accessible, damage due to flooding is expected to be severe. Flood could wipe out the entire exposed segment.
Raw Water Pipelines – Exposed or at Crossings	EXTREME HEAT	0	No Failure	No Failure
Raw Water Pipelines – Exposed or at Crossings	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Expect cold to burst pipe or cause cracks and minor leaks that could be repaired in a few days since pipe is exposed and easily accessible.
Raw Water Pipelines – Exposed or at Crossings	UPLAND NONURBAN WILD FIRE	0	No failure expected	No failure expected
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	EXTREME PRECIP OR FLOOD	3,2	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	DROUGHT DRYING OR EXPASIVE SOILS.	1,2	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Raw Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Treated Water Pipelines- Buried	EXTREME PRECIP OR FLOOD	3,3	Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. (Estimated 17 days. Previous District Reliability Study)
Treated Water Pipelines- Buried	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. (Estimated 17 days. Previous District Reliability Study)
Treated Water Pipelines- Buried	EXTREME COLD, COLD SNAPS	2,3	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. (Estimated 17 days. Previous District Reliability Study)

Infrastructure	CLIMATE EVENT	Score (Time, Adapt Capac)	Time= Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3	Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4
Treated Water Pipelines - Exposed or at Crossings	EXTREME PRECIP OR FLOOD	3,3	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected large debris flow (i.e. downed trees).	Repair of levees or other canal or piping that cracks or breaks is likely to take to take weeks. Estimated 17 days. Previous District Reliability Study. Although pipe is easily accessible, damage due to flooding is expected to be severe. Flood could wipe out the entire exposed segment.
Treated Water Pipelines - Exposed or at Crossings	EXTREME HEAT	0	No Failure	No Failure
Treated Water Pipelines - Exposed or at Crossings	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Expect cold to burst pipe or cause cracks and minor leaks that could be repaired in a few days since pipe is exposed and easily accessible.
Treated Water Pipelines - Exposed or at Crossings	UPLAND NONURBAN WILD FIRE	0	No failure expected	No failure expected
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	EXTREME PRECIP OR FLOOD	3,2	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	DROUGHT DRYING OR EXPASIVE SOILS.	1,2	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Treated Water Pipeline Air valves, components in vaults, blow offs, turnouts (mostly exposed assets)	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Cathodic Protection Components	EXTREME PRECIP OR FLOOD	3,2	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Cathodic Protection Components	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Cathodic Protection Components	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Water Treatment Plants:				
Rinconada	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Rinconada	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Unless failure is foreseen, it may take days to replace failed components or repair structures and foundations.
Rinconada	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.

Infrastructure	CLIMATE EVENT	Score (Time, Adapt Capac)	Time= Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3	Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4
Santa Teresa	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Santa Teresa	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Unless failure is foreseen, it may take days to replace failed components or repair structures and foundations.
Santa Teresa	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Santa Teresa	UPLAND NONURBAN WILD FIRE	3,3	Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.	Fire may cause accessibility or severe structural damage and could take weeks to repair. (STWTP is surrounded by High Fire Haz Cal-Fire map).
Penitencia	EXTREME PRECIP OR FLOOD	2,3	Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure	Damage associated with landslide, geotechnical work and site stability could take months.
Penitencia	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Penitencia	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Unless failure is foreseen, it may take days to replace failed components or repair structures and foundations.
Penitencia	EXTREME COLD, COLD SNAPS	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Raw Water Pump Stations:				
Coyote Pump Station	EXTREME PRECIP OR FLOOD	3,3	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.	In the event of flood, infrastructure may not be accessible for a long period of time, particularly if levee failure
Coyote Pump Station	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Coyote Pump Station	EXTREME COLD, COLD SNAPS	3,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Coyote Pump Station	UPLAND NONURBAN WILD FIRE	3,3	Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.	Fire may cause accessibility or severe structural damage and could take weeks to repair.
Coyote Pump Station	HIGH WIND	3,2	High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.	Assumed power can be restored either through energy supplier or by the use of temporary power if needed, in the order of days
Pacheco Pump Station	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Pacheco Pump Station	EXTREME COLD, COLD SNAPS	3,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Pacheco Pump Station	UPLAND NONURBAN WILD FIRE	3,3	Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.	Fire may cause accessibility or severe structural damage and could take weeks to repair.

Infrastructure	CLIMATE EVENT	Score (Time, Adapt Capac)	Time= Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3	Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4
Pacheco Pump Station	HIGH WIND	3,2	High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.	Assumed power can be restored either through energy supplier or by the use of temporary power if needed, in the order of days
Vasona Pump Station	EXTREME PRECIP OR FLOOD	3,3	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.	In the event of flood, infrastructure may not be able accessible for a long period of time, particularly if levee failure
Vasona Pump Station	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Vasona Pump Station	EXTREME COLD, COLD SNAPS	3,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Vasona Pump Station	HIGH WIND	3,2	High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.	Assumed power can be restored either through energy supplier or by the use of temporary power if needed, in the order of days
Treated Water Pump Stations				
Dutard Pump Station	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Dutard Pump Station	EXTREME COLD, COLD SNAPS	3,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Dutard Pump Station	UPLAND NONURBAN WILD FIRE	3,3	Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.	Fire may cause accessibility or severe structural damage and could take weeks to repair.
Dutard Pump Station	HIGH WIND	3,2	High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.	Assumed power can be restored either through energy supplier or by the use of temporary power if needed, in the order of days
Graystone Pump Station	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Graystone Pump Station	EXTREME COLD, COLD SNAPS	3,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
Graystone Pump Station	UPLAND NONURBAN WILD FIRE	0	No failure expected	No failure expected
Graystone Pump Station	HIGH WIND	3,2	High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.	Assumed power can be restored either through energy supplier or by the use of temporary power if needed, in the order of days
SFPUC Intertie Pump Station	EXTREME HEAT	2,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
SFPUC Intertie Pump Station	EXTREME COLD, COLD SNAPS	3,2	Extreme heat/cold expected to build throughout a day or days, and may not be immediate, although failure, may be at tipping point. Temperature extremes can usually be predicted and preventative measures put in place to avoid or postpone failure. Additionally, extreme events do not last long in this latitude	Assumed assets easily accessible and replacement parts available, can be repaired in days.
SFPUC Intertie Pump Station	HIGH WIND	3,2	High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.	Assumed power can be restored either through energy supplier or by the use of temporary power if needed, in the order of days

Infrastructure	CLIMATE EVENT	Score (Time, Adapt Capac)	Time= Duration of Impact to Failure Mode: No Failure = 0; Weeks = 1; Days = 2; Immediate =3	Adaptive Capacity = Can Failure Mode be Stopped or easily fixed at failure. Preventable = 0; Immediate =1; Days = 2; Weeks = 3; Years = 4
Raw Water Dams	EXTREME PRECIP OR FLOOD	0	No failure expected	No failure expected
Raw Water Dams	DROUGHT DRYING OR EXPASIVE SOILS.	0	No failure expected	No failure expected
Raw Water Dams	UPLAND NONURBAN WILD FIRE	0	No failure expected	No failure expected
Raw Water Reservoirs	EXTREME PRECIP OR FLOOD	0	TBD	
Raw Water Reservoirs	DROUGHT DRYING OR EXPASIVE SOILS.	0	No failure expected	No failure expected
Raw Water Reservoirs	UPLAND NONURBAN WILD FIRE	2,1	This could affect water quality. Fire is immediate. Downstream water quality effects wouldn't be realized for a few days	Ability to change sources to avoid water quality problems
Treated Water Reservoir	EXTREME PRECIP OR FLOOD	3,3	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected submersion of exposed assets in flood zones.	Don't know why rating is 3
Treated Water Reservoir	DROUGHT DRYING OR EXPASIVE SOILS.	1,3	Drying of soils to the point of failure from expansive soils is a slow process. Time to failure would like be in the order of weeks.	Don't know why rating is 3
Treated Water Reservoir	UPLAND NONURBAN WILD FIRE	3,3	Wildfire can be sudden and unexpected and spread unpredictably. When the origin of the fire and the asset are in close proximity, time to impact can be immediate.	Fire may cause accessibility or severe structural damage and could take weeks to repair.
Treated Water Reservoir	HIGH WIND	3,2	High wind can cause power failure or in extreme cases, structural damage such as roof failures. In either event, the effect is expected to be immediate.	Roof damage is expected to be minor to moderate and repairable in a few days
Groundwater Recharge Facilities	EXTREME PRECIP OR FLOOD	0	No failure expected	No failure expected
Groundwater Recharge Facilities	DROUGHT DRYING OR EXPASIVE SOILS.	0	No failure expected	No failure expected
Raw Water Canals & Ditches	EXTREME PRECIP OR FLOOD	2,3	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected levee erosion/washout.	In the event of flood, infrastructure may not be able accessible for a long period of time, particularly if levee failure
Raw Water Canals & Ditches	DROUGHT DRYING OR EXPASIVE SOILS.	0	No failure expected	No failure expected
Raw Water Canals & Ditches	UPLAND NONURBAN WILD FIRE	0	No failure expected	No failure expected
Tunnels				
Pacheco (raw water)	EXTREME PRECIP OR FLOOD	2,3	Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure	SFPUC Earthquake analysis indicates 30 to 60 days for tunnel repair
Santa Clara (raw water)	EXTREME PRECIP OR FLOOD	2,3	Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure	SFPUC Earthquake analysis indicates 30 to 60 days for tunnel repair
Santa Teresa (treated water)	EXTREME PRECIP OR FLOOD	2,3	Excessive precipitation can induce or worsen landslides. Precipitation accumulating over days or weeks could cause landslides, and result in failure of infrastructure	SFPUC Earthquake analysis indicates 30 to 60 days for tunnel repair
Diversion Dams	EXTREME PRECIP OR FLOOD	0	None related to infrastructure failure	No failure expected
Diversion Dams	DROUGHT DRYING OR EXPASIVE SOILS.	0	No failure expected	No failure expected
Natural Recharge Channels	EXTREME PRECIP OR FLOOD	3,3	Flooding impacts can be sudden and result in immediate failure, although hours notice of flooding may be available. In this case the damage is potentially sudden as it may be from unexpected levee erosion/washout.	In the event of flood, infrastructure may not be able accessible for a long period of time, particularly if levee failure

Climate Change Appendix:

Silicon Valley Advanced Water Purification Center Hazard Impacts

Silicon Valley Advanced Water Purification Center Hazard Impacts

Draft 5/11/2015

This memo summarizes the expected climate change impacts to the Silicon Valley Advanced Water Purification Center (SVAWPC) based on work performed for the Silicon Valley 2.0 project (SV 2.0). The SV 2.0 project did not consider SVAWPC explicitly, although the facility is within the boundaries of the land area considered part of the San Jose-Santa Clara Regional Water Pollution Control Plant that is evaluated. Figure 1 shows the land area for the San Jose-Santa Clara Water Regional Pollution Control Plant (yellow hatching) and the SVAWPC (red box).

Figure 1. San Jose-Santa Clara Water Pollution Control Plant Study Area

Table 1 summarizes the findings for the pollution control plant based on various climate change scenarios.

Table 1. Summary of Potential Climate Change Impacts

Scenario	Impact
Mid-century Sea Level Rise (SLR)	Minimal
Mid-century SLR + 100 yr. Storm Surge	Minimal
End of century SLR	< 25% of plant land area permanently inundated
End of century SLR + 100 yr. Storm Surge	Approx. 50% of plant land area temporarily flooded
Riverine Flooding and/or Storm Surge*	Approx. 33% of plant land area vulnerable

*- Riverine flooding is based on FEMA Flood Insurance Rate Maps and due to the facility's proximity to the Bay, flooding could be due to either storm surge and/or riverine flooding

Under the worst-case scenario (End of century SLR + 100 yr. storm surge), the assessment in SV 2.0 does not indicate flooding risk to the SVAWPC itself, although the flood potential is close to the facility. Figure 2 shows the temporary flooding potential under this scenario with the SVAWPC outlined in red.

Figure 2. End of century SLR + 100 yr. Storm Surge Flooding Potential

The results for riverine/storm surge flooding risk are similar, whereby the SVAWPC itself does not have riverine/storm surge flood risk but the vulnerable areas are immediately adjacent, as shown in Figure 3.

Figure 3. Riverine/Storm Surge Flooding Potential

Based on the information available in the SV 2.0 project, the SVAWPC does not appear to be directly vulnerable to SLR or river flooding/storm surge flooding. However, the vulnerable areas are immediately adjacent to the SVAWPC, and there are uncertainties associated with these assessments. It should be noted that these assessments do not take into account any mitigation strategies that may be in place for protection against these impacts.

Currently, the SVAWPC produces a maximum of 8 MGD of recycled water. In comparison, the SJ/SC Water Pollution Control Plant has a rated capacity of 167 MGD, with an average dry weather flow of 120 MGD in 2010. Therefore, the SVAWPC currently treats a small percentage of the pollution control plant effluent (<10%) and may not be a high priority following a major hazard. However, there are plans to expand the SVAWPC to its maximum design capacity of 32 MGD, which may increase its role in post hazard water delivery. Further considerations for the SVAWPC may be needed following the proposed expansion.

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Santa Clara Valley Water District

Infrastructure Reliability Plan

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Interim Summary Memorandum - Task 5.3
Planned Maintenance and Other Facility Outages

Purpose

The purpose of this Interim Summary Memo is to summarize historical and planned District facility outages. The District operates and maintains a complex raw water collection system to the three water treatment plants. The treated water pipelines are linear systems with numerous turnouts to serve the retail customers. The facilities include the District's raw water system, treated water system, treatment plants, and major pump stations. The District takes several major facilities out of service each year for maintenance. The District maintains a facility shutdown schedule that identifies when these facilities will be taken out of service for maintenance, and how long the facilities will be out of service. The schedule identifies shutdowns that are required for both capital and maintenance projects.

The following items are attached to this memo:

- Table 1: List of Treated Water Facilities Shutdowns (2008-2014)
- Table 2: List of Raw Water Facilities Shutdowns (2008-2014)
- Table 3: List of Planned Treated Water Facilities Shutdowns (2014-2017)
- Table 4: List of Planned Raw Water Facilities Shutdowns (2014-2019)
- Attachment 1: Current Shutdown Schedule

In addition, below are the findings from the July 23, 2014 meeting between the Infrastructure Reliability Project (IRP) Management Team and District management and staff responsible for raw and treated water conveyance systems regarding planned and unplanned outages, and the impacts of these outages to retailers and the District.

This memorandum will be used to prepare a technical memorandum detailing outage scenarios selected for analysis in the project, infrastructure expected to be out of service in those scenarios, and expected outage time of that infrastructure.

Meeting Summary

1. Facility Shutdown Schedule
   - District maintenance engineering unit staff develops and maintains the facility shutdown schedule. The schedule includes upcoming planned capital projects, planned maintenance projects, and anticipated shutdowns of facilities not owned/operated by the District such as the South Bay Aqueduct (SBA).
   - The schedule is adjusted based on perceived risk of having one or more sources of water down.
   - There is a formal QEMS process in place for creating and updating the Facility Shutdown Schedule, but it is currently not being followed.

- The schedule includes placeholders for future projects but no shutdown dates have been set.
- No list is kept tracking planned shutdowns vs. unplanned shutdowns.
- The District normally performs maintenance on two pipe segments per year. The length of pipe undergoing maintenance varies anywhere from 150 feet to 5 miles, but averages between 1 and 3.5 miles.

2. Treated Water Pipeline Outages and Impacts to Customers
   - The longest known shutdown on the West Pipeline lasted eight to ten weeks with outages occurring in segments. It impacted Cal Water, City of Sunnyvale, and City of Mountain View, as well as the Rainbow and Mann turnouts, which are managed by San Jose Water Company. Except for Cal Water, the retailers had sufficient backup supply during the shutdown.
   - Cal Water cannot maintain desired pressures utilizing its wells when the District pipeline is out of service. Wells are the only source of backup for Cal Water, so when District water is not supplied, Cal Water well pressure is not substantial enough to service all customers.
   - The longest known shutdown on the East Pipeline was six to eight weeks with outages occurring in segments. Retailers did not have trouble meeting demands during this shutdown. The ideal shutdown period is 12 weeks, however, contractor staffing cannot support that long of a shutdown.
   - San Jose Municipal Water System is the most vulnerable on the east side of the distribution system. They do not have backup supply, but are currently working on getting wells permitted for regular use.

3. Raw Water Outages and Impacts to Customers
   - The longest known raw water pipeline shutdown was Pacheco Conduit for 12 weeks. It takes eight weeks to dewater the pipeline.
   - Raw water can endure longer outages than treated water, typically, due to storage and redundancy of supplies available in the raw water system.
   - San Benito County Water District would typically fill San Justo Reservoir prior to a shutdown in order to make it through a shutdown period. San Benito WD can go months without San Luis supplies if San Justo reservoir is full. If the reservoir is not full, they can go weeks with no San Luis supplies.
   - Farmers may be impacted, but have interruptible contracts.

4. District Staff Preferred Shutdown Durations and Conditions
   - Shutdown duration depends on difficulty of work.
   - Generally, longer shutdown windows are better for individual projects. More work can be accomplished, thus avoiding multiple shorter shutdowns to accomplish the same work. This also avoids additional risk of de-watering and returning to service multiple times.
   - Desired duration of shutdown would be at least 12 weeks for each project.
   - Contractor staffing limitations sometimes require a need to shutdown for shorter periods.

- It can take up to ten weeks to dewater treated water pipelines due to regulatory requirements for disinfection of the pipe, and slow discharge rates, thus reducing the window of opportunity for actual work.
- Shutdown durations and schedules also need to take retailer maintenance shutdown schedules into account. Particularly because most systems target the same lower demand periods during winter months for major maintenance shutdowns.
- Maintenance work is typically done between October and March each year during low demand months.
- There is no need for longer "season" of shutdowns, or more months available to do shutdowns. Limitations are due to staff resources. Contractors and the District currently do not have enough staff to increase the number of projects they perform in one year.
- The District typically rehabilitates two segments of pipe per year of varying lengths. The shutdowns do not typically occur at the same time.
- The District does not typically shutdown more than one treatment plant at a time.

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7. Facilities Never Taken Out of Service
    - Snell Tunnel
    - Pacheco Tunnel Reach 1 (PPP to Reservoir) – cannot be dewatered (planning on robotic inspection this fall)
    - Anderson Force Main
    - Santa Teresa Force Main
    - Penitencia Force Main
    - Penitencia Delivery Main
    - Calero Bypass
    - Parallel East pipeline

Table 1. Treated Water Facilities Shutdown Schedule (2008-2014)

Facility	Month	Year	Shutdown Duration (Days)
Sunnyvale Distributary	Dec	2008	14
Penitencia WTP	Jan	2009	21
Rinconada WTP	Jan	2009	1
Penitencia WTP	Feb	2010	5
East Pipeline	March	2010	42
West Pipeline	March	2010	3
Penitencia WTP	April	2010	24
Penitencia WTP	Oct	2011	1
Rinconada WTP	Oct	2011	135
East Pipeline	Oct	2011	35
Santa Teresa WTP	Oct	2011	33
Penitencia WTP	Nov	2011	7
West Pipeline	Nov	2011	5
Santa Teresa WTP	Nov	2011	25
Penitencia WTP	Jan	2012	14
Santa Teresa WTP	Feb	2012	30
Santa Teresa WTP	March	2012	20
Penitencia WTP	May	2012	18
East Pipeline	July	2012	120
Penitencia Delivery Main	Oct	2012	14
Rinconada WTP	Nov	2012	4
Rinconada WTP	Jan	2013	4
Rinconada WTP	Feb	2013	4
Milpitas Pipeline	Oct	2013	NA
Stevens Creek Pipeline	Oct	2013	NA
Santa Teresa WTP	Feb	2014	21
Rinconada WTP	Feb	2014	18
Penitencia WTP	Feb	2014	60
Rinconada WTP	Feb	2014	3
West Pipeline	Feb	2014	14
Milpitas Pipeline	April	2014	30

Table 2. Raw Water Facilities Shutdown Schedule (2008-2014)

Facility	Month	Year	Shutdown Duration (Days)
South Bay Aqueduct	Nov	2008	40
Cal Water - Planned Work (Wells)	Nov	2008	71
Santa Clara Conduit	Feb	2009	49
Pacheco Pump Plant	Feb	2009	70
Almaden Valley Pipeline	Oct	2009	1
Pacheco Pump Plant	Oct	2009	1
South Bay Aqueduct	Nov	2009	56
SFPUC	Nov	2009	70
Rinconada Force Main	Nov	2009	7
Anderson Dam	Nov	2009	4
Stevens Creek Reservoir	Nov	2009	7
Pacheco Pump Plant	Nov	2009	1
SFPUC	Jan	2010	70
SFPUC	Jan	2010	55
Calero Dam	Jan	2010	1
Pacheco Pump Plant	Jan	2010	1
Coyote Pump Plant	Jan	2010	1
Almaden Valley Pipeline	Feb	2010	14
South Bay Aqueduct	March	2010	6
Pacheco Pump Plant	April	2010	1
Pacheco Pump Plant	May	2011	30
Pacheco Pump Plant	Aug	2011	3
Pacheco Pump Plant	Oct	2011	10
Santa Clara Conduit	Oct	2011	84
Pacheco Pump Plant	Dec	2011	30
Almaden Valley Pipeline	Feb	2012	42
South Bay Aqueduct	Jan	2012	2
South Bay Aqueduct	Jan	2012	28
Santa Clara Conduit, Calero Dam	Aug	2012	45
Pacheco Pump Plant	Aug	2012	29
SF Intertie	Aug	2012	29
Pacheco Pump Plant	Oct	2012	14
Pacheco Pump Plant	Oct	2012	14
Calero Dam	Oct	2012	43
Pacheco Pump Plant	Oct	2012	3
SF Intertie	Nov	2012	56
Penitencia Force Main	Dec	2012	24

Penitencia Force Main	Dec	2012	90
Central Pipeline	Jan	2013	14
Pacheco Pump Plant	Jan	2013	
Pacheco Pump Plant	Jan	2013	10
Pacheco Pump Plant	Feb	2013	83
Pacheco Pump Plant	April	2013	74
Coyote Pump Plant	Feb	2014	3
Pacheco Pump Plant	March	2014	2

Table 3. Planned Treated Water Facilities Shutdown Schedule (2014-2017)

Facility	Month	Year	Shutdown Duration (Days)
Santa Teresa WTP	Feb	2014	21
Rinconada WTP	Feb	2014	18
Penitencia WTP	Feb	2014	60
Rinconada WTP	Feb	2014	3
West Pipeline	Feb	2014	14
Milpitas Pipeline	April	2014	30
Rinconada WTP	Nov	2014	12
Snell Pipeline	Dec	2014	21
Rinconada WTP	Jan	2015	8
Snell Pipeline	Jan	2015	49
Snell Pipeline	Feb	2015	56
Snell Pipeline	Feb	2015	21
Santa Teresa WTP	Feb	2015	TBD
Penitencia WTP	April	2015	180
Penitencia WTP	Nov	2015	196
Penitencia WTP	Nov	2015	21
Rinconada WTP	Nov	2016	TBD
Anderson Force Main	Nov	2016	TBD
Parallel East Pipeline	Nov	2016	TBD
Penitencia WTP	Nov	2016	90
So. County Recycled Water	Nov	2016	TBD
Rinconada WTP	Nov	2016	TBD
Rinconada Force Main	Nov	2016	TBD
Rinconada WTP	Nov	2017	TBD
West Pipeline	Nov	2017	TBD

Table 4. Planned Raw Water Facilities Shutdown Schedule (2014-2019)

Facility	Month	Year	Shutdown Duration (Days)
Pacheco Pump Plant	Nov	2014	1
Pacheco Pump Plant	Nov	2014	28
Pacheco Pump Plant	Dec	2014	2
Pacheco Pump Plant	Dec	2014	28
Pacheco Pump Plant	Jan	2015	2
Cross Valley Pipeline	Oct	2015	35
Calero Bypass	Nov	2015	35
Anderson Reservoir	Jan	2016	TBD
Anderson Dam	April	2016	TBD
Anderson Reservoir	July	2016	TBD
Calero Reservoir	Sept	2016	TBD
Pacheco Conduit	Nov	2017	TBD
Central Pipeline	Nov	2018	TBD
Almaden Valley Pipeline	Nov	2019	TBD

Attachment One

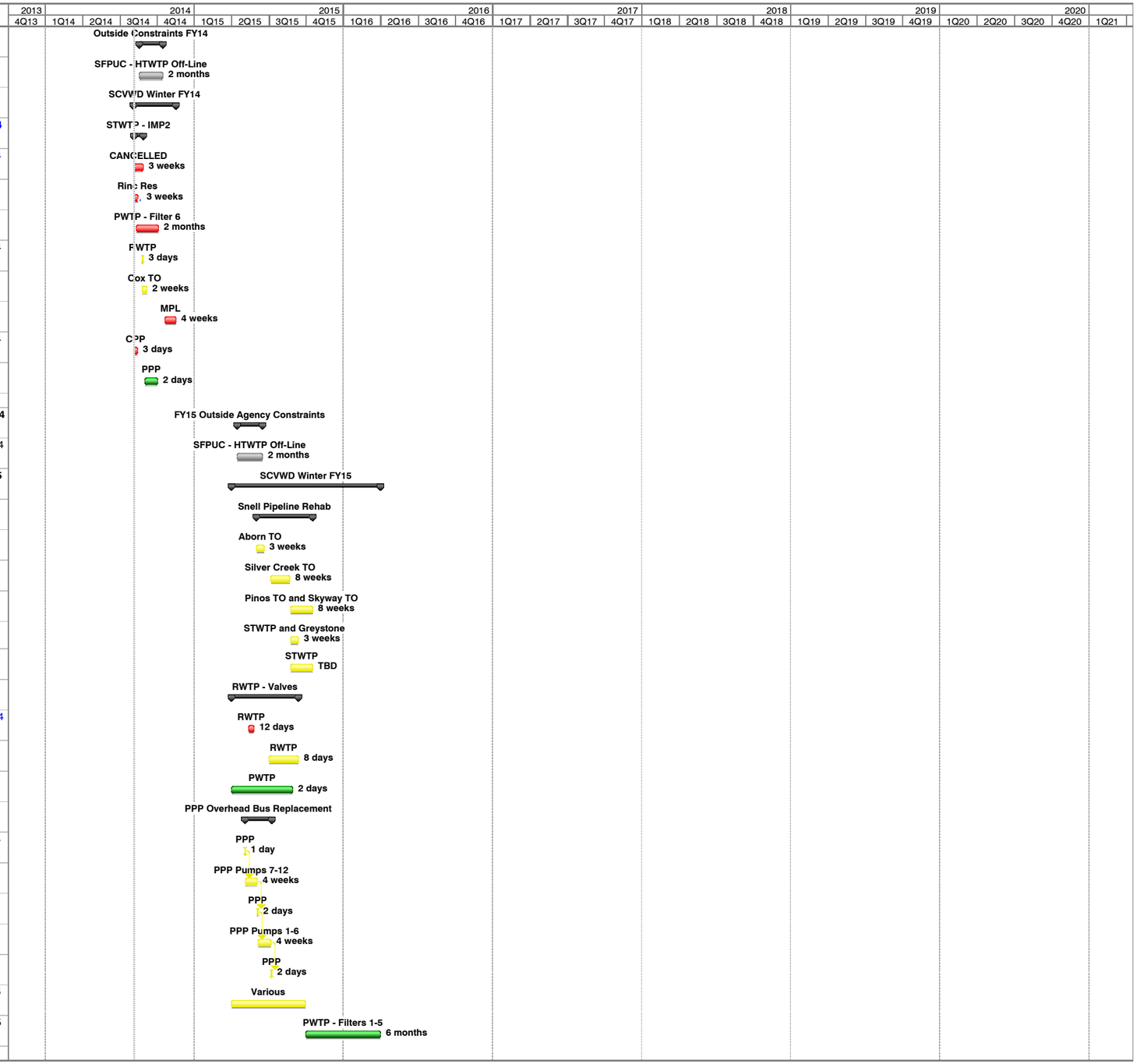
Timescale Is Shown By Fiscal Year

X:\Asset Management - WU Operation\Shutdown Schedule\Long Term Shutdown Schedule\

Water Utility Operations
Long-Term Shutdown Schedule

February 3, 2014

ID	Task Name	Notes	Estimated Duration	Start	Finish
1	**FY14 Outside Agency Constraints**			**Mon 2/17/14**	**Tue 4/15/14**
2	SFPUC - HTWTP Shutdown		2 months	Mon 2/17/14	Tue 4/15/14
3	**SCVWD FY14**			**Mon 2/3/14**	**Sat 5/17/14**
4	**STWTP - Incompatible Materials Project - Stage II**			**Tue 2/4/14**	**Wed 2/26/14**
5	STWTP - Half Plant Shutdown	STWTP - Half Plant Off-Line. End Date TBD.	3 weeks	Tue 2/4/14	Wed 2/26/14
6	Rinconada Reservoir Outage for Valves Upgrade Project	Reservior completely off-line. 18 calendar days.	3 weeks	Tue 2/4/14	Sat 2/22/14
7	PWTP - Filter 6 Rehab	Filter 6 Off-Line	2 months	Mon 2/10/14	Fri 4/4/14
8	RWTP Shutdown for Planned Maintenance	RWTP Off-Line. West Pipeline and Distributaries Off-Line. Tentative Dates Shown.	3 days	Mon 2/24/14	Wed 2/26/14
9	WPL - Cox TO Flow Meter and Valve Replacement	Cox TO Off-Line. To correspond with the beginning of the RWTP Shutdown.	2 weeks	Mon 2/24/14	Fri 3/7/14
10	Milpitas Pipeline Rehabilitation and Inspection	Entire MPL Off-Line. Intertie will be unavailable.	4 weeks	Mon 4/21/14	Sat 5/17/14
11	CPP Generator Replacement and Misc. Electrical Work	Coyote Pumping Plant Off-Line 2/4, 2/5, 2/12.	3 days	Mon 2/3/14	Wed 2/12/14
12	PPP Generator Replacement and Misc. Electrical Work	Dates TBD.	2 days	Mon 3/3/14	Wed 4/2/14
13					
14	**FY15 Outside Agency Constraints**			**Wed 10/15/14**	**Mon 12/15/14**
15	SFPUC - HTWTP Shutdown		2 months	Wed 10/15/14	Mon 12/15/14
16	**SCVWD FY15**			**Wed 10/1/14**	**Wed 9/30/15**
17	**Snell Pipeline and Graystone Pipeline Inspection and Rehab**			**Mon 12/1/14**	**Fri 4/17/15**
18	Snell Phase 1 - Thompson Line Valve to Aborn Line Valve	3 weeks - Aborn TO Off-Line.	3 weeks	Mon 12/1/14	Fri 12/19/14
19	Snell Phase 2 - Coyote Creek Line Valve to Thompson Line Valve	7 weeks - Silver Creek TO Off-Line.	8 weeks	Mon 1/5/15	Fri 2/20/15
20	Snell Phase 3 and Graystone - STWTP to Coyote Creek Line Valve	8 weeks - Pinos and Skyway Off-Line. STWTP only feeding Graystone.	8 weeks	Mon 2/23/15	Fri 4/17/15
21	Snell Phase 3B and Graystone - Snell Tunnel LV to Graystone TO	3 weeks - STWTP and Graystone Off-Line.	3 weeks	Mon 2/23/15	Fri 3/13/15
22	STWTP Sludge Pipeline Cleaning	To coincide with STWTP shutdown for Snell Pipeline Rehab.	TBD	Mon 2/23/15	Fri 4/17/15
23	**RWTP - RMP and Valves Upgrade Project**			**Wed 10/1/14**	**Fri 3/13/15**
24	RWTP - Shutdown No. 1	Full Plant Shutdown - 12 calendar days.	12 days	Wed 11/12/14	Mon 11/24/14
25	RWTP - Shutdown No. 2	Full Plant Shutdown - 8 calendar days. Dates TBD.	8 days	Thu 1/1/15	Fri 3/13/15
26	PWTP - Sulfuric Acid Extension	Possible 2-day shutdown for tie-in. Dates TBD	2 days	Wed 10/1/14	Fri 2/27/15
27	**Pacheco Pumping Plant Overhead Bus Replacement**			**Mon 11/3/14**	**Wed 1/7/15**
28	Full Plant Shutdown		1 day	Mon 11/3/14	Mon 11/3/14
29	Half Plant Shutdown - Bus 1A Off-Line	Pumps 7-12 Not Available.	4 weeks	Tue 11/4/14	Tue 12/2/14
30	Full Plant Shutdown		2 days	Wed 12/3/14	Thu 12/4/14
31	Half Plant Shutdown - Bus 2A Off-Line	Pumps 1-6 Not Available.	4 weeks	Fri 12/5/14	Mon 1/5/15
32	Full Plant Shutdown		2 days	Tue 1/6/15	Wed 1/7/15
33	Electrical Testing and Maint - 1 to 2 day shutdowns at all Treatment Plants and Pump Stations	Dates TBD.		Wed 10/1/14	Mon 3/30/15
34	PWTP - Filter 1-5 Rehab	PWTP at reduced capacity	6 months	Wed 4/1/15	Wed 9/30/15
35					



Notes:

Blue Text indicates Capital Project
Grey Bar indicates Outside Agency Outage
Red Bar indicates Committed Shutdown
Yellow Bar indicates Tentative Shutdown
Green Bar indicates Target Shutdown

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WATER UTILITY ENTERPRISE
Santa Clara Valley Water District

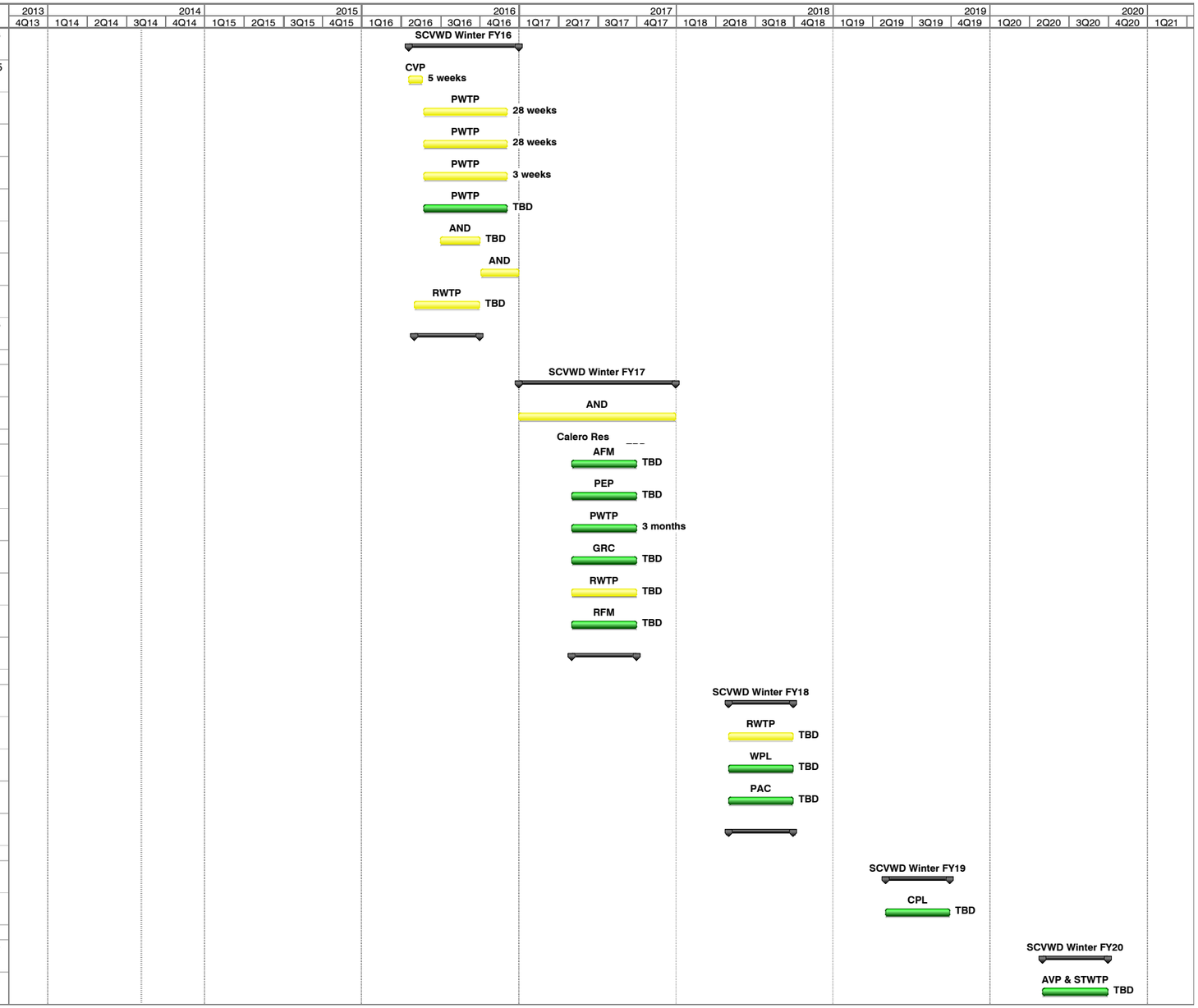
Timescale Is Shown By Fiscal Year

X:\Asset Management - WU Operation\Shutdown Schedule\Long Term Shutdown Schedule\

Water Utility Operations
Long-Term Shutdown Schedule

February 3, 2014

ID	Task Name	Notes	Estimated Duration	Start	Finish
36	**SCVWD FY16**			**Mon 10/19/15**	**Thu 6/30/16**
37	Cross Valley and Calero Bypass Pipeline Rehab and Inspection	San Felipe and Anderson not available.	5 weeks	Mon 10/19/15	Thu 11/19/15
38	PWTP - Clearwell Roof Replacement	PWTP Off-Line.	28 weeks	Mon 11/23/15	Fri 6/3/16
39	PWTP - IRP2 WTP Operations Building Seismic Retrofit	PWTP Off-Line.	28 weeks	Mon 11/23/15	Fri 6/3/16
40	PWTP - Effluent Valve and Flow Meter Replacement	PWTP Off-Line.	3 weeks	Mon 11/23/15	Fri 6/3/16
41	Penitencia Pipes Seismic Upgrade	Placeholder No. 1.	TBD	Mon 11/23/15	Fri 6/3/16
42	Draining of Anderson Reservoir for Anderson Dam Rehab	Draining to begin January 2016.	TBD	Fri 1/1/16	Fri 4/1/16
43	Anderson Dam Off-Line			Mon 4/4/16	Thu 6/30/16
44	RWTP - Reliability Improvement Project	Unknown Duration for Tie-In Work.	TBD	Sun 11/1/15	Thu 3/31/16
45	**Electrical Testing and Maint**			**Sun 11/1/15**	**Thu 3/31/16**
48					
49	**SCVWD FY17**			**Fri 7/1/16**	**Fri 6/30/17**
50	Anderson Reservoir Dam Retrofit	Anderson Reservoir Off-Line.		Fri 7/1/16	Fri 6/30/17
51	Calero Reservior Rehab	Dates TBD. Possibly 6 months.	TBD	Thu 9/1/16	Wed 2/22/17
52	Anderson Force Main Rehab and Inspection		TBD	Tue 11/1/16	Fri 3/31/17
53	Parallel East Pipeline Rehab and Inspection		TBD	Tue 11/1/16	Fri 3/31/17
54	PWTP Off-Line for Penitencia Pipes Seismic Upgrade	Placeholder No. 2.	3 months	Tue 11/1/16	Fri 3/31/17
55	South County Recycled Water Rehab and Inspection		TBD	Tue 11/1/16	Fri 3/31/17
56	RWTP - Reliability Improvement Project	RWTP Off-Line. Unknown Duration for Tie-In Work.	TBD	Tue 11/1/16	Fri 3/31/17
57	Rinconada Force Main Inspection	To correspond with RWTP RIP Shutdown. Stevens Creek Pipeline will be off-line.	TBD	Tue 11/1/16	Fri 3/31/17
58	**Electrical Testing and Maint**			**Tue 11/1/16**	**Fri 3/31/17**
62					
63	**SCVWD FY18**			**Wed 11/1/17**	**Fri 3/30/18**
64	RWTP - Reliability Improvement Project	RWTP Off-Line. Unknown Duration for Tie-In Work.	TBD	Wed 11/1/17	Fri 3/30/18
65	West Pipeline Inspection	To correspond with RWTP RIP Shutdown.	TBD	Wed 11/1/17	Fri 3/30/18
66	Pacheco Conduit, Tunnels, CFI/CFO		TBD	Wed 11/1/17	Fri 3/30/18
67	**Electrical Maint and Testing**			**Wed 11/1/17**	**Fri 3/30/18**
70					
71	**SCVWD FY19**			**Thu 11/1/18**	**Fri 3/29/19**
72	Central P/L Inspection		TBD	Thu 11/1/18	Fri 3/29/19
73					
74	**SCVWD FY20**			**Fri 11/1/19**	**Tue 3/31/20**
75	AVP inspection (Eddy current) - Coleman to Calero includes Santa Teresa Force Main	STWTP Off-Line. Dates TBD.	TBD	Fri 11/1/19	Tue 3/31/20



Notes:

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Red Bar indicates Committed Shutdown
Yellow Bar indicates Tentative Shutdown
Green Bar indicates Target Shutdown

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Santa Clara Valley Water District

Santa Clara Valley Water District

Infrastructure Reliability Plan

Delta Appendix

AECOM

Delta Appendix 627
Delta Levee Failure TM 629
State Delivery Report Summary TM 640
Delta Import Schematic 642
Delta Status Summary TM 644
Emergency Freshwater Pathway Description TM.....648

Delta Appendix:

Delta Levee Failure TM

Summary Memo
Bay Delta Levee Breaches
(Final Draft – March 12, 2015)

Introduction

The Sacramento San Joaquin River Delta (Delta) is a central component of California's water infrastructure. The Delta contains a network of over 1,100 miles of levees, many of which were built over a century ago and were not engineered. Figure 1 shows the Delta system and some related water transmission infrastructure. For more detailed information on the Delta and levee system, please refer to the documents listed in the References section.

Supplies for both the Federal Central Valley Project (CVP) and the State Water Project (SWP) flow through the Delta before being pumped south at the C.W. "Bill" Jones (CVP) and Harvey O. Banks (SWP) pumping plants. The Santa Clara Valley Water District (District) is a contractor with both the CVP and SWP. On average, approximately 40% of the water supplies for Santa Clara County are conveyed through the Delta. In dry years, this percentage can be as high as 90%. Failure of Delta levees could cause significant water quality degradation that may impact the ability to export water from the Delta. An outage of the Delta poses a significant potential risk for the District. This hazard was not specifically analyzed in the District's previous 2005 Infrastructure Reliability Project (IRP) report.

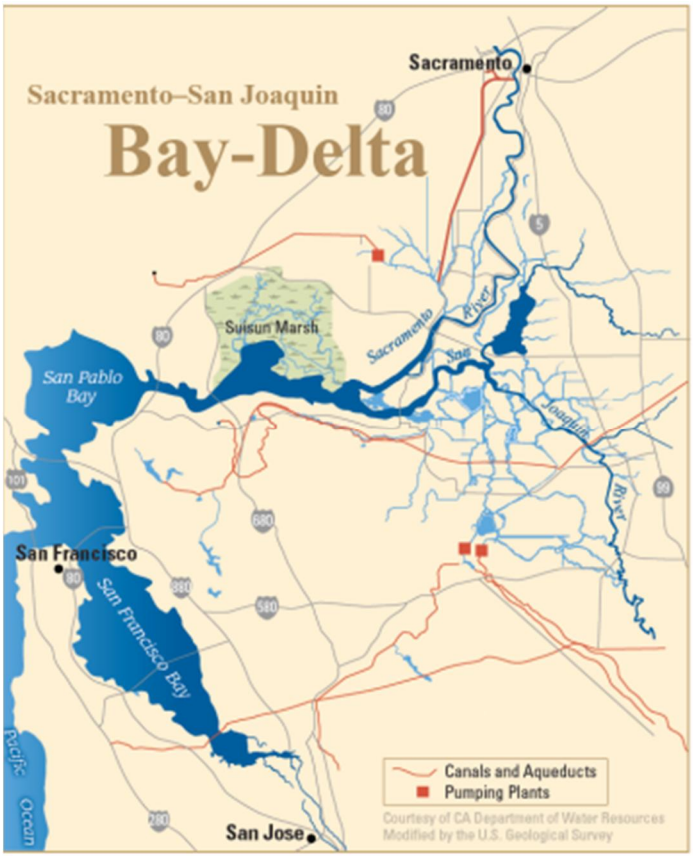

Figure 1. Bay Delta (Source: USGS)

This technical memorandum evaluates potential Delta outage scenarios utilizing existing hazard and risk analyses performed as part of the Delta Risk Management Strategy (DRMS) project commissioned by the California Department of Water Resources (2008). The DRMS project Phase 1 evaluated the risks and consequences to California and the Delta, due to failure of the Delta levees and other facilities as a result of exposure to potential current and foreseeable hazards. Two hazard types (flood and earthquake) are of primary concern and are considered in this evaluation. "Drivers of future change" such as subsidence and climate change are also included as part of the Delta outage scenarios because they are projected to increase the risk of all current hazards to the Delta levees over time.

Levee failures have the potential to degrade Delta water quality for a prolonged period of time dependent on numerous factors including:

- Size, location and number of levee breaches
- Initial salinity levels within the Delta at the time of failure
- Tides, inflows, exports and other diversions
- Available storage
- Related water management decisions
- Hydrology
- Management actions occurring after the failure event

For example, if levee breach(s) occurs during a flood event, the amount of saltwater that comes into the Delta from the San Francisco Bay (Bay) may be limited for a short period of time due to an influx of fresh flood water; however, an event during a storm surge from the Bay would increase the salinity. Increased salinity levels within the Delta can impact beneficial uses of the water including municipal, industrial and agricultural uses within the Delta and within the state or federal water project export areas. Additionally, flooding and draining of the Delta islands could release significant amounts of total organic carbon (TOC) into Delta waters from the highly organic peat soils of the islands as well as from algal blooms that may form in the warm shallow waters of the nutrient-rich flooded islands. Disinfectants used during the drinking water treatment process react with TOC, salinity, and bromide to produce disinfection by-products in treated water (URS/JBA, 2009). Other water quality constituents that could potentially suspend water exports or impact beneficial uses of exported water include:

- Suspended materials
- Metals: cadmium, chromium, copper, lead, selenium
- Pesticides
- Ammonia
- Phosphorous
- Algae

A flood or earthquake event may cause several simultaneous levee breaches on multiple islands in the Delta. The probability of island inundation is first presented individually for a flood event and an earthquake. After the likelihood of island flooding as a result of current and future hazards is presented, the results of the analyses of consequences of island flooding from various hazards are discussed for each type of hazard event and for all hazards combined.

Flood Risk

Flood events present a major hazard that could cause several islands to flood simultaneously during a single event. The probability of exceedance for simultaneous island failures as a result of a flood event based on 2005 risk analysis conditions are summarized in Table 1. In any given year, the annual frequency of exceedance is the probability that a flood event will occur and cause simultaneous island failures. When a longer time frame is considered, the probability of a flood event occurring that causes levee failure increases. The analysis from the DRMS report shows that there is a 99% chance that 10 islands will fail due to a flood event in a 100 year period. The chance that a lesser flood event will cause between 1-3 islands to fail simultaneously is over 99% given a 25 to 50 year period. The probability of a flood that causes simultaneous island failures occurring over a 25, 50, or 100 year period is not the same as projected future risk, which considers the increasing hazard potential or the changes in levee vulnerability that may exist in the future, and is discussed below.

Table 1. Probabilities of Simultaneous Island Failures as the Result of a Flood Under 2005 Risk Analysis Conditions

Number of Island Failures	Probability of Exceedance over a 25 Year Period[1]	Probability of Exceedance over a 50 Year Period[1]	Probability of Exceedance over a 100 Year Period[1]
1	99%	100%	100%
3	97%	99%	100%
10	72%	92%	99%
20	44%	69%	90%
30	21%	38%	62%
[1] - Assume no changes in risk in future years			

Source: DRMS Risk Report [URS/JBA 2008] Table 13-5

The evaluation of future risk considers the projected changes to the Delta that are expected to occur: subsidence of the islands, sea-level rise as a result of climate change, and the changing probabilities of flood frequencies. Flood frequencies are expected to increase due to the regional impacts of climate change. Climate change projections of precipitation are varied, but most projections forecast an increase in winter precipitation falling as rain rather than snow, and more frequent high intensity precipitation. The resulting annual frequency of island flooding from a Delta flood event is expected to increase due to the combined increase in flood frequency and to the increased risk of levee fragility due to subsidence and sea level rise.

There is significant uncertainty in the projections of factors that could increase the risk of future failure conditions. Considering the uncertainty in the projections and limitations in the available data, the DRMS study presented the future estimated increases in frequency as high, medium, and low risk scenarios for 2050 and 2100. These ranges represent a percentage increase in the annual frequency of exceedance for the island failure scenarios over the 2005 baseline. Table 2 summarizes the expected annual frequencies of exceedance under the medium risk scenario.

Table 2. Annual Frequencies of Simultaneous Island Failure Due to a Flood Hazard under 2005 and Medium Risk Projected Future Scenarios

Number of Island Failures	Annual Frequency of Exceedance in 2005	Annual Frequency of Exceedance by 2050[1]	Annual Frequency of Exceedance by 2100[2]
1	20%	74%	>100%
3	14%	50%	>100%
10	5%	18%	46%
20	2%	8%	21%
30	1%	4%	9%

Source: DRMS Risk Report [URS/JBA 2008] Tables 13-5 and 14-18

[1] 261% increase from 2005 conditions (Low and High Risk Scenarios range from 241% to 297% increase)

[2] 798% increase from 2005 conditions (Low and High Risk Scenarios range from 681% to 1,016% increase)

The estimated range of time to repair a levee breach and dewater the islands after simultaneous island failures due to a flood hazard event are summarized in Table 3.

Table 3. Time to Repair Levees and Dewater Islands after Flood Related Levee Failures

Number of Islands Flooded	Estimated Range of Time to Repair Breaches (days)	Estimated Range of Time to Dewater (days)
1	33-120	47-170
3	190-370	240-450
10	550-1,020	590-1,060
20	920-1,100	930-1,110
30	1,380-1,580	1,380-1,580

Source: DRMS Risk Report [URS/JBA 2009] Table 2/[URS/JBA 2008] Table 13-26

Note: The range provided includes one standard deviation from the mean values.

A scenario that considers simultaneous outage in the Delta and in the District service area from a single flood event was not evaluated. Although it is possible that a large enough storm to impact both the District and the Delta could occur, the exact conditions that would create a simultaneous outage of both Delta and District facilities is unknown and would require additional studies. In addition, the responses of the two areas to the same storm may be different (i.e., the storm causing a 100-year flood for the District may not cause the same magnitude of impact for the Delta). For planning purposes, it is recommended that separate outage scenarios representing District and Delta facility impacts are appropriate and severe enough to define appropriate performance targets.

Earthquake Risk

The probabilities of exceedance for simultaneous island failures as a result of a seismic event are summarized in Table 4. In any given year, the annual frequency of exceedance is the probability that a seismic event will occur and cause simultaneous island failures. When a longer time frame is considered, the probability of a seismic event occurring that causes levee failure increases. For example, the analysis from the DRMS report shows that there is a 99% chance that 10 islands will fail due to a seismic event in a 100 year period. The probability of an earthquake that causes simultaneous island failures occurring over a 25, 50, or 100 year period is not the same as projected future risk, which considers the increasing hazard potential or the changes in levee vulnerability that may exist in the future, and is discussed below.

Table 4. Probabilities of Simultaneous Island Failures as the Result of an Earthquake under 2005 Risk Analysis Conditions

Number of Island Failures	Probability of Exceedance over a 25 Year Period[1]	Probability of Exceedance over a 50 Year Period[1]	Probability of Exceedance over a 100 Year Period[1]
1	93%	99%	100%
3	87%	98%	100%
10	72%	92%	99%
20	55%	79%	96%
30	38%	62%	85%
[1] - Assume no changes in risk in future years			

Source: DRMS Risk Report [URS/JBA 2008] Table 13-2

The annual risks from a Delta levee failure are already high and the risks are expected to increase. The increase is due to the higher frequency of an earthquake based on the expected recurrence and elapsed time, and to the increased risk of levee fragility due to subsidence and sea level rise.

There is significant uncertainty in the projections of factors such as climate change impacts, subsidence, population growth, and land use that could increase the risk of future failure conditions. Considering the uncertainty in the projections and limitations in the available data, the DRMS study presented the future estimated increases in frequency as high, medium, and low scenarios of the future risk for 2050 and 2100. These ranges represent a percentage increase in the annual frequency of exceedance for the island failure scenarios over the 2005 baseline. Table 5 summarizes expected annual frequencies of exceedance under the medium risk scenario.

Table 5. Annual Frequencies of Simultaneous Island Flooding Due to an Earthquake under 2005 and Medium Risk Projected Future Scenarios

Number of Island Failures	Annual Frequency of Exceedance in 2005	Annual Frequency of Exceedance by 2050[1]	Annual Frequency of Exceedance by 2100[2]
1	11%	14%	21%
3	8%	11%	16%
10	5%	7%	10%
20	3%	4%	6%
30	2%	3%	4%

Source: DRMS Risk Report [URS/JBA 2008] Tables 13-2 and 14-17

[1] 35% increase from 2005 conditions (Low and High Risk Scenarios range from 28% to 49% increase)

[2] 93% increase from 2005 conditions (Low and High Risk Scenarios range from 68% to 140% increase)

The estimated range of time to repair a levee breach and dewater the islands after simultaneous island failures due to a flood hazard event are summarized in Table 6.

Table 6. Time to Repair Levees and Dewater Islands for Earthquake Induced Levee Failures

Number of Islands Flooded	Estimated Range of Time to Repair Breaches (days)	Estimated Range of Time to Dewater (days)
1	27-106	136-276
3	120-330	270-466
10	290-586	460-700
20	620-880	750-1,020
30	1,120-,1520	1,240-1,660

Source: DRMS Risk Report [URS/JBA 2009] Table 1/[URS/JBA 2008] Table 13-9

Note: The range provided includes one standard deviation from the mean values.

Based on the probabilities presented in Table 4, the chance of 10 simultaneous island failures as a result of a seismic event in the next 100 years is very high (>99%). However, it should be noted, that these probabilities are the cumulative probabilities of all possible seismic events on the faults in this region, which include the following:

- San Andreas
- Hayward-Rodgers Creek
- Calaveras
- San Gregorio
- Greenville
- Concord-Green Valley
- Mt. Diablo
- Southern Midland
- Midway-Black Butte
- Vernalis
- West Tracy
- Verona-Williams

Therefore, in the context of the IRP, which specifies discrete outage scenarios on the San Andreas and Calaveras faults, the individual risks to the Delta from these particular faults should be considered in determining the possibility of impacts to both the Delta and District facilities simultaneously. Based on the DRMS Phase 1 Report (pg. 6-19) an evaluation is made regarding a repeat of the 1906 San Andreas event (M 8.0). Based on the expected peak ground motions, an equivalent event is expected to cause:

> "Minor to moderate damage to the levees and foundations should a repeat of the 1906 earthquake occur today. The expected earthquake-induced deformations ranged from negligible to 3 feet depending on the levee vulnerability classes and its location in the Delta."

The peak ground accelerations generated by an equivalent M 8.0 earthquake on the San Andreas fault is < 0.2g at the Delta, given a recurrence interval of ~378 years (as estimated in the 2005 IRP). This magnitude of ground motion is not expected to cause significant damage to the levees as described above. Figure 2 shows the individual fault contributions to the mean peak ground acceleration at Clifton Court in the Delta.

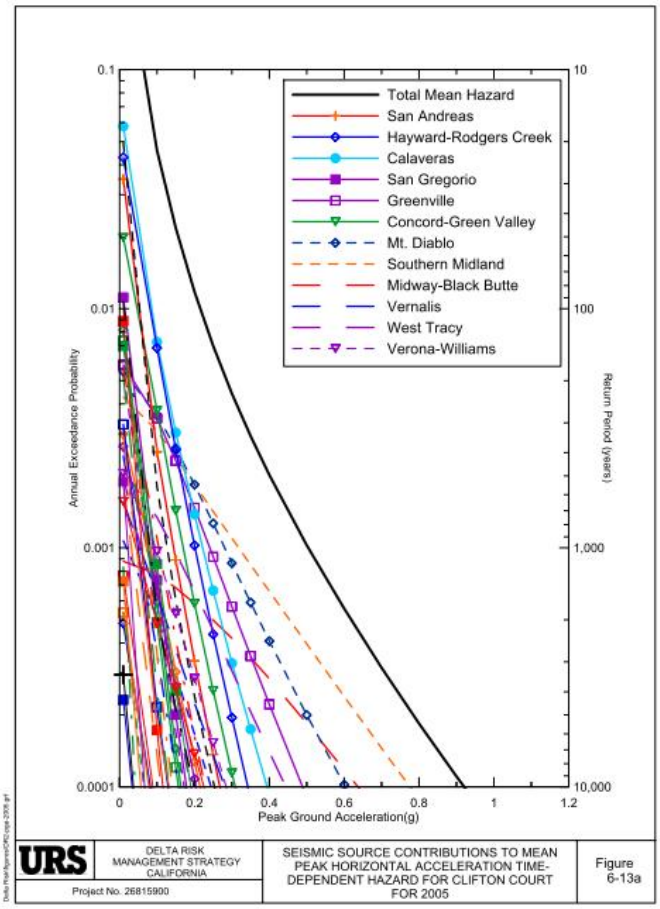

Figure 2. PGA Estimates for Various Faults

Using the individual seismic contribution data available in the DRMS report, the selected Calaveras fault event is also expected to produce ground motions < 0.2g, given an estimated recurrence interval of ~184 years. Therefore, it appears that the likelihood of significant Delta impacts from the selected seismic hazards is unlikely.

Combined Consequences of Hazard Risk

There is a greater probability of more simultaneous island failures during a large earthquake event than during a large flood event. This is because if an earthquake is strong enough to cause failure of one island, it is very likely that other islands would also fail. However, flood events occur more frequently than earthquakes and would therefore cause there to be more island failures over a long period of time.

The full estimate of risk is the probable outcome of all of the hazards (earthquake, floods, climate change, subsidence, wind waves, and sunny day failures) combined with the conditional probability of the subject outcome (levee failures, emergency response, water management, hydrodynamic response of the Delta and Suisun Marsh, ecosystem response, and economic consequences) given the stressing events. Table 7 summarizes the probability of exceedance given four different planning periods (1, 25, 50 and 100 years) for the combined risk of island inundation from a flood event, earthquake, and sunny day failure. No data for the combined risk under future risk projections are available. From Table 57 it can be seen that there is a high probability (>90%) of at least 10 simultaneous island failures over a 25 year planning period.

Table 7. Annual Probabilities of Exceeding Simultaneous Island Failures as a Result of All Hazards[1] Under 2005 Risk Conditions

Number of Island Failures	Probability of Exceedance over a 1 Year Period	Probability of Exceedance over a 25 Year Period[2]	Probability of Exceedance over a 50 Year Period[2]	Probability of Exceedance over a 100 Year Period[2]
1	42%	100%	100%	100%
3	22%	99%	100%	100%
10	10%	92%	99%	100%
20	5%	75%	94%	99%
30	3%	51%	76%	94%

[1] – All hazards include earthquake, floods, and sunny day failures
[2] – Assumes no changes in risk in future years

Source: DRMS Risk Report [URS/JBA 2008] Table 13-7

Conclusion

From the evaluation of potential flood and seismic risks to the Delta supply, it appears that this District water supply is vulnerable to interruption. Therefore, a unique outage scenario that only results in water export disruption from the Delta will be created and evaluated. Depending on if this is a flood or earthquake event, repair and dewatering could take between 47 to 1,660 days to repair from 1 to 30 islands (Figure 3).

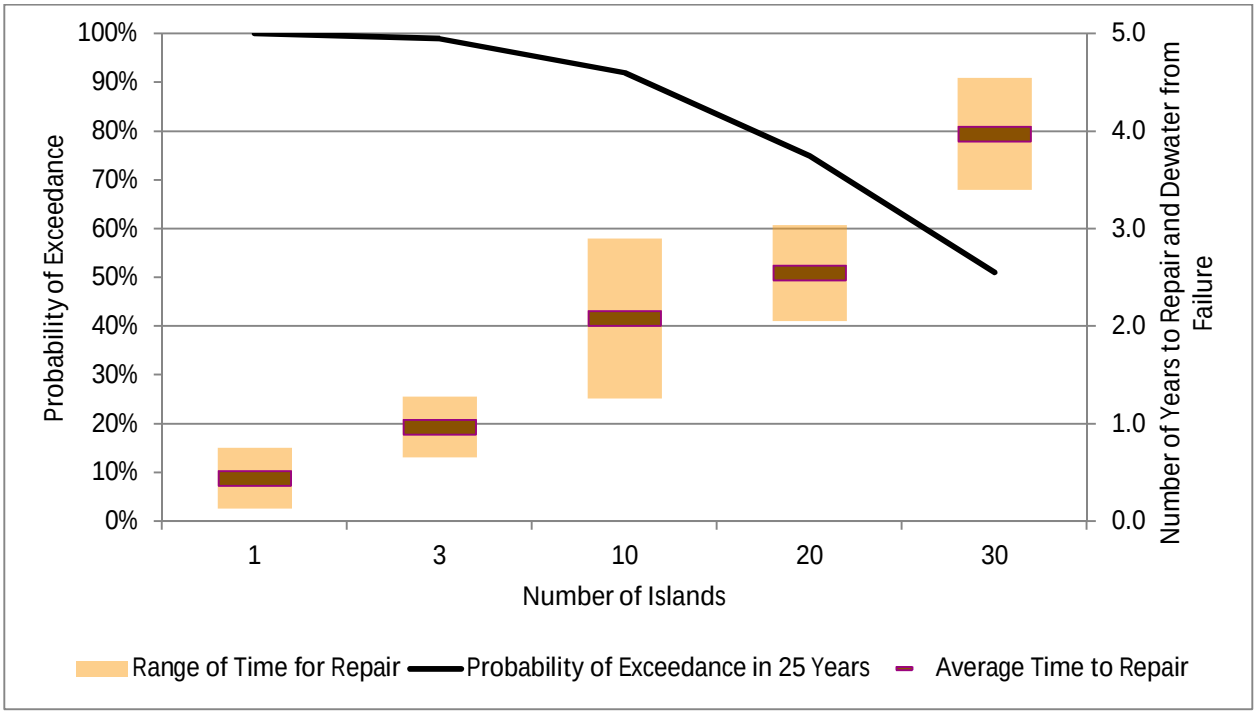

Figure 3. Probability of Failure Exceedance over a 25 Year Planning Period as a Result of All Failures and Estimated Range of Time (in years) to Repair the Levees and Dewater the Islands for Flood and Earthquake Hazards

Because the probability of at least one island failing is nearly 100% within a 25 year planning period, a short range water supply interruption was chosen for evaluation. Depending on the failure, the water supply could be interrupted from 47 to 276 days, or 1.6 to 9.2 months. After discussions with the District, a 6-month timeline for a short-term outage scenario, which is the approximate average of the range, was determined to be appropriate and selected.

Similarly, over a 25 year planning period, there is a greater than 90% chance that 10 islands could fail from a flood or seismic hazard event in the Delta. 10 damaged islands would take 460-1,060 days, or 15 to 35 months, to repair and dewater. Although there may be significant recovery periods (e.g., close to 3 years for 10 simultaneous island failures due to flooding), complete disruption to water exports may not last the entire time. As a result, a 24-month timeline for a long-term outage scenario, which is the approximate average of the range, was selected to represent a long-range, high probability Delta outage scenario.

References

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Delta Appendix:

State Delivery Report Summary TM

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Memorandum

To	Erin Baker (Santa Clara Valley Water District)	Page	1
CC			
Subject	Review of State Water Project Final Delivery Reliability Report 2013		
From	Courtney O'Neill, Aaron Lee, Jason Chen (AECOM)		
Date	January 28, 2015		

AECOM reviewed the (California) *State Water Project (SWP) Delivery Reliability Report 2013* that was finalized in December 2014. The SWP report describes the expected existing and future SWP water deliveries to its service areas and focuses on the SWP's delivery capability from the Sacramento–San Joaquin Delta (Delta). The water from the Delta is conveyed through the State and Federal systems to Santa Clara Valley Water District (District), which comprises 55% of the District's water supply. The following factors affect the ability to estimate existing and future water delivery reliability:

- Water availability at the source,
- Water rights with priority over the SWP
- Climate change
- Regulatory restrictions on SWP Delta exports (imposed by federal biological opinions [BOs] and State water quality plans)
- Ongoing environmental and policy planning efforts
- Delta levee failure

The analyses in the SWP report did not incorporate the risk of a disruption in SWP deliveries caused by catastrophic failure of the Delta levees. Also, the analysis assumes that both the regulatory restrictions issued by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service in their biological opinions and the Delta water quality and flow requirements contained in the State Water Resources Control Board's water quality control plan for the Delta are to remain unchanged (for future SWP deliveries).

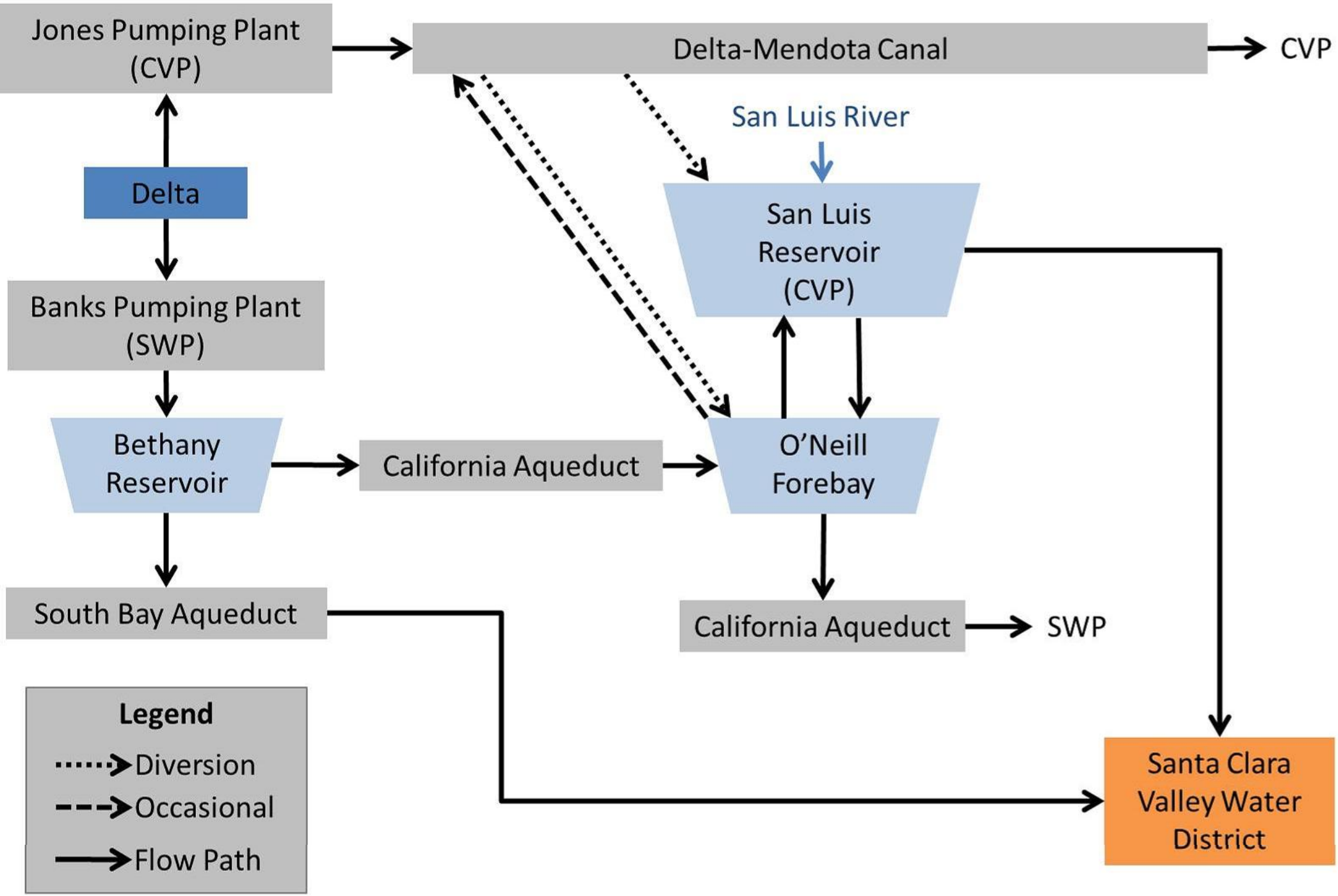
As discussed in the Bay Delta Levee Breach TM (Appendix G of the Task 5 Outage Scenario TM), the potential effects of a Delta levee failure associated with continued land subsidence, earthquakes, floods, and climate change on Delta water supplies poses a significant potential risk for the District. When islands are flooded, DWR may need to drastically decrease or even cease SWP Delta exports to their SWP contractors to evaluate the distribution of salinity in the Delta and avoid drawing saltier water toward the pumps. A Delta levee failure could interrupt water deliveries from the Delta for weeks, months, or even years, depending on the nature and the scope of the failure. Based on our evaluation of the Delta Risk Management Strategy (DRMS) report (2009), unique outage scenarios that capture Delta-specific failures are necessary. As a result, two Delta outage scenarios have been identified:

- Short-term/6-month Delta outage
- Long-term/18- to 24-month Delta outage

Even without the incorporation of a Delta Levee failure in the SWP reliability analysis, the results emphasize the ongoing need for local agencies to develop resilient and robust water sources and infrastructure to maximize the efficient use of a variable water supply. Given our review of the SWP reliability report, the outage scenarios that were developed for Task 5 of the District's Infrastructure Reliability Project (Project number: 93504001) will remain as documented in the Task 5 Outage Scenario TM (January 2015).

Delta Appendix:

Delta Import Schematic


Jones Pumping Plant (CVP)
Delta-Mendota Canal
CVP
San Luis River
Delta
San Luis Reservoir (CVP)
Banks Pumping Plant (SWP)
Bethany Reservoir
California Aqueduct
O'Neill Forebay
South Bay Aqueduct
California Aqueduct
SWP
Legend
Diversion
Occasional
Flow Path
Santa Clara Valley Water District

Delta Appendix:

Delta Status Summary TM

Delta Status Summary

1. Background

The Sacramento-San Joaquin Delta (Delta) is an important resource to the District because it provides 55% of the water supply for its customers, but it is also an important resource as the main water supply for other state water retailers as well. Unfortunately, the Delta is extremely susceptible to catastrophic damage in the event of earthquakes, floods, and other threats. An outage of the Delta could impact the District's ability to deliver potable water to its retailers.

Delta levee failure as a result of floods, earthquakes, erosion, or rising sea levels could interrupt water deliveries from the Delta for weeks, months, or even years, depending on the nature and the scope of the failure (SWP Delivery Reliability Report, 2013). The district receives water from the Delta via the California State Water Project (SWP) and Federal Central Valley Project (CVP) pumping plants, which are located in the south Delta. As presently configured, earthquakes, floods, and other threats in and around the Delta region will cause numerous levees to fail, with the result that some number of islands will flood. When these islands flood, sea water will be pulled into the Delta, potentially reducing or stopping project deliveries for some period of time (BDCP, 2013). Tech Memo 5 summarizes the outage times expected if the Delta levees were to fail under flood or earthquake scenarios. Two scenarios were chosen for evaluation: a short-term 6 month outage scenario, and a long-term 24 month (2 year) outage scenario. Both are potential outage scenarios under current baseline conditions.

However, because the Delta is so important to water retailers and because it offers a multitude of other benefits to the State of California, it is likely any necessary repairs to the Delta would be prioritized in an emergency, and that an outage scenario would not last longer than a year. Numerous initiatives and programs have already been undertaken in order to protect and enhance the Delta's valuable assets and to manage the state's water resources. Although the purpose of this TM is to examine the District's abilities to deliver water with its current baseline system and no improvements in place, the current projects and improvements occurring in the Delta must be considered in any evaluation of the District's water supply reliability.

The following programs have analyzed the current risk to the Delta and they evaluate potential strategies for reducing risk to the Delta and the state from adverse consequences of levee failure:

- **Delta Risk Management Strategy (DRMS)-** evaluates the potential impacts on Delta water supplies associated with continued land subsidence, earthquakes, floods, and climate change.
    - **Phase 1** (2008) -assessed the performance of Delta levees under various stressors and hazards and evaluated the consequences of levee failures to California as a whole
    - **Phase 2** (2011) -evaluated alternatives to reduce the risk to the Delta and the state from adverse consequences of levee failure. The recommended alternative was the construction of an Isolated Conveyance Facility (ICF) on the eastern side of the Delta.
- **Bay Delta Conservation Plan (BDCP) (2013)** - provides a comprehensive, 50-year conservation road map for the Delta that proposes new water intakes and conveyance. The BDCP included three new intakes located in the North Delta and two parallel underground pipelines conveying diverted water to the existing export facilities in the South Delta. It was paired with an extensive Habitat Conservation Plan (HCP).
    - **2013-2014 Joint Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS)**- used to analyze and disclose the potential environmental effects associated with the BDCP and its alternatives

- **2015 Recirculated Joint Draft EIR/EIS-** incorporates comments from the 2013-2014 Joint Draft EIR/EIS and evaluates an updated BDCP alternatives that does not include the elements of a habitat conservation plan

Note: These are the programs and plans most applicable to District concerning the strategies for exporting water from the Delta; it is not an exhaustive list.

Currently, the 2015 Recirculated Joint Draft EIR/EIS is out for public comment. The reports are targeted to be final in 2016, after which a decision to proceed with the program would be made. The 2015 Recirculated Joint Draft EIR/EIS recommends the Isolated Conveyance Facility (ICF) as the preferred alternative. The "agency's preferred alternative" is the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors. (For reference, in the BDCP and in the 2013-2014 Joint Draft EIR/EIS the ICF is sometimes also referred to as: Alternative 4, Conservation Measure (CM) 1, or the Twin Tunnels.)

Additional strategies for reducing the risk to the Delta were evaluated during Phase 2 of the DRMS. The report evaluated the costs and benefits of upgrading the Delta levees to meet the target PL 84-99 standards, and for building an armored pathway to move freshwater from the Sacramento River to the SWP and CVP intake facilities located in the south Delta. Upgrading the Delta levees would reduce the probability of failure due to small flooding events, but they might not be able to withstand a 100-year flood and upgrades would not reduce the seismic risk of levee failure. The armored pathway would improve the levees along the pathway so that they have a significantly lower probability of failure due to flooding and seismic events, but the cost-to-benefit valuation was lower than the ICF strategy that is recommended as the preferred alternative.

2. Proposed California Water Fix Case

The preferred alternative (Alternative 4A in the Recirculated Draft EIR/EIS) is also known as, “The California Water Fix.” It includes three new intakes located in the North Delta and two parallel underground pipelines conveying diverted water to the existing export facilities in the South Delta (2015 Recirculated Joint Draft EIR/EIS, Chapter 4). The 9,000 cfs capacity ICF would provide a north-to-south freshwater corridor through the construction of an isolated canal around the eastern periphery of the Delta, including capabilities to resist failure during a major earthquake or flood. This system allows water to be diverted from either the north or the south Delta, or both, so it would be a dual conveyance system which reduces the vulnerability of the water export system to levee failure.

With the ICF, water is diverted around the Delta, away from those islands most likely to be inundated by brackish water during a levee break. The seismic vulnerability of Delta levees would remain unchanged, so the frequency of occurrence of levee failures and island flooding remains the same as estimated in the Phase 1 analysis (base case). However, the ICF is expected to remain functional during the design seismic event, and the water export disruption under seismic events will be reduced by about 100 percent for any number of flooded islands (DRMS, Phase 2, Chapter 18).

Any repairs that might be required to the ICF canal, structures, and equipment if damages are incurred, (in particular from a seismic event), will be able to be made from land. It is assumed that the repairs required to return the ICF to service can be made in a short period (3 months or less in most cases, possibly a bit longer in other cases) (DRMS, Phase 2, Chapter 18).

Without the ICF, it is assumed that there would be 1.0 Million Acre-Feet (MAF) of total water supplies available after a major seismic event, although exports may not be available. The water supplies are to be split up between urban and agricultural contractors (BDCP, Appendix 9.A). The proposed ICF alternative (with a facility size of 9,000 cfs) would be able to supply 3.8 MAF in the event of an earthquake. The economic benefits analysis only assumed the post-earthquake shortages would last one year, even though in actuality, the decrease in water exports following a major seismic event are assumed to persist up to 3 years.

Cost estimates for the ICF (*CM1 Water Facilities and Operation)* are presented for the design, project management, construction management of the water conveyance facilities; the intake and conveyance construction costs; the construction cost contingency; land acquisition; annual operation, maintenance, power, and capital replacement. Construction of the ICF is estimated to cost $14.4 billion (BDCP, Chapter 8).

Construction of the ICF is expected to begin approximately 2 years after permit issuance and will continue for an estimated 9 to 10 years (BDCP, Chapter 6). Operations could begin as soon as 11 years after permit issuance, which is expected to occur in 2016.

3. References

California Department of Water Resources, 2008. *Delta Risk Management Strategy (DRMS) Phase 1*, December 2008.

California Department of Water Resources, 2011. *Delta Risk Management Strategy (DRMS) Phase 2*, December 2011.

California Department of Water Resources, 2013. *Public Review Draft Bay Delta Conservation Plan*.

California Department of Water Resources, 2013. *Public Review Draft Bay Delta Conservation Plan Environmental Impact Report / Environmental Impact Statement.*

California Department of Water Resources, 2014. *The State Water Project Final Delivery Reliability Report 2013*, December 2014.

California Department of Water Resources, 2015. *Public Review Partially Recirculated Draft Bay Delta Conservation Plan Environmental Impact Report / Supplemental Environmental Impact Statement.*

Delta Appendix:

Emergency Freshwater Pathway Description TM

Emergency Freshwater Pathway Description (Sacramento-San Joaquin Delta)

The California Department of Water Resources (DWR) has estimated that in the event of a major earthquake in or near the Delta, regular water supply deliveries from the SWP could be interrupted for up to three years, posing a substantial risk to the California business economy. Accordingly, a post-event strategy has been developed which would provide necessary water supply protections. The plan has been coordinated through DWR, the Army Corps of Engineers (Corps), Bureau of Reclamation, California Office of Emergency Services (Cal OES), the Metropolitan Water District of Southern California, and the State Water Contractors. Full implementation of the plan would enable resumption of at least partial deliveries from the SWP in less than six months.

DWR Delta Flood Emergency Management Plan. DWR has developed the Delta Flood Emergency Management Plan to provide strategies for a response to Delta levee failures, which addresses a range of failures up to and including earthquake-induced multiple island failures during dry conditions when the volume of flooded islands and salt water intrusion are large. Under such severe conditions, the plan includes a strategy to establish an emergency freshwater pathway from the central Delta along Middle River and Victoria Canal to the export pumps in the south Delta. The plan includes the pre-positioning of emergency construction materials at existing and new stockpiles and warehouse sites in the Delta, and development of tactical modeling tools (DWR Emergency Response Tool) to predict levee repair logistics, water quality conditions, and timelines of levee repair and suitable water quality to restore exports. The Delta Flood Emergency Management Plan has been extensively coordinated with state, federal and local emergency response agencies. DWR, in conjunction with local agencies, the Corps and Cal OES, regularly conduct simulated and field exercises to test and revise the plan under real time conditions.

DWR and the Corps provide vital Delta region response to flood and earthquake emergencies, complementary to an overall Cal OES structure. Cal OES is preparing its Northern California Catastrophic Flood Response Plan that incorporates the DWR Delta Flood Emergency Management Plan. These agencies utilize a unified command structure and response and recovery framework. DWR and the Corps, through a Draft Delta Emergency Operations Integration Plan (April 2015), would integrate personnel and resources during emergency operations.

Levee Improvements and Prioritization. The DWR Delta Levees Subvention Program has prioritized, funded, and implemented levee improvements along the emergency freshwater pathway and other water supply corridors in the central and south Delta region. These efforts have been complementary to the DWR Delta Flood Emergency Management Plan, which along with use of pre-positioned emergency flood fight materials in the Delta, relies on pathway and other levees providing reasonable seismic performance to facilitate restoration of the freshwater pathway after a severe earthquake. Together, these two DWR programs have been successful in implementing a coordinated strategy of emergency preparedness for the benefit of SWP and CVP export systems.

Significant improvements to the central and south Delta levee systems along Old and Middle Rivers began in 2010 and are continuing to the present time at Holland Island, Bacon Island, Upper and Lower Jones Tracts, Palm Tract and Orwood Tract. This complements substantially improved levees at Mandeville and McDonald Islands and portions of Victoria and Union Islands. Together, levee improvements along the pathway and Old River levees consisting of crest raising, crest widening, landside slope fill and toe berms, meet the needs of local reclamation districts and substantially improve seismic stability to reduce levee slumping and create a more robust flood-fighting platform. Many urban water supply agencies have participated or are currently participating in levee improvement projects along the Old and Middle River corridors.

Santa Clara Valley Water District

Infrastructure Reliability Plan

Earthquake Appendix

AECOM

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Pipe Damage Analysis Maps 660

Earthquake Appendix:

Updated Information on Infrastructure Impacts

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Earthquake Appendix:

Drought and Earthquake Recurrence Interval Evaluation

Earthquake and Drought Recurrence Intervals

SCVWD Infrastructure Reliability Plan

The following tables summarize recurrence intervals for earthquakes and droughts that may impact SCVWD.

Table 1. Summary of Earthquake Probabilities

			Any Year	Next 30 Years	
Fault	**Magnitude**	**Estimated Recurrence Interval (years)[1,2]**	**Estimated Probability of Occurence in Any Given Year (percent)**	**Estimated Probability of Occurrence in 30 years (percent) - 2002-2031[1,2]**	**Estimated Probability of Occurrence in Any Given Year (in the next 30 years)**
San Andreas	7.9	378	0.26%	4.7%	0.16%
Calaveras	6.23	184	0.54%	13.8%	0.46%
Hayward	6.67	292	0.34%	11.3%	0.38%

References:

[1] - Santa Clara Valley Water District Reliability Project: Preliability Baseline Evaluation Technical Memorandum. ABS Consulting (August, 2004)

[2] - Earthquake Probabilities in the San Francisco Bay Region: 2002-2031. Working Group on California Earthquake Probabilities. USGS OFR: 03-214

Table 2. Summary of Drought Probabilities

Date of Occurrence	Affected Area	Recurrence Interval
1917- 21	Statewide except central Sierra Nevada and north coast.	10 to 40
1922- 26	Statewide except central Sierra Nevada	20 to 40
1928- 37	Statewide	>100
1943- 51	Statewide	20 to 80
1959- 62	Statewide	10 to 75
1976- 77	Statewide, with the exception of southwestern deserts.	>100
1987- printing	Statewide	10 to 40

Reference:

"Major Floods and Droughts in California". National Water Summary 1988-1989 Hydrologic Events and Floods and Droughts. U.S. Geological Survey Water-Supply Paper 2375, 591 p.

Using a conservative recurrence interval of 10 years for a major drought, Table 3 summarizes the probabilities in any given year of a seismic event and drought occurring simultaneously.

Table 3. Probabilities of Simultaneous Earthquake and Drought Events

Fault	Magnitude	Estimated Probability of Occurence in Any Given Year (percent)	Estimated Probability of Occurrence in Any Given Year (in the next 30 years)
San Andreas	7.9	0.026%	0.016%
Calaveras	6.23	0.054%	0.046%
Hayward	6.67	0.034%	0.038%

Earthquake Appendix:

Pipe Damage Analysis Maps

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Santa Clara Valley Water District

Infrastructure Reliability Plan

Power Outage Appendix

AECOM

Power Outage Appendix 701
Fuel Analysis Memo 703

JOE HILL CONSULTING ENGINEERS

To: Erin Baker, SCVWD

From: JHCE and AECOM team – Joe Hill, JHCE and Jason Chen, AECOM

Date: January 8, 2016

Re: Summary of Fuel Analysis for SCVWD Facilities

Executive Summary

This memorandum provides a summary of the fuel supply analysis performed for critical facilities within the Santa Clara Valley Water District's (SCVWD or the District) service area. The analysis focused on the three District Water Treatment Plants (WTPs) – Rinconada (RWTP), Penitencia (PWTP), and Santa Teresa (STWTP) – which are the most critical for a continued supply of potable water. Other facilities such as pumping plants and the SCVWD/SFPUC Intertie were also considered. This is part of the District's Infrastructure Reliability Plan (IRP) Project to assess the potential impact of natural disasters on District infrastructure and operations.

Prolonged Power Outage

Historic energy consumption for WTPs and pumping plants, along with operational data for the SCVWD/SFPUC Intertie and the Campbell Well Fields were provided by SCVWD. The analysis assumed continued operation and energy consumption rates at pre-emergency flows following a power outage. The District would attempt to continue operations as they were immediately prior to the event. Based on historic outages in the United States, a two-week power outage was selected for the analysis.

Fuel storage for SCVWD facilities exists at RWTP, STWTP, PWTP, and at the SCVWD/SFPUC Intertie, which can be utilized in the event of a prolonged power outage. Based on historic energy consumption and assumptions regarding future upgrades to RWTP, the analysis estimated that the SCVWD could operate their facilities on backup fuel storage alone between 3.1 to 10.5 days, depending on the time of year. These constraints are based on when facilities run out of fuel and are typically limited by RWTP. However, this estimate is based on an extrapolation of the historical energy consumption at the existing RWTP and needs to be confirmed once performance data from the upgraded facility is available.

The District could continue operations for much longer on backup power if routine fuel deliveries are initiated as part of a coordinated disaster response effort. RWTP would need to be refueled every third day in the summer months, while STWTP and PWTP could be refueled every sixth and ninth day, respectively. Winter demands would require less frequent fuel deliveries (Table 7).

IRP Scenarios

The IRP Project identified specific facility outage scenarios associated with disaster events (seismic and other) and fuel needs associated with these IRP Scenarios were evaluated. Fuel is only useful at a particular facility if the facility and related raw/treated water conveyance systems are operable. The analysis showed that for a majority of the IRP scenarios, serious damage to most facilities would make the availability of fuel irrelevant since they would not be operable (due to damage or lack of source water) until after Day 14. The exception is the SCVWD/SFPUC Intertie facility, which is predicted to be operable on Day 4 for all scenarios except San Andreas 2. The Intertie would require refueling for continued operations longer than 3 days following return to service (7 days after the initial event).

For the Calaveras Event Scenario, PWTP is predicted to be damaged and STWTP is not operable due to lack of source water until after Day 14. RWTP and the SCVWD/SFPUC Intertie are assumed to have sustained only minor damage and are restored by Day 4. Under minimum water demands specified in the IRP, storage tanks at RWTP and the SCVWD/SFPUC Intertie would need to be refueled every fourth and third day, respectively.

1 Background

This memorandum summarizes a fuel supply analysis performed for critical facilities within the Santa Clara Valley Water District's (SCVWD or the District) service area. SCVWD is a wholesale supplier of water for 16 water retailers in Santa Clara County and is taking actions to prepare itself for extended power outages in the event of an earthquake, extreme weather, or other emergency.

As a preparatory action, the District is performing an Infrastructure Reliability Project (IRP) to assess the potential impact of natural disasters on District infrastructure. Each disaster could cause various degrees of damage to District facilities. The IRP made estimates regarding damage and potential facility repair schedules, which indicates the expected duration until these facilities are operational following the disaster.

This memo presents the results of an evaluation which estimates:

1. How long the District can operate its critical facilities with existing backup fuel storage;
2. Refueling requirements for continued operation without a primary power source; and
3. Refueling requirements for recovery based on the scenarios identified in the IRP Project, in which some facilities would be inoperable due to damage or lack of source water.

Section 2 discusses power outage durations as recommended by power utilities and experienced in historic outages during past storms and seismic events. Section 3 presents facility capacity along with generator and fuel storage capacity of the critical facilities evaluated in the study. Sections 4 and 5 present the energy consumption data, analysis methodology and results. Conclusions and recommendations for additional regional fuel storage considerations, based on ongoing discussions with San Jose Water Company (SJWC) and other Bay Area agencies, are discussed in Section 6.

2 Recent Power Outage Events and Durations

In order to address power outages, Pacific Gas and Electric (PG&E), the local provider of electricity in Santa Clara County, published an Electric Emergency Operations Plan (EEOP), dated August 29, 2014. This document describes a Level 5 Catastrophic Event having an estimated time to electricity restoration of greater than 6 days. By examining power outages throughout the U.S., it is clear there is potential and precedent for loss of power to extend well beyond 6 days. Table 1 below lists major power outages associated with natural disasters in other regions of the U.S. and provides context for the District's analysis. These recent events provide a realistic perspective of the impact of disasters on power supplies and potential duration to partial or complete restoration.

Table 1: Recent Power Outage Events

Event	Date	Outage Duration	Notes
Loma Prieta 6.9 Magnitude Earthquake (Northern CA)	Oct 1989	2 days	Majority of power restored to San Francisco within 2 days
Northridge 6.7 Magnitude Earthquake (Southern CA)	Jan 1994	1 day	Power unavailable to 25% of LA, most power restored within a day
Northeast Blackout 2003 (Equipment-Related Outage)	Aug 2003	2-4 days	Power restored within 3 hours for some while others took 2-4 days, rural areas took almost a week
Hurricane Katrina (LA, MS)	Aug 2005	> 23 days	40% of LA with no power at 2 weeks. 15 days to recovery for MS.
Hurricane Rita (TX)	Aug 2005	16-20 days	Followed Hurricane Katrina, affected 766,000 customers
Hurricane Wilma (FL)	Oct 2005	< 14 days	98% of Miami-Dade County lost power including major airports and hospitals.
Hurricane Ike (TX)	Sept 2008	6-16 days	Affected Greater Houston area
Ice Storm (Northeast US – Maine to Pennsylvania)	Dec 2008	> 14 days	Up to 1.25 million people affected
Hurricane Irene (East Coast)	Aug 2011	6-7 days	7 days for NY to reach 95%, 6 for NJ
2011 Halloween Nor'easter Snow Storm (NE US/E. Canada)	Oct 2011	10 days	1.7 million customers without power for 3 days before restoration began.
Derecho Wind Storm (Midwest)	June 2012	7-10 days	Wind Storm - Tree clearing and line restoration efforts in many cases took 7 to 10 days.
Hurricane Sandy (East Coast)	Oct 2012	10-14 days	Hospitals - 3 days, Fire Stations - several days. Primarily NY, NJ, WV.
February 2013 Nor'easter (Northeast U.S./East Canada)	Feb 2013	2-6 days	Downed wires and heavy snows were the cause of most power lost to 700,000 customers
North American Ice Storm (Ontario, Canada, mid-Michigan)	Dec 2013	7-9 days	Widespread power outages to over one million customers

A number of storm events resulted in lengthy outage durations of one to two weeks or more, including Hurricane Sandy (2012), the Derecho Wind Storm (2012), the 2011 Halloween Nor'easter Snow Storm, and a series of hurricanes in 2005. The outage durations reflect general power restoration to the public. Utilities typically make an effort to more rapidly restore power to critical facilities, (e.g. hospitals, fire departments, police stations, critical communications centers, emergency shelters, sewage treatment plants, and critical water treatment/distribution infrastructure). However, power restoration is highly dependent on the extent of damage to power infrastructure. For example, during Hurricane Sandy, critical facilities such as hospitals and wastewater plants had power restored between 1-3 days while other critical facilities were without power for two weeks due to extensive damage to power plants[1]. Further research into power restoration times specifically for water transmission and distribution infrastructure would be valuable to this analysis.

[1] FEMA P-942, Mitigation Assessment Team Report: Hurricane Sandy in New Jersey and New York, 2013.

Based on the examples in Table 1, the threat of extreme weather events and earthquakes in the San Francisco Bay Area, and discussions with the District, a power outage with a duration of two weeks was considered as a target for the purposes of this study.

3 Existing Facility Information

SCVWD facilities that could be impacted in the event of a power outage include water treatment plants, pumping plants, and SCVWD/SFPUC Intertie, and are listed in Table 2 along with facility capacity and generator and fuel storage availability.

Table 2: Generator and Fuel Type/Storage Information

Facility	Generator Capacity (kW)	Diesel Fuel Storage (gal)	Flow Capacity (MGD)/ Pump Capacity (GPM)
Santa Teresa Water Treatment Plant (STWTP)	900	3,000	100 MGD
Penitencia Water Treatment Plant (PWTP)	1,000	4,000	40 MGD
Rinconada Water Treatment Plant (RWTP)*	1,500 + 2,500 (proposed)	28,000 (proposed)	80 MGD
Pacheco Pumping Plant (PPP)	Generators available for minimum power (lights and SCADA only; use portable fuel tanks)	1,000	153,492 gpm; 12,000 hp (6 pumps, 0-2 in service)
Coyote Pumping Plant (CPP)		None	301,055 gpm; 24,000 hp (12 pumps, 7-8 in service)
Vasona Pumping Plant (VPP)		None	72,000 gpm; 1,200 hp (4 pumps, 0 in service)
SCVWD/SFPUC Intertie Pump Station	2,000	8,600 (2 - 4,000 gal and 600 gal on-board tank)	40 MGD
Campbell Well Fields	3 x 250	None	2 MGD for RWTP supplement

* Includes proposed changes to the RWTP during upcoming CIP.

Additional information on facilities relevant to the fuel analysis is provided below:

- Rinconada Water Treatment Plant – Treatment upgrades to RWTP in the upcoming Capital Improvement Program (CIP) will result in an increase in the energy demand load of approximately 4.5 times that of the existing RWTP. Generator capacity will also be increased.
- Pacheco Pumping Plant – This facility is critical for pumping raw water to the District's system and is always needed when using San Luis source water. This pump station does not have a backup electrical power generator capable of running a pump but does have 1,000 gallons of fuel storage.
- Coyote Pumping Plant – During periods of average to high flows, the CPP pumps water to the District's water treatment plants. It is also used to pump water into Anderson Reservoir. During periods of low flows, water can flow to the treatment plants by gravity. This pump station does not have a backup electrical power generator capable of running a pump.
- Vasona Pumping Plant – This pump station provides the flexibility to deliver South Bay Aqueduct (SBA), Central Valley Project (CVP), and other local water sources to any of the water treatment

plants. VPP has an interconnection network that allows for a rapid connection to a rented backup diesel generator should power be lost for an extended period. No on-site generator for running the pumps is available.

- SCVWD/SFPUC Intertie – This 40 MGD pump station provides a means for SCVWD and SFPUC to exchange water. The station has a flow capacity of 40 MGD (in both directions) using 3 pumps and one as a backup. Typically, SFPUC will gravity flow 10 MGD to SCVWD. One pump has been removed to facilitate gravity flow. SCVWD typically operates the pumps when SCVWD water is transferred to the SFPUC system. Generator and fuel storage is available on-site.
- Campbell Well Fields - This is a raw water backup source that can provide 2-3 MGD with portable generators stored at RWTP. However, there is no fuel storage on-site.

The District provided monthly historic water flows and energy consumption rates for the water treatment plants, CPP, and VPP (PPP energy consumption rates were not available) from 2006-2012. For the purposes of this analysis, fuel requirements were primarily focused on facilities that have both generators and on-site fuel storage for operating the facility: the three water treatment plants and the SCVWD/ SFPUC Intertie Facility. However, estimated fuel consumption rates for all facilities are summarized in Section 5.

4 Fuel Analysis

The fuel analysis is divided into two parts:

1) The first analysis considers fuel requirements from a prolonged power outage with the assumption that all facilities are operable for the duration of the power outage and will require emergency fuel to operate.
2) The second analysis, which is based on the IRP study, considers emergency scenarios and accounts for facility outages or lack of source water. That is, fuel is not required at a facility until that facility can be operated.

Details of these analyses can be found in the *Fuel Analysis Spreadsheet Tool*, an Excel spreadsheet which has been included with this memo for the District's use.

4.1 Assumptions

Additional assumptions made during the analysis are as follows:

1. Total monthly energy usage for the upgraded RWTP was estimated using the historic data from the existing RWTP and multiplying total monthly energy usage by approximately 4.5 (based on the proportional increase in anticipated energy demands of the upgraded facility and the upsized generator). Updates to the analysis should be made once more accurate flow and energy demand estimates for RWTP are available.
2. Energy demand data for SCVWD/SFPUC Intertie was not available. However, the District provided information that the 8,600-gallon storage tank can run the SCVWD/SFPUC Intertie pumps for 3 days. As such, we estimated an average fuel demand of 1/3 of 8,600 gallons, or 2,830 gallons per day.

4.2 Prolonged Power Outage Fuel Analysis

This section summarizes the steps taken to assess a prolonged power outage at each facility. There is a range in the energy consumption rates of each facility since operations vary throughout the year. Based on the historic energy consumption data and assumptions discussed in Section 4.1, the following steps were taken to calculate fuel consumption rates and total fuel needs. Refer to the *Fuel Analysis Spreadsheet Tool* for detailed calculations.

1. *Fuel Consumption Rates by Month Worksheet*:
    a. Monthly energy consumption data (in kWH) were converted into gallons of diesel fuel needed using the EPA recommended conversion of 0.07 gallons of diesel fuel per kWh[2].
    b. Daily fuel consumption rates were calculated for each month by dividing total gallons of fuel by the respective number of days in each month.
    c. Average, minimum and maximum daily fuel consumption rates (gallons of diesel fuel per day) for the 6-year period for which historical data was provided (2006 – 2012) are tabulated on this spreadsheet for each facility.
    d. Fuel consumption rates for the upgraded RWTP were estimated based on a proportional generator size increase. While the flow capacity of the RWTP is not increasing, this was considered the best approach to account for the increased energy demands due to treatment process upgrades.
    e. Fuel consumption rate estimates for SFPUC/SCVWD Intertie and Campbell Well Fields were calculated based on available fuel storage and generator capacity provided by the District.
2. *Refueling Schedule Worksheet*: Refueling requirements were calculated based on the daily fuel consumption rate and the storage available at each facility. The schedule is based on maintaining at least a 25% fuel tank level each day and is discussed in Section 5.1.
3. *kW per MGD Worksheet*: Historic energy usage and monthly flows were examined to determine energy consumption and fuel consumption demand (in kW) per MGD of water flow. This can be used in further analyses to estimate energy consumption rates based on target emergency water demands.

Additional worksheets are included at the end of the Fuel Analysis Spreadsheet Tool which contain raw data provided by the District and intermediary calculations.

4.3 IRP Study Fuel Analysis

Under Task 5 of the IRP, a list of emergency scenarios was developed which were used to evaluate the impact of water supply losses, facility damages, power outages and/or water quality issues on delivering water to the District's customers. These emergency outage scenarios are presented in the IRP Task 5 TM, and include:

1. Extreme weather: Extreme flood/storm event
2. Earthquake: 2 scenarios for a San Andreas fault event and 1 scenario for a Calaveras fault event

[2] EPA 903-F-11-002, Is Your Water or Wastewater System Prepared? What You Need to Know About Generators, March 2011.

3. Delta Failure: Loss of the water source supplied from the State Water Project.

Of the identified scenarios, only the extreme weather and earthquake scenarios are predicted to experience power outages that could impact SCVWD facilities. Critical facilities in the District's water distribution and treatment system that require power to operate are listed below in Table 3. A facility is denoted with an 'X' where there is potential for facility damage that renders it inoperable (i.e. structural damage, water damages from flooding, etc.) and lists the estimated number of days it is unavailable. This table also lists the number of days a facility may be unavailable as a result of other issues (i.e. lack of water supply, inaccessibility, etc.).

Table 3: Potential Facility Damages (marked by X) for IRP Emergency Scenarios
(Undamaged Facilities not requiring repair are assumed to undergo 14-day power outage)

Facility	Outage, X (Earliest Day Available for Operation*)			
	Flood/Storm	San Andreas Earthquake #1	San Andreas Earthquake #2	Calaveras Earthquake
STWTP	(18)	(32)	(18)	(18)
PWTP	X (78)	X (106)	X (92)	X (78)
Existing RWTP	(18)	(32)	(18)	(4)
Upgraded RWTP**	Not available			
Pacheco Pump Station	(18)	(32)	(18)	(4)
Coyote Pump Station	X (78)	(32)	(18)	(4)
Vasona Pump Station	X (78)	(32)	(18)	(4)
SCVWD/SFPUC Intertie Pump	(4)	(4)	(18)	(4)

* Includes when source water is available and/or facility has been repaired. Days shown is the soonest available of two restoration scenarios provided by SCVWD for each outage scenario.

** Upgrades to the RWTP during the upcoming Capital Improvement Program (CIP) are expected to improve its reliability in the event of an earthquake. Until these upgrades are completed, RWTP remains susceptible to these hazards.

The supply of power and availability of fuel is irrelevant until a facility becomes operable. The *Total Fuel Needs by Scenario Worksheet* utilizes the *Fuel Consumption Rates by Month Worksheet* data and presents the amount of fuel needed under average, minimum, and maximum energy consumption periods grouped by IRP emergency scenario. It also provides dynamic estimates of daily fuel needs for each facility based the number of days until PG&E power is restored. The number of days, *n,* can be adjusted in the worksheet cell indicated to conceptualize a range of outage events.

5 Summary of Results

5.1 Prolonged Power Outage

The goal of the analysis is to estimate how long the District can operate their system utilizing backup power. Table 4 and Table 5 show the estimated daily fuel consumption rates by month for the WTPs and for the pumping plants, respectively. Fuel consumption rates were not estimated for Pacheco PP since historic energy consumption data was not available. Fuel consumption rates for SCVWD/SFPUC Intertie and the Campbell Well Fields are based on storage or generator capacity. These estimates should be revised when additional information becomes available.

Table 4: Fuel Consumption Rates for Water Treatment Plants

Month	Fuel Consumption Rates (gallons/day) based on Historical Energy Consumption								
	PWTP			STWTP			RWTP (Upgraded)		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
January	298	189	355	460	348	971	4,371	3,054	6,773
February	330	270	449	375	276	435	4,009	3,131	5,759
March	313	184	390	356	255	421	4,110	2,678	6,757
April	312	213	372	416	374	470	5,160	2,947	7,371
May	324	229	391	408	361	437	6,786	5,770	7,607
June	372	298	437	384	243	445	7,554	6,841	8,207
July	372	336	403	428	357	488	7,513	5,397	8,374
August	359	331	385	388	126	474	7,718	6,982	8,130
September	392	352	526	419	331	481	7,758	7,308	8,197
October	344	286	412	424	386	533	6,945	6,000	7,592
November	293	143	375	396	369	429	5,542	3,736	7,021
December	313	254	382	368	309	421	4,268	2,749	6,195

Table 5: Fuel Consumption Rates for Pumping Plants and Other Facilities

Month	Fuel Consumption Rates (gallons/day) based on Historical Energy Consumption							
	Coyote PP*			Vasona PP*			SCVWD/ SFPUC Intertie**	Campbell Well Field**
	Avg	Min	Max	Avg	Min	Max	Avg	Avg
January	414	13	814	77	25	334	2,867	252
February	250	220	280	198	28	779		
March	1,820	288	3,352	67	28	160		
April	444	24	864	36	26	74		
May	0	0	0	50	24	149		
June	182	50	314	34	26	61		
July	293	287	298	31	28	34		
August	15	14	14	31	28	34		
September	46	45	45	31	29	33		
October	38	38	38	33	26	47		
November	238	44	432	29	25	32		
December	237	237	237	29	24	33		

*Note that fuel storage for operations are not available for Coyote and Vasona PP. Temporary storage tanks and generators would have to be used for operations. Fuel consumption rates were not estimated for Pacheco PP since historic energy consumption data was not available.

** Fuel consumption rates for SCVWD/SFPUC Intertie and the Campbell Well Fields are based on storage or generator capacity. These estimates should be revised when additional information becomes available.

Based on the analyses discussed in Section 4.0 (including upcoming upgrades to RWTP) and assuming that all facilities are operational but without PG&E power, it is estimated that the SCVWD could operate their facilities on backup fuel storage alone between 3.3 to 5.2 days in the summer (June – August) until RWTP runs out of fuel, assuming no flow changes are made (See Table 6 in red). Winter demands (December to February) are limited by both RWTP and STWTP, which have between 3.1 – 9.7 days of backup fuel (See Table 4 in green). In most cases, it is estimated that RWTP would run out of fuel first, with some fuel remaining in the other facilities. The limiting facility for all other months is indicated in blue.

Table 6: Number of Days of Backup Fuel Storage Available

Month	PWTP			STWTP			RWTP (Upgraded)		
	Number of Days of Storage Available based on Historical Avg, Min, and Max Energy Consumption								
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
January	13.4	21.1	11.3	6.5	8.6	3.1	6.4	9.2	4.1
February	12.1	14.8	8.9	8.0	10.9	6.9	7.0	8.9	4.9
March	12.8	21.7	10.3	8.4	11.7	7.1	6.8	10.5	4.1
April	12.8	18.8	10.8	7.2	8.0	6.4	5.4	9.5	3.8
May	12.3	17.5	10.2	7.4	8.3	6.9	4.1	4.9	3.7
June	10.8	13.4	9.2	7.8	12.4	6.7	3.7	4.1	3.4
July	10.7	11.9	9.9	7.0	8.4	6.2	3.7	5.2	3.3
August	11.1	12.1	10.4	7.7	23.7	6.3	3.6	4.0	3.4
September	10.2	11.4	7.6	7.2	9.1	6.2	3.6	3.8	3.4
October	11.6	14.0	9.7	7.1	7.8	5.6	4.0	4.7	3.7
November	13.7	27.9	10.7	7.6	8.1	7.0	5.1	7.5	4.0
December	12.8	15.8	10.5	8.1	9.7	7.1	6.6	10.2	4.5

Note: Green – Limiting facilities for Winter; Red – Limiting facilities for Summer; Blue – Limiting facilities for all other months.

The District can extend the length of time it can operate without power by scheduling storage tank refueling deliveries. The *Refuel Schedule Worksheet* provides a schedule of when fuel deliveries would be required for the three WTPs and for the SFPUC-SCVWD Intertie (facilities with both generators and fuel storage). This data is summarized in Table 7 and shows when and how much refueling is needed based on estimate fuel consumption rates. This schedule was extrapolated over two weeks and is based on maintaining a minimum fuel tank level target of no less than 25%.

Note that over the study period, STWTP operated at an average flow of 44 MGD from 2009-2012, well below its 100 MGD flow capacity. There may be potential to adjust plant operations at the other two WTPs to conserve fuel following a regional power outage, increasing output at STWTP and decreasing output at RWTP as appropriate, potentially extending the duration the District can operate without power.

Table 7: Refueling Day and Amount Based on Monthly Energy Consumption

Facility	STWTP		PWTP		New RWTP		SCVWD/SFPUC Intertie	
Month	Refuel Day	Refuel Amount (gal)	Refuel Day	Refuel Amount	Refuel Day	Refuel Amount	Refuel Day	Refuel Amount
January	5	2,301	11	3,278	5	21,856	3	8,600
February	6	2,252	10	3,297	6	24,054		
March	7	2,597	10	3,117	6	24,922		
April	6	2,455	10	3,134	5	24,650		
May	6	2,501	10	3,216	4	24,730		
June	6	2,295	9	3,305	3	19,117		
July	6	2,601	9	3,277	3	19,398		
August	6	2,317	9	3,202	3	19,446		
September	6	2,554	8	3,043	3	19,887		
October	6	2,496	9	3,078	4	24,845		
November	6	2,441	11	3,228	4	20,999		
December	7	2,586	10	3,145	5	21,081		

Notes: 1) Refueling is scheduled so that tanks never fall below 25% capacity. 2) Deliveries are assumed to take place at the end of the day. 3) Pumping plants and Campbell Well Fields have no storage therefore refueling is not an option.

5.2 IRP Study

As shown on Table 3, some facilities in the IRP scenarios are not available, either due to damage or lack of source water until after Day 14. Results of the fuel analysis as it relates to the IRP Study are as follows:

1. In the San Andreas Earthquake #1 and Flood/Storm Event, the only facility available during the 14-day power outage is the SCVWD/SFPUC Intertie, which is estimated to require 2,867 gallons of fuel per day and would require refueling every third day.

2. The Calaveras Earthquake Event is the only scenario where any of the WTPs will be available during the 14-day power outage (STWTP and RWTP are available while PWTP is offline until Day 78). However, STWTP is not anticipated to be in operation due to lack of source water. RWTP and SCVWD/SFPUC Intertie are available to provide water to the West and East, respectively, starting at Day 4.

4.

Table 8 shows minimum demands to be met in the IRP Study for the upgraded RWTP (West), along with the estimated fuel consumption rate based on correlations between historic energy consumption and water flows from 2009 to 2012. This calculation can be found in the *kW per MGD Worksheet.*

Refueling requirements for minimum demands for the duration of a 14-day power outage for the Calaveras Earthquake Event are shown on Table 9. This only includes the Upgraded RWTP and the SCVWD/SFPUC Intertie.

Table 8. Estimated Fuel Requirements for Minimum and Average Demands

Facility	Average Gallons of Fuel/MG water	IRP Minimum Demands (MGD)	Fuel Consumption Rate (gallons/day)
Upgraded RWTP	127.8*	42	5,368

*Back calculated using kW per MGD estimates based on historic energy consumption and flows at existing RWTP.

Table 9. Minimum Demand Refueling Requirements of 14-day Power Outage for Calaveras Event

Burn Rate (gal/day)	Upgraded RWTP*		SCVWD/SFPUC Intertie		Total Refueling Needs (gal)
	5,368 gallons/day		2,867 gallons/day		
Outage Day	Fuel Tank Vol (gallons)	Refuel Volume (gallons)	Fuel Tank Vol (gallons)	Refuel Volume (gallons)	
0	28,000	0	8,600	0	0
1	28,000	0	8,600	0	0
2	28,000	0	8,600	0	0
3	28,000	0	8,600	0	0
4	22,632	0	5,733	0	0
5	17,263	0	2,867	0	0
6	11,895	0	8,600	8,600	8,600
7	28,000	20,114	5,733	0	20,114
8	22,632	0	2,867	0	0
9	17,263	0	8,600	8,600	8,600
10	11,895	0	5,733	0	0
11	28,000	20,114	2,867	0	20,114
12	22,632	0	8,600	8,600	8,600
13	17,263	0	5,733	0	0
14	11,895	0	2,867	0	0
Total		**40,228**		**25,800**	**66,028**

* Based on extrapolation of historic energy consumption for existing RWTP. Confirmation of actual energy consumption of upgraded facility is necessary.

Notes: 1) Refueling is scheduled so that tanks never fall below 25% capacity. 2) Fuel Tank Volumes show volume left at the end of the day. 3) Deliveries are assumed to take place at the end of the day. 4) PWTP is damaged and STWTP does not have source water.

6 Conclusions and Recommendations

Prolonged Power Outage

Fuel storage for SCVWD facilities is limited to RWTP, STWTP, PWTP, and the SCVWD/SFPUC Intertie in the event of a prolonged power outage. Based on historic energy consumption and assumptions regarding future upgrades to RWTP, the analysis estimates that the SCVWD could operate their facilities on backup fuel storage alone between 3.1 to 10.5 days, depending on the time of year. However, this estimate is based on an extrapolation of the historical energy consumption at the existing RWTP and needs to be confirmed when additional information on the upgraded facility is available.

The District could operate for a longer period on backup power if fuel deliveries were initiated as part of a coordinated disaster response effort.

IRP Scenarios

In the San Andreas Earthquake #1 and Flood/Storm Event, the only facility available during the 14-day power outage is the SCVWD/SFPUC Intertie, which is assumed to be operable by Day 4, and requires refueling every three days for continued operations. For the Calaveras Event Scenario, SCVWD/SFPUC Intertie is used to supply the East while the West is supplied by Calero Reservoir via RWTP. PWTP is assumed to be damaged while STWTP does not have source water available. Both SCVWD/SFPUC Intertie and RWTP are assumed to have sustained minor damage and are restored by Day 4. Storage tanks at RWTP and SCVWD/ SFPUC Intertie would need to be refueled every fourth and third day, respectively.

Recommendations

The analyses and results discussed should be reviewed by the District as part of regular emergency preparation activities. In addition, we recommend collecting additional data, as noted below, to improve the accuracy of this analysis, and refine planning efforts to respond to a prolonged power outage.

1. Record energy use data at District facilities:
    a. Once RWTP is upgraded, collect data and recalculate fuel consumption rates accordingly.
    b. Continue to collect energy consumption usage for PWTP and STWTP and update fuel consumption rates as needed.
    c. Collect energy consumption data for SCVWD/SFPUC Intertie during future operations and recalculate fuel consumption rates.
2. Target emergency flows were not provided for a prolonged outage so it was assumed that SCVWD would attempt to maintain system/facility operations as they were prior to the event. In reality, operating strategies may be employed to reduce fuel consumption, including flow rate changes, treatment process changes, and switching to manual operations. These strategies should be investigated by SCVWD at both a facility and system level. The District may also develop a policy to reduce the total amount of water supplied to customers following certain events.

3. It is understood that San Jose Water Utility has a fuel burn rate calculator. If available, it would be valuable to compare to current estimates and better align planning efforts with other regional agencies.

The following are recommended actions to help improve the reliability of the District's water system:

1. Confirm that refueling procedures are established and followed to maintain initial fuel storage levels at facilities in the event of an emergency.
2. Identify off-site fuel storage possibilities and confirm that adequate staff and equipment are available to make fuel deliveries between off-site storage and facilities.
3. Continue discussions with regional agencies to coordinate regional fuel storage/supply efforts.
4. Develop emergency operations strategies for the SCVWD system and specific facilities (especially the RWTP), which seek to minimize fuel consumption during emergency operations.
5. Re-evaluate consumption rates with emergency operations strategies developed under #4 above. If RWTP is still predicted to most frequently run out of fuel first, consider increasing fuel storage at RWTP.
6. Consider discussing and exercising power outage scenarios via emergency planning workshops and/or tabletop exercises.

Santa Clara Valley Water District

Infrastructure Reliability Plan

Retailer Appendix

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