Valley Water

Water Supply Master Plan 2040

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Santa Clara Valley Water District
Water Supply Master Plan 2040

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Water Supply Master Plan 2040 Executive Summary

A reliable supply of clean water is necessary for the social, economic, and environmental well-being of Santa Clara County. This is reflected in the Santa Clara Valley Water District Act that states one of the purposes of the Santa Clara Valley Water District (Valley Water) 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 or uses of the lands or inhabitants within the District." Furthermore, Board Policy states that "there is a reliable, clean water supply for current and future generations." The Water Supply Master Plan 2040 (Master Plan) presents Valley Water's strategy for meeting the county's future water needs.

The Master Plan looks ahead at how our water needs, and our water supply may change over the next 20 years. The population is likely to grow; aging water infrastructure must be maintained and renewed; additional regulations and land use changes may impact how we use water; and climate changes are likely to alter the Sierra Nevada Mountains' snowpack resulting in longer and more severe droughts.

Valley Water's Ensure Sustainability water supply strategy focuses on investments that secure our existing water supplies, expand water conservation and reuse, and optimize our water infrastructure systems. Valley Water must secure existing supplies and facilities for future generations because they are, and will continue to be, the foundation of our water supply system. Valley Water is committed to working with the community to meet Silicon Valley's future increases in water demand through conservation, water reuse, and other drought-resilient strategies. Some projects are preferred more than others by the community. Stakeholders all agree that 1) water supply reliability is important; 2) we should maximize water conservation, water reuse, and stormwater capture; and 3) we need to keep water rates affordable. Based on stakeholder input, technical analyses, and the climate of uncertainty, the Ensure Sustainability strategy provides a framework for balancing multiple needs and interests while making effective and efficient investment decisions. Finally, Valley Water has opportunities to make more effective use of its existing assets.

> The Master Plan is the Valley Water's strategy for providing a reliable and sustainable future water supply for Santa Clara County and ensuring new water supply investments are effective and efficient.

The Master Plan's annual Monitoring and Assessment Program (MAP) provides a mechanism for adapting to changing supply and demand conditions, climate change, regulatory and policy changes, other risks, and uncertainty. Through regular monitoring of specific projects and overall conditions, Valley Water will assess whether changes to the Master Plan strategy or projects are needed. Alternative projects will be evaluated based on their impacts to the water supply reliability, costs, relationships with other projects, risks and opportunities, and stakeholder input. Any changes to the Master Plan will be reflected in the annual water rate-setting process, Capital Improvement Program, and budget.

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1 A Reliable Water Supply Is Important to the Community

A reliable supply of clean water is necessary for the environmental, economic, and social well-being of Santa Clara County. A safe and reliable water supply extends beyond the significant social requirements of basic health and sanitation. This extension includes economic vitality, environmental needs, agricultural requirements, social benefits, cultural expectations and requirements, and quality of life enhancements. On behalf of the community, the Santa Clara Valley Water District (Valley Water) has made significant investments to manage demands for water and develop water supplies and infrastructure to meet the county's water needs. These investments currently enable Valley Water to manage the natural variability in demands and supplies to meet the county's current needs in all but critical drought years, when the community will be requested to reduce their water use. However, Valley Water anticipates the county's need for water will grow in the future.

1.1 Santa Clara County Needs Water for Multiple Purposes

Long-term average water use in Santa Clara County is approximately 350,000 acre-feet per year (AFY). This water is used for domestic, municipal, industrial, and agricultural use.[1] Valley Water estimates that water demand would be higher, by about 77, 000 AF in 2018, if not for the combined efforts of Valley Water, the water retailers, and the community to conserve water. Because of Valley Water's investments in water conservation since 1992, water use in the county has remained relatively consistent despite a 25 percent increase in population over the same period (Figure 1). The various significant decreases in water use are associated with the extended droughts of 1987 to 1992, 2007 to 2009, and 2012 to 2016. Rainfall and economics also affect water use.

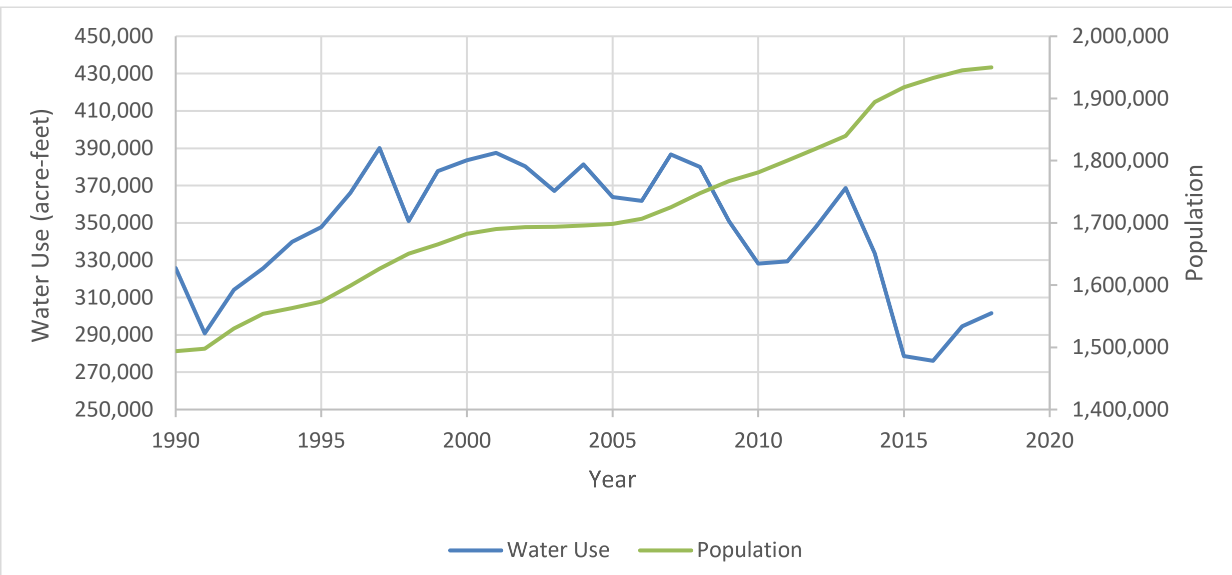

Figure 1. Historic Water Use and Population

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[1] Environmental water needs vary by year and are addressed in the supply side of Valley Water's water supply system. Environmental requirements are given priority to local water supplies over use for recharge or treatment plants.

The community uses water for several purposes, including residential, commercial, industrial, institutional, landscape irrigation, and agriculture. Figure 2 shows the percentage of water use by these sectors. Residents who need water for basic sanitation and to support their quality of life, account for almost half the water used each year in the county. Nearly one-half of residential water use is outdoors. Commerce, industry, and institutions need water for product manufacturing and delivery. The agriculture sector needs water to grow crops and for livestock.

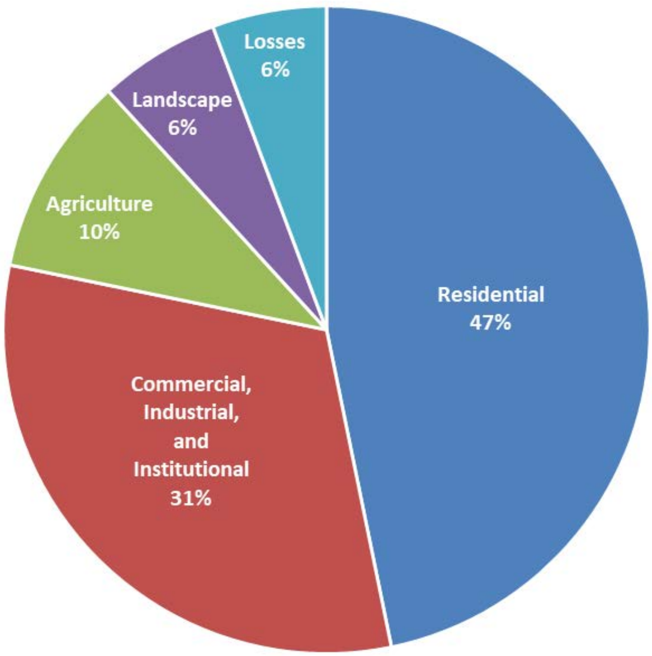


Figure 2. Water Use by Sector
(Water Retailers' 2015 Urban Water Management Plans)

The San José-Sunnyvale-Santa Clara Metropolitan Area had a gross domestic product of over $275 billion in 2017, the 13th highest in the nation (Bureau of Economic Analysis, 2018). Water shortages can have severe economic consequences. Shortage costs can range from about $85 million per year for a shortage of 10 percent up to $1.5 billion per year for a shortage of 50 percent (Appendix B, Cost Analysis Methodology). Furthermore, shortages can lead to groundwater overdraft and land subsidence, which can damage the county's infrastructure and increase flooding risks.

1.2 Valley Water has Made Significant Investments in Water Supply Reliability

Valley Water is an independent, special district/local agency that provides wholesale water supply, groundwater management, flood protection, and stream stewardship. Its service area includes all of Santa Clara County, which is located at the southern end of San Francisco Bay (Figure 3). The county encompasses approximately 1,300 square miles and has a population of about 1.9 million. Most water use occurs on the valley floor between the Santa Cruz Mountains to the west and the Diablo Range to the east. Santa Clara County is home to Silicon Valley, and the valley floor is highly urbanized. Southern Santa Clara County has some urban development, but much of the land use is still rural and agricultural.

Valley Water was formed in 1929 in response to groundwater overdraft and significant land subsidence. Northern Santa Clara County had experienced land subsidence from pumping more groundwater than could be replaced or replenished through rainfall. In response, Valley Water constructed six reservoirs in the 1930s to store winter rains for groundwater recharge and summer irrigation use. Beginning as early as 1939, the San Francisco Public Utilities Commission (SFPUC) began the delivery of some water into the county. In 1952, SFPUC began delivering imported water to water retailers in northern Santa

Clara County through what is now called the Regional Water System. Also in the 1950s, Valley Water constructed four additional reservoirs, nearly tripling local storage to approximately 169,000 acre-feet (AF).

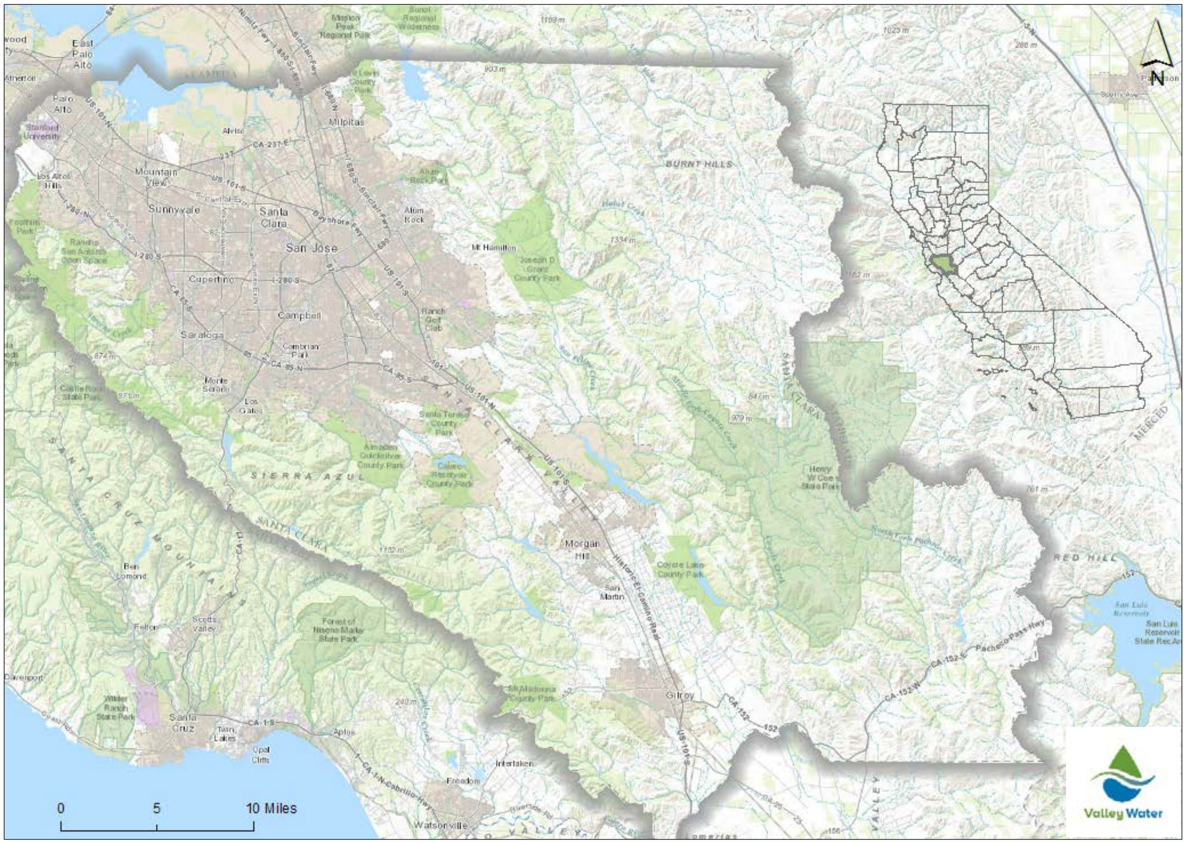


Figure 3. Santa Clara County

Still, local supplies were insufficient to meet the county’s growing population, particularly after World War II, and subsidence continued. In 1965, Valley Water began importing water from the State Water Project (SWP) for groundwater recharge and use at drinking water treatment plants. By 1970, groundwater levels recovered, and land subsidence was essentially halted. To continue to provide a reliable water supply, Valley Water began receiving water from the Federal Central Valley Project (CVP) in 1987. The historical relationship between population growth, groundwater levels, land subsidence, and water sources is illustrated in Figure 4. These additional supplies, along with investments in water conservation and water reuse, have further supported and maintained groundwater level recovery.

Valley Water operates an integrated water supply system to meet demands in Santa Clara County. Current operations include 10 dams, 17 miles of raw surface water canals, five water supply diversion dams, 393 acres of groundwater recharge ponds, 91 miles of controlled in-stream recharge, 142 miles of pipelines, three drinking water treatment plants, one advanced water purification center, and three pump stations.

Local surface water, SWP and CVP water imported through the Sacramento-San Joaquin River Delta (Delta):

- replenish the local groundwater subbasins, which are pumped for use by individual well owners and retail water suppliers;
- supply Valley Water's drinking water treatment plants;
- are delivered directly to agricultural water users; and,
- help meet environmental needs.

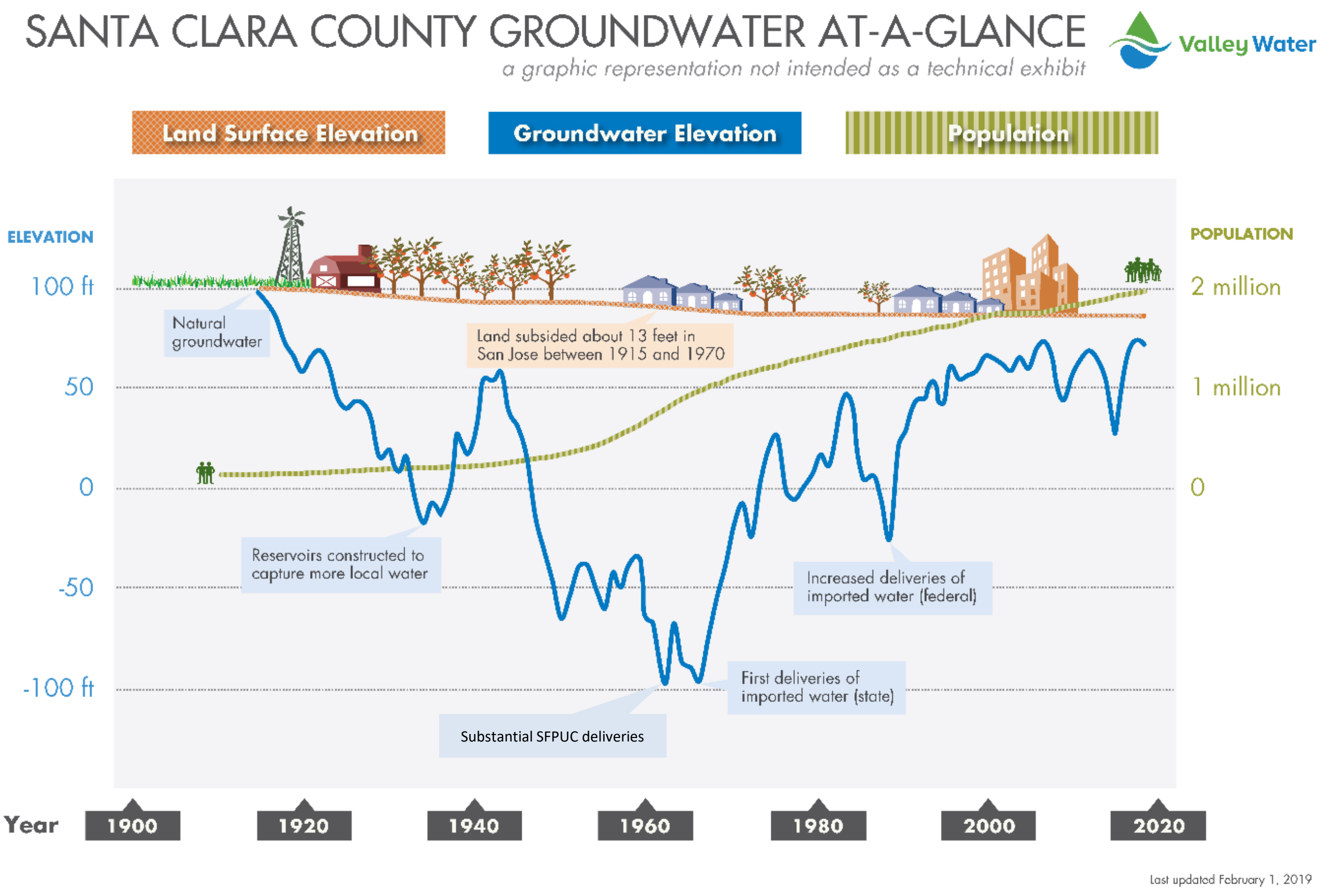


Figure 4. Relationship between Groundwater Levels, Land Subsidence, and Population

The largest source of water used in Santa Clara County is imported from outside the county, mostly through the SWP and CVP (approximately 40 percent). Another 15 percent is delivered through SFPUC's Regional Water System. Of local supplies, about 15 percent is natural groundwater recharge, 20 percent is local surface water, and 5 percent is recycled water (Figure 5).

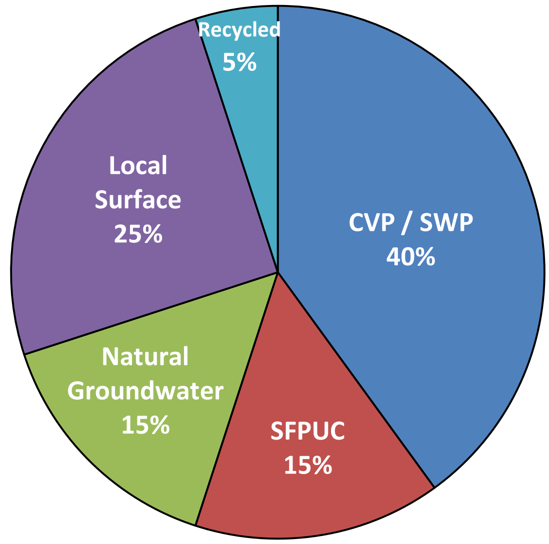


Figure 5. Santa Clara County Historic Water Sources

Valley Water manages groundwater supplies in conjunction with surface water supplies. In wet and normal years, excess supplies are stored in the local groundwater basin, local and statewide reservoirs, or the Semitropic Groundwater Bank in Kern County for use in dry years. This helps Valley Water manage natural variations in rainfall and the associated changes in water supply availability.

Other agencies and organizations also contribute to water supply reliability in Santa Clara County. The San Francisco Public Utilities Commission (SFPUC) delivers water to retailers in northern Santa Clara County. Stanford University and San Jose Water hold their own surface water rights. All four of the county's wastewater treatment plants produce recycled water for non-potable uses such as irrigation and cooling towers. The county's water supply, treatment, and distribution facilities are illustrated in Figure 6.

Figure 6. Water Supply Facilities

1.3 Need for the Water Supply Master Plan 2040

The District Act states that one of the purposes of Valley Water 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 or uses of the lands or inhabitants within the District." Furthermore, Board Policy states that "there is a reliable, clean water supply for current and future generations." One of Valley Water's strategies for achieving this goal is to develop water supplies designed to meet at least 100 percent of average annual water demands in non-drought years and not call for water use reductions greater than 20% during drought years. The purpose, policy, and strategy recognize that a reliable water supply is vital to the social, economic, and environmental well-being of the county.

The Association of Bay Area Governments (ABAG) projects that the county's population will increase from about 1.9 million in 2015 to about 2.4 million by 2040 (ABAG, 2013[2]). Jobs are projected to increase from approximately 1 million in 2015 to approximately 1.2 million in 2040. Even though per capita water use continues to decline, Valley Water estimates that increases in population and jobs will result in an increase in water demands from the current long-term average of approximately 350,000 acre-feet per year (AFY) to a non-drought year demand of approximately 399,000 AFY in 2040, assuming no additional investments in conservation beyond the 99,000 AF by 2030 (Appendix C, Demand Projection Methodology). Urban water use throughout the county is expected to increase, but rural and agricultural water use is expected to stay about the same. This projected increase in demands, along with projected reductions in supplies and ongoing risks, means that additional water supply investments will be needed to provide a reliable water supply in the future.

1.4 Contents and Use of this Report

The modeling results in this report are based on demand, supply, and operating assumptions as of May 2019. Valley Water regularly reviews and refines its models. Future Master Plan reports will reflect updated modeling results and, if appropriate, make recommendations for revisions.

The Master Plan is organized as follows:

- Chapter 1 - A Reliable Water Supply is Important to the Community: discusses the community's water use and needs, Valley Water's role in meeting those needs, and the need for the Master Plan.
- Chapter 2 – Valley Water Needs to Ensure Adequate Supplies for Future Droughts: describes the water supply outlook, challenges, and risks to providing a reliable future water supply in Santa Clara County.
- Chapter 3 – The Water Supply Strategy Ensures Sustainability: presents Valley Water's strategy for meeting the county's future water supply needs.

[2] These were the most current ABAG data available at the time of modeling and development of the various planning level portfolios. Valley Water is in the process of developing a new demand model, which will include updated information.

- Chapter 4 – The Monitoring and Assessment Plan Will Help Keep Valley Water on Track: describes how the water supply strategy will be monitored and adjusted over time to ensure Valley Water is on track with its water supply investments.
- Chapter 5 – References

2 Valley Water Needs to Ensure Adequate Supplies for Future Droughts

This chapter describes the water supply reliability outlook for Santa Clara County. The Master Plan evaluates the ability to meet projected water demands through year 2040 with the baseline water supply system. The evaluation shows existing supplies are sufficient to meet most future demands in normal years, but will not meet needs in future droughts. In addition, risks such as climate change, changes to regulations, and new policies could affect future water supply reliability.

2.1 Baseline Water Supplies

The baseline water supply system consists of existing water supplies and infrastructure, including several improvements. The Master Plan assumes Valley Water will improve existing dams to remove operating restrictions, complete the Rinconada Water Treatment Plant Reliability Improvement Project, upgrade Vasona Pumping Plant, rehabilitate pipelines, support water retailers' efforts to increase non-potable reuse water use to about 33,000 AFY in 2040, and increase water conservation savings to about 99,000 AFY by 2030. The Master Plan assumes declining Delta-conveyed imported water reliability as a baseline condition, which is consistent with historical trends. Lastly, the Master Plan assumes Valley Water makes reservoir releases consistent with environmental requirements and commitments, including the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) and regulatory permits.

The Master Plan also assumes that existing infrastructure is maintained consistent with Valley Water's Asset Management Plan and that Valley Water works with other agencies to maintain and manage their assets that support water supply reliability in Santa Clara County.

Modeling indicates that the baseline system will be able to meet non-drought year demands through 2025. However, shortfalls between supplies and demands begin in year 2030. Figure 7 and Table 1 shows the projected average water supply use and non-drought year demands through year 2040. Table 1 aims to demonstrate that Valley Water will see shortfalls between supplies and demands if we only invest in those Baseline Water Supply System projects, as demand continues to grow to 399,000 AFY by

Baseline Water Supply System

- Conservation savings increasing from about 77,000 AFY in 2018 to about 99,000 AFY by 2030
- Existing natural groundwater recharge
- Existing local surface water supplies with Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) reservoir releases and flow requirements
- Recycled water use increasing from about 18,000 AFY in 2018 to about 33,000 AFY in 2040
- Existing imported water supplies, with declining Delta water reliability
- Dam seismic retrofits and other improvements to remove operating restrictions
- 10-Year Pipeline Rehabilitation
- Vasona Pumping Plant Upgrade
- Rinconada Water Treatment Plant Reliability Improvement

2040. This shortfall can be avoided through additional long-term water supply investments. Projects that provided water supply benefits were analyzed as a suite to determine how individual projects work together to provide a water supply benefit. Various suites of projects were presented to internal stakeholders and the Board to help develop the final investment strategy recommended in the WSMP. Those new investments are being guided by Valley Water's "ensure sustainability" water supply strategy (Section 3).

The modeling assumes decreased Delta-conveyed supplies due to increased regulatory restrictions in year 2030. The decrease of Delta supplies is anticipated to progress gradually with time, but 2030 was selected in the model as the timeframe to reflect the loss. Valley Water’s water supply system model and assumptions are described in Appendix D.

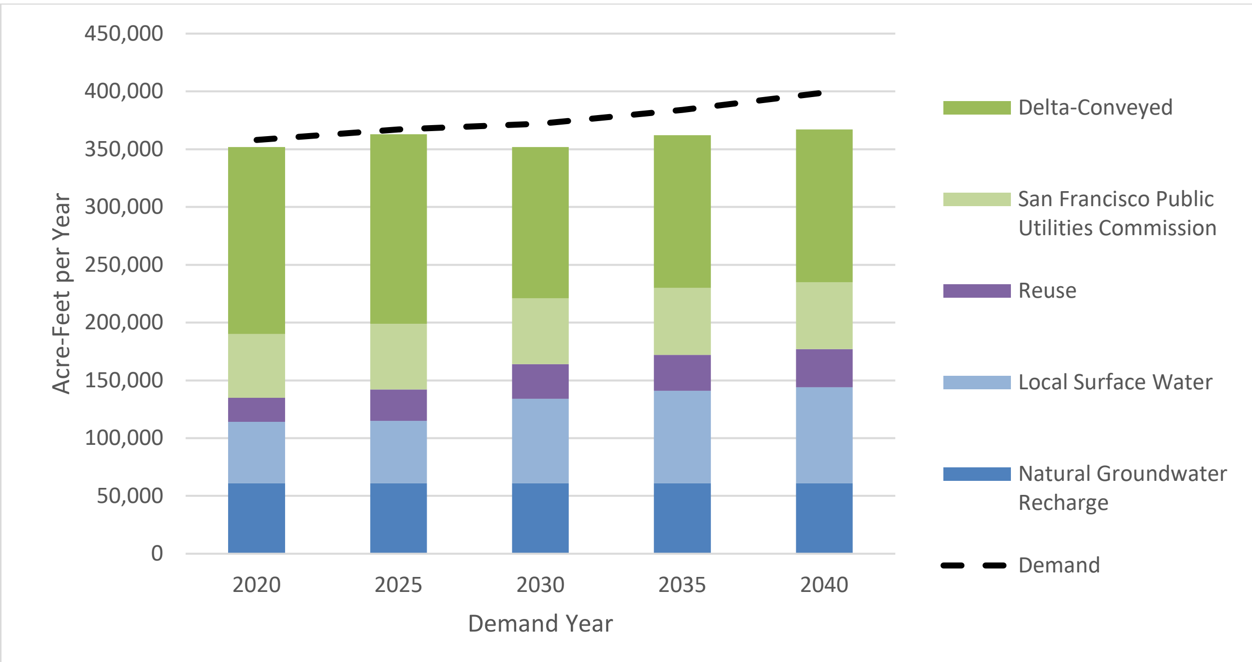


Figure 7. Average Water Supply Through 2040 with Baseline Projects

Table 1. Average Baseline Water Supply Through 2040

Source of Supply (Acre-Feet)	2020	2025	2030	2035	2040
Natural Groundwater Recharge	61,000	61,000	61,000	61,000	61,000
Local Surface Water	53,000	54,000	73,000	80,000	83,000
Reuse Water	21,000	27,000	30,000	31,000	33,000
San Francisco Public Utilities Commission	55,000	57,000	57,000	58,000	58,000
Delta-Conveyed	162,000	164,000	131,000	132,000	132,000
Average Supply	**352,000**	**363,000**	**352,000**	**362,000**	**367,000**
Demand	**358,000**	**367,000**	**372,000**	**384,000**	**399,000**

2.1.1 Local Water Supply Sources

The groundwater subbasins are naturally recharged with rainfall, seepage from surrounding hills, seepage into and out of the groundwater subbasin, leakage from pipelines, and irrigation return flows. Natural groundwater recharge varies based on rainfall and groundwater levels. On average, natural groundwater recharge provides about 61,000 AFY of supply.

Local reservoirs capture rainfall and run-off. This water is used for groundwater recharge, irrigation, or sent to a drinking water treatment plants. Currently, Valley Water surface water supplies are constrained by an average of about 44,000 AFY due to operating restrictions on local reservoirs for seismic safety. Improvements to Anderson and Guadalupe Dams are modeled to be completed before 2030 and improvements to Calero and Almaden Dams before 2035. On average, Valley Water's local surface water supplies will provide about 83,000 AFY in 2040. On average, San José Water and Stanford University's local surface water supplies provide about 11,000 AFY.

Reuse water is a local water supply source that is not dependent on rainfall. Reuse water is produced by the county's four publicly-owned wastewater treatment plants. It is municipal wastewater that has been treated to levels that make it appropriate for various non-drinking water (non-potable) purposes. In addition, Valley Water provides advanced treated purified water to South Bay Water Recycling to improve the quality of the non-potable supply. Recycled water use is projected to increase from about 18,000 AFY in 2018 to about 33,000 AFY in 2040.

Anderson Reservoir is currently being operated at a reduced capacity due to seismic concerns with the dam at full capacity.

2.1.2 Imported Water Supply Sources

Imported supplies are used to meet a large percentage of county's water needs. Imported water conveyed through the Delta via the State Water Project (SWP) and Central Valley Project (CVP) is used to supply Valley Water's drinking water treatment plants, groundwater recharge facilities, and irrigators. On average, more than 70 percent of Delta-conveyed supply is delivered to treatment plants, almost 30 percent is used for recharge, and a small percentage is delivered to irrigators. In addition, when available, Valley Water stores excess Delta-conveyed supplies in the Semitropic Groundwater Bank and San Luis Reservoir in the Central Valley, and locally in Anderson and Calero Reservoirs. Valley Water has a contract for 100,000 AFY of SWP water and 152,500 AFY of CVP water. However, the actual amount of water allocated under these contracts each year is typically less than these contractual amounts and depends on hydrology and regulatory restrictions. The average allocation of Delta-conveyed water projected for 2020 is 171,000 AFY. However, without additional investments, Valley Water expects average allocations to decline over time, to an average of about 133,000 AFY in 2040. The Master Plan assumes average Delta-conveyed imported water use within Santa Clara County will differ from SWP and CVP allocated supplies due to carryover losses in extreme wet years and evaporation from surface water reservoirs.

Santa Clara County began receiving SFPUC water to supplement local supplies in 1939. This water is provided to north county cities with access to SFPUC's Regional Water System. On average, the SFPUC delivers about 55,000 AFY to Santa Clara County. This amount is expected to increase slightly to 59,000 AFY in 2040 as SFPUC customer demands increase. While SFPUC water is not distributed through Valley Water, it is included here to reflect its role in the overall water portfolio for Santa Clara County.

2.1.3 Supply Variability and Hydrology

Santa Clara County, like the rest of California, experiences drastic changes in year-to-year annual precipitation. The variation in precipitation, both locally and in the Delta's watersheds, results in fluctuations in the amount of water supply available from year to year. In many years, annual supplies exceed demands, while in other years, demands can greatly exceed supplies. Figure 8 and Table 2 illustrate 2040 projected demand and the availability of different water supplies in a very wet year, an average year, and in a very dry year. The supplies shown do not include the use of reserves, which lessen any shortfalls in dry years. The long-term average supplies in Table 2 include environmental flows and streamflow that is operationally difficult to store, and are different than the supplies in Table 1. However, a significant amount of water may be used for environmental purposes now and into the future. Table 1 and the remaining tables in this report show the available supply Valley Water can use to meet municipal and agricultural demands but do not include environmental flows. Figure 8 and Table 2 show all the water that is flowing into the county on average.

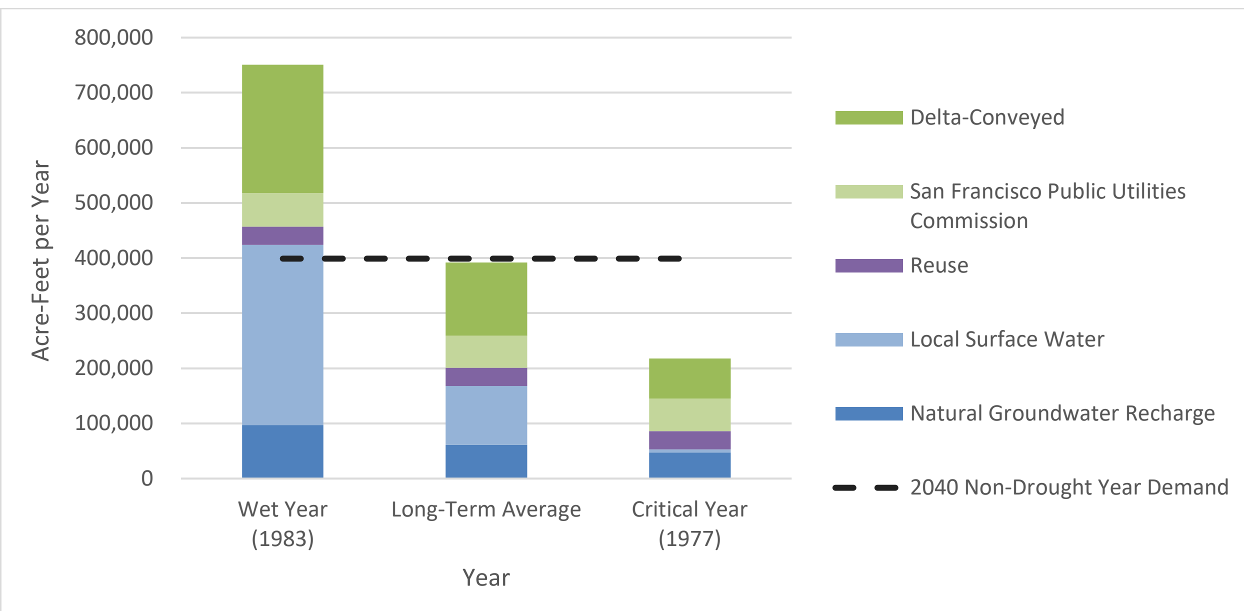


Figure 8. Projected Baseline Water Supply Availability in 2040 under Different Hydrologic Conditions

Table 2. Projected Baseline Water Supply Availability in 2040 under Different Hydrologic Conditions

Source of Supply (Acre-Feet)	Wet Year (1983)	Long-Term Average	Critical Year (1977)
Natural Groundwater Recharge	97,000	61,000	47,000
Local Surface Water	327,000	107,000	6,000
Reuse Water	33,000	33,000	33,000
San Francisco Public Utilities Commission	61,000	58,000	59,000
Delta-Conveyed	233,000	133,000	73,000
Total Supply (Acre-Feet)	**751,000**	**392,000**	**218,000**

Valley Water's basic water supply strategy to compensate for supply variability is to store excess wet year supplies in the groundwater basin, local reservoirs, San Luis Reservoir, or Semitropic Groundwater Bank. Valley Water draws on these reserve supplies during dry years to help meet demands. These reserves will be sufficient to meet demands during a critical dry year and the first several years of an extended drought. Valley Water also works with retailers to balance groundwater pumping and treated water use based on groundwater basin conditions to maximize the use of available supplies.

2.2 Future Droughts are the Primary Water Supply Challenge

Water supply reserves (e.g., water banked in the Semitropic Groundwater Bank) are insufficient to meet needs throughout an extended drought. Modeling indicates shortages during droughts in all demand years, with shortages increasing in severity and frequency as demands increase and Delta-conveyed supplies decrease. By 2040, without new supplies or conservation savings, shortages could occur in about 40 percent of years and water supplies would only be able to meet about 60 percent of normal demand during some years. Short-term water use reductions of up to 50 percent would be needed to minimize the risk of land subsidence and avoid undesirable groundwater conditions. Figure 9 and Table 3 show the supplies and groundwater reserves that would be used with year 2040 demands during a six-year drought, similar to the one that occurred between 1987 and 1992. Reserves are more available in Drought Year 4 because the water use reductions in Drought Year 3 allowed groundwater conditions to improve. However, reserves are depleted by Drought Year 5.

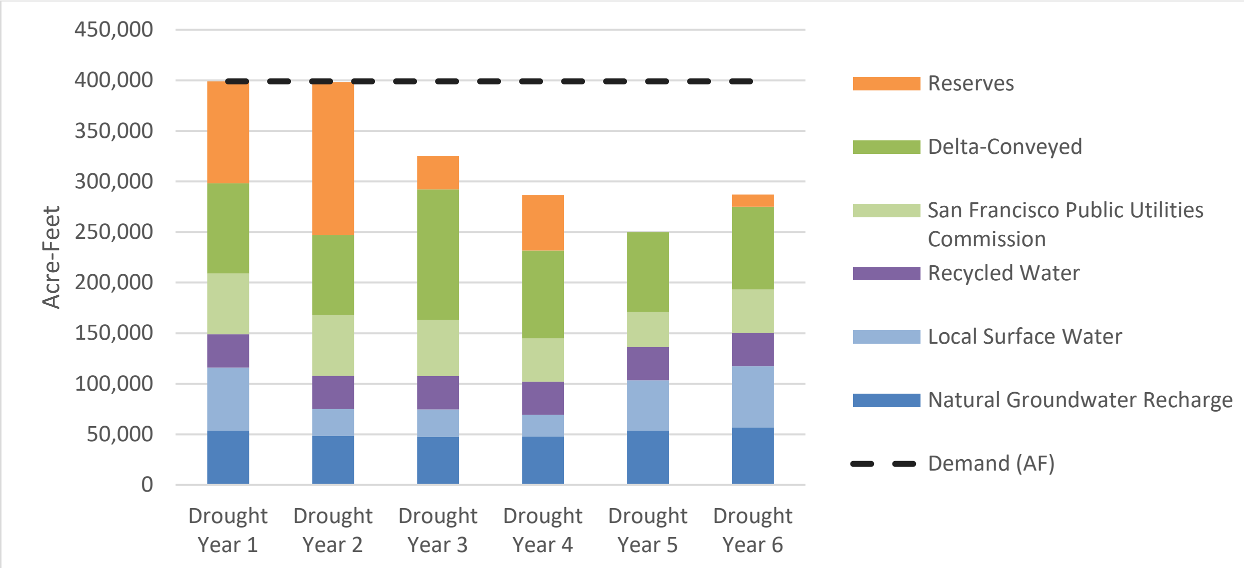


Figure 9. Baseline Water Supplies During an Extended Drought with Year 2040 Demands

Table 3. Baseline Water Supplies During an Extended Drought with Year 2040 Demands

Source of Supply (AF)	Drought Year 1	Drought Year 2	Drought Year 3	Drought Year 4	Drought Year 5	Drought Year 6
Natural Groundwater Recharge	54,000	48,000	47,000	48,000	54,000	57,000
Local Surface Water*	62,000	26,000	27,000	21,000	50,000	61,000
Reuse Water	33,000	33,000	33,000	33,000	33,000	33,000
San Francisco Public Utilities Commission	60,000	60,000	56,000	43,000	35,000	43,000
Delta-Conveyed	89,000	79,000	129,000	87,000	79,000	82,000
Reserves	101,000	151,000	33,000	55,000	0	12,000
Total Supply (AF)	**399,000**	**398,000**	**325,000**	**287,000**	**250,000**	**287,000**
Shortfall	**0,000**	**1,000**	**74,000**	**112,000**	**149,000**	**112,000**

* Local surface water increases due to demand reductions and overall conjunctive use management.

2.3 Other Water Supply Challenges and Uncertainties

Droughts are the greatest challenge to water supply reliability. However, other significant challenges and uncertainties need to be considered as part of the Water Supply Master Plan. These include climate change, additional regulatory requirements, and land-use decisions.

2.3.1 Climate Change

The impacts of climate change are already being felt in the San Francisco Bay Area and northern California. Average annual maximum temperatures have increased by 1.7°F since 1950, sea level has risen over 8 inches in the last 100 years, and the 2012-2016 drought led to a 1-in-500 year low in Sierra snowpack and $2.1 billion in economic losses statewide. These changes are projected to increase significantly in the coming decades. The Bay Area will likely see a significant temperature increase by mid-century. Precipitation will continue to exhibit high year-to-year variability, with very wet and very dry years. Average Sierra Nevada snowpack is projected to decline, up to 60 percent in mid-century under a high greenhouse gas emissions scenario. Future increases in temperature will likely cause longer and deeper droughts. These impacts will affect the quantity of available water and quality of water supplies (Ackerly et al., 2018).

Climate change is a global phenomenon, though it is manifested differently in different regions.

Valley Water's water supply vulnerabilities to climate change include:

- Decreases in the quantity of imported water supplies: More precipitation falling as rain and earlier snowmelt may exceed the storage capabilities of the existing SWP and CVP reservoirs. Increases in temperature and evapotranspiration may also lead to a higher intensity of droughts, which can decrease imported water allocations. Rising air temperatures also increase the water temperatures, which can lead to increased evaporation rates, a higher risk of harmful algal blooms, and negative impacts to fish and wildlife, all of which can impact the availability of imported water supplies for Santa Clara County. Sea level rise may also have negative impacts on imported water supplies, largely because of saltwater intrusion into the Sacramento-San Joaquin Delta. Saltwater intrusion can impact water supply allocations, as more fresh water may be needed to flow through the Delta and into San Francisco Bay to hold back the saltwater, making it unavailable for CVP and SWP use. Sea level rise will also put additional pressure on the fragile Delta levees, making them more susceptible to failure.
- Increases in seasonal irrigation demands: Higher temperatures will increase agricultural, residential, and commercial/institutional irrigation demands. It is estimated that about 40 percent of water use in the county is for irrigation.

- Increases in cooling water demands: The county has several energy plants, multiple data centers, and facilities with cooling towers. Higher temperatures may also increase demands by these users.
- Decreases in the ability to utilize local surface water supplies: Shifts in the timing and intensity of rainfall and runoff could affect the ability to capture and use local surface water supplies. It is difficult to capture rainfall when it comes in a few intense storms because reservoirs are more likely to fill and spill or releases are needed to make room for the storm flows. When it is wet, there are typically lower demands for water, so the storm flows are difficult to put to immediate use. Thus, even if average annual rainfall stays the same, the ability to utilize local supplies may decrease.

Drought-resistant landscaping helps reduce demands on water.

- Decreases in water quality: Higher temperatures, wildfire, and changes in flow patterns could result in more algal blooms, increased turbidity, and increased salinity in imported and local surface water supplies. Sea level rise could also contribute to increased salinity in Delta-conveyed supplies. At a minimum, changes in water quality require additional monitoring. Often, they require changes to treatment processes. Sometimes, they can result in the interruption of supplies from the CVP or SWP.
- Increases in the severity and duration of droughts: Droughts are already Valley Water's greatest water supply challenge. With increases in demands and reductions in supplies, this challenge will only grow. Without additional supplies and demand management measures, Valley Water would need to call for more frequent and severe water use reductions. These actions affect the economic and social well-being of the county. More severe and longer droughts will also affect the environmental well-being of the county.

Valley Water needs to implement a water supply strategy that will adapt well to future climate change by managing demands, providing drought-resilient supplies, and increasing system flexibility in managing supplies and water quality.

2.3.2 Additional Regulations and Permit Requirements

Valley Water supplies have previously been affected by changes in regulatory requirements, and additional requirements are anticipated in the future. Locally, the greatest impact of regulations has been on instream recharge operations. Historically, Valley Water constructed gravel dams to increase groundwater recharge within creeks and released water from reservoirs to maximize recharge. However, over 25 years, Valley Water has revised its instream recharge operations to comply with new regulatory requirements to better balance water supply operations with fishery and other environmental needs. Additional future changes are anticipated as Valley Water implements the Settlement Agreement produced by the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) in 2003. These past and anticipated future changes limit Valley Water's ability to use creeks for conveying and recharging water, which in turn could reduce the flexibility of Valley Water to manage groundwater basins. Groundwater recharge is a key component of Valley Water's conjunctive use program.

Imported water supplies have also been affected by regulations related to environmental protection. Valley Water holds contracts with the California Department of Water Resources (DWR) and U.S. Bureau of Reclamation for up to 252,500 AF per year of supplies from the SWP and CVP, with actual deliveries subject to availability of water supplies and the satisfaction of regulatory constraints to protect fish, wildlife, and water quality in the Sacramento-San Joaquin Delta. These Delta-conveyed imported water deliveries from the SWP and CVP have been negatively impacted by significant restrictions on Delta pumping required by biological opinions issued by the U.S. Fish and Wildlife Service in 2008 and National Marine Fisheries Service in 2009. Based on modeling projections provided by DWR, future average imported water deliveries could decrease with additional regulatory restrictions and impacts from climate change.

The California Aqueduct delivers Delta-conveyed supplies to municipal, industrial, and agricultural customers

The State Water Resources Control Board (State Water Board) approved amendments to the Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) in December 2018 that will result in increased restrictions on water users within the San Joaquin Basin (Basin), potentially reducing SFPUC supplies. State Water Board staff are working with Basin stakeholders to develop voluntary agreements that will achieve an equivalent level of environmental protection while reducing impacts on water supplies. If these voluntary agreements are not developed and adopted by the State Water Board as an alternative to the December 2018 approved changes and the objectives in the recently approved plan are implemented, SFPUC supplies to Santa Clara County retailers will likely be reduced, which could increase demand for Valley Water supplies.

Imported supplies are particularly vulnerable to climate change and regulatory actions like the Bay Delta Water Quality Control Plan. State policy, as stated in the Delta Reform Act of 2009 (California Water Code Section 85021), is to "*reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. Each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts.*"

2.3.3 Demands

The Master Plan includes demand projections in five-year increments through year 2040, but these long-term demand projections are uncertain. Water use is affected by multiple factors, including population, number of jobs, type of use, weather, economic conditions, social behavior, and regulations. Each of these factors has its own inherent uncertainties in projections and/or is too variable to predict over a 20-year planning horizon. For example, we know implementing the State's "Making Conservation a Way of Life" will include outdoor water use targets. However, we do not currently know what those targets will be and whether they will be achieved on schedule. We also know that maximum high temperatures will almost certainly increase, but we do not know how that will affect irrigation and cooling demands. We can anticipate an economic recession over the next 20 years, but we cannot predict when it will occur.

Historically, actual demands have been lower than those projected in prior long-term plans. For example, Valley Water's 2005 Urban Water Management Plan had a demand projection of 396,000 AF for 2015. Actual water use in 2015 was about 283,000 AF, which was low due to severe drought reductions, and actual water use in 2013 (before the drought) was about 367,000 AF. Some of the variations between projected and actual water use are related to using conservative projections to ensure we are planning for sufficient water supplies. Some of the variation are related to other factors such as regulations, social behavior, and type of water use.

2.3.4 Other Uncertainties

The greatest risk to natural groundwater recharge is a reduction in pervious surfaces due to an expanded urban footprint. Activities that keep water onsite and protect open spaces on the valley floor will help maintain natural groundwater recharge.

Open spaces and agriculture help maintain natural infiltration/recharge.

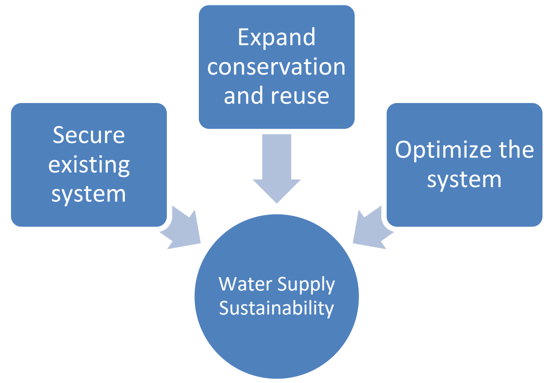
The quantity of SFPUC supplies used in the county could be reduced in the future. This could result from retailers' shifting their use of SFPUC to other supplies, future decreases in demand, or changing regulations. This could also result from SFPUC discontinuing deliveries to San José and Santa Clara because these cities have interruptible contracts with SFPUC. SFPUC, the cities, and Valley Water are looking at options to make San José and Santa Clara permanent SFPUC customers.

Valley Water continues to monitor those risks that can change the water supply outlook and is working to influence key external decisions that have the potential to impact water supply reliability. The Master Plan will be reviewed annually and updated at least every five years based on the monitoring and assessment plan described in Chapter 4. This planning cycle allows risks to be evaluated on an ongoing basis so that the water supply strategy can be updated as better information becomes available.

3 The Water Supply Strategy Ensures Sustainability

Valley Water's Ensure Sustainability water supply strategy relies on the following three elements to provide a reliable supply of water to meet needs through 2040:

1. Secure existing supplies and infrastructure, and
2. Increase water conservation and water reuse, and
3. Optimize the use of existing supplies and infrastructure.



This strategy ensures sustainability because it maintains and builds on the existing baseline system, develops drought-resistant supplies to meet drought needs, and manages risks to water supply reliability from climate change and other risks and uncertainties.

No individual project can address all the county's future water supply needs, so various combinations of projects were evaluated for their ability to meet Valley Water's reliability goal under various scenarios. Several different approaches or strategies will meet Valley Water's water supply reliability goals, but they all have tradeoffs. Some strategies rely heavily on projects that perform well during droughts and in a changed climate, but they are more expensive. Other strategies rely on lower-cost projects but are more susceptible to risks. Some strategies include projects that have environmental or other benefits but lower water supply reliability benefits. Some projects are preferred more than others by the community. Stakeholders all agree that 1) water supply reliability is important; 2) we should maximize water conservation, water reuse, and stormwater capture; and 3) we need to keep water rates affordable. Based on stakeholder input, technical analyses, and the climate of uncertainty, the Ensure Sustainability strategy provides a framework for balancing multiple needs and interests while making effective and efficient investment decisions.

3.1 The Elements of the Ensure Sustainability Water Supply Strategy Work Together

The Ensure Sustainability strategy elements work together to protect and build on past investments in water supply reliability, leverage those past investments to increase flexibility, and develop alternative supplies and demand management measures to manage risk and meet future needs, especially during extended droughts in a changing climate. These elements, combined with Valley Water's Asset Management and Infrastructure Reliability programs, provide a pathway to a sustainable water supply system. The water supply strategy elements and the associated projects for this Master Plan are discussed below. Information on specific projects that are currently in the plan and that have been evaluated for inclusion in the plan is summarized in Appendix H (Project List).

3.1.1 Secure Existing Supplies and Infrastructure

Valley Water should secure existing supplies and facilities for future generations because they are, and will continue to be, the foundation of the county's water supply system. The baseline water supply system was described in Section 2.1. While local water supplies are expected to increase as dams are retrofitted and non-potable reuse expands, Delta-conveyed imported water supplies are at risk to decline as a result of regulations and climate change.

Non-potable reuse (purple pipe) reduce demands on potable supplies.

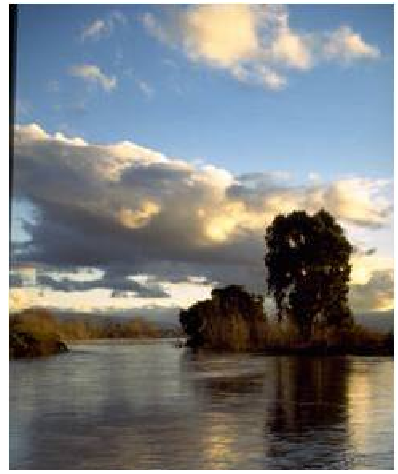
The Ensure Sustainability strategy includes Valley Water participation in the Delta Conveyance Project (formally known as the California WaterFix). The Delta Conveyance Project involves constructing alternative conveyance (one tunnel), which may be able to divert up to 9,000 cubic feet-per-second from the Sacramento River north of the Delta and deliver it to the SWP and CVP pumps at the southern end of the Delta. The goal is to reduce impacts of diversions, help maintain existing deliveries, improve the ability to do transfers, and protect water quality from sea level rise and levee failure events. The Board had decided to participate in the previously planned conveyance project, the California WaterFix, on May 8, 2018. The California WaterFix planned to improve the average available Delta-conveyed imported supply to 170,000 AFY from 133,000 AFY. The project definition of the new Delta Conveyance Project is currently under review by the State, following Governor Newsom's decision to adopt a new approach to Delta conveyance that centers on a single, smaller capacity tunnel project.

3.1.2 Increase Water Conservation and Reuse

Demand management, stormwater capture, and water reuse are critical elements of the water supply strategy. They perform well under current climate conditions and late-century climate change. Water reuse provides local supplies that are not directly hydrologically dependent, so they are resilient to extended droughts when Valley Water most needs additional supplies. They make efficient use of existing supplies, so they are sustainable. In addition, these activities are broadly supported by stakeholders.

Specific water conservation and stormwater projects include incentivizing the use of advanced metering infrastructure (AMI); customer side leak repair incentives; graywater program expansion; rebates for the installation of rain barrels, cisterns, and rain gardens; partnerships to construct stormwater capture basins; and a flood-managed aquifer project. The Additional Conservation and Stormwater Projects and Programs package should reduce future demands by an additional 10,000 AFY (above the current target of 99,000 AFY of savings by 2030) and increase water supplies by about 1,000 AFY by 2040.

The Master Plan also includes developing at least 24,000 AFY of additional recycled water (above and beyond the current target of 33,000 AFY of non-potable reuse) by 2040. For budget and schedule purposes, the Master Plan assumes the reuse target will be achieved by implementing the Los Gatos Ponds Potable Reuse Project, which includes sending purified water to Campbell for groundwater recharge in the existing ponds along Los Gatos Creek. Valley Water is currently developing a Countywide Water Reuse Master Plan that will evaluate potable reuse options, including identifying other options for achieving the Master Plan's reuse target.

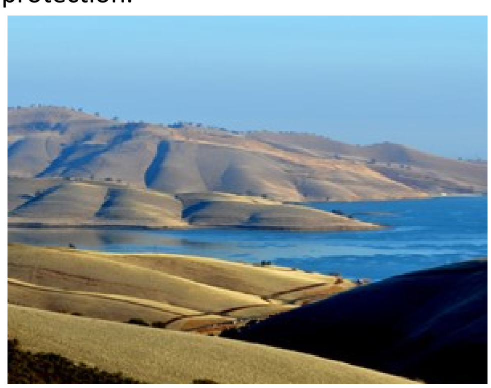


Potable reuse includes delivering purified recycled water to groundwater recharge ponds.

3.1.3 Optimize the Use of Existing Supplies and Infrastructure

This element of the Ensure Sustainability strategy includes projects that increase Valley Water's ability to use existing supplies and infrastructure. Valley Water's existing supplies are more than sufficient to meet current and future needs in wet and above normal years. In some years, supplies exceed needs, and additional facilities would increase flexibility and the ability to use or store those excess supplies. Additional infrastructure could increase Valley Water's ability to respond to outages and challenges such as droughts and water quality problems with existing supplies.

The Master Plan includes three projects that optimize the use of existing supplies and infrastructure – Pacheco Reservoir, Transfer-Bethany Pipeline, and South County Recharge. Pacheco Reservoir is consistent with the Board's priority to actively pursue efforts to increase water storage opportunities. The project, through a partnership with Pacheco Pass Water District, San Benito County Water District, and potentially other partners, will enlarge Pacheco Reservoir from about 6,000 AF to about 140,000 AF and connect the reservoir to San Felipe Division facilities of the CVP. The reservoir will be used to store local runoff and CVP supplies, operated to provide water for fisheries downstream of the reservoir, and increase in-county storage and flexibility of CVP supplies. Other potential benefits could include managing water quality impacts from low-point conditions in San Luis Reservoir and downstream incidental flood protection.



The Transfer-Bethany pipeline will connect Contra Costa Water District's Los Vaqueros Reservoir and Delta intakes to the State Water Project.

The Transfer-Bethany Pipeline will be a pipeline that connects Contra Costa Water District's (CCWD's) system to Bethany Reservoir, which serves both the South Bay Aqueduct and the California Aqueduct. This project will enable Valley Water to receive Delta surplus supplies and some contract supplies through CCWD's system in the Delta instead of or in addition to the CVP and SWP pumps in the southern Delta. This will increase reliability and flexibility for Valley Water. The project would also facilitate other potential regional projects. This project is a partnership between CCWD, Valley Water, and agencies in the Bay Area and Central Valley as part of the larger Los Vaqueros Reservoir Expansion Project.

South County Recharge includes increasing groundwater recharge capacity in the northern end of the Llagas Subbasin, either through reoperation of existing facilities or connecting existing facilities to additional water sources. This will enable Valley Water to capture more wet season water, more effectively manage supplies, and maintain groundwater levels during droughts.

Both the Transfer-Bethany Pipeline portion of the Los Vaqueros Reservoir Expansion and the Pacheco Reservoir Expansion increase Valley Water's water supply operations flexibility and increase emergency water storage. The State, which conditionally approved more than $450 million for each of the projects, recognizes that those projects also provide ecosystem improvements, recreation opportunities, and/or flood protection benefits.

The three projects – South County Recharge, Pacheco, and Transfer-Bethany Pipeline – would increase system flexibility and/or emergency supply and would also provide a combined average annual yield of about 11,500 AFY.

3.2 Water Supply Reliability Improvements Meet the Level of Service Goal

The Valley Water Board approved an updated long-term water supply reliability level of service goal on January 14, 2019 (Appendix G, Board Agenda Memorandum for January 14, 2019). The goal is to develop supplies to meet at least 100 percent of annual water demand identified in the Valley Water's Master Plan during non-drought years and at least 80 percent of annual water demand in drought years. This level of service goal balances the goals of minimizing shortages and costs. The community demonstrated its ability to manage shortages by achieving water use reductions of almost 30 percent in the 2012 to 2016 drought.

The Master Plan projects (Delta Conveyance Project, Additional Conservation and Stormwater Projects and Programs, Potable Reuse Program, Pacheco Reservoir Expansion, Transfer-Bethany Pipeline, and South County Recharge), along with the baseline supplies and infrastructure, meet the water supply reliability level of service goals, even though there are small supply shortages in demand years 2020 – 2030. The Master Plan projects will exceed Valley Water's newly-adopted level of service goal beginning in 2035. Rather than adding a project to address any small shortages (no more than 10,000 AFY), these small shortages will be managed through the monitoring and assessment plan discussed in Chapter 4.

Figure 10 and Table 4 shows average water supply use and non-drought year demands in five-year increments through 2040. Average supplies are less than demands in some years because the supply reflects how much water supply the county can expect to receive and manage. Projected demands could exceed water supplies during drought years without directed water use reductions.

Master Plan Projects:

- Delta Conveyance Project
- Additional Conservation and Stormwater Projects and Programs
- Potable Reuse Program
- Pacheco Reservoir Expansion
- South County Recharge
- Transfer-Bethany Pipeline

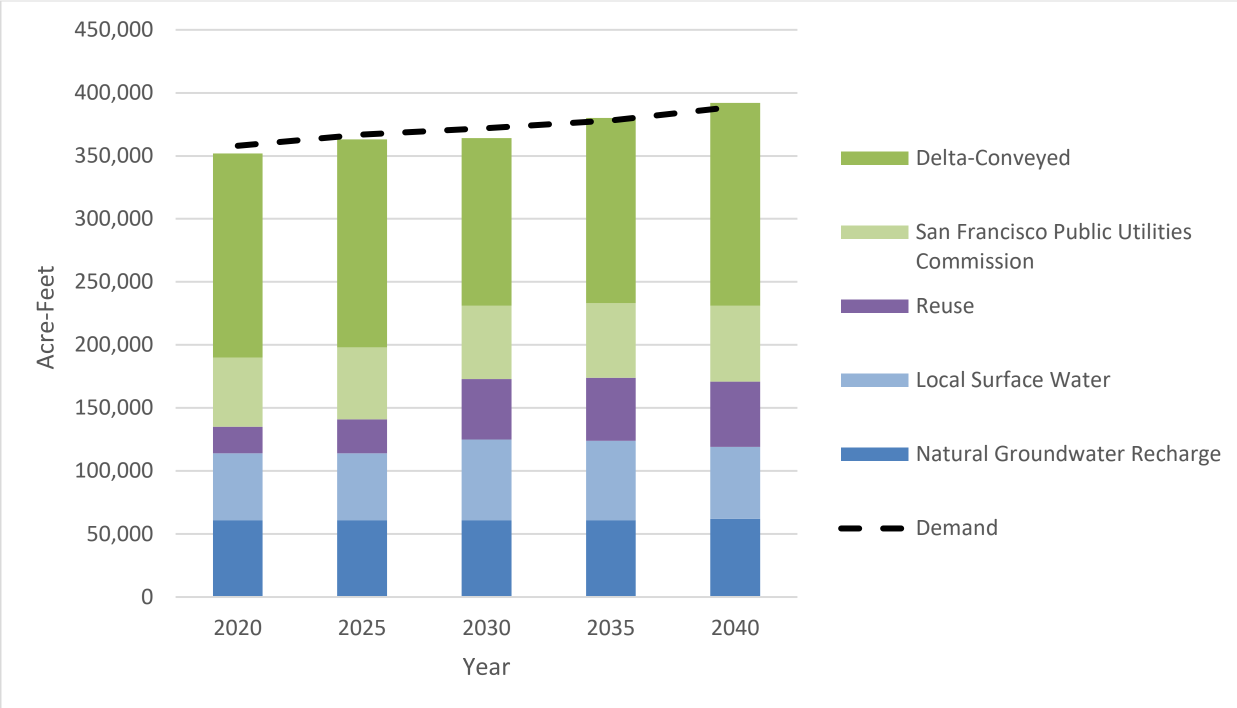


Figure 10. Average Water Supplies with Master Plan Projects

Table 4. Average Water Supplies with Master Plan Projects (AF)

Supply	2020	2025	2030	2035	2040
Natural Groundwater Recharge	61,000	61,000	61,000	61,000	62,000
Local Surface Water	53,000	53,000	64,000	63,000	57,000
Reuse	21,000	27,000	48,000	50,000	52,000
San Francisco Public Utilities Commission	55,000	57,000	58,000	59,000	60,000
Delta-Conveyed*	162,000	165,000	133,000	147,000	161,000
Average Supply	**353,000**	**363,000**	**364,000**	**379,000**	**391,000**
Demand	**358,000**	**367,000**	**372,000**	**378,000**	**389,000**

* Current Delta supplies are expected to decrease in future years, and new supplies may be provided. These values include both the expected gains and losses of supplies over time.

Figure 11 and Table 5 shows water supplies during an extended drought similar to the one that occurred from 1987 to 1992 with the Ensure Sustainability water supply strategy in place and the 2040 demand level. With the Ensure Sustainability strategy in place, the supplies are sufficient to meet 100 percent of demand during the first five years of drought and more than 90 percent in the last year.

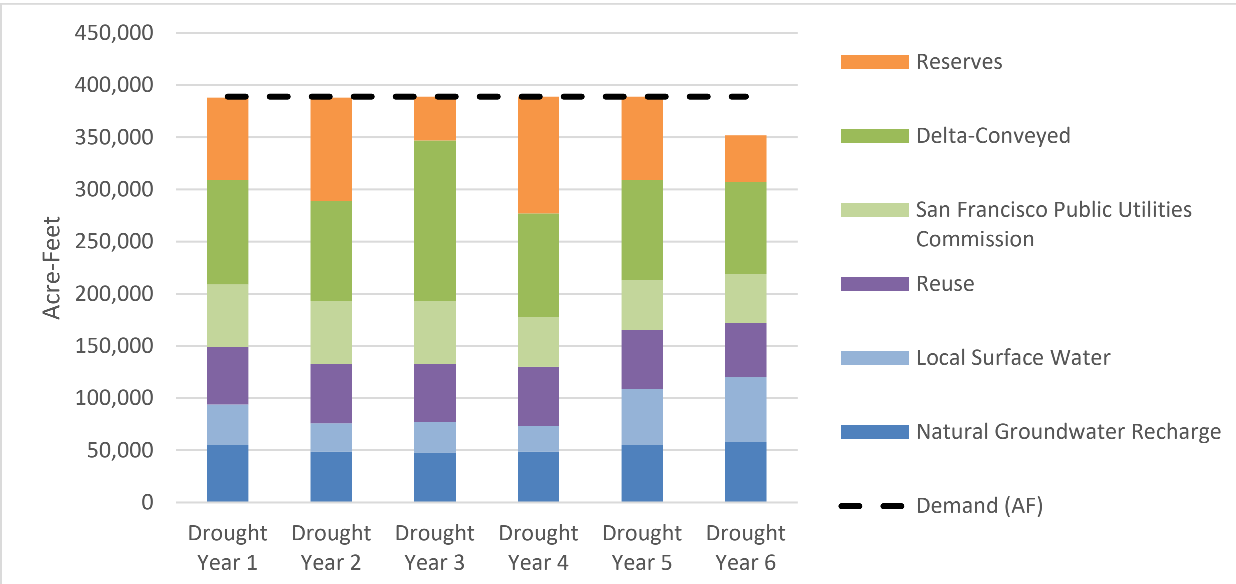


Figure 11. Water Supply Use During an Extended Drought based on 2040 Demands with Master Plan Projects included

Table 5. Water Supply Use During an Extended Drought based on 2040 Demands (AF)

Source of Supply	Drought Year 1	Drought Year 2	Drought Year 3	Drought Year 4	Drought Year 5	Drought Year 6
Natural Groundwater Recharge	55,000	49,000	48,000	49,000	55,000	58,000
Local Surface Water	39,000	27,000	29,000	24,000	54,000	62,000
Reuse	55,000	57,000	56,000	57,000	56,000	52,000
San Francisco Public Utilities Commission	60,000	60,000	60,000	48,000	48,000	47,000
Delta-Conveyed	100,000	96,000	154,000	99,000	96,000	88,000
Reserves*	79,000	99,000	42,000	112,000	80,000	45,000
Total Supply	**389,000**	**389,000**	**389,000**	**389,000**	**389,000**	**352,000**
Shortfall	**0**	**0**	**0**	**0**	**0**	**37,000**

* Water in storage used to meet demands.

Implementation of the Ensure Sustainability water supply strategy would reduce the frequency and magnitude of short-term water use reductions under 2040 demands. Figure 12 shows shortages with and without the Master Plan projects. The small blue area shows that, with full implementation of all elements of the water supply strategy, short-term water use reductions would occur only three percent of the time, and the maximum call for water use reductions would be 20 percent. If only baseline investments are made, illustrated by the orange area in Figure 12, the model predicts that water use reductions would occur about 40 percent of the time, and the level of short-term water reductions could be as high as 50 percent. Water use reductions this high would necessitate water use restrictions and impact the local economy. Water use reductions would be needed almost half the time, and in some years, water supply would only be available to meet health and safety needs.

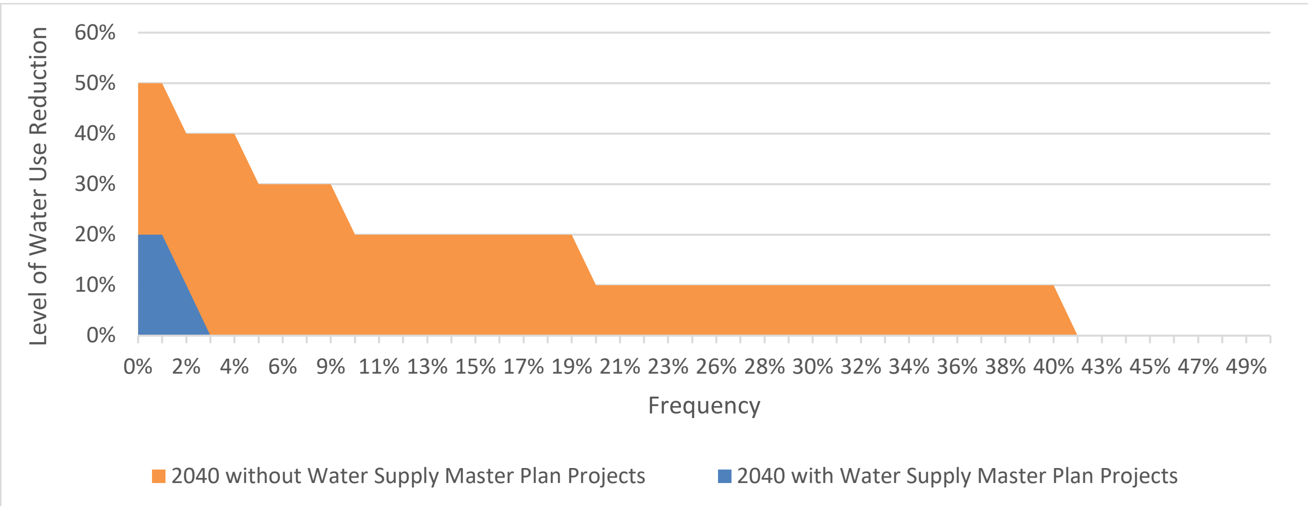


Figure 12. Water Use Reductions under Different Investment Scenarios

3.3 The Water Supply Strategy Supports Other Important Benefits

The key benefit of the Ensure Sustainability strategy is that it develops potable reuse and conservation, which are local drought-resistant supplies, to achieve Valley Water's strategy to develop supplies to meet at least 80 percent of demands during drought years. The Master Plan also achieves the following other planning objectives, which are described in Appendix A:

- Maintaining Groundwater Storage: Groundwater storage is in the Normal stage of Valley Water's water shortage contingency plan in more than 95 percent of modeled years due to the combination of projects in the Master Plan. In the Llagas Subbasin, South County Recharge projects (Butterfield Channel and/or San Pedro Ponds) will help maintain groundwater storage.
- Securing Existing Water Supplies: The Ensure Sustainability strategy includes implementing FAHCE to secure existing local water rights, retrofitting dams to remove operating restrictions, and participating in the Delta Conveyance Project to maintain existing imported water supplies.
- Maximizing Water Conservation and Water Use Efficiency: The Additional Conservation and Stormwater Projects and Programs increase the Valley Water's water conservation savings target to 109,000 AFY by 2040 and adds stormwater capture projects. The strategy also includes increasing countywide reuse to 52,000 AFY in 2040, which exceeds Valley Water's goal of water reuse meeting at least 10 percent of countywide demand.
- Protecting Groundwater Quality: Potable reuse will increase recharge using highly purified water, which will help maintain or improve groundwater quality in northern Santa Clara County. The

Delta Conveyance Project will help maintain current salinity levels in imported water supplies used for groundwater recharge.

- Meeting Drinking Water Regulations: Delta Conveyance Project should help maintain current salinity levels in imported water supplies used at drinking water treatment plants. Pacheco Reservoir and Transfer-Bethany Pipeline will increase Valley Water's flexibility in where it can obtain water from to send to treatment plants, which will help avoid water quality issues in San Luis Reservoir and the Delta.
- Maximizing Valley Water Influence over Supplies and Operations: Pacheco Reservoir, Transfer-Bethany Pipeline, and South County Recharge will increase Valley Water's ability to manage variability in water supplies and respond to emergencies. Pacheco Reservoir, Transfer-Bethany Pipeline, reuse, and Additional Conservation and Stormwater Projects and Programs will involve partnerships with other agencies, which will increase regional cooperation.
- Allowing for Phased Implementation of New Projects and Programs: Chapter 4 describes how the Master Plan projects and programs will be phased in over time. This will allow Valley Water to adjust to changes in demand and supply projections, as well as changes in project definitions.

The Pacheco Reservoir Expansion Project will increase storage capacity in Pacheco Reservoir from about 6,000 AF to over 140,000 AF.

- Adapting to Climate Change: All the elements of the Ensure Sustainability strategy adapt to climate change. Delta Conveyance Project addresses changes in runoff patterns and sea level rise in the Delta. Additional Conservation and Stormwater Projects and Programs will reduce demands for water. Reuse develops drought-resilient supplies that help carry us through dry periods. Pacheco Reservoir, Transfer-Bethany Pipeline, and South County Recharge add flexibility to the system to take advantage of increased storm intensity.
- Protecting and Restoring Creek, Bay, and Other Aquatic Ecosystems: The California Water Commission, which has conditionally awarded $485 million to the Pacheco Reservoir project, found that the project may benefit steelhead habitat in Pacheco Creek downstream of the reservoir. Implementing FAHCE will support native fisheries in Santa Clara County.
- Fulfilling Reasonable Customer Expectations for Good Service: The Master Plan projects improve water supply reliability throughout the county.
- Providing Natural Flood Protection and/or Reduced Potential for Flood Damages: The Additional Conservation and Stormwater Projects and Programs will keep stormwater on site and/or reduce discharges to stormwater facilities. The Pacheco Reservoir could also provide flood benefits to San Benito County by attenuating peak flows entering the reservoir and lowering water levels in Pacheco Creek and Pajaro River downstream.

Another important benefit of the Ensure Sustainability strategy is that it would reduce reliance on imported water supplies, which Valley Water measures by the percent of imported supplies in its water supply portfolio, as a result of increases in water use efficiency and conservation. A more diverse portfolio of supplies will be more resilient to risks and uncertainties, including climate change, than a portfolio with increased reliance on imported water supplies. Imported supplies are particularly vulnerable to climate change and regulatory actions like the Bay Delta Water Quality Control Plan. State policy, as stated in the Delta Reform Act of 2009 (California Water Code Section 85021), is to "*reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. Each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts.*"

Figure 13 shows how the mix of countywide supplies would change between 2020 and 2040. The significant changes are in reuse and Delta-conveyed supplies. Delta-conveyed supplies decrease from 46 percent of countywide supply in 2020 to 41 percent in 2040. Reuse increases from six percent of countywide supply in 2020 to 13 percent in 2040. In addition to the seven percent increase in reuse, long-term water conservation program savings are projected to increase from about 80,000 AFY in 2020 to about 109,000 AFY in 2040.

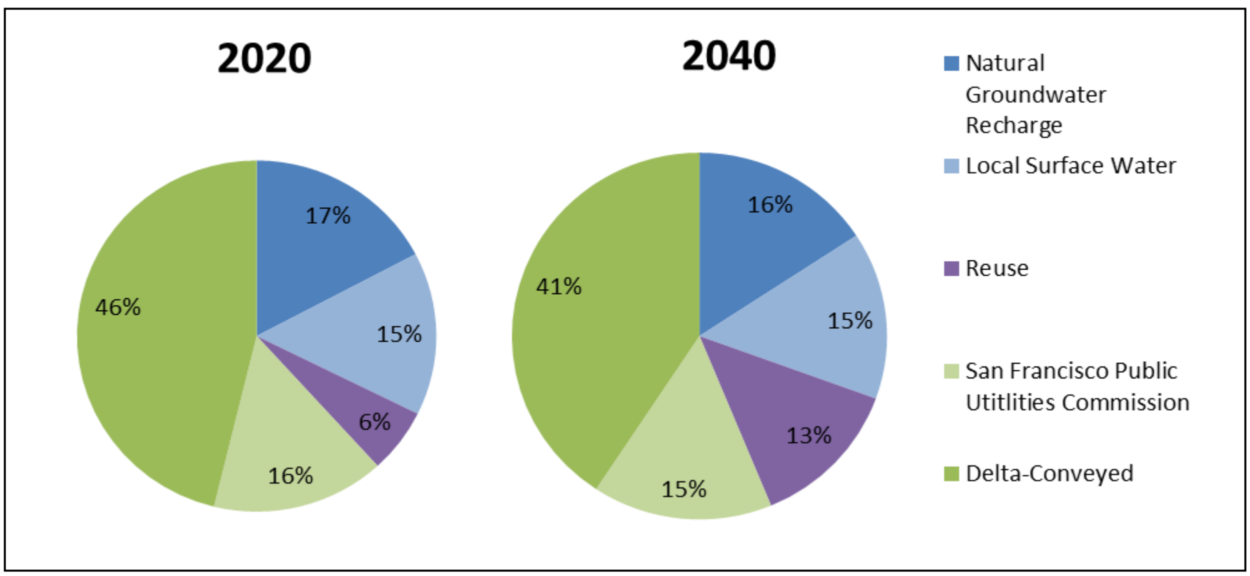


Figure 13. Change in Water Supply Mix over Time with WSMP Projects

3.4 The Ensure Sustainability Strategy is Consistent with Stakeholder Input

The Ensure Sustainability strategy incorporates stakeholder input, through several forums, including Board meetings, stakeholder meetings, Board Advisory Committee meeting, Board Committee meetings, retailer meetings, and a voter survey. Input received through January 14, 2019 is summarized in Appendices E and G (2017 Voter Survey and Board Agenda Memorandum January 14, 2019).

Stakeholders support a reliable water supply, affordable rates, and projects and programs related to water conservation, water reuse, and stormwater capture. The water supply reliability level of service and Ensure Sustainability strategy balances interests in water supply reliability and impacts on rates. Additional reuse and the Additional Conservation and Stormwater Projects and Programs are critical elements of the water supply strategy. Some of the projects in the Master Plan are not as universally supported as water reuse and the Additional Conservation and Stormwater Projects and Programs, but they address many stakeholders' interests. For example, Delta Conveyance Project is generally opposed by environmental groups. However, the project will secure Delta-conveyed water supplies at a much lower cost than some other projects, which addresses other stakeholders' interests related to costs and water supply reliability. Expanded storage is favored by voters, and Pacheco Reservoir can provide expanded storage. However, there is some opposition in the environmental community to new surface reservoirs.

3.5 The Ensure Sustainability Strategy Balances Risks and Costs

Valley Water evaluated the costs and risks associated with projects being considered for this Master Plan (Table 6). Risks were considered in four categories – stakeholder, implementation, operations, and cost. Stakeholder risks include public perception, regulatory restrictions, and partnerships. Implementation risks include construction complexity and phasing potential. Operation risks include climate change and uncertainty in long-term operations and maintenance. Cost risks include stranded assets and financing security. In general, lower-cost projects and/or local projects have lower risks than higher cost and more complex projects. The projects in the Master Plan have a balanced risk profile, with some projects considered low risk (most of the Additional Conservation and Stormwater Projects and Programs and South County Recharge), some considered medium risk (potable reuse, Pacheco Reservoir, and Transfer-Bethany Pipeline), and some considered high risk (Delta Conveyance Project). The Risk Ranking report and additional information is included in Appendix F.

Valley Water also evaluated the costs and economic benefits of improved water supply reliability associated with different projects and water supply strategies (Appendix B, Cost Analysis Methodology). Other water supply strategies included: local flexibility, regional flexibility, local storage, regional storage and statewide storage projects. The Delta Conveyance project costs were Board approved on October 17, 2017 and continue to be used until given other direction. The Ensure Sustainability strategy costs more than the other water supply strategies, but, as discussed above, it meets multiple objectives, addresses multiple stakeholder interests, and balances risk. The economic analysis of the Master Plan portfolio of projects determined the water supply reliability benefits exceed the costs. The present value of the avoided water supply shortages (benefits) is about $2.4 billion, and the present value cost of the Master Plan projects is about $2.1 billion, for a benefit:cost ratio of about 1.15. This calculation does not include benefits associated with ecosystem improvement, emergency storage, flood risk reduction, or water quality. Nor does it include costs associated with potential increases in greenhouse gas emissions from potable reuse and Pacheco Reservoir. Table 7 shows the reduction in the frequency and severity of shortage with the Master Plan projects and the economics associated with the water supply reliability improvements.

Table 6. Master Plan Project Costs and Risks

Project	Average Annual Yield (AFY)	Valley Water Lifecycle Cost[3]	Unit Cost (AF)	Risk
Delta Conveyance Project	41,000	$630 million	$600	High/ Extreme
Additional Conservation & Stormwater Projects	11,000	$100 million	$400	Medium
Potable Reuse	19,000	$1.2 billion	$2,000	Medium
Pacheco Reservoir Expansion[1]	6,000[2]	$340 million[4]	$2,000	Medium
Transfer-Bethany Pipeline[1]	3,500	$78 million	$700	Medium
South County Recharge	2,000	$20 million	$400	Medium

Ultimately the amount of project yield and benefit that is usable by Valley Water depends on the portfolio of water supply projects that Valley Water ultimately implements and the outcome of ongoing regulatory processes.

[1] Assumes Prop. 1 Water Storage Investment Program (WISP) funding. Costs would roughly double without funding.

[2] From the Prop. 1 Water Storage Investment Program (WISP) application.

[3] Valley Water lifecycle costs are presented in 2018 present value dollars. Lifecycle cost is a 100-year cost.

[4] Assumes project cost of $1.3 billion with 3% inflation. Project assumes Prop. 1 funding ($484.5 million), WIIN funding ($250 million) WIFIA loan (49% at 35-year amortization at 3.7% interest), and partner agencies pay 20% of the project. [Valley Water Board Agenda October 8, 2019]

Table 7. Water Supply Reliability Benefits and Costs

	Without Projects	With Projects
Number of Years (out of 94) with Shortages	38	2
Maximum Shortage/Water Use Reduction	50%	20%
Present Value of Benefits (2018$)	Not applicable	$2.1 billion
Present Value of Costs (2018$)	Not applicable	$2.4 billion
Benefit:Cost Ratio	Not applicable	1.15

The estimated impacts on municipal and industrial groundwater production charges from the implementation of the Master Plan in Fiscal Year 2040 are an incremental $1,116/AF in Zone W-2 (North County) and an incremental $187/AF in Zone W-5 (South County). The average annual increase over the next 20+ years in North County groundwater charges is 4.6 percent versus about 2.6 percent without implementation of the Master Plan. In South County, the average annual increase is 5.6 percent versus about 4.9 percent without the Master Plan. This projection is based on the groundwater production charge analysis in Valley Water's Protection and Augmentation of Water Supplies 2019-2020 (Santa Clara Valley Water District, 2019), which does not include costs for the CVP portion of Delta Conveyance Project due the uncertainty with the amount and timing of costs and assumes external funding for most of the Pacheco Reservoir capital costs. This year's groundwater production and surface water charge setting process will be conducted consistent with the District Act, and Board Resolutions 99-21 and 12-10. While recognizing the Supreme Court found Proposition 218 inapplicable to groundwater production charges, only the surface water charge setting process will mirror the process described in Proposition 218 for property-related fees for water services. Additional financial information may be found in Valley Water's annual Protection and Augmentation of Water Supplies (PAWS) report, available at valleywater.org. Figure 14 shows the anticipated impacts of the Master Plan projects on groundwater production charges.

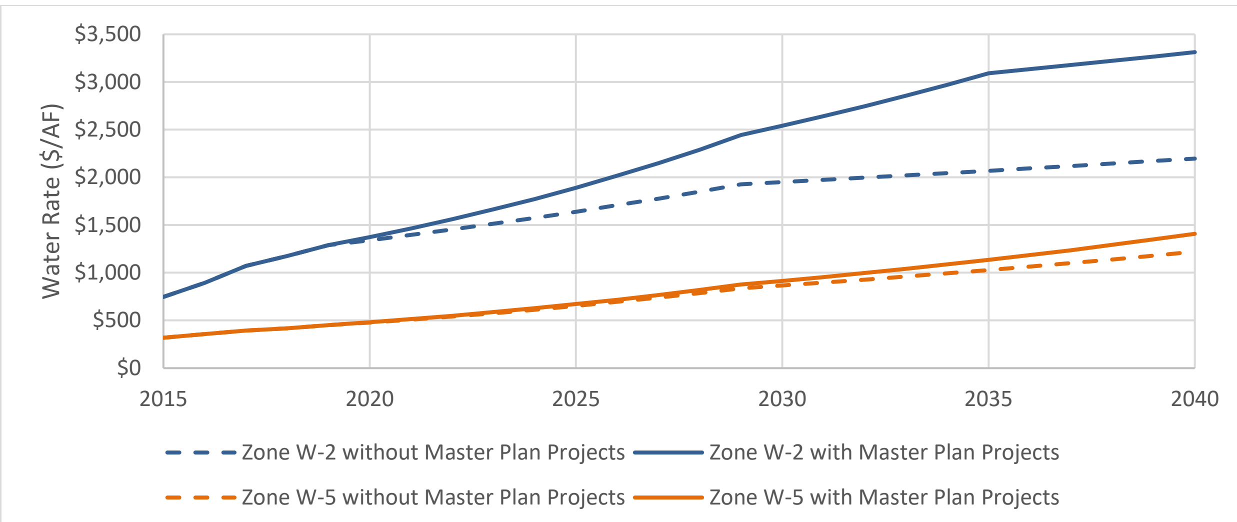


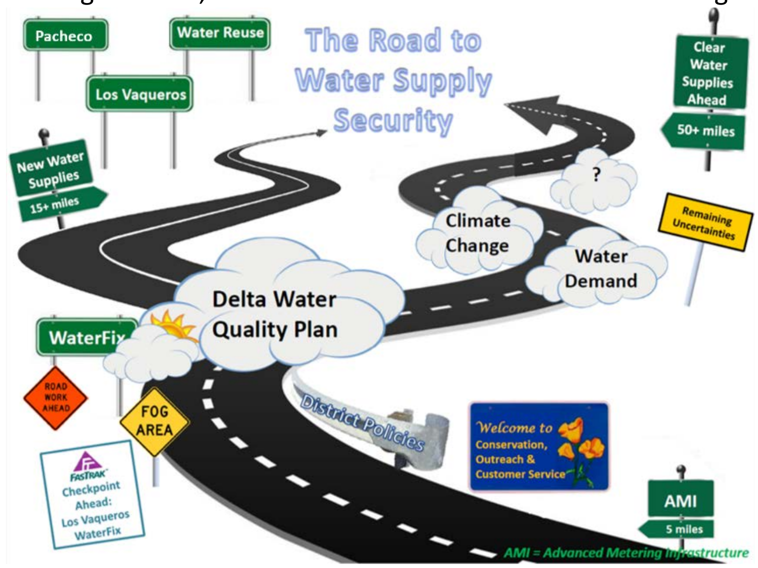
Figure 14. Municipal and Industrial Groundwater Production Charge Impacts from Master Plan

Valley Water may be able to reduce groundwater production charge impacts if the following opportunities become available in the future:

- Direct potable reuse is permitted and accepted by the community and regulatory agencies;
- Advanced treatment technologies become less expensive, more efficient, or both;
- Additional partners join the Pacheco Reservoir project;
- Cities and Valley Water agree on approaches for impact fees to benefit Master Plan projects;
- Cities implement stormwater projects with Valley Water cost-sharing;
- Projects are funded through special taxes (i.e. State Water Project Tax) or other funding mechanisms; and/or
- Projects are postponed because demands remain flat.

4 The Monitoring and Assessment Plan (MAP) Will Help Keep Valley Water on Track

A primary purpose of the Master Plan is to inform investment decisions; therefore, a critical piece of the plan is the annual Monitoring and Assessment Plan (MAP). The MAP will monitor and report on demands, supplies, and the status of projects and programs in the Master Plan so the Valley Water Board can use that information in its annual strategic planning sessions, which inform the annual water rate-setting process, Capital Improvement Program (CIP), and budget processes. Monitoring will identify where adjustments to the Master Plan might be needed to respond to changed conditions. Such adjustments could include accelerating or delaying projects due to changes in the demand trend, changing projects due to implementation challenges, adding projects due to lower than expected supply trends, etc. The MAP is an important tool for Valley Water to continuously assess its current water supplies, demands, and progress of the portfolio of Master Plan projects and to evaluate the next steps if milestones are not met. This chapter presents the Master Plan's Monitoring and Assessment Plan (MAP) for keeping the Ensure Sustainability strategy on track.



The road to water supply reliability has many obstacles. The MAP will help keep Valley Water on track. Graphic courtesy of Alameda County Water District.

4.1 The Master Plan Will be Implemented over the Next 20 Years

The first part of the MAP is the planned schedule for implementation of the Master Plan projects. The schedule is based on Valley Water's current understanding of project schedules, yields, and costs. Table 8 summarizes the schedule for constructing/implementing the various projects and programs in the Master Plan. In addition, each of the projects has its own detailed project plan and is reported on at Valley Water Board committee meetings. The project summaries are in Appendix H. Significant milestones, and risks and uncertainties for the individual projects and programs are discussed below.

4.1.1 Delta Conveyance Project

The Delta Conveyance Project is intended to secure Delta-conveyed supplies. The effort, previously known as the California WaterFix, has been in planning for over a decade. An Environmental Impact Statement/Environmental Impact Report (EIS/EIR) was completed on the two-tunnel project. The two-tunnel California WaterFix project is being revised to a single tunnel (Delta Conveyance Project) and will require new environmental analysis. The project will need to secure permits, resolve legal issues, and secure financing.

Table 8. Implementation Schedule

Project	Now – 2024	2025 – 2029	2030 – 2034	2035-2039
Delta Conveyance Project	• Planning • Permitting	• Permitting • Design	• Design • Construction	Operation
Additional Conservation & Stormwater Projects and Programs	Design and begin implementing additional conservation and stormwater projects and programs.	Support implementation of additional conservation and stormwater projects and programs.	Support implementation of additional conservation and stormwater projects and programs.	Support implementation of additional conservation and stormwater projects and programs.
Potable Reuse Program	• Complete Countywide Reuse Plan • MOU(s) with wastewater provider (s) • Select P3 entity, if applicable • EIR • Design	Construction	Operation	Operation
Pacheco Reservoir Expansion	• EIR/Feasibility Study • Permitting • Planning and Design	Construction	Operation	Operation
Transfer Bethany Pipeline	• EIR/Feasibility Study • Permitting • Planning, Design, and Construction	Operation	Operation	Operation
South County Recharge		Planning, Design, and Permitting	Construction	Operation

The benefits of the project to Valley Water's CVP supplies are unclear because sufficient CVP participation in the project has not been secured, and the project may only secure State supplies.

Other projects that could potentially help secure Delta-conveyed supplies include Sites Reservoir, long-term transfers of SWP contract supplies, and other long-term transfer and exchange agreements. Valley Water will continue to monitor these opportunities and will review the cost escalation of any project via the WSMP Monitoring and Assessment Plan (MAP).

4.1.2 Additional Conservation and Stormwater Projects and Programs

The Additional Conservation and Stormwater Projects and Programs will reduce water demands by about 10,000 AFY and increase natural groundwater recharge by about 1,000 AFY when fully implemented by the end of the planning horizon. Three of the projects – rain garden rebates, rain barrel/cistern rebates, and graywater program expansion have already been implemented. Implementation plans and potential issues for the remaining elements are summarized below.

- Advanced Metering Infrastructure (AMI): Valley Water partnered with the Bay Area Water Supply and Conservation Agency on a study that identified each water retailer's metering and related system, data gaps, and potential for collaborative procurement for AMI as an option for the region. This research, along with lessons learned from the pilot studies funded by Valley Water's Water Conservation Research Grant Program (funding through Safe, Clean Water), will help inform the direction of a future AMI Program, so that it can be as cost effective and as impactful as possible. The key issue that needs to be resolved is investor-owned utility concerns about cost distribution.
- Leak Repair Incentives: Valley Water, in coordination with the water retailers, will implement a customer-side leak repair incentive program after studying the AMI results.
- Graywater Rebate Program Expansion: Expand Valley Water's existing rebate program for laundry-to-landscape graywater systems.

Graywater from clothes washers can be used to water fruit trees, shrubs, vines, and some vegetables.

- Rain Barrels, Rain Gardens, and Cistern: Initiate a Valley Water rebate program to incentivize the installation of rain barrels and cisterns, and the construction of rain gardens in residential and commercial landscapes.
- Model Water Efficiency New Development Ordinance: The Model Water Efficiency New Development Ordinance has been finalized. The ordinance has the following main requirements on new development:
    - Require hot water recirculation for single-family development;
    - Pre-plumb all new single-family development for graywater collection, treatment, and redistribution;

- Pre-plumb all new multi-family and non-residential development for alternative water sources;
- Mandate reuse water connections for common areas in HOA developments; and
- Outlaw the sale of non-compliant fixtures.

Valley Water will begin working with all the county's jurisdictions on adoption in 2019. Valley Water's role will be to encourage ordinance adoption and implementation and provide technical assistance. One challenge with getting jurisdictions to adopt the policy is concern about imposing additional requirements on new development. This concern could be offset in jurisdictions that are developing climate action plans, because model ordinance implementation would reduce energy use and greenhouse gas emissions.

- Flood-Managed Aquifer Recharge (Flood-MAR): Valley Water is currently working to develop a pilot program for capturing and recharging stormwater on open space, a process referred to as Flood-MAR. The pilot program will help identify and develop strategies for collaborating with private land owners and other agencies, assessing appropriate cost-sharing amounts, and evaluating the groundwater benefit of Flood-MAR to Santa Clara County residents. The work plan is scheduled for completion in 2019.
- Centralized Stormwater Capture Projects: Includes development of two centralized stormwater capture projects in northern Santa Clara County. Centralized stormwater capture projects capture stormwater from multiple parcels for recharge in a single location and/or are municipal projects, including "green streets" projects. The Santa Clara Basin Storm Water Resources Plan completed in December 2018 identified potential projects throughout northern Santa Clara County. These projects would likely be partnerships with other jurisdictions and require outside funding, so their schedules are yet to be determined. Valley Water will continue to track project opportunities through our participation in the Santa Clara Valley Urban Runoff Pollution Prevention Program. In addition, Valley Water is continuing planning for the Upper Penitencia Creek flood protection project, which could include some stormwater retention components.

Green infrastructure and stormwater capture can provide multiple benefits, including improved water quality, reduced runoff, and groundwater recharge.

The greatest risks and uncertainties with water conservation programs is the level of active participation by residents, businesses, and governments. This risk is mitigated by the fact that new technologies and standards provide for currently unforeseen opportunities. The greatest risk for implementing stormwater projects is finding willing partners for projects that are cost-effective for Valley Water's water supply program. This risk is somewhat mitigated by regulatory requirements for stormwater management and green infrastructure that will provide water supply benefits.

4.1.3 Potable Reuse Program

The Ensure Sustainability strategy includes a Potable Reuse Program to increase drought supplies, adapt to climate change, and manage risks to imported water supplies. Valley Water is completing a Countywide Water Reuse Master Plan (Reuse Plan) that will identify a preferred mix of non-potable and potable reuse, reverse osmosis concentrate management strategies, and different alternatives for achieving the 24,000 AFY of reuse. The placeholder for the Potable Reuse Program is an indirect potable reuse project at the Los Gatos Ponds.

Reverse osmosis is one step in the advanced treatment process for purified wastewater.

Some of the challenges and uncertainties with the project are securing a source of wastewater, reverse osmosis concentrate management, potentially using a public-private partnership (P3) procurement for the first time, timing of regulations for direct potable reuse, and determining the mix of non-potable and potable reuse that best meets countywide interests. Near-term milestones include executing an agreement (or agreements) with a wastewater provider (or providers).

Other projects that could help achieve the 24,000 AFY of reuse include groundwater recharge at alternative locations than Los Gatos Ponds, groundwater injection wells, augmenting drinking water treatment supplies with purified water (direct potable reuse), expanded non-potable reuse, Regional Desalination/Brackish Water Treatment, and the Refinery Recycled Water Exchange Project.

4.1.4 Pacheco Reservoir Expansion

The expanded Pacheco Reservoir would optimize the use of existing supplies by increasing in-county storage. Project planning is underway, but several significant milestones need to be achieved before January 1, 2022 to remain eligible for State funding. These milestones include completing a feasibility study, preparing a draft EIR, and determining non-State funding. Risks and uncertainties include potentially significant environmental and cultural resource impacts, streamflow requirements for fisheries, and water rights.

Alternative projects that Valley Water will monitor and could provide similar benefits include expanding existing in-county reservoirs, Lexington Pipeline, and Los Vaqueros Reservoir Expansion.

4.1.5 Transfer-Bethany Pipeline

Transfer-Bethany Pipeline, which is one element of the larger Los Vaqueros Reservoir Expansion Project, would optimize the use of existing supplies and increase operational flexibility by enabling Valley Water to move water from Contra Costa Water District's intakes in the Delta to Valley Water's system without relying on south-of-Delta CVP and SWP pumps. This project is subject to the same State requirements for Proposition 1 funding as Pacheco, but the Los Vaqueros feasibility and environmental documents are nearly complete. Nevertheless, the project currently involves nine (9) local agency partners, so project financing and operating agreements will be complex, and water rights changes will be required. Valley

Water continues to evaluate the benefits of this project as more information becomes available. Evaluation includes performing water supply modeling, assessing the capital, operation and maintenance, and repair and rehabilitation costs, as well as investigating the appropriate governance structure. Regular project updates are provided at the Board's Water Storage Exploratory Committee.

Lexington Pipeline could serve as another mechanism to optimize the use of existing supplies as it conveys water from the Lexington Reservoir to the raw water conveyance system.

4.1.6 South County Recharge

South County recharge optimizes the use of existing supplies by increasing groundwater recharge capacity in the Llagas Subbasin. Modeling currently indicates that a south county recharge project should be on line by 2035. Valley Water will continue to consider alternative recharge projects, including expanding local reservoirs or a South County Water Treatment Plant.

One option for increasing South County recharge is to extend the Madrone Pipeline to Morgan Hill's Butterfield Channel.

4.1.7 Other Plans and Projects

Valley Water has multiple plans and programs that support the implementation of the Ensure Sustainability strategy and Master Plan, including the Groundwater Management Plan, Asset Management Plan, Recycled and Purified Water Program, Raw Water Master Plan, Imported Water Program, and Dam Safety Program. Implementing these plans and programs is critical to securing existing supplies and infrastructure consistent with the Ensure Sustainability strategy. In addition, the following activities support the implementation of the Master Plan:

- Demand Projection Update: Valley Water is reviewing its current demand projection and anticipates updating the projection in 2020 to update the demand modeling methodology and to account for actual water use following the 2012 to 2016 drought.
- Groundwater Recharge Assessment: This special study will identify strengths, weaknesses, opportunities, and threats associated with Valley Water's in-county groundwater recharge program. It will identify potential future projects for maintaining or increasing recharge capacity under a changed climate, increased regulations on instream operations, and potential Sustainable Groundwater Management Act requirements. Projects could include additional off-stream recharge ponds, additional stormwater capture projects, and Flood-Managed Aquifer Recharge.
- Ongoing Project Participation: Valley Water will continue to track and participate in projects that could serve as alternatives to the Master Plan projects, including Los Vaqueros Reservoir Expansion, Refinery Recycled Water Exchange, Regional Desalination/Brackish Water Treatment, Sites Reservoir, and long-term transfers of imported water contracts. See Appendix H.
- Coordination with Retailers: Valley Water will continue to coordinate with retailers to track groundwater pumping and treated water demand, and on broader water conservation projects.

4.2 Other Policies, Plans, and Programs May Affect Implementation

The second step of the MAP is to manage unknowns and risks through regular monitoring and assessment. Master Plan monitoring and assessment will build on regular project reports and the annual water supply outlook and look at how different deviations from the plan affects the long-term water supply reliability outlook. Staff will also evaluate how changing external factors such as changes in policy, regulations, and scientific understanding affect the long-term water supply reliability outlook. This section describes some of the activities, beyond monitoring the Master Plan projects and alternative projects.

4.2.1 Making Conservation a Way of Life

The California legislature and governor passed Senate Bill 606 (Hertzberg) and Assembly Bill 1668 (Friedman) into law in 2018 to improve water conservation and drought planning. Pursuant to the legislation, DWR and the State Water Resources Control Board (State Water Board) are developing new standards for indoor residential water use; outdoor residential water use; commercial, industrial, and institutional water use for landscape irrigation with dedicated meters; and water loss. Retail urban water supplies will be required to stay within annual water budgets based on these standards for their service areas. The methodologies for determining the annual water budgets are still being developed, so it is unclear how the standards may affect Valley Water's long-term water supply reliability outlook. Valley Water already has aggressive water conservation targets of 99,000 AFY of savings by 2030 and 109,000 AFY of savings by 2040. However, the new standards could further drive down water use and reduce or postpone the need for some Master Plan projects.

4.2.2 Fisheries and Aquatic Habitat Collaborative Effort

The Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) was a process established to resolve a 1996 complaint with the State Water Resources Control Board over Valley Water's use of its appropriative water rights in the Stevens Creek, Coyote Creek, and Guadalupe River watersheds (Three Creeks). In 2003, Valley Water initialed a Settlement Agreement regarding water rights with the Guadalupe-Coyote Resource Conservation District, the California Department of Fish and Wildlife, U. S. Fish and Wildlife Service and National Marine Fisheries Service and a group of non-governmental organizations, including Trout Unlimited, Pacific Coast Federation of Fishermen's Associations, California Trout, Urban Creeks Council and the Northern California Council of Federation of Fly Fishers.

Stevens Creek after restoration efforts.

The Settlement Agreement provides a roadmap for resolving the water rights complaint by balancing the use of Three Creeks waters for meeting the County's water supply needs, while improving habitat conditions for fish in the Guadalupe River, Coyote Creek, and Stevens Creek watersheds through:

- Modifications to reservoir operations to provide instream flows;

- Restoration measures to improve habitat conditions and provide fish passage; and
- Monitoring and adaptive management.

Valley Water is currently preparing a Fish Habitat Restoration Plan (FHRP) and EIR. These will be used to request modifications to Valley Water's appropriative water rights in the Three Creeks and obtain resource agency permits to implement the FHRP.

Changes to Valley Water's reservoir operations in the Three Creeks that are made through the FHRP or FAHCE adaptive management program may result in impacts to Valley Water's local water supply, but the nature of those impacts have yet to be determined.

4.2.3 Bay-Delta Water Quality Control Plan

The State Water Resources Control Board recently amended the Bay-Delta Water Quality Control Plan (Bay-Delta Plan) to establish flow and revise salinity objectives for the San Joaquin River and its major salmon bearing tributaries. The amendments could significantly reduce SFPUC's water supply, including water delivered to customers in Santa Clara County, especially during droughts. The flow requirements of the Bay-Delta Plan will not be implemented until updates to the Sacramento River and Delta portions of the Bay-Delta Plan are completed, and an implementation program is adopted through water rights proceedings. The Sacramento River and Delta updates could impose additional flow requirements on the Sacramento River and its tributaries, which is the primary source of Valley Water's State and federal imported water supplies. Hence, such flow requirements imposed by the Bay-Delta Plan are likely to reduce Valley Water's imported water supplies.

The Delta holds historic, cultural, economic, and environmental significance.

Valley Water filed a lawsuit in January 2019 challenging the amendments to the Bay-Delta Plan, asking the state court to determine whether the state has taken proper action to impose a requirement for 40% of unimpaired flow in San Joaquin River tributaries, including the Tuolumne River, within a range of 30-50%. In addition to Valley Water's lawsuit, ten other lawsuits were filed in state court by California public entities and non-profits regarding the Bay-Delta Plan. The Judicial Council of California coordinated these lawsuits for trial before one judge in Sacramento Superior Court. The United States also filed lawsuits challenging the Bay-Delta Plan, one in state court and one in federal court. All of these lawsuits are in their preliminary procedural stages.

While these lawsuits are pending resolution, Valley Water continues to work with state officials, conservation organizations, and other water agencies to develop settlement agreements (otherwise known as "Voluntary Agreements"). The Voluntary Agreements will include habitat restoration and other measures that can benefit fish and wildlife, while reducing the amount of required unimpaired flow specified in the Phase One Amendment and future Bay-Delta Plan amendments.

4.2.4 SFPUC Contracts with San José and Santa Clara

The cities of San José and Santa Clara have interruptible contracts with SFPUC. To make San José and Santa Clara permanent customers, SFPUC needs to secure sufficient supplies to meet the cities' contract amounts. Valley Water and SFPUC are partners in several efforts that could enable SFPUC to grant San José and Santa Clara permanent contract status, including Los Vaqueros Reservoir Expansion Project, Regional Desalination/Brackish Water Treatment, and a pre-feasibility study on potable reuse. Valley Water will continue to collaborate with SFPUC and the cities on efforts to make the cities permanent SFPUC customers.

4.2.5 Land Use Planning

Land use decisions can have significant impacts on demands and water supplies. Decisions to build up rather than out can maintain natural groundwater recharge and reduce per-person water use. Decisions to require water use efficiency measures beyond those mandated in state law can also reduce water use and encourage the use of alternative water supplies. Enforcing requirements for reuse water connections and water-efficient landscapes can reduce demands on potable supplies. Aggressive implementation of stormwater requirements can increase groundwater recharge, as well as provide water quality, flood protection, and environmental benefits.

The water industry is recognizing the importance of greater coordination among land use agencies and water suppliers. In addition to working with land use agencies to implement the Model Water Efficient New Development Ordinance, Valley Water is developing a plan to better coordinate with jurisdictions on land use and water supply planning. Valley Water will continue to look for opportunities to partner with local agencies to discuss the challenges and develop opportunities to protect the County's water supply.

Low impact development includes sustainable land use practices.

4.2.6 Climate Change

The impacts of climate change are already being felt in the Bay Area and northern California, and these changes are projected to increase significantly in the coming decades. Valley Water needs to continue to monitor and improve its understanding of climate change to better incorporate climate change impacts into modeling of future conditions. Valley Water will continue to review and incorporate California Department of Water Resources projections when considering the effects on imported water supplies, which are currently based on near-term climate and growth conditions. Additionally, since Valley Water's local surface water supply projections are based on historic hydrology and demand projections do not utilize a temperature factor, future evaluations would benefit from incorporating additional climate change science and projections. Valley Water will consider these areas and others for more refined analyses of climate change impacts as critical components to the MAP and future Master Plan updates.

4.2.7 One Water Plan

Valley Water is developing the One Water Plan as a roadmap for integrated water resource planning on a watershed scale in Santa Clara County. It brings state, regional, and local policies together into a countywide framework with goals and objectives for Valley Water's three mission components of flood protection, stream stewardship, and water supply. One Water seeks to provide guidance from an overarching perspective and look for opportunities to further protect and enhance water resources.

The One Water Plan is a long-term endeavor. It offers a framework for incremental, intentional, and measurable improvement in water resources management and watershed conditions short-term and over decades. Within this vision, however, One Water will continue to operate under the current commitments, regulations, restrictions, and challenges that drive Valley Water's day-to-day operations.

4.3 Annual Reporting Will Help Keep the Ensure Sustainability Strategy on Track

The third step of the MAP is to prepare at least annual reports on Master Plan implementation that consider the following elements:

- Demand trends based on actual use, climate change science, and policy and regulatory changes;
- Supply trends based on actual supplies, climate change science, policy and regulatory changes;
- Project status, including current scope, schedule, and budget;
- Funding;
- Risk and uncertainties;
- Population growth; and
- Stakeholder input.

The Valley Water Board of Directors sets policy to provide Silicon Valley safe, clean water for a healthy life, environment, and economy.

The annual reports will include recommended changes to the Master Plan projects, as appropriate, and how those changes would affect water supply reliability, costs and groundwater production charges, risks, and relationships between projects. The annual reports will be presented to the Valley Water Board of Directors in the summer or fall, so the report can help inform the Board's annual strategic planning process and subsequent budget and water rates processes.

The implementation schedule in Section 4.1 will be updated at least annually based on Board direction. This annual cycle will enable Valley Water to adjust the Master Plan projects based on changes to assumptions, funding, supplies, demands, and infrastructure. It is anticipated that major updates to the Master Plan will occur about every five years, to precede the Urban Water Management Plan updates. The annual reviews and periodic updates will help ensure the Master Plan is living document and it continues to provide a framework for efficient and effective investment in water supply reliability in an environment of uncertainty.

Valley Water cannot forecast the future and identify a specific response for every potential water supply scenario. The path we are on today will look different in the future, near and distant. A balanced, diverse, and sustainable water supply will help us adapt to future challenges. A strong MAP will help us stay on top of challenges and uncertainties and our options for managing them.

5 References

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6 Acronyms

ABAG	Association of Bay Area Governments
AF	Acre-Foot or Acre-Feet
AFY	Acre-Foot per Year or Acre-Feet per Year
AMI	Advanced Metering Infrastructure
Bay-Delta Plan	Bay-Delta Water Quality Control Plan
Board	Valley Water Board of Directors
Central San	Central Contra Costa Sanitary District
CCWD	Contra Costa Water District
cfs	cubic feet per second
CIP	Capital Improvement Program
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
DOT	California Department of Transportation
District Act	Santa Clara Valley Water District Act
DWR	California Department of Water Resources
EIS/EIR	Environmental Impact Statement/Environmental Impact Report
FHRP	Fish Habitat Restoration Plan
FAHCE	Fisheries and Aquatic Habitat Collaborative Effort
Flood-MAR	Flood-Managed Aquifer Recharge
M&I	Municipal and Industrial
MAP	Water Supply Master Plan's Monitoring and Assessment Plan
Master Plan	Water Supply Master Plan
MOU	Memorandum of Understanding
Reuse Plan	Countywide Water Reuse Master Plan
P3	public-private partnership
PAWS	Protection and Augmentation of Water Supplies
SBCWD	San Benito County Water District
SFPUC	San Francisco Public Utilities Commission
State Water Board	State Water Resources Control Board
SWP	State Water Project
UWMP	Urban Water Management Plan
Valley Water	Santa Clara Valley Water District
WEAP	Water Evaluation and Planning
WSCP	Water Shortage Contingency Plan
WUE	Water Utility Enterprise
Zone W-2	Charge zone W-2, as defined by zone boundary in map of Water Utility Zones/ North County
Zone W-5	Charge zone W-5, as defined by zone boundary in map of Water Utility Zones/ South County

Santa Clara Valley Water District
Water Supply Master Plan 2040

Appendices

A. WSMP Planning Objectives
B. Cost Analysis Methodologies
C. Demand Projection Methodology
D. Model Description and Assumptions
E. 2017 Voter Survey
F. Risk Ranking
G. Board Agenda Memorandum for January 14, 2019
H. Project List

Appendix A -WSMP Planning Objectives

Water Supply Master Plan 2040 Planning Objectives

Santa Clara Valley Water District Water Supply Master Plan 2040 Planning Objectives

The Water Supply Master Plan (WSMP) presents Valley Water's strategy for ensuring a reliable, clean water supply to meet future demands. One of the first tasks for such a planning activity is to establish objectives that the agency hopes to achieve through implementation of the plan. The objectives guide development of alternatives and include criteria to measure how well identified strategies meet the objectives. Ultimately, they help develop a recommended strategy to pursue.

Planning objectives were developed for the 2012 Water Supply and Infrastructure Master Plan (WSIMP) by staff, with input from a technical team, Stakeholder Review Committee, management team, and Valley Water Board. These objectives were based on Board policies, and staff worked with stakeholders to rank the objectives. The objectives have been reviewed and updated for proposed use in the Water Supply Master Plan 2040 update.

The proposed planning objectives and sub-objectives for the WSMP are described below. They are listed in order of priority from the 2012 WSIMP. The objectives are broad ideas that Valley Water expects to attain with the plan. With each objective are more detailed sub-objectives, which include evaluation criteria designed to be quantitatively or qualitatively measurable, non-redundant, and clear.

Most of the proposed objectives overlap with objectives in the One Water Master Plan and many may be related to stream stewardship objectives and Safe Clean Water objectives and outcome measures. Development of the WSMP is being coordinated with development of plans addressing other District mission components. Projects that primarily address Valley Water's water supply responsibilities will be included in the WSMP. Projects that are designed to address other components of Valley Water mission will be addressed in the One Water Master Plan and/or other District planning efforts.

The objectives of the WSMP are to:

Objective / Sub-objective	In support of:
1. Provide a Reliable Water Supply for Municipalities, Industries, Agriculture, and the Environment (by):	Board Ends Policy 2.1
Meeting service area demands	CEO Interpretation S 2.4
Maintaining groundwater storage	State Law and Regulations; Board Ends Policy 2.1.1
Securing existing water supplies	Board Ends Policies 2.1.2, 2.1.3, 2.1.4
Reducing reliance on the Delta	State Law and Regulations
Maximizing water conservation and water use efficiency	Board Ends Policy 2.1.5
2. Ensure Drinking Water Quality (by):	
Protecting groundwater quality	State Law and Policy; Board Ends Policy 2.1.1
Meeting drinking water quality regulations	State and Federal Law and Regulations; Board Ends Policy 2.3
3. Minimize Costs (by):	
Minimizing life-cycle costs	Executive Limitation 4.2
4. Maximize Flexibility in the Water Supply System (by):	
Maximizing District influence over supplies and operations	State Law and Policy
Minimizing implementation complexities and barriers	Board Ends Policy 1.3
Allowing for phased implementation of new projects and programs	Executive Limitation 4.2
Adapting to climate change	CEO Interpretation S.2.7
5. Protect the Natural Environment (by):	
Protecting and restoring creek, bay, and other aquatic ecosystems	State and Federal Law; Ends Policy 4.1; FAHCE Initialed Settlement Agreement
Reducing greenhouse gas emissions	Ends Policy 4.3
6. Ensure Community Benefits (by):	
Fulfilling reasonable customer expectations for good service	Executive Limitation EL-2
Improving quality of life in the county through appropriate public access to trails, open space, and District facilities	Ends Policy 4.2
Providing natural flood protection and/or reduce potential for flood damages	Ends Policies 3.1 and 3.2

Objective 1 – Provide a Reliable Water Supply for the County

This objective relates to Board Ends Policy 2.1 "Current and future water supply for municipalities, industries, agriculture and the environment is reliable." Valley Water strives to meet water demands throughout the county under all water supply conditions by maintaining a diverse mix of water supplies and a reliable infrastructure system. One of strengths of Valley Water's water supply and infrastructure system is the inter-connected nature of Valley Water's infrastructure and the variety of water supply sources. Valley Water is actively engaged in maintaining its existing imported and local water supplies and is looking at regional and local projects for new supplies. Maintaining a diverse water supply and system reliability minimizes Valley Water's risk of being unable to provide a reliable supply if one part of the system is not performing up to expectations.

Meeting Service Area Demands

CEO Interpretation S 2.4 requires Valley Water to "Develop water supplies designed to meet at least 100 percent of average annual water demand identified in Valley Water's Urban Water Management Plan during non-drought years and at least 80 percent of average annual water demand in drought years." Valley Water manages water supplies to maximize storage in wet periods for use during dry periods. Currently, supplies exceed demands in most years. However, during droughts, storage can be depleted and result in shortages between water supplies and water demands. Valley Water's Water Shortage Contingency Plan (WSCP) provides a strategy for detecting and responding to water shortages where calls for short-term reductions in water use begin when the projected end of year groundwater storage falls below 300,000 acre-feet. Shortages are primarily managed by requesting short-term behavioral changes that result in reduced water use/water demands. Projected end-of-year storage is one of the outputs of Valley Water's water supply system model.

Water supply strategies should avoid the need to call for short-term reductions in water use of more than 20 percent. Strategies will be evaluated to determine the modeled level of short-term demand reductions required.

Maintaining Groundwater Storage

Board Ends Policy 2.1.1 calls for Valley Water to "aggressively protect groundwater from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and salt water intrusion." In years where supplies exceed demands excess water is stored for future years. The largest 'reservoir' available to Valley Water is the groundwater basin. Maintaining groundwater storage provides reserves for use during droughts/emergencies and is also important in avoiding permanent land subsidence.

Water supply strategies ideally maintain groundwater storage above the "severe" stage in Valley Water's water shortage contingency plan in at least 95% of years modeled to avoid the need to call for short-term reductions in water use of more than 20 percent.

Securing Existing Water Supplies

Board Ends Policies 2.1.2, 2.1.3, and 2.1.4 call for Valley Water to "protect, maintain, and develop" local surface water, imported water, and recycled water, respectively. Valley Water's existing water supply system supports most of the county's water needs and will continue to do so into the future. Optimizing the use of existing supplies and infrastructure leverages the investments Valley Water has already made in water supply reliability and increases the system's flexibility. The existing system includes the use of surface water, groundwater, recycled and purified water, imported water, and a strong commitment to water conservation. Optimizing the use of existing supplies and infrastructure leverages the investments Valley Water has already made in water supply reliability and increases the system's flexibility.

Water supply strategies should maintain existing local and imported water supplies, protect existing water supply infrastructure, and provide redundancy for outages of supplies and/or infrastructure.

Reducing Reliance on the Delta

Section 85021 of the 2009 Delta Reform Act states that "The policy of the State of California is to reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. Each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts."

This sub-objective will be evaluated based on the degree to which local and regional supplies are maximized as a means of minimizing risks associated with the reliability of imported water supplies. When first developing, Santa Clara County relied on groundwater and local streams for its water supply, but excessive pumping resulted in ground subsidence. Over the last half-century, Valley Water has brought in imported water supplies to meet increasing demands, to the point where over half the water used in the county is imported from outside the county boundaries. Imported water from the Delta is Valley Water's largest source of supply (about 40 percent on average) and a single event, such as a large levee failure or failure of one of the aqueducts or pipelines, could adversely impact these deliveries.

Water supply diversity helps reduce the county's exposure to risk of any one supply investment not performing up to expectations. This sub-objective is an insurance measure that says, in effect, "Don't put all your eggs in one basket." Individual local supplies are a significantly lower percentage of the county's overall supply and less susceptible to widespread outages from single events. Although imported supplies will continue to be an important part of the county's water supply, maintaining existing local water rights and expanding supplies from local and regional projects will help maintain water supply diversity.

Water supply strategies should focus of developing local and regional sources and decrease the overall percentage of Valley Water's water supply that is imported.

Maximizing Water Conservation and Water Use Efficiency

Board Ends Policy 2.1.5, is to "Maximize water use efficiency, water conservation and demand management opportunities." Valley Water has a history of promoting water conservation and other water use efficiency efforts. By 2030, Valley Water anticipates that current and planned conservation activities will result in 98,800 acre-feet per year in savings. These conservation savings will offset demands by about 20 percent and reduce the need for new supplies. Conservation also provides other benefits. These benefits include energy conservation, reduced greenhouse gas emissions, reduced costs, and reduced demand for wastewater treatment. Water conservation benefits may also be attributable to land use practices such low-impact development. In addition to efficient use of existing water resources, the water savings and/or yields associated with water use efficiency are minimally affected by changes in hydrology.

Water supply strategies that can exceed conservation savings of 98,800 acre-feet per year by 2030, as anticipated in the 2012 Water Master Plan, are preferred.

Objective 2 - Ensure Drinking Water Quality

This objective is based on Board Ends Policies 2.1.1 "Aggressively protect groundwater basins from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and saltwater intrusion" and 2.3 "Reliable high quality drinking water is delivered." Valley Water's water quality efforts focus on protecting groundwater quality and meeting State and Federal drinking water quality regulations. The purpose of these efforts is to protect public health and drinking water supplies for current and future beneficial use.

Protecting Groundwater Quality

Valley Water is concerned with a number of threats to groundwater quality, including nitrate, salts, gasoline, and solvents. Nitrate, primarily from anthropogenic sources, has historically been the contaminant most frequently detected above drinking water standards in groundwater. Residual nitrate from past practices may contribute to nitrate concentrations in groundwater for decades to come, as water slowly infiltrates from the surface. Further, ongoing land use practices including fertilizer and septic system use can contribute to nitrate in groundwater. Salts, primarily sodium and chloride, are also a concern as the use of recycled water continues to increase. Recycled water, without advanced treatment, is relatively high in salts and recycled water use has the potential to increase salt concentrations in groundwater. Both salts and nitrate are conservative constituents in groundwater, meaning their concentrations do not decrease significantly due to natural subsurface processes. Recharge with surface water, which typically has low concentrations of both constituents, can help reduce salt and nitrate concentrations in groundwater. Treatment processes that remove salt and nitrate from groundwater or waters that will infiltrate to groundwater can also positively affect groundwater quality.

Water supply strategies should help improve groundwater quality by reducing the concentrations of salt, nitrates, and other contaminants.

Meeting Drinking Water Quality Regulations

Valley Water's treatment plants must comply with a long list of state and federal water quality regulations related to chemical, biological, radiological, and physical parameters prior to treatment, during treatment, and within the treated water distribution system. A key treatment challenge is to maximize the disinfection of biological contaminants such as bacteria, viruses, and protozoa, while minimizing the formation of harmful disinfection by-products such as bromate, trihalomethanes, and n-nitrosodimethylamine. Valley Water is also concerned with potential threats to surface water quality, such as protozoan pathogens, perchlorate, endocrine disruptors, pharmaceuticals, and personal care products, each of which could require the addition of new treatment processes. Research level efforts to determine which emerging contaminants are most important to test for are on-going. However, many of the contaminants have no concrete guidelines monitoring or testing yet.

Source water quality can impact the effectiveness of the water treatment processes at Valley Water's water treatment plants. Large or sudden fluctuations in source water quality constituents of algae, turbidity, salinity, organic carbon, pH and temperature can create operational problems that can potentially result in plant shutdowns, with algae being of greatest concern. Valley Water collaborates and cooperates with other agencies to protect and monitor surface water sources but needs to have a variety of water sources to draw from should an individual source have water quality issues.

Water supply strategies need to meet current and anticipated treated water quality standards with existing or currently planned treatment facilities and should provide various options of supply water to the treatment plants that can be selected if other sources are impacted by adverse water quality constituents.

Objective 3 - Minimize Cost

This objective relates to Executive Limitation 4.2 that the Board Appointed Officers shall "Spend in ways that are cost-efficient." Costs include capital and operations costs associated with a project or program, including maintenance and mitigation. Valley Water looks at total cost to the county's residents and businesses, not just District costs.

Water supply strategies will be measured by total present value cost.

Objective 4 - Maximize Flexibility in the Water Supply System

In addition to its variety of water supply sources, one of Valley Water's strengths is the inter-connectedness and reliability of its water supply infrastructure. The WSMP will lay out Valley Water's long-term water supply strategy and identify the associated new infrastructure and infrastructure upgrade needs. Infrastructure reliability and asset management are addressed through separate programs. However, system reliability is an important consideration in long-term planning, as water supply reliability can only be assured if the system that provides the supplies is flexible to address various conditions. Multiple water supply sources, multiple storage and recharge facilities, and a well-maintained and connected infrastructure system all provide Valley Water with a flexible system that can respond to change. Some expected changes are short-term, such as switching sources due to water quality issues, calling on reserves in dry years, or asking retailers to use more groundwater during treated water pipeline shutdowns. Other changes are long-term, such as reservoir and recharge re-operations to meet aquatic habitat needs and climate change. So far, Valley Water's system has proven capable of responding to change. However, some parts of the infrastructure system may not be prepared for future changes. Some new supplies or projects may provide more flexibility for responding to future changes than others.

Maximizing District Influence over Supplies and Operations

Valley Water's influence over a source of water or water supply operation affects Valley Water's ability to manage that supply's performance. For example, Valley Water has greater ability to affect deliveries from its own reservoirs than deliveries from the State and Federal water projects. Likewise, Valley Water should have greater ability to affect expansion of the recycled and purified water with agencies it has already established a partnership. Local and regional partnerships are another means to increase Valley Water's ability to secure supplies and influence operations, and are consistent with State policy direction to implement integrated regional water management.

Water supply strategies should allow Valley Water to adapt to changes in water supplies by providing a high degree of District control including directly controlled supplies and supplies developed in partnership with other local and regional agencies.

Minimizing Implementation Complexities and Barriers

Different types of projects and programs have different levels of implementation complexity and barriers. Very complex projects and projects with significant barriers are more difficult to implement. The types of complexities and barriers that may affect Valley Water's ability to implement a project or program include legal and regulatory requirements, conflicts with existing policy, public perception, institutional and contractual relationships, and technical complexity. For instance, a local water exchange (i.e., an exchange with San Jose Water Company or the San Francisco Public Utilities Commission) might be easier to implement than an exchange that involves moving water through the Delta. Ends Policy E-1.3 states that "collaboration with government, academic, private, non-governmental, and non-profit organizations is integral to accomplishing Valley Water's mission."

Water supply strategies should be supported by the public and minimize legal, regulatory, and technical complexity.

Allowing for Phased Implementation of New Projects and Programs

The WSMP is based on assumptions about future conditions, including assumptions regarding future water demands, precipitation patterns, availability of new technologies, and imposition of future regulations. Depending of the accuracy of these assumptions new supplies may be needed sooner or later or at a different scale. Alternatives that can be implemented in phases, as needed, are more desirable.

Water supply strategies that can be phased over time and allow Valley Water to adjust to changes in water supplies or demands from those forecasted are preferred to those that must occur at once.

Adapting to Climate Change

CEO Interpretation S.2.7 of Ends Policy E-2 "there is a reliable, clean water supply for current and future generations" calls for Valley Water to "incorporate climate change mitigation and adaptation into District planning efforts." Climate change is expected to increase sea level and change precipitation patterns, both of which can impact Valley Water's water supplies. Sea level is projected to increase by 55 inches by 2100, resulting in increased salinity in the Delta and reduced exports if no action is taken to offset impacts. Modeling results indicate that changing weather patterns may also result in more intense storms over a shorter period which could impact both local surface supplies and imported water. In addition, the frequency and severity of droughts may increase.

Water supply strategies that are not affected by changing weather patterns, or are adaptable to these changes are preferable to those that are not.

Objective 5 - Protect the Natural Environment

This objective relates to Board Ends Policies 4.1 "Protect and restore creek, bay, and other aquatic ecosystems" and 4.3 "Strive for zero net greenhouse gas emission or carbon neutrality." Valley Water and its customers value the natural environment. While the purpose of the WSMP is to provide for water supply reliability, it is important that the projects and programs be considered in the context of their impacts on the environment. This includes avoiding impacts to watersheds, streams, and natural resources such as water quality and habitat degradation. It also includes maximizing energy efficiency to reduce greenhouse gas emissions.

Protecting and Restoring Creek, Bay, and Other Aquatic Ecosystems

Santa Clara County is rich in natural resources and Valley Water participates in and supports watershed stewardship to protect and enhance resources and ensure consistency with State and Federal laws and regulations. These activities include protecting and restoring fisheries and aquatic species, preserving and restoring natural stream functions and processes, protecting and restoring riparian and in-stream habitat conditions, and protecting and improving water quality in streams, the Bay, and the Delta. District programs such as the Fisheries and Aquatic Habitat Collaborate Effort are expected to restore and maintain fisheries, wildlife, water quality, and other beneficial uses of creeks in good condition.

Water supply strategies should provide benefits to environmental resources and in-stream and reservoir water quality, or at a minimum avoid impacts to these resources.

Reducing Greenhouse Gas Emissions

Board Ends Policy 4.3 calls for Valley Water to "strive for zero net greenhouse gas emissions or carbon neutrality." Planning for future water supplies and infrastructure should consider both total emissions generated or sequestered and adaptation to climate change (which is addressed under the Maximize Flexibility criterion). The California Water Plan 2009 suggests that local agencies should implement cost effective, energy efficiency measures in their water projects as a means of reducing GHG emissions.

Water supply strategies should reduce greenhouse gas emissions.

Objective 6 - Ensure Community Benefits

This objective relates to Board Executive Limitation EL-2 “The BAOs shall promote conditions, procedures, and decisions that fulfill reasonable customer expectations for good service, are safe, dignified, and nonintrusive.” This objective also relates to Board Ends Policies 3.2 “Reduced potential for flood damages,” and 4.2.1 “Support healthy communities by providing additional trails, parks, and open space along creeks and in the watersheds.” Valley Water provides multiple services to the community. In addition to environmental stewardship and water supply, Valley Water provides flood protection services and supports recreational opportunities when possible. In developing its water supply strategy, Valley Water will consider these benefits for the community and work to ensure benefits are distributed equitably.

Fulfilling Reasonable Customer Expectations for Good Service

It is important for Valley Water to provide even levels of service within zones of benefit and minimizing adverse socio-cultural impacts. Minimizing socio-cultural impacts includes minimizing disproportionate impacts to minority and low-income populations (environmental justice), minimizing adverse impacts to cultural resources, and minimizing adverse social effects such as impacts to community character.

Water supply strategies will be evaluated by the degree to which water supply benefits are provided throughout Valley Water’s service area and the likelihood of disruption is the same throughout the service area.

Improving Quality of Life in the County through Appropriate Public Access to Trails, Open Space, and District Facilities

Valley Water supports recreational opportunities on and around its reservoirs, along creeks, and in the watersheds by providing access to District facilities and, in some cases, providing funding for recreation projects. The recreation programs are maintained and operated by other entities.

Water supply strategies should provide additional water-based recreational opportunities benefits.

Providing Natural Flood Protection and/or Reducing Potential for Flood Damages

One of the primary missions of Valley Water is to minimize flooding impacts to residents and property in Santa Clara County. Flood protection benefits could be associated with water supply projects that increase reservoir storage or reduce stormwater runoff to creeks.

Water supply strategies should provide additional flood protection benefits.

Appendix B - Cost Analysis Methodologies

B-1. Methodology for Estimating Cost of Water Shortage

B-2. Cost of Water Shortage Template

B-3. Unit Cost of Water Methodology Memo

B-4. Unit Cost of Water Methodology Memo Addendum

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DATE: February 27, 2018
TO: Tracy Hemmeter
FR: David Mitchell
RE: Methodology for Estimating Cost of Water Shortage

Introduction

This memorandum presents a methodology for estimating the cost of water shortage. The cost of water shortage is defined as the dollar amount that water users would be willing to pay to avoid the shortage. The methodology rests on the theory of economic demand, which posits that consumers order their preferences for a good such as water from the most to the least valuable and consume up to the point where the value of the last unit consumed is equal to the price of the good. The ordering of consumption preferences in this way is what gives rise to the ubiquitous downward sloping demand curve.

We use the methodology developed in Griffin (1990) to estimate consumer willingness to pay for the increment of water forgone by water users due to restrictions on water use during a water supply shortage. This is a widely used methodology for valuing increments (or decrements) of water supply. For example, it provides the basis for the calculation of water supply benefits for the California Water Fix (CWF) (Sunding, et al., 2013; Sunding, et al., 2015), the economic cost of the state conservation mandate (M.Cubed, et al., 2015; M.Cubed, et al., 2016), as well as numerous other statewide and regional water resources benefit-cost assessments (e.g., Jenkins, et al., 1999; Jenkins, et al., 2003; EBMUD, 2012).[1]

In the next section, we lay out the methodology in detail. Following this, we give an example to illustrate how to use the methodology to estimate the water supply benefits of a water project or portfolio of projects that would increase county water supply.

Methodology

Urban water use can be classified into several broad categories, each with a different priority of use, and the willingness to pay for water by utility customers depends on the intended use of each unit of water. The willingness to pay for water used for drinking and basic sanitation, for example, is larger than the willingness to pay for water used for bathing and laundry, which in turn is larger than the willingness to pay for water used for washing cars, for filling swimming pools, and for irrigating landscape. When faced with a water use restriction, utility customers have the choice of which types of water uses to curtail, and the framework for measuring shortage losses incorporates the idea that utility customers respond to a water use restriction by eliminating less valuable water uses before eliminating more

[1] A comprehensive discussion of the methodology is provided in Chapter 5 of the textbook Water Resource Economics by Ronald C. Griffin. The methodology is also discussed in Chapter 7 of Robert A. Young's book Determining the Economic Value of Water: Concepts and Methods.

valuable water uses, for instance by reducing water used for irrigating landscape prior to reducing drinking water consumption.

Figure 1 depicts a schedule of willingness to pay for different units of water as a demand curve for water that orders these units from highest valued uses to lowest valued uses. Under normal conditions, a customer facing a volumetric water rate of P* demands units of water for which willingness to pay exceeds P*. In Figure 1, this quantity is Q* units. Units of water beyond Q* have value to the customer, but their value is less than their cost, P*, so a rational consumer would choose to forego purchasing units beyond Q*.

Suppose a quantity restriction is placed on water use so that the customer can purchase no more than Q^R units of water. The customer must forego Q*- Q^R units of water. The value of these foregone units of water is measured by the shaded area in Figure 1. Mathematically, this shaded area is calculated as the integral of the demand function evaluated between Q^R and Q*:

$$WTP(Q^* - Q^R) = \int_{Q^R}^{Q^*} D(Q)dQ$$

The customer will also avoid having to directly pay for Q*- Q^R. Thus the customer initially saves P^*(Q*- Q^R). However, most utilities set P* to recover both their variable operating costs and a portion of their fixed costs. Since utilities operate on a break-even basis, they will still need to recoup the fixed costs that would have been recovered by selling the Q*- Q^R units of water. Denoting V as the portion of P* that covers the variable costs of production, the utility will still need to recover (P*-V) (Q*- Q^R) from the customer to cover its fixed costs. Thus, while the customer initially avoids P^*(Q*- Q^R), the utility will seek to recover (P*-V) (Q*- Q^R) in the future, and the net cost avoided by the customer is therefore only V(Q*- Q^R).

The economic loss to the customer of foregoing Q*- Q^R units of water is therefore:

$$L(Q^*, Q^R) = \int_{Q^R}^{Q^*} D(Q)dQ - V(Q^* - Q^R)$$

Viewed in the other direction, $L(Q^*, Q^R)$ also measures the economic benefit to the customer of not having to forego Q*- Q^R units of water.

It is convenient to represent Q^R as a multiple of Q*. Let r be the corresponding percentage reduction in Q* that yields Q^R. Then Q^R = (1-r)Q* and the economic loss function becomes:

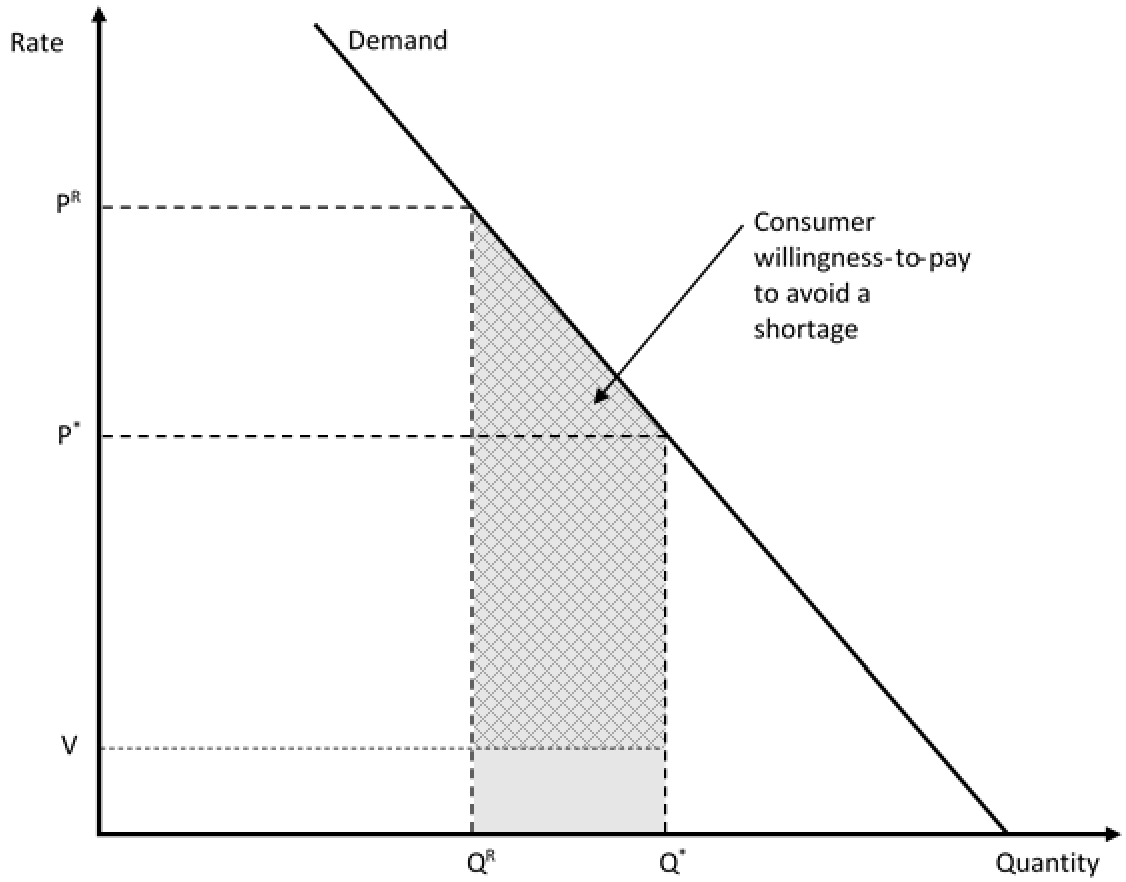
$$L(Q^*, r) = \int_{(1-r)Q^*}^{Q^*} D(Q)dQ - rVQ^*$$

Operationalizing the economic loss function requires assigning a functional form to D(Q). If we use a linear demand function, where D(Q) = a-bP, then the economic loss function is given by

$$Linear\ Demand\ Function\colon\ L(r|Q^*, P^*, e^*, V) = rP^*Q^*\left(1 - \frac{1}{2}\frac{r}{e^*}\right) - rVQ^*$$

where e* is the elasticity of demand at Q*.[2]

Figure 1. Consumer Willingness to Pay to Avoid a Water Shortage



It is more common, however, to use a constant elasticity demand (CED) function, where $D(Q)=AQ^{1/e}$. Then the economic loss function is given by

$$CED\ Loss\ Function\!:\ L(r|Q^*,P^*,e,V) = \frac{e}{1+e}P^*Q^*\left[1-(1-r)^{\frac{1+e}{e}}\right] - rVQ^*$$

where e is the constant elasticity of demand.

A limitation of the CED specification is that it can produce unrealistically high estimates of shortage cost for very large shortages.[3] For this reason, it is customary to place an upper limit on the marginal value of water assigned by the CED. Denoting this upper limit as P_{max}, we can calculate the shortage level, r*, above which the CED would assign marginal values greater than P_{max} as

[2] The elasticity parameter measures the percentage change in quantity demanded given a one percent change in the price of water and is governed by the slope of the demand schedule.
[3] This is due to the fact that marginal values of water under the CED specification increase exponentially as shortages increase in magnitude.

$$r^* = 1 - \left[P_{max} \cdot Q^{*1/e}(1/P^*)\right]^e \cdot [1/Q^*]$$

This leads to the following constrained CED loss function

$$L(r|Q^*, P^*, e, V, r^*) = \begin{cases} \frac{e}{1+e} P^* Q^* \left[1 - (1-r)^{\frac{1+e}{e}}\right] - rVQ^* & if\ r \leq r^* \\ \frac{e}{1+e} P^* Q^* \left[1 - (1-r^*)^{\frac{1+e}{e}}\right] + (r - r^*)P_{max}Q^* - rVQ^* & if\ r > r^* \end{cases}$$

The economic analyses for CWF (Sunding, et al., 2013; Sunding, 2015) and the state conservation mandate (M.Cubed, et al., 2015; M.Cubed, et al., 2016) set P_{max} to $20,000/AF.

The CED specification generally produces larger loss estimates than the linear demand specification. For comparative purposes, we provide shortage loss estimates under both specifications in the example that follows.

We note that the CED specification was used in the state's CWF Economic Analysis (Sunding, et al., 2013; Sunding, 2015). It was also used in the state's analysis of the economic cost of the urban conservation mandate (M.Cubed, et al., 2015; M.Cubed, et al., 2016). For consistency with these analyses, the CED specification should be preferred over the linear demand specification.[4]

Example Calculation of Shortage Cost

To illustrate the application of the methodology in practice, we use it to calculate the water supply benefits to Santa Clara County for the originally proposed two tunnel CWF. Because the administration's current proposal to phase the construction of CWF may result in different water supplies to Santa Clara County than were used in this example, the results should not be treated as an estimate of CWF water supply benefits. The calculations herein are for illustrative purposes only.

The calculations summarized in this memo are contained in two Excel workbooks. The shortage costs calculated with the linear demand loss function are in the workbook

"SCVWD_CWF_Example_Shortage_Costs_LinearDemand_Loss_Function.xlsx"

The shortage cost calculated with the constrained CED loss function are in the workbook

"SCVWD_CWF_Example_Shortage_Costs_CED_Loss_Function.xlsx"

Per the loss functions described above, the key parameters needed to estimate shortage cost are the baseline price of water (P*), the baseline quantity of demand (Q*), the elasticity of demand (e), the variable cost of water supply (V), and the percentage shortage (r). The values for these parameters used for the example are summarized in Tables 1 through 4.

The baseline price of water is set to each Santa Clara County retailer's current water rate, which were provided by SCVWD staff in the Excel file "Retailer Water Rates 2001-18 update 12-01-17.xlsx." Stanford is not a retail water supplier and does not have a published water rate. We therefore use the volume-

[4] In its 2040 Water Supply Update Plan, East Bay Municipal Utilities District, used the mid-point between the linear demand and constant elasticity demand estimates to characterize shortage costs for their water system.

weighted average rate of the other retailers for Stanford. In the case of independent groundwater users, we use the average pumping cost, also provided by SCVWD staff.

The baseline quantities are for the 2040 level of demand for the county and were provided by SCVWD staff in the Excel file "Retailer Demands v2.xlsx." We apportioned each retailer's gross demand to four water use categories: (1) residential, (2) commercial/institutional, (3) industrial, and (4) system losses. This is the same level of disaggregation used in the state's assessment of the economic costs of the urban water conservation mandate (M.Cubed, et al., 2015; M.Cubed, et al., 2016). We used the demand shares shown in Table 2 to apportion each retailer's gross demand to these categories. We derived the shares in Table 2 using data from each retailer's 2015 Urban Water Management Plan.[5]

The residential elasticity estimates are mostly taken from Sunding (2012). Estimates were not available for Purissima Hills or the independent groundwater users. We use the volume-weighted average elasticity of the other retailers for these entities. For CWS Los Altos, we use a recently estimated elasticity from M.Cubed (2018).[6]

For the commercial/institutional and industrial sectors, we use the same elasticity assumptions as were used for the state's assessment of the economic costs of the urban water conservation mandate (M.Cubed, et al., 2015; M.Cubed, et al., 2016). The basis for the commercial/institutional and industrial elasticity estimates are as follows:

> <u>Commercial/Institutional</u>: The estimate is based on a review of the literature on short run commercial water use elasticities. Lynn et al. (1993) reported a range of -0.12 to -0.48. These results are supported by studies by Schneider and Whitlach (1991) who find elasticities ranging from -0.36 to -0.40, and by Williams and Suh (1986) who estimate an elasticity of -0.23 for short-run commercial water use. For this analysis we use -0.3, the midpoint of the range reported in Lynn et al.
>
> <u>Industrial</u>: Renzetti (1992) summarized studies of industrial water use elasticities and reported a range between -0.15 and -0.59. Reynaud (2003) estimated an elasticity of -0.29 for industrial water use. For this analysis we use -0.37, the midpoint of the range cited by Renzetti.

The variable cost of water production is assumed to average $250/AF. This assumption is taken from the state's assessment of the economic costs of the urban water conservation mandate (M.Cubed, et al., 2015; M.Cubed, et al., 2016).

The maximum willingness to pay (P_{max}) for the constrained CED loss function is set to $20,000/AF, which is the same limit as is used in the state's economic analysis of CWF and the urban water conservation mandate.

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[5] Except in the case of Purissima Hills, which is not required to prepare and Urban Water Management Plan. In their case, we used data from their 2015 Water Rates Study to apportion the aggregate demand. We assume Stanford water use is entirely institutional and we assume groundwater use is 75% residential and 25% commercial/institutional.

[6] The Brattle Group estimate of -0.075 for CWS Los Altos is unusually low and outside of the normal range of published estimates for urban retail water demand. Using 10 years of monthly consumption data for CWS Los Altos, M.Cubed (2018) estimates an elasticity of -0.15 for CWS Los Altos, which is in line with the estimates from The Brattle Group for the other Santa Clara County retailers.

Table 1. Data for Shortage Cost Estimation

Water Provider	Quantity (Q*) AF	Vol Rate (P*) $/AF	Elasticity Residential	Elasticity Comm/Inst	Elasticity Industrial	Variable Cost (V) $/AF
CWS Los Altos	14,200	2,154	-0.150	-0.300	-0.370	$250
Gilroy	14,935	1,056	-0.275	-0.300	-0.370	$250
Great Oaks	10,726	1,652	-0.192	-0.300	-0.370	$250
Milpitas	14,627	2,801	-0.164	-0.300	-0.370	$250
Morgan Hill	9,162	897	-0.187	-0.300	-0.370	$250
Mountain View	14,054	2,962	-0.218	-0.300	-0.370	$250
Palo Alto	13,788	3,999	-0.127	-0.300	-0.370	$250
San Jose Muni	29,349	1,560	-0.155	-0.300	-0.370	$250
San Jose Water	150,130	2,366	-0.207	-0.300	-0.370	$250
Santa Clara	35,088	2,479	-0.221	-0.300	-0.370	$250
Sunnyvale	30,865	2,243	-0.197	-0.300	-0.370	$250
Purissima Hills	2,046	2,840	-0.198	-0.300	-0.370	$250
Stanford	4,700	2,281	-0.198	-0.300	-0.370	$250
N. County GW	8,992	1,175	-0.198	-0.300	-0.370	$250
Coyote & S. County GW	8,578	418	-0.198	-0.300	-0.370	$250
Total	361,240					

Table 2. 2040 Demand Shares by Retailer

Retailer	Residential	Commercial/ Institutional	Industrial	Losses	Total
CWS Los Altos	75%	22%	0%	3%	100%
Gilroy	63%	25%	2%	10%	100%
Great Oaks	73%	21%	2%	4%	100%
Milpitas	54%	21%	15%	10%	100%
Morgan Hill	66%	27%	0%	7%	100%
Mountain View	50%	39%	4%	8%	100%
Palo Alto	57%	33%	4%	7%	100%
San Jose Municipal	45%	25%	28%	3%	100%
San Jose Water Company	53%	40%	1%	7%	100%
Santa Clara	49%	37%	9%	5%	100%
Sunnyvale	48%	47%	0%	5%	100%
Purissima Hills	88%	7%	0%	5%	100%
Stanford	0%	100%	0%	0%	100%
North County GW	75%	25%	0%	0%	100%
Coyote & S. County GW	75%	25%	0%	0%	100%

The simulated annual water shortages in Santa Clara County for 94 years of hydrology without and with CWF are summarized in Tables 3 and 4, respectively. The simulation results were provided by SCVWD staff in the Excel file "Shortages with and without CWF includes No Regrets.xlsx." The simulations are based on the 2040 demands in Table 1. Both the "without" and "with" CWF simulations assume the No Regrets supply and conservation projects are implemented. The "with" CWF simulation also assumes implementation of the Butterfield Recharge Project, which SCVWD groundwater modeling has indicated is needed for reliability in the southern portion of its service area..

Table 3. Simulated Santa Clara County Annual Supply Shortage % Without CWF

Hydro Year	Shortage %	**Hydro Year**	Shortage %	**Hydro Year**	Shortage %	**Hydro Year**	Shortage %
1922	0%	**1946**	0%	**1970**	0%	**1994**	10%
1923	0%	**1947**	0%	**1971**	0%	**1995**	10%
1924	0%	**1948**	10%	**1972**	0%	**1996**	0%
1925	10%	**1949**	15%	**1973**	10%	**1997**	0%
1926	0%	**1950**	10%	**1974**	0%	**1998**	0%
1927	0%	**1951**	0%	**1975**	0%	**1999**	0%
1928	0%	**1952**	0%	**1976**	0%	**2000**	0%
1929	0%	**1953**	0%	**1977**	15%	**2001**	0%
1930	10%	**1954**	0%	**1978**	30%	**2002**	0%
1931	10%	**1955**	10%	**1979**	10%	**2003**	0%
1932	15%	**1956**	10%	**1980**	0%	**2004**	10%
1933	15%	**1957**	0%	**1981**	0%	**2005**	10%
1934	15%	**1958**	0%	**1982**	0%	**2006**	0%
1935	30%	**1959**	0%	**1983**	0%	**2007**	0%
1936	10%	**1960**	0%	**1984**	0%	**2008**	0%
1937	0%	**1961**	10%	**1985**	0%	**2009**	15%
1938	0%	**1962**	15%	**1986**	0%	**2010**	15%
1939	0%	**1963**	10%	**1987**	0%	**2011**	10%
1940	0%	**1964**	10%	**1988**	0%	**2012**	0%
1941	0%	**1965**	0%	**1989**	30%	**2013**	0%
1942	0%	**1966**	0%	**1990**	15%	**2014**	10%
1943	0%	**1967**	15%	**1991**	50%	**2015**	30%
1944	0%	**1968**	0%	**1992**	30%		
1945	0%	**1969**	0%	**1993**	30%		

Table 4. Simulated Santa Clara County Annual Supply Shortage % With CWF

Hydro Year	Shortage %	**Hydro Year**	Shortage %	**Hydro Year**	Shortage %	**Hydro Year**	Shortage %
1922	0%	**1946**	0%	**1970**	0%	**1994**	0%
1923	0%	**1947**	0%	**1971**	0%	**1995**	0%
1924	0%	**1948**	0%	**1972**	0%	**1996**	0%
1925	0%	**1949**	0%	**1973**	0%	**1997**	0%
1926	0%	**1950**	0%	**1974**	0%	**1998**	0%
1927	0%	**1951**	0%	**1975**	0%	**1999**	0%
1928	0%	**1952**	0%	**1976**	0%	**2000**	0%
1929	0%	**1953**	0%	**1977**	0%	**2001**	0%
1930	0%	**1954**	0%	**1978**	10%	**2002**	0%
1931	0%	**1955**	0%	**1979**	0%	**2003**	0%
1932	0%	**1956**	0%	**1980**	0%	**2004**	0%
1933	10%	**1957**	0%	**1981**	0%	**2005**	0%
1934	15%	**1958**	0%	**1982**	0%	**2006**	0%
1935	15%	**1959**	0%	**1983**	0%	**2007**	0%
1936	10%	**1960**	0%	**1984**	0%	**2008**	0%
1937	0%	**1961**	0%	**1985**	0%	**2009**	0%
1938	0%	**1962**	10%	**1986**	0%	**2010**	0%
1939	0%	**1963**	0%	**1987**	0%	**2011**	0%
1940	0%	**1964**	0%	**1988**	0%	**2012**	0%
1941	0%	**1965**	0%	**1989**	10%	**2013**	0%
1942	0%	**1966**	0%	**1990**	0%	**2014**	0%
1943	0%	**1967**	0%	**1991**	15%	**2015**	10%
1944	0%	**1968**	0%	**1992**	30%		
1945	0%	**1969**	0%	**1993**	15%		

We use the data in Tables 1 through 4 in conjunction with the loss functions described previously to estimate the shortage cost with and without CWF for each year in the hydrologic record. We take the difference in the without and with CWF estimates to get the annual avoided shortage cost. We then average the annual estimates to get the expected annual avoided shortage cost. The results for the linear and constrained CED loss functions are summarized in Table 5.

In implementing the calculations, we have assumed the shortages in Tables 3 and 4 are uniformly distributed across the three user classes. This is a conservative assumption since it is common for water retailers to allocate shortages in a way that shields commercial and industrial water uses, thereby putting a disproportionate share of the shortage on the residential sector. Residential marginal losses are greater than commercial/institutional and industrial marginal losses because commercial/institutional and industrial demands are more elastic. Thus if we had instead assumed the residential sector absorbed a disproportionate share of the shortage, the total loss would be somewhat greater than what we have estimated.

We also have assumed that system losses decrease proportionately with the magnitude of the shortage. This also is a conservative assumption since a significant fraction of water loss is associated with system pressurization and is not strongly influenced by the level of water delivery. Thus we likely overstate by some small amount the total avoided variable production cost.

Table 5. Expected Annual Avoided Shortage Cost with CWF

User Class	Linear Loss Function	Constrained CED Loss Function
Residential	28,368,189	42,034,921
Commercial & Institutional	16,570,072	20,924,206
Industrial	1,792,451	2,113,455
System Water Loss	-226,012	-226,012
Total	46,504,700	64,846,570
Total Rounded to Nearest $M	**47,000,000**	**65,000,000**

Assuming CWF becomes operational in 2040, the 2018 present value of avoided shortage cost can be calculated as:

$$2018\ Present\ Value = \frac{1}{(1+d)^{21}}\frac{\mu}{(1+d)^{n}}\frac{(1+d)^{n}-1}{d}$$

where μ is the expected annual shortage cost, n is the CWF operational life in years, and d is the real discount rate. For example, given the countywide expected annual shortage costs from Table 5 and setting n to 100 and d to 0.03, we get the present value of avoided shortage costs shown in Table 6.[7] The values for d and n were selected to match the ones the state is currently using for its benefit-cost analysis of CWF.

In this example, the 2018 present value of CWF avoided shortage cost is approximately $0.8 billion using the linear demand loss function and $1.1 billion using the constrained constant elasticity demand loss function. As with any present value calculation, the results are sensitive to the values selected for d and n. The present value is increasing in n and decreasing in d. It is good practice to sensitivity test present value results for alternative values of d and n.

Table 6. Example Countywide 2018 Present Value of CWF Avoided Water Shortage Cost

Linear Demand Loss Function	Constrained CED Loss Function
$798,000,000	$1,104,000,000
Note: Based on countywide expected annual shortage cost in Table 5, real discount rate of 0.03, and CWF operation life of 100 years. Results rounded to nearest million. As with any present value calculation, results are sensitive to choice of discount rate, project life, and the assumptions underlying the estimates of annual shortage losses. It is always good practice to sensitivity test present value results for this reason.	

[7] Results are rounded to the nearest million.

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Water Shortage Cost Model Inputs

2040 Demand Shares

Class	CWS Los Altos	Gilroy	Great Oaks	Milpitas	Morgan Hill	Mountain View	Palo Alto	San Jose Muni	San Jose Water	Santa Clara	Sunnyvale	Purissima Hills	Stanford	North County GW	Coyote & South County GW	County Avg
Residential	0.752	0.630	0.726	0.540	0.657	0.499	0.566	0.446	0.531	0.489	0.482	0.884	0.000	0.750	0.750	0.544
Commercial/Institutional	0.219	0.253	0.213	0.209	0.271	0.387	0.332	0.249	0.397	0.368	0.472	0.066	1.000	0.250	0.250	0.355
Industrial	0.001	0.017	0.021	0.148	0.000	0.037	0.037	0.280	0.007	0.093	0.000	0.000	0.000	0.000	0.000	0.045
Losses	0.028	0.100	0.040	0.103	0.072	0.077	0.065	0.025	0.065	0.050	0.046	0.050	0.000	0.000	0.000	0.056
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Source: Retailer 2015 UWMP demand projections, except Purissima Hills which is based on its 2015 Water Rates Study.
Stanford is assumed to provide water for institutional puporses only. GW water shares are assumed.

	CWS Los Altos	Gilroy	Great Oaks	Milpitas	Morgan Hill	Mountain View	Palo Alto	San Jose Muni	San Jose Water	Santa Clara	Sunnyvale	Purissima Hills	Stanford	North County GW	Coyote & South County GW	County Total
2040 Total M&I Demand	14,200	14,935	10,726	14,627	9,162	14,054	13,788	29,349	150,130	35,088	30,865	2,046	4,700	8,992	8,578	361,240

Source: Retailer Demands v2.xlsx

Imputed 2040 Class Baseline Quantities

	CWS Los Altos	Gilroy	Great Oaks	Milpitas	Morgan Hill	Mountain View	Palo Alto	San Jose Muni	San Jose Water	Santa Clara	Sunnyvale	Purissima Hills	Stanford	North County GW	Coyote & South County GW	County Total
Residential	10,678	9,409	7,787	7,899	6,019	7,013	7,804	13,090	79,719	17,158	14,877	1,809	0	6,744	6,434	196,439
Commercial/Institutional	3,110	3,779	2,285	3,057	2,483	5,439	4,578	7,308	59,602	12,912	14,568	135	4,700	2,248	2,145	128,347
Industrial	14	254	225	2,165	0	520	510	8,218	1,051	3,263	0	0	0	0	0	16,220
System Losses	398	1,494	429	1,507	660	1,082	896	734	9,758	1,754	1,420	102	0	0	0	20,233
Total	14,200	14,935	10,726	14,627	9,162	14,054	13,788	29,349	150,130	35,088	30,865	2,046	4,700	8,992	8,578	361,240

Demand Elasticities

	CWS Los Altos	Gilroy	Great Oaks	Milpitas	Morgan Hill	Mountain View	Palo Alto	San Jose Muni	San Jose Water	Santa Clara	Sunnyvale	Purissima Hills	Stanford	North County GW	Coyote & South County GW
Residential	-0.150	-0.275	-0.192	-0.164	-0.187	-0.218	-0.127	-0.155	-0.207	-0.221	-0.197	-0.198	-0.198	-0.198	-0.198
Commercial/Institutional	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300	-0.300
Industrial	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370	-0.370

Sources:

Residential — *The Brattle Group (2012). Residential Losses from Urban Water Shortages in Santa Clara Valley Water District. Prepared for Santa Clara Valley Water District, October 4, 2012.*
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Purissima Hills, Stanford and GW are weighted averages of the other retailers.

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	CWS Los Altos	Gilroy	Great Oaks	Milpitas	Morgan Hill	Mountain View	Palo Alto	San Jose Muni	San Jose Water	Santa Clara	Sunnyvale	Purissima Hills	Stanford	North County GW	Coyote & South County GW
Baseline Water Price ($/AF)	$2,154	$1,056	$1,652	$2,801	$897	$2,962	$3,999	$1,560	$2,366	$2,479	$2,243	$2,840	$2,267	$1,175	$418

Source: Retailer Water Rates 2001-18 updated 12-01-17.xlsx

	CWS Los Altos	Gilroy	Great Oaks	Milpitas	Morgan Hill	Mountain View	Palo Alto	San Jose Muni	San Jose Water	Santa Clara	Sunnyvale	Purissima Hills	Stanford	North County GW	Coyote & South County GW
Variable Production Cost ($/AF)	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250

County Water Shortage Percent by Hydrologic Year

Hydrologic Year	Base Case	With WSMP
1922	0%	0%
1923	0%	0%
1924	0%	0%
1925	10%	0%
1926	0%	0%
1927	0%	0%
1928	0%	0%
1929	10%	0%
1930	10%	0%
1931	10%	0%
1932	30%	0%
1933	20%	0%
1934	20%	0%
1935	20%	0%
1936	10%	0%
1937	0%	0%
1938	0%	0%
1939	0%	0%
1940	0%	0%
1941	0%	0%
1942	0%	0%
1943	0%	0%
1944	0%	0%
1945	0%	0%
1946	0%	0%
1947	0%	0%
1948	20%	0%
1949	20%	0%
1950	10%	0%
1951	0%	0%
1952	0%	0%
1953	0%	0%
1954	0%	0%
1955	10%	0%
1956	10%	0%
1957	0%	0%
1958	10%	0%
1959	0%	0%
1960	0%	0%
1961	10%	0%
1962	30%	0%
1963	20%	0%
1964	0%	0%
1965	10%	0%
1966	0%	0%
1967	10%	0%
1968	0%	0%
1969	0%	0%
1970	0%	0%

1971	0%	0%
1972	0%	0%
1973	10%	0%
1974	0%	0%
1975	0%	0%
1976	0%	0%
1977	20%	0%
1978	40%	0%
1979	10%	0%
1980	0%	0%
1981	0%	0%
1982	0%	0%
1983	0%	0%
1984	0%	0%
1985	0%	0%
1986	0%	0%
1987	0%	0%
1988	0%	0%
1989	30%	0%
1990	20%	0%
1991	50%	0%
1992	40%	10%
1993	30%	20%
1994	10%	0%
1995	10%	0%
1996	0%	0%
1997	0%	0%
1998	0%	0%
1999	0%	0%
2000	0%	0%
2001	0%	0%
2002	0%	0%
2003	10%	0%
2004	0%	0%
2005	10%	0%
2006	0%	0%
2007	0%	0%
2008	0%	0%
2009	20%	0%
2010	20%	0%
2011	0%	0%
2012	0%	0%
2013	10%	0%
2014	10%	0%
2015	40%	0%

Expected Avoided Shortage Cost With WSMP
2040 Level of Demand

User Class	Expected Average Annual Shortage Cost
Residential	71,286,663
Commercial & Institutional	34,231,047
Industrial	3,431,375
Avoided System Water Losses	-355,161
Total	**108,593,923**
Rounded to nearest million	**109,000,000**
2018 Present Value	**$ 2,460,000,000**

Present value of avoided shortage costs (aka benefits) with the Master Plan projects

Level of Shortage	Annual Cost
10%	$86,461,993
20%	$236,860,198
30%	$504,076,623
40%	$956,888,340
50%	$1,546,337,639

Annual cost of a single year of shortage at the level indicated

Santa Clara Valley Water District

MEMORANDUM

FC 14 (01-02-07)

TO: Jerry De La Piedra

FROM: Tracy Hemmeter

SUBJECT: Unit Cost of Water Methodology

DATE: December 9, 2016

The District's 2017 Water Supply Master Plan will evaluate projects and portfolios using several criteria, including the unit cost of water. Other factors include supply reliability (the frequency and magnitude of projected shortages), groundwater storage, reducing reliance on the Delta, water quality, total cost, flexibility and adaptability, environmental effects, and other community effects. It is important to use a methodology that provides for an "apples-to-apples" comparison of unit costs, since different projects have different scales of operation, different operating periods, or both. Given that the District Board needs information on projects and portfolios in Spring 2017, it is also important to use an approach that is readily implemented by staff. This memorandum summarizes Expert Panel input on the different methodologies, describes the proposed method for calculating unit costs of water, and presents other considerations related to the presentation of unit costs of water.

Background

Staff discussed three approaches to calculating unit costs of water with the Expert Panel on December 8, 2016. The first approach was the "Levelized Unit Cost of Water" method provided by David Mitchell on December 1, 2016 (Attachment 1). The levelized unit cost of water, or LCW, is the cost that, if assigned to every unit of water produced or saved by the project of the analysis period, will equal the total lifecycle cost of the project, when discounted back to the base year. LCW is expressed as:

$$LCW = \frac{\sum_{t=0}^{T} \frac{C_t}{(1+d)^t}}{\sum_{t=0}^{T} \frac{Q_t}{(1+d)^t}}$$

Where:

C_t = cost in period t, including capital costs, finance charges as appropriate, O&M costs, repair and replacement costs, and expected salvage value.[1]
d = annual discount rate of 5.5%
T = analysis period or useful life of the project
Q_t = project yield in period t

In presenting this method to the Expert Panel, staff used an analysis period corresponding to the WEAP simulation period of 94-years and the yields corresponding to the annual output of total water supply system yield from WEAP for each of the 94 years. The second approach that was presented to the Expert Panel used a "Simplified" method that was based on the "Levelized Unit Cost of Water" method, but used an analysis period corresponding the useful life of projects and the average annual water supply system yield. The third approach presented was the "Reliability-Weighted" method, which only considered the critical dry year yield of projects.

Expert Panel Input

The panel generally agreed with using the "Levelized Unit Cost of Water" or "Simplified" approach and associated assumptions, with the following comments:

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[1] Salvage value represents the residual value of the project in period T+1. Any value would be negative cost. The District assumes minimal salvage value and does not propose to include them in the cost evaluation at this time.

- Unit costs are most meaningful when they are for projects and portfolios that generate the same level of benefit or service, e.g., the same level of reliability or the same average yield. Since it is unlikely that any individual project would be able to achieve the District's reliability target, it would be best to use the unit cost of water for comparing portfolios of projects that achieve the same level of reliability.
- The assumed inflation rate of 3 percent is higher than long-term current forecasts for California, but may be appropriate for construction projects that historically have higher inflation rates than the general inflation rate. Staff noted that the District uses 3 percent inflation in its water rate forecast model and Capital Improvement Plan.
- The distribution of capital costs should replicate the anticipated actual expenditure rate.
- Using an analysis period that is different than the useful life of a project, i.e., the WEAP simulation period, would need to account for things such as reinvesting in projects that have a shorter useful life or costs that extend past the useful life.
- The assumption that that the project would be fully financed at the start of the construction period results in a somewhat inflated estimate. It would be reasonable to assume that we would we would let out bonds as we incur costs and, since the assumed finance rate and discount rates of 5.5 percent are the same, we could represent all capital costs as "pay as you go" without inflation.
- Using the average annual yield is fine for projects that have fairly stable yields. For projects that have a lot of variation, staff should sample the average yield over 10 year periods to determine variability in the results.
- The "Reliability-Weighted" method is trying to do two things at once – measuring both the cost-effectiveness and the value of the projects. However, these are two different things. The value of projects is better estimated by doing a benefit-cost analysis.
- Costs should be normalized for point of delivery. The cost for transfers at a customer's door will be greater than the cost of transfers at San Luis Reservoir.
- The District needs to be clear that the costs being calculated are District costs. Significant non-District costs should be noted where applicable, e.g., landscape conversion costs not rebated by the District.
- The District should not include loss of revenue as a "cost" associated with water conservation and demand management programs. The District should, however, account for avoided variable costs (treatment, pumping, etc) associate with such programs.
- A sensitivity analysis of costs and yields should be performed for any portfolio that includes the California WaterFix or other very large infrastructure projects.

The Expert Panel stressed the importance of looking at more than just unit costs, or cost-effectiveness. They noted the importance of local control, risk, and diversification. Since a full benefit-cost analysis is not practical for all the potential portfolios, they concurred with using a "consumer reports" approach to presenting benefits. They also suggested presenting the assessment of portfolio benefits to the Board prior to presenting costs, so that Board can discuss what it values and then look at the costs.

"Simplified" Method

Staff proposes using the simplified LCW method for estimated unit costs of water. The spreadsheet in Attachment 2 illustrates how this approach will be implemented using the Mid-Basin Potable Reuse project described in the 2014 South Bay Water Recycling Strategic and Master Plan.

Costs

The starting date of the analysis is 2016. Costs are expressed in 2016 dollars. Cost estimates from prior years are inflated to 2016 dollars using the Engineering News Records (ENR) construction cost index (CCI).

Capital costs are estimated using project-specific preliminary engineering estimates where available, planning level cost estimates, or actual costs from comparable projects. The estimated capital cost for the example project in 2016 dollars is $155 million.

Capital costs typically start in Year 3 and are distributed according to the following pattern over a total of nine years – 0.06, 0.06, 0.06, 0.06, 0.1, 0.2, 0.2, 0.2, and 0.06.

Operations and maintenance (O&M) costs are estimated using project-specific preliminary engineering estimates where available, planning level cost estimates, or actual costs from comparable projects. For projects with variable O&M costs (e.g., their yield varies from year to year), the O&M costs will be estimated using projected yield and estimated annual unit costs for O&M. The annual O&M costs for the example project are $642.67 per AF of potable reuse yield[2]. The average annual potable reuse yield is 4,440 AF or an annual O&M cost of about $2.9 million.

Repair and replacement (R&R) costs will be estimated using the District's asset management database. The database has R&R activities for existing facilities for 100 years. The R&R costs for proposed facilities will be scaled based on the planned costs for similar facilities. The costs will be expressed as annual values, with the assumption that the District would put the necessary funding in to a R&R reserve that would be used as needed. This approach is consistent with the District Asset Management Plan. For the example project, it is assumed that the pump stations and other mechanical equipment will be replaced every 20 years at a cost of $20 million in 2016 dollars. In other words, the R&R costs are $1 million per year.

The District, for purposes of this analysis, is assuming there are no salvage values for the projects.

Discount Rate

The District is using a discount rate of 5.5 percent.

Analysis Period

The analysis period will be the time it takes to complete the Water Supply Master Plan, implement or construct the project, and operate the project for its useful life. Year 0 is 2016. The project start date is assumed to be Year 3 (2019), which provides one year for completing the Water Supply Master Plan and one year for project validation/initiation.

In the example project, the useful life of the project is estimated at 50 years.

Project Yield

The District's water supply system model[3] is used to evaluate the water supply yield of projects and portfolios, with the exception of water conservation and demand management programs. The yield of projects and portfolios is determined by calculating the difference between total system supplies with and without the project on an average annual basis. The yield for water conservation and demand management programs will be the annual reduction in demands on the water supply system associated with the program.

In the example project, the average annual water supply system yield from the project is 4,116 AFY. This is slightly lower than the average amount of potable reuse because there is a slight decrease in the use of surface water supplies with the project.

[2] The O&M unit costs are for a facility producing 5,600 AFY of constant yield.

[3] The District uses the Water Supply Evaluation and Planning (WEAP) system to evaluate and compare water supply scenarios.

Discussion

The purpose of the Water Supply Master Plan is to present the District's strategy for providing a reliable and sustainable water supply and ensuring new water supply investments are effective and efficient. Currently, the District is evaluating individual projects. Based on those evaluations, staff will combine projects into portfolios and evaluate how different projects work together toward meeting our water supply reliability goals. Unit costs provide an indication of the cost-effectiveness of projects and portfolios, but they are only one of the factors being considered in the Water Supply Master Plan analysis. Other factors include supply reliability (the frequency and magnitude of projected shortages), total cost, groundwater storage, reducing reliance on the Delta, water quality, flexibility and adaptability, environmental effects, and other community effects. Staff will also include information on total cost and reliability when presenting summary information on the projects and portfolios. Groundwater storage, Semitropic storage, and percent of local versus imported supplies are factors that can easily be presented in graphic format. Staff concurs with and appreciates the Expert Panel's emphasis on looking at non-cost factors in valuing different water supply strategies.

Tracy

Senior Project Manager
Water Supply Planning and Conservation Unit

Attachments:
Attachment 1 – Levelized Unit Cost of Water
Attachment 2 – Example Calculation of Unit Costs

Levelized Unit Cost of Water

The levelized unit cost of water (LCW) allows alternative projects to be compared when different scales of operation, different investment and operating time periods, or both exist. For example, the LCW could be used to compare the cost of water from the Water Fix with that from direct potable reuse.

The LCW is that cost that, if assigned to every unit of water produced (or saved) by the project over the analysis period, will equal the total lifecycle cost (TLCC) of the project, when discounted back to the base year.

TLCC is given by

$$TLCC = \sum_{t=0}^{T} \frac{C_t}{(1+d)^t}$$

Where:

C_t = cost in period t, including capital costs, finance charges as appropriate, O&M costs, repair and replacement costs, and expected salvage value.[1]

d = annual discount rate

T = analysis period or useful life of the project

TLCC is the present value cost of the project.

LCW is the constant unit rate for project water that would fully recover the project's TLCC.

$$TLCC = \sum_{t=0}^{T} \frac{Q_t \times LCW}{(1+d)^t}$$

Where:

Q_t = project yield in period t

Since LCW is a constant, it can be taken out of the summation operator.

$$TLCC = LCW \sum_{t=0}^{T} \frac{Q_t}{(1+d)^t}$$

Rearranging terms gives:

[1] Salvage value is a negative cost and represents the residual value of the project in period T+1.

$$LCW = \frac{TLCC}{\sum_{t=0}^{T} \frac{Q_t}{(1+d)^t}} = \frac{\sum_{t=0}^{T} \frac{C_t}{(1+d)^t}}{\sum_{t=0}^{T} \frac{Q_t}{(1+d)^t}}$$

If project yield is constant over time, the formula for LCW reduces to the familiar levelized cost formula used in many engineering economics textbooks:

$$LCW = \frac{TLCC \times \frac{d(1+d)^T}{(1+d)^T - 1}}{Q}$$

Where:

Q = Constant annual project yield

Sources:

Cooley, H. and R. Phurisamban (2016), The Cost of Alternative Water Supply and Efficiency Options in California, Pacific Institute.

Fidar A., F. A. Memon & D. Butler (2016): Economic implications of water efficiency measures I: assessment methodology and cost-effectiveness of micro-components, Urban Water Journal, DOI: 10.1080/1573062X.2016.1223859

Short, W., D. Packey, and T. Holt (1995), A Manual for the Economic Evaluation of Energy Efficiency and Renewable Energy Technologies, National Renewable Energy Laboratory, Golden, Colorado.

Visser, E. and A. Held (2014), Methodologies for Estimating Levelized Cost of Electricity: Implementing the Best Practice LCoE Methodology, ECOFYS, Netherlands B.V.

Project Name: **Template**

PV Cost/PV AF:	$2,400

Source of Costs:
Source of Yield:
Notes:

Real Discount Rate:	2.43%
Nominal Discount Rate	5.5%
Inflation Rate	3.0%

Year	Year #	Capital Cost (2018$)	O&M Cost (2018$)	R&R Cost (2018$)	Total Cost	Present Value Cost (2018$)	Average Water Supply System Yield (AF)	Present Value Yield (AF)
	Total	**$155,000,000**	**$147,000,000**	**$49,000,000**	**$351,000,000**	**$221,359,248**	**201,684**	**92,222**
2016	-2	$0	$0	$0	$0	$0		-
2017	-1	$0	$0	$0	$0	$0		-
2018	0	$0	$0	$0	$0	$0		-
2019	1	$0	$0	$0	$0	$0		-
2020	2	$9,300,000	$0	$0	$9,300,000	$8,864,464		-
2021	3	$9,300,000	$0	$0	$9,300,000	$8,654,406		-
2022	4	$9,300,000	$0	$0	$9,300,000	$8,449,325		-
2023	5	$9,300,000	$0	$0	$9,300,000	$8,249,104		-
2024	6	$15,500,000	$0	$0	$15,500,000	$13,422,713		-
2025	7	$31,000,000	$0	$0	$31,000,000	$26,209,278		-
2026	8	$31,000,000	$0	$0	$31,000,000	$25,588,205		-
2027	9	$31,000,000	$0	$0	$31,000,000	$24,981,849		-
2028	10	$9,300,000	$0	$0	$9,300,000	$7,316,959		-
2029	11		$3,000,000	$1,000,000	$4,000,000	$3,072,504	4,116	3,162
2030	12		$3,000,000	$1,000,000	$4,000,000	$2,999,696	4,116	3,087
2031	13		$3,000,000	$1,000,000	$4,000,000	$2,928,613	4,116	3,014
2032	14		$3,000,000	$1,000,000	$4,000,000	$2,859,214	4,116	2,942
2033	15		$3,000,000	$1,000,000	$4,000,000	$2,791,460	4,116	2,872
2034	16		$3,000,000	$1,000,000	$4,000,000	$2,725,312	4,116	2,804
2035	17		$3,000,000	$1,000,000	$4,000,000	$2,660,731	4,116	2,738
2036	18		$3,000,000	$1,000,000	$4,000,000	$2,597,681	4,116	2,673
2037	19		$3,000,000	$1,000,000	$4,000,000	$2,536,124	4,116	2,610
2038	20		$3,000,000	$1,000,000	$4,000,000	$2,476,027	4,116	2,548
2039	21		$3,000,000	$1,000,000	$4,000,000	$2,417,353	4,116	2,487
2040	22		$3,000,000	$1,000,000	$4,000,000	$2,360,070	4,116	2,429
2041	23		$3,000,000	$1,000,000	$4,000,000	$2,304,144	4,116	2,371
2042	24		$3,000,000	$1,000,000	$4,000,000	$2,249,543	4,116	2,315
2043	25		$3,000,000	$1,000,000	$4,000,000	$2,196,237	4,116	2,260
2044	26		$3,000,000	$1,000,000	$4,000,000	$2,144,193	4,116	2,206
2045	27		$3,000,000	$1,000,000	$4,000,000	$2,093,383	4,116	2,154
2046	28		$3,000,000	$1,000,000	$4,000,000	$2,043,777	4,116	2,103
2047	29		$3,000,000	$1,000,000	$4,000,000	$1,995,346	4,116	2,053
2048	30		$3,000,000	$1,000,000	$4,000,000	$1,948,063	4,116	2,005
2049	31		$3,000,000	$1,000,000	$4,000,000	$1,901,900	4,116	1,957
2050	32		$3,000,000	$1,000,000	$4,000,000	$1,856,831	4,116	1,911
2051	33		$3,000,000	$1,000,000	$4,000,000	$1,812,831	4,116	1,865
2052	34		$3,000,000	$1,000,000	$4,000,000	$1,769,873	4,116	1,821
2053	35		$3,000,000	$1,000,000	$4,000,000	$1,727,932	4,116	1,778
2054	36		$3,000,000	$1,000,000	$4,000,000	$1,686,986	4,116	1,736
2055	37		$3,000,000	$1,000,000	$4,000,000	$1,647,010	4,116	1,695
2056	38		$3,000,000	$1,000,000	$4,000,000	$1,607,982	4,116	1,655
2057	39		$3,000,000	$1,000,000	$4,000,000	$1,569,878	4,116	1,615
2058	40		$3,000,000	$1,000,000	$4,000,000	$1,532,677	4,116	1,577
2059	41		$3,000,000	$1,000,000	$4,000,000	$1,496,357	4,116	1,540
2060	42		$3,000,000	$1,000,000	$4,000,000	$1,460,899	4,116	1,503
2061	43		$3,000,000	$1,000,000	$4,000,000	$1,426,280	4,116	1,468
2062	44		$3,000,000	$1,000,000	$4,000,000	$1,392,482	4,116	1,433
2063	45		$3,000,000	$1,000,000	$4,000,000	$1,359,485	4,116	1,399
2064	46		$3,000,000	$1,000,000	$4,000,000	$1,327,270	4,116	1,366
2065	47		$3,000,000	$1,000,000	$4,000,000	$1,295,818	4,116	1,333
2066	48		$3,000,000	$1,000,000	$4,000,000	$1,265,111	4,116	1,302
2067	49		$3,000,000	$1,000,000	$4,000,000	$1,235,132	4,116	1,271
2068	50		$3,000,000	$1,000,000	$4,000,000	$1,205,864	4,116	1,241
2069	51		$3,000,000	$1,000,000	$4,000,000	$1,177,289	4,116	1,211

2070	52	$3,000,000	$1,000,000	$4,000,000	$1,149,391	4,116	1,183
2071	53	$3,000,000	$1,000,000	$4,000,000	$1,122,154	4,116	1,155
2072	54	$3,000,000	$1,000,000	$4,000,000	$1,095,563	4,116	1,127
2073	55	$3,000,000	$1,000,000	$4,000,000	$1,069,602	4,116	1,101
2074	56	$3,000,000	$1,000,000	$4,000,000	$1,044,256	4,116	1,075
2075	57	$3,000,000	$1,000,000	$4,000,000	$1,019,510	4,116	1,049
2076	58	$3,000,000	$1,000,000	$4,000,000	$995,351	4,116	1,024
2077	59	$3,000,000	$1,000,000	$4,000,000	$971,765	4,116	1,000
2078	60			$0	$0		-
2079	61			$0	$0		-
2080	62			$0	$0		-
2081	63			$0	$0		-
2082	64			$0	$0		-
2083	65			$0	$0		-
2084	66			$0	$0		-
2085	67			$0	$0		-
2086	68			$0	$0		-
2087	69			$0	$0		-
2088	70			$0	$0		-
2089	71			$0	$0		-
2090	72			$0	$0		-
2091	73			$0	$0		-
2092	74			$0	$0		-
2093	75			$0	$0		-
2094	76			$0	$0		-
2095	77			$0	$0		-
2096	78			$0	$0		-
2097	79			$0	$0		-
2098	80			$0	$0		-
2099	81			$0	$0		-
2100	82			$0	$0		-
2101	83			$0	$0		-
2102	84			$0	$0		-
2103	85			$0	$0		-
2104	86			$0	$0		-
2105	87			$0	$0		-
2106	88			$0	$0		-
2107	89			$0	$0		-
2108	90			$0	$0		-
2109	91			$0	$0		-
2110	92			$0	$0		-
2111	93			$0	$0		-
2112	94			$0	$0		-
2113	95			$0	$0		-
2114	96			$0	$0		-
2115	97			$0	$0		-
2116	98			$0	$0		-
2117	99			$0	$0		-
2118	100			$0	$0		-

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MEMORANDUM

FC 14 (01-02-07)

TO: Karen Koppett

FROM: Tracy Hemmeter

SUBJECT: Addendum to Unit Cost of Water Methodology Memorandum dated December 9, 2016

DATE: January 30, 2019

The purpose of this memorandum is update or clarify portions of the enclosed Unit Cost of Water Methodology Memorandum dated December 9, 2016. The updates and clarifications reflect how the methodology was actually applied during development of the Water Supply Master Plan 2040 (WSMP 2040). The changes are consistent with subsequent input from David Mitchell of M.Cubed related to unit costs analyses for California WaterFix. Updates and clarifications are only provided for those elements that differ from the original memorandum.

Costs

Costs in the WSMP 2040 are expressed as 2017 dollars. Cost estimates from prior years are inflated to 2017 dollars using the Engineering News and Records construction cost index. The costs are expressed as 2017 dollars to be consistent with presentations to the District Board of Directors in 2017 and 2018.

Capital costs are distributed according to the project-specific engineering estimate. If a project-specific schedule is unavailable, capital costs are typically distributed according to the following pattern over nine years – 0.06, 0.06, 0.06, 0.06, 0.1, 0.2, 0.2, 0.2, and 0.06.

Discount Rate

The District is using a real discount rate of approximately 2.43 percent, which is calculated using the following equation:

$$d=(1+d_n)/(1+i)-1$$

where d_n is the assumed nominal discount rate of 5.5 percent and i is the assumed inflation rate of 3.0 percent. These assumptions are consistent with other District financial assumptions.

Analysis Period

The analysis period will be the time it takes to implement or construct the project and operate the project for its useful life, up to 100 years. Infrastructure projects are assumed to be renewed and replaced, rather than salvaged. Therefore, they are analyzed over a 100-year period. A 100-year analysis is consistent with the District's Asset Management Plan. Year 0 is 2017. Most project expenses are assumed to start in Year 2020.

Project Yield

Water supply yield is determined by calculating difference between water used with and without the project. Recognizing that projects perform differently depending on the other projects they are paired with, staff will estimate project yields under a variety of scenarios and calculate a range of unit costs. In the example project, the annual water supply yield used in the unit cost analysis is 4,116 AFY. This is how much of the 5,600 AFY of project capacity the model indicates would be used in a scenario that includes other potable reuse projects. In a scenario without other projects, the project yield (or utilization rate) is about 4,500 AFY, resulting in a unit cost of about $3,200 per AF.

Please let me know if you have any questions or need additional information.

Tracy

Senior Project Manager

Enclosure: Unit Cost of Water Methodology dated December 9, 2016

cc (all w/enc): S. Greene, M. Richert

Appendix C - Demand Projection Methodology

Water Supply Master Plan 2040 Demand Forecasting Methodology

WATER SUPPLY MASTER PLAN

WATER DEMAND FORECASTING METHODOLOGY – TRENDING SCENARIO 20*2020 Baseline

Demand Projection Steps

- Utilized the IWRMain Forecast Model. One model area was created for each retailer to create service area demands for the water supply model, WEAP.
- For the 2020 base year water use, we used the lower of the retailer's 2015 Urban Water Management Plan (UWMP) 20x2020 targets or their projection for 2020, if different. The base year water use was input by water use sector for each service area. To break down the 2020 water use into water sector, we used the retailer's 2013 water use monthly billing data by sector. We assumed that the proportion of monthly use by sector remains relatively similar between 2013 and 2020.
- To account for future demographic growth out to 2040, we used a previous analysis of ABAG 2013 data and updated that growth in households and jobs using Plan Bay Area 2016 county data and 2016 DOT jobs forecast. We adjusted household type growth (single family vs multi-family) in some service areas based on previous conversations with some of the retailers and cities. Those conversations were documented in the appendix of the 2015 UWMP.
- We applied household growth rates to the residential water use sectors. The city and retailer conversations of their residential makeup in the future were considered. We placed most growth in the multifamily sector because most areas in north county will see less new single family developments; and where single family homes are built, water use efficiencies and smaller landscapes will likely make future water use characteristics in that sector look more like multifamily use.
- We used job growth rates from the regional projections for non-residential growth. Job growth by sector was applied to appropriate water use sectors.
- Once the base water demand projections were run using these inputs, we applied unaccounted for water to each retailer using their UWMP data in the post-processing files.
- Then we used our future water conservation program savings modelled after 2020, and applied water conservation demand reduction to each service area to the post-processing files.
- Where applicable, we also added recycled water demand based on the retailer's UWMPs in the post processing files.

Assumptions

- Assume retailers achieve their 20x2020 targets, or their 2020 water use projections in their UWMPs.
- Assumes that much of the expected post drought rebound would be realized by, or near, 2020
- Using 2020 water use projections as a base year, assumes many water use efficiencies in place
- Passive and active conservation based on Valley Water's WUE model are realized

Benefits and Disadvantages

- Benefits
  - Allows for a good comparison of updated retailer projections in the 2015 UWMPs
  - Allows for a consistent approach to be applied across all service areas for a better countywide analysis.
  - Includes the effect of more recent demographic projections
- Disadvantage – Many retailers adjusted their projections to include effect of the 2012 -2016 drought and, therefore, the 20 x 2020 targets have already been achieved by many of the retailers

Appendix D - Model Description and Assumptions

Water Supply Master Plan 2040 Modeling Approach and Assumptions

WATER SUPPLY MASTER PLAN 2040 MODELING APPROACH AND ASSUMPTIONS

WEAP BACKGROUND

The Santa Clara Valley Water District (Valley Water) uses the Water Evaluation and Planning (WEAP) model developed by the Stockholm Environment Institute as one method of evaluating water supply alternatives. WEAP is a software tool developed for water resources planning that uses water demand and supply information that takes into account multiple and competing uses and priorities. It is a deterministic integrated water resources management model. Valley Water simulates its facilities and operations including groundwater basins, reservoirs and creeks, imported supplies, treatment plants, water banking, distribution facilities, and conservation efforts in the model. The model also accounts for non-Valley Water sources and distribution of water in the county such as water from San Francisco Public Utilities Commission (SFPUC) Regional Water System, recycled water, and local water developed by other organizations.

ASSUMPTIONS

WEAP operates on a monthly time-step that simulates the water supply and demand of the last 94 years (1922 through 2015). The baseline condition includes existing facilities and assumes completion of dam seismic retrofits according their current schedules for completion. Future Delta-conveyed imported water deliveries for Years 2020 and 2025 are based on DWR's 2015 Final Delivery Capability Report – Early Long-Term Scenario, which includes climate change and existing restrictions from biological opinions (USFWS 2008 for Delta Smelt, NMFS 2009 for Salmonids). Delta-conveyed baseline supplies for Years 2030 through 2040 are based on the H4 Existing Conveyance High Outflow (ECHO) Scenario from the DWR 2015 Final Delivery Capability Report. The model also includes revised operations associated with the FAHCE 2003 settlement agreement.

Water delivery is modeled to meet demands according to availability and priority. Demands in the system include retailer demands, agricultural demands, independent groundwater pumping, raw water deliveries, environmental flow requirements, and groundwater recharge. Retailer demands are from Valley Water's "Trending Scenario" (as described in Appendix B). Agricultural demands, independent groundwater pumping, and raw water deliveries are estimated based on historical use and growth projections. Environmental flow requirements are based on requirements in the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) settlement agreement and permit requirements. Groundwater recharge demands are based on recharge facility capacity.

To meet county-wide demands in the model, non-Valley Water water supplies are used first; including SFPUC supplies, recycled water, and local surface water supplies from San Jose Water. These supplies are followed by Valley Water-managed local surface water and imported water. Stanford University has surface water rights that serve the demands of the Stanford University service area. Currently, Stanford's surface water diversions are only used for the non-potable irrigation system on campus. If there are remaining unmet demands for municipal or agricultural use, they are met with groundwater pumping. This preserves groundwater supplies for droughts and other shortages as much as possible. Supplies in excess of municipal, industrial, domestic, agricultural, and environmental needs are sent to percolation ponds to recharge the groundwater basins, held over in reservoirs, and/or delivered to Semitropic Groundwater Bank.

The model tracks water resources throughout the county including imported water, rainfall, reservoir levels, river flow, treatment plant production, groundwater recharge, groundwater pumping, recycled water, and delivery of water to meet all demands.

A complete summary of assumptions used in the modeling for the Water Supply Master Plan is included in Attachment 1 (WSMP WEAP Modeling Assumptions).

ALTERNATIVE ANALYSIS

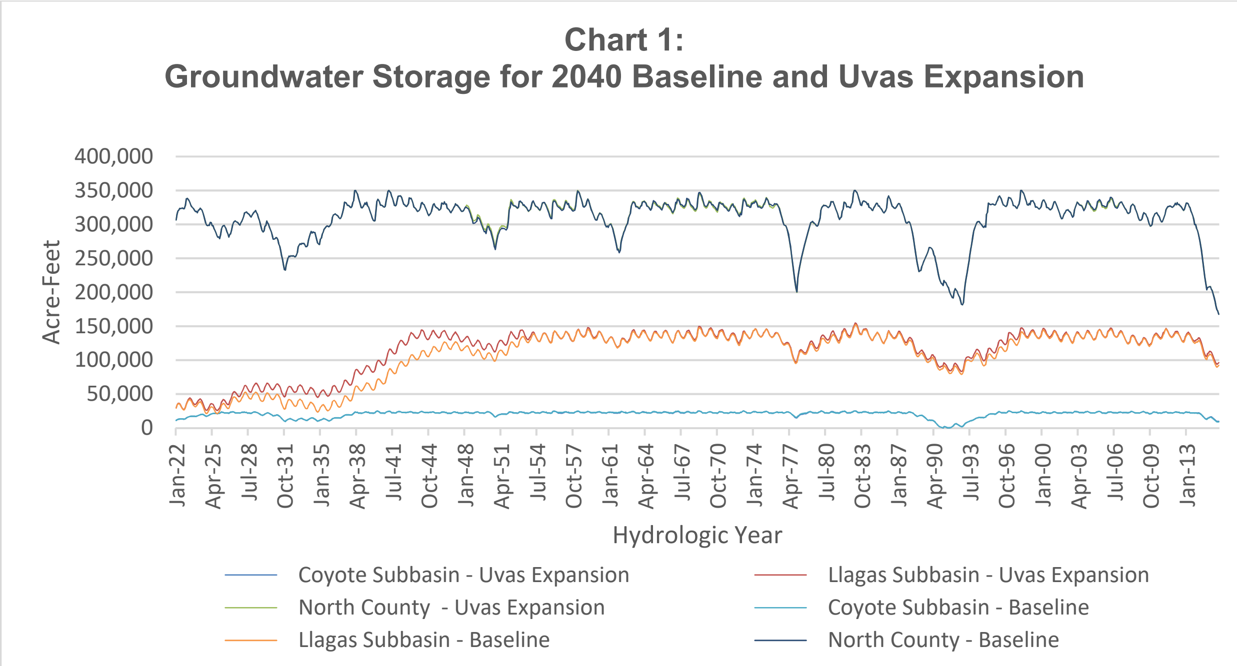
A baseline utilizing projected water demands and supplies in the year 2040 was created to compare and evaluate the project alternatives considered for the Water Supply Master Plan 2040. Each project alternative was then added and integrated into the baseline model and the model re-run to obtain new results.

Output from the model includes monthly and annual reporting of a wide range of data including groundwater storage levels, local reservoir operations, flows at key locations, and Valley Water's ability to meet demands. The output is summarized for the baseline and each alternative as illustrated in Attachment 2 (an example model output).

The effectiveness of a given project alternative is determined with the evaluation of a few key outputs as measured against the baseline; these include groundwater storage, the ability of a project alternative to avoid water use restrictions, and total water yield. Other criterion, such as project complexity, water quality, and recreation, are considered outside of the WEAP modeling framework described herein.

Groundwater Storage

Groundwater is important because one of Valley Water's key missions is to maintain groundwater storage as a reserve for dry years and to ensure that subsidence does not reoccur. Groundwater storage for the three groundwater management areas with and without a project can be compared to see how well the alternative improves groundwater conditions, such as in Chart 1 below showing groundwater storage for the 2040 Baseline and a scenario expanding Uvas Reservoir. Groundwater level is also used to determine if water use restrictions are triggered under Valley Water's Water Shortage Contingency Plan.



Avoidance of Water Use Restrictions

The Board approved Valley Water's Water Shortage Contingency Plan (WSCP) that identifies when Valley Water should call on the community to reduce water use in response to drought or other shortages. The WSCP is based on the end of year groundwater storage, as this reflects the general health of the water system. The plan has five levels; ranging from Level 1 (Normal) when short-term water use reductions are not required to Level 5 (Emergency) which can be triggered by an immediate crisis. Each level has a short-term water use reduction target that the Board can call upon the public to achieve. For example, in 2015 when the groundwater level was projected to be in the 'critical' stage by the end of the year, the Board called for a 30% reduction in water use. In evaluating potential water supply facilities and programs, Valley Water seeks alternatives that can reduce the number of years (over the 94-year simulation in the model) that trigger a call for reductions, as well as the severity of those reductions. Valley Water's current level of service goal is to develop supplies to meet 100 percent of demands in normal years and at least 80 percent of demands in drought years. In the model, this equates to finding project alternatives that avoid calls for water use reductions of more than 20 percent. The number of years with reductions and the maximum demand reduction can be seen in rows 37 through 45 in the example model output shown in Attachment 2.

Total Water Yield

A third measure of the robustness of a project alternative is the total water yield. This is a summation of average water supply use from natural groundwater recharge, local surface water, recycled water, potable reuse, imported water, and supplemental supplies. The total water yield is also used to calculate the unit cost of each alternative. The average supply from each type of source can be seen in rows 47 through 54 in the example model output shown in Attachment 2.

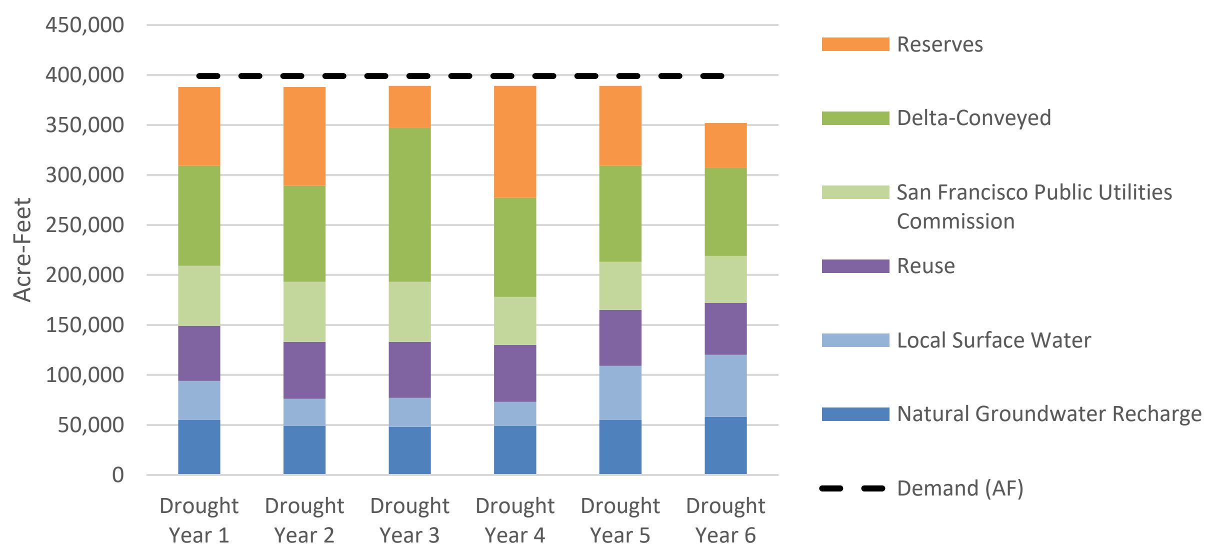
<u>Other Outputs</u>

Other outputs are also considered when evaluating water supply alternatives based on WEAP modeling results. The amount of storage in the Semitropic groundwater bank, unused carryover in the federal Central Valley Project (CVP) and State Water Project (SWP) systems, and creek water that flows to San Francisco Bay are examined and can show the efficiency of the water supply system with a project alternative included.

The drought years of 1987 through 1992 can be specifically analyzed for each project alternative to see how well the project alternative performs in extended dry conditions. Chart 2 shows how the Water Supply Master Plan projects perform during a repeat of the 1987 to 1992 drought.

Other types of data may be important for specific types of project alternatives. For example, the amount of water stored by a new or expanded reservoir is critical for storage projects, or the volume of water that can be delivered to a new percolation pond is key for those types of projects.

Chart 2: Supplies During an Extended Drought



USE OF MODEL RESULTS

The data from the WEAP model is used to identify project alternatives that best meet county-wide demands. Individual project alternatives are combined into portfolios and these portfolios run through the model to evaluate the performance of the portfolio against the baseline. The WEAP model provides a consistent method of assessing the effectiveness of various project alternatives and portfolios. The effectiveness of project alternatives is balanced with the cost, environmental impact, effects to water quality, and other criteria to recommend a set of projects in the master plan for future implementation that best meets Valley Water objectives.

	Trending Scenario Baseline Model Assumptions
1 General	
Historical Hydrology	1922 – 2015
Demand Year	2040
Model Version	Water Evaluation And Planning model (WEAP), WEAP Version: 2018.1, August 23, 2018 Dictionary Version: 375
Model Name	Master WEAP Model April 2018 v016_July 2018
Elements modeled	Complete water supply system
General Scenario Description	Planned operations for 2040
Model Method	Deterministic
2 Surface Water Supplies	
CVP Supplies to Coyote Creek	Downstream recharge and flow requirements less 2 cfs min Anderson release if combined (Anderson and Coyote) storage is less than: Nov: 42.0 TAF Dec: 46.1 TAF Jan: 71.3 TAF Feb: 74.8 TAF Mar: 87.6 TAF Apr: 87.6 TAF May - Oct: 0 cfs
CVP supplies to Anderson Reservoir	Link 1 (Diversion to Anderson, storage priority = 94): Yes, if month is March or April AND San Luis Reservoir storage < 950,000 af; then move 200 cfs Link 2 (Demand Priority = 4; FAHCE): Yes, if month is March or April AND Anderson storage <35,000 af, then move 150 cfs until storage reaches 35,000 af
CVP supplies priorities	1 - Minimum flows to Upper Coyote (10 cfs), Madrone (7 cfs), Santa Teresa WTP 2 - Rinconada and Penitencia Water Treatment Plants 3 - Remaining recharge in Upper Coyote and Llagas System (Madrone, Main, San Pedro) 4 - Other Coyote recharge (remaining Upper Coyote Creek, Coyote Perc Pond, Lower Coyote Creek) 5 - Los Gatos, Guadalupe and most other recharge 6 - Westside recharge (west of Los Gatos system)
CVP Reallocation Agreement (1997 - 25 year agreement)	Assumed to expire and no longer be used after 2022; historical M&I use set at 130,000; 2004-2014 actual allocations applied to same formula as 1922-2003; 2015 actual allocation for CVP of 40,300 af, which included an additional 7,800 af of supply to meet SCVWD 'Public Health and Safety' requirements

	Trending Scenario Baseline Model Assumptions
Imported Water Allocations	2015 Delivery Capability Report - Existing Conveyance High Outflow (ECHO) Scenario; includes enhanced spring outflow, 2025 climate change, existing biological opinions (FWS 2008 for Delta Smelt, NMFS 2009 for Salmonids), South Delta operating restrictions (Scenario 6) and Fall X2 and enhanced spring outflow requirements; average = 133,000 AFY (CVP + SWP) Cal WaterFix: Department of Water Resources Change in Point of Diversion hearing exhibit 500. 2025 climate change, existing biological opinions (FWS 2008 for Delta Smelt, NMFS 2009 for Salmonids), South Delta operating restrictions (Scenario 6) and Fall X2 and enhanced spring outflow requirements. CVP agriculture contract amount of 33,100 AFY and assuming CVP M&I historic use of 130,000 AFY
Semitropic Participation	350,000 acre-foot (AF) capacity; initial storage = 200,000 AF
Semitropic Water Bank "Put"	Once 10,000 AF of water has gone to each primary carryover reservoir (both SWP and CVP), then send any surplus imported water to Semitropic until annual maximum put capacity is reached or Semitropic Bank is full. SCVWD maximum annual Semitropic put is 31,675 AF (based on SCVWD's participation rate of 35% * current total Semitropic maximum annul put capacity of 90,500 acre-feet: 0.35 * 90,500 = 31,675 acre-feet)
Semitropic Water Bank "Take"	Take if Santa Clara Plain groundwater storage falls below 278 TAF, there are unmet treated water demands, or if there are other unmet demands and Semitropic storage is above 189 TAF. 189 TAF in Semitropic is being reserved for use in an extended drought (6 years of minimum takes of 31,500 acre-feet each). There is no capacity restrictions on takes, only annual take limits. Annual take limits are based on SWP allocations.
San Luis Reservoir	2015 Final Delivery Capability Report - H4 no tunnels scenario. Includes climate change, biological opinions, and enhanced spring and fall outflows.
San Luis Low Point	CVP deliveries are restricted to 75% of allocation to Santa Teresa and Rinconada WTP when a low point event is active (San Luis storage < 300,000 AF); however if expanded Anderson or Pacheco Reservoirs are active AND their storage is available for release, this restriction is not implemented.
CVP Carryover	Up to 50 TAF max per year; lost if San Luis Reservoir storage goes to 2,000,000 AF; fill with 10 TAF before putting to Semitropic, then once Semitropic put is maxed, put to carryover again (also see Semitropic "Put" assumptions)

	Trending Scenario Baseline Model Assumptions
SWP Carryover	Up to 50 TAF max per year; lost if San Luis Reservoir storage goes to 2,000,000 AF; fill with 10 TAF before putting to Semitropic, then once Semitropic put is maxed, put to carryover again (also see Semitropic "Put" assumptions)
Wheeling CVP to SWP	Transfer CVP water thru SBA when we have a San Luis Reservoir (SLR) low point condition (when SLR storage drops below 300 TAF) or during the month of December to allow surplus CVP water to be used in the SWP system -- including being sent to Semitropic Water Bank
Delta Conveyance Project	Not in base case. Only in Delta Conveyance Project scenarios
San Francisco Public Utilities Commission (SFPUC)	SFPUC supplies identified in SCVWD’s 2015 Urban Water Management Plan (UWMP) and SFPUC's 2015 UWMP
Climate Change	Included in CalSim II imported water allocations and San Luis Reservoir storage values received from California Department of Water Resources. Climate change for year 2025
3 Recycled Water	
Recycled Water Demands	Included in SCVWD 2015 UWMP demand setup from retailers' master plans; 33,000 af in 2040
4 Groundwater	
Natural Groundwater Recharge (Annual Average)	Santa Clara Plain = 36043 AFY
	Coyote Valley Study Area = 2396 AFY
	Llagas = 22478 AFY
Net groundwater losses (average)	0
Includes subbasin exchanges?	No
Initial Groundwater Storage	Santa Clara Plain = 301,400 AF (EOY 2013)
	Coyote Valley Study Area = 10,300 AF (EOY 2013)
	Llagas = 26,600 AF (EOY 2013)
Santa Clara Plain Stop Recharge	345,000 AF
Maximum Groundwater Pumping Capacity	Santa Clara Plain = 200,000 AF; Coyote Valley = 20,000 AF; Llagas = 100,000 AF
Groundwater Storage Capacity	Santa Clara Plain = 350,000 AF
	Coyote Valley Study Area = 25,000 AF
	Llagas = 155,000 AF

	Trending Scenario Baseline Model Assumptions
5 Reservoir Operations	
Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) Operations	Active
South County LSAA Reservoir Flow Requirements (Chesbro & Uvas)	Active
Anderson / Coyote combined Reservoir Operations Rule Curve	Nov - 74,000 AF Dec - 82,000 AF Jan - 90,000 AF Feb - 100,000 AF Mar - 105,000 AF Apr - 111,998 AF
Anderson and Coyote Water Rights	Maximum annual withdrawal of 43,370 + 24,560 AF/year
Anderson supplies to Main and Madrone	Yes
Emergency Storage for Water Supply	Anderson 20,000 AF; Calero 4,000 AF
Anderson to distribution system	Release 6TAF/month less required for downstream recharge if Anderson Storage plus inflow > 62TAF
Division of Safety of Dams (DSOD) Seismic Restrictions	Coyote Reservoir - per DSOD storage management compliance procedure, December 1992
Almaden-Calero Canal	Almaden above transfer rule curve; Calero below transfer rule curve; Almaden FAHCE pulse flow requirements prioritized over transfers in Feb-Apr; maximum transfer of 6,000 AF per water year
6 Recharge	
Total recharge capacity	Santa Clara Plain = 92,600 AFY
	Coyote = 17,100 AFY
	Llagas = 39,300 AFY
7 Demands	
Demand Projections	Calculated by SCVWD by assuming water retailers meet the State of California's "20x2020 Water Conservation Plan" goal of reducing per capita urban water use by 20 percent by the year 2020, then used regional growth projections and residental growth projections to calculate demands through 2040

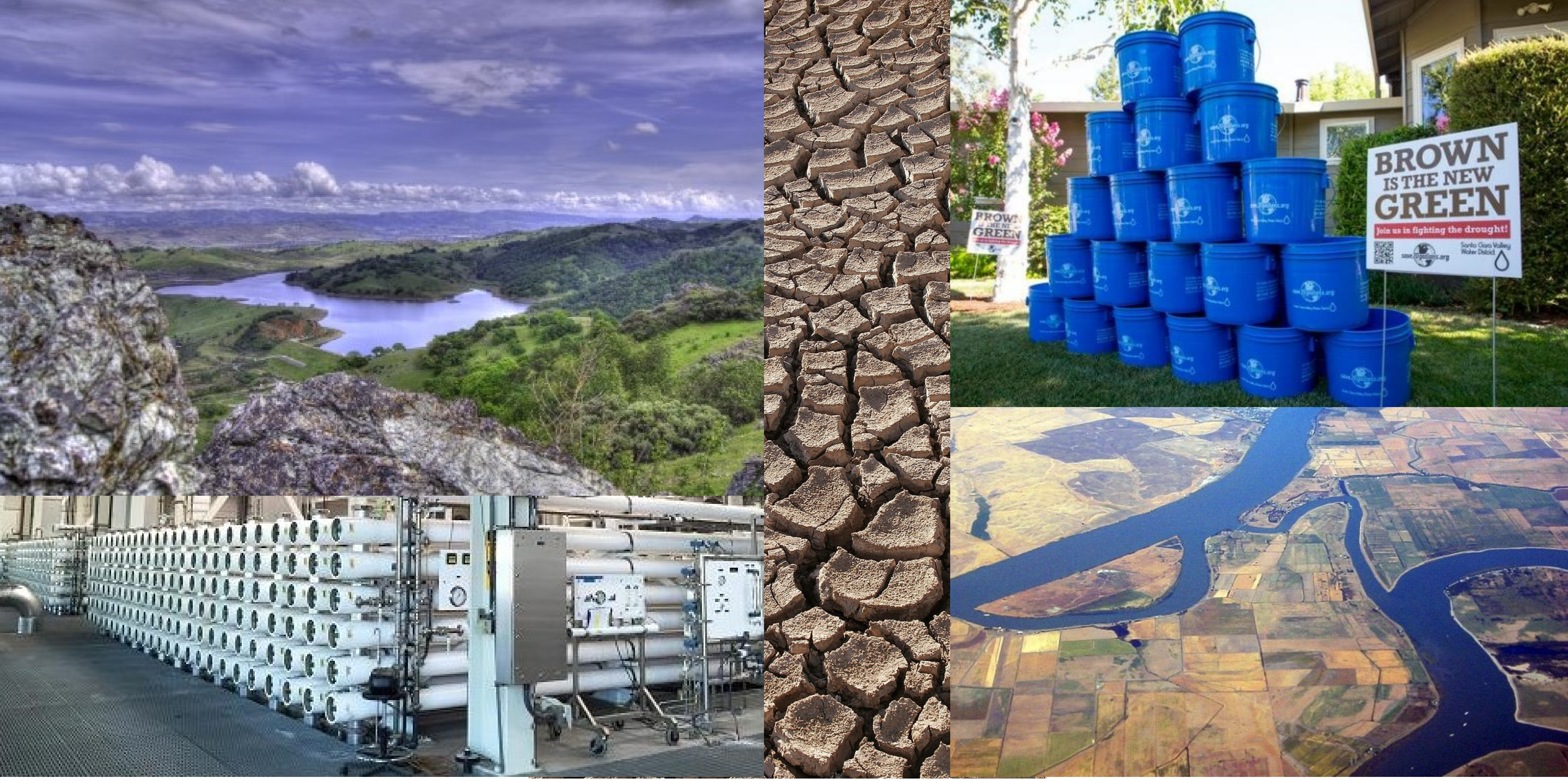
	Trending Scenario Baseline Model Assumptions
Weather Demand Reduction Factors	None
Conservation ('92 Baseline) including Agriculture	2030: 98,800 AF
Water Shortage Contingency Plan (WSCP) Actions	New Water Shortage Contingency Plan as follows: There are 5 groundwater storage thresholds or stages the model uses to trigger a WSCP demand reduction action or event, all based on Santa Clara Plain/North County groundwater storage at the end of the calendar year and applied to the following calendar year: **Stage 1 (Normal)** occurs when Santa Clara Plain storage is above 278,000 AF **Stage 2 (Alert)** occurs when Santa Clara Plain storage is <= 278,000 AF and above 232,000 AF **Stage 3 (Severe)** occurs when Santa Clara Plain storage is <= 232,000 AF and above 185,000 AF **Stage 4 (Critical)** occurs when Santa Clara Plain storage is <= 185,000 AF and above 139,000 AF **Stage 5 (Emergency)** occurs when Santa Clara Plain storage is <= 139,000 AF Each stage has a base demand reduction factor assigned to it: **Stage 1** = 0% **Stage 2** = 10% **Stage 3** = 15% **Stage 4** = 30% **Stage 5** = 50%
Total Countywide Demands	2040: 399,000 AF, based on SCVWD's '20x2020 Demand Projections' which includes Service Area Demands + new Surface Deliveries + TW losses captured as 2.15 % of raw water deliveries to treatment plant that is returned to Santa Clara Plain groundwater subbasin
Increased Demand Allocation	Per retailers, maintain groundwater/treated water proportion for incremental increases in demand
8 Treated Water	
Water Treatment Plant (WTP) Capacity	Rinconada WTP = 80 MGD
	Penitencia WTP = 40 MGD
	Santa Teresa WTP = 100 MGD
Treated Water (Contract)	2040: 131,273 AF
Treated Water (Non-Contract)	18,992 AFY; 0 if SWP allocation is less than 52%

	Trending Scenario Baseline Model Assumptions
9 Baseline Projects	
Dam Seismic Upgrades	Almaden, Anderson, Calero, and Guadalupe Active 2030, 2035, 2040
Main and Madrone Pipeline Repair	Active/Completed in 2019

ATTACHMENT 2: EXAMPLE WEAP MODEL OUTPUT SUMMARY

DRAFT	2040 Trending H4, No Regrets + CWF + IPR + Pacheco + Xfer Bethany	
Groundwater Storage (Annual Avg Acre-foot)		
Coyote Subbasin	22,934	
Llagas Subbasin	133,948	
North County Santa Clara Sbb	336,286	
Sum	**493,168**	
Local Reservoir Storage (Annual Avg Acre-foot)		
Almaden Reservoir	660	
Anderson Reservoir	55,938	
Calero Reservoir	5,870	
Chesbro Reservoir	3,151	
Coyote Reservoir	9,541	
Guadalupe Reservoir	1,533	
Lexington Reservoir	6,890	
Stevens Creek Reservoir	1,995	
Uvas Reservoir	5,654	
Pacheco Reservoir	108,932	
Sum of Local Storage	**200,164**	
Non-Local Storage (Annual Avg Acre-foot)		
Semitropic	270,470	
CVP Carryover	10,026	
swp carryover	11,009	
GW Bank SOD	0	
Los Vaqueros Expansion (bank or monthly avg supp	0	
Sum of Non-Local Storage	**291,505**	
Flow to Bay (Total)		
San Francisco Bay	6,062,595	
Los Gatos Creek	1,122,304	
Monterey Bay	4,041,269	
Water Shortage Contingency Plan Actions		
Count of Years with Demand Reductions	2	
Maximum Demand Reduction	-20.00%	
Number of Years in Stage 2 (10%)	1	
Number of Years in Stage 3 (20%)	1	
Number of Years in Stage 4 (30%)	0	
Number of Years in Stage 5 (40%)	0	
Number of Years in Stage 6 (50%)	0	
Meets Reliability Targets	Yes	
Baseline Supplies Used		
Natural Groundwater Recharge	62,207	
Local Surface Water	56,502	
Recycled Water	32,848	
Potable Reuse	18,940	
San Francisco Public Utilities Commission	59,643	
Delta-Conveyed	160,697	
Supplemental Dry Year Supplies	0	
Sum	390,836	
Annual Average Losses		
Reservoir Evaporation	12,483	
Spills to Bay - San Francisco	23,090	
Spills to Bay - Monterey	16,329	
CVP Overflow Not Used	4,820	
SWP Overflow Not Used	8,426	
Unused Potable Reuse Capacity	4,857	
Lost Groundwater	4,633	
Lost Groundwater Bank (Semitropic rule: 10% of pu	942	
Lost Water Sum	**75,581**	

Appendix E – 2017 Voter Survey



EMC RESEARCH
MARKET & OPINION RESEARCH SERVICES

Santa Clara Valley Water District

Telephone Survey of Santa Clara County Voters
Re: Water Conservation

Conducted for: Santa Clara Valley Water District

April 2017

Appendix E

Methodology

- Telephone survey of registered voters in Santa Clara County
- Conducted by trained, professional interviewers from March 23 – 28, 2017
- 400 completed interviews
- Margin of error: ± 4.9 percentage points
- Interviews conducted in English, Spanish, Chinese, and Vietnamese

Please note that due to rounding, some percentages may not add up to exactly 100%.

Appendix E

FMC RESEARCH

Key Findings

- In spite of the wet winter and potential end to the drought, voters in the Santa Clara Valley Water District still see the need to prepare for the future and invest in a more reliable water supply.
- They do not recall cutting back their water use during the drought as having been much of a challenge.
- A majority are open to a small rate increase of $5-10 per month, but many oppose a larger $20-30 increase.
- Framing the investment as something that would ensure a more reliable water supply is sufficient—adding information on the corresponding use reductions could introduce confusion.
- Specific investments in recycled water for irrigation and industrial uses, storm water capture, and updating aging infrastructure generate the most enthusiasm.

EMC RESEARCH
MARKET & OPINION RESEARCH SERVICES

Water Use Reductions

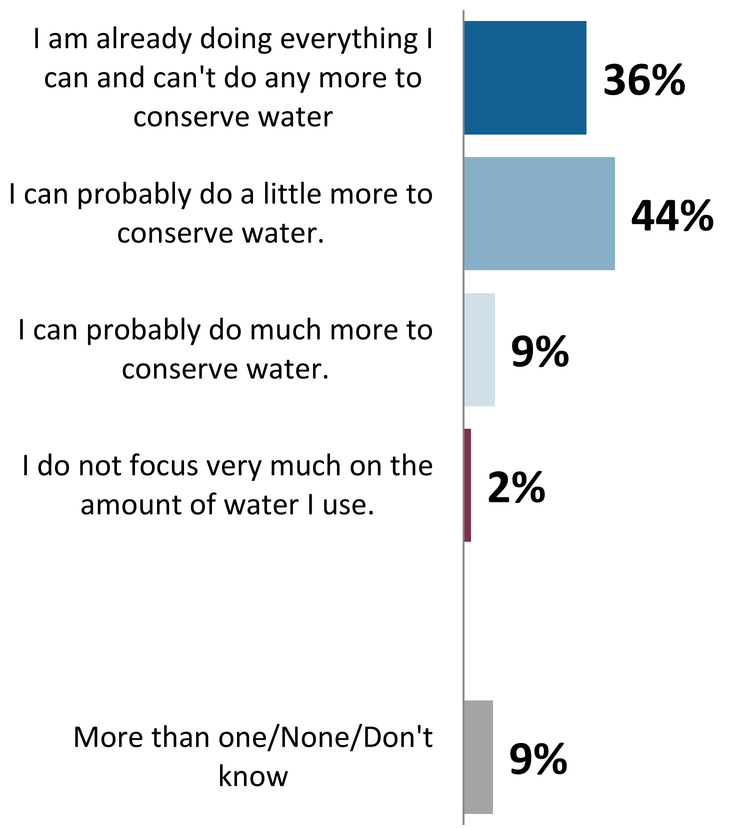
Appendix E

Efforts to Reduce Water Use

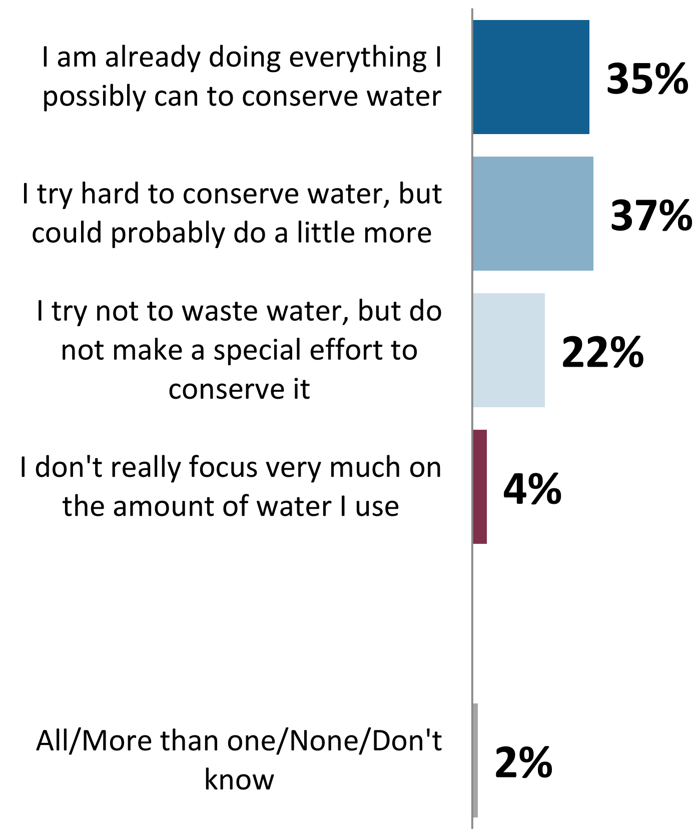
Most report they are still making an effort to conserve water, although the majority could do more. The number who say they're doing everything they can to conserve has not changed since a similar question in 2015.

Which of the following statements best describes your current efforts to reduce your water use?

15-5606 Drought and Drought Policy Survey



2017 Water Conservation Survey



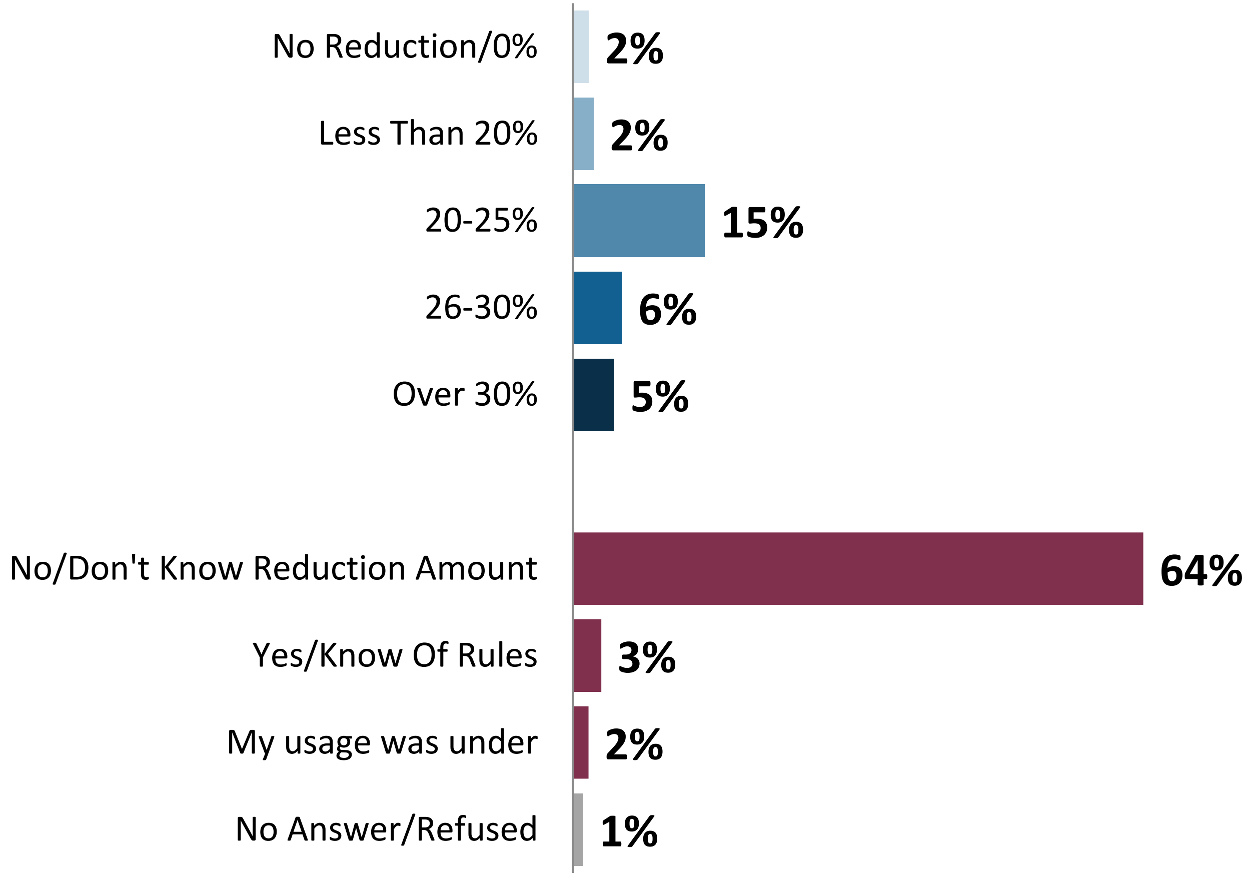
Appendix E

Q3.

Knowledge of Water Use Reduction

Few recall how large of a reduction in water use was called for last summer.

Do you happen to know how much of a reduction in water use your local water agency was calling for last summer during the statewide drought?



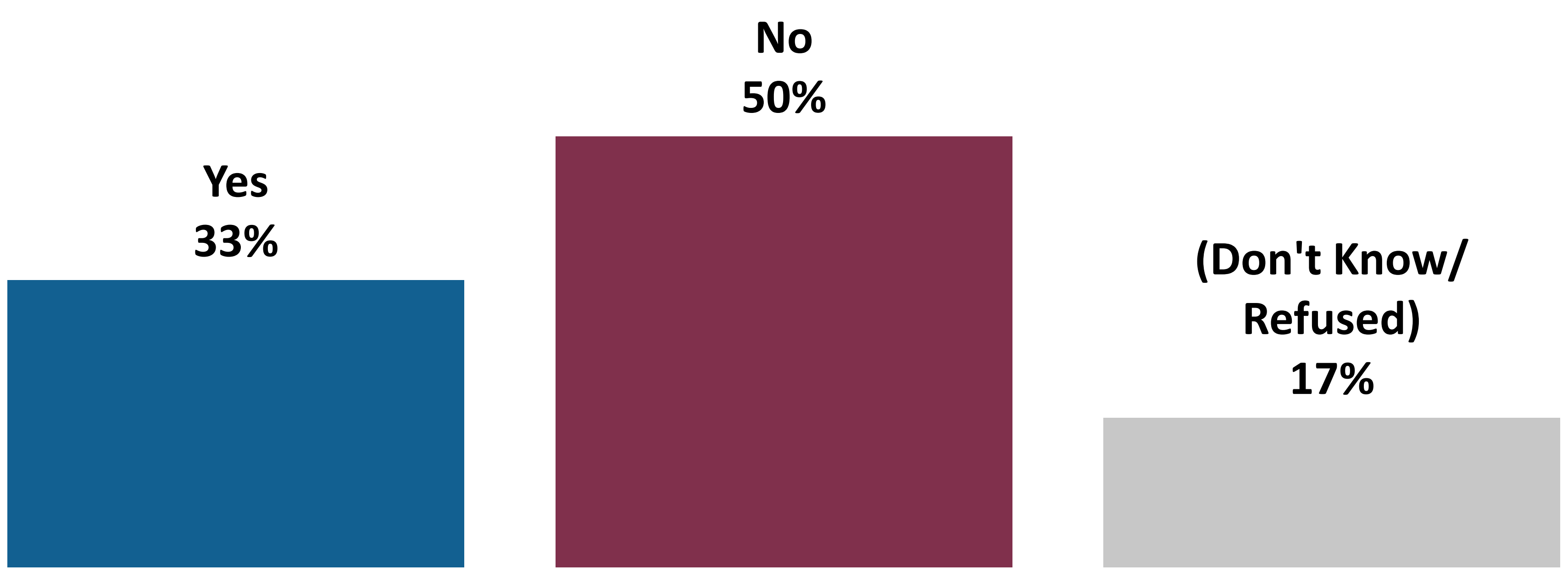
Appendix E

Q4.

Knowledge of Fines

Only a third report that their local agency imposed fines during the drought.

As far as you know, did your local water agency impose any fines or surcharges for using too much water during the statewide drought?



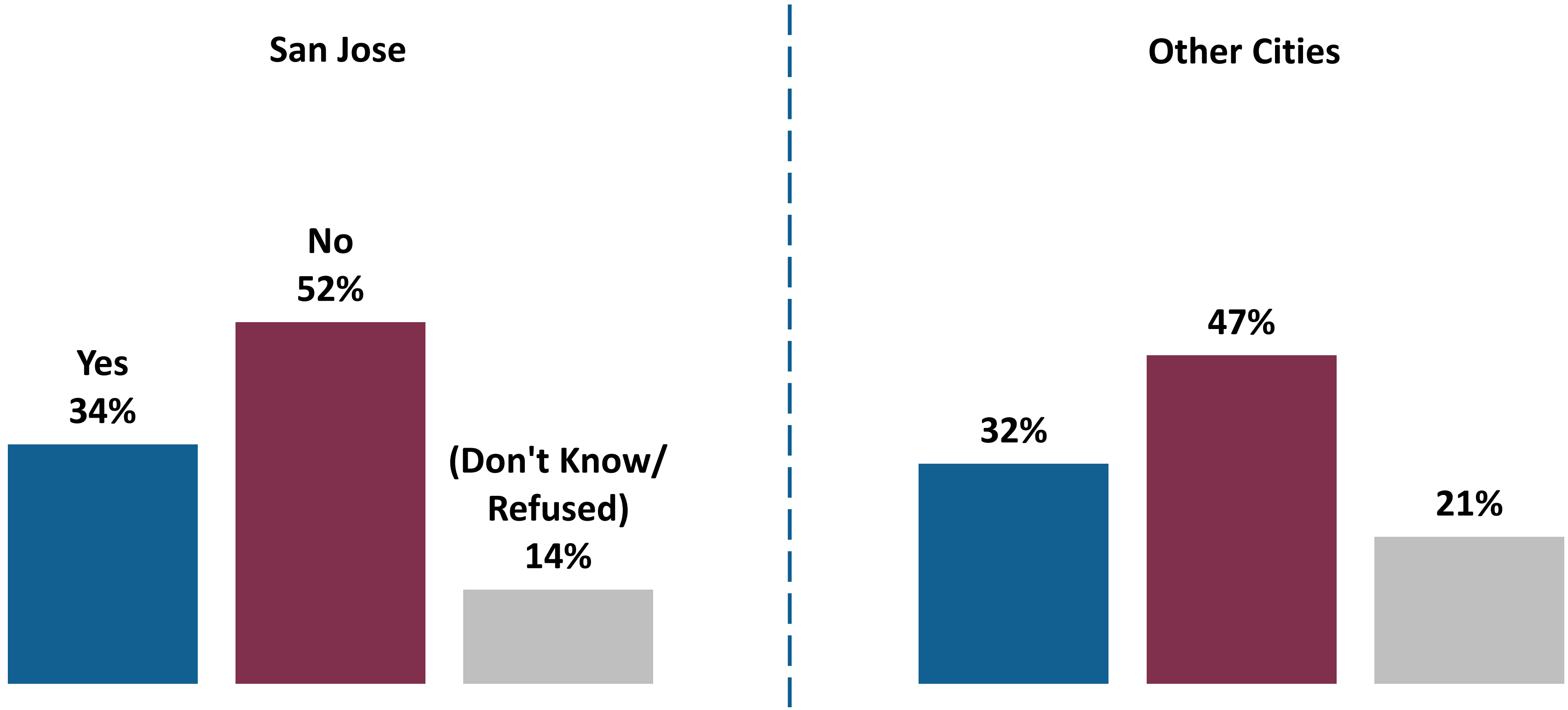
Appendix E

Q5.

Knowledge of Fines by City

Recollection of fines or surcharges is similar in San Jose and other cities.

As far as you know, did your local water agency impose any fines or surcharges for using too much water during the statewide drought?



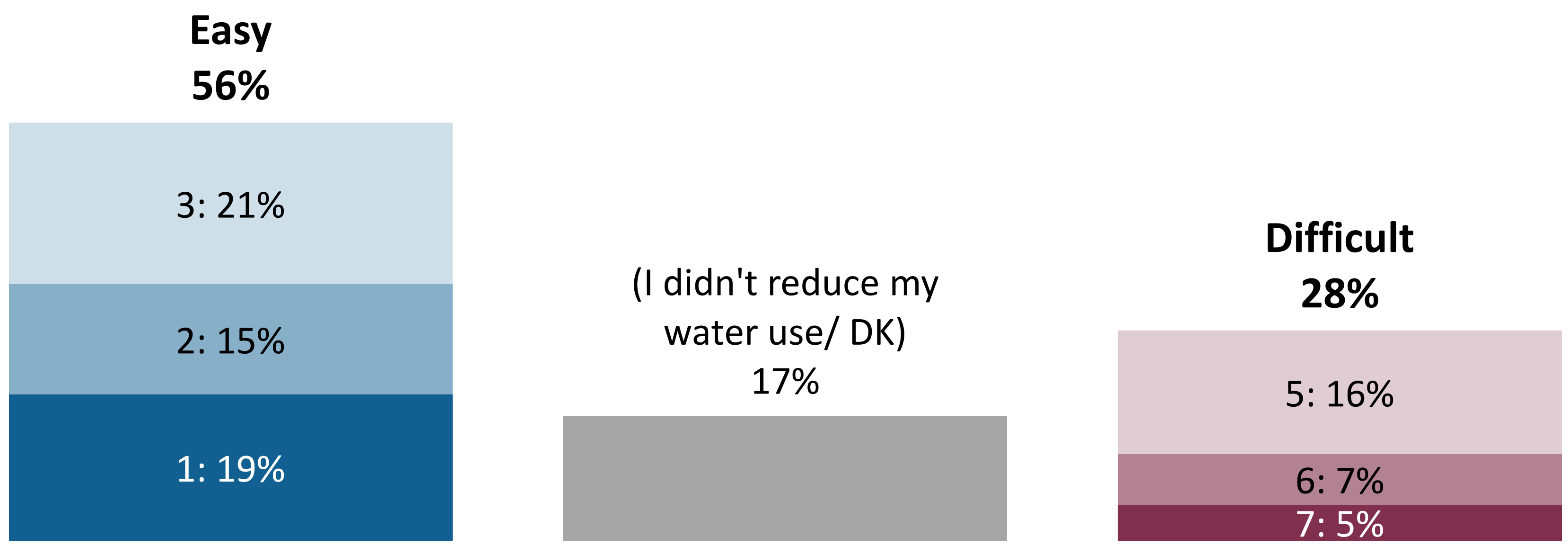
Appendix E

Q5.

Reducing Water Use During the Drought

A majority felt that reducing their water use during the drought was relatively easy.

Thinking about a scale where 1 is very easy and 7 is very difficult, how easy or difficult was it for you to reduce your water use during the drought?



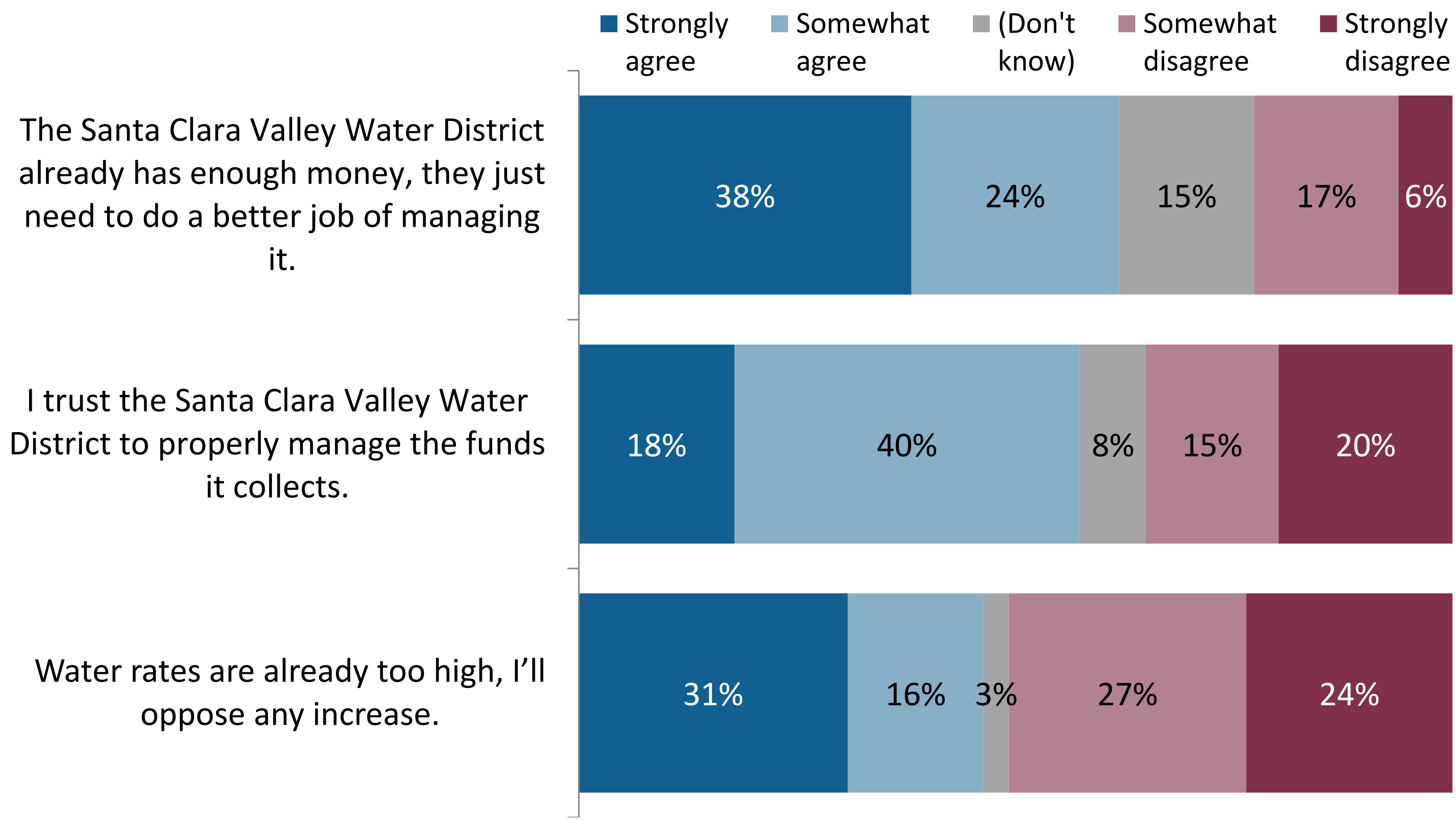
Q6.

Support for Increased Water Rates

Appendix E

Water Attitudes

While there is widespread agreement that SCVWD already has enough money, most voters also trust the District to spend funds properly and less than a third are strongly opposed to rate increases.



Q12-14. Please tell me whether you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with each of the following statements.

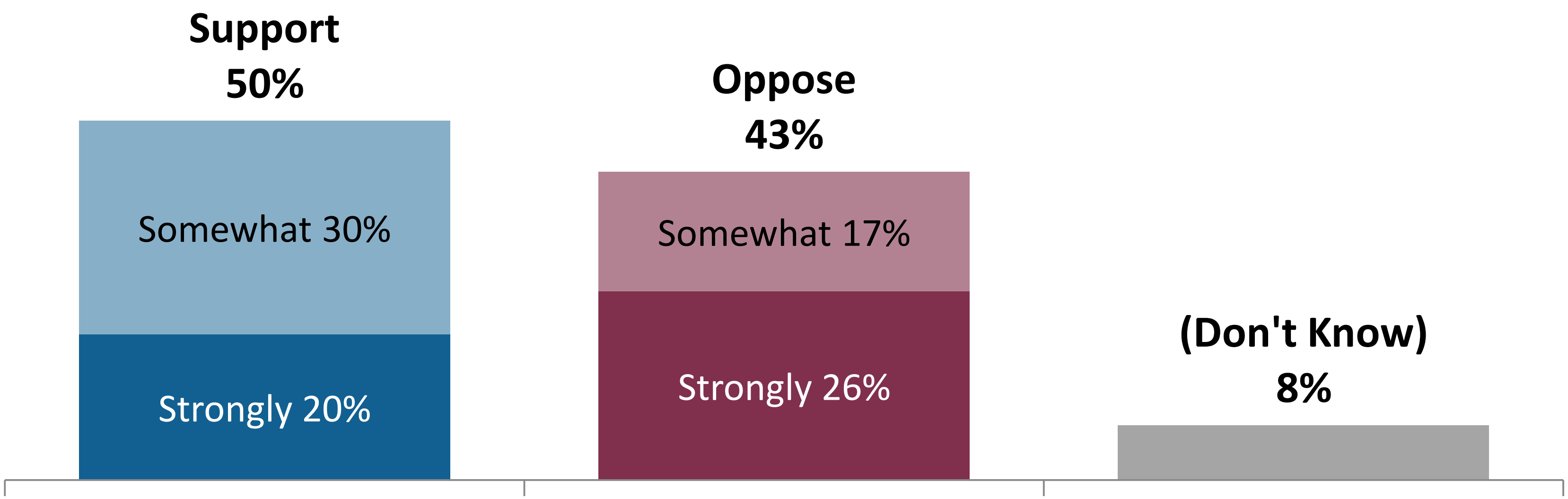
Appendix E

FMC RESEARCH

Initial Support for Increase

Before hearing any details, half at least somewhat support increasing water rates to ensure a more reliable supply of water.

In general, would you say you support or oppose modest increases in water rates to ensure a more reliable supply of water for our future?

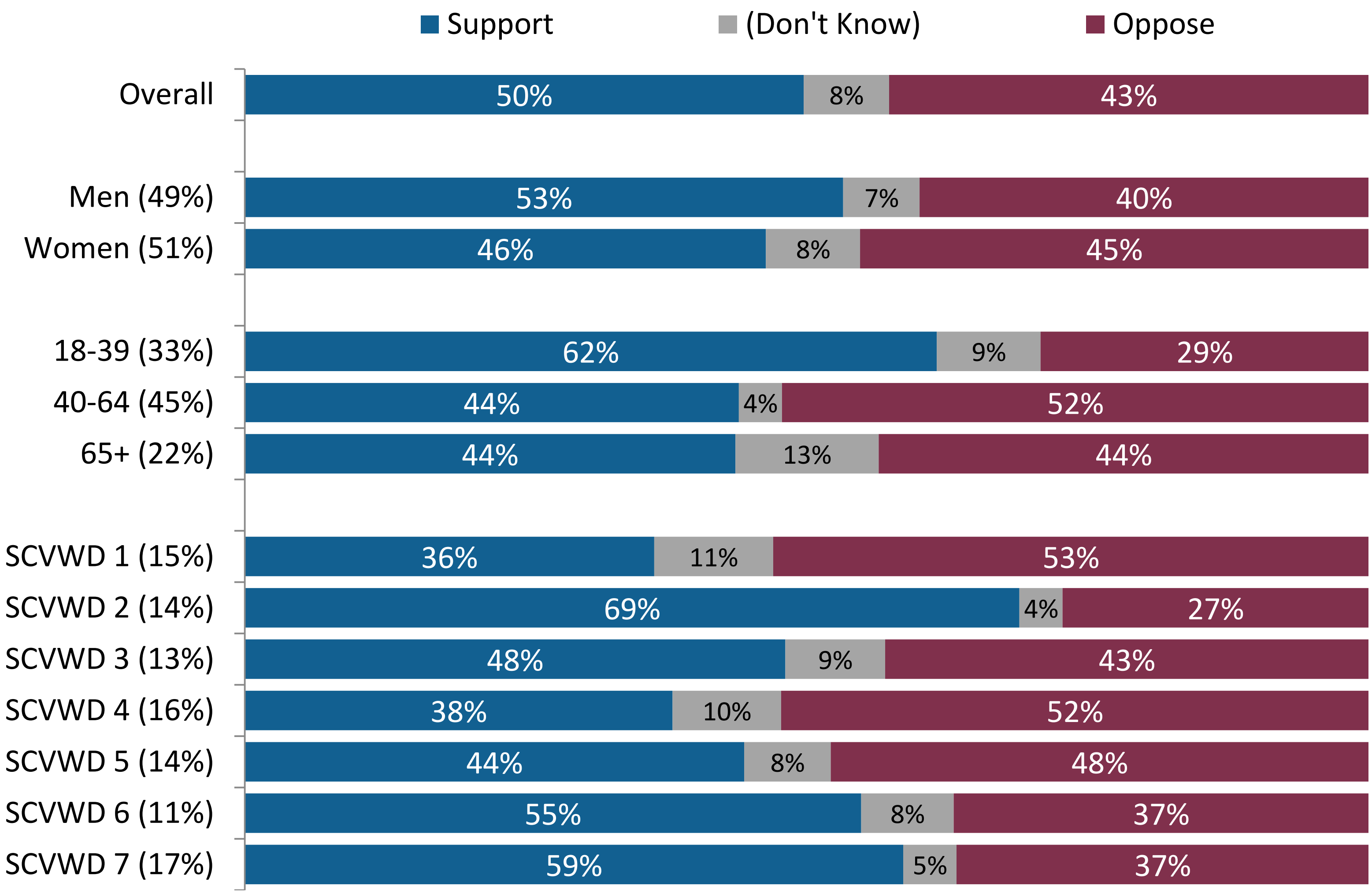


Appendix E

Q7.

Initial Support by Subgroup

Younger voters are likely to support increased rates to ensure a more reliable supply of water. Support varies considerably by geography.



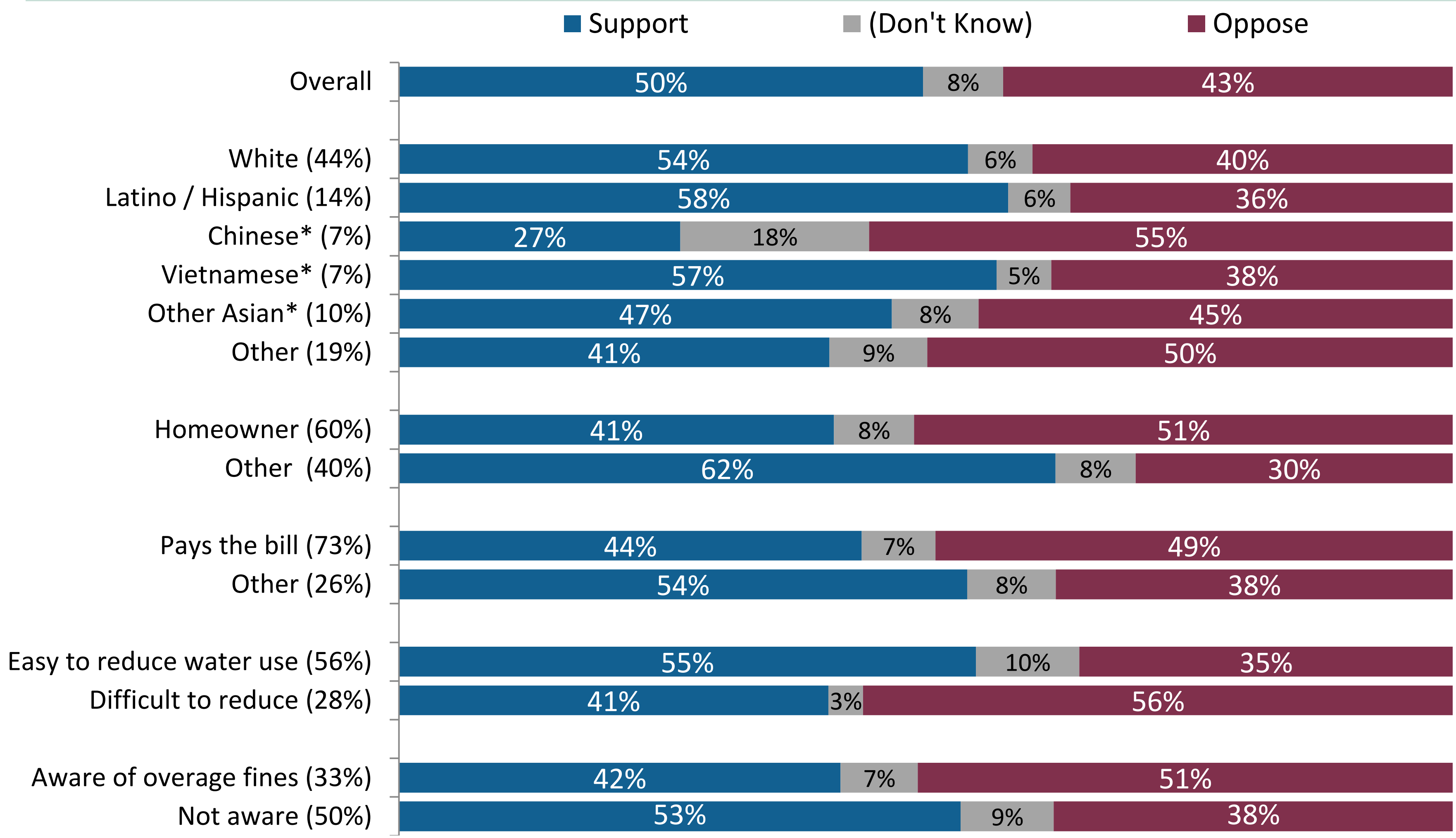
Q7. In general, would you say you support or oppose modest increases in water rates to ensure a more reliable supply of water for our future?

Appendix E

EMC RESEARCH

Initial Support by Subgroup

Homeowners and water bill-payers are more likely to oppose modest rate increases, as are those wo found it harder to reduce their water use during the drought.



**use caution when generalizing the results among these groups due to small sample sizes*

Q7. In general, would you say you support or oppose modest increases in water rates to ensure a more reliable supply of water for our future?

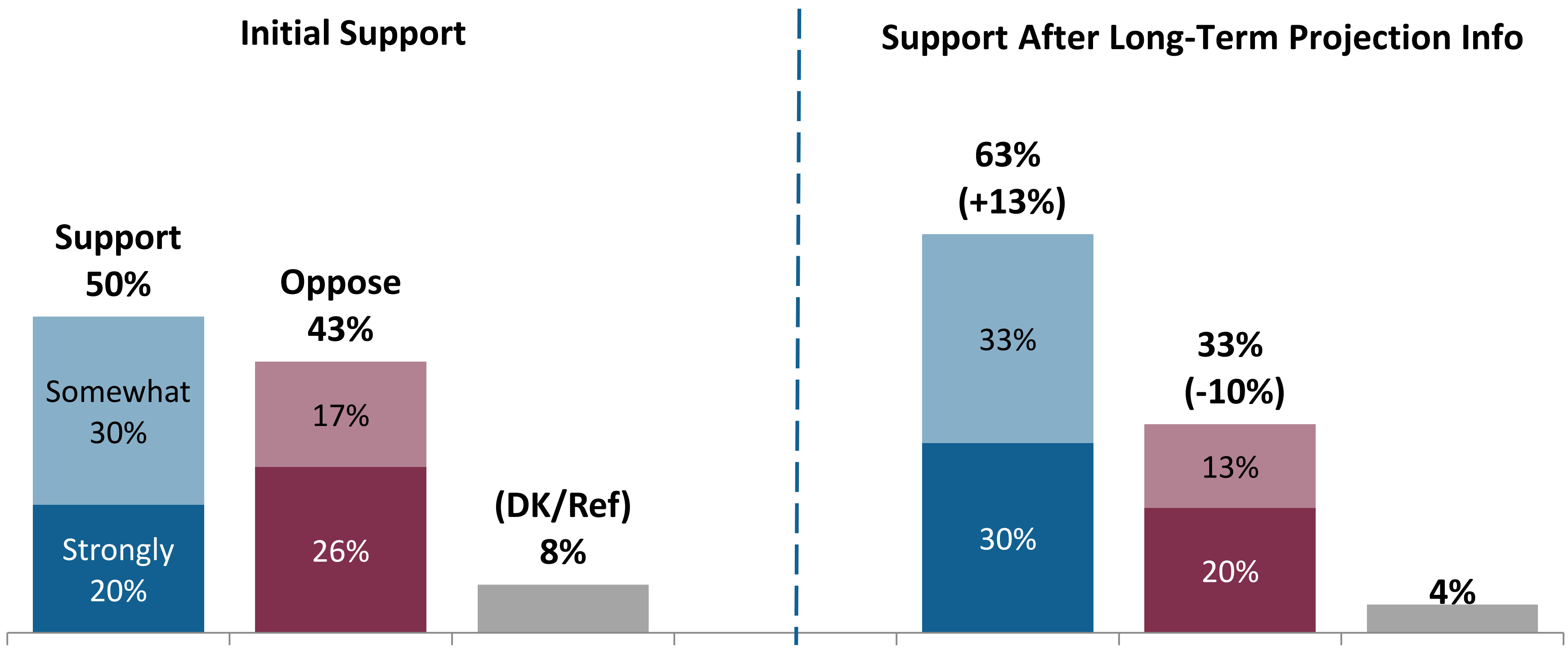
Appendix E

FMC RESEARCH

Support After Long-Term Projection Information

Support increases to well over a majority once voters hear more information about the need for investments in water supply reliability.

Despite the recent rain, our local water suppliers are continuing to evaluate long-term water supply needs for our area given future challenges such as droughts, climate change, and population growth. Projections show that in future drought years we may have to cut back water use by up to 30%. To prepare for water shortages during drought years, local water agencies are planning to invest in projects that would ensure a more reliable water supply like expanding reservoirs, expanding the use of recycled water and increasing storm water reuse. These investments would increase water rates for local residents, but would mean that customers would not have to make such significant cuts in water use during drought years.



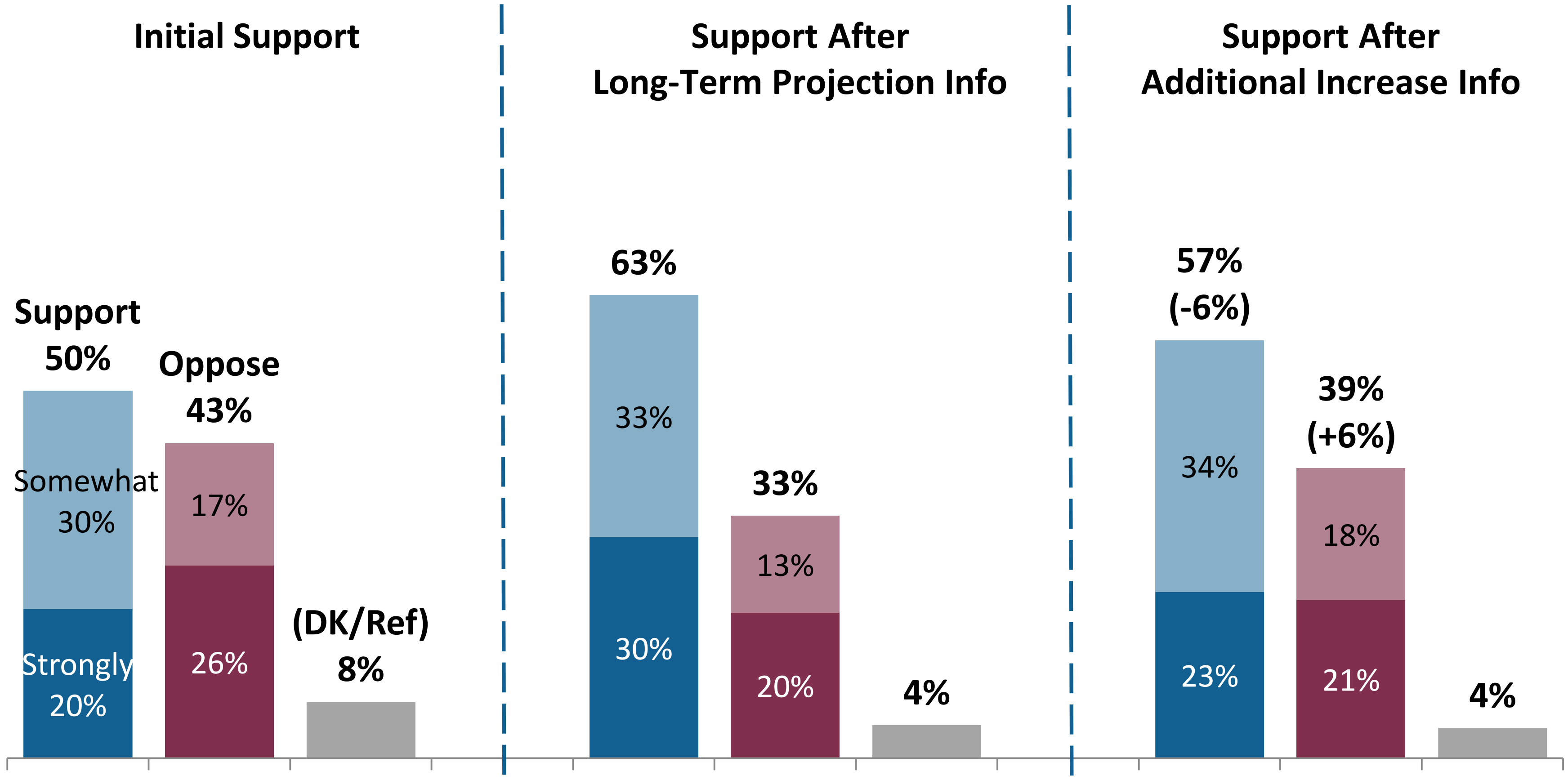
Q8. Given what you've heard, would you say you support or oppose modest increases in water rates to ensure a more reliable supply of water for our future?

Appendix E

Support After Additional Increase Information

Support decreases slightly after voters learn that these increases would come on top of other increases that are already planned, but a majority remains supportive.

Rate increases to further improve water supply reliability would be in addition to already planned increases, primarily for maintaining and improving existing infrastructure.



Q9. Given what you've heard, would you say you support or oppose modest increases in water rates to ensure a more reliable supply of water for our future?

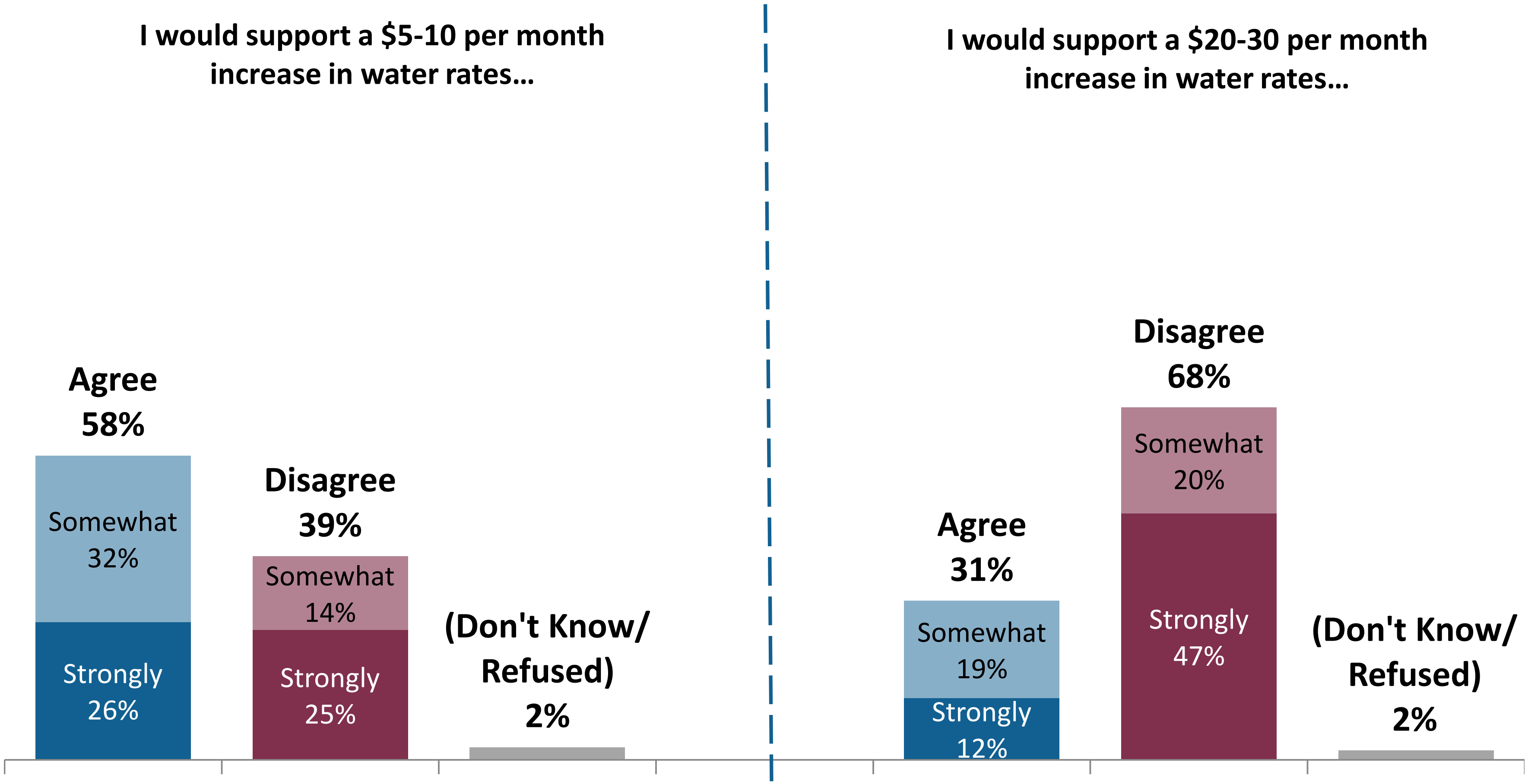
Appendix E

Attitudes Toward Specific Increases

Appendix E

Attitudes Towards Water Rates Increase

A majority would support a $5-10 per month increase. Twenty to $30 is a much harder sell.



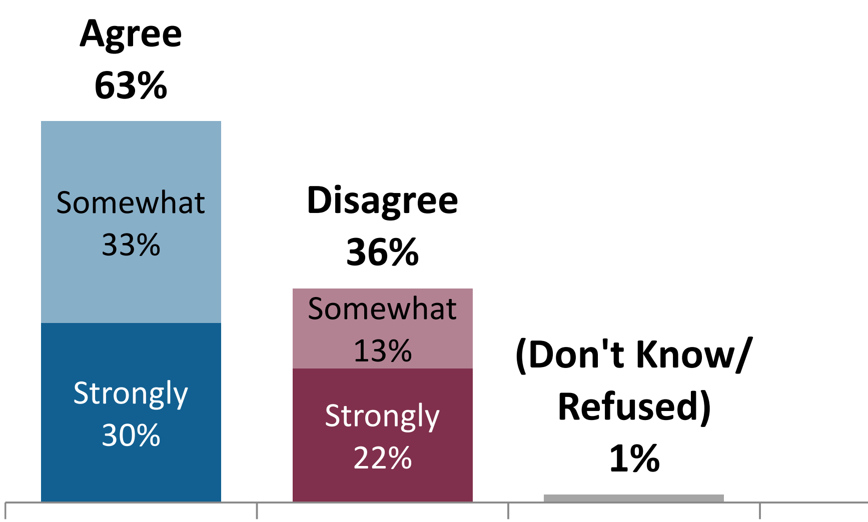
Q10-11. Please tell me whether you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with each of the following statements.

Attitudes Toward a $5 to $10 Increase

Those who hear an increase amount only are more open to a $5-10 increase than those who also hear about the corresponding tradeoff in cutbacks.

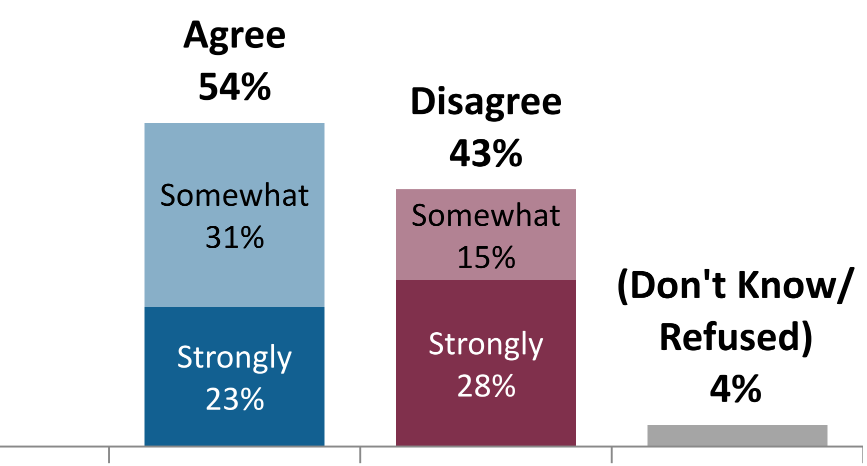
Rate Increase Only
n=200, MoE=±6.9%

In order to ensure a more reliable supply of water for our area, I would support a $5-10 per month increase in water rates now to invest in infrastructure for the future.



Percent Reduction and Rate Increase
n=200, MoE=±6.9%

In order to avoid having to reduce my water use by more than 20% during drought years, I would support a $5-10 per month increase in water rates now to invest in infrastructure for the future.



Q11. Please tell me whether you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with each of the following statements.

Attitudes Toward a $20 to $30 Increase

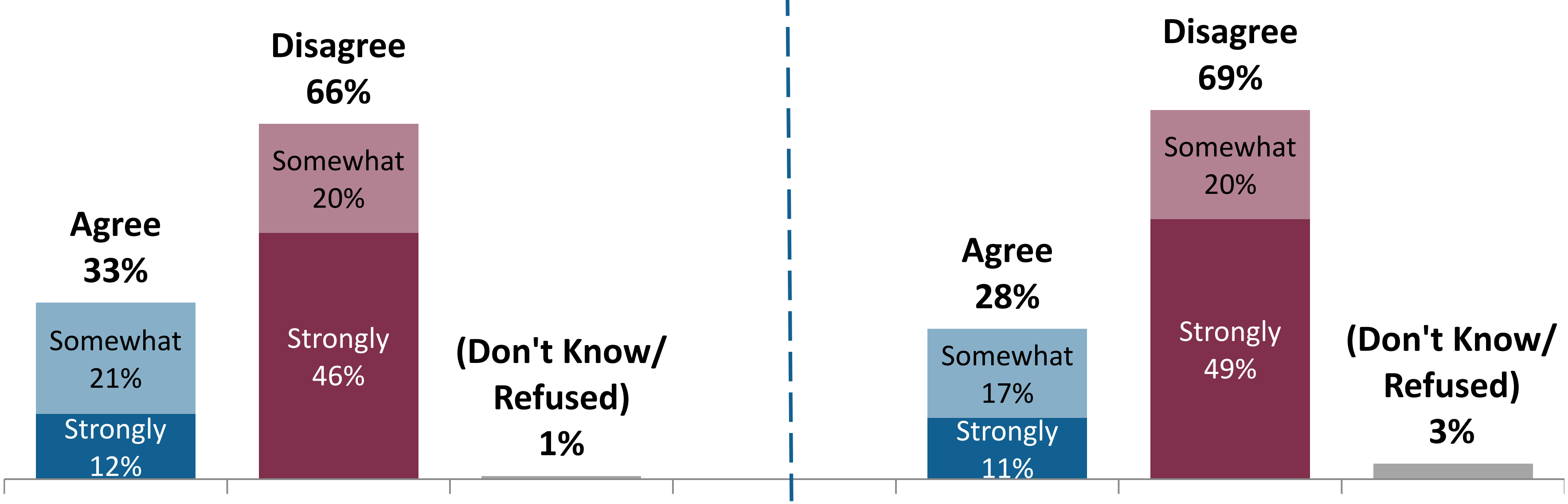
Including the reduction tradeoff does not make a $20-30 increase more palatable.

Rate Increase Only
n=200, MoE=±6.9%

In order to ensure a more reliable supply of water for our area, I would support a $20-30 per month increase in water rates now to invest in infrastructure for the future.

Percent Reduction and Rate Increase
n=200, MoE=±6.9%

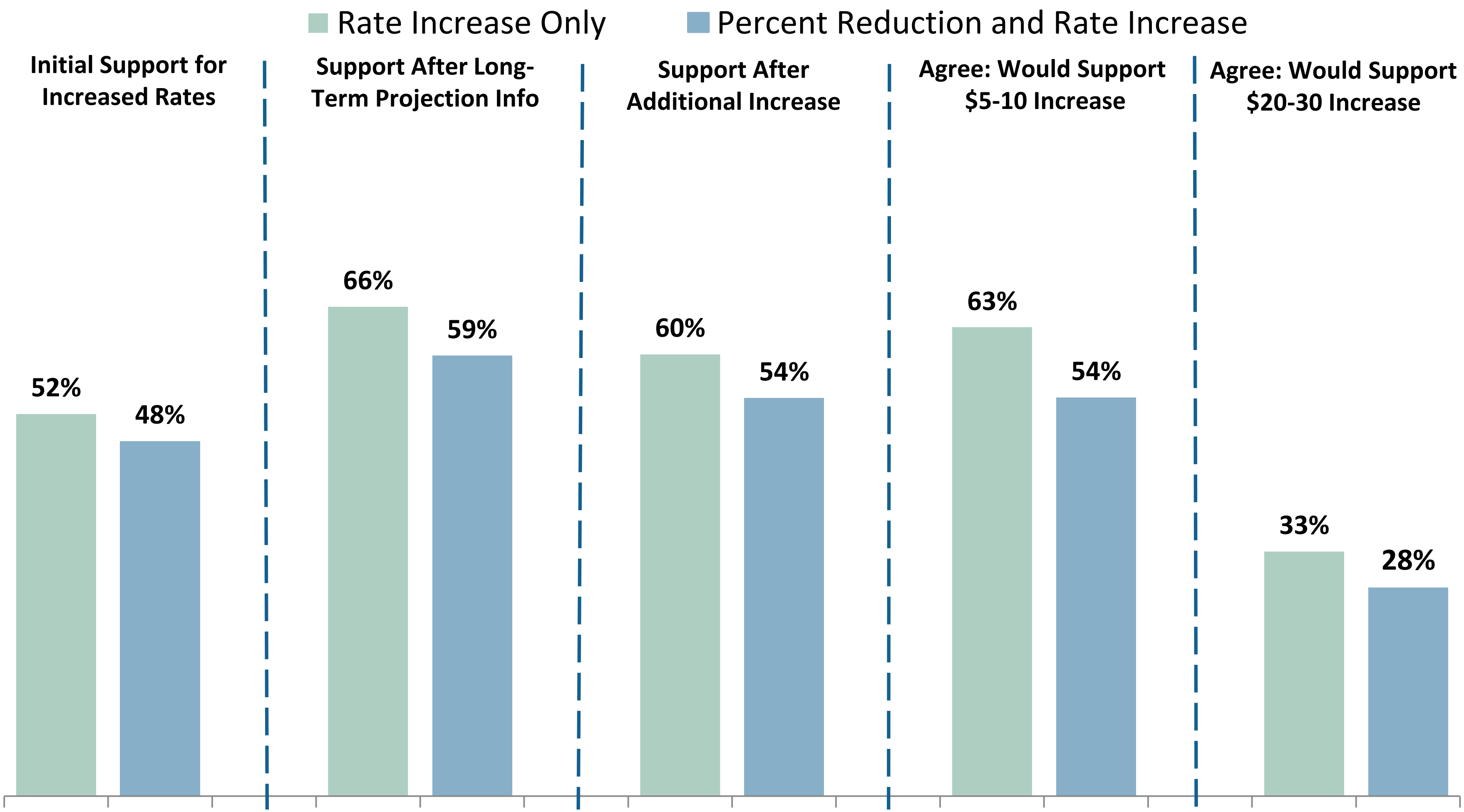
In order to avoid having to reduce my water use by more than 10% during drought years, I would support a $20-30 per month increase in water rates now to invest in infrastructure for the future.



Q10. Please tell me whether you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with each of the following statements.

Support and Attitudes - Rate Increase Only

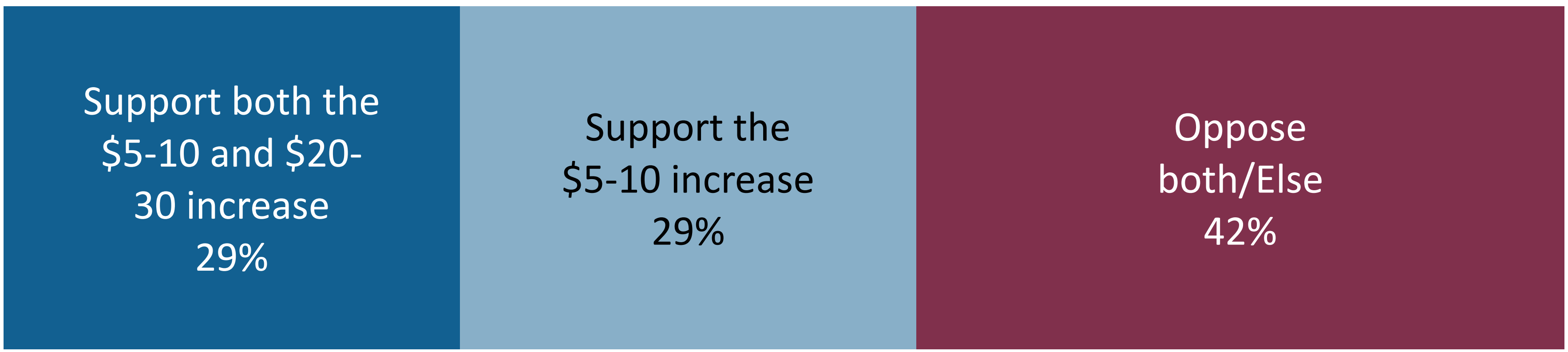
Although we don't see that explaining the limit on cutbacks is helpful, note that those who heard about the reduction targets were less supportive of rate increases throughout.



Appendix E

Support Segmentation: Increase in Water Rates

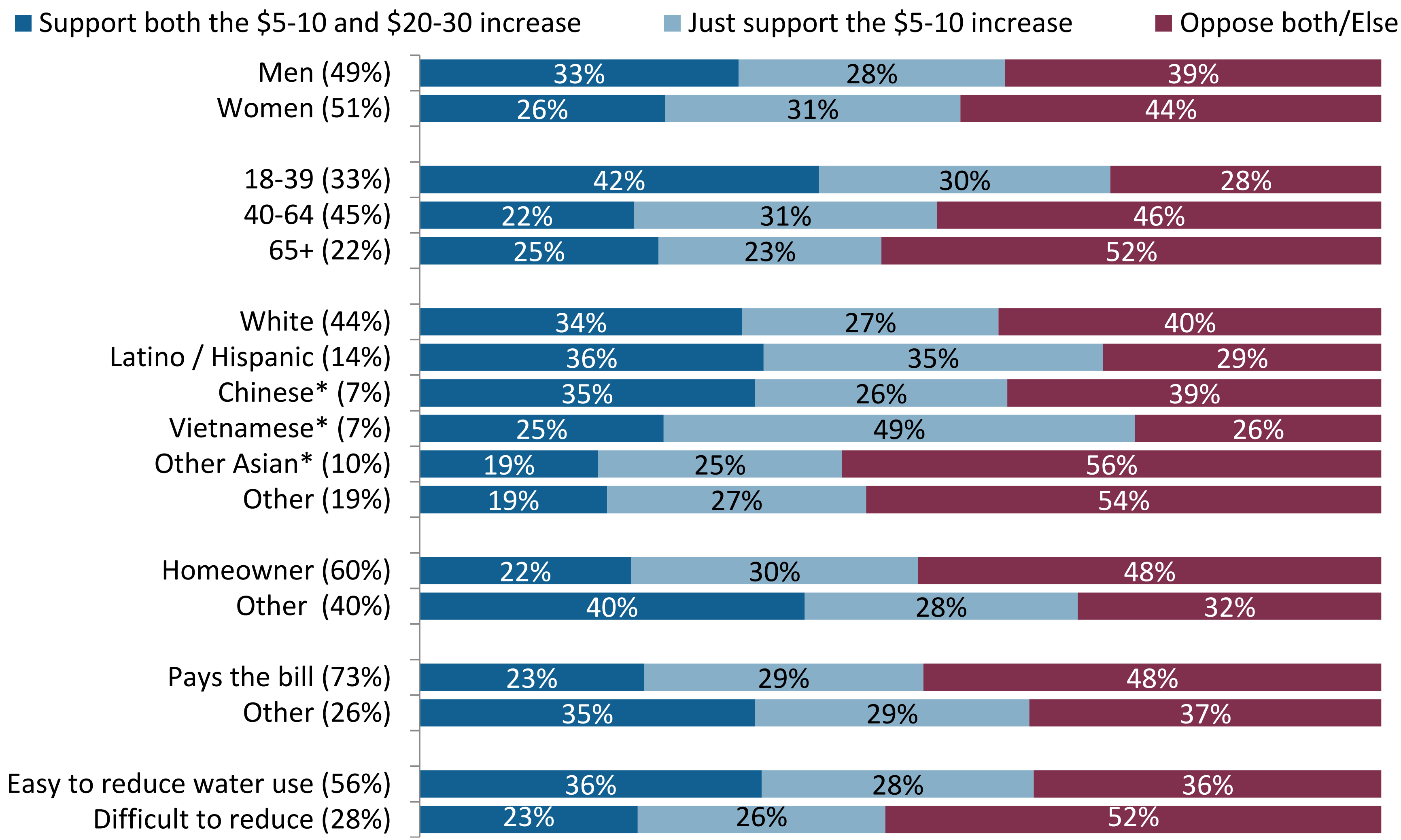
Just under a third support both increase amounts. The same number support the smaller increase only.



Appendix E

Support Segmentation by Subgroup

Younger voters and renters are most likely to be supportive of both increases.



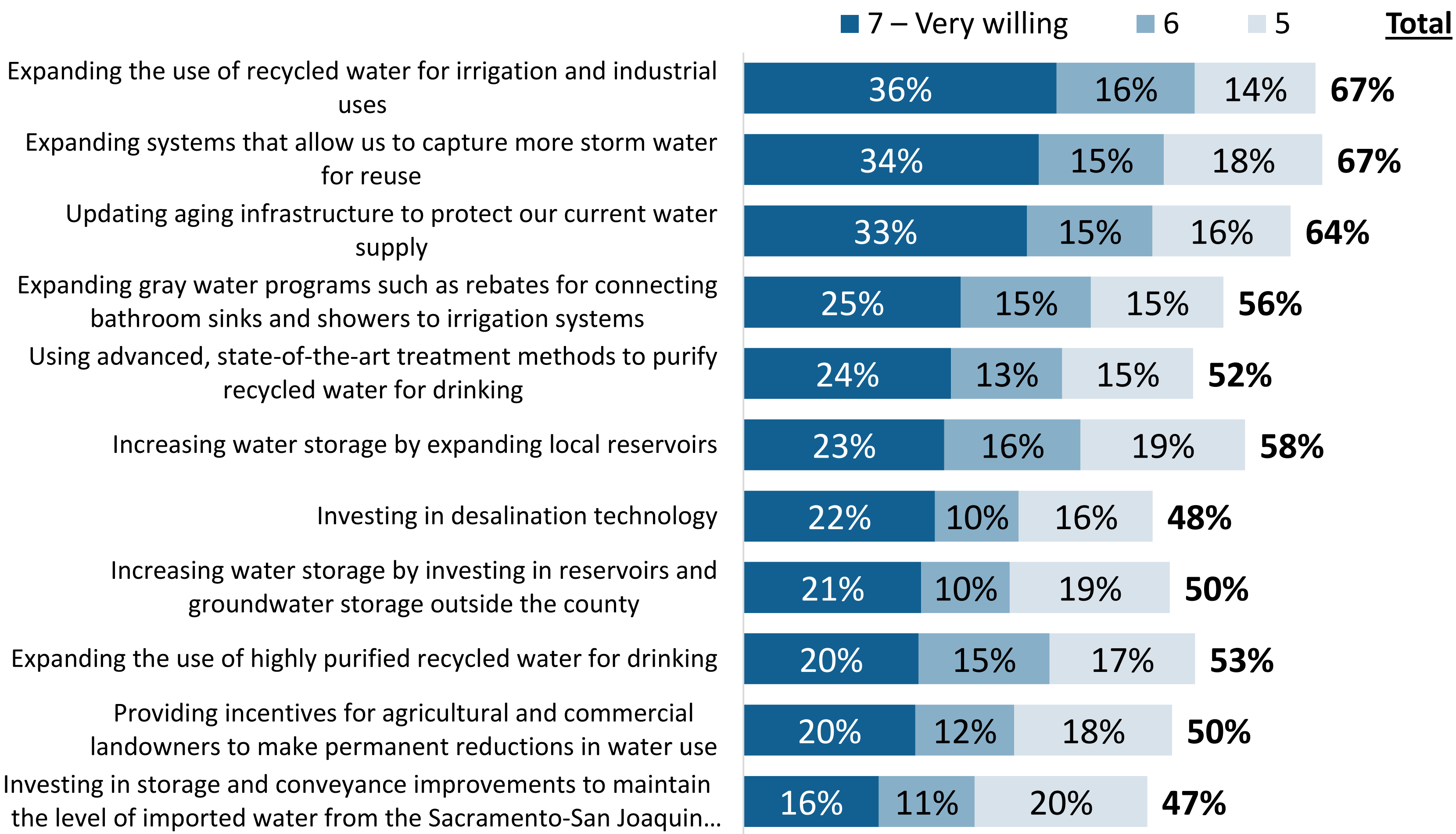
**use caution when generalizing the results among these groups due to small sample sizes*

Appendix E

FMC RESEARCH

Willingness to Pay for Specific Improvements

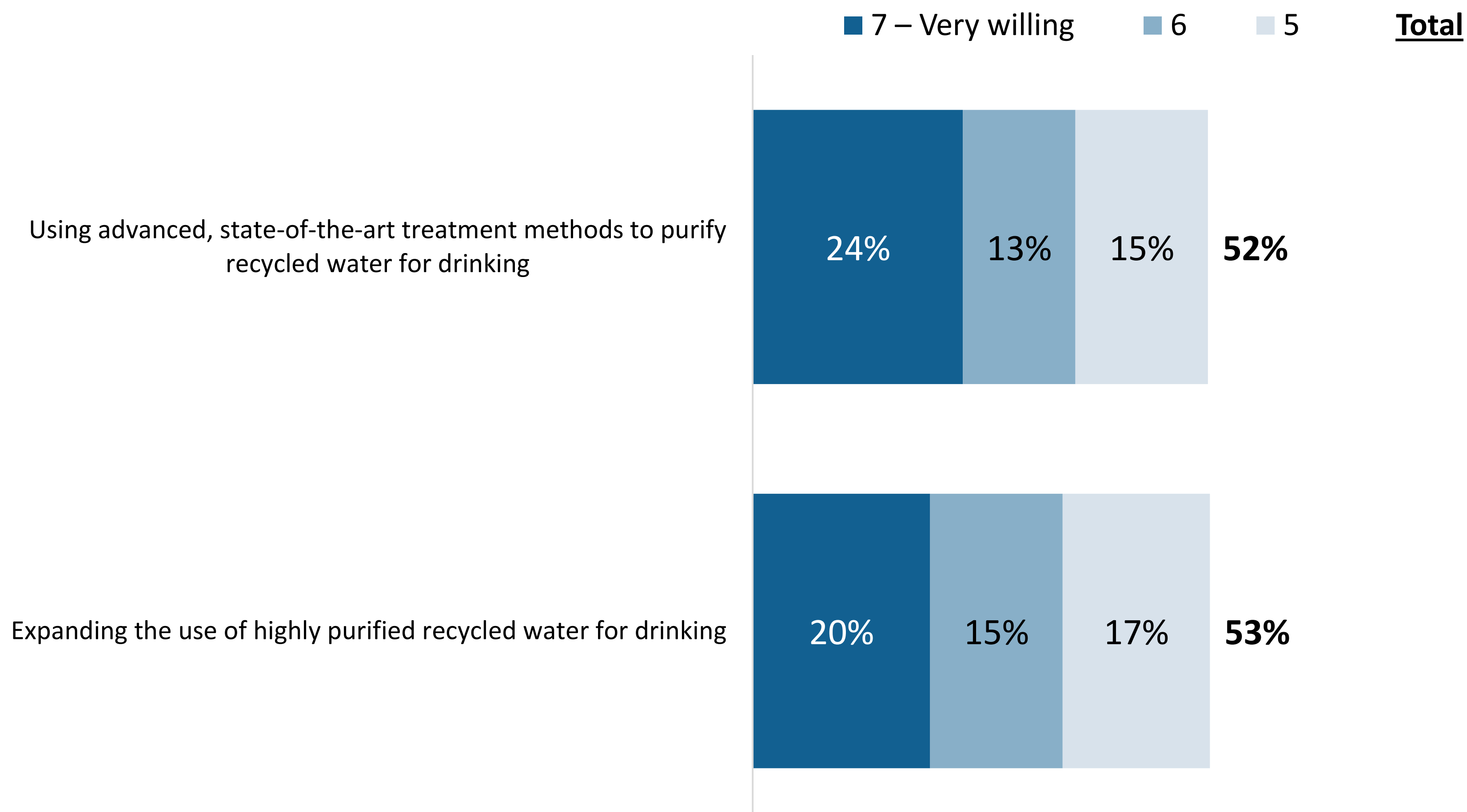
Expanding purple water use and storm water capture and updating aging infrastructure are the specific improvements for which voters are most willing to pay increased rates.



Q15-Q25. I'm going to read you a list of improvements the Santa Clara Valley Water District could make to ensure a more reliable supply of water. These improvements could potentially lead to changes in water rates. For each one, please indicate your willingness to pay increased rates for each type of improvement. Please use a scale from 1 to 7, where 1 means you are not at all willing to pay higher water rates for that item, and 7 means you are very willing to pay higher water rates for that item.

Willingness to Pay for Potable Reuse

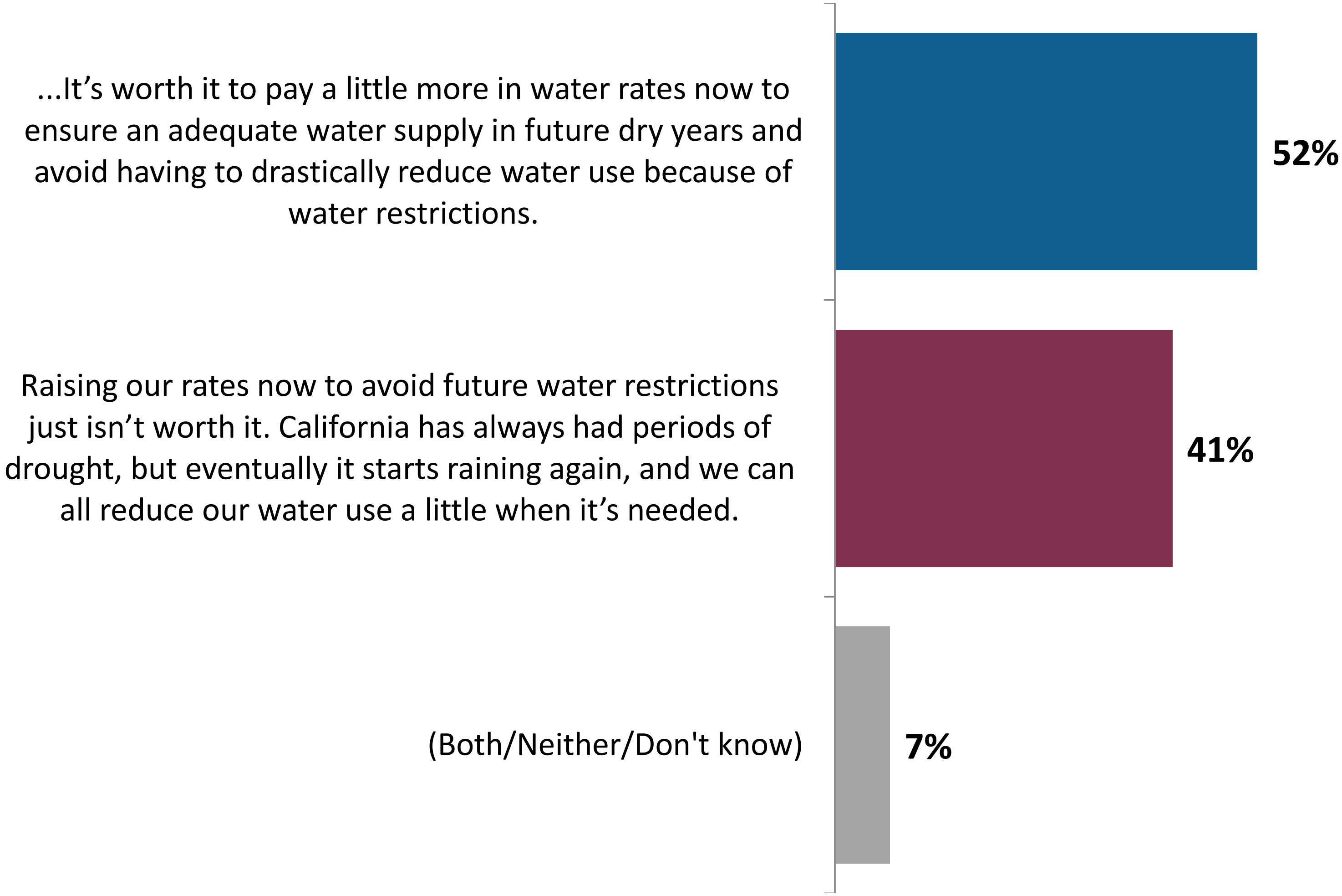
State-of-the-art treatment of recycled water for drinking generates slightly more enthusiasm than highly purified recycled water.



Q15-Q25. I'm going to read you a list of improvements the Santa Clara Valley Water District could make to ensure a more reliable supply of water. These improvements could potentially lead to changes in water rates. For each one, please indicate your willingness to pay increased rates for each type of improvement. Please use a scale from 1 to 7, where 1 means you are not at all willing to pay higher water rates for that item, and 7 means you are very willing to pay higher water rates for that item.

Forced Choice: Worth Investing Now?

Just about half agree that it's worth it to pay more now to be prepared for future dry years and avoid big water restrictions later.

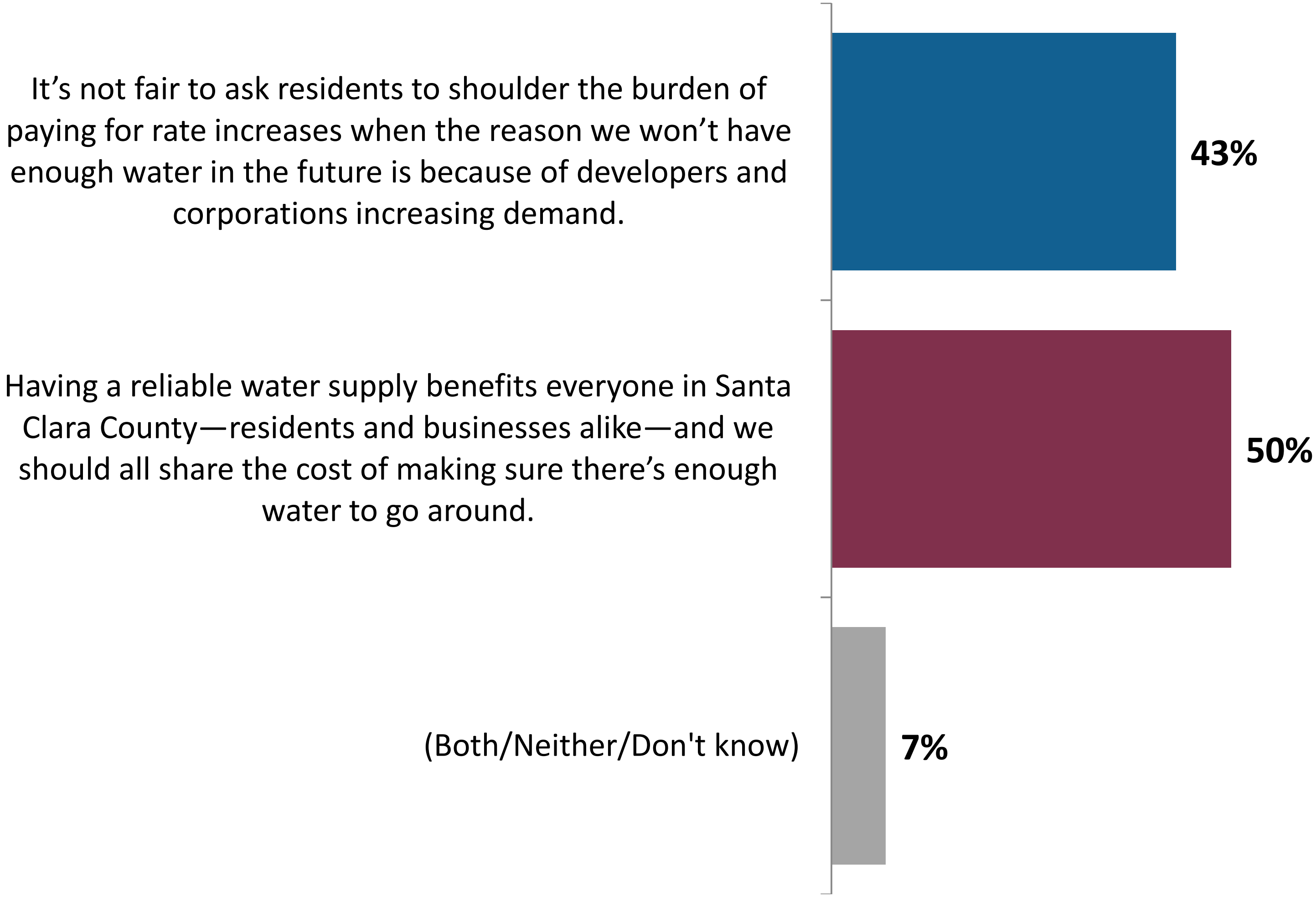


Q26. Now I'd like to read you a pair of statements. Please tell me whether the first one or the second one is closer to your opinion.

Appendix E

Forced Choice: Cost Sharing

Half feel that residents and businesses should all share the cost of ensuring an adequate water supply, while slightly fewer say it's not fair for residents to shoulder the burden.



Q27. Now I'd like to read you a pair of statements. Please tell me whether the first one or the second one is closer to your opinion.

Appendix E

Contacts

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Appendix F – Risk Ranking

WATER SUPPLY MASTER PLAN 2017 – PROJECT RISKS

9/8/2017	Results of Pairwise and Traditional Risk Analyses

Contents

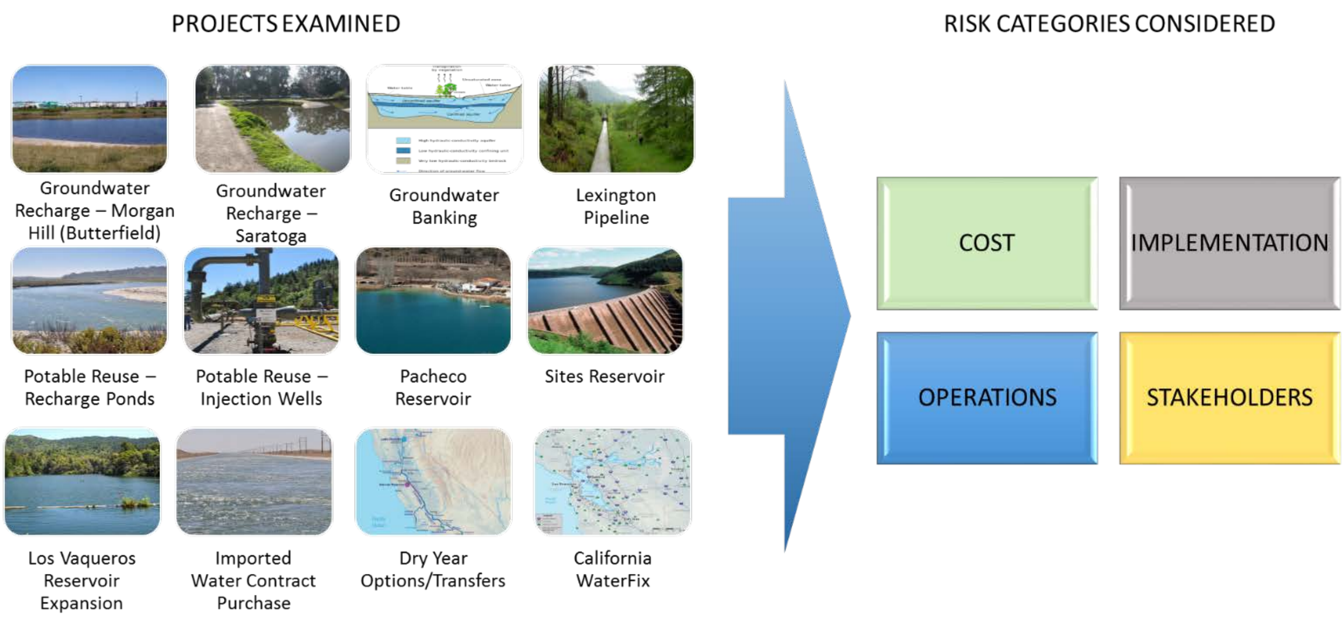
Appendices

OVERVIEW

Santa Clara Valley Water District (District) staff conducted a risk analysis of the projects being considered for inclusion in the 2017 Water Supply Master Plan (WSMP; Figure 1). The WSMP is the District's strategy for providing a reliable and sustainable water supply in a cost-effective manner. The WSMP process includes assessing the existing water supply system, estimating future supplies and demands, identifying and evaluating projects to fill gaps between supplies and demands, and recommending a strategy for long-term water supply reliability. This risk analysis helps evaluate the types, severity, and likelihood of risk associated with each WSMP project so that the District Board of Directors and community better understand the uncertainties associated with each project's ability to meet future water demands.

This report summarizes the results of the risk analysis developed to quantitatively assess the types and level of risk impacting each project. Project descriptions and cost estimates are in Appendix A - Project Descriptions. Appendix B details the methodology used to conduct the risk analysis.

FIGURE 1. PROJECTS AND RISK CATEGORIES – PROJECTS BEING CONSIDERED FOR THE 2017 WSMP AND THE TYPES OF RISK INCLUDED IN THE RISK ANALYSIS.



RISK CATEGORIES

During an Expert Panel meeting on June 8, 2017, staff and panel experts discussed different types of project risks. Afterwards, staff grouped the risks into four risk categories: Cost, Implementation, Operations, and Stakeholders. The types (or elements) of risk are summarized in Table 1 by risk category. At four meetings, one for each risk category, District subject matter experts discussed risk elements within the risk category and then conducted pairwise and traditional risk analyses of the 2017 WSMP projects. Many risks spanned the categories, but the aspects of the risk were distinct in each meeting. For example, the capital costs risk was considered during the Cost and Stakeholders risk meetings, but the Costs meeting considered the uncertainty of the capital cost estimates for each project while the Stakeholders meeting considered whether higher capital costs could result in greater stakeholder opposition. Table 1 summarizes the risks by risk category.

TABLE 1. RISK ELEMENTS BY CATEGORY. SUBJECT MATTER EXPERTS IN EACH RISK CATEGORY MET TO ASSESS PROJECT RISK WITH CONSIDERATION OF THE RISK ELEMENTS WITHIN EACH RISK CATEGORY. SEPARATE MEETINGS WERE HELD FOR EACH RISK CATEGORY.

Risk Category	Risk Elements
Costs	• Capital costs, including quality of cost estimate • Costs of regulatory compliance • Match requirements and cost-sharing • Counter-party risk/ability of partners to pay costs • Stakeholders and rate payer ability to pay • Financing and funding security • Scheduling issues • Economic fluctuations and instability • Potential for stranded assets
Implementation	• Phasing potential • Project duration and schedule • Reoperation requirements • Land availability • Constructability (e.g., structural issues, technology) • Managerial capacity (knowledge and resource availability) • Range of implementation options • Regulatory requirements • Project planning maturity
Operations	• Climate change • Yield variability and reliability • Operating Partnerships • Uncertainty of long-term operations and maintenance costs • Project inter-dependency • Environmental and water quality regulations • Control • Appropriate infrastructure • Redundancy • Emergency operations/asset failures
Stakeholders	• Public support • Permitting risks • Media • Internal stakeholder concerns • External stakeholder opposition • Environmental/special interest groups • Partnership risks • Government stakeholders • Costs

PAIRWISE RISK ANALYSIS

A pairwise risk analysis provides a quantitative approach for ranking projects by risk. Having projects ranked by riskiness improves the District Board's and community's ability to compare projects' ability to meet future needs. To complete the risk assessment, the project team assembled five to six subject matter experts from the District into four groups, one group for each risk category. The team chose District experts that had knowledge specific to their assigned risk category. Then, the subject matter experts compared each project against another project using the pairwise matrix in Table 2. The crossed-out boxes represent duplicate comparisons or compare the project against itself. The subject matter experts each determined which of the two projects being compared was a higher risk for the risk category. For example, the first comparison is Morgan Hill (Butterfield) Recharge and Groundwater Banking. If someone determined that Groundwater Banking has more risk, they would enter a "G" for Groundwater Banking

PAIRWISE RISK ANALYSIS BY RISK ELEMENT

Tables 3a-d provide the results of the pairings by risk category. Each project is represented by an abbreviation and the numbers indicate how many people chose it as the higher risk. For example, all six participants assessing cost risks thought that Imported Water Contract Purchase was higher risk than Morgan Hill (Butterfield) Recharge, so the associated cell is filled with "I6." Alternatively, two of the six participants thought Imported Water Rights Purchase (I) was higher risk than Groundwater Banking (G), so the associated cell is filled with "I2 G4."

TABLE 2. PAIRWISE COMPARISON MATRIX. EACH SUBJECT MATTER EXPERT COMPLETED THE PAIRWISE ANALYSIS BY ENTERING THE LETTER ASSOCIATED WITH THE HIGHER RISK PROJECT IN EACH EMPTY CELL.

* Morgan Hill (Butterfield) Recharge Pond

	Dry Year Options/ Transfers **D**	Lexington Pipeline **LX**	Ground-water Recharge-Saratoga **SP**	Ground-water Recharge - Morgan Hill* **B**	Ground -water Bankin g **G**	Sites Reservoir **S**	Los Vaqueros Reservoir Expansion **L**	Potable Reuse – Los Gatos Ponds **PL**	Potable Reuse – Ford Pond **PF**	Potable Reuse – Injection Wells **PI**	Imported Water Contract Purchase **I**	Pacheco Reservoir **PR**	California Water Fix **C**
Dry Year Options/ Transfers **D**	X												
Lexington Pipeline **LX**	X	X											
Groundwater Recharge-Saratoga **SP**	X	X	X										
Groundwater Recharge - Morgan Hill* **B**	X	X	X	X									
Groundwater Banking **G**	X	X	X	X	X								
Sites Reservoir **S**	X	X	X	X	X	X							
Los Vaqueros Reservoir Expansion **L**	X	X	X	X	X	X	X						
Potable Reuse – Los Gatos Ponds **PL**	X	X	X	X	X	X	X	X					
Potable Reuse – Ford Pond **PF**	X	X	X	X	X	X	X	X	X				
Potable Reuse – Injection Wells **PI**	X	X	X	X	X	X	X	X	X	X			
Imported Water Contract Purchase **I**	X	X	X	X	X	X	X	X	X	X	X		
Pacheco Reservoir **P**	X	X	X	X	X	X	X	X	X	X	X	X	
California WaterFix **C**	X	X	X	X	X	X	X	X	X	X	X	X	X

TABLE 3A-D. PAIRWISE COMPARISON RESULTS. THE TABULATED RESULTS FOR THE COST (A), IMPLEMENTATION (B), OPERATION (C), AND STAKEHOLDER (D) PAIRWISE ANALYSIS. EACH LETTER PRESENTS A PROJECT AS SHOWN IN THE HEADER ROW AND COLUMN. THE NUMBER FOLLOWING THE LETTERS IN EACH CELL REPRESENTS THE NUMBER OF EXPERTS WHO THINK THE ASSOCIATED PROJECT IS RISKIER.

a.

COST RISKS	Dry Year Options/ Transfers **D**	Lexington Pipeline **LX**	Ground-water Recharge Saratoga **SP**	Ground-water Recharge - Morgan Hill* **B**	Ground-water Banking **G**	Sites Reservoir **S**	Los Vaqueros Reservoir Expansion **L**	Potable Reuse – Los Gatos Ponds **PL**	Potable Reuse – Ford Pond **PF**	Potable Reuse – Injection Wells **PI**	Imported Water Contract Purchase **I**	Pacheco Reservoir **PR**	California WaterFix **C**
Dry Year Options/ Transfers **D**	X	D2 LX2	D2 SP2	D2 B2	D2 G2	D0 S4	D0 L4	D1 PL3	D1 PF3	D1 PI3	D2 I2	D0 PR4	D0 C4
Lexington Pipeline **LX**	X	X	LX3 SP1	LX4 B0	LX1 G3	LX0 S4	LX0 L4	LX0 PL4	LX0 PF4	LX0 PI4	LX2 I2	LX0 PR4	LX0 C4
Groundwater Recharge-Saratoga **SP**	X	X	X	SP4 B0	SP1 G3	SP0 S4	SP0 L4	SP0 PL4	SP0 PF4	SP0 PI4	SP1 I3	SP0 PR4	SP0 C4
Groundwater Recharge - Morgan Hill* **B**	X	X	X	X	B0 G4	B0 S4	B0 L4	B0 PL4	BO PF4	B0 PI4	B0 I4	B0 PR4	B0 C4
Groundwater Banking **G**	X	X	X	X	X	G1 S3	G0 L4	G0 PL4	G0 PF4	G0 PI4	G1 I3	G0 PR4	G0 C4
Sites Reservoir **S**	X	X	X	X	X	X	S3 L1	S3 PL1	S3 PF1	S3 PI1	S3 I1	S0 PR4	S0 C4
Los Vaqueros Reservoir Expansion **L**	X	X	X	X	X	X	X	L3 PL1	L3 PF1	L3 PI1	L2 I2	L0 PR4	L0 C4
Potable Reuse – Los Gatos Ponds **PL**	X	X	X	X	X	X	X	X	PL1 PF3	PL0 PI4	PL2 I2	PL0 PR4	PL0 C4
Potable Reuse – Ford Pond **PF**	X	X	X	X	X	X	X	X	X	PF0 PI4	PF2 I2	PF0 PR4	PF0 C4
Potable Reuse – Injection Wells **PI**	X	X	X	X	X	X	X	X	X	X	PI2 I2	PI0 PR4	PI0 C4
Imported Water Contract Purchase **I**	X	X	X	X	X	X	X	X	X	X	X	I0 PR4	I0 C4
Pacheco Reservoir **P**	X	X	X	X	X	X	X	X	X	X	X	X	PR1 C3
California WaterFix **C**	X	X	X	X	X	X	X	X	X	X	X	X	X

* Morgan Hill (Butterfield) Recharge Pond

b.

IMPLEMEN-TATION RISKS	Dry Year Options/ Transfers **D**	Lexington Pipeline **LX**	Ground-water Recharge-Saratoga **SP**	Ground-water Recharge - Morgan Hill* **B**	Ground-water Banking **G**	Sites Reservoir **S**	Los Vaqueros Reservoir Expansion **L**	Potable Reuse – Los Gatos Ponds **PL**	Potable Reuse – Ford Pond **PF**	Potable Reuse – Injection Wells **PI**	Imported Water Contract Purchase **I**	Pacheco Reservoir **PR**	California WaterFix **C**
Dry Year Options/ Transfers **D**	X	D1 LX3	D2 SP2	D3 B1	D4 G0	D0 S4	D0 L4	D1 PL3	D0 PF4	D0 PI4	D4 I0	D0 PR4	D0 C4
Lexington Pipeline **LX**	X	X	LX3 SP1	LX3 B1	LX3 G1	LX1 S3	LX1 L3	LX1 PL3	LX1 PF3	LX1 PI3	LX3 I1	LX0 PR4	LX0 C4
Groundwater Recharge-Saratoga **SP**	X	X	X	SP3 B1	SP2 G2	SP2 S2	SP1 L3	SP1 PL3	SP0 PL4	SP0 PI4	SP3 I1	SP0 PR4	SP0 C4
Groundwater Recharge - Morgan Hill* **B**	X	X	X	X	B3 G1	B0 S4	B0 L4	B0 PL4	B0 PF4	B0 PI4	B3 I1	B0 PR4	B0 C4
Groundwater Banking **G**	X	X	X	X	X	G0 S4	G0 L4	G0 PL4	G0 PI4	G0 PI4	G3 I1	G0 PR4	B0 C4
Sites Reservoir **S**	X	X	X	X	X	X	S3 L1	S4 PL0	S3 PF1	S4 PI0	S4 I0	S0 PR4	S0 C4
Los Vaqueros Reservoir Expansion **L**	X	X	X	X	X	X	X	L3 PL1	L2 PF2	L3 PI1	L4 I0	L1 PR3	L0 C4
Potable Reuse – Los Gatos Ponds **PL**	X	X	X	X	X	X	X	X	PL3 PF1	PL0 PI4	PL4 I0	PL0 PR4	PL0 C4
Potable Reuse – Ford Pond **PF**	X	X	X	X	X	X	X	X	X	PF1 PI3	PF4 I0	PF0 PR4	PF0 C4
Potable Reuse – Injection Wells **PI**	X	X	X	X	X	X	X	X	X	X	PI2 I2	PI0 PR4	PI0 C4
Imported Water Contract Purchase **I**	X	X	X	X	X	X	X	X	X	X	X	I0 PR4	I0 C4
Pacheco Reservoir **P**	X	X	X	X	X	X	X	X	X	X	X	X	PR0 C4
California WaterFix **C**	X	X	X	X	X	X	X	X	X	X	X	X	X

* Morgan Hill (Butterfield) Recharge Pond

c.

OPERATION RISKS	Dry Year Options/ Transfers **D**	Lexington Pipeline **LX**	Ground-water Recharge-Saratoga **SP**	Ground-water Recharge - Morgan Hill* **B**	Ground-water Banking **G**	Sites Reservoir **S**	Los Vaqueros Reservoir Expansion **L**	Potable Reuse – Los Gatos Ponds **PL**	Potable Reuse – Ford Pond **PF**	Potable Reuse – Injection Wells **PI**	Imported Water Contract Purchase **I**	Pacheco Reservoir **PR**	California Water Fix **C**
Dry Year Options/ Transfers **D**	X	D3 LX2	D4 SP1	D4 B1	D3 G2	D0 S5	D2 L3	D3 PL2	D3 PF2	D2 PI3	D4 I1	D1 PR4	D0 C4
Lexington Pipeline **LX**	X	X	LX5 SP0	LX5 B0	LX0 G5	LX0 S5	LX0 L5	LX0 PL5	LX0 PF5	LX0 PI5	LX2 I3	LX0 PR5	LX0 C5
Groundwater Recharge-Saratoga **SP**	X	X	X	SP1 B4	SP0 G5	SP0 S5	SP0 L5	SP0 PL5	SP0 PF5	SP0 PI5	SP0 I5	SP0 PR5	SP0 C5
Groundwater Recharge - Morgan Hill* **B**	X	X	X	X	B0 G5	B0 S5	B0 L5	B0 PL5	B0 PF5	B0 PI5	B2 I3	B0 PR5	B0 C5
Groundwater Banking **G**	X	X	X	X	X	G0 S5	G0 L5	G3 PL2	G3 PF2	G1 PI4	G2 I3	G0 PR5	G0 C5
Sites Reservoir **S**	X	X	X	X	X	X	S5 L0	S5 PL0	S5 PF0	S4 PI1	S5 I0	S4 PR1	S0 C5
Los Vaqueros Reservoir Expansion **L**	X	X	X	X	X	X	X	L5 PL0	L5 PF0	L4 PI1	L5 I0	L5 PR0	L0 C4
Potable Reuse – Los Gatos Ponds **PL**	X	X	X	X	X	X	X	X	PL3 PF2	PL1 PI4	PL3 I2	PL0 PR5	PL0 C5
Potable Reuse – Ford Pond **PF**	X	X	X	X	X	X	X	X	X	PF0 PI5	PF3 I2	PF0 PR5	PR0 C5
Potable Reuse – Injection Wells **PI**	X	X	X	X	X	X	X	X	X	X	PI4 I1	PI0 PR5	PI0 C5
Imported Water Contract Purchase **I**	X	X	X	X	X	X	X	X	X	X	X	I0 PR5	I0 C5
Pacheco Reservoir **P**	X	X	X	X	X	X	X	X	X	X	X	X	PR0 C5
California WaterFix **C**	X	X	X	X	X	X	X	X	X	X	X	X	X

* Morgan Hill (Butterfield) Recharge Pond

d.

STAKE-HOLDER RISKS	Dry Year Options/ Transfers **D**	Lexington Pipeline **LX**	Ground-water Recharge-Saratoga **SP**	Ground-water Recharge - Morgan Hill* **B**	Ground-water Banking **G**	Sites Reservoir **S**	Los Vaqueros Reservoir Expansion **L**	Potable Reuse – Los Gatos Ponds **PL**	Potable Reuse – Ford Pond **PF**	Potable Reuse – Injection Wells **PI**	Imported Water Contract Purchase **I**	Pacheco Reservoir **PR**	California WaterFix **C**
Dry Year Options/ Transfers **D**	X	D1 LX2	D1 SP2	D1 B2	D1 G2	D1 S2	D1 L2	D1 PL2	D1 PF2	D1 PI2	D2 I1	D0 PR3	D0 C3
Lexington Pipeline **LX**	X	X	LX2 SP1	LX3 B0	LX1 G2	LX0 S3	LX0 L3	LX1 PL2	LX1 PF2	LX1 PI2	LX1 I2	LX0 PR3	LX0 C3
Groundwater Recharge-Saratoga **SP**	X	X	X	SP3 B0	SP1 G2	SP0 S3	SP0 L3	SP0 PL3	SP0 PF3	SP0 PI3	SPI I2	SP0 PR3	SP0 C3
Groundwater Recharge - Morgan Hill* **B**	X	X	X	X	B1 G2	B0 S3	BO L3	B0 PL3	B0 PF3	B0 PI3	B2 I1	B0 PR3	B0 C3
Groundwater Banking **G**	X	X	X	X	X	G1 S2	G1 L2	G1 PL2	G1 PF2	G1 PI2	G2 I1	G0 PR3	G0 C3
Sites Reservoir **S**	X	X	X	X	X	S3 S0	S2 L1	S2 PL1	S2 PF1	S2 PI1	S2 I1	S0 PR3	S0 C3
Los Vaqueros Reservoir Expansion **L**	X	X	X	X	X	X	X	L1 PL2	L1 PF2	L1 PI2	L2 I1	L0 PR3	L0 C3
Potable Reuse – Los Gatos Ponds **PL**	X	X	X	X	X	X	X	X	PL1 PF2	PL0 PI3	PL2 I1	PI0 PR3	PL0 C3
Potable Reuse – Ford Pond **PF**	X	X	X	X	X	X	X	X	X	PF0 PI3	PF2 I1	PF0 PR3	PF0 C3
Potable Reuse – Injection Wells **PI**	X	X	X	X	X	X	X	X	X	X	PI2 I1	PI0 PR3	PI0 C3
Imported Water Contract Purchase **I**	X	X	X	X	X	X	X	X	X	X	X	I0 PR3	I0 C3
Pacheco Reservoir **P**	X	X	X	X	X	X	X	X	X	X	X	X	PR0 C3
California WaterFix **C**	X	X	X	X	X	X	X	X	X	X	X	X	X

* Morgan Hill (Butterfield) Recharge Pond

PAIRWISE RANKING RESULTS

Table 4 shows the pairwise ranking results. The letter designation represents the riskier project based on the results of the four subject matter expert groups combined. The percentage indicates the amount of agreement between the four groups. 100% indicates that all four risk groups agree the project was riskier. Where 75 percent is indicated, three of four teams ranked it higher risk (where 75%* is noted, the result was three of four, and one tie). Where 66% is indicated, two of three groups agreed and a tie in the fourth group. Finally, 50 percent indicates an even split between the four risk categories. Most the comparisons had agreement among the four categories.

TABLE 4. PAIRWISE RANKING RESULTS

ALL RISK CATEGORIES	Dry Year Options/ Transfers **D**	Lexington Pipeline **LX**	Ground-water Recharge-Saratoga **SP**	Ground-water Recharge - Morgan Hill* **B**	Ground-water Banking **G**	Sites Reservoir **S**	Los Vaqueros Reservoir Expansion **L**	Potable Reuse – Los Gatos Ponds **PL**	Potable Reuse – Ford Pond **PF**	Potable Reuse – Injection Wells **PI**	Imported Water Contract Purchase **I**	Pacheco Reservoir **PR**	California WaterFix **C**
Dry Year Options/ Transfers **D**	X	LX 66%	D/SP 50%	D/B 50%	D 66%	S 100%	L 100%	PL 75%	PF 75%	PI 100%	D 75%	PR 100%	C 100%
Lexington Pipeline **LX**	X	X	LX 100%	LX 100%	G 75%	S 100%	L 100%	PL 100%	PF 100%	PI 100%	I 66%	PR 100%	C 100%
Groundwater Recharge-Saratoga **SP**	X	X	X	SP 75%*	G 75%*	S 75%*	L 100%	PL 100%	PF 100%	PI 100%	I 75%	PR 100%	C 100%
Groundwater Recharge - Morgan Hill* **B**	X	X	X	X	G 75%	S 100%	L 100%	PL 100%	PF 100%	PI 100%	B/I 50%	PR 100%	C 100%
Groundwater Banking **G**	X	X	X	X	X	S 100%	L 100%	PL 75%	PF 75%	PI 100%	G/I 50%	PR 100%	C 100%
Sites Reservoir **S**	X	X	X	X	X	X	S 100%	S 100%	S 100%	S 100%	S 100%	PR 75%	C 100%
Los Vaqueros Reservoir Expansion **L**	X	X	X	X	X	X	X	L 75%	L/PF 50%	L 75%	L 75%*	PR 100%	C 100%
Potable Reuse – Los Gatos Ponds **PL**	X	X	X	X	X	X	X	X	PL/PF 50%	PI 100%	PL 75%*	PR 100%	C 100%
Potable Reuse – Ford Pond **PF**	X	X	X	X	X	X	X	X	X	PI 100%	PF 75%*	PR 100%	C 100%
Potable Reuse – Injection Wells **PI**	X	X	X	X	X	X	X	X	X	X	PI 50%	PR 100%	C 100%
Imported Water Contract Purchase **I**	X	X	X	X	X	X	X	X	X	X	X	PR 100%	C 100%
Pacheco Reservoir **P**	X	X	X	X	X	X	X	X	X	X	X	X	C 100%
California WaterFix **C**	X	X	X	X	X	X	X	X	X	X	X	X	X

* Morgan Hill (Butterfield) Recharge Pond

From the pairwise analysis results, California WaterFix is the riskiest project being considered, followed by the surface water reservoirs and potable reuse using injection wells. The two potable reuse projects using recharge ponds are tied, as are groundwater banking and the Lexington Pipeline. The least risky projects are the groundwater recharge projects.

TABLE 5. PAIRWISE COMPARISON RISK RANKING. Project pairwise rank determined using the count of comparisons for which each project was determined as the riskiest. The total votes by experts lists the sum of the raw scores for each project.

PAIRWISE TOTALS	PAIRWISE RANK	TOTAL VOTES BY EXPERTS
California WaterFix C	13	187
Pacheco Reservoir PR	12	165
Sites Reservoir S	11	146
Los Vaqueros Reservoir Expansion L	9	130
Potable Reuse – Injection Wells PI	10	120
Potable Reuse – Ford Road PF	8	96
Potable Reuse – Los Gatos Ponds PL	8	93
Groundwater Banking G	6	62
Imported Water Contract Purchase I	3	61
Dry Year Options/Transfers D	4	58
Lexington Pipeline LX	6	58
Groundwater Recharge - Saratoga SP	2	38
Groundwater Recharge Morgan Hill (Butterfield) B	1	23

RISK SEVERITY AND LIKELIHOOD ANALYSIS

The four risk category teams also assessed the severity and likelihood of risk for each project. The goal of this risk scoring exercise is to help determine how much riskier one project is compared to another and to identify if the risk is primarily from the likelihood that the risk materializes, the severity of the outcome if the risk materializes, or both. The methodology and risk scoring criteria are included in Appendix B. Each risk category expert scored the risk severity and likelihood for each project on a scale from 1 to 4, with four (4) being the highest magnitude of risk. The definitions are summarized in Table 6. Table 7 presents the sum of the median score for each of the risk categories by project, from highest to lowest risk. The relative ranking of risk using the severity and likelihood is the same as when the pairwise results are used. Figure 2. Risk Matrix. illustrates the severity and likelihood analysis results in a risk matrix.

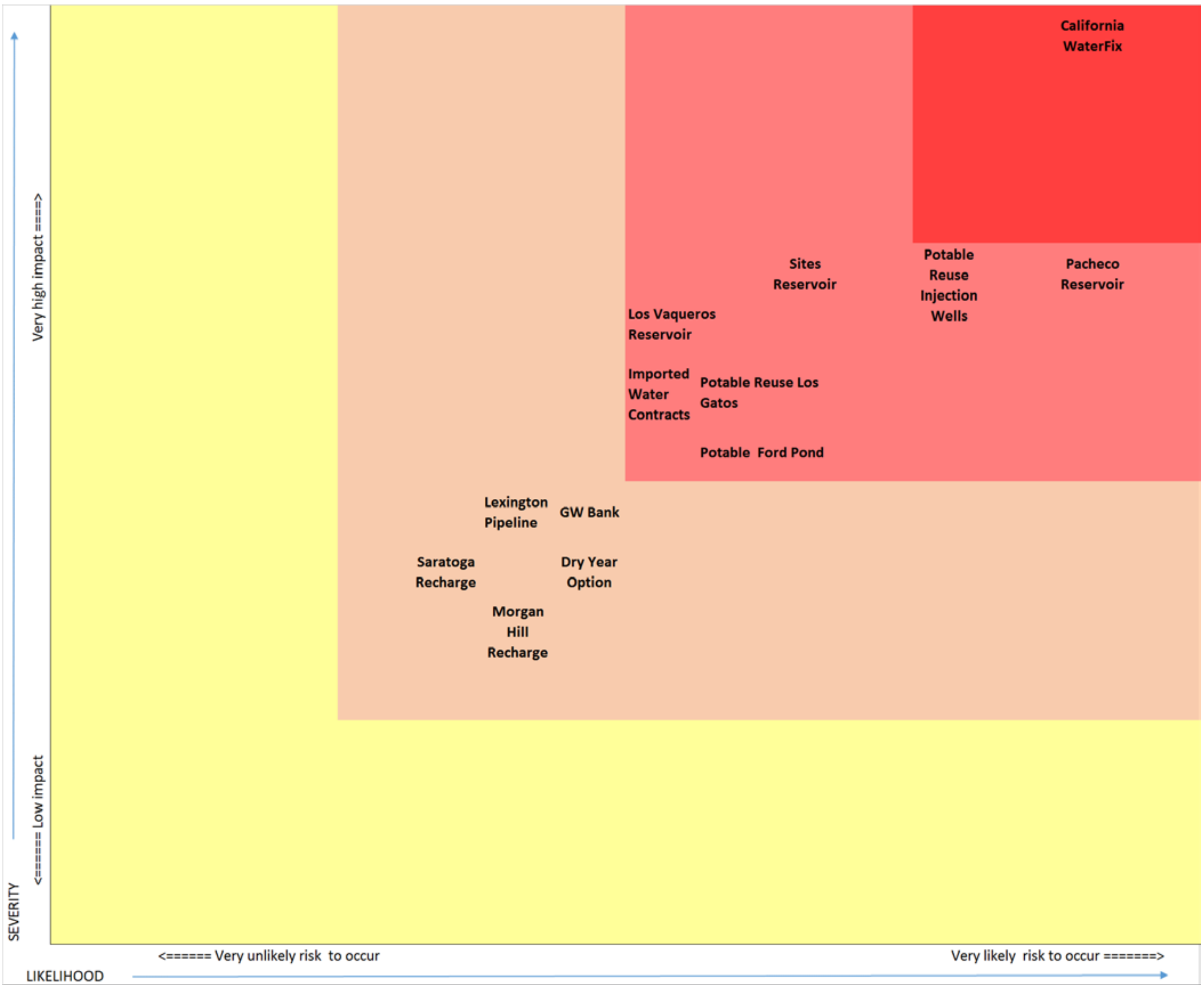
TABLE 6. RISK SEVERITY AND LIKELIHOOD DEFINITIONS

Severity	1. Low= low to no effect on project 2. Medium = minor to modest impacts 3. High = significant or substantial impacts 4. Very High = extreme potential impacts
Likelihood	1. Very Unlikely = Risks will not materialize 2. Unlikely = Risks probably will not materialize 3. Likely = Risks probably will materialize 4. Very Likely = Almost certain risks will materialize

TABLE 7. RISK SEVERITY AND LIKELIHOOD RESULTS

Project	Severity Score (Max. of 16)	Likelihood Score (Max of 16)
California WaterFix C	16	15
Pacheco Reservoir PR	12	15
Sites Reservoir S	12	11
Potable Reuse – Injection Wells PI	12	13
Los Vaqueros Reservoir Expansion L	11	9
Potable Reuse – Ford Road PF	9	10
Potable Reuse -Los Gatos Ponds PL	10	10
Groundwater Banking G	8	8
Lexington Pipeline LX	8	7
Dry year options/transfers D	7	8
Imported Water Contract Purchase I	10	9
Groundwater Recharge -Saratoga SP	7	6
Groundwater Recharge Morgan Hill (Butterfield) B	6	7

FIGURE 2. RISK MATRIX. LIKELIHOOD OF PROJECT IMPACT INCREASES UPWARD ALONG THE VERTICAL AXIS AND SEVERITY INCREASES ALONG THE HORIZONTAL AXIS. SEE TABLE 9 FOR THE RAW DATA USED TO DEVELOP THIS FIGURE.



TOTAL PROJECT RISK CALCULATION

Staff calculated the total project risk for each category by weighting the pairwise ranking by the severity and likelihood (equation 1).

Equation 1

$$Risk_{category} = (1 + \frac{Severity + \ Likelihood}{8}) \times \ Pairwise\ Ranking$$

The severity and likelihood score is divided by eight (the maximum possible combined score) to represent severity and likelihood as a portion of the maximum possible combined score. This proportion is then added to one (1) so that the pairwise analysis remains the primary driver of the order of risk, and then the severity and likelihood is a multiplicative factor that acts on the risk ranking. If the severity and likelihood is significant, it will substantially increase the total risk score. If the severity and likelihood score are small, there will be little impact on the total risk score. Alternatively, not adding one (1) to the severity and likelihood proportion would result in the severity and likelihood decreasing the ranking number unless the severity and likelihood proportion equals one. Then the risk score was normalized by dividing by the maximum possible score and multiplying by 100 to convert to a percentage value. The project risks for each category are in Figures 3 through 6. The combined total project risk is in Figure 7.

FIGURE 3. WEIGHTED COST RISK

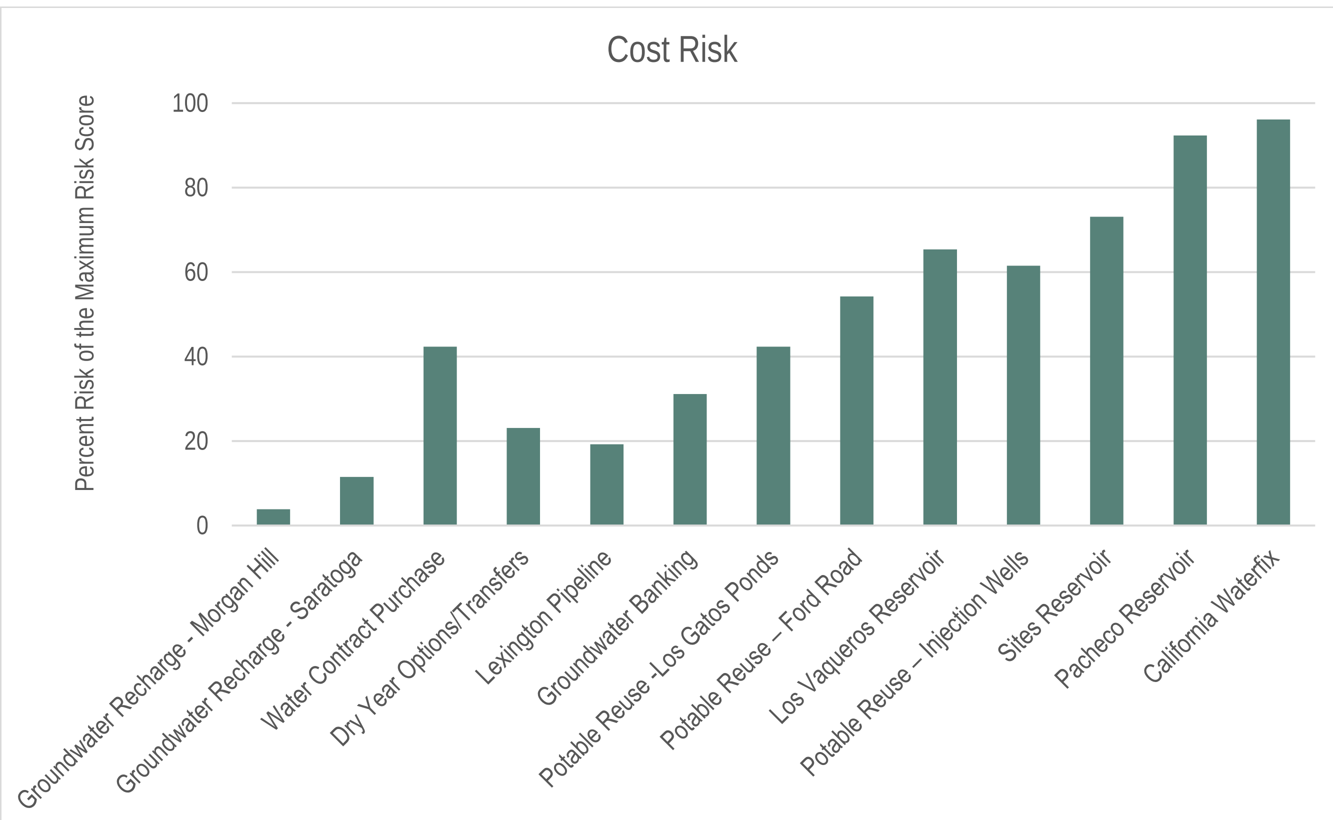


FIGURE 4. WEIGHTED IMPLEMENTATION RISK

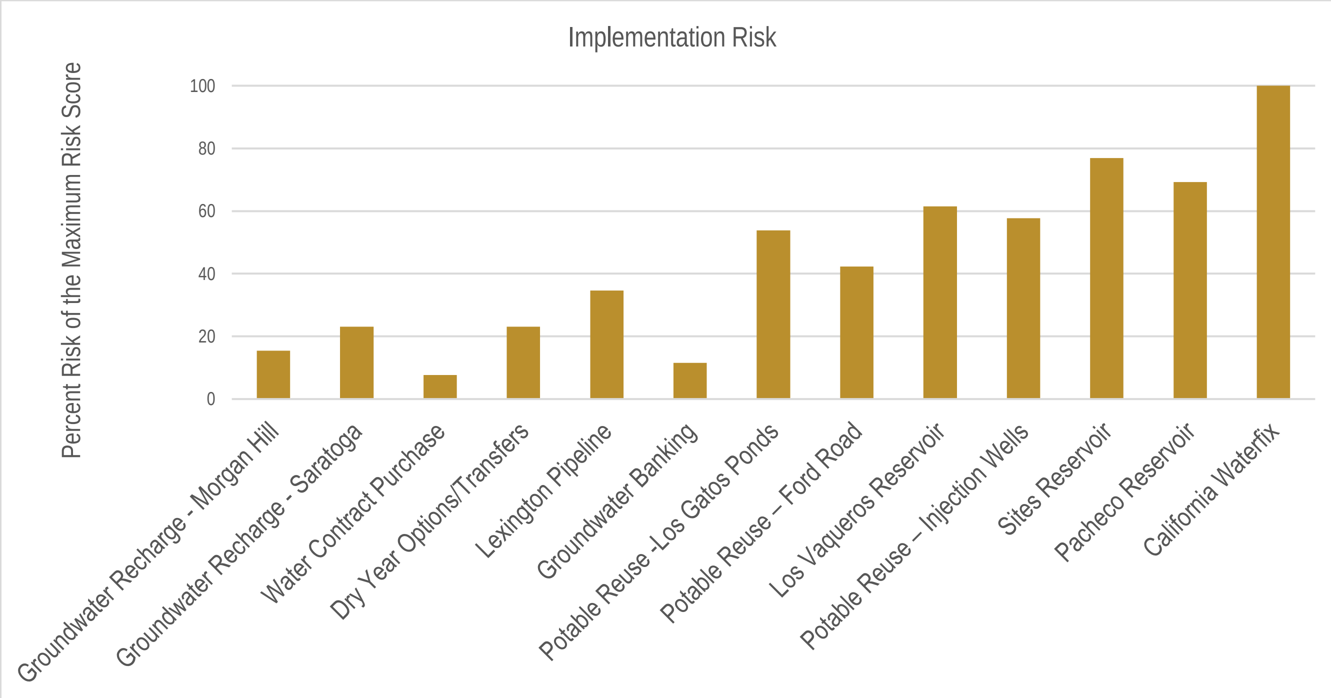


FIGURE 5. WEIGHTED OPERATIONS RISK

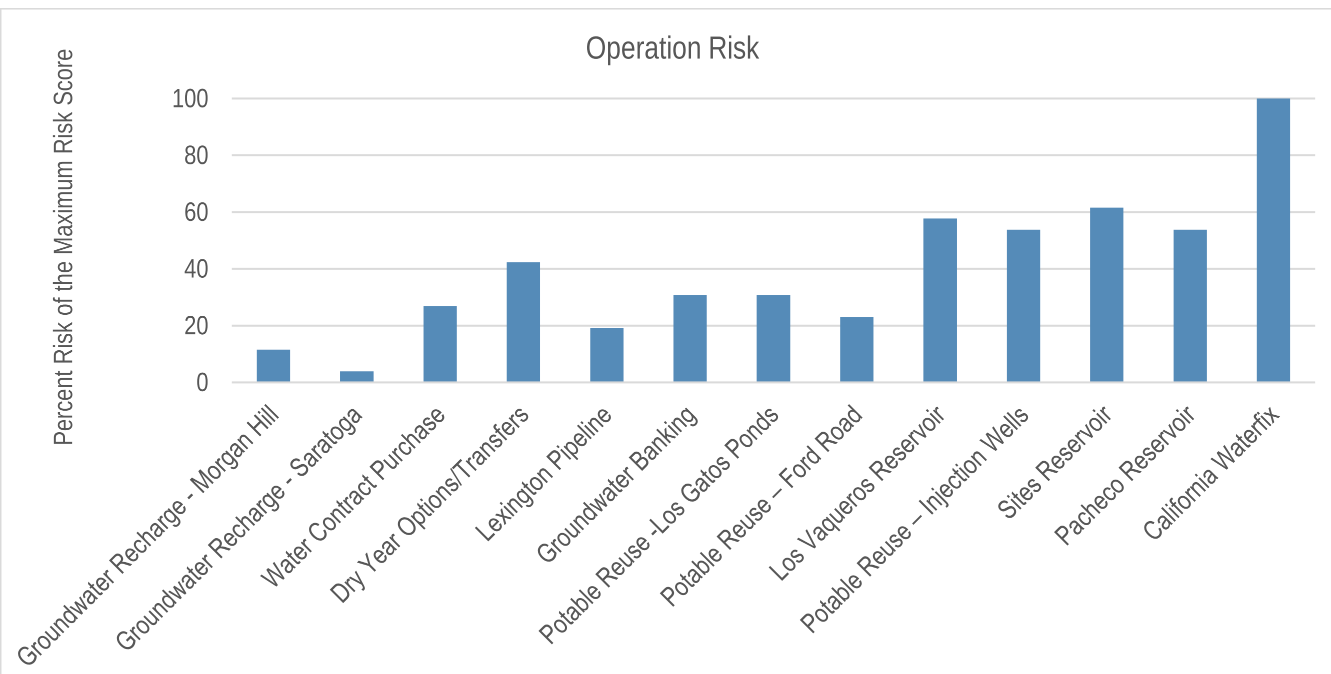


FIGURE 6. WEIGHTED STAKEHOLDER RISK

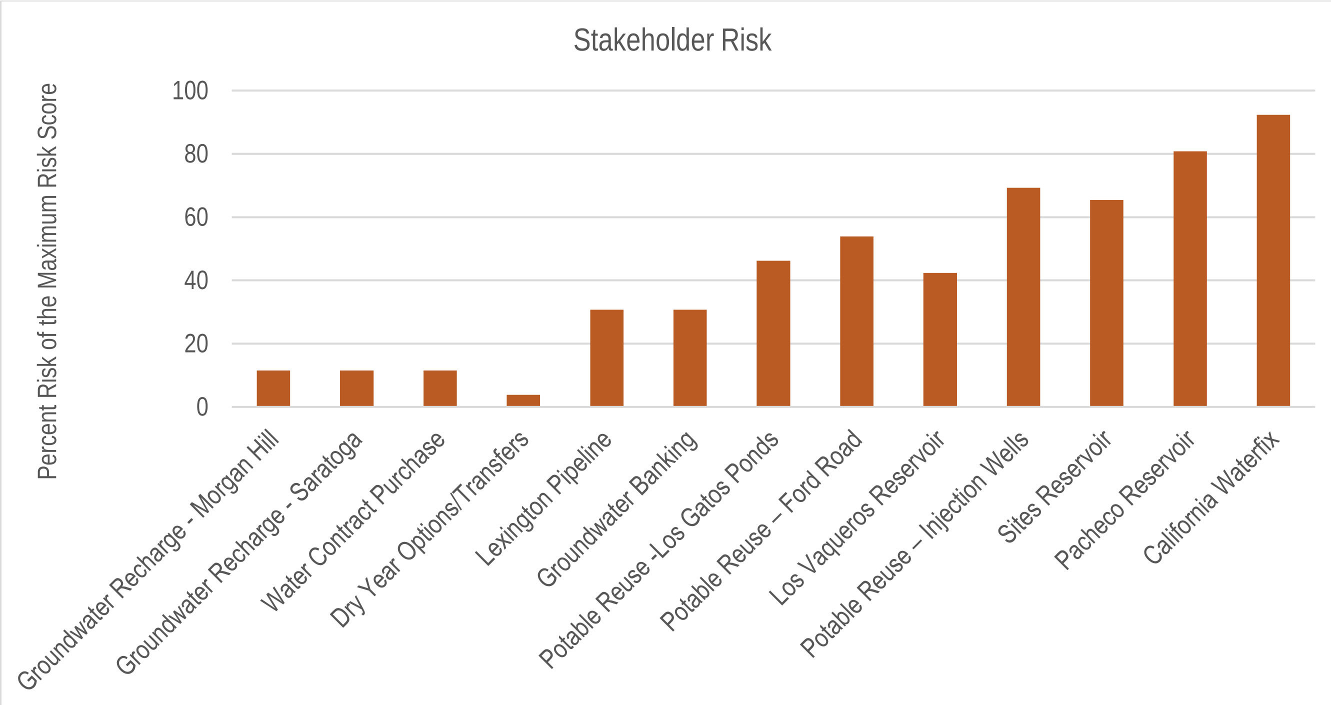
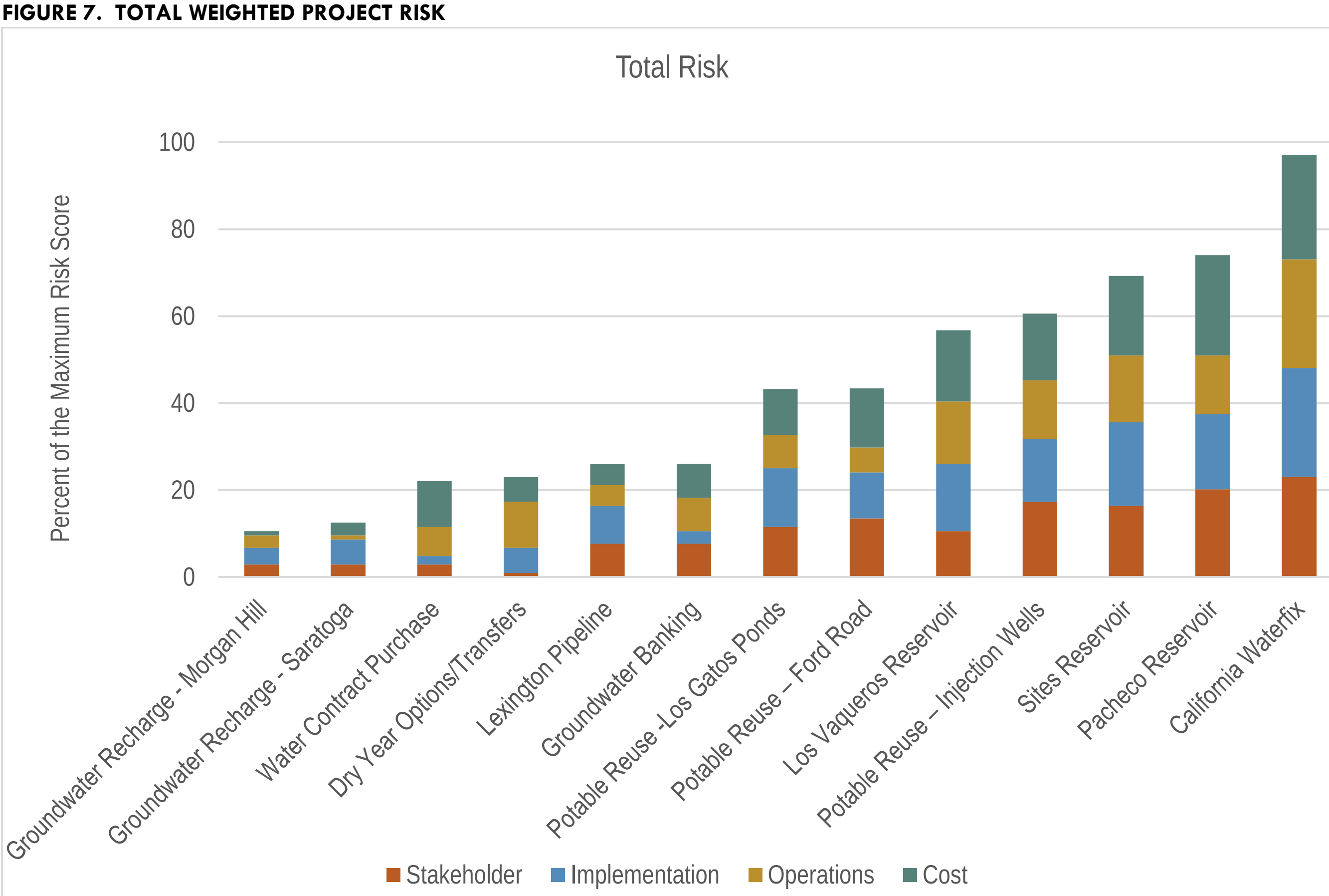


FIGURE 7. TOTAL WEIGHTED PROJECT RISK



PROJECT RISK SUMMARY AND CONCLUSIONS

California WaterFix and the three surface water reservoirs (Pacheco, Sites, and Los Vaqueros) are among the highest risk projects based on this analysis. California WaterFix and Sites Reservoir risk is distributed relatively evenly among the four categories, while Pacheco has more cost risk and Los Vaqueros has less stakeholders risk compared to the other risk categories.

Uncertainties related to future regulatory requirements for the California WaterFix may affect project operations and impact water supply yields. Although significant contingencies have been included in the cost estimates, there could be cost overruns due to the size and complexity of the construction project. Additionally, opposition from vocal stakeholders and potential legal challenges could lead to schedule delays and changes in proposed operations that impact the project's water supply benefit.

Sites Reservoir would depend on Sacramento River flows and Pacheco Reservoir would store Delta-conveyed supplies (along with local water), causing uncertainty in the amount of water that either reservoir will supply. Future environmental regulations and hydrologic changes could significantly affect the modeled yields from the reservoirs. In addition, both reservoirs will likely have significant environmental mitigation requirements that could further reduce the water supply and increase the project costs.

In contrast to Sites, California WaterFix, and Los Vaqueros, the risk analysis results suggest that the Pacheco Reservoir cost-related risk is more significant than the stakeholders, implementation, and operations risks. The cost risks are based on concerns that Pacheco partners have less financial resources and the project has less secure funding sources compared to Sites, California WaterFix, or Los Vaqueros. In addition, the cost estimate for construction and operations/maintenance could increase considerably since the project is in the early phases of planning.

The analysis shows that Los Vaqueros Reservoir has a relatively low risk compared to the other reservoir proposals and California WaterFix, with 12 percent less total risk than the next riskiest reservoir (Sites Reservoir). Risk experts from each of the risk categories commented that Los Vaqueros has been expanded before with little opposition, on time, and on budget. In addition, experts from the costs group noted that there are several potential cost-sharing partners that are financially reliable. There are potential implementation and operation complexities due to the large number of partners.

The analysis also shows that potable reuse using injection wells is riskier than potable reuse using recharge ponds. Injection wells are a relatively new technology compared to recharge ponds and recharge pond operations, maintenance, and costs are better understood. However, experts were concerned that Ford Ponds will require decommissioning several retailer wells, potentially being a stakeholder acceptance and project implementation issue. General potable reuse concerns included public acceptance, poor cost estimates for advanced purification systems, and unknown regulatory requirements. However, experts thought it is less risky than reservoirs or California WaterFix because the water will be a drought-proof, reliable, local supply and that the current socio-political environmental surrounding potable reuse as a water supply will help improve public perception.

Groundwater banking and Lexington Pipeline both had the same amount of total risk. However, compared to Lexington Pipeline, groundwater banking had higher cost and operations risks and lower implementation risks. Since the District already participates in groundwater banking with Semitropic Water Storage District (Semitropic), stakeholders are familiar banking and the associated costs risks. In addition, implementation risks and operations risks are like those with Semitropic in that there needs to be exchange capacity in dry years and the storage is not in-county. While those risks exist, they are relatively small compared to other projects since the District has experience planning for and mitigating those risks. However, the new potential banking partners will need to build infrastructure to be able to bank District water.

In contrast to groundwater banking, most of the risk associated with Lexington Pipeline is implementation risk. The implementation concern is the ability to build the pipeline through urban areas and potentially complex geologies. Since the pipeline would be locally maintained and operated, there are less operational and cost-related risks. The main cost risk associated with Lexington Pipeline is the construction cost. In contrast, the District would not control the groundwater banking operations and costs would be a recurrent negotiation.

Imported water contract purchase and dry year transfer risks are primarily associated with cost and operation. The contract purchase option is a permanent transfer of SWP Table A contractual water supplies, which are subject to the same regulatory restrictions and delivery uncertainties as our current imported water supplies. In addition, the SWP South Bay Aqueduct has conveyance limits that could make it difficult to receive additional Table A contract water during higher allocation years. In contrast, dry year transfers can only be delivered during specific months. However, if dry year transfers are available, there is little risk that the District will not receive the purchased transfer water. Imported water contract purchase and dry year transfer are both lower risk relative to most other projects since neither require construction, reducing their implementation and cost risks. However, stakeholder experts suggested that it may have poor optics to buy more Table A water when we already do not receive 100 percent of our contract allotment and that it may be difficult to find someone interested in selling their Table A water contract. Similarly, dry year transfers may not be available for purchase when needed.

The Morgan Hill (Butterfield) recharge channel and Saratoga recharge pond were the lowest risk projects because they are less costly than other projects, are local, and the District has successfully completed similar projects. Morgan Hill (Butterfield) recharge channel is currently owned by Morgan Hill and actively used for stormwater conveyance during the winter. To use the channel for recharge as planned, the District will need to coordinate operations with Morgan Hill and extend the District's Madrone Pipeline to the channel. The chief concern with Saratoga recharge pond is identifying and purchasing a suitable property for recharge.

In general, the lowest risk projects are those that are locally controlled or similar to already completed projects. Imported water rights purchase, dry year transfer, and groundwater banking are current practices, so the District is prepared for the uncertainties associated with those projects. Similarly, Morgan Hill (Butterfield) recharge channel is similar to the Madrone recharge channel and is locally controlled. Potable reuse is the newest technology the District is considering, but the facilities are locally controlled and the District is currently testing potable reuse to confirm its operational capabilities. Experts did find potable reuse with recharge ponds to be lower risk than potable reuse with injection wells. The District has experience managing recharge ponds, consistent with the conclusion that lower risk projects are those that are most similar to existing District projects. Projects that require substantial construction and cost-sharing are higher risk, such as California WaterFix and the Pacheco, Sites, and Los Vaqueros Reservoirs.

This risk assessment helps provide the Board of Directors and external stakeholders more thorough understanding of each proposed project. Understanding project risks and how these risks may materialize can help determine which projects to invest in and what project-related issues to prepare for in the future as project development proceeds.

Appendix A: Project and Program Descriptions (as of September 2017)

Project	Pros	Cons	Average Annual Yield (AFY)[1]	Present Value Cost to District (2017)	Cost/AF
California WaterFix: Constructs two 40-foot diameter tunnels at least 100 feet below ground surface capable of diverting up to 9,000 cubic feet-per-second from the Sacramento River and delivering it to the federal and state pumps. Alternative to conveying water all Central Valley Project and State Water Project supplies through the Delta. Would require environmental flow and water quality criteria be met.	• Secures existing Delta-conveyed supplies • Upgrades aging infrastructure • Protects the environment through less impactful diversions • Improves reliability of other Delta-conveyed supplies and transfers • Protects water quality	• Implementation complexity • Long-term operational uncertainty • Stakeholder opposition • Financing uncertainty	41,000	$620 million	$600
Dry Year Options / Transfers: Provides 12,000 AF of State Water Project transfer water during critical dry years. Amount can be increased or decreased. Can also include long-term option agreements.	• Provides supply in critical years when needs are greatest • Allows for phasing • Can implement in larger increments • Complements all other projects	• Subject to Delta-restrictions • Increases reliance on Delta • Cost volatility • Uncertainty with willing sellers	2,000	$100 million	$1,400

[1] The average annual yield of many projects depends on which projects they are combined and the scenario being analyzed. For example, groundwater banking yields is higher in portfolios that include wet year supplies. Similarly, they would be lower in scenarios where demands exceed supplies and excess water is unavailable for banking.

Project	Pros	Cons	Average Annual Yield (AFY)[1]	Present Value Cost to District (2017)	Cost/AF
Groundwater Banking: Provides 120,000 AF of banking capacity for Central Valley Project and State Water Project contract water. Sends excess water to a groundwater bank south of the Delta during wet years and times of surplus for use during dry years and times of need. Annual put and take capacities of 30,000 AFY. Project more effective in portfolios that include new supplies.	• Significantly reduces drought shortages when paired with projects with all-year supply • Allows for phasing	• Subject to Delta restrictions • Uncertainty with Sustainable Groundwater Management Act implementation	2,000	$170 million	$3,900
Groundwater Recharge – Morgan Hill Recharge: Extends the Madrone Pipeline from Madrone Channel to Morgan Hill's Butterfield Channel and Pond near Main Street. Would need to be operated in conjunction with the City's stormwater operations.	• Optimizes the use of existing supplies • Conjunctive use strategy • Helps drought recovery • Local project	• Minimal impact on drought shortages • North County locations limited • Potential siting conflicts with existing land uses	2,000	$20 million	$400
Groundwater Recharge – Saratoga: Constructs a new groundwater recharge facility in the West Valley, near the Stevens Creek pipeline.			1,000	$50 million	$1,300

Project	Pros	Cons	Average Annual Yield (AFY)[1]	Present Value Cost to District (2017)	Cost/AF
Lexington Pipeline: Constructs a pipeline between Lexington Reservoir and the raw water system to provide greater flexibility in using local water supplies. The pipeline would allow surface water from Lexington Reservoir to be put to beneficial use elsewhere in the county, especially when combined with the Los Gatos Ponds Potable Reuse project which would utilize the capacity of the Los Gatos recharge ponds where most water from Lexington Reservoir is currently sent. In addition, the pipeline will enable the District to capture some wet-weather flows that would otherwise flow to the Bay.	• Optimizes the use of existing local supplies • Increases local flexibility • Complements potable reuse	• Water quality issues will require pre-treatment/management • Minimal reduction in drought shortages	3,000	$90 million	$1,000

Project	Pros	Cons	Average Annual Yield (AFY)[1]	Present Value Cost to District (2017)	Cost/AF
Los Vaqueros Reservoir: Secures an agreement with Contra Costa Water District and other partners to expand the off-stream reservoir by 110,000 AF (from 160 TAF to 275 TAF) and construct a new pipeline (Transfer-Bethany) connecting the reservoir to the South Bay Aqueduct. Assumes District's share is 35,000 AF of storage, which is used to prorate costs. Emergency storage pool of 20,000 AF for use during droughts. District would also receive Delta surplus supplies when there is capacity to take. Average yield for District about 3,000 AFY. Assumes sales of excess District supplies to others. Transfer-Bethany Pipeline provides about ¾ of the project benefits at ¼ of the cost.	• Provides drought supplies • Improved transfer/exchange capacity • Allows for phasing (Transfer-Bethany Pipeline provides significant benefit) • Complements projects with all-year supply • Supports regional reliability • Public and agency support	• Operational complexity • Institutional complexity	3,000	$40 million	$400
Pacheco Reservoir: Enlarges Pacheco Reservoir to 140,000 AF. Assumes local inflows and ability to store Central Valley Project supplies in the reservoir. Construction in collaboration with Pacheco Pass Water District and San Benito County Water District. Potential other partners.	• Locally controlled • Addresses San Luis Reservoir Low-Point problem • Provides flood protection • Provides cold water for fisheries • Increases operational flexibility	• Impacts to cultural resources • Long-term operational uncertainty • Increases long-term environmental commitments • May require use of Delta-conveyed supplies to meet environmental commitments • Stakeholder opposition	6,000	$450 million	$2,700

<table>
<tr><th>Project</th><th>Pros</th><th>Cons</th><th>Average Annual Yield (AFY)[1]</th><th>Present Value Cost to District (2017)</th><th>Cost/AF</th></tr>
<tr><td>Potable Reuse – Ford Pond: Constructs potable reuse facilities for 5,000 AFY of groundwater recharge capacity at/near Ford Ponds.</td><td rowspan="3">Local supply
Not subject to short or long term climate variability
Allows for phasing</td><td rowspan="3">Reverse osmosis concentrate management for injections wells and Los Gatos Ponds projects
Uncertainty with agreements with San Jose
Injection well operations complex
Potential public perception concerns</td><td>3,000</td><td>$190 million</td><td>$2,500</td></tr>
<tr><td>Potable Reuse – Injection Wells: Constructs (or expands in conjunction with the Los Gatos Ponds project) potable reuse facilities for 5,000 to 15,000 AFY of groundwater injection capacity.</td><td>5,000 – 15,000</td><td>$290 million - $860 million</td><td>$2,000</td></tr>
<tr><td>Potable Reuse -Los Gatos Ponds: Constructs facility to purify water treated at wastewater treatment plants for groundwater recharge. Potable reuse water is a high-quality, local drought-proof supply that is resistant to climate change impacts. Assumes 24,000 AFY of advanced treated recycled water would be available for groundwater recharge at existing recharge ponds in the Los Gatos Recharge System.</td><td>19,000</td><td>$990 million</td><td>$1,700</td></tr>
</table>

Project	Pros	Cons	Average Annual Yield (AFY)[1]	Present Value Cost to District (2017)	Cost/AF
Sites Reservoir: Establishes an agreement with the Sites JPA to build an off-stream reservoir (up to 1.8 MAF) north of the Delta that would collect flood flows from the Sacramento River and release them to meet water supply and environmental objectives. Assumes District's share is 24,000 AF of storage, which is used to prorate yields from the project. The project would be operated in conjunction with the SWP and CVP. In some years, District would receive less Delta-conveyed supply with the project than without the project.	• Off-stream reservoir • Improves operational flexibility of Statewide water system	• Increases reliance on the Delta • Subject to Delta risks • Long-term operational uncertainty • Operational complexity • Institutional complexity	8,000	$170 million	$800
Water Contract Purchase: Purchase 20,000 AF of SWP Table A contract supply from other SWP agencies.	• Provides all year supply	• Increases reliance on the Delta • Subject to Delta risks • Willing sellers' availability	12,000	$360 million	$800

APPENDIX B. WSMP 2017 PROJECT RISK ANALYSIS METHODOLOGY

CONTENTS

The following staff participating in the risk analysis:

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Darin Taylor

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Debra Caldon

Erin Baker

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Jose Villarreal

Karen Uyeda

Lei Hong

Luisa Sangines

Marty Grimes

Paul Randhawa

Samantha Green

Tracy Hemmeter

Vanessa De La Piedra

BACKGROUND:

At the expert panel meeting on June 8, 2017, a panel member suggested that the Water Supply Planning team conduct a risk assessment on the projects being considered as part of the WSMP. A participant at the expert panel meeting suggested using a Paired Comparison Analysis. The WSMP project team and expert panel brainstormed elements of project risk, which the technical team then used to create risk categories that encompassed the risk elements. After the meeting, the project team identified internal subject matter experts for each risk category to participate in the paired comparison risk assessment. The project team then decided to combine the paired comparison risk analysis with a traditional risk ranking (severity and likelihood) to better understand the relative magnitude of each risk. This provides a detailed explanation of the methodology employed. The results and conclusions are presented in the September 8, 2017, *WSMP 2017 – PROJECT RISKS: Results of Pairwise and Traditional Risk Analyses.*

RISK CATEGORIES

The WSMP project team reviewed the risk elements brainstormed during the expert panel meeting and grouped them into four risk categories: stakeholder, implementation, operations, and cost (Table 1). The risk categories reflect the different stages of a project where risk can occur. Each project requires approval or support from a diverse set of stakeholders, ranging from the public to the Board of Directors. This may be needed only at the beginning of a project, or throughout as is the case with regulatory approval. Once a project is supported by stakeholders, the project enters the planning/implementation phase. Implementation risks capture risks that occur during planning, design, permitting, and construction. The cost risk category encompasses elements of uncertainty associated with the initial cost estimates through the uncertainty associated with recurring operations and maintenance costs during the project's lifespan. Once the project is implemented, issues associated with project operations will need to be addressed throughout the lifespan of the project. An example of a potential recurring operations issue is the need to re-operate as environmental regulations or climate changes.

Once the project team determined the risk categories, they reviewed risk management references to ensure they were presenting a comprehensive assessment of risk. During the literature review, the technical team found a risk category structure named POET that is analogous to their risk categorization (TRW, Inc.). POET categories include political, operational, economic, and technical, and is used to assess challenges and opportunities associated with programs, customer challenges, and strategies, regardless of the size and complexity.

- Political: Assess and articulate associated leadership, mission/business decision drivers, organizational strengths/weaknesses, policies, governance, expectation management (e.g., stakeholder relationship), program management approach, etc.
- Operational: Obtain and evaluate mission capabilities, requirements management, operational utility, operational constraints, supporting infrastructure and processes, interoperability, supportability, etc.
- Economic: Review capital planning and investment management capabilities, and assess the maturity level of the associated processes of budgeting, cost analysis, program structure, acquisition, etc.
- Technical: Assess and determine the adequacy of planned scope/scale, technical maturity/obsolescence, policy/standards implementation, technical approach, etc.

The risk categories determined by the project team have slightly different names than the POET categories, but they cover very similar content.

Table 1: Risk Category and Risk Elements.

Risk Category	Risks
Costs	• Capital costs, including quality of cost estimate • Costs of regulatory compliance • Match requirements and cost-sharing • Counter-party risk • Stakeholders and rate payer perspective and ability to pay • Financing and funding security • Scheduling issues • Economic fluctuations and instability • Stranded assets
Implementation	• Phasing potential • Required time table • Reoperation requirements • Land availability • Constructability (e.g., structural issues, technology) • Managerial capacity (knowledge and resource availability) • Range of implementation options • Regulatory requirements • Project planning maturity
Operations	• Climate change • Yield variability and reliability • Operating Partnerships • Uncertainty of long-term operations and maintenance costs • Project inter-dependency • Environmental and water quality regulations • Control • Appropriate infrastructure • Redundancy • Emergency operations/asset failures
Stakeholders	• Public support • Permitting risks • Media • Internal stakeholder concerns • External stakeholder opposition • Environmental/special interest groups • Partnership risks • Government stakeholders • Costs

WSMP PROJECT RISK ASSESSMENT

After a review of risk assessment methodologies, the project team determined that while a pairwise comparison provides the relative risk ranking of projects, it does not indicate how much riskier one project is in comparison to one of lower rank. To quantify the magnitude of risk, the project team decided to add an evaluation of risk severity and likelihood.

To complete the risk assessment, the project team assembled five to six subject matter experts from the District into four groups, one group for each risk category. The team chose District experts that had knowledge specific to their assigned risk category (Table 1). At each of the four risk assessment meetings, the following agenda was followed:

1) Projects were discussed to the experts could understand the projects sufficiently to perform their analysis.
2) District experts reviewed and brainstormed additional elements of risk associated with the category.
3) District experts independently completed a pairwise comparison.
4) A meeting facilitator tallied the pairwise comparisons during the meeting and the District experts discussed some of the project comparisons where experts had disagreements.
5) District experts independently completed the risk magnitude assessment, which was tallied afterwards.

After this assessment was completed, the project team added four additional projects to the list. This required the analysis to be conducted again with the added projects. The same process was followed for the second analysis, with the following exceptions:

- A subset of the same staff was used in the second analysis, with four to five experts per category.
- The subject matter experts did not meet in person for the second analysis, so there was not the same level of discussion or ability to ask questions about projects as during the first analysis.

PAIRED COMPARISON

The subject matter experts received a matrix of the projects where they could complete their paired comparisons (Table 2A). Each expert compared one project to another and identified which project between the two is of greater risk for the risk category being evaluated. The project team then tabulated the results during the meeting for the first phase (Table 2B- All results), and the experts discussed some of the project comparisons where there was not consensus. Given time constraints, not all paired comparisons with disagreements could be discussed; instead, the project team selected the most significant disagreements for discussion. For the second phase, the experts were provided the same information and forms, and they completed the assessments on their own.

Table 2A: Pairwise Template

OPERATIONS Risk	Butterfield Recharge Pond B	Groundwater Banking South of Delta G	Sites Reservoir S	Los Vaqueros Reservoir Expansion L	Potable Reuse – Ford Road PF	Potable Reuse – Injection Wells PI	Imported Water Rights Purchase I	Pacheco Reservoir PR	California Waterfix C
Butterfield Recharge Pond B	X								
Groundwater Banking South of Delta G	X	X							
Sites Reservoir S	X	X	X						
Los Vaqueros Reservoir Expansion L	X	X	X	X					
Potable Reuse – Ford Road PF	X	X	X	X	X				
Potable Reuse – Injection Wells PI	X	X	X	X	X	X			
Imported Water Rights Purchase I	X	X	X	X	X	X	X		
Pacheco Reservoir P	X	X	X	X	X	X	X	X	
California Waterfix C	X	X	X	X	X	X	X	X	X

Table 2B: Pairwise Results

	Butterfield Recharge Pond B	Groundwater Banking South of Delta G	Sites Reservoir S	Los Vaqueros Reservoir Expansion L	Potable Reuse – Ford Road PF	Potable Reuse – Injection Wells PI	Imported Water Rights Purchase I	Pacheco Reservoir PR	California Waterfix C
Butterfield Recharge Pond B	X	G5	S5	L5	PF5	PI5	I4 B1	PR5	C5
Groundwater Banking South of Delta G	X	X	S5	L3 G2	PF3 G2	PI2 G3	I2 G3	PR5	C5
Sites Reservoir S	X	X	X	S5	S5	PI1 S4	S5	PR5	C5
Los Vaqueros Reservoir Expansion L	X	X	X	X	PF1 L4	PI1 L4	I1 L4	PR5	C5
Potable Reuse – Ford Road PF	X	X	X	X	X	PI5	I3 PF2	PR5	C5
Potable Reuse – Injection Wells PI	X	X	X	X	X	X	I3 PI2	PR5	C5
Imported Water Rights Purchase I	X	X	X	X	X	X	X	PR5	C5
Pacheco Reservoir P	X	X	X	X	X	X	X	X	C4 PR1
California Waterfix C	X	X	X	X	X	X	X	X	X

RISK SCORING METHODOLOGY

Following the pairwise comparison, the experts scored the risk severity and likelihood for individual projects (Table 3). The goal of this risk scoring exercise is to help determine how much riskier one project is from another and to identify if the risk is primarily from the likelihood that the risk materializes, the severity of the outcome if the risk did materialize, or both. For example, it is unlikely that an earthquake would destroy a dam, but if it did, the results could be catastrophic for life and property (low likelihood, high severity). However, when completing this exercise, experts considered all the risk elements discussed during the pairwise comparison activity to determine one project risk rating for severity and one for likelihood. The ranking criteria for each risk category is explained in detail in the next section.

Table 3: Risk Scoring Template

	Severity of Implementation Risk Impact 1-4, 1 - Low Severity 4 - High severity	**Likelihood of Implementation Risk Impact 1-4, 1 - Very unlikely 4 - Very likely within timeframe**
Butterfield Recharge Pond		
Groundwater Banking South of Delta		
Sites Reservoir		
Los Vaqueros Reservoir Expansion		
Potable Reuse – Ford Road		
Potable Reuse – Injection Wells		
Imported Water Rights Purchase		
Pacheco Reservoir		
California Waterfix		

The scores from this exercise were multiplied by the ordered ranking from the pairwise analysis to determine total risk. The following section provides detailed methods for the total risk calculation.

An example of how the subject matter experts could consider risk rating was provided, but not relied upon due to the many different sub-elements of risk to consider.

EXAMPLE:

Rank the **likelihood** of a stakeholder risk adversely impacting the project

1 = Very unlikely – Support available within 5 to 10 years

2 = Unlikely – appropriate support will Probably be garnered within 5 to 10 years

3 = Likely - Probably will NOT get support within 5 to 10 years

4 = Very likely - Almost certain NOT to get needed support within 5 to 10 years

Rank the **severity** of a stakeholder risk adversely impacting the project:

1 = Low – Stakeholder support exists or lack of support will not affect project success

2 = Medium –Potential for stakeholder issues to impact project success

3 = High – Potential for stakeholder issues to significantly impact project success

4 = Very High – Likely that lack of stakeholder support would result in project failure

TOTAL PROJECT RISK CALCULATION

The project team calculated category risk for each project by weighting the pairwise ranking by the severity and likelihood (equation 1). Then, the category risks were summed to obtain each project's total risk.

Equation 1

$$Risk_{category} = (1 + \frac{Severity + \ Likelihood}{8}) \times Pairwise\ Ranking$$

The severity and likelihood score is divided by eight (the maximum possible combined score) to represent severity and likelihood as a portion of the maximum possible combined score. The technical team then added that proportion to one (1) so that the pairwise analysis remains the primary driver of the order of risk, and then the severity and likelihood is a multiplicative factor that acts on the risk ranking. If the severity and likelihood is significant, it will substantially increase the total risk score. If the severity and likelihood score are small, there will be little impact on the total risk score. Alternatively, not adding one (1) to the severity and likelihood proportion would result in the severity and likelihood decreasing the ranking number unless the severity and likelihood proportion equals one.

CONCLUSION

The risk assessment methods were easy to apply to the projects and provided a robust and multi-variant method assess risks associated with each project. However, explaining the methods clearly to the subject matter experts was needed. Since the second phase of review with the added project did not include discussions or the opportunity to ask questions, it may have been subject to less project understanding by the experts.

The results are discussed in September 8, 2017, *WSMP 2017 – PROJECT RISKS: Results of Pairwise and Traditional Risk Analyses.*

Appendix G - Board Agenda Memorandum for January 14, 2019

The entire Board Agenda package for January 14, 2019 (including the attachments) can be found at:
https://www.valleywater.org/how-we-operate/board-meetings-agendas-minutes

Santa Clara Valley Water District
CONFORMED COPY

File No.: 19-0060

Agenda Date: 1/14/2019
Item No.: 2.1.

BOARD AGENDA MEMORANDUM

SUBJECT:
Water Supply Master Plan 2040 Update. (Continued from January 8, 2019)

RECOMMENDATION:
A. Reaffirm the 2012 “Ensure Sustainability” Strategy for the Water Supply Master Plan 2040;
B. Approve changing the water supply reliability level of service goal from meeting 90 percent of normal year demands, as identified in the Water Supply Master Plan, in drought years to meeting 80 percent of demands in drought years;
C. Receive information and provide direction on the approach to the monitoring and assessment plan (MAP) for implementing the Water Supply Master Plan 2040; and
D. Direct staff to return with updates on projects with near-term decisions points.

SUMMARY:
The Water Supply Master Plan (Master Plan) is the District’s strategy for providing a reliable and sustainable water supply in a cost-effective manner. It informs investment decisions by describing the type and level of water supply investments the District is planning to make through 2040, the anticipated schedule, the associated costs and benefits, and how Master Plan implementation will be monitored and adjusted. The Board last received information on the Master Plan update at its November 20, 2018 meeting. At that time, the Board received and discussed staff’s recommendations to change the water supply reliability level of service goal, reaffirm the 2012 “Ensure Sustainability” strategy, and provide input on the monitoring and assessment approach. The Board requested that staff return to the Board at a later date for formal Board action and include additional information on project risks and other agencies’ level of service goals. This memorandum summarizes prior analyses including the risk analysis, provides a rationale for updating the District’s current water supply reliability level of service goal including other agencies’ level of service goals, and describes how the Master Plan will be monitored and adapted to changing conditions.

Summary of Prior Analyses

Staff has analyzed anticipated water supply and demand conditions for 2040, without any new projects. The supply conditions assume dam retrofits are completed, the Fisheries and Aquatic Habitat Collaborative (FAHCE) settlement agreement is implemented, and State Water Project (SWP) and Central Valley Project (CVP) supplies decline over time due to additional regulatory restrictions and climate change. The demands are based on 2020 water use targets in retailers’

APPROVED
JAN 14 2019

Urban Water Management Plans, extended through 2040 to account for updated regional growth projections and expected water conservation program savings. The analysis continues to indicate that extended droughts are our greatest challenge and the county could experience shortages of up to about 150,000 acre-feet (AF) in the most critical year.

A number of projects and combinations of projects have been evaluated for addressing these projected shortages. The analyses considered:

- Water supply yields under different scenarios,
- Other benefits such water quality or environmental benefits,
- Costs,
- Risks,
- Performance with different demand assumptions,
- Performance with different imported water supply assumptions,
- Performance under late century climate change,
- Input from the Expert Panel, and
- Stakeholder and Board interests.

Staff presented the results of these analyses at prior Board meetings, with most of the information provided at the September 19, 2017 and June 12, 2018 meetings. Based on direction from the Board on November 20, 2018, staff has now added an abbreviated risk analysis of the projects the Board has approved for planning. Most of these projects were evaluated in the Risk Ranking Report from Summer 2017 (Attachment 1). The projects are summarized in the Project List (Attachment 2). The new risk analysis considers the probabilities and consequences of projects not achieving their projected yields by 2040, the planning horizon for the Master Plan. The results are similar to the results reported in the Risk Ranking Report. The notable difference is that the risk ranking for Pacheco Reservoir is lower than last year’s result, probably due to increased certainty in funding and additional information on project benefits. In general, projects with lower yields have less risk, because the consequence of not delivering is low. Projects with higher yields and higher probabilities of not succeeding have higher risk rankings. The results are summarized in the following table.

Project	**Risk Ranking**
California WaterFix - Federal Side	Extreme
California WaterFix - State Side Only	High
No Regrets - Complete Package	Medium
No Regrets - Advanced Metering Infrastructure	Low
No Regrets - Graywater Rebate Program Expansion	Low
No Regrets - Leak Repair Incentives	Low
No Regrets - Model Water Efficient New Development Ordinance	Medium
No Regrets - Stormwater/Ag Land Recharge	Low
No Regrets - Stormwater/Rain Barrels and Cisterns	Low

No Regrets - Stormwater/Rain Gardens	Low
No Regrets - Stormwater/San Jose	Low
No Regrets - Stormwater/Saratoga	Low
Pacheco Reservoir	Medium
Potable Reuse and/or Additional Non-Potable Reuse	Medium
South County Recharge	Low
Transfer-Bethany Pipeline	Medium

A number of different approaches or strategies will meet the District's water supply reliability goals, but there are tradeoffs. Some projects perform better during droughts and a changed climate, but are expensive. Other projects may be relatively inexpensive, but do not contribute to drought reliability or are high risk. Some projects have significant benefits for the environment or other interests, but relatively little water supply benefit. Some projects types are preferred more than others by the community. Stakeholders all agree that 1) water supply reliability is important, 2) we should maximize water conservation, water reuse, and stormwater capture, and 3) we need to keep water rates affordable. Based on stakeholder input, technical analyses, and the climate of uncertainty, staff's recommendations are intended to provide a framework for balancing multiple needs and interests while making effective and efficient investment decisions.

Recommended Water Supply Strategy

The Board adopted the "Ensure Sustainability" strategy in 2012 as part of the Water Supply and Infrastructure Master Plan. The "Ensure Sustainability" strategy is comprised of three elements:

1) Secure existing supplies and infrastructure,
2) Expand the water conservation and reuse, and
3) Optimize the use of existing supplies and infrastructure.

Together these elements protect and build on past investments in water supply reliability, leverage those investments, and develop alternative supplies and demand management measures to manage risk and meet future needs, especially during extended droughts in a changing climate. Staff recommends that the Board continue with the "Ensure Sustainability" strategy, combined with the District's Asset Management and Infrastructure Reliability programs, as it provides a pathway to a sustainable water supply system. The following discussion describes the three elements of the recommended strategy and how different potential projects could support them.

1. <u>Secure Existing Supplies and Infrastructure</u>

   The District should secure existing supplies and facilities for future generations because they are, and will continue to be, the foundation of the county's water supply system. Existing supplies include about 55,000 acre-feet per year (AFY) of natural groundwater recharge, 85,000 AFY of local surface water supplies, about 20,000 AFY of recycled water, 55,000 AFY of San Francisco Public Utilities Commission (SFPUC) deliveries, and 160,000 AFY of combined Central Valley Project (CVP) and State Water Project (SWP) imported supplies. These baseline supplies are conveyed, treated, and stored in a complex and integrated system of water supply infrastructure.

Key ongoing projects and programs that support this strategic element include the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE), dam retrofits, pipeline maintenance and other asset management activities, and the Rinconada Water Treatment Plant Reliability Project. These and similar projects support securing our local supplies and infrastructure and are considered baseline projects.

Projects and programs that could support securing existing imported water supplies and infrastructure include:

- California WaterFix (SWP and/or CVP sides),
- Dry Year Options/Transfers,
- Sites Reservoir, and
- Water Contract Purchases.

Staff recommends that the Master Plan include at least 60,000 AFY of SFPUC deliveries and 150,000 AFY of CVP/SWP supplies. These numbers are based on modeling how much of these supplies are needed to meet a goal of meeting at least 80 percent of normal year demands in drought years and assume other elements of the recommended strategy are implemented.

The 60,000 AFY of SFPUC deliveries is within existing SFPUC contract amounts with its Santa Clara County customers, but may need to be revised based on how the State Water Resources Control Board implements recent changes to the Bay Delta Water Quality Control Plan. The Board decided to participate in California WaterFix on May 8, 2018, which would secure up to about 170,000 AFY of CVP/SWP water supplies.

2. Increase Water Conservation and Reuse

Master Plan analyses show that demand management, stormwater capture, and water reuse are critical elements of the water supply strategy. They perform well under current climate conditions and late century climate change. Water recycling and reuse provide local supplies that are not hydrologically dependent, so they are resilient to extended droughts when the District most needs additional supplies. They make efficient use of existing supplies, so they are sustainable and consistent with a "One Water" approach. In addition, these activities are broadly supported by stakeholders.

A more diverse portfolio of supplies will also be more resilient to risks and uncertainties, including climate change, than a portfolio with increased reliance on imported water supplies. Imported supplies are particularly vulnerable to climate change and regulatory actions like the Bay Delta Water Quality Control Plan. Furthermore, State policy, as stated in the Delta Reform Act of 2009 (Water Code Section 85021), is to "*reduce reliance on the Delta in* *meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. Each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts*."

The analysis for the Master Plan assumes that non-potable recycled water use will increase by about 13,000 AFY consistent with projections in the water retailers' 2015 Urban Water Management Plans and that long-term water conservation programs will achieve 99,000 AFY of savings by 2030. Other programs and projects that contribute to increasing water reuse and conservation include:

- Countywide Water Reuse Master Plan Projects,
- Local Land Fallowing,
- Morgan Hill Recycled Water,
- No Regrets Package of Water Conservation and Stormwater Capture Projects,
- Potable Reuse: Ford Pond,
- Potable Reuse: Injection Wells,
- Potable Reuse: Los Gatos Ponds,
- Refinery Recycled Water Exchange,
- Bay Area Brackish Water Treatment, and
- Stormwater: Saratoga #2.

Staff plans to include the "No Regrets" package of water conservation and stormwater projects in the Master Plan. The Board approved moving this package of projects into planning in September 2017 and the FY 19 budget includes $1 million for beginning implementation of the "No Regrets" package. Attachment 3, a memo presented to the Board's Water Conservation and Demand Management Committee on October 31, 2018, describes the implementation approach for the "No Regrets" package. The "No Regrets" package should reduce future demands by about 10,000 AFY and increase water supplies by about 1,000 AFY by 2040.

Staff recommends that the Master Plan include at least 24,000 AFY of additional reuse by 2040. This could be potable reuse and/or non-potable recycled water (purple pipe). Staff believes that additional reuse, along with the "No Regrets" package, is vital to the long-term sustainability of water supply reliability in the county. As described above, water reuse and conservation are local drought resistant supplies that are resilient to climate change.

The Board approved pursuing a public-private partnership for up to 24,000 AFY of potable reuse (with Los Gatos Ponds as the likely location) in December 2017. Like other major projects being considered, there are challenges and uncertainty with this project. However, there are alternatives to the project and there is time to address the challenges. Additional water reuse projects, both potable and non-potable, and governance options will be evaluated through the Countywide Water Reuse Master Plan, which is scheduled for completion in 2019.

A pre-feasibility study of the Refinery Recycled Water Exchange project is scheduled for completion in Winter 2018. The Refinery Recycled Water Exchange project would be a partnership with Central Contra Costa Sanitary District and Contra Costa Water District that would increase recycled water deliveries in Contra Costa County and provide in-lieu surface water to the District.

3. Optimize the Use of Existing Supplies and Infrastructure

This element of the strategy includes projects that increase the District's ability to use existing supplies and infrastructure. The District's existing supplies are more than sufficient to meet current and future needs in wet and above normal years. In some years, supplies exceed needs and additional facilities would increase flexibility and the ability to use or store those excess supplies. Additional infrastructure could increase the District's ability to respond to outages and respond to challenges such as droughts and water quality problems. Projects that support this element of the recommended water supply strategy include:

- Anderson Reservoir Expansion,
- Calero Reservoir Expansion,
- Church Avenue Pipeline,
- Groundwater Banking,
- Lexington Pipeline,
- Los Vaqueros Reservoir Expansion,
- North County Recharge,
- Pacheco Reservoir Expansion,
- South County Recharge: Butterfield Channel,
- South County Recharge: San Pedro Ponds,
- South County Water Treatment Plant,
- Transfer-Bethany Pipeline portion of Los Vaqueros Reservoir Expansion,
- Uvas Pipeline, and
- Uvas Reservoir Expansion.

Staff is planning to include a South County recharge project (either Butterfield Channel or San Pedro Ponds) in the Master Plan, because groundwater modeling indicates the need for additional recharge capacity. Pacheco Reservoir is consistent with the Board's priority to actively pursue efforts to increase water storage opportunities. Both the Transfer-Bethany Pipeline portion of the Los Vaqueros Reservoir Expansion and the Pacheco Reservoir Expansion increase the District's water supply operations flexibility and increase emergency water storage. The State, in approving funding of at least half the Pacheco Reservoir Expansion and Los Vaqueros Reservoir Expansion projects' construction costs (in 2015$), recognized those projects also provide ecosystem improvements, recreation opportunities, and/or flood protection benefits.

The three projects - South County Recharge, Pacheco, and Transfer-Bethany Pipeline - would provide a combined average annual yield of about 5,000 AFY, increase system flexibility, and/or emergency supply.

In summary, staff is recommending that the Board reaffirm the “Ensure Sustainability” strategy, because it:

- Protects existing assets,
- Leverages past investments,
- Meets new demands with water reuse and conservation,
- Supports “One Water” approach,
- Develops local and regional supplies to reduce reliance on the Delta,
- Increases flexibility, and
- Increases resiliency to climate change.

The three elements of the recommended strategy work together to provide a framework for providing a sustainable and reliable water supply. Furthermore, they strike a balance between protecting what we have, investing for the future, and making the most of the water supply system.

Water Supply Reliability Level of Service Goal

The water supply reliability level of service goal is important because it guides long-term water supply planning efforts and informs Board decisions regarding investments. The current level of service, which was approved by the Board in June 2012, is an interpretation of Board Policy E-2 that “there is a reliable, clean water supply for current and future generations.” The current goal is to “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.” Staff is recommending a water supply reliability level of service goal to “develop water supplies designed to meet 100 percent of demands identified in the Master Plan in non-drought years and at least 80 percent of average annual water demand in drought years.”

Staff recommends using the Master Plan demand projection because it is closer to historic trends than the Urban Water Management Plan projection and will be reviewed and updated annually as part of Master Plan monitoring. Staff recommends updating the level of service goal for planning for drought reliability to meeting 80 percent of demands because it strikes a balance between minimizing shortages and the costs associated with the higher level of service. Furthermore, the community was able to reduce water use as much as 28 percent in 2015, indicating that shortages in the range of 20 percent are manageable. The recommendation for reducing the level of service to meeting 80 percent of demands in droughts is consistent with the following:

- **April 2017 Telephone Survey of Santa Clara County Voters re: Water Conservation**: The survey results (Attachment 4) indicate that voters see the need to invest in a more reliable water supply and the majority are open to small rate increases, but oppose large increases.
- **Stakeholder Input**: Staff conducted two stakeholder workshops in January 2018 (Attachment

5). During the workshops, staff discussed an interim level of service goal of meeting 85 percent of demands in drought years. Some stakeholders were interested in a lower level of service goal with planned mandatory water use restrictions to force more efficient water use. Others expressed interest in a lower level of service goal to reduce costs. Others thought the interim level of service goal was about right, and one retailer preferred the existing Board-approved goal. Stakeholders were concerned about overinvesting and impacts on water rates and affordability.

- **Incremental Costs**: The incremental costs of increasing the level of service from meeting 80 percent of demands in drought years to meeting 90 percent of demands in drought years exceed the value of benefits achieved by the increase. The present value lifecycle cost (in 2017 dollars) of additional projects that are needed to increase the level of service from 80 percent to 90 percent range from about $90 million to over $450 million. However, the present value (in 2017 dollars) of the benefits of fewer shortages over the lifecycle of the projects range from $0 to about $300 million. In other words, few projects provide incremental benefits that are worth the incremental cost of increased reliability.
- **Frequency of Shortage**: Modeling indicates that most scenarios that achieve the recommended level of service goal have shortages in less than 10 percent of years. Scenarios that meet 90 percent of demands in droughts years typically have shortages in less than five percent of years, which is a very high level of water supply reliability. By comparison, the District has called for mandatory water use reductions in about 30 percent of the last 30 years.
- **Planning for Uncertainty:** The water supply planning model evaluates water supply conditions under a variety of scenarios, but it cannot anticipate every potential scenario and there is inherent uncertainty in projections. For example, staff is using a demand projection that is based on current water use trends and growth projections. State efforts on “making water conservation a California way of life” or initiatives like Climate Smart San Jose could drive water use lower. On the other hand, climate change could result in more extended droughts, which continue to be our greatest water supply challenge. The recommended level of service strikes a balance between overinvesting in new supplies that may not be needed and underinvesting in supplies needed to manage future extreme conditions. In addition, uncertainty will be managed through annual review of the Master Plan and its assumptions and periodic updates to reflect changed conditions.
- **Regional Agencies’ Goals:** Staff reviewed the water supply reliability goals for other Bay Area water agencies, including Alameda County Water District, Zone 7 Water Agency, East Bay Municipal Utility District, Contra Costa Water District, San Francisco Public Utilities Commission, and Marin Municipal Water District. The water supply reliability level of service goals for these agencies ranged from meeting 75 percent to 90 percent of demands during droughts, with the median being 85 percent.

Agency	**District Equivalent**
Alameda County Water District	Meet at least 90% of demands during droughts
Zone 7 Water Agency	Meet at least 85% of demands during droughts
East Bay Municipal Utility District	Meet at least 85% of demands during droughts

Contra Costa Water District	Meet at least 85% of demands during droughts
San Francisco Public Utilities Commission	Meet at least 80% of demands during droughts
Marin Municipal Water District	Meet at least 75% of demands during droughts

Staff previously evaluated goals of 80, 85, and 90 percent as part of the Master Plan update. The projects, and therefore costs, needed to achieve the 80 and 85 percent levels of reliability were almost the same in numerous scenarios that were evaluated. However, increasing the level of reliability from 80 or 85 percent to 90 percent required significant additional investment. Staff is recommending the 80 percent level of reliability rather than 85% because it better aligns with the Water Shortage Contingency Plan (WSCP) stages in the "Making Water Conservation a California Way of Life" legislation, the Board's current call for a 20 percent reduction in water use compared to 2013, and was exceeded during 2015.

The recommended level of service is intended to be used for long-term planning purposes and guiding associated long-term investments. While long-term planning considers a range of hydrologic conditions, uncertainties, and risks, the actual level of service in a particular year will depend on actual conditions and could be affected by hydrologic conditions, short-term outages, and extreme situations.

The Water Conservation and Demand Management Committee concurred with staff's recommended updates to the level of service goal at its June 25, 2018 meeting. The Committee did request that staff further elaborate on the State water conservation requirements and uncertainty and their relationship with the level of service goal. That is part of the monitoring and assessment plan discussed below.

The projects already approved by the Board for planning (California WaterFix (SWP and CVP), 24,000 AFY of reuse, the "No Regrets" package of additional water conservation and stormwater capture projects, Transfer-Bethany Pipeline, and Pacheco Reservoir), along with South County Recharge, exceed the recommended level of service goal. However, it is unlikely that all the projects would be implemented and delivering their assumed benefits by Year 2040, the planning horizon for this Master Plan. Staff also evaluated a subset of the potential Master Plan projects (SWP side of California WaterFix (no CVP side), 24,000 AFY of reuse, the "No Regrets" package, and South County Recharge). This subset of projects, as well as others, meets the recommended level of service goal. The present value of the lifecycle benefits range from about $2.48 billion to $2.7 billion. The present value lifecycle costs (2017$) to the District from the two scenarios range from about $1.6 billion to $2.45 billion.

The water rate impacts associated with different scenarios are not included at this point because the impacts depend on the timing of project implementation and the project funding mechanisms. Additional information on the range of potential water rate impacts will be included in the draft Water Supply Master Plan 2040 report, along with a schedule for project implementation. It is important to note that not all the Master Plan projects need to be implemented in the near future. Project phasing will allow the District to implement projects to align with supply and demand projections, as well manage cash flow and impacts on rates.

Scenario	Without Projects (Basecase)	With Some Projects Approved for Planning	With All Projects Approved for Planning
Minimum Drought Reliability	Meets 50% of demands	Meets 80% of demands	Meets 90% of demands
Present Value Benefits (2017$)	Not applicable	$2,480,000,000	$2,700,000,000
Present Value Cost to District (2017$)	Not applicable	$1,600,000,000	$2,450,000,000
Benefit:Cost Ratio	Not applicable	1.6	1.1

Monitoring and Assessment Plan (MAP) Approach

A primary purpose of the Master Plan is to inform investment decisions. Therefore, a critical piece of the water supply plan is a process to monitor and report to the Board on the demands, supplies, and status of projects and programs in the Master Plan so the Board can use that information in its annual strategic planning sessions, which inform the annual water rate setting, Capital Improvement Program (CIP), and budget processes. Monitoring will identify where adjustments to the Master Plan might be needed to respond to changed conditions. Such adjustments could include accelerating and delaying projects due to changes in the demand trend, changing projects due to implementation challenges, adding projects due to lower than expected supply trends, etc. This section describes the Monitoring and Assessment Plan (MAP) approach for the Master Plan.

The first step in the MAP is to develop an implementation schedule for the Master Plan based on Board direction on the recommended water supply strategy and Master Plan projects. The implementation schedule will consider how projects should be timed to meet reliability goals, costs, cash flow, rate impacts, and other needs and opportunities. The schedule will include anticipated start and completion dates for planning, permitting design, and construction, and major decision points. Staff will monitor the status of all these components and plans to report to the Board on Master Plan implementation at least annually.

The second step of the MAP is to manage unknowns and risks through regular monitoring and assessment. Master Plan monitoring and assessment will build on regular reports on projects and annual water supply conditions and will look at how all the different deviations from schedule affect the long-term water supply reliability outlook. Staff will also evaluate how changing external factors such as changes in policy, regulations, and scientific understanding affect the long-term water supply reliability outlook. Examples of external factors include policies and regulations affecting the Delta (e.g., Bay Delta Water Quality Control Plan) and land use decisions.

Another external factor that the District will be monitoring closely is the state's effort to make water conservation a California way of life. There are various components to the effort, including requiring that all urban water retailers in the state establish an urban water use objective (i.e. a water budget for their service area). Much of the methodology on how to calculate that objective will be determined over the next few years, so it is still to be determined how that may affect the District's long-term water supply reliability outlook. However, the District already has an aggressive water conservation target out to 2030 that will be further expanded with implementation of the No Regrets package of projects. Staff estimates that water conservation savings will be equivalent to over 20 percent of what water use would be in 2040 without conservation savings.

Staff will also identify and monitor the status of projects that could serve as alternative projects should changes to the Master Plan be needed. Examples of such projects include Sites Reservoir, groundwater banking, and shallow groundwater reuse. Staff will also continue to track and participate in projects currently in development, such as the Refinery Recycled Water Exchange project. Ideally, the District will be able to keep all project opportunities open at minimum cost. Realistically, keeping some opportunities open will be costly.

The third step of the MAP is to report to the Board on Master Plan implementation on at least an annual basis, usually during the summer. In addition, the Board will receive reports on specific projects and pertinent policy and regulatory developments as needed. If changes to or decisions about the Master Plan, Master Plan projects, or other projects appear needed, staff will develop recommendations for the Board based on how decisions would affect the level of service, costs and rate impacts, risk management, and relationships between projects. Staff will also describe how projects relate to each other and stakeholder input. The intent is for staff to provide as complete a picture as possible to inform the Board's strategic planning and investment decisions and to incorporate the Board's decisions into the CIP, budget, and water rate setting processes.

The fourth step of the Map is to adjust projects as necessary upon approval by the Board. It is more likely than not that projects, both existing and new projects, will evolve and change over time. The path we are on today will look different in the future, near and distant. We cannot forecast the future and identify a specific response for every possible scenario. However, having a balanced, diverse, and sustainable water supply will help us adapt to future challenges and a strong monitoring and assessment plan (MAP) will help us stay on top of challenges and uncertainties and our options for managing them.

This paragraph illustrates how the MAP would work, in the context of the Master Plan's inclusion of 24,000 AFY of reuse. The placeholder project for implementing the 24,000 AFY of reuse is the Los Gatos Ponds Potable Reuse Project, which has a current CIP construction estimate of about $215 million (District share of construction cost; private partner would pay difference) and a completion date of 2027, followed by P3 water service agreement costs and post-P3 agreement term operations, maintenance, and replacement costs. If the Master Plan were prepared today, staff would use the CIP budget and schedule, as well as estimated post-construction costs, in Step 1 of the MAP - developing the implementation schedule. Step 2 would include ongoing evaluation of the project in light of ongoing discussions with wastewater producers, the Countywide Water Reuse Master Plan, the Recycled Water Exchange Pre-Feasibility Study and other potential reuse project analyses, and the Board's direction on water rates. As part of Step 3, staff would report to the Board on the status of the Los Gatos Ponds Potable Reuse Project and other projects, as well water supplies, demands, financial considerations, any pertinent regulatory changes, etc. Based on the information, staff could recommend that the Board adjust the scope, schedule, and/or budget for the Los Gatos Ponds project or consider alternative projects. For example, if demands remain low, finances are a concern, and/or there is a lack of progress securing wastewater for treatment, the Board could choose to delay the project. Based on the Board's direction, staff would adjust the CIP, budget, and water rate forecast as part of Step 4 of the MAP. Then, the annual MAP process would restart. This same analysis would be performed for all the projects in the Master Plan on at least an annual basis.

Next Steps

The next steps for the Master Plan are to prepare a draft Master Plan 2040 based on Board direction. Staff anticipates having a draft Master Plan ready for Board and stakeholder review in March 2019. The intent is to have at least two workshops - one with water retailers and one with other stakeholders. Additional presentations may be made at Board advisory committees. Staff plans to present a final Master Plan to the Board in June 2019.

Staff anticipates returning to Board in the next six months on several projects that are currently in development and will require Board deliberation on next steps. These projects include, but are not limited to, Sites Reservoir, Los Vaqueros Reservoir, and California WaterFix Long-Term Transfers. Staff will incorporate the Board's input on the Master Plan's water supply strategy and level of service into these presentations.

FINANCIAL IMPACT:
There is no financial impact associated with this item. The water supply reliability level of service goal and water supply strategy help inform Board investment decisions but do not commit the District to a specific course of action regarding projects. Rather, it affirms the District's commitment to balance the costs and benefits of investments in long-term water supply reliability.

CEQA:
The recommended action does not constitute a project under CEQA because it does not have a potential for resulting in direct or reasonable foreseeable indirect physical change in the environment. The water supply reliability level of service goal and water supply strategy help inform Board investment decisions, but do not commit the District to a specific course of action regarding projects. All projects that are planned for implementation will go through environmental review consistent with CEQA.

ATTACHMENTS:
Attachment 1: Risk Ranking Report
Attachment 2: Project List
Attachment 3: No Regrets Memo
Attachment 4: 2017 Survey Results
Attachment 5: 2018 Stakeholder Workshops Summary

Attachment 6: PowerPoint

UNCLASSIFIED MANAGER:
Jerry De La Piedra, 408-630-2257

Appendix H – Project List

Project List (as of February 2019)

Water Supply Master Plan 2040
Project List (as of February 2019)

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Anderson Reservoir Expansion: Increases reservoir storage by 100,000 AF to about 190,000 AF, increasing Valley Water's ability to capture and store local runoff. Planning for reconstruction of Anderson Reservoir to meet seismic standards is currently underway. Consideration of also expanding the reservoir would likely delay the required work.	Inactive	$1.2 billion	10,000	$5,300	TBD
Bay Area Brackish Water Treatment/Regional Desalination: Secures a partnership with other Bay Area agencies to build a brackish water treatment plant in Contra Costa County. Valley Water would receive up to 5 MGD of water in critical dry years. There are concerns permitting and the availability of water rights during dry periods when such a facility would be most needed. This project will require collaboration among multiple agencies and requires partners for moving forward.	Active	$80 million	1,000	$2,900	TBD

[1] Project status is either "Master Plan Project" for projects in the Water Supply Master Plan 2040, "Active" for projects where there is ongoing Valley Water activity and the project could be an alternative project for the Water Supply Master Plan, or "Inactive" for projects that could be potential future projects.
[2] Valley Water Lifecycle Cost (Present Value, 2018$) includes capital, operations, maintenance, rehabilitation, and replacement costs, as applicable, for a 100-year period, discounted back to 2018 dollars. Only Valley Water costs, after grants and other funding sources, are included. All costs are subject to change pending additional planning and analysis.
[3] The average annual yield of many projects depends on which projects they are combined with and the scenario being analyzed. For example, groundwater banking yields are higher in portfolios that include wet year supplies. Similarly, they would be lower in scenarios where demands exceed supplies and excess water is unavailable for banking.
[4] Valley Water staff complete risk ranking analyses in September 2017 and December 2018. Not all the potential projects were included in the analysis. "TBD" indicates the project was not included in either of the risk ranking analyses.

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Calero Reservoir Expansion: Expands Calero Reservoir storage by about 14,000 AF to 24,000 AF. Planning and design for Calero Reservoir Seismic Retrofit project is currently underway. Consideration of also expanding the reservoir would likely delay the required work.	Inactive	$180 million	3,000	$2,300	TBD
Church Avenue Pipeline: Diverts water from the Santa Clara Conduit to the Church Avenue Ponds. The Morgan Hill recharge projects provide the same or better yields at a lower cost.	Inactive	$31 million	1,000	$900	TBD
Conservation Rate Structures: Many retailers implement conservation rate structures. Given recent court rulings on rate structure, retailers are reluctant to add new conservation rate structures at this time	Inactive	TBD	TBD	TBD	TBD
Countywide Water Reuse Master Plan: Valley Water is working with local recycled water producers, retailers, and other stakeholders to develop a Countywide Water Reuse Master Plan (CWRMP) that will address key challenges in potable water reuse, including: (1) identification of how much water will be available for potable reuse and non-potable recycled water expansion, (2) evaluation of system integration options, (3) identification of specific potable reuse and recycled water projects, and (4) development of proposals for governance model alternatives including roles and responsibilities. The plan, which is scheduled to be completed in 2020, may identify additional reuse opportunities to incorporate into the Water Supply Master Plan.	Active	TBD	TBD	TBD	TBD

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Delta Conveyance Project (formerly known as California WaterFix): Constructs alternative conveyance capable of diverting up to 9,000 cubic feet-per-second from the Sacramento River north of the Delta and delivering it to the SWP pumps at the southern end of the Delta. The goal is to reduce impacts of diversions, help maintain existing deliveries, improve the ability to do transfers, help adapt to changing precipitation and runoff patterns, and protect water quality from sea level rise. The project has significant implementation complexity and stakeholder opposition. The State is currently revising the project from two tunnels down to one tunnel. A new project description is forthcoming.	Master Plan Project	$630 million	41,000	$600	High - Extreme
Del Valle Reoperations: This project, as currently envisioned, would allow for more storage in Lake Del Valle, a State Water Project facility in Del Valle Regional Park that is operated by East Bay Regional Park District. The benefits of the additional storage are primarily related to operational flexibility and water quality. The project may not increase long-term water supply yields or drought year yields.	Inactive				TBD
Dry Year Options / Transfers: Provides 12,000 AF of State Water Project transfer water during critical dry years through long-term agreements. Amount can be increased or decreased. There are uncertainties with long-term costs and ability to make transfers in critical dry years. Short-term water transfers and exchanges are part of routine Valley Water imported water operations.	Inactive	$100 million	2,000	$1,400	Low

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Groundwater Banking: Provides up to 120,000 AF of banking capacity for Central Valley Project and State Water Project contract water. Sends excess water to a groundwater bank south of the Delta during wet years and times of surplus for use during dry years and times of need. Amount could be increased or decreased. There are uncertainties with the ability to make transfers in critical dry years and Sustainable Groundwater Management Act implementation.	Active	$75 million	2,000	$1,300	Low
Lexington Pipeline: Constructs a pipeline between Lexington Reservoir and the raw water system to provide greater flexibility in using local water supplies. The pipeline would allow surface water from Lexington Reservoir to be put to beneficial use elsewhere in the county and increase utilization of existing water rights, especially in combination with the Los Gatos Ponds Potable Reuse project. In addition, the pipeline will enable Valley Water to capture some wet-weather flows that would otherwise flow to the Bay. Water quality issues would require pre-treatment/management. An institutional alternative could include an agreement to use some of Valley Water's Lexington Reservoir water right at San Jose Water Company's Montevina Water Treatment Plant.	Inactive	$85 million	3,000	$1,000	Low
Local Land Fallowing: Launches program to pay growers not to plant row crops in critical dry years. This would primarily save water in the South County. The South County recharge projects have similar or greater yields at a lower cost and are more consistent with County land use policy and grower interests.	Inactive	$50 million	1,000	$2,400	TBD

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Los Vaqueros Reservoir: Secures an agreement with Contra Costa Water District and other partners to expand the off-stream reservoir by 115 TAF (from 160 TAF to 275 TAF) and construct a new pipeline (Transfer-Bethany) connecting the reservoir to the South Bay Aqueduct. Assumes Valley Water's share is 30 TAF of storage, which includes an emergency storage pool of 20 TAF for use during droughts. Would require funding and operating agreements with multiple parties, likely including formation of a Joint Powers Authority.	Active	$131 million	3,600	$1,200	Medium
Morgan Hill Recycled Water: Constructs a 2.25 MGD scalping plant in Morgan Hill. Would need to replace a lower cost recycled water project in Gilroy due to capacity constraints on the system.	Inactive	$85 million	3,000	$1,100	TBD
Additional Conservation and Stormwater Projects and Programs	Master Plan Project	$60 million	11,000	$200	Medium
Advanced Metering Infrastructure (AMI): Implements a cost share program with water retailers to install AMI throughout their service area. AMI would alert customers of leaks and provide real-time water use data that allows users to adjust water use.		$20 million	4,000	$100	Low
Graywater Rebate Program Expansion: Expand Valley Water's existing rebate program for laundry-to-landscape graywater systems. Potentially could include a direct installation program and/or rebates for graywater systems that reuse shower and sink water.		$1 million	< 1,000	$3,300	Low
Leak Repair Incentive: Provides financial incentivizes homeowners to repair leaks.		$1 million	< 1,000	$9,200	Low

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
New Development Model Ordinance: Encourages municipalities to adopt an ordinance for enhancing water efficiency standards in new developments. Components include submetering multi-family residences, onsite water reuse (rainwater, graywater, black water), and point-of use hot water heaters.		$2 million	5,000	$100	Medium
Stormwater - Agricultural Land Recharge: Flooding or recharge on South County agricultural parcels during the winter months.		$10 million	1,000	$1,000	Low
Stormwater - Rain Barrels: Provides rebates for the purchase of a rain barrels.		$10 million	< 1,000	$17,900	Low
Stormwater - Rain Gardens: Initiates a Valley Water rebate program to incentivize the construction of rain gardens in residential and commercial landscapes.		$10 million	< 1,000	$3,000	Low
Stormwater - San Jose: Constructs a stormwater infiltration system in San Jose. Assumes 5 acres of ponds. Potential partnership with City of San Jose.		$3 million	1,000	$100	Low
Stormwater – Saratoga #1: Constructs a stormwater infiltration system in Saratoga. Assumes 5 acres of ponds. Assumes easement rather than land purchase. Close to Stevens Creek Pipeline, so could also potentially be used as a percolation pond.		$3 million	< 1,000	$1,100	Low

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Pacheco Reservoir: Through a partnership with Pacheco Pass Water District, San Benito County Water District (SBCWD), and potentially other partners, Valley Water will enlarge Pacheco Reservoir from about 6,000 AF to about 140,000 AF and connect the reservoir to the San Felipe Division of the CVP. The primary water sources to fill the expanded reservoir would be natural inflows from the North and East Forks of Pacheco Creek. Supplemental flows to the expanded reservoir would arrive from Valley Water's SBCWD's share of contracted CVP pumped water from San Luis Reservoir. The project will be operated to provide water for fisheries downstream of the reservoir and increase in-county storage. Other potential benefits could include managing water quality impacts from low-point conditions in San Luis Reservoir and downstream flood protection. The project will also deliver water to up to eight south-of-Delta wildlife refuges in Merced County. Potentially significant environmental and cultural resource impacts.	Master Plan Project	$340 million	6,000	$2,000	Medium
Potable Reuse – Ford Pond: Constructs potable reuse facilities for 4,000 AFY of groundwater recharge capacity at/near Ford Ponds. Potable reuse water is a high-quality, local drought-proof supply that is resistant to climate change impacts. The project would require agreements with the City of San Jose and may require moving existing water supply wells.	Inactive	$295 million	3,000	$2,800	Medium
Potable Reuse – Injection Wells: Constructs potable reuse facilities for 15,000 AFY of groundwater injection capacity. Potable reuse water is a high-quality, local drought-proof supply that is resistant to climate change impacts. The injection wells could be constructed in phases and be connected to the pipeline carrying purified water to the Los Gatos Ponds. The project would require agreements with the City of San Jose and reverse osmosis concentrate management. Injection well operations are more complex than recharge pond operations.	Inactive	$1.2 billion	12,000	$3,100	High

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Potable Reuse - Los Gatos Ponds: Involves purifying water at an expanded Silicon Valley Advanced Water Purification Center in Alviso, pumping the water to Campbell, and using the purified water for groundwater recharge in the existing ponds along Los Gatos Creek. Potable reuse water is a high-quality, local drought-proof supply that is resistant to climate change impacts. Assumes up to 24,000 AFY of advanced treated recycled water would be available for groundwater recharge at existing recharge ponds in the Los Gatos Recharge System. Some of the outstanding issues with the project are reverse osmosis concentrate management and agreements with the City of San Jose or another wastewater provider.	Master Plan Project	$1.2 billion	19,000	$2,000	Medium
Refinery Recycled Water Exchange: Central Contra Costa Sanitary District (Central San) is a wastewater agency in Contra Costa County. It currently produces about 2,000 acre-feet per year (AFY) of recycled water, but has wastewater flows that could support more than 25,000 AFY of recycled water production. The conceptual program would involve delivering recycled water to two nearby refineries that are currently receiving about 22,000 AFY of CCWD Central Valley Project (CVP) water; in exchange Valley Water would receive some of CCWD's CVP water.	Active	TBD	11,000	TBD	TBD
Retailer System Leak Detection/Repair: Recent legislation requires retailers to complete annual water loss audits, which will then be used by the State to establish water loss standards. Staff will reconsider this alternative after the standards are developed.	Inactive	TBD	TBD	TBD	TBD
Saratoga Recharge: Constructs a new groundwater recharge facility in the West Valley, near the Stevens Creek pipeline. Would help optimize the use of existing supplies. Land availability and existing land uses limit potential project locations.	Inactive	$50 million	1,000	$1,300	Low

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Shasta Reservoir Expansion: A Feasibility Study and Environmental Impact Statement have been completed for a Shasta Reservoir Expansion. The United States Bureau of Reclamation concluded the project is technically feasible, and is conducting preliminary investigations. State law prohibits Prop 1 storage funding for the project and restricts funding for any studies. Staff will continue to monitor opportunities related to Shasta Reservoir Expansion. US Fish & Wildlife Service recommended against the project in 2014 because it would fail to protect endangered salmon in the Sacramento River. The State sued Westlands Water District for working on the EIS and planning studies. The judge has since ordered Westlands Water District to stop work and ruled that it violated state law for working on projects that would adversely affect the McCloud River. Westlands Water District has appealed the decision.	Incctive	TBD	TBD	TBD	TBD
Sites Reservoir: Establishes an agreement with the Sites JPA to build an off-stream reservoir (up to 1,800 TAF) north of the Delta that would collect flood flows from the Sacramento River and release them to meet water supply and environmental objectives. The project would be operated in conjunction with the SWP and CVP, which improves flexibility of the statewide water system but would be subject to operational complexity.	Active	$250 million	8,000	$1,200	High

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Shallow Groundwater Reuse: A feasibility study for the recovery and beneficial use of shallow groundwater was completed in 2009. Although potential sites for shallow groundwater reuse were identified, staff has identified several concerns. These concerns include water quality, sustainable yields, and lack of infrastructure for storage and conveyance. In addition, several reuse sites are in areas where recycled water is already delivered for non-potable use. Valley Water will new opportunities as they arise.	Inactive	TBD	TBD	TBD	TBD
South County Recharge – Butterfield Channel: Extends the Madrone Pipeline from Madrone Channel to Morgan Hill's Butterfield Channel and Pond near Main Street. Would help optimize the use of existing supplies. Would need to be operated in conjunction with the City's stormwater operations.	Master Plan Project	$10 million	2,000	$400	Low
South County Recharge - San Pedro Ponds: Implements a physical or institutional alternative to enable the ponds to be operated at full capacity without interfering with existing septic systems in the vicinity.	Active	$10 million	1,000	$400	TBD
South County Water Treatment Plant: Provides in-lieu groundwater recharge by delivering treated surface water to the Cities of Morgan Hill and Gilroy. Would require a connection to the Santa Clara Conduit or other raw water pipeline and pipelines from the plant to the cities' distribution systems. Valley Water owns two properties that could potentially be used for this project. The South County recharge projects provide similar benefits at significantly lower cost.	Active	$112 million	2,000	$2,400	TBD

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Stormwater – Saratoga #2: Constructs a stormwater infiltration system on a parcel in Saratoga. Assumes 5 acres of ponds. Currently zoned as ag land; assumes land purchase. About 0.6 miles from the Stevens Creek Pipeline. The cost-effectiveness is low due to the land purchase requirement. Other stormwater projects are included in the "No Regrets" package.	Inactive	$50 million	<1,000	$10,700	TBD
Temperance Flat Reservoir: Temperance Flat Reservoir would be located upstream of Friant Dam on the San Joaquin River. Staff's current analysis is that any water supply benefits to Valley Water from the project would be indirect, largely manifested by lowered requirements for Delta pumping for delivery to the San Joaquin Exchange contractors at the Delta-Mendota Pool.	Inactive	TBD	TBD	TBD	TBD
Transfer-Bethany Pipeline: The pipeline will connect Contra Costa Water District's (CCWD's) system to Bethany Reservoir, which serves the South Bay Aqueduct and the California Aqueduct. This project will enable Valley Water to receive Delta surplus supplies and some contract supplies through CCWD's system in the Delta instead of (or in addition to) the CVP and SWP pumps in the southern Delta. This will increase reliability and flexibility for Valley Water. The project would also facilitate other potential regional projects. Would provide an alternative to through-Delta conveyance of supplies from projects such as the Bay Area Brackish Water Treatment and Refinery Recycled Water Exchange projects. Also, it would facilitate conveyance of Delta surplus supplies or transfers from CCWD and East Bay Municipal Utility District. The pipeline is one element of the larger Los Vaqueros Reservoir Expansion Project, which is partnership between CCWD, Valley Water, and agencies in the Bay Area and Central Valley. Would require funding and operating agreements with multiple parties, likely including formation of a Joint Powers Authority.	Master Plan Project	$78 million	3,500	$700	Medium

Project	Project Status[1]	District Lifecycle Cost (Present Value, 2018)[2]	Average Annual Yield (AFY)[3]	Cost/AF	Relative Risk[4]
Uvas Pipeline: Captures excess water (e.g., water that would spill) from Uvas Reservoir and diverts the water to Church Ponds and a 25 acre-foot pond near Highland Avenue. The new pond would be adjacent to and connected by a pipe to West Branch Llagas Creek. The South County recharge projects provide similar or better yields at a lower cost.	Inactive	$90 million	1,000	$2,600	TBD
Uvas Reservoir Expansion: Would expand Uvas Reservoir by about 5,100 AF to 15,000 AF, reducing reservoir spills. Project would be located on Uvas Creek, which currently provides good steelhead habitat. Other water storage options under consideration provide better yield for the cost.	Inactive	$330 million	1,000	$20,500	TBD
Water Contract Purchase: Purchase 20,000 AF of SWP Table A contract supply from other SWP agencies. Would increase reliance on the Delta and be subject to willing sellers' availability. Could also include Long-Term Transfers being considered along with California WaterFix.	Active	$365 million	12,000	$800	Medium

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Valley Water

Clean Water • Healthy Environment • Flood Protection

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