

Montecito Water District

Water Supply Optimization Plan



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and
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June, 2005



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LETTER OF SUBMITTAL

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June 7, 2005

Board of Directors
Montecito Water District
583 San Ysidro Rd
Santa Barbara, CA 93108

Re: Transmittal of report entitled *Montecito Water District – Water Supply Optimization Plan*

Dear Directors:

Transmitted herewith is a report entitled *Montecito Water District – Water Supply Optimization Plan* prepared pursuant to your authorization dated July 20, 2004. The report presents plans for integrating the operations of existing sources of water supply (i.e. Jameson Reservoir/Doulton Tunnel, groundwater, Cachuma Reservoir, and the State Water Project) to achieve satisfaction of future water demands at the least cost. These plans have been developed for levels of annual demand of 6,000 (approximately present demand), 7,000 and 8,000 acre-feet. As demand rises, so does the cost of supply alternatives to meet that demand.

It is found that with the recurrence of water supply conditions of the 1986-91 drought period, there would be a shortfall in water supply of about 1,250 acre-feet per year under current demand. This shortfall can be eliminated by storage (banking) of excess State water during wet years in Cachuma Reservoir prior to the drought, as has been undertaken in the past few years.

Because of the frequency of spilling of Cachuma Reservoir and loss of stored water, alternative groundwater banking options both within and outside of Santa Barbara County should be investigated as well as the possibility of dry-year purchases of water from northern California districts.

It was further found that use of water is increasing within the District both from a greater use on presently developed properties and from additional development. A water conservation plan should be prepared which among its elements should include a program of public education and awareness to encourage reduction of usage during drought periods and to mitigate the continuing increase in overall consumer water use.

Implementation of the plans set forth herein should help provide sufficient water to satisfy the water demands of Montecito Water District for the foreseeable future.

Thank you for the opportunity of preparing this report on your behalf.

Sincerely,

Steven Bachman

EXECUTIVE SUMMARY

This study formulated a water supply plan for Montecito Water District (MWD) which prioritized use of MWD's various sources of supply, determined optimal operation of Cachuma and Jameson reservoirs, addressed the need for storage of State Water outside of the District, and examined possible costs of alternative sources of dry year supplies and storage (banking) options. The study determined that banking and/or alternative dry-year supplies are likely required during drought periods at demand levels of 6,000 acre-feet per year (AFY) or so, a demand level that MWD has now exceeded. Storage of unused portions of MWD's State Water allocation appears to provide sufficient drought supply as MWD average demand reaches 7,000 AFY, depending upon the storage project. If demand levels increase above 7,000 AFY, then additional water supplies must be purchased to bring bank storage to appropriate levels.

The Santa Ynez River Model, used by Santa Barbara County Water Agency for a number of tasks ranging from modeling Cachuma operations to determining fish flows in the Santa Ynez River, was used as the basis for much of the analysis of reservoir operating methods and supply reliability in this study. The existing model uses historic hydrologic data for the Santa Ynez watershed for the period October 1917 through September 1993, and superimposes the various water resource facilities and policies on the hydrology. The model is coupled with results from a similar model for northern California that predicts State Water availability. The Santa Ynez River model was enhanced in this study to include more details of MWD facilities on both the Santa Ynez River and Montecito sides of the mountains. The model period includes both the last drought period and a more-severe drought period during the 1920s. Thus, the water supply plan formulated using the model is fairly protective for future drought periods.

The study concluded that Cachuma Reservoir is currently being operated to optimize yield and to provide a drought buffer. For Jameson Reservoir, a rule curve was formulated to maximize yield when reservoir levels are high, with monthly diversions determined by a combination of demand on existing supplies and Jameson Reservoir levels. As reservoir levels fall, proposed diversions also fall to ensure an adequate supply during drought years.

The study also concluded that additional supplies were likely required during drought periods at demand levels of 6,000 AFY and 7,000 AFY, with or without drought conservation. As indicated in Table 1, drought year supplies of around 5,000 AFY fall considerably short of demand in the 6,000 to 7,000 AFY range. Additional supplies for drought periods could be obtained by either purchase of

dry-year supplies or by storing unused portions of MWD's State Water allocation in a storage bank.

Dry-year supplies are generally purchased through the Central Coast Water Authority to meet demand in the same dry year, and are transported through the Coastal Aqueduct to Cachuma Reservoir for use by MWD. In contrast, water purchased for a storage bank are purchased during wetter years when water is more plentiful and MWD has unused State Water allocation. This banked water is stored for several years until it is needed during a dry period. The banked water is then incrementally taken from storage over several years to meet demand during the dry period. As wetter climatic conditions return, the bank is replenished in preparation for the next dry period.

	<i>Entitlement Or Allocation</i>	<i>Average Year Supply</i>	<i>Drought Year Supply</i>
<i>Total District Supplies</i>	9,800 AFY	7,000 AFY	±5,000 AFY

Table 1. District supplies vary considerably with wet and dry climatic cycles. Supplies in average and drought years were calculated over the 76-year period of the Santa Ynez River model. In the worst drought year of the model, supplies were calculated to be 4,900 AFY.

Options for storage of unused State Water (banking) were evaluated for both surface storage and groundwater storage. The least costly storage option for drought supply (about \$500 per AF delivered) was storing unused State Water in a groundwater banking project in the Central Valley. The most costly option evaluated (\$1,400 to \$2,700 per AF) was storing unused State Water in Cachuma Reservoir (as MWD has been doing for several years) for use in drought years, because the reservoir fills frequently, spilling the stored water and requiring the purchase of additional replacement water. However, storage in Cachuma is the easiest option to implement; MWD should continue to use this alternative until a less-expensive groundwater storage project is identified and sufficient water is stored to provide drought protection. Further, storage in a groundwater basin could have problems of retrieval and delivery, which would have to be thoroughly investigated.

At the 7,000 AFY demand level for MWD, the river model indicates that there are times during dry years when MWD's portion of South Coast Conduit (SCC) capacity is exceeded by up to 2 cfs. There may be an opportunity to mitigate SCC capacity restrictions by coordinating operations with Carpinteria, with Carpinteria occasionally relying more on its stored groundwater in exchange for MWD's reimbursement for some of its costs associating with groundwater storage.

BACKGROUND

During the drought of the late 1980s and early 1990s, water supplies for the south coast of Santa Barbara County reached a critically low level. An emergency seawater desalination plant was constructed just prior to the end of the drought, and voters subsequently passed a bond issue to build the Coastal Aqueduct of the State Water Project to bring additional supplies into the area. These new supplies were aimed at drought-proofing the area into the future.

Land use plans were updated during the 1990s for the Montecito, Summerland, and Toro Canyon areas. These plans specify the number of housing units that can be built annually until buildout is achieved. These plans sequentially increase the demand for water within the Montecito Water District (MWD) service area over the next twenty to thirty years. The actual increase in demand depends upon both the number of new service connections and the water use per meter. Historic rates of water use per meter have varied over the years¹, with the lowest use during and following droughts when conservation is forefront in customers' minds. The increase in demand over the last decade is indicated in Figure 1.

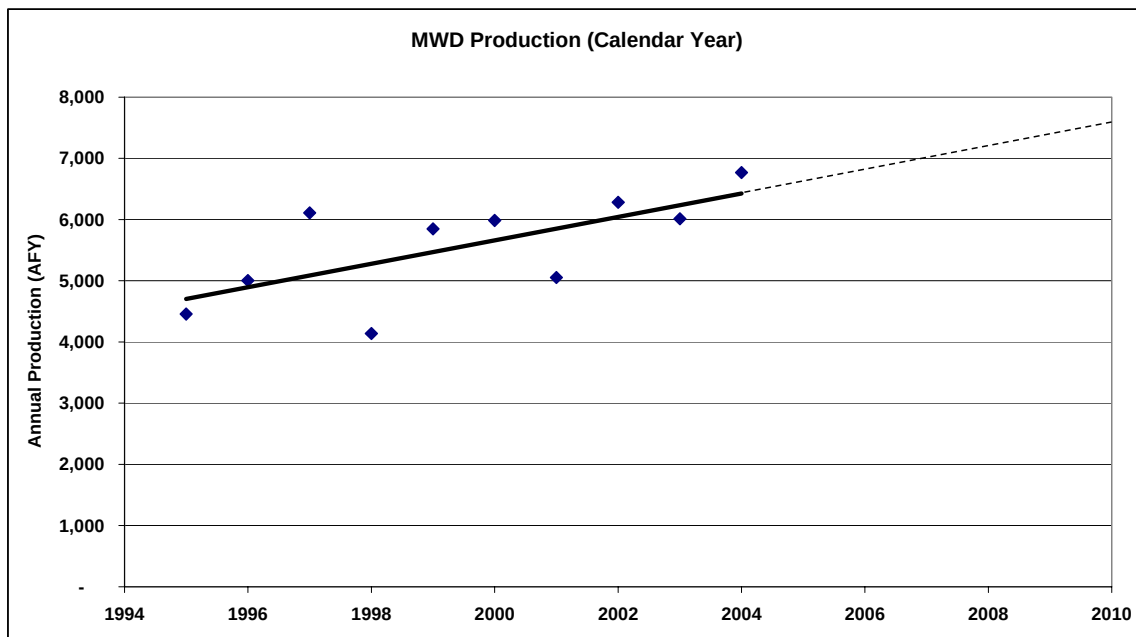


Figure 1. Increasing MWD water production since 1995. Trend line is computer-generated linear best-fit of the data points; dashed line is projection of the trend line.

An analysis of MWD supply and demand through the year 2020 indicated that shortfalls in supply could occur during dry periods unless MWD operations optimized use of current facilities and State Water was stored during wet years for

¹ Bachman, S., 2003, MWD Future Supply/Demand and Aquifer Storage; study, oral report, graphical presentation to MWD Board.

use during dry years². This analysis also identified some supply components that were critical to dry-year supply in the District. The study identified the importance of overall water conservation within the District. For example, supplies are considerably less than demand without conservation reductions during droughts (Figure 2).

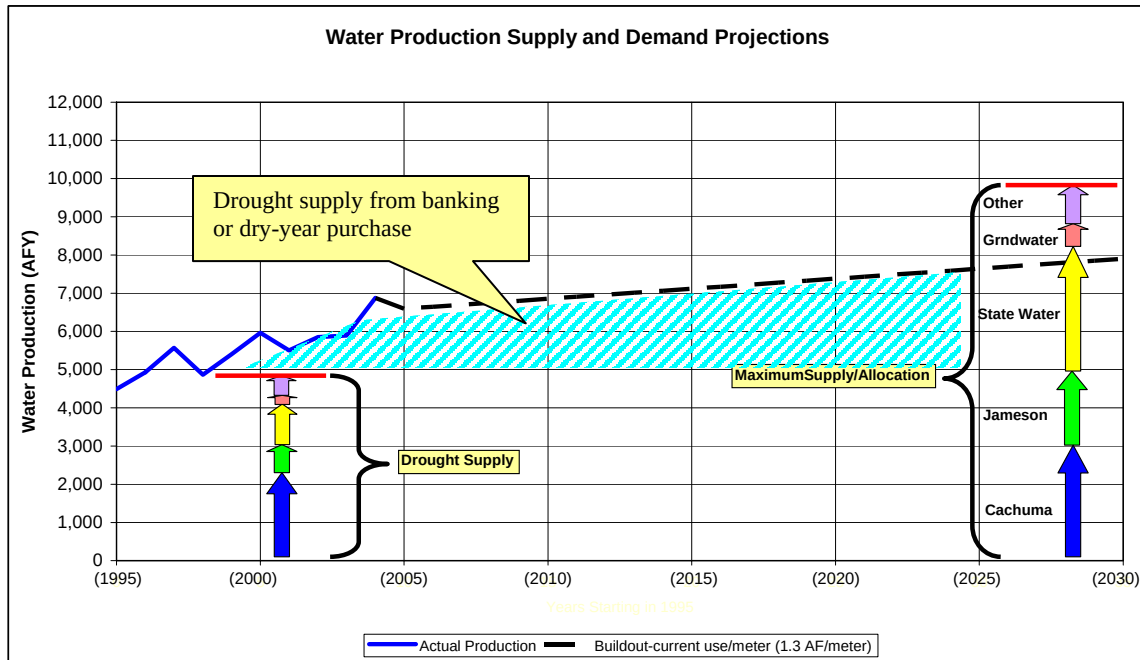


Figure 2. Demand projections based on actual production increases of past decade (solid blue line) and planned buildout increases with current use per meter (dashed line). Range of water supply is shown as minimum and maximum extent of existing sources. Additional water needed during a drought is indicated by hachure.

As a follow-up to the supply and demand analysis, MWD contracted this study to determine the reliability of existing water supply components, to determine how that reliability could be enhanced, to evaluate several options for drought storage and supply enhancement, and to determine the reliability of the enhanced components during a drought.

² Bachman, S., 2003, MWD Future Supply/Demand and Aquifer Storage; study, oral report, graphical presentation to MWD Board.

GOALS AND METHODS OF THIS STUDY

There were several goals for this study:

- Optimize use of local sources of water, which are MWD's cheapest supplies;
- Identify sources of supplemental water and water storage/banking opportunities;
- Develop plan to have sufficient supplies during drought periods at least as severe as the drought of 1986 to 1991;
- Determine the critical supply components of MWD's system;

This study used the Santa Ynez River Model as the basis for much of the analysis of reservoir operating methods and supply reliability. The existing model uses historic hydrologic data for the Santa Ynez watershed for the period October 1917 through September 1993, and superimposes the various water resource facilities and policies on the hydrology. The model was enhanced in this study to include more details of MWD facilities on both the Santa Ynez and Montecito sides of the mountains. The enhanced model was used to experiment with operating procedures, determine the required amount of drought storage, compare drought storage options, and evaluate the enhanced reliability of the system. In addition, cost analyses were performed on drought-supply storage projects. These cost analyses were based on year-to-year output from the enhanced river model.

CRITICAL SUPPLY COMPONENTS

There are several critical supply components that affect the ability of MWD to supply water during both drought and seasonal high-demand periods. These include: 1) State Water availability during droughts; 2) the ability of the South Coast Conduit (SCC) to move sufficient water during droughts; 3) sufficient water flow from the South Portal of Doulton Tunnel to maintain reservoir levels when the SCC alone cannot meet MWD demand; and 4) storage of a sufficient supply of water to augment supplies during a drought.

State Water Availability in Drought – During certain drought periods, there is insufficient State Water available to MWD for either supply or for banking. The California Department of Water Resources (DWR) has spent considerable effort using historical records to determine the availability of State Water during drought periods.

South Coast Conduit Capacity – The SCC delivers water from Lake Cachuma to MWD and Carpinteria. The previous supply and demand study indicated that MWD’s share of the capacity of the SCC limits supply options in periods of peak usage³. As MWD demand increases in the future, there may be insufficient MWD capacity in the SCC to meet all of the MWD demand during the driest months – some of the supply during this period will have to be from sources such as Jameson Reservoir, Doulton Tunnel seepage, and groundwater wells. Alternatively, MWD could acquire extra SCC capacity during these periods by a cooperative arrangement with Carpinteria.

Water Flow at the South Portal – Water supplies at the South Portal of Doulton Tunnel serve both as a supplemental water supply and to maintain reservoir levels when the SCC alone cannot meet MWD demand. There must be sufficient water available in Jameson Reservoir to meet minimum flow requirements throughout a drought. This requirement may reduce the potential long-term yield of the reservoir in order to leave a buffer of water in the reservoir for drought periods.

Storage of Water for Drought – The previous supply and demand study indicated that by 2010, there will be insufficient MWD supply during a state-wide drought. This problem is exacerbated in later years as MWD demand increases. MWD appears to have a sufficient allocation of State Water to mitigate this problem by simply storing State Water when there is plentiful supply to be used when supply is short. Thus, a storage option must be pursued. Storage options include Lake Cachuma, a groundwater basin along the South Coast, a groundwater basin along the Coastal Aqueduct, or a groundwater basin along the main State Project Aqueduct.

Capacity of Coastal Aqueduct – The capacity of the aqueduct system from the San Joaquin Valley to Cachuma Reservoir available for use by MWD may limit the amount and timing of water deliveries to the District from sources and/or storage banks outside of Santa Barbara County.

³ Bachman, S., 2003, MWD Future Supply/Demand and Aquifer Storage; study, oral report, graphical presentation to MWD Board.

SANTA YNEZ RIVER MODEL

The Santa Ynez River Model (“model”) was developed by Jon Ahlroth of the Santa Barbara County Water Agency over the past two decades to simulate flow rates along the river and dozens of tributaries, as well as capture and spilling of water from the three reservoirs along the river. The model has been used for reservoir studies, to determine water rights issues, to plan conservation releases, and to assist in issues related to fish flows.

EXISTING MODEL

The model runs over the 76 water-year period from October 1917 through September 1993 in monthly time steps. Measured and estimated historic stream flows, rainfall, evaporation, and tunnel infiltration values provide the data base for a set of algorithms that simulate reservoir and river-course conditions. Changes in one portion of the model (such as increasing annual deliveries from a reservoir) result in changes throughout the model. Output from the model includes graphs of reservoir storage and flow rates through time, with monthly data for a variety of parameters downloadable into Excel spreadsheets for analysis.

The 76-year period of the model represents several wet and dry periods. All of the droughts of the 20th century are included in the modeling period except the 1901 through 1904 portion of a dry period which began in the mid 1890s. The modeling period begins and ends with years during which the Santa Ynez River surface water reservoirs are filled to capacity and the riparian alluvial deposits are in a generally wet and re-charged state. Figure 3 indicates Santa Barbara hydrology during this period.

ENHANCEMENTS TO THE MODEL

The Santa Ynez River Model was first set up to represent Cachuma operations with downstream releases for fish, and a fixed 20% drought period delivery cutback. Program code was then added to make a detailed monthly water delivery program for MWD. This included Doulton Tunnel plus Alder Creek diversion flows, pumped groundwater, Jameson diversions, changing MWD State Water Project allocation for each year, delivery of MWD’s portion of Cachuma spill water, a water bank of State Water in Lake Cachuma, and a groundwater bank of State Water at an unspecified location somewhere within the State Water Project. Also included were annual and monthly delivery limitations from Doulton Tunnel and flow limitations on the SCC. Reservoir operating rules can be changed within modules to test the effect of these operating rules.

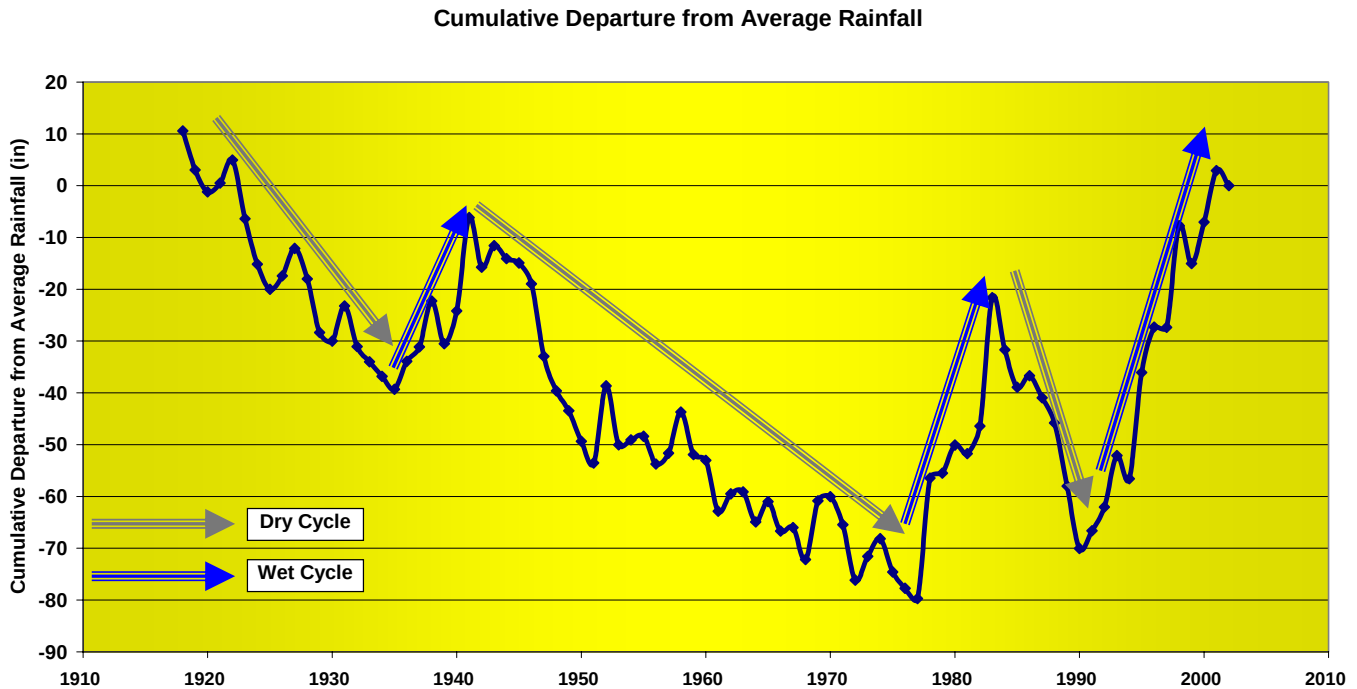


Figure 3. Cumulative departure of rainfall (Santa Barbara rain gauge) that includes the 1917-1993 period of Santa Ynez River model.

The annual water demand for MWD was programmed to be set at any number of levels representing water usage ranging from current to levels at buildout. Annual water demand is proportioned into monthly segments based on historic usage within MWD. The model superimposes this current or future demand on the hydrology of the 76 years of Santa Ynez River hydrology as if current facilities were in place during the entire period. This allows a simulation of the most recent 1986 to 1991 drought, as well as longer droughts during the model period (see Figure 3). The amount of State Water available for MWD use (or storage) in any year was based on DWR simulations using northern California hydrology covering the same period as the Santa Ynez River model.

The output from the model tracks monthly deliveries from all MWD water sources, as well as monthly reservoir levels and flow through the SCC. These monthly outputs can then be summarized and graphed for better understanding of how the MWD system responds over the model period.

A detailed description of the various model runs is included as Appendix A of this report.

SOURCES OF SUPPLY TO THE DISTRICT

MWD has a diverse variety of local and supplemental water supplies available to meet customers' needs. Water supplies include local surface water supplies from Lake Cachuma, Jameson Lake, District diversions at Alder and Fox Creeks, groundwater infiltration water in Doulton Tunnel, 18 water wells, and importation of State Water. At the time the Urban Water Management Plan was prepared in 2000, MWD obtained approximately 49% of its water supplies from Lake Cachuma, 41 % from Jameson Lake, Fox and Alder Creeks and Doulton Tunnel, 8% from the State Water Project, and 2% from water wells⁴. Adjustments to the available surface water supply occur during periods of extended drought. The adjustments for the water supply from Lake Cachuma are mutually agreed to by the Cachuma member agencies. For example, the Cachuma entitlements for all water purveyors were reduced by 40% in 1991, during the 1987-92 drought.

The degree of vulnerability of each of the District's sources of water to drought depends on the length and severity of the drought, and on whether water shortages are localized or statewide. The annual safe yield accounts for the possibility of a long dry period. Water that flows into the reservoirs during wet years can be stored and used during dry years. Lake Cachuma, for example, is a large reservoir with enough capacity to withstand a long dry period when managed conjunctively with other supplies. Alternatively, Jameson Lake, which is much smaller than Lake Cachuma, might provide less water during a long dry period, but recovers more quickly during wet years.

Delivery of water from the State Water Project, which is obtained by MWD as a member agency of the Central Coast Water Authority, varies with climatic conditions in northern California. The allocation is based each year on reservoir levels and the amount of snow runoff expected. The California Department of Water Resources has calculated probabilities of water delivery over a range of climatic conditions; these probabilities are used to help predict water supply availability by MWD.

OPTIMIZING RESERVOIR SUPPLIES

One of the first tasks of this study was to use the enhanced river model to determine the reliability of Cachuma and Jameson reservoirs using current operating procedures. The reservoir operations were then modified to identify potential changes in operation that would enhance overall water supply reliability. Several operational changes were tested by model runs.

⁴ Urban Water Management Plan, Montecito Water District, 2000.

This enhancement was made more complex because the two reservoirs serve somewhat different purposes for MWD. Cachuma is the primary source of year-around supply. Jameson supplements this supply in providing a secondary independent source of water to make up for SCC limitations during periods of high water demand, as well as providing service to the higher-elevation portions of MWD's service area. This reduces the need to pump water uphill from the lower-elevation SCC. Thus, there are minimum monthly flow requirements from Jameson Reservoir. Likewise, overall annual supply from Jameson cannot exceed 2,000 AFY by court decree.

CURRENT RESERVOIR OPERATIONS

MWD records of monthly water deliveries from each water source for the period 1931 through 2003 were used to determine the historic operation of the reservoirs. Cachuma Reservoir was constructed by the Bureau of Reclamation and is operated under contract to the Bureau. The yield of MWD's portion of Cachuma Reservoir has been increasing since its construction in the early 1950s (Figure 4), largely because of increased demand along the South Coast. The 15-year moving average has now stabilized at just over 2,300 AFY; supplies in individual years have varied from 850 AFY to 3,800 AFY. Current Cachuma operations have already been optimized based on previous modeling using the existing version of the Santa Ynez River Model. Water is diverted from the reservoir at a fixed rate that is somewhat higher than the yield of the reservoir, with deliveries cut back by 20% during drought periods. MWD's portion of this fixed rate is 2,651 AFY; actual deliveries over the past eight years have averaged this rate.

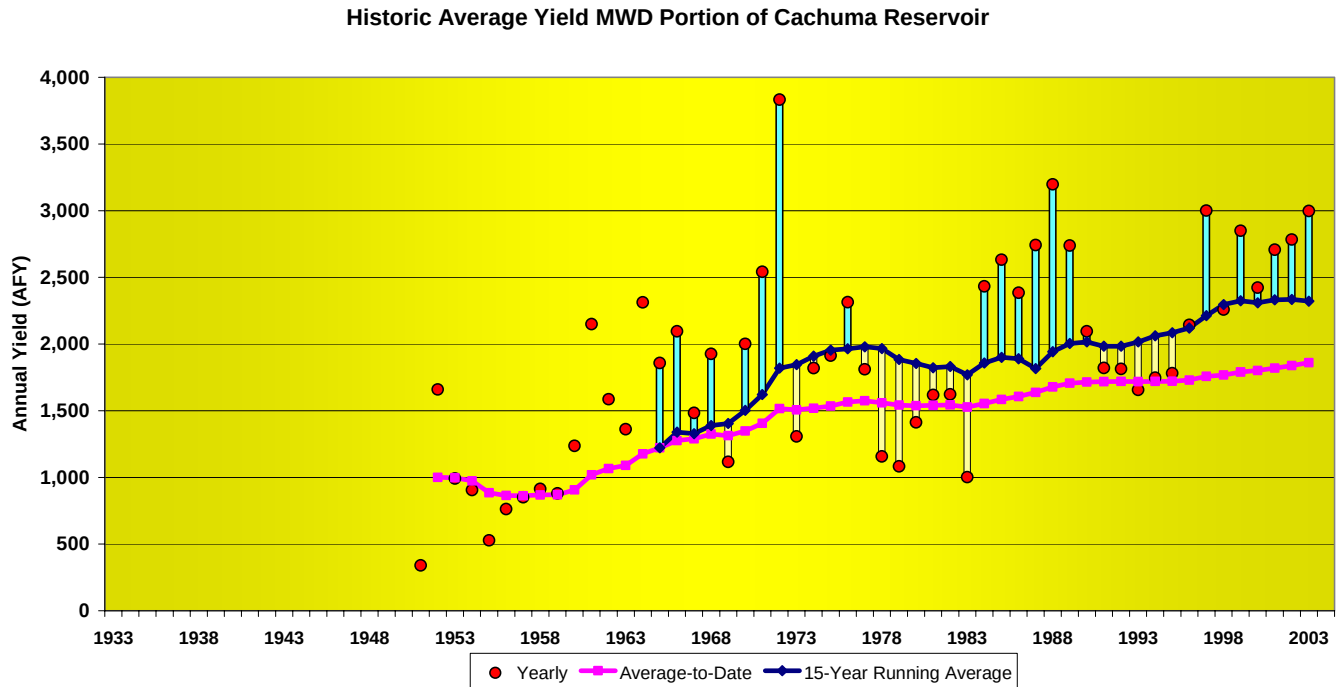


Figure 4. Yield of the MWD portion of Cachuma Reservoir over the life of the reservoir.

The average yield of Jameson Reservoir has been about 1,500 AFY for the past 30-year period (Figure 5). During this period, annual drafts have varied from 800 AFY to almost 2,300 AFY. Storage in Jameson Reservoir has varied considerably over the years (Figure 6). From the late 1940s into the late 1960s (a dry weather cycle – see Figure 3), the reservoir was pulled down rapidly following wet years that filled the reservoir. Since that time, a wetter weather pattern has allowed the reservoir to remain at least half full. An exception to this was during the last drought during 1986 to 1991, when the reservoir was emptied to near minimum pool level.

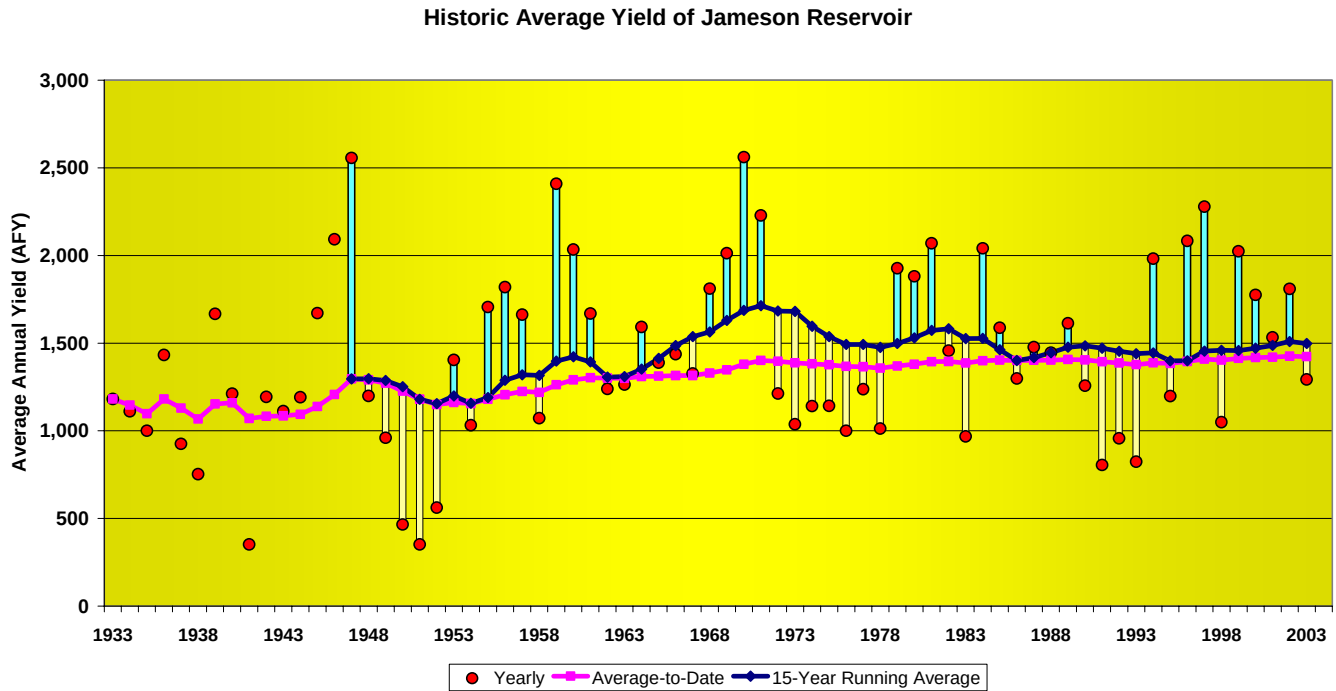


Figure 5. Yield of Jameson Reservoir over the life of the reservoir.

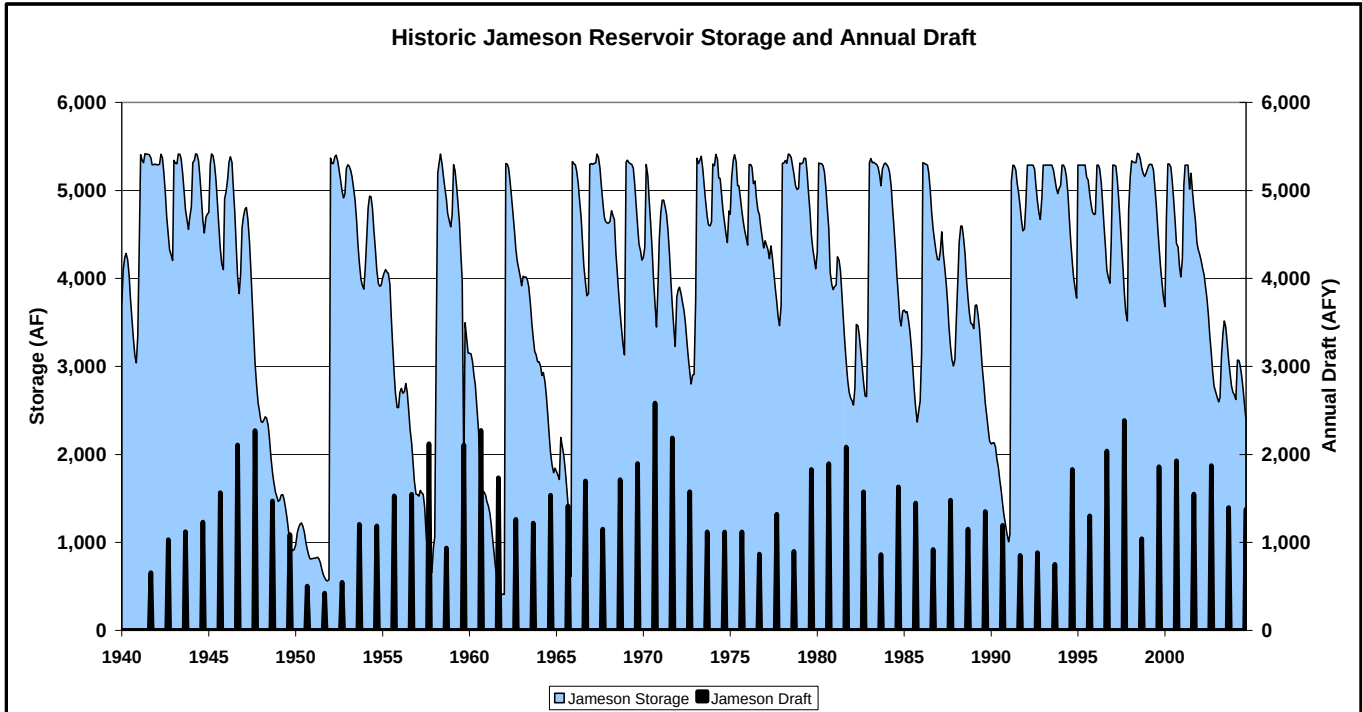


Figure 6. Historic operation of Jameson Reservoir.

Supplies from the two reservoirs vary by month and by wet/dry climatic cycles. Water from Cachuma Reservoir makes up 40% to 60% of the annual supply (Figure 7 and Figure 8), and it supplies a relatively constant percentage of total supply from wet to dry years (Figure 9). Water from Jameson Reservoir makes up 20% to 45% of the annual supply, although it supplies a lower percentage of the total supply during dry years. Starting in 1992 when the treatment plants were constructed downstream of the South Portal, flow restrictions through the plants reduced MWD's ability to divert large amounts of water from Jameson when supplemental water is needed during periods of high demand.

Monthly use is highest during August of most years (Figure 10), with Cachuma supplying an increasing percentage of supply during the summer months as flows from Fox Creek and inflows into Doulton Tunnel decrease during those dry months (Figure 11). The percentage of supplies from Jameson decreases during the spring months, but is relatively constant the remainder of the year.

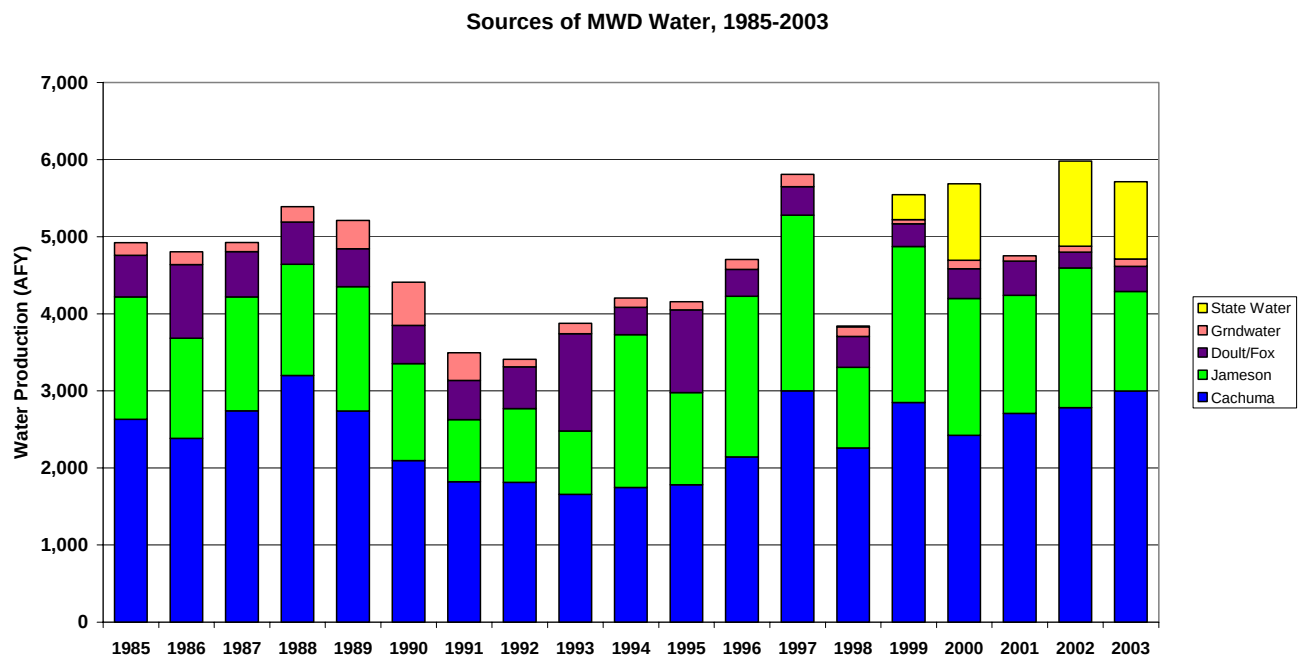


Figure 7. All sources of MWD water during the period 1985 to 2003.

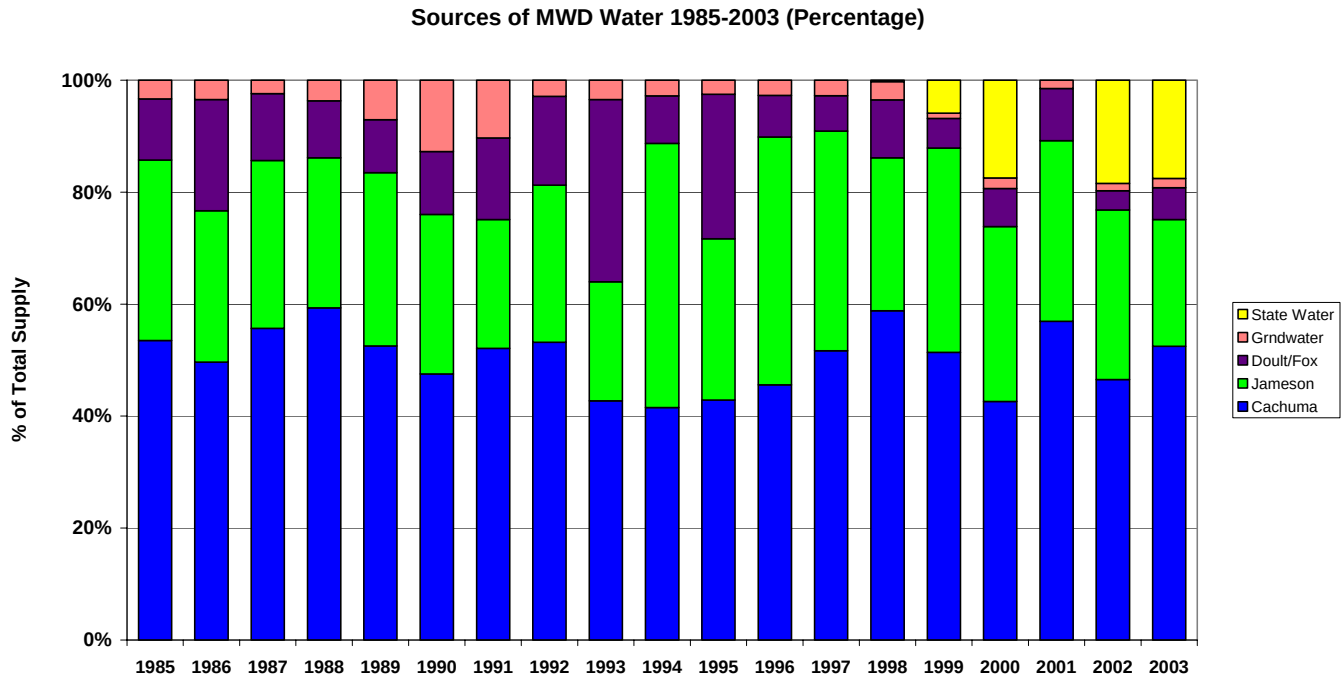


Figure 8. Percentage of MWD water from various sources for the period 1985 to 2003.

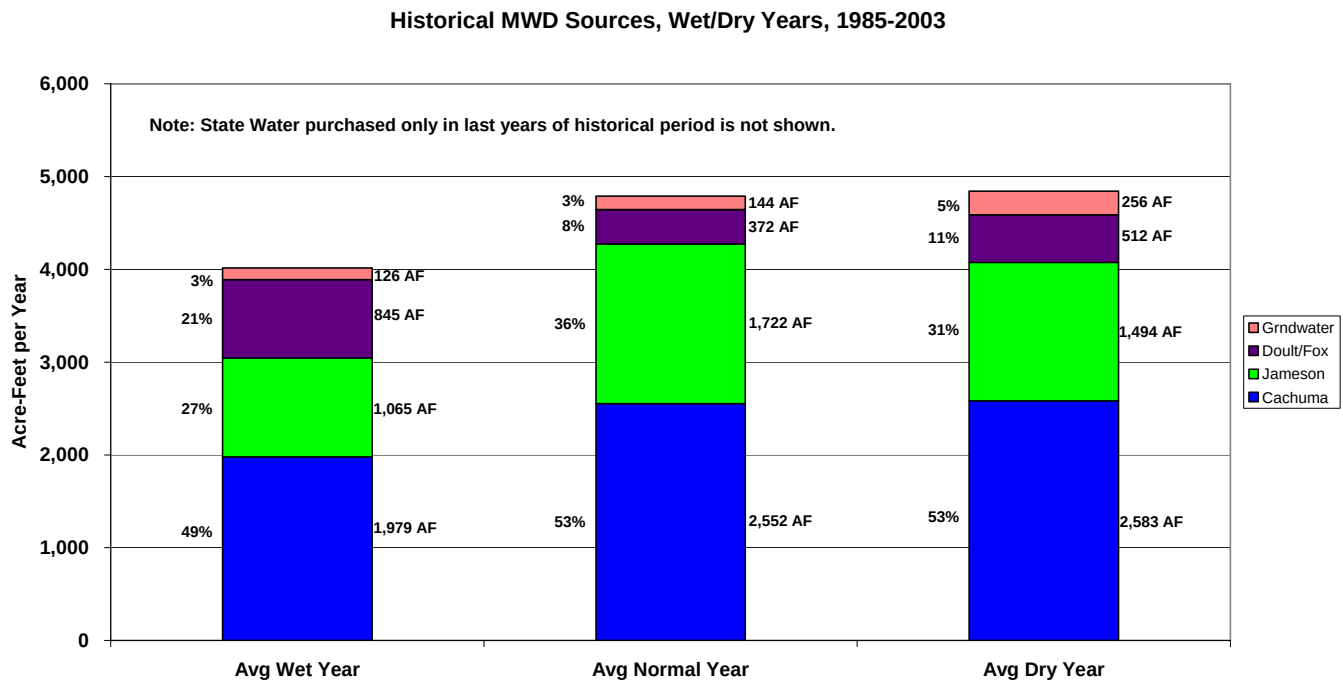


Figure 9. Quantity of water supply from MWD sources during wet, average, and dry years.

Historical Sources by Month, 1985-2003

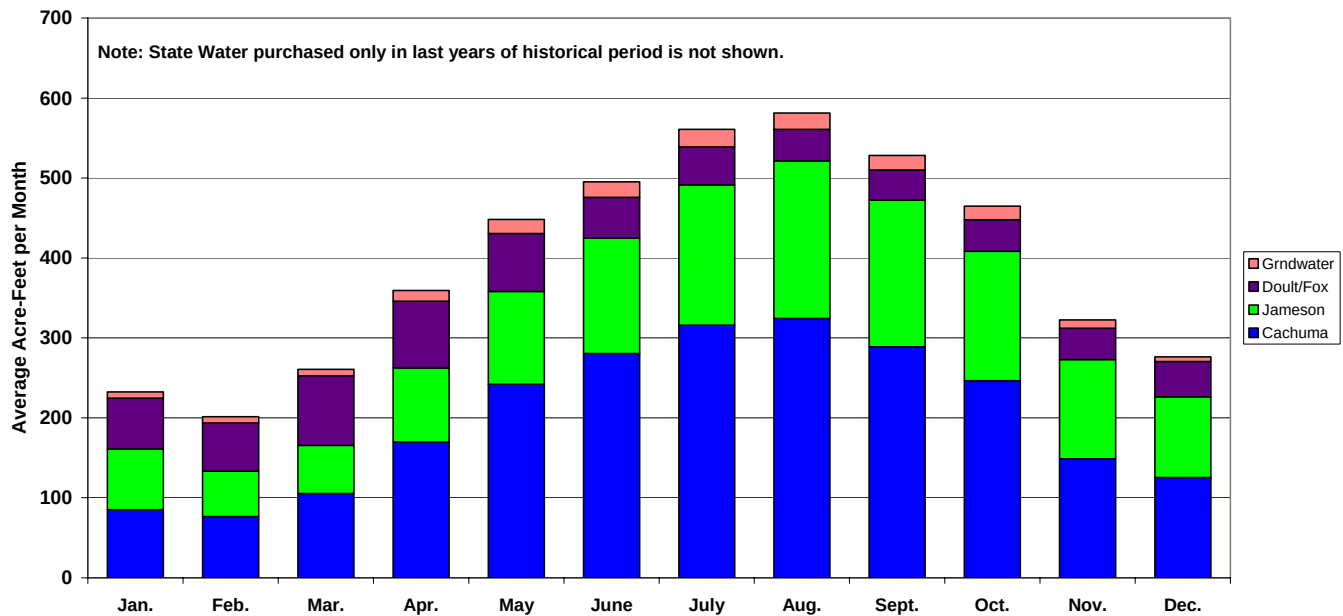


Figure 10. Sources of water supply by month for period 1985 to 2003.

Historical Sources by Month (percentage), 1985-2003

Note: State Water purchased only in last years of historical period is not shown.

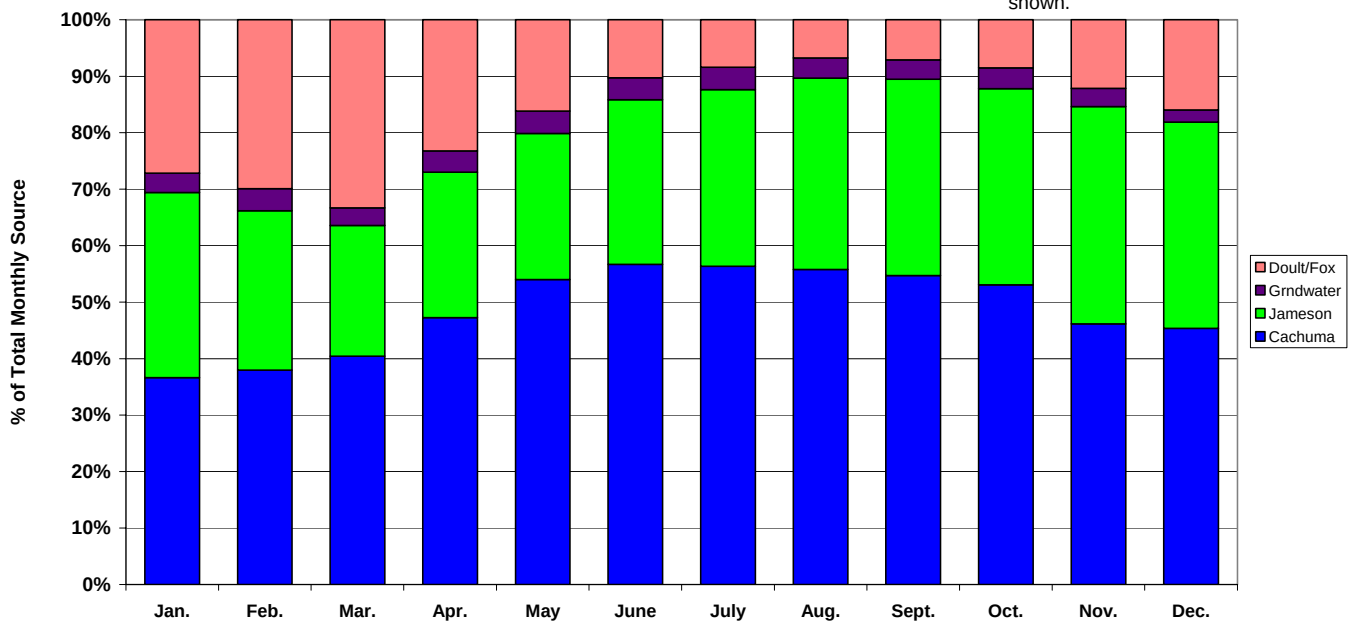


Figure 11. Sources of water supply by month for period 1985 to 2003 (percentage).

Supplies at the South Portal during these dry-season months of the last nineteen years have varied from 75 AF/month to 285 AF/month (Figure 12), with supplies averaging just less than 200 AF/month over the past six years. MWD prefers a minimum supply of 120 AF/month to 150 AF/month during the summer at the South Portal⁵. The design flow of the Doulton treatment plants is 0.14 MGD (100 gpm).

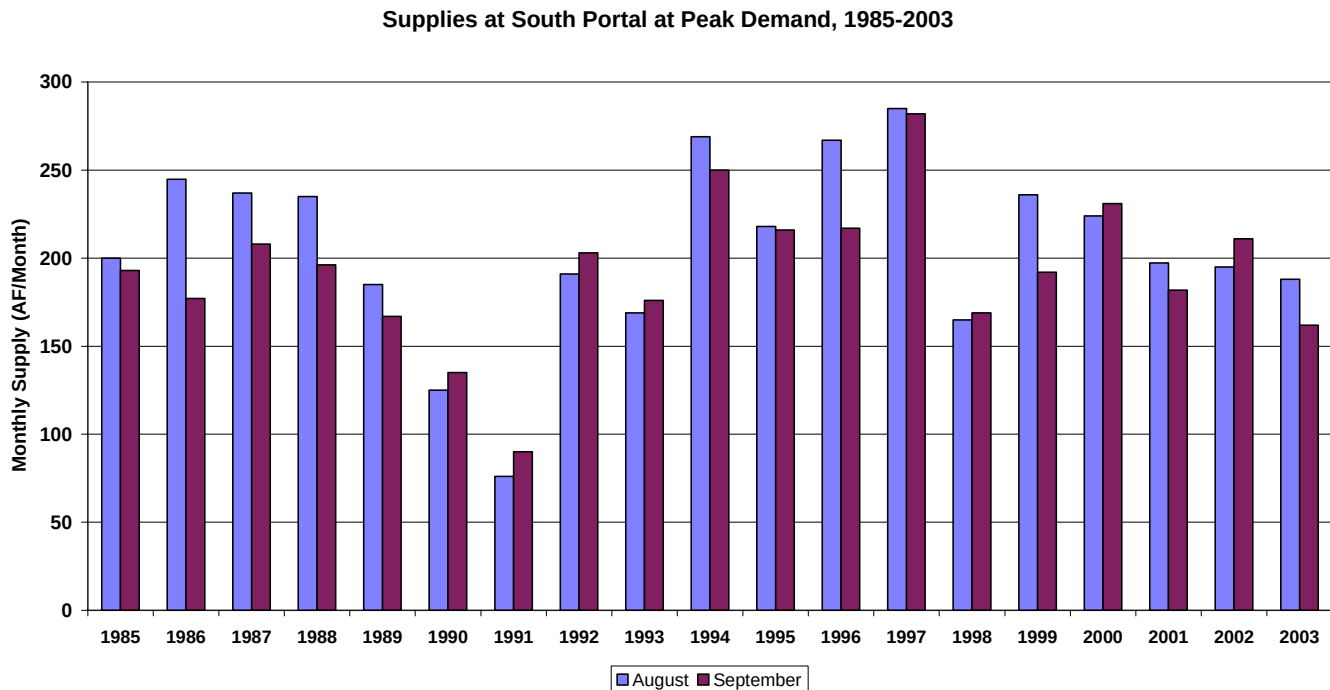


Figure 12. Historical delivery at South Portal during peak demand months.

CURRENT SUPPLY RELIABILITY

The reliability of both the reservoirs and of total supplies under current methods of operation were evaluated using the Santa Ynez River Model. These operations were superimposed on the hydrology of the river for the model period 1917-1993. Four model runs were initially conducted, including: 1) 6,000 AFY demand; 2) 7,000 AFY demand; 3) 6,000 AFY demand, up to 20% drought conservation; and 4) 7,000 AFY demand, up to 20% drought conservation. An additional model run for 8,000 AFY demand was also conducted (Appendix E). In these model runs, MWD's monthly supplies were predicted using Santa Ynez River historic hydrology. For State Water, calculations of historic year-by-year availability by the California Department of Water Resources were used.

⁵ T. Mosby, 2004, personal communication

The model runs indicate that MWD may not be able to meet demand during drought periods at both the 6,000 AFY and 7,000 AFY demand levels under current operational procedures (Figure 13 and Figure 14; the uppermost red-colored area represents period and magnitude of MWD shortages). This finding is consistent with the previous study that indicated that increased demand can only be met with the addition of a storage project for State Water or with an additional source of supply⁶. Supply shortages of as much as 1,450 AFY occurred during the 1917-1993 period of the model at a demand level of 6,000 AFY, and as much as 2,550 AFY at a demand level of 7,000 AFY. During the last drought period of 1986 to 1991, shortages of 1,250 AFY to 2,400 AFY would have occurred at these respective demand levels. Jameson Reservoir storage would have reached minimum pool levels during the worst droughts.

The reliability of current supplies improves somewhat when drought conservation of up to 20% is used in the model (corresponding to actual conservation during the 1986 to 1991 drought). There continue to be supply shortfalls, however, even with this drought conservation considered (Figure 15 and Figure 16). Supply shortages of as much as 560 AFY occurred during the model period at a demand level of 6,000 AFY, and as much as 1,440 AFY at a demand level of 7,000 AFY. During the last drought period of 1986 to 1991, shortages of 380 AFY to 1,240 AFY would have occurred at these respective demand levels, even with drought conservation. Jameson Reservoir storage would have reached minimum pool levels during the worst droughts.

Thus, current reservoir operations and current use of available supplies will not likely provide reliability through drought conditions at demand levels of 6,000 AFY and 7,000 AFY, even with drought conservation of 20%. If drought conservation alone is relied upon to meet demand through drought periods, customers may have to conserve a total of at least 29% at a 6,000 AFY demand level and at least 41% at a 7,000 AFY demand level.

⁶ Bachman, S., 2003, MWD Future Supply/Demand and Aquifer Storage; study, oral report, graphical presentation to MWD Board.

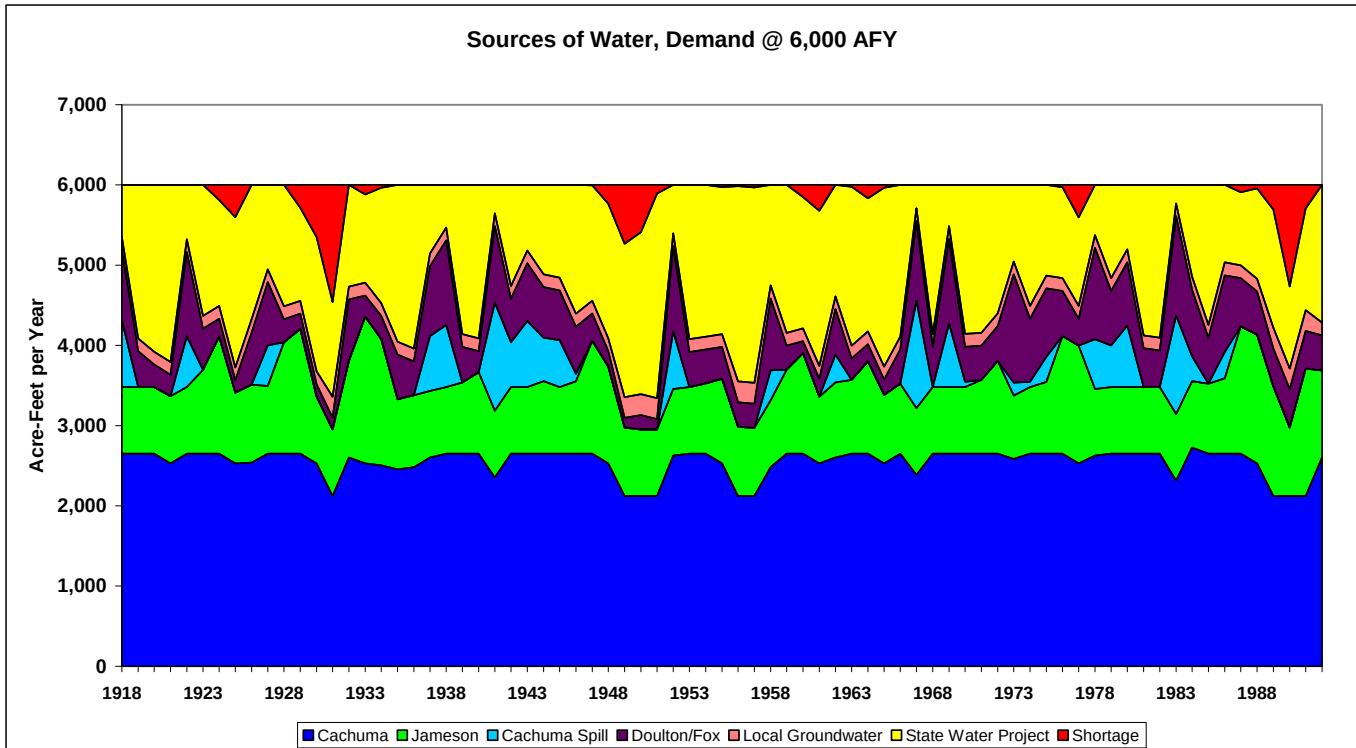


Figure 13. Modeled water supplies under current operating conditions, 6,000 AFY demand.

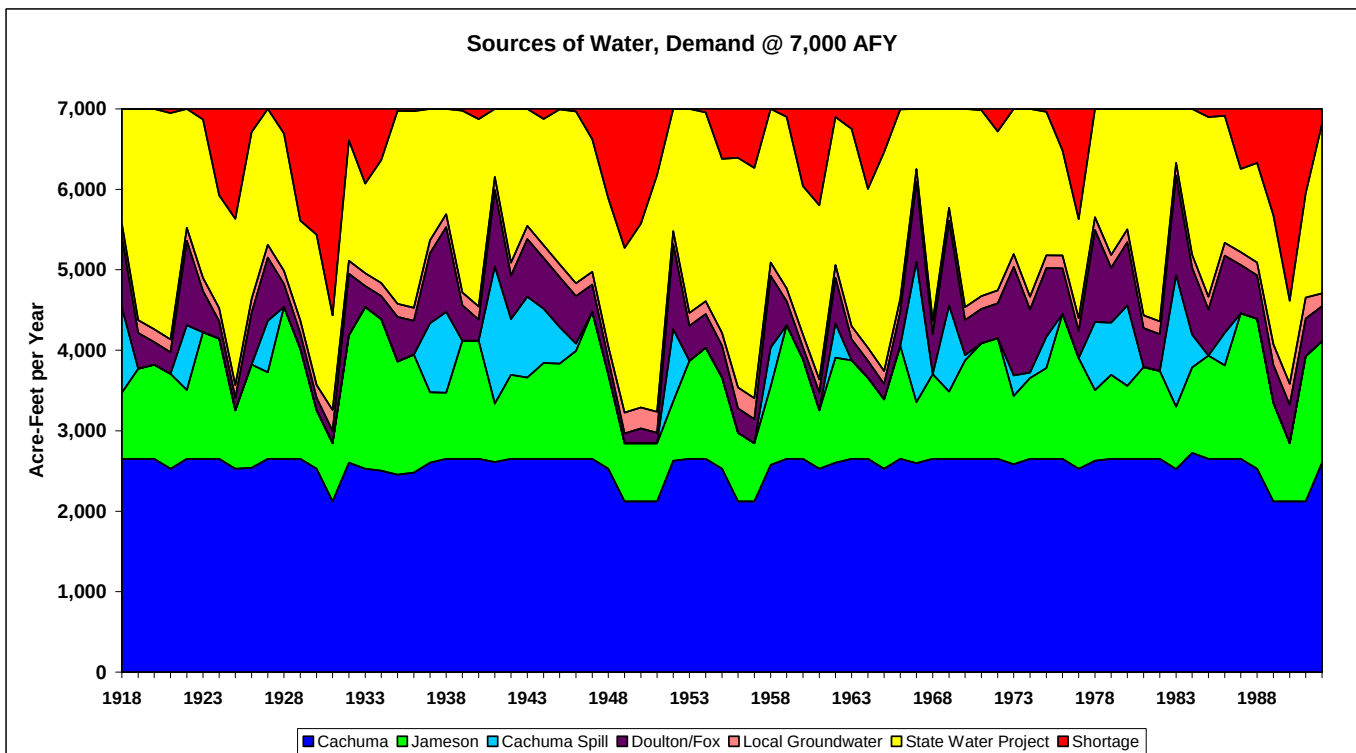


Figure 14. Modeled water supplies under current operating conditions, 7,000 AFY demand.

Sources of Water, Demand @ 6,000 AFY, 20% Drought Conservation

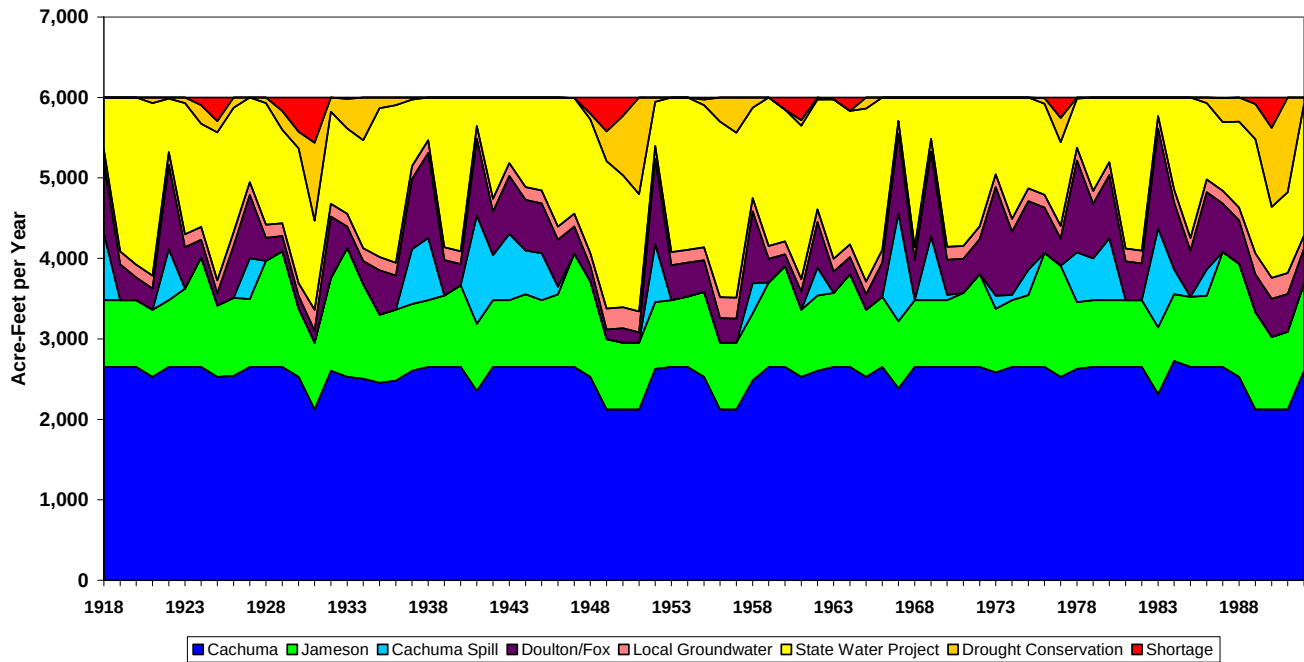


Figure 15. Modeled water supplies under current operating conditions, 6,000 AFY demand, and up to 20% drought conservation.

Sources of Water, Demand @ 7,000 AFY, 20% Drought Conservation

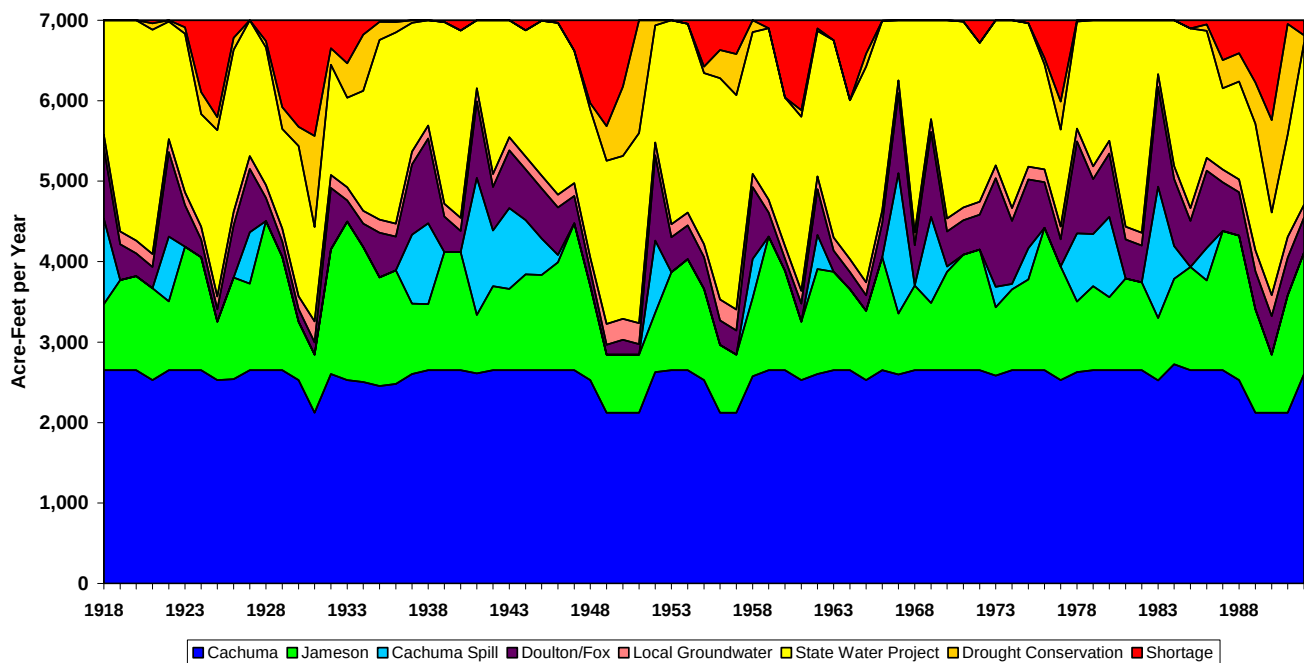


Figure 16. Modeled water supplies under current operating conditions, 7,000 AFY demand, and up to 20% drought conservation.

RECOMMENDED RESERVOIR OPERATIONS

Cachuma Reservoir is currently being operated using a rule curve that was optimized using the existing Santa Ynez River Model. In this study, this rule curve was used with the addition of modeled use of spill water, carry-over water, and temporarily-stored State Water. The State Water storage option is discussed in the section “*Storage of State Water in Cachuma Reservoir.*”

When Cachuma is operated by delivering an entitlement to MWD of 2,651 AFY with a 20% drought reduction (see storage changes – Figure 17), MWD’s average Cachuma yield over the 1917 to 1993 model period is about 2,540 AFY. When MWD’s use of Cachuma carry-over water was included, the additional Cachuma yield over the model period is 8 to 22 AFY at 6,000 AFY and 7,000 AFY demand levels, respectively.

Cachuma spill water (water that is delivered to MWD during the time that Cachuma is spilling) is essentially “free” water – that is, it is not debited from MWD’s annual allocation. However, spills occur during very wet months, when MWD demand is low. Therefore, spill water only increases the yield of Cachuma by an average of 204 AFY to 259 AFY, based on MWD demand, over the model period.

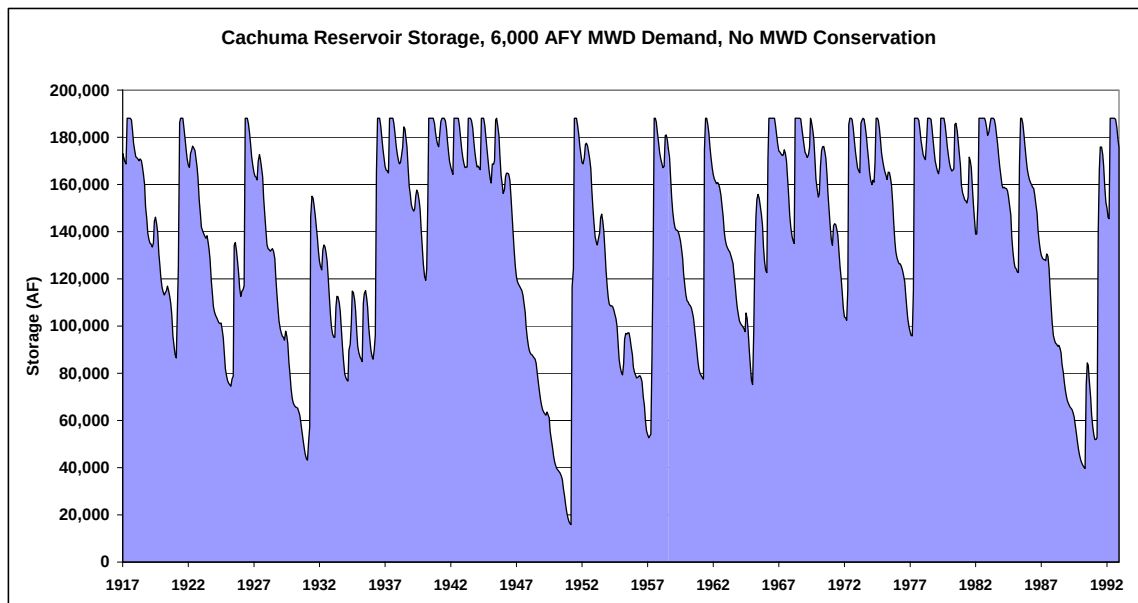


Figure 17. Storage in Cachuma Reservoir with operations based on previous optimization using Santa Ynez River Model.

Jameson Reservoir is MWD's most valuable water supply in terms of low cost and its ability to serve as a supplemental water supply to maintain reservoir levels when the SCC alone cannot meet MWD demand and to deliver water to high-elevation portions of the District. Three operating scenarios were evaluated to determine which provided the most value to the District:

- Drafting the reservoir at **1,000 AFY** until the minimum pool of about 700 AF⁷ is reached and deliveries terminate;
- Drafting the reservoir at **2,000 AFY** until the minimum pool of about 700 AF is reached and deliveries terminate;
- Drafting the reservoir at a rate up to **2,000 AFY**, based on MWD supplies, with a reduced annual rate when the reservoir drops beneath certain levels of stored water remaining.

The results of the analysis of Jameson operating options were:

- Drafting at **1,000 AFY** allows storage to remain relatively high (which provides a safety net), but reduces the historical yield of 1,500 AFY to the lower 1,000 AFY yield. Since this is among the least expensive water sources for MWD, it doesn't make sense to reduce the yield of the reservoir. The lost Jameson yield would have to be made up with more expensive State Water in wet years and even more expensive banked State Water or Dry-Year supplies in dry years.
- Drafting at **2,000 AFY** until supplies are exhausted increases the yield of the reservoir to 1,700 AFY over the model period. However, the shortfall in meeting MWD demand during dry years (when the reservoir is exhausted) is substantial (3,200 AFY in the worst droughts). This shortfall would need to be met by an increase in either the size of the State Water bank or by substantial purchase of Dry-Year supplies (if they are available during these worst droughts). Delivering this shortfall water will likely exceed SCC capacity. Upper Toro Canyon demand may not be able to be met during these dry periods when supplies from Fox Creek and Doulton Tunnel inflow fall below this required demand level.
- Drafting at up to **2,000 AFY** with a reduction at reservoir storage levels below 4,400 AF (Figure 18) combines the advantages of a higher draft level during wet and normal years and a safety net during dry years. This operating rule results in a Jameson yield of 1,470 to 1,571 AFY (depending upon MWD demand levels and customer drought conservation), not significantly different from the current reservoir yield. However, the

⁷ It may be possible to take additional water from Jameson below the 700 AF minimum pool, but that possibility is considered as a safety net and not part of the regular yield of the reservoir.

recommended reduced draft rate would see MWD through a repetition of all of the last century's wet and dry hydrologic cycles (e.g., Figure 19). This reservoir yield would be somewhat lower than for the unmodified 2,000 AFY draft, but the reduced rate of drafting as storage levels drop allows adequate flow to Upper Toro Canyon and to the treatment plants, reduces the need for expensive dry-year supply options, and reduces SCC capacity problems.

The Jameson Rule Curve (Figure 18) is a summary of a two-part equation relating reservoir levels, demand, and available supplies. The reservoir storage indicated on the y-axis is the average storage during the year. In practice, this average is not known at the beginning of the water year; therefore, diversions will have to be adjusted as the water year progresses. The only time that this will have significant effects is when reservoir levels are low at the beginning of the water year and the year is very wet, with reservoir levels changing rapidly.

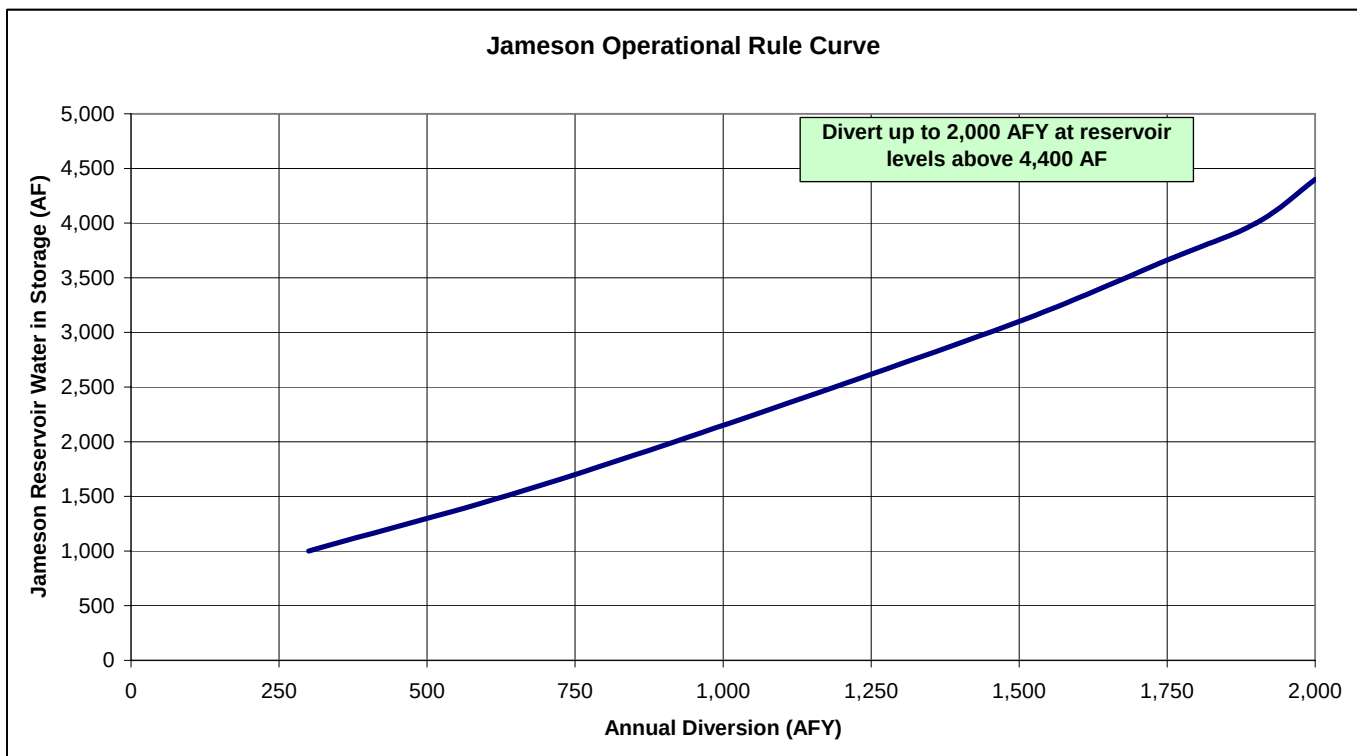


Figure 18. Jameson Rule Curve for determining the annual draft based on reservoir storage levels. In wet years when MWD demand is lower, it may not be possible to use all of the recommended diversion.

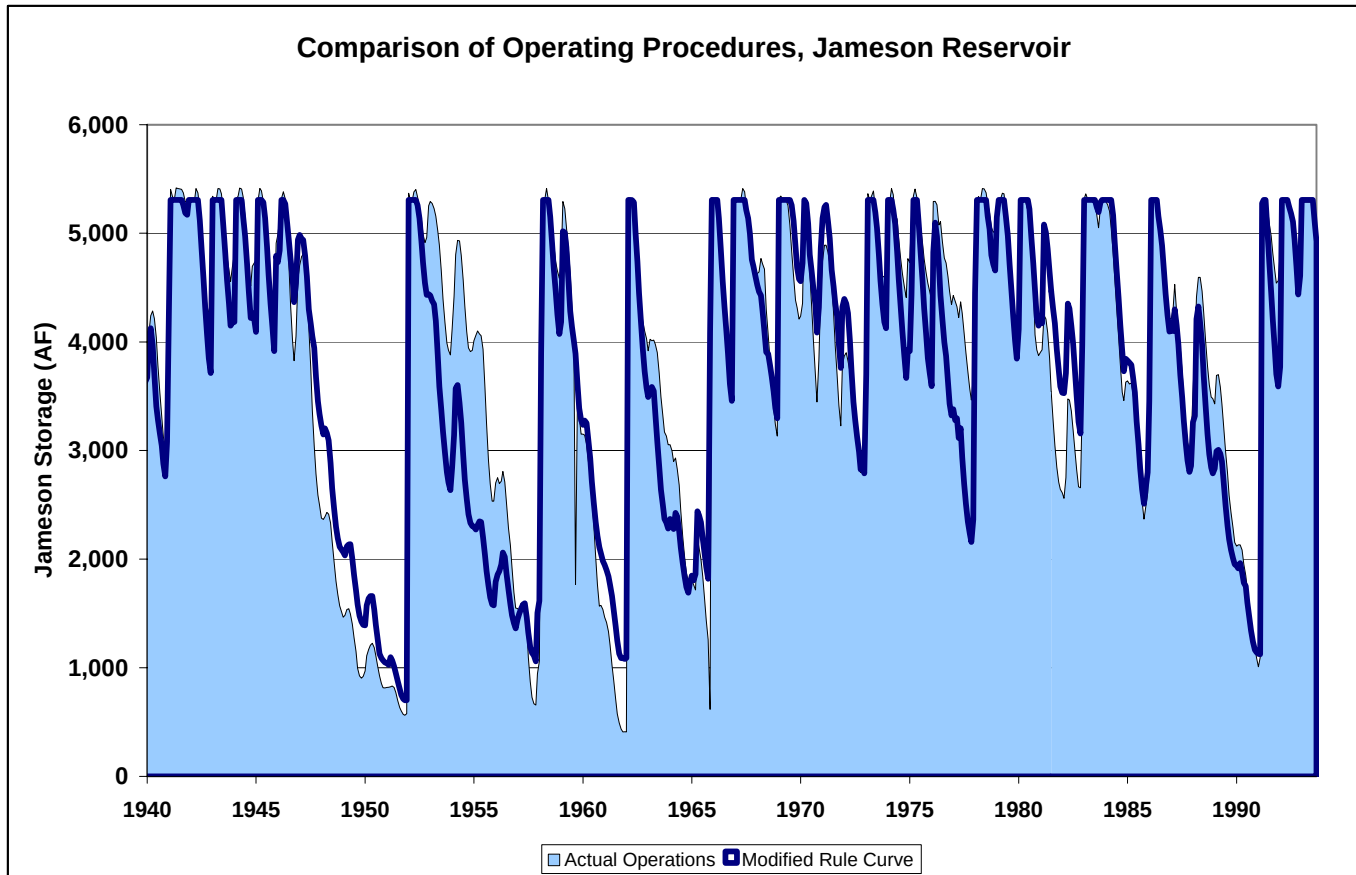


Figure 19. Storage in Jameson Reservoir, comparing historical storage with storage using modified rule curve.

DROUGHT SUPPLY OPTIONS

Previous sections of this report indicate that additional drought supplies are likely needed to meet future MWD demand. A number of drought supply options were evaluated to determine both cost effectiveness and effectiveness in meeting drought demands. Several options include storing MWD's unused State Water allocation during wetter years for use during drought years – storage in Lake Cachuma or groundwater storage either locally or elsewhere along the State Water delivery system. Another option is buying Dry Year supplies through programs with the State Water Contractors. Additionally, MWD should coordinate deliveries through the SCC with Carpinteria Valley Water District (CVWD) so that MWD will have the delivery capacity to meet high season and drought demands.

PURCHASE OF DRY YEAR SUPPLIES

There may be opportunities to purchase water during dry years. An example of such a recent program occurred in calendar year 2004 when northern California farmers and water organizations expressed a desire to enter into water purchase programs with State Water Contractors. The Central Coast Water Authority (CCWA) and other State Water Contractors pursued an option/purchase program to develop additional water supplies. As currently operated, each customer reserves an option to a certain amount of water by making a \$15 per AF payment. The option will hold the water until a set date, at which time the water must either be called for or the option expires. For 2005, the price of the called water ranges from \$100 to \$125 per AF. A 20% carriage loss is anticipated as the water transverse the Sacramento Delta (a call of 100 AF results in a delivery of 80 AF). MWD is participating in this program for 2005, with an option for 3,300 AF.

The following table indicates the cost of purchasing Dry Year supplies, based on the 2005 program.

<i>Cost Component</i>	<i>Cost per AF</i>
Option Payment	\$15
Call Price	\$125
Combined cost	\$140
Cost after 20% carriage loss	\$175
State Project delivery cost (variable cost to Cachuma)	\$250
Total cost @ Cachuma	\$425

Table 2. Cost of 2005 Dry-Year supplemental supplies.

The cost of the water was quite favorable for the 2005 program, although the cost of groundwater banking is even lower (as discussed later in this report). There are several aspects to consider if dry-year supplies are relied upon to make up supply shortfalls during a drought:

- The cost of the water may be substantially higher when there is a widespread drought and there is high demand for this water;
- The water may not be available during a widespread drought;
- All costs should be considered, including potential future costs of third-party impacts in the area of origin of the water.

STORAGE OF STATE WATER FOR DROUGHT SUPPLY

Another option for drought supply is to store MWD's unused State Water allocation each year (or water that may be purchased from other northern California sources) and have it available as a drought supply. This can be done by either storing the unused State Water in Cachuma Reservoir or in a groundwater bank. The enhanced Santa Ynez River Model was used to determine the amount of State Water storage necessary to supply MWD demand during the drought periods represented in the 76-year model period from 1917 to 1993. This storage capability would likely allow MWD to meet demand through all of the drought periods experienced in Montecito and in California over almost a century of record-keeping. Four demand scenarios were used in the modeling⁸:

- Annual demand of 6,000 AFY;
- Annual demand of 6,000 AFY with 20% drought conservation (actual conservation in last drought);
- Annual demand of 7,000 AFY;
- Annual demand of 7,000 AFY with 20% drought conservation (actual conservation in last drought).

The amount of storage needed for each demand scenario was calculated in the model so that no shortages occurred. This storage requirement is indicated in Table 3.

<i>Demand Scenario</i>	<i>Storage Required</i>
6,000 AFY	2,545 AF
6,000 AFY, 20% drought conservation	1,683 AF
7,000 AFY	7,732 AF
7,000 AFY, 20% drought conservation	6,228 AF

Table 3. Total amount of State Water storage required for the four demand scenarios; the banked water would be used over several dry years to meet supply shortfalls.

The following figures (Figure 20 to Figure 23) indicate the supply mix for each demand scenario. This supply mix is the same whether water is stored in Cachuma Reservoir or in a groundwater bank. The figures graphically indicate the importance of the stored State Water – in model years such as 1931 and 1990, the stored water supply replaces the shortages indicated in Figure 13 to Figure 16.

⁸ These demands include the 300 AFY delivered to the City of Santa Barbara.

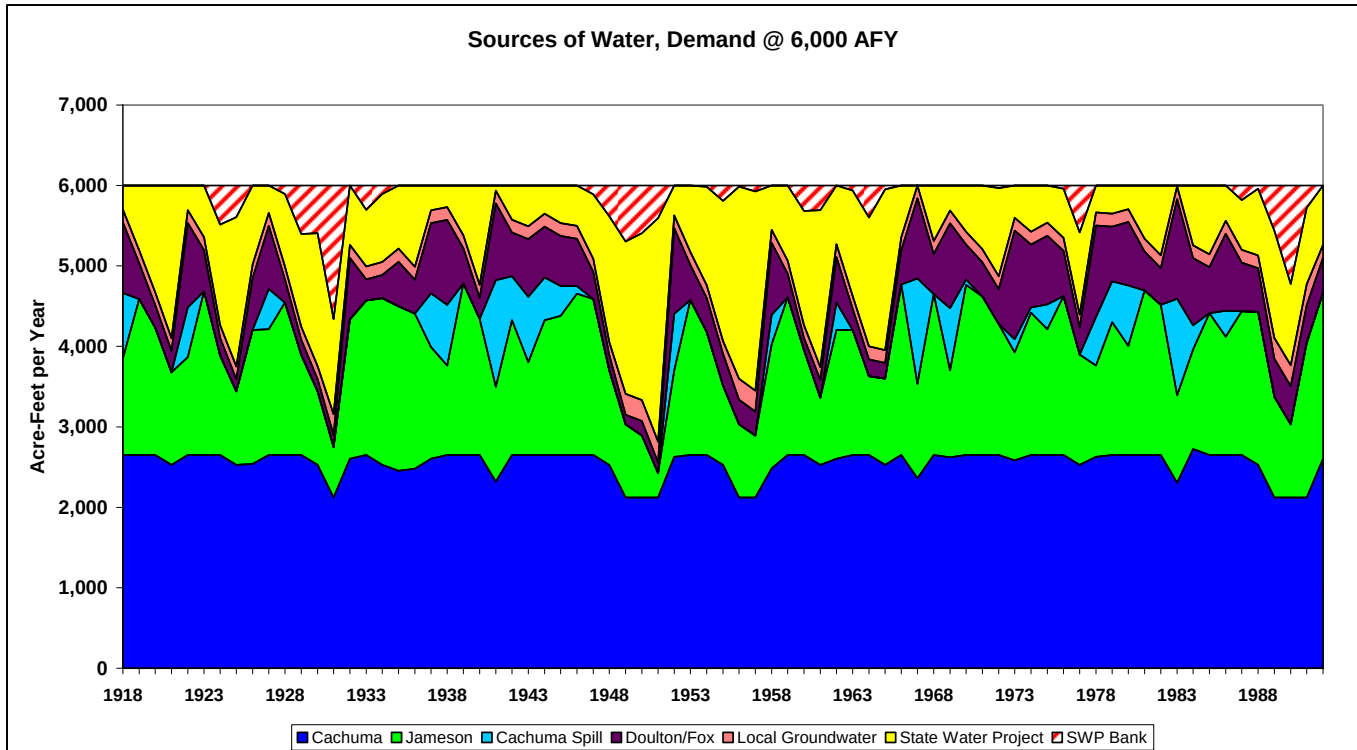


Figure 20. Modeled sources of water using storage of unused State Water, 6,000 AFY demand.

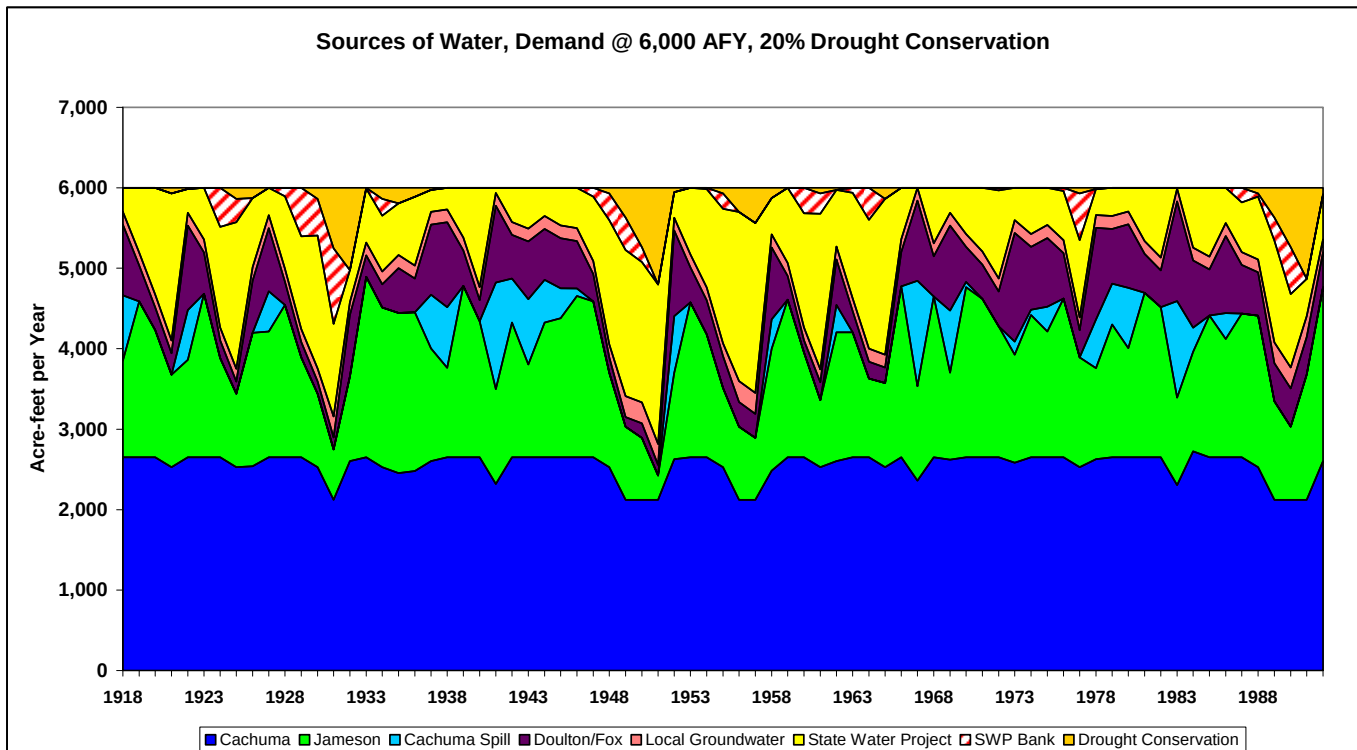


Figure 21. Modeled sources of water using storage of unused State Water, 6,000 AFY demand and 20% drought conservation.

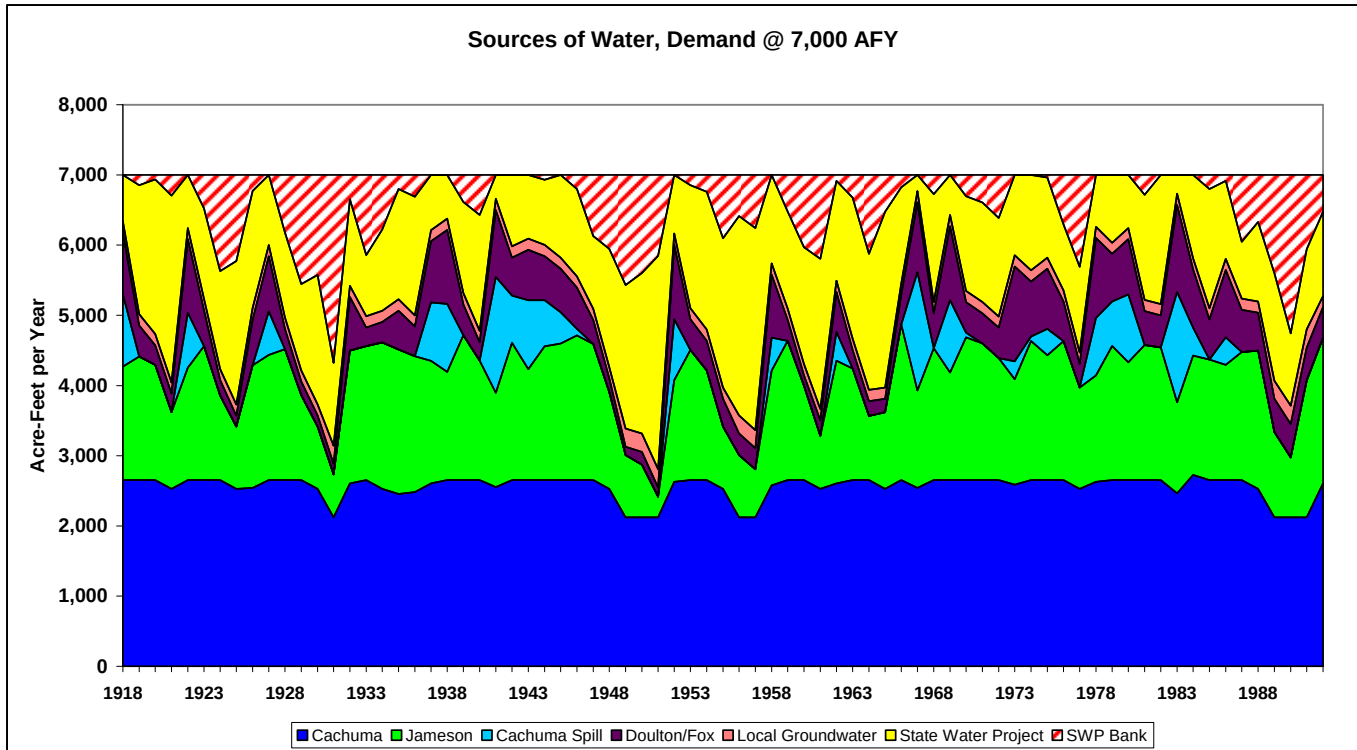


Figure 22. Modeled sources of water using storage of unused State Water, 7,000 AFY demand.

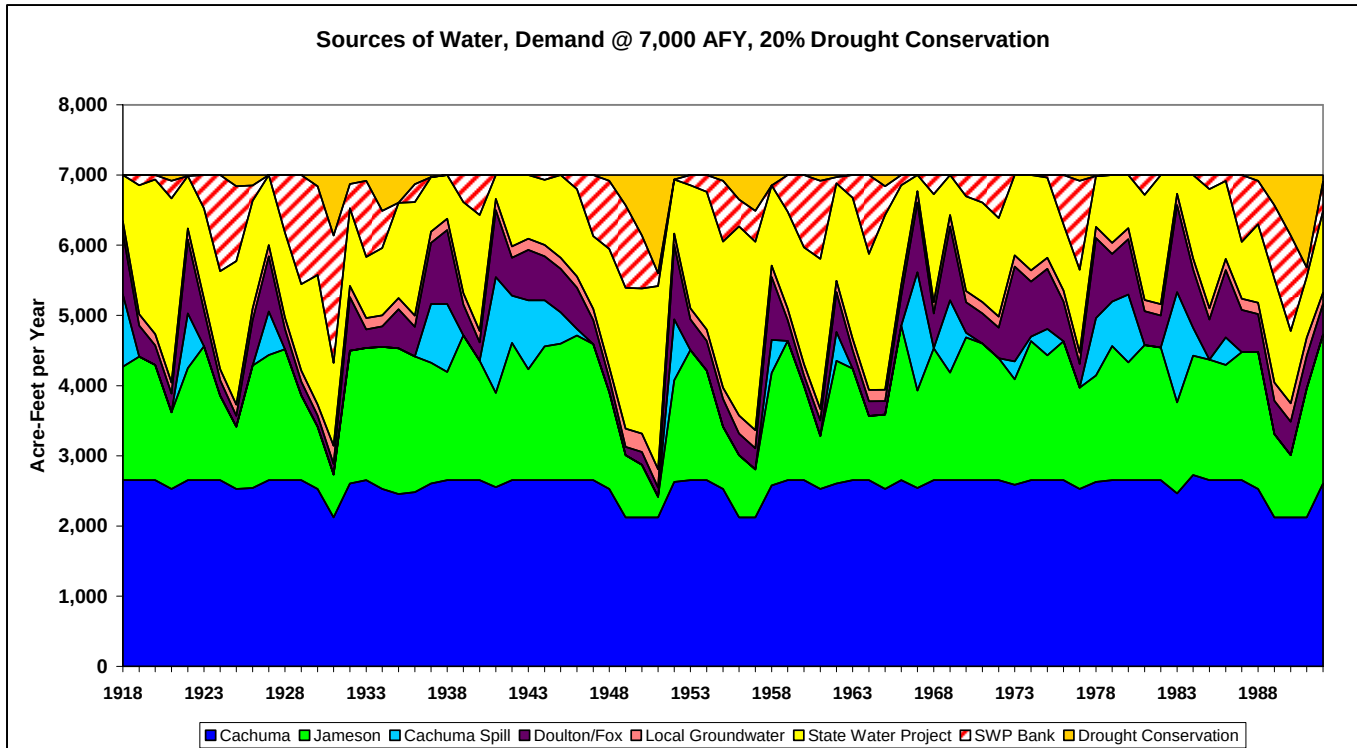


Figure 23. Modeled sources of water using storage of unused State Water, 7,000 AFY demand and 20% drought conservation.

STORAGE OF STATE WATER IN CACHUMA RESERVOIR

The easiest option for storing a portion of MWD's unused State Water allocation is in Cachuma Reservoir, where it is readily available during drought periods. This banking strategy has effectively been used by MWD over the past several years. The drawback to this strategy is that Cachuma spills on the average of about once every three years, and the banked water is considered to be the first water over the dam. Thus, the banked State Water is lost completely on a regular basis. MWD would then have to refill its bank again following the spill. The cost of this storage project thus becomes the repeated replacement of the spilled storage water.

This spilled water cannot be entirely replaced only with unused portions of MWD's State Water allocation; additional supplies must be purchased during wet or average years from another source. For the purpose of this study, it was assumed that the cost of this supplemental water was equivalent to the cost of Dry-Year Program water. The amount of storage needed for each demand scenario is indicated in Table 4.

<i>Demand Scenario</i>	<i>Storage Needed (AF)</i>
6,000 AFY	2,545
6,000 AFY, 20% drought conservation	1,683
7,000 AFY	7,732
7,000 AFY, 20% drought conservation	6,228

Table 4. Size of State Water drought supply bank when water is stored in Cachuma.

Replacement of some portion of the spilled water needs to occur soon after the spill event; dry periods can follow these spill events within several years and the bank needs to be in place for these dry years. A set of procedures for operating the Cachuma banking project were tested to identify the optimum procedure that is both least costly and meets the objective of supplying sufficient drought supply. The cost of each of these procedures is indicated in Table 5.

- 1) Replace spilled storage water in the same water year as the spill (Year 1)
 - This method is the most expensive, because spill water may be replaced just prior to a second year of spill (consecutive spill years are common during wet cycles).
- 2) Replace spilled storage water in the water year following the spill (Year 2)
 - This method is less costly because the repeated spill-replace-spill scenario of consecutive wet years is avoided.
- 3) Replace spilled water over the two years following the spill (Years 2 and 3)
 - This method replaces half of the spilled water in the year following the

spill and the remaining portion in year after that. Although this option is less costly, significant amounts of supplemental water for storage must be purchased in the midst of the worst droughts to prevent supply shortfalls; this water may not be always be available in these situations.

- 4) Replace one half of spilled water in Year 2, remainder from unused State Water, modify when Cachuma storage less than 100,000 AF – This alternative replaces one half of spilled water in the water year following the spill, then continues to fill the bank over the following years with any unused State Water. However, in the first year that Cachuma storage drops below 100,000 acre-feet, the bank is bolstered by a one-time addition of water equal to one half of the total bank storage needed (not to exceed maximum bank storage). This method reduces costs in purchasing storage water when Cachuma is relatively full, but immediately augments the bank when Cachuma storage falls, indicating a potential imminent drought. Although some supplemental water must be used when large quantities of water are added to the bank, this water is not purchased in the middle of a drought and is more likely to be available. Applying this method to model results, there is never a need to obtain additional water supplies during the worst of a drought because the bank has sufficient water to meet demand.

<i>Cachuma Storage Method</i>	<i>Costs @ 6,000AFY Demand Levels</i>	<i>Costs @ 7,000AFY Demand Levels</i>
<i>1) Replace Spill in Year 1</i>	\$2,675	\$1,831
<i>2) Replace Spill in Year 2</i>	\$1,808	\$1,436
<i>3) Replace Spill in Years 2 & 3</i>	\$1,408	\$1,301
<i>4) Replace Spill in Year 2 & beyond (augment by ½ if Cachuma<100K)</i>	\$1,395	\$1,070

Table 5. Cost per acre-foot of banked water delivered during drought from Cachuma storage project.

Therefore, the most favorable all-around Cachuma storage project is method 4, where Cachuma storage levels trigger purchase of additional water early in a potential drought when these supplies are more likely available. A Cachuma banking project employing this method is relatively easy to operate, using the following steps illustrated in Figure 24. In addition, a year-by-year example of the operation of the Cachuma bank is included in Appendix C.

In any water year, purchase the entire unused portion of MWD's State Water allocation for storage in Cachuma without exceeding the maximum size of the required storage bank (e.g., 7,732 AF at the 7,000 AFY demand level), except:

- 1) In a water year when Cachuma has spilled the banked water, do not purchase any water for banking.

- 2) In the water year following a Cachuma spill, purchase and store water in the amount equal to one half of the storage bank requirement (e.g., 3,866 AF at the 7,000 AFY demand level). This purchase may require an additional source of water besides the unused portion of MWD's State Water entitlement.
- 3) In the first water year in which storage levels in Cachuma Reservoir drop below 100,000 AF, purchase and store water in the amount of water equal to one half of the maximum storage bank requirement (e.g., 3,866 AF at the 7,000 AFY demand level) without exceeding the maximum size of the required storage bank (e.g., 7,732 AF at the 7,000 AFY demand level). This purchase may require an additional source of water besides the unused portion of MWD's State Water entitlement.

The costs of operating a Cachuma State Water Bank over the length of the Santa Ynez River enhanced model are indicated in Figure 25 for a demand scenario of 7,000 AFY.

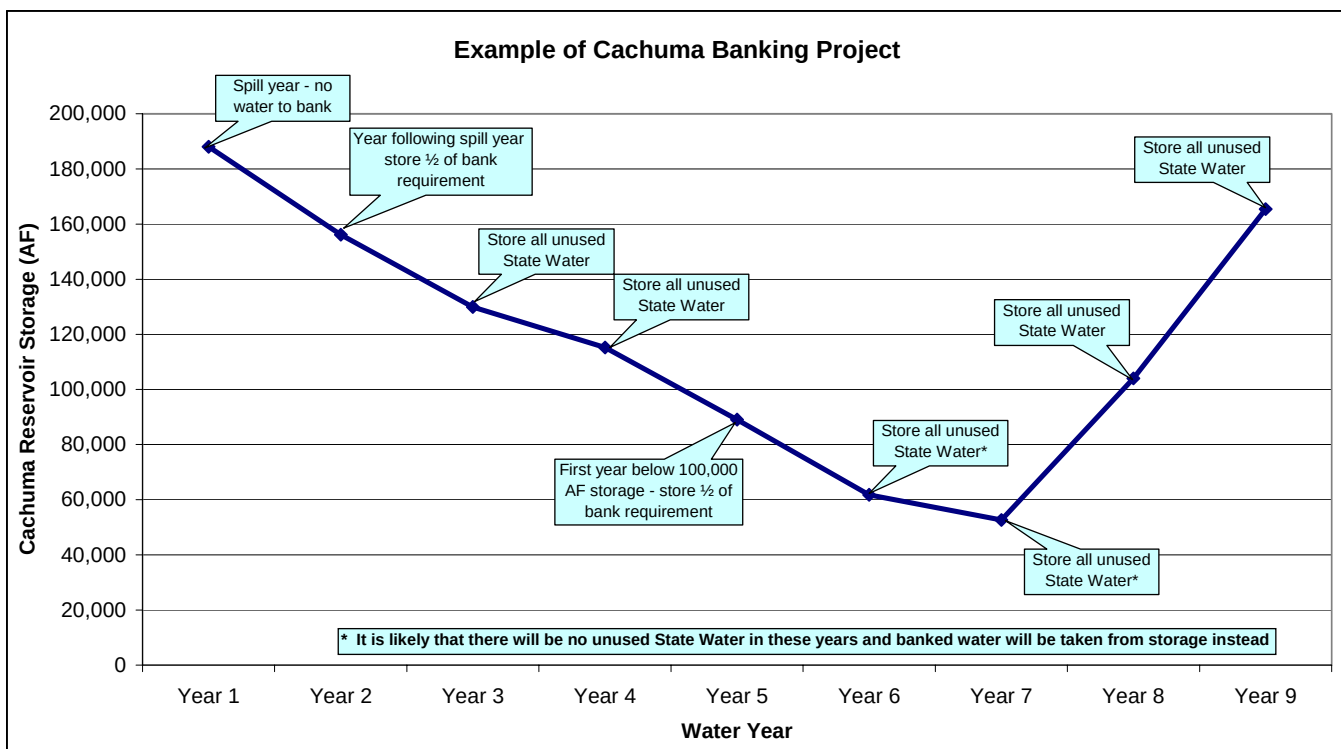


Figure 24. A banking example to illustrate the storage criteria for Cachuma State Water Bank.

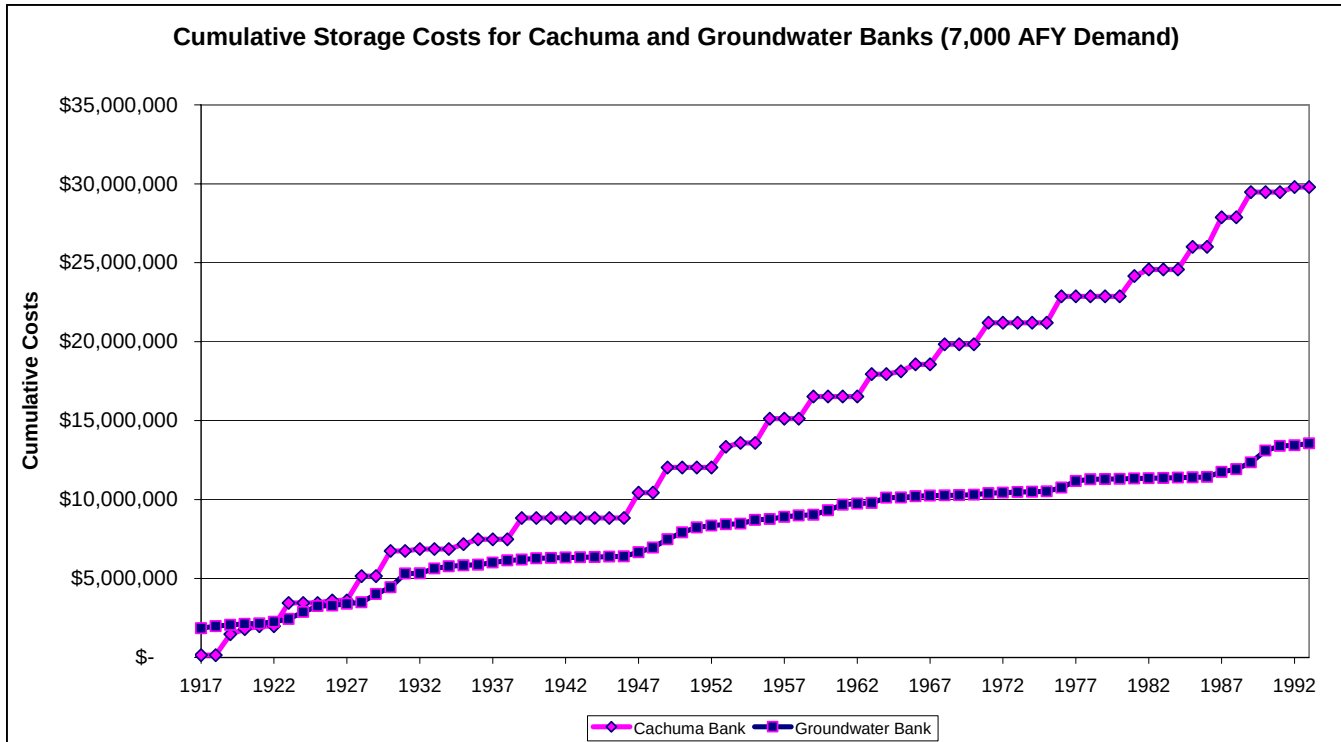


Figure 25. Comparison of cumulative costs over the model period for storing State Water in Cachuma Reservoir (optimized method) and in a groundwater bank at the 7,000 AFY demand level.

STORAGE OF STATE WATER IN A GROUNDWATER BANK

Groundwater storage of a drought supply has both advantages and disadvantages. The main advantage is that the supply is not dependent upon excess space being available in a surface-water reservoir, so there are not the large losses associated with spilling stored water. However, the stored water must be recharged and then extracted from the storage aquifer. Recharge is generally accomplished through in-lieu surface-water deliveries to groundwater pumpers, who forego that amount of groundwater pumping. There are various techniques for extraction, ranging from pumping the stored water for delivery to various exchanges of water supplies. Two groundwater storage scenarios were investigated – storage both within and outside Santa Barbara County. For the example outside of the county, current costs for storing water in the Semi Tropic Water Bank were used.

Groundwater Storage Within Santa Barbara County

Local groundwater storage of a drought supply is in principle preferable because the water is close at hand when it is needed. However, groundwater storage projects are generally compromises between aquifer suitability, accessibility, and institutional considerations. MWD overlies a relatively small

aquifer with limited storage capability. In addition, there are many small private pumpers who tap into the aquifer and would likely complicate storage attempts by pumping the stored water.

Among other storage options are Goleta and Santa Maria. The aquifer under Goleta has been used for groundwater storage by Goleta Water District, and Goleta is in the process of expanding that program. MWD has had discussions with Goleta Water District over the past several years on sharing a portion of a groundwater storage program; Goleta has not turned down such an idea, but has taken a go-slow approach. Given MWD's current demand that has exceeded 6,000 AFY (when storage is required to weather a drought without shortfalls), it would not be prudent for MWD to wait out a decision by Goleta on a shared storage program. There may be future opportunities with Goleta as MWD expands its need for drought storage.

The Santa Maria basin had been considered to be in overdraft, with subsequent creation of storage space in the aquifers of the basin. However, water levels in the basin recovered rapidly during the wet period of the 1990s, and a 2004 court decision in Phase 3 of litigation to adjudicate the basin declared that the basin was not now in overdraft. Thus, the basin is not a good geologic candidate for an MWD storage project because filling of the basin in wet periods would "spill" MWD's stored water. The basin may be a candidate for a storage project in the future if basin pumping increased and storage space was created, and if the basin adjudication permits groundwater banking.

Groundwater Storage Outside of Santa Barbara County

There are a number of ongoing groundwater banking projects operated by public agencies along the State Water Project in the Central Valley. These banking projects are being used extensively for drought supply by southern California water agencies such as Metropolitan Water District and Castaic Lake Water Agency. These banking projects have existing rules of operation, and any agency with access to the State Water Project can generally "rent" storage space.

The mode of operation in each groundwater banking project can vary but they have common elements. For MWD, such a bank would likely work in the following manner:

- MWD purchases rights to store a certain amount of water in the bank.
- When MWD wants to store unused State Water, that portion of State Water would be delivered to the banking agency instead of MWD. The banking agency would deliver it to agricultural pumpers, who would use it directly rather than pumping a like amount of groundwater. Thus, the in-lieu recharge created by this delivery creates a storage credit in the aquifer.

- When MWD wants to retrieve stored water, extra State Water is delivered to MWD directly from the State Water Project. The banking agency would either pump a like amount of groundwater into the State Project aqueduct or forego a like amount of State Water for their needs.

There are pros and cons of groundwater banking:

- Pro – The banked groundwater can be stored for multiple years without threat of loss;
- Pro – The cost of groundwater banking is currently less expensive than storing water in Cachuma Reservoir (see Figure 25 and Table 6);
- Con – There must be sufficient water in the State Project aqueduct at the time of delivery to divert the extra water to MWD;
- Con – The groundwater pumped back into the State Project aqueduct must meet appropriate water quality standards. There is a concern that the new drinking water standard for arsenic may require treatment of this groundwater before it is pumped into the aqueduct, raising future banking costs.

The capacity of the Coastal Aqueduct, which brings State Water from the San Joaquin Valley to Santa Barbara and San Luis Obispo counties, also needs to be determined to ensure that banked water can be transported to MWD during dry periods.

The groundwater banking project operated by Semi Tropic Water District in northern Kern County was used as an example to estimate potential groundwater banking costs for MWD. Banking costs include: \$233 per AF one-time fee for storage rights; annual management fee of \$1 per AF of storage rights; annual maintenance fee of \$1.33 per AF of storage rights; one-time recharge fee of \$20 for each AF put in the bank; one-time extraction fee of \$20 for each AF taken from the bank; and an energy fee for pumping the water from the bank (assumed here to be \$50/AF). In addition, there would be State Water Project variable costs for initial delivery to Semi Tropic (assumed here to be \$25/AF) and subsequent delivery to MWD (\$250/AF).

The cost of storing water in the Semi Tropic bank during the 76 years used in the river model is indicated in Table 6. The cost of obtaining storage rights front-load the costs somewhat (see Figure 25).

<i>Demand Scenario</i>	<i>Storage Needed (AF)</i>	<i>Cost per AF Delivered</i>
6,000 AFY	2,545	\$534
6,000 AFY, 20% drought conservation	1,683	\$556
7,000 AFY	7,732	\$487
7,000 AFY, 20% drought conservation	6,228	\$498

Table 6. Groundwater storage bank cost example, SemiTropic Water Bank. Cost is for one acre-foot of banked water delivered to Cachuma during a drought.

OPERATIONAL COORDINATION WITH CARPINTERIA VALLEY WATER DISTRICT (CVWD)

Both MWD and CVWD share capacity in the SCC. As water demand increases during buildout, there will be increased use of the SCC, up to its carrying capacity. At the 7,000 AFY demand level for MWD, the enhanced river model indicates that there are times during dry years when MWD's portion of SCC capacity is exceeded by up to 2 cfs (Figure 26). MWD should work cooperatively with CVWD to explore programs to alleviate this possible problem if it should develop.

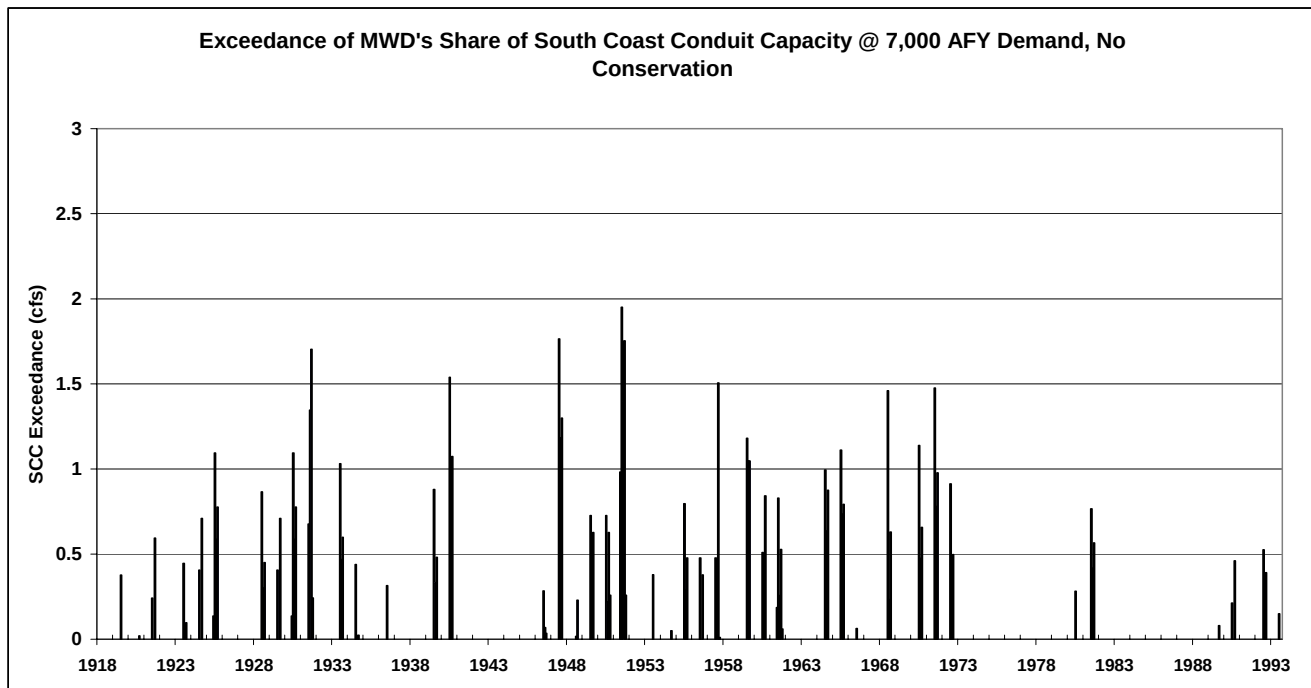


Figure 26. Exceedance of MWD's share of capacity of South Coast Conduit during demand scenario of 7,000 AFY, determined from 76-year enhanced river model.

ENHANCED SUPPLY RELIABILITY

Implementation of the recommendations in this report regarding reservoir operations and augmenting drought supplies through storage of unused State Water will result in significant enhancement of supply reliability for MWD. Applying the recommended drought storage volumes, there were no shortages of water supply during droughts over the 76 years of the enhanced Santa Ynez River model. This period not only included the drought of 1986 to 1991, but also the more severe drought of 1946 to 1952. For the State Water Project, the model period included the driest set of years in several hundred years.

The demand scenarios of 6,000 and 7,000 AFY used in the model cover the range of demand currently experienced by MWD. However, if water demand from existing meters continues to increase as it has for the past several years⁹, higher demand scenarios will have to be examined. An analysis of supplies at the 8,000 AFY demand level is included in Appendix E of this report. Although these higher demand levels can be met by MWD, the cost of added storage substantially increases the cost of the water supply.

For the groundwater bank evaluated at the 6,000 AFY and 7,000 AFY demand levels, source water for the bank can apparently be generated entirely from unused portions of MWD's State Water allocation. For demand levels higher than 7,000 AFY and for all Cachuma bank scenarios, additional sources of water will have to be procured for the storage program.

FINDINGS AND CONCLUSIONS

The enhanced Santa Ynez River Model, coupled with results from a similar model for northern California that predicts State Water availability, was used over the 76-year period from 1917 to 1993 to examine MWD's various sources of water supply. This work led to the following principal findings and conclusions:

- 1) Allocations for Cachuma Reservoir and State Project water held by the District, supplies from Jameson Reservoir and other local surface sources, together with groundwater supplies will yield 9,000 acre-feet per year under ideal conditions, compared to a current demand for water of between 6,000 and 7,000 acre-feet per year.
- 2) During drought periods such as 1986 to 1991, these sources would not be able to meet the District's current demand, supplying only on the order of 5,000 acre-feet per year.

⁹ Bachman, S., 2003, MWD Future Supply/Demand and Aquifer Storage; study, oral report, graphical presentation to MWD Board.

- 3) In order to avoid significant shortfalls in water supply during drought periods at current levels of demand as well as even greater shortfalls in the future with increased demand, the present program of storage of unused State Water (banking for future use) in Cachuma Reservoir should be continued.
- 4) The banking program should envision storage of at least 2,500 acre-feet under current levels of demand and up to 7,700 acre-feet when demand approaches 7,000 acre-feet annually.
- 5) It appears that there are groundwater banking opportunities at other locations that would be less costly than the use of Cachuma Reservoir, as the risk of losing banked water during periods of spill would be avoided.
- 6) With continuation of the current banking program at Cachuma Reservoir or at other locations which might prove feasible, and with the possibility of dry-year water from northern California sources, the District should have sufficient water to meet demands for many years. However, as demand levels increase, costs of meeting these demands go up substantially.
- 7) The capacity of the aqueduct system from the San Joaquin Valley to Cachuma Reservoir that is available for use by MWD may be the limiting factor in the amount of water that can be delivered to the District from sources outside of Santa Barbara County. This matter is currently under study by CCWA.
- 8) In order to minimize future costs of banking and/or purchase of expensive dry-year water, it would be prudent for the District to develop a water conservation plan which among its elements should include a program of public education and awareness to encourage reduction of usage during drought periods and to mitigate the continuing increase in overall consumer water use.
- 9) A proposed rule curve for drafting Jameson Reservoir decreases the rate of drafting as the reservoir is lowered. This rule curve satisfied the dual objectives of maximizing reservoir yield and preserving enough storage to serve high-elevation customers during drought.
- 10) The proposed storage criteria for a Cachuma Reservoir bank presented herein consider costs and reliability so that the replacement costs of spilled banked water are minimized.

RECOMMENDATIONS

As a result of this investigation to develop a plan of optimization of the District's water supplies, it is recommended that:

- 1) To optimize the District's use of Santa Ynez River water both with respect to availability and cost, the Jameson Rule Curve developed in this study be implemented as soon as practicable.
- 2) The current District practice of pumping groundwater during drought periods to the maximum extent feasible be continued. Minimal groundwater should be pumped during wet or normal rainfall periods to allow the groundwater basin to recharge.
- 3) The current program of banking unused State Water in Cachuma Reservoir be continued until a lower-cost option can be implemented.
- 4) The current Cachuma banking program be optimized using the criteria developed in this report.
- 5) Lower-cost banking options as well as dry-year sources in northern California be investigated as soon as possible in conjunction with the Central Coast Water Authority.
- 6) A cooperative program be developed with the Carpinteria Valley Water District to overcome capacity limitations in the South Coast Conduit.
- 7) Continue to work with the staff of CCWA to ascertain the capacity available to MWD in the aqueduct system from the San Joaquin Valley to Cachuma Reservoir.
- 8) A water conservation plan be prepared as suggested herein which among its elements should include a program of public education and awareness to encourage reduction of usage during drought periods and to mitigate the continuing increase in overall consumer water use.

APPENDIX A. DESCRIPTION OF MODEL VERSIONS

Model Configuration 1: The initial annual water demand for MWD in the model was set at the Urban Water Management Plan Year 2010 level of 6,506 AFY. The model starts each month with a seasonally varying demand level (monthly percentage of annual demand based on historic MWD percentages) which is met by Doulton Tunnel plus Fox Creek diversion flows plus pumped groundwater and default Cachuma Project water deliveries for that month. If those three waters meet the demand level then any extra Cachuma Project (CP) water is saved as a surplus for the next month, and any available State Water is put into an upstream State Water Project (SWP) bank up to a maximum capacity level set for the bank. For this case Jameson Reservoir diversions are set to zero.

If more water than any extra CP water from last month is needed, then it must come from either Jameson or from that month's available and/or banked SWP water. If sufficient SWP monthly direct delivery water is available, then the remaining demand is met by that source; any extra is put into upstream water bank up to the bank account capacity limit and Jameson Reservoir diversions (Jdivs) are set to zero. Otherwise, any extra demand is met by banked SWP water and/or Jameson Reservoir water. If the 20% delivery reduction is in place for Cachuma when local conditions are dry, the remaining demand is met by SWP water (if there is enough SWP water, then Jdivs are set to zero), or by SWP water and Jdivs. If 100% CP deliveries are available, then the additional demand is met by Jdivs. Each month the quantity of water delivered to MWD via the SCC is monitored. This is CP water and/or SWP water. The quantity thus delivered is saved in a table, and the monthly amounts exceeding a delivery rate of 20.8 AF per day for the month are also saved in another table as an exceedence of MWD's share of SCC capacity.

The problem with this first approach to modeling monthly water deliveries for MWD is that the Jdivs are way too small (811 AFY) on average, and undesirably large at times when the lake storage is low. To avoid Jameson storage dropping below a minimum pool of 700 AF, the upstream SWP bank size must be 4,345 AF.

Model Configuration 2: Configuration 2 contains a much better procedure for utilizing Jameson Reservoir. The lake diversions (Jdivs) are based upon two modes of operation. First is a default beginning of month safe yield type diversion which, depending on the month and other sources of supply, may be augmented by additional diversions up to the entire monthly need minus groundwater pumped and Doulton Tunnel + Fox Creek flows and available CP water. These additional Jdivs are available in a tiered fashion as a function of last month's end-of-month

lake storage. When Jameson Reservoir storage drops below 2,400 AF, only the default safe yield for the month is taken. If lake storage drops below 1,200 AF, then the default safe yield take is reduced by 60%. When annual MWD demand is at the 6,506 AFY level, the default safe yield is set at 886 AFY, and the 76 year (912 months) average lake yield is a robust 1,698 AFY.

Each month, MWD water deliveries are initially built up using pumped groundwater, tunnel inflows (tunnel here means Doulton Tunnel + Fox Creek diversions, if any), and the default safe yield Jdivs. If this is sufficient water to meet the monthly demand level (in the model, with historic tunnel flows, this only occurs if annual demand levels drop below 6,000 AFY), then CP water for the month is carried over to the next month as a surplus and groundwater pumping and/or Jdivs are reduced to meet the exact monthly demand volume. Available SWP water for the month is used to augment the upstream SWP bank account if not already full. However, this initial water delivery is generally not sufficient to meet the monthly demand and is therefore augmented by this month's normal CP delivery plus any CP surplus water from the previous month.

If this quantity meets the demand, then any extra CP water becomes CP surplus water for the next month, and, as before, SWP water can be used to augment the upstream SWP bank. This condition shows up for a few months out of the 912 month modeling period even at the 7,000 AFY demand level. If, however, more water is required to meet the monthly demand, and if this need is greater than the month's available SWP water, then the need is reduced by the SWP water, with any remaining need met by Jdivs and/or the upstream SWP bank. If the need is less than the monthly SWP water, then the need is first met by additional Jdivs, if available, and then by monthly SWP water. Any leftover SWP water is then used to augment the upstream SWP bank. As noted above, the modeling period average Jameson yield (Jdivs) is 1,698 acre-feet. The upstream SWP bank size required for no shortages at the 6,506 AFY demand level is 5,523 acre-feet.

Model Configuration 3: The next modeling effort was directed toward adding a SWP water bank at Cachuma Reservoir. Some changes were made to the model structure at this time. The MWD build delivery routine was made a subprogram in the model instead of a growing part of the main modeling subprogram of SYRM (a condition which results in a "Module Code too large" error). Also, code lines for depositing and withdrawing water from the upstream SWP and Cachuma water banks were placed into *DepositTo* and *WithdrawFrom* Banks subprograms. Most of the new variable names in the MWD build delivery program were shortened. Four new tables were created to save model run data related to the Cachuma SWP water bank. These tables save the monthly values for bank deposits, bank withdrawals, bank account, banked SWP water losses due to evaporation, and reservoir spills.

A range of banking scenarios was attempted with this version of the model. It became obvious that if SWP water was stored in Cachuma year round, the losses of that water due to evaporation and spilling (the great majority of losses were due to spilling) were a function of the Cachuma storage above which no more bank deposits are allowed, and the size of the bank account. The following table shows the relationship of bank account maximum size, deposits, withdrawals, losses, and maximum reservoir storage-allowing-deposits threshold (excepting the storage threshold, all values are 76-year modeling period average annual values):

Max Storage Threshold	Bank Size	Deposits	Withdrawals	Losses	% Lost
100,000 acre-feet	400	57	33	24	42
100,000 “	1000	76	33	43	57
100,000 “	2000	78	33	45	58
100,000 “	3000	78	33	45	58
120,000 “	400	92	43	49	53
120,000 “	600	109	43	66	61
120,000 “	1000	133	43	90	68
120,000 “	2000	150	43	107	71
120,000 “	3000	156	43	113	72
140,000 “	400	121	55	66	55
140,000 “	600	143	57	86	60
140,000 “	1000	169	57	112	66
140,000 “	2000	197	57	140	71
140,000 “	3000	203	57	146	72

On top of the very large loss percentages indicated in the table, there is the other significant fact that this Cachuma SWP bank, for all of the maximum bank sizes shown in the table, has little or no impact on the size of the upstream SWP bank required to enable full deliveries through the 76-year modeling period at the 6,506 AFY demand level. As with Model Configuration 2, this version showed a Jameson Reservoir average yield of 1,698 AFY and an upstream SWP bank size requirement of 5,528 AF for no shortages at the MWD 6,506 AFY demand level.

Model Configuration 4: Model Configuration 3 operated many display subprograms that are not necessary for MWD supply purposes and used considerable memory in the older software running the model. Therefore some major stripping away of a number of unnecessary display subprograms and associated data arrays was undertaken to free up space for the expanding model runs.

Model Configuration 4 added several features to those of Model Configuration 3. First, a new Cachuma SWP seasonal water bank was developed. This bank only deposits water in the April through July time window and only if Cachuma Reservoir is finished with any spilling for the year. The losses of this water are evaporation only, and thus nearly all of the water is available for use during the May through November time frame. This type of SWP bank may be useful as insurance for more SWP water availability during the high summer demand periods in case any glitches occur in the regular SWP delivery schedule.

The second feature is the addition of a spill status identifier which allows monthly calculations for MWD water deliveries to be made knowing that Cachuma Reservoir was or was not spilling during the present calculation month. Each month, calculations in the model proceed sequentially, east to west, from Jameson Reservoir to Lompoc Valley. MWD calculations are performed with Jameson Reservoir in the early part of this sequence. To know whether Cachuma is spilling or will spill during the calculation month requires running the model in a preliminary iteration where the Cachuma spill status flags are set; the calculations are then repeated for the MWD portion of the model with the correct Cachuma status flags in place.

The third new feature in Model Configuration 4 is the handling of water available when Cachuma Reservoir is spilling. During a Cachuma spill, MWD deliveries are comprised of base Jdivs plus Tunnel plus groundwater pumping (if any), and the balance comes from Lake Cachuma (and is not CP water).

The fourth feature added to Model Configuration 4 is the correct handling of CP carryover water (Cachuma Project water carried over to the next October through September water-year). At the beginning of the water year, carryover water, if any, must be used before any Project (CP) water is taken. This water, like SWP water stored in Lake Cachuma, is subject to evaporation and reservoir spill losses. The fifth and last new feature added to Model Configuration 4 is a limitation on Jdivs such that Tunnel plus Jdivs in any month cannot exceed 265 AF. The south Portal, Doulton Tunnel flow treatment plant is scheduled to have a 265 AF/ month capacity by sometime in the year 2006 (pers commun, Steve Hickox). The Jdivs 76-year average yield with Model Configuration 4 is 1,548 AFY (smaller than Model Configuration 3 mainly because of the 265 AF/month south Portal limitation). The upstream SWP bank size required for no MWD shortages over the 76-year modeling period is 4,913 AF.

Model Configuration 5: Two changes were implemented to fine-tune the interaction between Cachuma and Jameson reservoirs. The first change was to the way *CacRedFac!* (Cachuma delivery reduction factor) is changed during the model run. For Model Configurations 1 thru 4, the factor was reduced from 1.0 to 0.8 whenever the beginning of the month Cachuma storage dropped below

100,000 AF. The change is that this factor is reduced only if the October 1st storage (the beginning of the new water year) is found to be below 100,000 AF; this is the way the Cachuma member units are accomplishing the 20% reduction at this time.

The second change adds an October thru September water-year Jameson Reservoir diversion (Jdivs) limitation of 2,000 AFY. This change caused only a small loss in average annual Jdivs yield (1548 AFY reduced to 1541 AFY). The upstream SWP bank size at the 6,506 AFY demand level is 4,481 AF. This bank size is smaller than the 4,913 AF size in Model Configuration 4, which does not limit Jdivs to 2,000 AFY. This reduction in bank size is related to the amount of storage required for MWD to have adequate supplies during the 1929-1934 northern California drought (the SWP's most critical stage in the period); Jameson Reservoir had more water to deliver during this critical SWP period, thus reducing reliance on the upstream SWP bank. Thus, it is ironic that the 2,000 AFY Jameson limitation is actual an advantage in reducing necessary SWP storage.

Model Configuration 6: In this version, an MWD conservation algorithm was developed and added to the MWD monthly build delivery program code. This conservation algorithm can be used with the earlier configurations. With drought conservation that reaches 20% in the worst drought years, Jameson yield (for 6,506 AFY demand) is reduced to 1536 AFY, whereas the upstream SWP bank size is reduced from 4,481 to 3,462 AF.

Model Configuration 7: This model version combines model configurations 5 and 6 (i.e. conservation can be turned on or off) with the addition of two small revisions. The first revision portions out the summer diversions from Jameson Reservoir so that September diversions are not zero or very small amounts. This revision was necessary because of the 2,000 AFY water year diversion limitation imposed at Jameson Reservoir. The second revision makes sure that Cachuma SWP seasonal bank water that is carried over into the next October-September water year is used up as much as possible during the fall quarter, so that losses of that water due to Cachuma reservoir spills do not occur.

Model Configuration 8: This model version is simply Model Configuration 7 minus all SWP water banks. It was created to demonstrate whether supply shortages would occur if there was no SWP water banked.

Model Configuration 9: This model version is Model Configuration 7, with a modification to Jameson diversions to test the effect of constant Jameson drafts of 1,000 AFY and 2,000 AFY. The build delivery sub-program places diversions from Jameson Reservoir first in line each month. Jameson is drafted at a constant rate until Jameson storage goes below 700 AF; at this point, diversions are set to

zero and water flows at the South Portal are comprised of tunnel seepage and Fox Creek diversions only.

Model Configuration A: This model version is Model Configuration 8 (no water banks), with the same modifications to Jameson diversions as in Configuration 9.

APPENDIX B. TABULAR RESULTS OF STORAGE COST ANALYSES

Tabular results of various storage scenarios are included in this appendix in the following order:

- Cachuma storage, 6,000 AFY demand
- Cachuma storage, 6,000 AFY demand with 20% drought conservation
- Cachuma storage, 7,000 AFY demand
- Cachuma storage, 7,000 AFY demand with 20% drought conservation
- Groundwater bank storage, 6,000 AFY demand
- Groundwater bank storage, 6,000 AFY demand with 20% drought conservation
- Groundwater bank storage, 7,000 AFY demand
- Groundwater bank storage, 7,000 AFY demand with 20% drought conservation

MWD Storage Options -- Cachuma Banking -- 6,000 AFY Demand, No Drought Conservation											
Variable cost SWP @ Cachuma= \$ 250											
Dry Year Purchase Program Admin Cost/AF= \$ 5.00 Price w/option/AF= \$ 125.00 Carriage Loss= 20% CCWA delivery= \$ 250.00											
	To	From	Cachur	SWP	SWP	Dry Yr	Dry Yr	Dry Yr		Annual	
Year	Storage	Storage	Spill?	Avail	In	Supplies	Supplies	Supplies	Storage	Water	Total
						Order	Deliv	Cost	Acct	Purchase	Costs-to-Date
1917	755				755				755	\$ 188,750	\$ 188,750
1918			yes	3,003	0	-	\$ -	-	\$ -	\$ -	\$ 188,750
1919	2545			2,494	2,494	64	51	\$ 21,120	2,545	\$ 644,620	\$ 833,370
1920				1,974	0	-	\$ -	-	2,545	\$ -	\$ 833,370
1921				1,403	0	-	\$ -	-	2,545	\$ -	\$ 833,370
1922			yes	2,855	0	-	\$ -	-	\$ -	\$ -	\$ 833,370
1923	2545			1,692	1,692	1,066	853	\$ 351,780	2,545	\$ 774,780	\$ 1,608,150
1924		404		152	0	-	\$ -	-	2,141	\$ -	\$ 1,608,150
1925		86		307	0	-	\$ -	-	2,055	\$ -	\$ 1,608,150
1926	490			1,271	490	-	\$ -	-	2,545	\$ 122,500	\$ 1,730,650
1927			yes	2,654	0	-	\$ -	-	\$ -	\$ -	\$ 1,730,650
1928	2545	107		956	956	1,986	1,589	\$ 655,380	2,438	\$ 867,630	\$ 2,598,280
1929		510		94	0	-	\$ -	-	1,928	\$ -	\$ 2,598,280
1930		265		329	0	-	\$ -	-	1,663	\$ -	\$ 2,598,280
1931		1,661		-	0	-	\$ -	-	1	\$ -	\$ 2,598,280
1932	846			846	846	-	\$ -	-	847	\$ 211,500	\$ 2,809,780
1933	108			409	108	-	\$ -	-	955	\$ 27,000	\$ 2,836,780
1934	603			705	603	-	\$ -	-	1,558	\$ 150,750	\$ 2,987,530
1935	987			1,848	987	-	\$ -	-	2,545	\$ 246,750	\$ 3,234,280
1936				1,720	0	-	\$ -	-	2,545	\$ -	\$ 3,234,280
1937			yes	2,843	0	-	\$ -	-	\$ -	\$ -	\$ 3,234,280
1938			yes	2,885	0	-	\$ -	-	\$ -	\$ -	\$ 3,234,280
1939	2545			2,013	2,013	665	532	\$ 219,450	2,545	\$ 722,700	\$ 3,956,980
1940				1,387	0	-	\$ -	-	2,545	\$ -	\$ 3,956,980
1941			yes	3,203	0	-	\$ -	-	\$ -	\$ -	\$ 3,956,980
1942			yes	2,841	0	-	\$ -	-	\$ -	\$ -	\$ 3,956,980
1943			yes	2,488	0	-	\$ -	-	\$ -	\$ -	\$ 3,956,980
1944			yes	1,984	0	-	\$ -	-	\$ -	\$ -	\$ 3,956,980
1945			yes	2,386	0	-	\$ -	-	\$ -	\$ -	\$ 3,956,980
1946			yes	2,163	0	-	\$ -	-	\$ -	\$ -	\$ 3,956,980
1947	2545			880	880	2,081	1,665	\$ 686,730	2,545	\$ 906,730	\$ 4,863,710
1948		367		286	0	-	\$ -	-	2,178	\$ -	\$ 4,863,710
1949		543		152	0	-	\$ -	-	1,635	\$ -	\$ 4,863,710
1950		306		285	0	-	\$ -	-	1,329	\$ -	\$ 4,863,710
1951	120			521	120	-	\$ -	-	1,449	\$ 30,000	\$ 4,893,710
1952			yes	2,928	0	-	\$ -	-	\$ -	\$ -	\$ 4,893,710
1953	2545			2,390	2,390	194	155	\$ 64,020	2,545	\$ 661,520	\$ 5,555,230
1954				1,516	0	-	\$ -	-	2,545	\$ -	\$ 5,555,230
1955				610	0	-	\$ -	-	2,545	\$ -	\$ 5,555,230
1956				877	0	-	\$ -	-	2,545	\$ -	\$ 5,555,230
1957				792	0	-	\$ -	-	2,545	\$ -	\$ 5,555,230
1958			yes	2,559	0	-	\$ -	-	\$ -	\$ -	\$ 5,555,230
1959	2545			1,474	1,474	1,339	1,071	\$ 441,870	2,545	\$ 810,370	\$ 6,365,600
1960		235		427	0	-	\$ -	-	2,310	\$ -	\$ 6,365,600
1961		56		301	0	-	\$ -	-	2,255	\$ -	\$ 6,365,600
1962			yes	1,794	0	-	\$ -	-	\$ -	\$ -	\$ 6,365,600
1963	2545	16		1,568	1,568	1,221	977	\$ 402,930	2,529	\$ 790,930	\$ 7,156,530
1964		75		502	0	-	\$ -	-	2,454	\$ -	\$ 7,156,530
1965	91			1,152	91	-	\$ -	-	2,545	\$ 22,750	\$ 7,179,280
1966				2,285	0	-	\$ -	-	2,545	\$ -	\$ 7,179,280
1967			yes	3,300	0	-	\$ -	-	\$ -	\$ -	\$ 7,179,280
1968	2545			2,610	2,545	-	\$ -	-	2,545	\$ 636,250	\$ 7,815,530
1969			yes	2,957	0	-	\$ -	-	\$ -	\$ -	\$ 7,815,530
1970			yes	2,577	0	-	\$ -	-	\$ -	\$ -	\$ 7,815,530
1971	2545			2,004	2,004	676	541	\$ 223,080	2,545	\$ 724,080	\$ 8,539,610
1972				1,140	0	-	\$ -	-	2,545	\$ -	\$ 8,539,610
1973			yes	2,874	0	-	\$ -	-	\$ -	\$ -	\$ 8,539,610
1974			yes	2,653	0	-	\$ -	-	\$ -	\$ -	\$ 8,539,610
1975			yes	2,416	0	-	\$ -	-	\$ -	\$ -	\$ 8,539,610
1976	2545	40		759	759	2,233	1,786	\$ 736,890	2,505	\$ 916,640	\$ 9,456,250
1977		309		271	0	-	\$ -	-	2,196	\$ -	\$ 9,456,250
1978			yes	2,874	0	-	\$ -	-	\$ -	\$ -	\$ 9,456,250
1979			yes	2,678	0	-	\$ -	-	\$ -	\$ -	\$ 9,456,250
1980			yes	2,963	0	-	\$ -	-	\$ -	\$ -	\$ 9,456,250
1981	2545			2,514	2,514	39	31	\$ 12,870	2,545	\$ 641,370	\$ 10,097,620
1982				2,433	0	-	\$ -	-	2,545	\$ -	\$ 10,097,620
1983			yes	3,291	0	-	\$ -	-	\$ -	\$ -	\$ 10,097,620
1984			yes	2,333	0	-	\$ -	-	\$ -	\$ -	\$ 10,097,620
1985	2545			1,727	1,727	1,022	818	\$ 337,260	2,545	\$ 769,010	\$ 10,866,630
1986			yes	2,143	0	-	\$ -	-	\$ -	\$ -	\$ 10,866,630
1987	2545	154		421	421	2,655	2,124	\$ 876,150	2,391	\$ 942,900	\$ 11,809,530
1988	154			448	154	-	\$ -	-	2,545	\$ 38,500	\$ 11,848,030
1989		563		311	0	-	\$ -	-	1,982	\$ -	\$ 11,848,030
1990		1,201		21	0	-	\$ -	-	781	\$ -	\$ 11,848,030
1991	97			344	97	-	\$ -	-	878	\$ 24,250	\$ 11,872,280
1992	1592			1,595	1,592	-	\$ -	-	2,470	\$ 398,000	\$ 12,270,280
1993			yes		0	-	\$ -	-	\$ -	\$ -	\$ 12,270,280

MWD Storage Options -- Cachuma Banking -- 6,000 AFY Demand, 20% Drought Conservation											
Variable cost SWP @ Cachuma= \$ 250											
Dry Year Purchase Program Admin Cost/AF= \$ 5.00 Price w/option/AF= \$ 125.00 Carriage Loss= 20% CCWA delivery= \$ 250.00											
	To	From	Cachur	SWP	SWP	Dry Yr	Dry Yr	Dry Yr		Annual	
Year	Storage	Storage	Spill?	Avail	In	Supplies	Supplies	Supplies	Storage	Water	Total
						Order	Deliv	Cost	Acct	Purchase	Costs-to-Date
1917	755			755	755			\$ -	755	\$ 188,750	\$ 188,750
1918	0		yes	3,003	0			\$ -		\$ -	\$ 188,750
1919	1683			2,494	1,683			\$ -	1,683	\$ 420,750	\$ 609,500
1920	0			1,974	0			\$ -	1,683	\$ -	\$ 609,500
1921	0			1,472	0			\$ -	1,683	\$ -	\$ 609,500
1922	0		yes	2,863	0			\$ -		\$ -	\$ 609,500
1923	1683			1,692	1,683			\$ -	1,683	\$ 420,750	\$ 1,030,250
1924	0			152	0			\$ -	1,279	\$ -	\$ 1,030,250
1925	52			340	52			\$ -	1,331	\$ 13,000	\$ 1,043,250
1926	352			1,393	352			\$ -	1,683	\$ 88,000	\$ 1,131,250
1927	0		yes	2,654	0			\$ -		\$ -	\$ 1,131,250
1928	1683	107		956	956	909	727	\$ 299,970	1,576	\$ 512,220	\$ 1,643,470
1929	0	510		94	0			\$ -	1,066	\$ -	\$ 1,643,470
1930	0	127		329	0			\$ -	939	\$ -	\$ 1,643,470
1931	0	910		28	0			\$ -	29	\$ -	\$ 1,643,470
1932	1277			1,188	1,277			\$ -	1,306	\$ 319,250	\$ 1,962,720
1933	377			444	377			\$ -	1,683	\$ 94,250	\$ 2,056,970
1934	0			858	0			\$ -	1,683	\$ -	\$ 2,056,970
1935	0			1,991	0			\$ -	1,683	\$ -	\$ 2,056,970
1936	0			1,875	0			\$ -	1,683	\$ -	\$ 2,056,970
1937	0		yes	2,882	0			\$ -		\$ -	\$ 2,056,970
1938	0		yes	2,885	0			\$ -		\$ -	\$ 2,056,970
1939	1683			2,013	1,683			\$ -	1,683	\$ 420,750	\$ 2,477,720
1940	0			1,387	0			\$ -	1,683	\$ -	\$ 2,477,720
1941	0		yes	3,203	0			\$ -		\$ -	\$ 2,477,720
1942	0		yes	2,841	0			\$ -		\$ -	\$ 2,477,720
1943	0		yes	2,488	0			\$ -		\$ -	\$ 2,477,720
1944	0		yes	1,984	0			\$ -		\$ -	\$ 2,477,720
1945	0		yes	2,386	0			\$ -		\$ -	\$ 2,477,720
1946	0		yes	2,163	0			\$ -		\$ -	\$ 2,477,720
1947	1683			880	880	1,004	803	\$ 331,320	1,683	\$ 551,320	\$ 3,029,040
1948	0	298		303				\$ -	1,385	\$ -	\$ 3,029,040
1949	0	167		230				\$ -	1,218	\$ -	\$ 3,029,040
1950	431			615	431			\$ -	1,649	\$ 107,750	\$ 3,136,790
1951	34			1,314	34			\$ -	1,683	\$ 8,500	\$ 3,145,290
1952	0		yes	2,982	0			\$ -		\$ -	\$ 3,145,290
1953	1683			2,390	1,683			\$ -	1,683	\$ 420,750	\$ 3,566,040
1954	0			1,516	0			\$ -	1,683	\$ -	\$ 3,566,040
1955	0			679	0			\$ -	1,683	\$ -	\$ 3,566,040
1956	0			1,164	0			\$ -	1,683	\$ -	\$ 3,566,040
1957	0			1,156	0			\$ -	1,683	\$ -	\$ 3,566,040
1958	0		yes	2,658	0			\$ -		\$ -	\$ 3,566,040
1959	1683			1,474	1,474	261	209	\$ 86,130	1,683	\$ 454,630	\$ 4,020,670
1960	0	235		427	0			\$ -	1,448	\$ -	\$ 4,020,670
1961	13			318	13			\$ -	1,461	\$ 3,250	\$ 4,023,920
1962	0		yes	1,821	0			\$ -		\$ -	\$ 4,023,920
1963	1683	16		1,568	1,568	144	115	\$ 47,520	1,667	\$ 435,520	\$ 4,459,440
1964	0	75		502	0			\$ -	1,592	\$ -	\$ 4,459,440
1965	91			1,217	91			\$ -	1,683	\$ 22,750	\$ 4,482,190
1966	0			2,291	0			\$ -	1,683	\$ -	\$ 4,482,190
1967	0		yes	3,300	0			\$ -		\$ -	\$ 4,482,190
1968	1683			2,610	1,683			\$ -	1,683	\$ 420,750	\$ 4,902,940
1969	0		yes	2,957	0			\$ -		\$ -	\$ 4,902,940
1970	0		yes	2,577	0			\$ -		\$ -	\$ 4,902,940
1971	1683			2,004	1,683			\$ -	1,683	\$ 420,750	\$ 5,323,690
1972	0			1,140	0			\$ -	1,683	\$ -	\$ 5,323,690
1973	0		yes	2,874	0			\$ -		\$ -	\$ 5,323,690
1974	0		yes	2,653	0			\$ -		\$ -	\$ 5,323,690
1975	0		yes	2,416	0			\$ -		\$ -	\$ 5,323,690
1976	1683	40		759	759	1,155	924	\$ 381,150	1,643	\$ 560,900	\$ 5,884,590
1977	0	246		335	0			\$ -	1,397	\$ -	\$ 5,884,590
1978	0		yes	2,886	0			\$ -		\$ -	\$ 5,884,590
1979	0		yes	2,678	0			\$ -		\$ -	\$ 5,884,590
1980	0		yes	2,963	0			\$ -		\$ -	\$ 5,884,590
1981	1683			2,514	1,683			\$ -	1,683	\$ 420,750	\$ 6,305,340
1982	0			2,433	0			\$ -	1,683	\$ -	\$ 6,305,340
1983	0		yes	3,291	0			\$ -		\$ -	\$ 6,305,340
1984	0		yes	2,333	0			\$ -		\$ -	\$ 6,305,340
1985	1683			1,727	1,683			\$ -	1,683	\$ 420,750	\$ 6,726,090
1986	0		yes	2,143	0			\$ -		\$ -	\$ 6,726,090
1987	1683	154		421	421	1,577	1,262	\$ 520,410	1,529	\$ 587,160	\$ 7,313,250
1988	154			497	154			\$ -	1,683	\$ 38,500	\$ 7,351,750
1989	0	286		377	0			\$ -	1,397	\$ -	\$ 7,351,750
1990	0	463		120	0			\$ -	934	\$ -	\$ 7,351,750
1991	749			833	749			\$ -	1,683	\$ 187,250	\$ 7,539,000
1992	0			1,775	0			\$ -	1,683	\$ -	\$ 7,539,000
1993	0		yes		0			\$ -		\$ -	\$ 7,539,000

MWD Storage Options -- Cachuma Banking -- 7,000 AFY Demand, No Drought Conservation											
Variable cost SWP @ Cachuma= \$ 250											
Dry Year Purchase Program Admin Cost/AF= \$ 5.00 Price w/option/AF= \$ 125.00 Carriage Loss= 20% CCWA delivery= \$ 250.00											
	To	From	Cachur	SWP	SWP	Dry Yr	Dry Yr	Dry Yr	Annual		
Year	Storage	Storage	Spill?	Avail	In	Supplies	Supplies	Supplies	Storage	Water	Total
						Order	Deliv	Cost	Acct	Purchase	Costs-to-Date
1917	594				594			\$ -	594	\$ 148,500	\$ 148,500
1918	0		yes	2,908	0		-	\$ -	-	\$ -	\$ 148,500
1919	4548			1,696	1,696	3,565	2,852	\$ 1,176,450	4,548	\$ 1,600,450	\$ 1,748,950
1920	1040			1,325	1,040		-	\$ -	5,588	\$ 260,000	\$ 2,008,950
1921	345			740	345		-	\$ -	5,933	\$ 86,250	\$ 2,095,200
1922	0		yes	2,676	0		-	\$ -	-	\$ -	\$ 2,095,200
1923	7732	476		1,240	1,240	8,115	6,492	\$ 2,677,950	7,256	\$ 2,868,950	\$ 4,964,150
1924	0	1,361		9	0		-	\$ -	5,895	\$ -	\$ 4,964,150
1925	0	1,109		118	0		-	\$ -	4,786	\$ -	\$ 4,964,150
1926	383			635	383		-	\$ -	5,169	\$ 95,750	\$ 5,059,900
1927	0		yes	2,248	0		-	\$ -	-	\$ -	\$ 5,059,900
1928	7165	254		792	792	7,966	6,373	\$ 2,628,780	6,911	\$ 2,763,280	\$ 7,823,180
1929	0	1,539		15	0		-	\$ -	5,372	\$ -	\$ 7,823,180
1930	0	1,288		137	0		-	\$ -	4,084	\$ -	\$ 7,823,180
1931	0	2,677		0	0		-	\$ -	1,407	\$ -	\$ 7,823,180
1932	11			465	11		-	\$ -	1,418	\$ 2,750	\$ 7,825,930
1933	0	885		300	0		-	\$ -	533	\$ -	\$ 7,825,930
1934	0	377		458	0		-	\$ -	156	\$ -	\$ 7,825,930
1935	861			1,248	861		-	\$ -	1,017	\$ 215,250	\$ 8,041,180
1936	730			1,223	730		-	\$ -	1,747	\$ 182,500	\$ 8,223,680
1937	0		yes	2,610	0		-	\$ -	-	\$ -	\$ 8,223,680
1938	0		yes	2,800	0		-	\$ -	-	\$ -	\$ 8,223,680
1939	7591			1,526	1,526	7,581	6,065	\$ 2,501,730	7,591	\$ 2,883,230	\$ 11,106,910
1940	0	185		1,128	0		-	\$ -	7,406	\$ -	\$ 11,106,910
1941	0		yes	2,926	0		-	\$ -	-	\$ -	\$ 11,106,910
1942	0		yes	2,463	0		-	\$ -	-	\$ -	\$ 11,106,910
1943	0		yes	2,356	0		-	\$ -	-	\$ -	\$ 11,106,910
1944	0		yes	1,565	0		-	\$ -	-	\$ -	\$ 11,106,910
1945	0		yes	1,736	0		-	\$ -	-	\$ -	\$ 11,106,910
1946	0		yes	1,484	0		-	\$ -	-	\$ -	\$ 11,106,910
1947	7732	774		754	754	8,722	6,978	\$ 2,878,260	6,958	\$ 2,878,260	\$ 13,985,170
1948	0	870		185	0		-	\$ -	6,088	\$ -	\$ 13,985,170
1949	0	1,566		2	0		-	\$ -	4,522	\$ -	\$ 13,985,170
1950	0	1,327		69	0		-	\$ -	3,195	\$ -	\$ 13,985,170
1951	0	893		260	0		-	\$ -	2,302	\$ -	\$ 13,985,170
1952	0		yes	2,715	0		-	\$ -	-	\$ -	\$ 13,985,170
1953	6087			1,695	1,695	5,490	4,392	\$ 1,811,700	6,087	\$ 2,235,450	\$ 16,220,620
1954	545			922	545		-	\$ -	6,632	\$ 136,250	\$ 16,356,870
1955	0	678		224	0		-	\$ -	5,954	\$ -	\$ 16,356,870
1956	0	128		457	0		-	\$ -	5,826	\$ -	\$ 16,356,870
1957	0	338		418	0		-	\$ -	5,488	\$ -	\$ 16,356,870
1958	0		yes	1,938	0		-	\$ -	-	\$ -	\$ 16,356,870
1959	7339	50		1,214	1,214	7,656	6,125	\$ 2,526,480	7,289	\$ 2,817,480	\$ 19,174,350
1960	0	837		193	0		-	\$ -	6,452	\$ -	\$ 19,174,350
1961	0	1,084		110	0		-	\$ -	5,368	\$ -	\$ 19,174,350
1962	0		yes	1,118	0		-	\$ -	-	\$ -	\$ 19,174,350
1963	6974			1,094	1,094	7,350	5,880	\$ 2,425,500	6,974	\$ 2,699,000	\$ 21,873,350
1964	0	958		166	0		-	\$ -	6,016	\$ -	\$ 21,873,350
1965	122			693	122		-	\$ -	6,138	\$ 30,500	\$ 21,903,850
1966	1384			1,760	1,384		-	\$ -	7,522	\$ 346,000	\$ 22,249,850
1967	0		yes	3,069	0		-	\$ -	-	\$ -	\$ 22,249,850
1968	7732			2,003	2,003	7,161	5,729	\$ 2,363,130	7,732	\$ 2,863,880	\$ 25,113,730
1969	0		yes	2,967	0		-	\$ -	-	\$ -	\$ 25,113,730
1970	0		yes	1,958	0		-	\$ -	-	\$ -	\$ 25,113,730
1971	7732	242		1,602	1,602	7,662	6,130	\$ 2,528,460	7,490	\$ 2,868,460	\$ 27,982,190
1972	0	98		949	0		-	\$ -	7,392	\$ -	\$ 27,982,190
1973	0		yes	2,315	0		-	\$ -	-	\$ -	\$ 27,982,190
1974	0		yes	2,045	0		-	\$ -	-	\$ -	\$ 27,982,190
1975	0		yes	1,874	0		-	\$ -	-	\$ -	\$ 27,982,190
1976	7732	706		532	532	9,000	7,200	\$ 2,970,000	7,026	\$ 2,970,000	\$ 30,952,190
1977	0	1,237		73	0		-	\$ -	5,789	\$ -	\$ 30,952,190
1978	0		yes	2,742	0		-	\$ -	-	\$ -	\$ 30,952,190
1979	0		yes	2,276	0		-	\$ -	-	\$ -	\$ 30,952,190
1980	0		yes	2,775	0		-	\$ -	-	\$ -	\$ 30,952,190
1981	7732			1,904	1,904	7,285	5,828	\$ 2,404,050	7,732	\$ 2,880,050	\$ 33,832,240
1982	0			1,658	0		-	\$ -	7,732	\$ -	\$ 33,832,240
1983	0		yes	3,032	0		-	\$ -	-	\$ -	\$ 33,832,240
1984	0		yes	2,160	0		-	\$ -	-	\$ -	\$ 33,832,240
1985	7732	5		1,009	1,009	8,404	6,723	\$ 2,773,320	7,727	\$ 3,024,320	\$ 36,856,560
1986	0		yes	1,597	0		-	\$ -	-	\$ -	\$ 36,856,560
1987	7732	952		280	280	9,315	7,452	\$ 3,073,950	6,780	\$ 3,073,950	\$ 39,930,510
1988	0	508		195	0		-	\$ -	6,272	\$ -	\$ 39,930,510
1989	0	1,289		111	0		-	\$ -	4,983	\$ -	\$ 39,930,510
1990	0	2,256		(0)	0		-	\$ -	2,727	\$ -	\$ 39,930,510
1991	0	880		177	0		-	\$ -	1,847	\$ -	\$ 39,930,510
1992	629			1,272	629		-	\$ -	2,476	\$ 157,250	\$ 40,087,760
1993	0		yes		0		-	\$ -	-	\$ -	\$ 40,087,760

MWD Storage Options -- Cachuma Banking -- 7,000 AFY Demand, 20% Drought Conservation											
Variable cost SWP @ Cachuma= \$ 250											
Dry Year Purchase Program Admin Cost/AF= \$ 5.00 Price w/option/AF= \$ 125.00 Carriage Loss= 20% CCWA delivery= \$ 250.00											
	To	From	Cachur	SWP	SWP	Dry Yr	Dry Yr	Dry Yr	Annual		
Year	Storage	Storage	Spill?	Avail	In	Supplies	Supplies	Supplies	Storage	Water	Total
						Order	Deliv	Cost	Acct	Purchase	Costs-to-Date
1917	594			594	594				594	\$ 148,500	\$ 148,500
1918	2637		yes	2,637	-			\$ -	-	\$ -	\$ 148,500
1919	1461			1,461	1,461	3,296	2,637	\$ 1,087,680	4,098	\$ 1,452,930	\$ 1,601,430
1920	1103			1,103	1,103			\$ -	5,201	\$ 275,750	\$ 1,877,180
1921	680			680	680			\$ -	5,881	\$ 170,000	\$ 2,047,180
1922			yes	2,414	-			\$ -	-	\$ -	\$ 2,047,180
1923				1,045	1,045	6,045	4,836	\$ 1,994,850	5,881	\$ 2,256,100	\$ 4,303,280
1924		1,361		9	-			\$ -	4,520	\$ -	\$ 4,303,280
1925		948		118	-			\$ -	3,572	\$ -	\$ 4,303,280
1926	499			718	499			\$ -	4,071	\$ 124,750	\$ 4,428,030
1927	1996		yes	1,996	-			\$ -	-	\$ -	\$ 4,428,030
1928		530		648	648	6,774	5,419	\$ 2,235,420	5,537	\$ 2,397,420	\$ 6,825,450
1929		1,539		15	-			\$ -	3,998	\$ -	\$ 6,825,450
1930		1,127		137	-			\$ -	2,871	\$ -	\$ 6,825,450
1931		1,816		-	-			\$ -	1,055	\$ -	\$ 6,825,450
1932	137			484	137			\$ -	1,192	\$ 34,250	\$ 6,859,700
1933		828		257	-			\$ -	364	\$ -	\$ 6,859,700
1934	79			607	79			\$ -	443	\$ 19,750	\$ 6,879,450
1935	1293			1,294	1,293			\$ -	1,736	\$ 323,250	\$ 7,202,700
1936	856			1,112	856			\$ -	2,592	\$ 214,000	\$ 7,416,700
1937	2376		yes	2,376	-			\$ -	-	\$ -	\$ 7,416,700
1938	1260		yes	2,529	-			\$ -	-	\$ -	\$ 7,416,700
1939		80		1,334	1,334	6,118	4,894	\$ 2,018,940	6,148	\$ 2,352,440	\$ 9,769,140
1940		247		972	-			\$ -	5,901	\$ -	\$ 9,769,140
1941	327		yes	2,926	-			\$ -	-	\$ -	\$ 9,769,140
1942	0		yes	2,248	-			\$ -	-	\$ -	\$ 9,769,140
1943	0		yes	2,087	-			\$ -	-	\$ -	\$ 9,769,140
1944	0		yes	1,465	-			\$ -	-	\$ -	\$ 9,769,140
1945	0		yes	1,681	-			\$ -	-	\$ -	\$ 9,769,140
1946		-	yes	1,484	-			\$ -	-	\$ -	\$ 9,769,140
1947		774		648	648	6,975	5,580	\$ 2,301,750	5,454	\$ 2,463,750	\$ 12,232,890
1948		790		185	-			\$ -	4,664	\$ -	\$ 12,232,890
1949		1,136		40	-			\$ -	3,528	\$ -	\$ 12,232,890
1950		466		291	-			\$ -	3,062	\$ -	\$ 12,232,890
1951	507			690	507			\$ -	3,569	\$ 126,750	\$ 12,359,640
1952	2528		yes	2,528	-			\$ -	-	\$ -	\$ 12,359,640
1953	131			1,465	1,465	5,954	4,763	\$ 1,964,820	6,228	\$ 2,331,070	\$ 14,690,710
1954		223		784	-			\$ -	6,005	\$ -	\$ 14,690,710
1955		597		269	-			\$ -	5,408	\$ -	\$ 14,690,710
1956	191			574	191			\$ -	5,599	\$ 47,750	\$ 14,738,460
1957	142			582	142			\$ -	5,741	\$ 35,500	\$ 14,773,960
1958	487		yes	1,967	-			\$ -	-	\$ -	\$ 14,773,960
1959		444		1,027	583	6,501	5,201	\$ 2,145,330	5,784	\$ 2,291,080	\$ 17,065,040
1960		837		193	-			\$ -	4,947	\$ -	\$ 17,065,040
1961		1,003		110	-			\$ -	3,944	\$ -	\$ 17,065,040
1962	1064		yes	1,149	-			\$ -	-	\$ -	\$ 17,065,040
1963	574			898	898	5,855	4,684	\$ 1,932,150	5,582	\$ 2,156,650	\$ 19,221,690
1964		958		166	-			\$ -	4,624	\$ -	\$ 19,221,690
1965	252			662	252			\$ -	4,876	\$ 63,000	\$ 19,284,690
1966	1352			1,513	1,352			\$ -	6,228	\$ 338,000	\$ 19,622,690
1967	0		yes	3,069	-			\$ -	-	\$ -	\$ 19,622,690
1968	0			1,762	1,762	5,582	4,466	\$ 1,842,060	6,228	\$ 2,282,560	\$ 21,905,250
1969	0		yes	2,696	-			\$ -	-	\$ -	\$ 21,905,250
1970	0		yes	1,803	-			\$ -	-	\$ -	\$ 21,905,250
1971		242		1,377	1,135	6,064	4,851	\$ 2,001,120	5,986	\$ 2,284,870	\$ 24,190,120
1972		98		841	-			\$ -	5,888	\$ -	\$ 24,190,120
1973	339		yes	2,131	-			\$ -	-	\$ -	\$ 24,190,120
1974	0		yes	1,868	-			\$ -	-	\$ -	\$ 24,190,120
1975	0		yes	1,737	-			\$ -	-	\$ -	\$ 24,190,120
1976		706		429	-	7,248	5,798	\$ 2,391,840	5,521	\$ 2,391,840	\$ 26,581,960
1977		1,156		114	-			\$ -	4,365	\$ -	\$ 26,581,960
1978	1863		yes	2,486	-			\$ -	-	\$ -	\$ 26,581,960
1979	0		yes	2,063	-			\$ -	-	\$ -	\$ 26,581,960
1980	0		yes	2,503	-			\$ -	-	\$ -	\$ 26,581,960
1981	0			1,676	1,676	5,690	4,552	\$ 1,877,700	6,228	\$ 2,296,700	\$ 28,878,660
1982	0			1,459	-			\$ -	6,228	\$ -	\$ 28,878,660
1983	0		yes	3,032	-			\$ -	-	\$ -	\$ 28,878,660
1984	0		yes	1,891	-			\$ -	-	\$ -	\$ 28,878,660
1985		5		884	879	6,680	5,344	\$ 2,204,400	6,223	\$ 2,424,150	\$ 31,302,810
1986	5		yes	1,472	-			\$ -	-	\$ -	\$ 31,302,810
1987		952		252	-	7,470	5,976	\$ 2,465,100	5,276	\$ 2,465,100	\$ 33,767,910
1988		444		177	-			\$ -	4,832	\$ -	\$ 33,767,910
1989		885		161	-			\$ -	3,947	\$ -	\$ 33,767,910
1990		1,363		-	-			\$ -	2,584	\$ -	\$ 33,767,910
1991	298			431	298			\$ -	2,882	\$ 74,500	\$ 33,842,410
1992	771			1,186	771			\$ -	3,653	\$ 192,750	\$ 34,035,160
1993	2198		yes	2,198	-			\$ -	-	\$ -	\$ 34,035,160

MWD Storage Options -- Groundwater Banking -- 6,000 AFY Demand, No Drought Conservation										
Variable cost SWP @ Cachuma= \$ 250				Semitropic Fees (Second Priority) Cost/share/AF Storage right= \$ 233.33 Annual Management/AF storage right= \$ 1.00 Annual Maintenance/AF storage right= \$ 1.33 SWP cost to Semitropic= \$ 25.00 Recharge fee/AF= \$ 20.00 Recovery fee/AF= \$ 20.00 Energy cost extraction/AF= \$ 50.00 Extra SWP/CCWA delivery@Cachuma= \$ 250.00						
Year	To Storage	From Storage	Storage Acct	One-Time Storage Right	Annual Fees	SWP Cost	Recharge Fee	Extraction Fee	Total Fees-to-Date	
1917	755		755	\$ 593,833	\$ 5,938	\$ 18,875	\$ 15,100	\$ -	\$ 633,747	
1918	1790		2545		\$ 5,938	\$ 44,750	\$ 35,800	\$ -	\$ 720,235	
1919			2545		\$ 5,938	\$ -	\$ -	\$ -	\$ 726,173	
1920			2545		\$ 5,938	\$ -	\$ -	\$ -	\$ 732,112	
1921			2545		\$ 5,938	\$ -	\$ -	\$ -	\$ 738,050	
1922			2545		\$ 5,938	\$ -	\$ -	\$ -	\$ 743,988	
1923			2545		\$ 5,938	\$ -	\$ -	\$ -	\$ 749,927	
1924		404	2141		\$ 5,938	\$ -	\$ -	\$ 129,280	\$ 885,145	
1925		86	2055		\$ 5,938	\$ -	\$ -	\$ 27,520	\$ 918,603	
1926	490		2545		\$ 5,938	\$ 12,250	\$ 9,800	\$ -	\$ 946,592	
1927			2545		\$ 5,938	\$ -	\$ -	\$ -	\$ 952,530	
1928		107	2438.4		\$ 5,938	\$ -	\$ -	\$ 34,127	\$ 992,595	
1929		510	1927.9		\$ 5,938	\$ -	\$ -	\$ 163,335	\$ 1,161,869	
1930		265	1662.9		\$ 5,938	\$ -	\$ -	\$ 84,800	\$ 1,252,607	
1931		1,661	1,461.1		\$ 5,938	\$ -	\$ -	\$ 531,670	\$ 1,790,216	
1932	846		847.46		\$ 5,938	\$ 21,150	\$ 16,920	\$ -	\$ 1,834,224	
1933	108		955.46		\$ 5,938	\$ 2,700	\$ 2,160	\$ -	\$ 1,845,022	
1934	603		1558.5		\$ 5,938	\$ 15,075	\$ 12,060	\$ -	\$ 1,878,096	
1935	987		2545.5		\$ 5,938	\$ 24,675	\$ 19,740	\$ -	\$ 1,928,449	
1936			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,934,387	
1937			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,940,326	
1938			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,946,264	
1939			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,952,202	
1940			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,958,141	
1941			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,964,079	
1942			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,970,017	
1943			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,975,956	
1944			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,981,894	
1945			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,987,832	
1946			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,993,771	
1947			2545.5		\$ 5,938	\$ -	\$ -	\$ -	\$ 1,999,709	
1948	367		2178.7		\$ 5,938	\$ -	\$ -	\$ 117,361	\$ 2,123,008	
1949	543		1635.7		\$ 5,938	\$ -	\$ -	\$ 173,754	\$ 2,302,701	
1950		306	1329.7		\$ 5,938	\$ -	\$ -	\$ 97,920	\$ 2,406,559	
1951	120		1449.7		\$ 5,938	\$ 3,000	\$ 2,400	\$ -	\$ 2,417,897	
1952	1095		2544.7		\$ 5,938	\$ 27,375	\$ 21,900	\$ -	\$ 2,473,111	
1953			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,479,049	
1954			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,484,987	
1955			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,490,926	
1956			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,496,864	
1957			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,502,802	
1958			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,508,741	
1959			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,514,679	
1960	235		2310		\$ 5,938	\$ -	\$ -	\$ 75,119	\$ 2,595,736	
1961	56		2254.1		\$ 5,938	\$ -	\$ -	\$ 17,868	\$ 2,619,543	
1962	291		2544.9		\$ 5,938	\$ 7,269	\$ 5,815	\$ -	\$ 2,638,566	
1963		16	2528.9		\$ 5,938	\$ -	\$ -	\$ 5,120	\$ 2,649,624	
1964		75	2453.7		\$ 5,938	\$ -	\$ -	\$ 24,067	\$ 2,679,629	
1965	91		2544.7		\$ 5,938	\$ 2,275	\$ 1,820	\$ -	\$ 2,689,662	
1966			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,695,601	
1967			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,701,539	
1968			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,707,477	
1969			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,713,416	
1970			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,719,354	
1971			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,725,292	
1972			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,731,231	
1973			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,737,169	
1974			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,743,107	
1975			2544.7		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,749,046	
1976		40	2504.6		\$ 5,938	\$ -	\$ -	\$ 12,818	\$ 2,767,802	
1977		309	2195.6		\$ 5,938	\$ -	\$ -	\$ 98,880	\$ 2,872,621	
1978	349		2545.1		\$ 5,938	\$ 8,737	\$ 6,990	\$ -	\$ 2,894,285	
1979			2545.1		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,900,224	
1980			2545.1		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,906,162	
1981			2545.1		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,912,100	
1982			2545.1		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,918,039	
1983			2545.1		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,923,977	
1984			2545.1		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,929,915	
1985			2545.1		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,935,854	
1986			2545.1		\$ 5,938	\$ -	\$ -	\$ -	\$ 2,941,792	
1987		154	2391.1		\$ 5,938	\$ -	\$ -	\$ 49,280	\$ 2,997,011	
1988	154		2545.1		\$ 5,938	\$ 3,850	\$ 3,080	\$ -	\$ 3,009,879	
1989		563	1982		\$ 5,938	\$ -	\$ -	\$ 180,188	\$ 3,196,005	
1990		1,201	781.02		\$ 5,938	\$ -	\$ -	\$ 384,320	\$ 3,586,263	
1991	97		878.02		\$ 5,938	\$ 2,425	\$ 1,940	\$ -	\$ 3,596,567	
1992	1592		2470.4		\$ 5,938	\$ 39,809	\$ 31,847	\$ -	\$ 3,674,161	
1993	72		2542.4		\$ 5,938	\$ 1,800	\$ 1,440	\$ -	\$ 3,683,339	

MWD Storage Options -- Groundwater Banking -- 6,000 AFY Demand, 20% Drought Conservation										
Variable cost SWP @ Cachuma= \$ 250				Semitropic Fees (Second Priority) Cost/share/AF Storage right= \$ 233.33 Annual Management/AF storage right= \$ 1.00 Annual Maintenance/AF storage right= \$ 1.33 SWP cost to Semitropic= \$ 25.00 Recharge fee/AF= \$ 20.00 Recovery fee/AF= \$ 20.00 Energy cost extraction/AF= \$ 50.00 Extra SWP/CCWA delivery@Cachuma= \$ 250.00						
Year	To Storage	From Storage	Storage Acct	One-Time Storage Right	Annual Fees	SWP Cost	Recharge Fee	Extraction Fee	Total Fees-to-Date	
1917	755		755	\$ 392,700	\$ 3,927	\$ 18,875	\$ 15,100	\$ -	\$ 430,602	
1918	928		1683		\$ 3,927	\$ 23,200	\$ 18,560	\$ -	\$ 476,289	
1919	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 480,216	
1920	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 484,143	
1921	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 488,070	
1922	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 491,997	
1923	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 495,924	
1924		404	1279		\$ 3,927	\$ -	\$ -	\$ 129,280	\$ 629,131	
1925	52		1331		\$ 3,927	\$ 1,300	\$ 1,040	\$ -	\$ 635,398	
1926	352		1683		\$ 3,927	\$ 8,800	\$ 7,040	\$ -	\$ 655,165	
1927	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 659,092	
1928		107	1576		\$ 3,927	\$ -	\$ -	\$ 34,240	\$ 697,259	
1929		510	1066		\$ 3,927	\$ -	\$ -	\$ 163,200	\$ 864,386	
1930		127	939		\$ 3,927	\$ -	\$ -	\$ 40,640	\$ 908,953	
1931		910	29		\$ 3,927	\$ -	\$ -	\$ 291,200	\$ 1,204,080	
1932	1277		1306		\$ 3,927	\$ 31,925	\$ 25,540	\$ -	\$ 1,265,472	
1933	377		1683		\$ 3,927	\$ 9,425	\$ 7,540	\$ -	\$ 1,286,364	
1934	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,290,291	
1935	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,294,218	
1936	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,298,145	
1937	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,302,072	
1938	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,305,999	
1939	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,309,926	
1940	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,313,853	
1941	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,317,780	
1942	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,321,707	
1943	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,325,634	
1944	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,329,561	
1945	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,333,488	
1946	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,337,415	
1947	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,341,342	
1948		298	1385		\$ 3,927	\$ -	\$ -	\$ 95,360	\$ 1,440,629	
1949		167	1218		\$ 3,927	\$ -	\$ -	\$ 53,440	\$ 1,497,996	
1950	431		1649		\$ 3,927	\$ 10,775	\$ 8,620	\$ -	\$ 1,521,318	
1951	34		1683		\$ 3,927	\$ 850	\$ 680	\$ -	\$ 1,526,775	
1952	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,530,702	
1953	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,534,629	
1954	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,538,556	
1955	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,542,483	
1956	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,546,410	
1957	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,550,337	
1958	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,554,264	
1959	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,558,191	
1960		235	1448		\$ 3,927	\$ -	\$ -	\$ 75,200	\$ 1,637,318	
1961	13		1461		\$ 3,927	\$ 325	\$ 260	\$ -	\$ 1,641,830	
1962	222		1683		\$ 3,927	\$ 5,550	\$ 4,440	\$ -	\$ 1,655,747	
1963		16	1667		\$ 3,927	\$ -	\$ -	\$ 5,120	\$ 1,664,794	
1964		75	1592		\$ 3,927	\$ -	\$ -	\$ 24,000	\$ 1,692,721	
1965	91		1683		\$ 3,927	\$ 2,275	\$ 1,820	\$ -	\$ 1,700,743	
1966	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,704,670	
1967	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,708,597	
1968	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,712,524	
1969	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,716,451	
1970	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,720,378	
1971	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,724,305	
1972	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,728,232	
1973	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,732,159	
1974	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,736,086	
1975	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,740,013	
1976		40	1643		\$ 3,927	\$ -	\$ -	\$ 12,800	\$ 1,756,740	
1977		246	1397		\$ 3,927	\$ -	\$ -	\$ 78,720	\$ 1,839,387	
1978	286		1683		\$ 3,927	\$ 7,150	\$ 5,720	\$ -	\$ 1,856,184	
1979	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,860,111	
1980	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,864,038	
1981	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,867,965	
1982	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,871,892	
1983	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,875,819	
1984	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,879,746	
1985	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,883,673	
1986	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 1,887,600	
1987		154	1529		\$ 3,927	\$ -	\$ -	\$ 49,280	\$ 1,940,807	
1988	154		1683		\$ 3,927	\$ 3,850	\$ 3,080	\$ -	\$ 1,951,664	
1989		286	1397		\$ 3,927	\$ -	\$ -	\$ 91,520	\$ 2,047,111	
1990		463	934		\$ 3,927	\$ -	\$ -	\$ 148,160	\$ 2,199,198	
1991	749		1683		\$ 3,927	\$ 18,725	\$ 14,980	\$ -	\$ 2,236,830	
1992	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 2,240,757	
1993	0		1683		\$ 3,927	\$ -	\$ -	\$ -	\$ 2,244,684	

MWD Storage Options -- Groundwater Banking -- 7,000 AFY Demand, No Drought Conservation										
Variable cost SWP @ Cachuma= \$ 250				Semitropic Fees (Second Priority) Cost/share/AF Storage right= \$ 233.33 Annual Management/AF storage right= \$ 1.00 Annual Maintenance/AF storage right= \$ 1.33 SWP cost to Semitropic= \$ 25.00 Recharge fee/AF= \$ 20.00 Recovery fee/AF= \$ 20.00 Energy cost extraction/AF= \$ 50.00 Extra SWP/CCWA delivery@Cachuma= \$ 250.00						
Year	To Storage	From Storage	Storage Acct	One-Time Storage Right	Annual Fees	SWP Cost	Recharge Fee	Extraction Fee	Total Fees-to-Date	
1917	594		594	\$ 1,804,133	\$ 18,041	\$ 14,850	\$ 11,880	\$ -	\$ 1,848,905	
1918	2637		3231		\$ 18,041	\$ 65,925	\$ 52,740	\$ -	\$ 1,985,611	
1919	1317		4548		\$ 18,041	\$ 32,925	\$ 26,340	\$ -	\$ 2,062,917	
1920	1040		5588		\$ 18,041	\$ 26,000	\$ 20,800	\$ -	\$ 2,127,759	
1921	345		5933		\$ 18,041	\$ 8,625	\$ 6,900	\$ -	\$ 2,161,325	
1922	1799		7732		\$ 18,041	\$ 44,975	\$ 35,980	\$ -	\$ 2,260,321	
1923		476	7256		\$ 18,041	\$ -	\$ -	\$ 152,320	\$ 2,430,683	
1924		1,361	5895		\$ 18,041	\$ -	\$ -	\$ 435,520	\$ 2,884,244	
1925		1,109	4786		\$ 18,041	\$ -	\$ -	\$ 354,880	\$ 3,257,165	
1926	383		5169		\$ 18,041	\$ 9,575	\$ 7,660	\$ -	\$ 3,292,442	
1927	1996		7165		\$ 18,041	\$ 49,900	\$ 39,920	\$ -	\$ 3,400,303	
1928		254	6911		\$ 18,041	\$ -	\$ -	\$ 81,280	\$ 3,499,624	
1929		1,539	5372		\$ 18,041	\$ -	\$ -	\$ 492,480	\$ 4,010,146	
1930		1,288	4084		\$ 18,041	\$ -	\$ -	\$ 412,160	\$ 4,440,347	
1931		2,677	1407		\$ 18,041	\$ -	\$ -	\$ 856,640	\$ 5,315,028	
1932	11		1418		\$ 18,041	\$ 275	\$ 220	\$ -	\$ 5,333,565	
1933		885	533		\$ 18,041	\$ -	\$ -	\$ 283,200	\$ 5,634,806	
1934		377	156		\$ 18,041	\$ -	\$ -	\$ 120,640	\$ 5,773,487	
1935	861		1017		\$ 18,041	\$ 21,525	\$ 17,220	\$ -	\$ 5,830,274	
1936	730		1747		\$ 18,041	\$ 18,250	\$ 14,600	\$ -	\$ 5,881,165	
1937	2366		4113		\$ 18,041	\$ 59,150	\$ 47,320	\$ -	\$ 6,005,676	
1938	2529		6642		\$ 18,041	\$ 63,225	\$ 50,580	\$ -	\$ 6,137,523	
1939	949		7591		\$ 18,041	\$ 23,725	\$ 18,980	\$ -	\$ 6,198,269	
1940		185	7406		\$ 18,041	\$ -	\$ -	\$ 59,200	\$ 6,275,510	
1941	326		7732		\$ 18,041	\$ 8,150	\$ 6,520	\$ -	\$ 6,308,222	
1942	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 6,326,263	
1943	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 6,344,304	
1944	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 6,362,346	
1945	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 6,380,387	
1946	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 6,398,428	
1947		774	6958		\$ 18,041	\$ -	\$ -	\$ 247,680	\$ 6,664,150	
1948		870	6088		\$ 18,041	\$ -	\$ -	\$ 278,400	\$ 6,960,591	
1949		1,566	4522		\$ 18,041	\$ -	\$ -	\$ 501,120	\$ 7,479,752	
1950		1,327	3195		\$ 18,041	\$ -	\$ -	\$ 424,640	\$ 7,922,434	
1951		893	2302		\$ 18,041	\$ -	\$ -	\$ 285,760	\$ 8,226,235	
1952	2465		4767		\$ 18,041	\$ 61,625	\$ 49,300	\$ -	\$ 8,355,201	
1953	1320		6087		\$ 18,041	\$ 33,000	\$ 26,400	\$ -	\$ 8,432,643	
1954	545		6632		\$ 18,041	\$ 13,625	\$ 10,900	\$ -	\$ 8,475,209	
1955		678	5954		\$ 18,041	\$ -	\$ -	\$ 216,960	\$ 8,710,210	
1956		128	5826		\$ 18,041	\$ -	\$ -	\$ 40,960	\$ 8,769,212	
1957		338	5488		\$ 18,041	\$ -	\$ -	\$ 108,160	\$ 8,895,413	
1958	1851		7339		\$ 18,041	\$ 46,275	\$ 37,020	\$ -	\$ 8,996,749	
1959		50	7289		\$ 18,041	\$ -	\$ -	\$ 16,000	\$ 9,030,791	
1960		837	6452		\$ 18,041	\$ -	\$ -	\$ 267,840	\$ 9,316,672	
1961		1,084	5368		\$ 18,041	\$ -	\$ -	\$ 346,880	\$ 9,681,593	
1962	1032		6400		\$ 18,041	\$ 25,800	\$ 20,640	\$ -	\$ 9,746,075	
1963	574		6974		\$ 18,041	\$ 14,350	\$ 11,480	\$ -	\$ 9,789,946	
1964		958	6016		\$ 18,041	\$ -	\$ -	\$ 306,560	\$ 10,114,547	
1965	122		6138		\$ 18,041	\$ 3,050	\$ 2,440	\$ -	\$ 10,138,079	
1966	1384		7522		\$ 18,041	\$ 34,600	\$ 27,680	\$ -	\$ 10,218,400	
1967	210		7732		\$ 18,041	\$ 5,250	\$ 4,200	\$ -	\$ 10,245,891	
1968	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 10,263,933	
1969	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 10,281,974	
1970	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 10,300,015	
1971		242	7490		\$ 18,041	\$ -	\$ -	\$ 77,440	\$ 10,395,497	
1972		98	7392		\$ 18,041	\$ -	\$ -	\$ 31,360	\$ 10,444,898	
1973	340		7732		\$ 18,041	\$ 8,500	\$ 6,800	\$ -	\$ 10,478,239	
1974	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 10,496,281	
1975	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 10,514,322	
1976		706	7026		\$ 18,041	\$ -	\$ -	\$ 225,920	\$ 10,758,283	
1977		1,237	5789		\$ 18,041	\$ -	\$ -	\$ 395,840	\$ 11,172,165	
1978	1943		7732		\$ 18,041	\$ 48,575	\$ 38,860	\$ -	\$ 11,277,641	
1979	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 11,295,682	
1980	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 11,313,724	
1981	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 11,331,765	
1982	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 11,349,806	
1983	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 11,367,848	
1984	0		7732		\$ 18,041	\$ -	\$ -	\$ -	\$ 11,385,889	
1985		5	7727		\$ 18,041	\$ -	\$ -	\$ 1,600	\$ 11,405,530	
1986	5		7732		\$ 18,041	\$ 125	\$ 100	\$ -	\$ 11,423,797	
1987		952	6780		\$ 18,041	\$ -	\$ -	\$ 304,640	\$ 11,746,478	
1988		508	6272		\$ 18,041	\$ -	\$ -	\$ 162,560	\$ 11,927,079	
1989		1,289	4983		\$ 18,041	\$ -	\$ -	\$ 412,480	\$ 12,357,601	
1990		2,256	2727		\$ 18,041	\$ -	\$ -	\$ 721,920	\$ 13,097,562	
1991		880	1847		\$ 18,041	\$ -	\$ -	\$ 281,600	\$ 13,397,203	
1992	629		2476		\$ 18,041	\$ 15,725	\$ 12,580	\$ -	\$ 13,443,550	
1993	2198		4674		\$ 18,041	\$ 54,950	\$ 43,960	\$ -	\$ 13,560,501	

MWD Storage Options -- Groundwater Banking -- 7,000 AFY Demand, 20% Drought Conservation										
Variable cost SWP @ Cachuma= \$ 250				Semitropic Fees (Second Priority) Cost/share/AF Storage right= \$ 233.33 Annual Management/AF storage right= \$ 1.00 Annual Maintenance/AF storage right= \$ 1.33 SWP cost to Semitropic= \$ 25.00 Recharge fee/AF= \$ 20.00 Recovery fee/AF= \$ 20.00 Energy cost extraction/AF= \$ 50.00 Extra SWP/CCWA delivery@Cachuma= \$ 250.00						
Year	To Storage	From Storage	Storage Acct	One-Time Storage Right	Annual Fees	SWP Cost	Recharge Fee	Extraction Fee	Total Fees-to-Date	
1917	594		0	\$ 1,453,200	\$ 14,532	\$ 14,850	\$ 11,880	\$ -	\$ 1,494,462	
1918	2637		2637		\$ 14,532	\$ 65,925	\$ 52,740	\$ -	\$ 1,627,659	
1919	1461		4098		\$ 14,532	\$ 36,525	\$ 29,220	\$ -	\$ 1,707,936	
1920	1103		5201		\$ 14,532	\$ 27,575	\$ 22,060	\$ -	\$ 1,772,103	
1921	680		5881		\$ 14,532	\$ 17,000	\$ 13,600	\$ -	\$ 1,817,235	
1922			5881		\$ 14,532	\$ -	\$ -	\$ -	\$ 1,831,767	
1923			5881		\$ 14,532	\$ -	\$ -	\$ -	\$ 1,846,299	
1924		1,361	4520		\$ 14,532	\$ -	\$ -	\$ 435,520	\$ 2,296,351	
1925		948	3572		\$ 14,532	\$ -	\$ -	\$ 303,360	\$ 2,614,243	
1926	499		4071		\$ 14,532	\$ 12,475	\$ 9,980	\$ -	\$ 2,651,230	
1927	1996		6067		\$ 14,532	\$ 49,900	\$ 39,920	\$ -	\$ 2,755,582	
1928		530	5537		\$ 14,532	\$ -	\$ -	\$ 169,600	\$ 2,939,714	
1929		1,539	3998		\$ 14,532	\$ -	\$ -	\$ 492,480	\$ 3,446,726	
1930		1,127	2871		\$ 14,532	\$ -	\$ -	\$ 360,640	\$ 3,821,898	
1931		1,816	1055		\$ 14,532	\$ -	\$ -	\$ 581,120	\$ 4,417,550	
1932	137		1192		\$ 14,532	\$ 3,425	\$ 2,740	\$ -	\$ 4,438,247	
1933		828	364		\$ 14,532	\$ -	\$ -	\$ 264,960	\$ 4,717,739	
1934	79		443		\$ 14,532	\$ 1,975	\$ 1,580	\$ -	\$ 4,735,826	
1935	1293		1736		\$ 14,532	\$ 32,325	\$ 25,860	\$ -	\$ 4,808,543	
1936	856		2592		\$ 14,532	\$ 21,400	\$ 17,120	\$ -	\$ 4,861,595	
1937	2376		4968		\$ 14,532	\$ 59,400	\$ 47,520	\$ -	\$ 4,983,047	
1938	1260		6228		\$ 14,532	\$ 31,500	\$ 25,200	\$ -	\$ 5,054,279	
1939		80	6148		\$ 14,532	\$ -	\$ -	\$ 25,600	\$ 5,094,411	
1940		247	5901		\$ 14,532	\$ -	\$ -	\$ 79,040	\$ 5,187,983	
1941	327		6228		\$ 14,532	\$ 8,175	\$ 6,540	\$ -	\$ 5,217,230	
1942	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 5,231,762	
1943	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 5,246,294	
1944	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 5,260,826	
1945	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 5,275,358	
1946		-	6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 5,289,890	
1947		774	5454		\$ 14,532	\$ -	\$ -	\$ 247,680	\$ 5,552,102	
1948		790	4664		\$ 14,532	\$ -	\$ -	\$ 252,800	\$ 5,819,434	
1949		1,136	3528		\$ 14,532	\$ -	\$ -	\$ 363,520	\$ 6,197,486	
1950		466	3062		\$ 14,532	\$ -	\$ -	\$ 149,120	\$ 6,361,138	
1951	507		3569		\$ 14,532	\$ 12,675	\$ 10,140	\$ -	\$ 6,398,485	
1952	2528		6097		\$ 14,532	\$ 63,200	\$ 50,560	\$ -	\$ 6,526,777	
1953	131		6228		\$ 14,532	\$ 3,275	\$ 2,620	\$ -	\$ 6,547,204	
1954		223	6005		\$ 14,532	\$ -	\$ -	\$ 71,360	\$ 6,633,096	
1955		597	5408		\$ 14,532	\$ -	\$ -	\$ 191,040	\$ 6,838,668	
1956	191		5599		\$ 14,532	\$ 4,775	\$ 3,820	\$ -	\$ 6,861,795	
1957	142		5741		\$ 14,532	\$ 3,550	\$ 2,840	\$ -	\$ 6,882,717	
1958	487		6228		\$ 14,532	\$ 12,175	\$ 9,740	\$ -	\$ 6,919,164	
1959		444	5784		\$ 14,532	\$ -	\$ -	\$ 142,080	\$ 7,075,776	
1960		837	4947		\$ 14,532	\$ -	\$ -	\$ 267,840	\$ 7,358,148	
1961		1,003	3944		\$ 14,532	\$ -	\$ -	\$ 320,960	\$ 7,693,640	
1962	1064		5008		\$ 14,532	\$ 26,600	\$ 21,280	\$ -	\$ 7,756,052	
1963	574		5582		\$ 14,532	\$ 14,350	\$ 11,480	\$ -	\$ 7,796,414	
1964		958	4624		\$ 14,532	\$ -	\$ -	\$ 306,560	\$ 8,117,506	
1965	252		4876		\$ 14,532	\$ 6,300	\$ 5,040	\$ -	\$ 8,143,378	
1966	1352		6228		\$ 14,532	\$ 33,800	\$ 27,040	\$ -	\$ 8,218,750	
1967	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 8,233,282	
1968	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 8,247,814	
1969	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 8,262,346	
1970	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 8,276,878	
1971		242	5986		\$ 14,532	\$ -	\$ -	\$ 77,440	\$ 8,368,850	
1972		98	5888		\$ 14,532	\$ -	\$ -	\$ 31,360	\$ 8,414,742	
1973	339		6227		\$ 14,532	\$ 8,475	\$ 6,780	\$ -	\$ 8,444,529	
1974	0		6227		\$ 14,532	\$ -	\$ -	\$ -	\$ 8,459,061	
1975	0		6227		\$ 14,532	\$ -	\$ -	\$ -	\$ 8,473,593	
1976		706	5521		\$ 14,532	\$ -	\$ -	\$ 225,920	\$ 8,714,045	
1977		1,156	4365		\$ 14,532	\$ -	\$ -	\$ 369,920	\$ 9,098,497	
1978	1863		6228		\$ 14,532	\$ 46,575	\$ 37,260	\$ -	\$ 9,196,864	
1979	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 9,211,396	
1980	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 9,225,928	
1981	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 9,240,460	
1982	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 9,254,992	
1983	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 9,269,524	
1984	0		6228		\$ 14,532	\$ -	\$ -	\$ -	\$ 9,284,056	
1985		5	6223		\$ 14,532	\$ -	\$ -	\$ 1,600	\$ 9,300,188	
1986	5		6228		\$ 14,532	\$ 125	\$ 100	\$ -	\$ 9,314,945	
1987		952	5276		\$ 14,532	\$ -	\$ -	\$ 304,640	\$ 9,634,117	
1988		444	4832		\$ 14,532	\$ -	\$ -	\$ 142,080	\$ 9,790,729	
1989		885	3947		\$ 14,532	\$ -	\$ -	\$ 283,200	\$ 10,088,461	
1990		1,363	2584		\$ 14,532	\$ -	\$ -	\$ 436,160	\$ 10,539,153	
1991	298		2882		\$ 14,532	\$ 7,450	\$ 5,960	\$ -	\$ 10,567,095	
1992	771		3653		\$ 14,532	\$ 19,275	\$ 15,420	\$ -	\$ 10,616,322	
1993	2198		5851		\$ 14,532	\$ 54,950	\$ 43,960	\$ -	\$ 10,729,764	

APPENDIX C. EXAMPLE OF OPERATION OF CACHUMA STORAGE BANK

The table on the next page is an example of the optimum operation of the Cachuma Storage Bank.

Operation Of Cachuma Storage Bank							
Operation; 7,732 AF max bank, add 3,866 AF after spill or <100,000 AF lake level							
Storage scenario based on 77-year enhanced river model.							
Year	Cachuma 1-May Lake Level	Spill Year?	From Storage	To Storage	SWP Purchase for bank	Supplemental Purchase for bank	Cachuma Storage Account
1917				594	594		594
1918	188,035	yes		-	-	-	-
1919	167,956			3,866	1,696	2,170	3,866
1920	146,257			1,325	1,325	-	5,191
1921	115,073			740	740	-	5,931
1922	188,035	yes		-	-	-	-
1923	174,343		476	4,342	764	3,102	3,866
1924	135,824		1,361	-	-	-	2,505
1925	101,093		1,109	-	-	-	1,396
1926	133,171			635	635	-	2,031
1927	188,035	yes		-	-	-	-
1928	170,603		107	4,120	685	3,328	3,866
1929	133,360		1,539	-	-	-	2,327
1930	97,122		1,288	3,866	-	3,866	4,905
1931	63,596		2,677	-	-	-	2,228
1932	155,239			465	465	-	2,693
1933	131,895		885	-	-	-	1,808
1934	108,834		377	-	-	-	1,431
1935	113,546			1,248	1,248	-	2,679
1936	112,941			1,223	1,223	-	3,902
1937	188,035	yes		-	-	-	-
1938	188,035	yes		-	-	-	-
1939	183,321			3,866	1,526	2,340	3,866
1940	156,328		185	-	-	-	3,681
1941	188,035	yes		-	-	-	-
1942	188,035	yes		-	-	-	-
1943	188,035	yes		-	-	-	-
1944	188,035	yes		-	-	-	-
1945	188,035	yes		-	-	-	-
1946	188,035	yes		-	-	-	-
1947	161,364		774	4,640	-	3,866	3,866
1948	112,409		870	-	-	-	2,996
1949	83,750		1,566	3,866	-	3,866	5,296
1950	60,534		1,327	-	-	-	3,969
1951	34,485		893	-	-	-	3,076
1952	188,035	yes		-	-	-	-
1953	174,482			3,866	1,695	2,171	3,866
1954	147,681			922	922	-	4,788
1955	106,241		678	-	-	-	4,110
1956	98,343		128	3,750	-	3,750	7,732
1957	79,231		338	-	-	-	7,394
1958	188,035	yes		-	-	-	-
1959	178,545		50	3,916	1,164	2,702	3,866
1960	136,973		837	-	-	-	3,029
1961	104,023		1,084	-	-	-	1,945
1962	188,035	yes		-	-	-	-
1963	158,542			3,866	1,094	2,772	3,866
1964	126,448		958	-	-	-	2,908
1965	105,660			693	693	-	3,601
1966	152,786			1,760	1,760	-	5,361
1967	188,035	yes		-	-	-	-
1968	173,399			3,866	2,003	1,863	3,866
1969	188,035	yes		-	-	-	-
1970	186,124	yes		-	-	-	-
1971	172,736		242	4,108	1,360	2,506	3,866
1972	138,778		98	-	-	-	3,768
1973	188,035	yes		-	-	-	-
1974	187,596	yes		-	-	-	-
1975	188,035	yes		-	-	-	-
1976	162,733		706	4,572	-	4,040	3,866
1977	121,464		1,237	-	-	-	2,629
1978	188,035	yes		-	-	-	-
1979	188,035	yes		-	-	-	-
1980	188,035	yes		-	-	-	-
1981	185,504			3,866	1,904	1,962	3,866
1982	170,940			1,658	1,658	-	5,524
1983	188,035	yes		-	-	-	-
1984	185,318	yes		-	-	-	-
1985	155,130		5	3,871	1,004	2,862	3,866
1986	188,035	yes		-	-	-	-
1987	156,184		952	4,818	-	4,538	3,866
1988	129,964		508	-	-	-	3,358
1989	89,102		1,289	3,866	-	3,866	5,934
1990	61,809		2,256	-	-	-	3,678
1991	84,113		880	-	-	-	2,798
1992	175,456			1,272	1,272	-	4,070
1993	188,035	yes		-	-	-	-

APPENDIX D. TABULAR RESULTS OF MODEL VERSIONS

Month-by-month tabular results of Model Configuration 7 are included on a CD included with this report. Four runs in this configuration are included:

- 6,000 AFY demand with SWP Bank;
- 7,000 AFY demand with SWP Bank;
- 6,000 AFY demand, 20% drought conservation, with SWP Bank;
- 7,000 AFY demand, 20% drought conservation, with SWP Bank.

APPENDIX E. ANALYSIS FOR DEMAND OF 8,000 AFY

Following review of this report by MWD, it was decided to conduct modeling at the higher demand level of 8,000 AFY. Analyses were similar to those for the 6,000 and 7,000 AFY demand levels. At the 8,000 AFY demand level, shortages of up to 4,000 AF exist during the worse drought years (Figure 27). Thus, a banking project is essential to maintain delivery capability at these demand levels. The amount of banked water used in any year is represented by the hachured area in Figure 27.

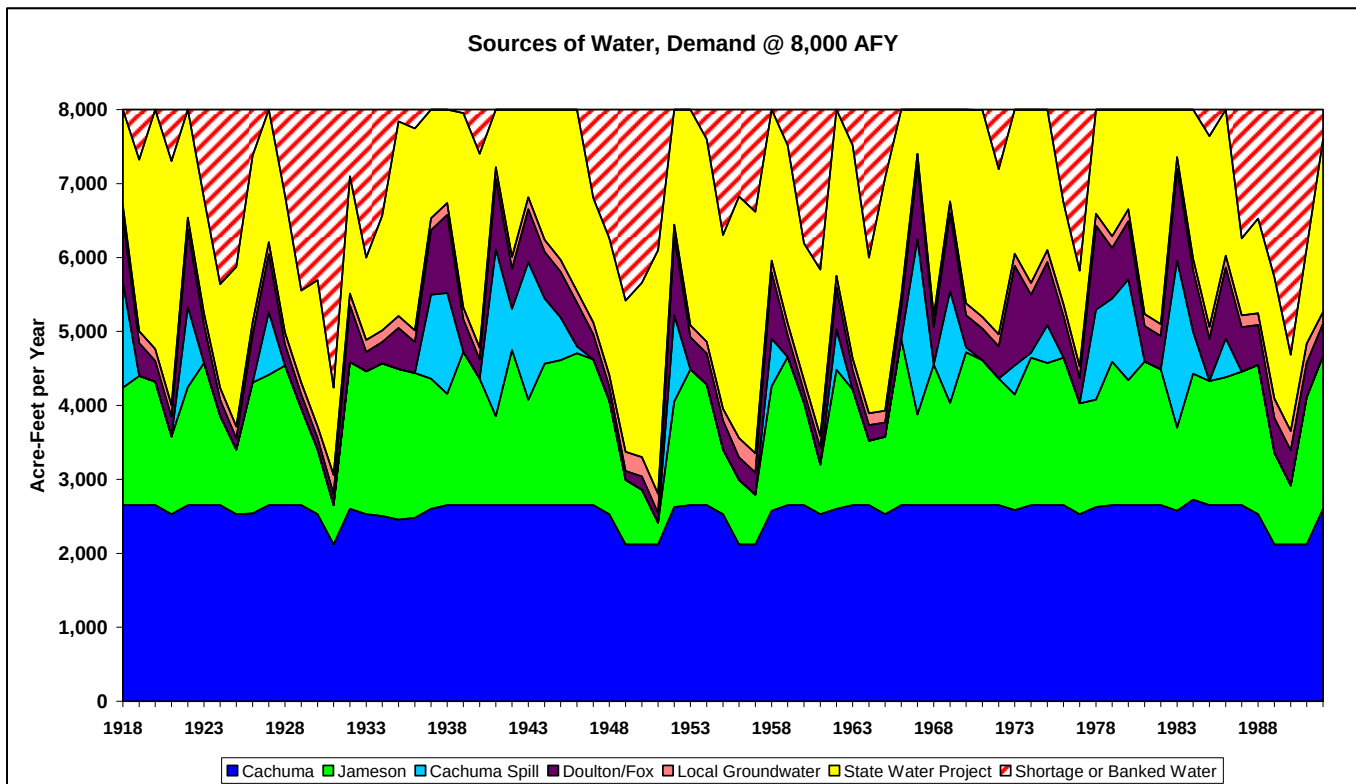


Figure 27. Sources of supply at 8,000 AFY demand level. The hachured area represents either a shortage of water when there is no banking project operating or it represents the amount of banked water used.

Both Cachuma and groundwater banking projects were evaluated for the 8,000 AFY demand level. The size of a storage bank required to prevent supply shortages ranges from 13,000 AF to over 14,000 AF depending upon the project.

Banking Project	Storage Required (AF)	Cost per AF Delivered
Cachuma	13,200	\$975
Groundwater	14,360	\$752

Table 7. Size and costs of banking projects for the 8,000 AFY demand level.

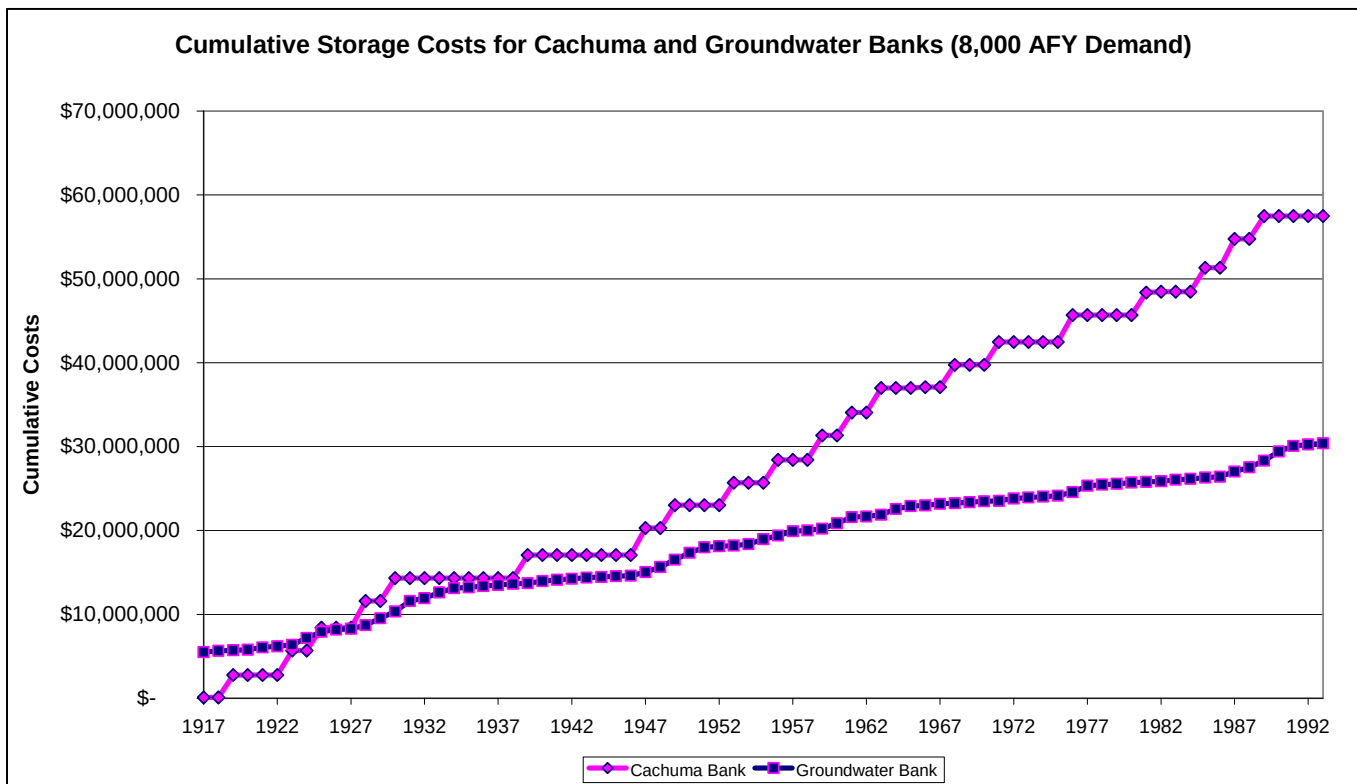


Figure 28. Cumulative costs of banking projects at the 8,000 AFY demand level.

An additional constraint at the 8,000 AFY demand level is the capacity of the South Coast Conduit. The enhanced river model indicated that MWD's share of the pipeline would be exceeded in the dry season of essentially every year, with capacity exceedences of up to 4.5 cfs during dry years. Thus, coordination with CVWD would be essential.