January 12, 2011

PASADENA
Water&Power

Water Integrated Resources Plan

Prepared in cooperation with CDM

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List of Acronyms

AF	Acre-feet
AFY	Acre-feet per year
cfs	Cubic feet per second
CRA	Colorado River Aqueduct
DWR	California Department of Water Resources
ETo	Evapotranspiration rate
GCM	General circulation model
IPR	Indirect potable reuse
IRP	Integrated Resources Plan
LA	Los Angeles
LACDPW	Los Angeles County Department of Public Works
LAG WRP	Los Angeles/Glendale Water Reclamation Plant
LRP	Local Resource Program
MWD	Metropolitan Water District of Southern California
NDMA	N-nitrosodimethlamine
NPR	Non-potable reuse
Pasadena	City of Pasadena
PGSP	Pasadena Groundwater Storage Program
PPCPs	Pharmaceuticals and personal care products
PV	Present value
PWP	Pasadena Water and Power Department
QSA	Quantification Settlement Agreement
RBMB	Raymond Basin Management Board
SCAG	Southern California Association of Governments
SDCWA	San Diego County Water Authority
SWP	State Water Project
TMDL	Total Maximum Daily Load
TOC	Total organic carbon
WIRP	Water Integrated Resources Plan
WTP	Water Treatment Plant

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Executive Summary

Overview of Water Issues

The City of Pasadena and neighboring communities receive water supply from the City of Pasadena Water and Power Department (PWP), which relies on two main sources: local groundwater from the Raymond Basin and imported water purchased from Metropolitan Water District of Southern California (MWD). The historical supply mix has averaged 60 percent imported and 40 percent local supplies.

MWD imports water from the Sacramento-San Joaquin Delta via the State Water Project, and from the Colorado River. In recent years, prolonged droughts and environmental flow restrictions have triggered MWD to impose allocation limits to its member agencies for the first time since 1991. Future reliability of imported water will continue to face uncertainties from climate change, environmental regulations, and droughts. Although MWD has taken steps to plan for these uncertainties, achieving reliability will depend on a number key water policy and management decisions on a regional and local level. Other important issues associated with imported water include water quality and cost, which in the past few years has increased substantially.

In addition to imported water issues, recent groundwater levels in the Raymond Basin have resulted in the Raymond Basin Management Board calling for a reduction in water rights holders for the foreseeable future. This will results in a 20 percent reduction in PWP's groundwater pumping by 2014.

Purpose of Water Integrated Resources Plan

To address these critical water supply challenges, PWP has taken a proactive step to lead as a model water agency by developing a Water Integrated Resources Plan (WIRP). The WIRP was developed using an open, participatory

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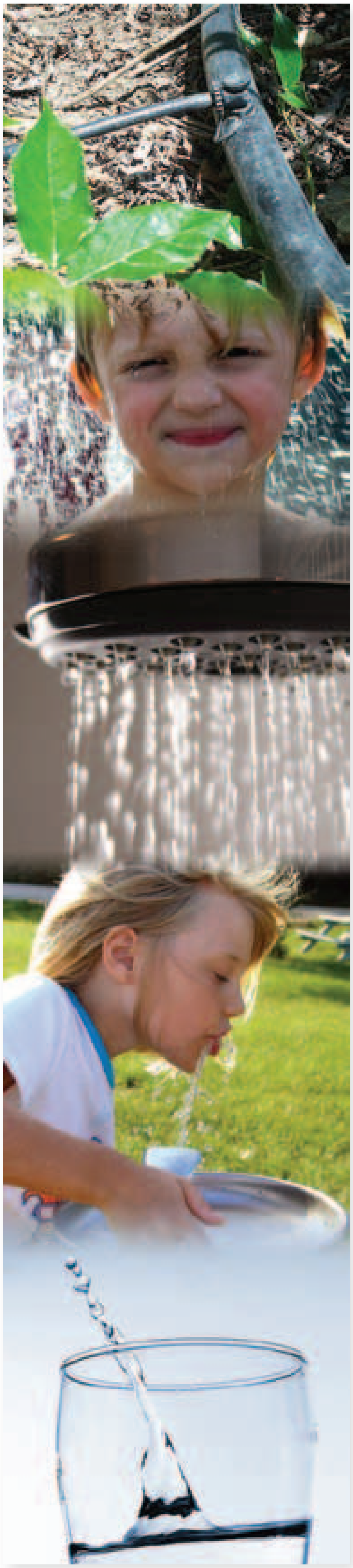

planning process, with input from a dedicated stakeholder Advisory Committee and the public at large.

The WIRP Advisory Committee, representing Pasadena's major stakeholders, developed the following WIRP mission statement:

The Pasadena Water Integrated Resources Plan will provide an achievable, long-term strategy to meet current and future water needs. The goals of the WIRP are to sustainably and cost-effectively address local and regional water supply and demand issues, reflect community values, and adapt to changing conditions.

In addition to providing an overall long-term water resources strategy through the year 2035, the WIRP is a source document for Pasadena's 2010 Urban Water Management Plan, a document required to be completed every five years per California state law.

Stakeholder Involvement

Stakeholder input and collaboration was essential to the success of this plan's development. At the start of the WIRP process, Pasadena's mayor formed a WIRP Advisory Committee that represented a wide range of interests and backgrounds. The purpose of forming this committee was to have an organized group that would have a focus attention of the WIRP throughout the process. The Advisory Committee met eight times to develop objectives for the plan, review key baseline data, help identify various supply and conservation options to be evaluated, review analyses and provide key input and comments on recommendations and strategy.

Additionally, public workshops were held at key points in the process to share information and exchange ideas. The overall goal of the public communication effort was to inform the public about the City's water planning activities and garner public feedback and input. The City also developed a website and an e-mail distribution list that was used throughout the course of the WIRP to distribute relevant materials and notify interested parties of upcoming meetings and events.

Evaluation Process

Planning objectives were developed by the WIRP Advisory Committee with input from the public, which include:

- Provide a reliable water supply
- Maintain affordability, while addressing fairness and equity
- Protect and enhance source waters and the environment
- Protect cultural and recreational resources
- Maximize efficiency of water use
- Maintain quality of life and positive economic climate
- Reduce risk and maximize opportunities
- Reduce energy footprint for water operations
- Ensure safe, high quality drinking water
- Ensure public safety

Evaluation criteria or metrics were established for these objectives in order to evaluate various alternatives to meet future water demands. Approximately fifty water supply and conservation options were considered in the WIRP, including alternative options such as conservation plumbing retrofits on resale of property, drought-tolerant landscape ordinances, stormwater capture, recycled water, graywater, and ocean desalination. The list of options was developed through brainstorming sessions held with the public, the WIRP Advisory Committee, and PWP staff.

Recommended Projects

After extensive evaluation of many different combinations of the various water supply and conservation options, a recommended supply portfolio called Hybrid 1, was determined to be the best strategy.

The major elements included in this recommended strategy include:

- Aggressive water conservation through new ordinances and rebates
- Devil's Gate Dam storage to Eaton Canyon for groundwater recharge
- Recycled water from Los Angeles-Glendale Water Reclamation Plant for non-potable reuse, focusing on Brookside Golf Course and surrounding park areas
- Recycled water from Los Angeles-Glendale Water Reclamation Plant for groundwater recharge in Eaton Canyon (tertiary-treated indirect potable reuse with blending of natural runoff and surface waters)
- Groundwater storage of imported water
- On-site stormwater capture projects for direct landscaping use and groundwater recharge

The benefits of these six major elements for PWP are: (1) greater supply reliability during droughts and emergency situations; (2) reduced overall lifecycle costs compared to a future in which these elements are not implemented; (3) improved groundwater levels; (4) improved local environment and surface water quality; (5) mitigation against potential climate change impacts; (6) consistency with MWD's regional water strategy of increasing conservation and local water supplies; and (7) compliance with the new state mandate for reducing per capita water usage by 20 percent by the year 2020.

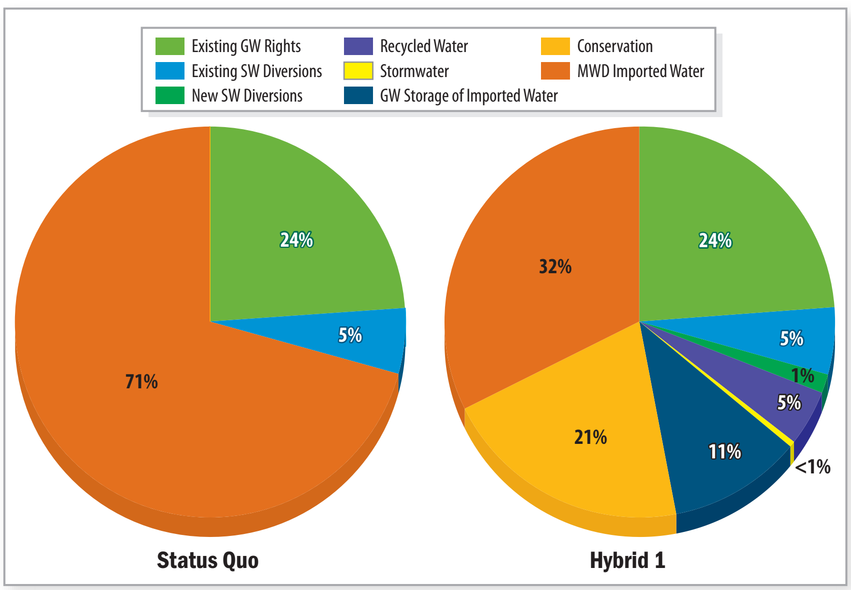

Figure ES-1. Future Supply Mix - Status Quo versus Hybrid 1

Figure ES-1 compares breakdown of water supplies to meet projected water demands in year 2035 between the status quo (current strategy) and the recommended Hybrid 1 strategy.

Near-term Actions

As with any long-term plan, various assumptions regarding water demand projections, and reliability and cost of water supplies have to be made. Recognizing that there are uncertainties in the future and that these planning assumptions may not unfold exactly as anticipated, it is recommended that these six elements be implemented in a phased manner.

The phased WIRP strategy prioritizes those projects that offer the most benefits at the lowest cost (when compared to projected costs of purchasing MWD imported water) in the near-term. Other projects would be phased-in based on "triggers" that would measure actual water demands, MWD reliability, compliance with state regulations, and other factors. A summary of the near-term actions recommended by 2015, along with cost estimates for the City is presented in Table ES-1.

Table ES-1. Summary of Near-term Actions and Costs (2010-2015)

Devil's Gate Storage to Eaton Canyon

- Pursue project in coordination with LA County, with goal of construction by 2015. Will require design coordination (to include indirect potable reuse and stormwater capture concepts), environmental permitting strategy, negotiation of spreading credits, and development of partnerships for cost-sharing.

Capital Cost: $11-15 million total capital costs

Portion of cost to be paid by PWP to be determined during implementation. Cost will be offset through partnerships and grant funding.

Recycled Water

- Develop ordinances that require new developments along planned recycled water corridors to have recycled water connection capability.
- Monitor progress of tunnel project to Brookside Golf Course with goal of construction by 2013.
- Pursue Core Phase 1 system with goal of construction by 2015.
- Investigate regulatory requirements for indirect potable reuse, with goal of constructing tertiary-treated indirect potable reuse by 2017 (pending completion of Devil's Gate Dam to Eaton Canyon and Core Phase 1 non-potable system).

Capital Cost: $1 million capital cost for tunnel project; $6.8 million capital cost for Core Phase 1 system

Some of these costs may be offset by partnerships and state or federal grant funding.

Conservation

- Implement a rate structure that allows PWP to increase fixed revenue sources and explore ways to increase cost fairness related to how customers use water.
- Continue to implement programmatic conservation measures at similar levels as in the past, and consider a stewardship fee on all water sold to help pay for these measures.
- Develop and implement ordinances for new development and resale that requires:
  - Landscaping to be compliant with California Model Landscape requirements for all *new* residential and commercial properties;
  - Individual meters for all *new* multifamily developments; and
  - Plumbing retrofits on resale of residential and commercial properties.

Average Annual Cost: $1.6 million

Some of these PWP costs may be offset by MWD's conservation credits program and state grant funding.

On-site Stormwater Capture

- Evaluate and implement appropriate Low Impact Development (LID) ordinances.
- Work with other City departments and agencies to develop a comprehensive stormwater strategy.
- Pursue funding through grants and partnerships and implement projects as funding becomes available.

Average Annual Cost: Up to $1.2 million, depending on projects pursued

Some of these costs may be offset through partnerships or state grant funding.

Imported Water to Groundwater Storage

- Complete projects underway to activate wells in Monk Hill subarea.
- Construct East-side Well Collector project.
- Negotiate use of storage accounts in with Raymond Basin Management Board.

Capital Cost: $12.6 million

Some of these costs may be offset by state or federal grant funding.

Section 1
Introduction

Located at the base of the San Gabriel Mountains, the City of Pasadena is a vibrant place to live and work. Pasadena is characterized by many scenic features such as the Arroyo Seco, Huntington Library and Botanical Gardens, the Rose Bowl, and adjacent Angeles National Forest. The City also has distinctive historic districts such as Old Pasadena, the Civic Center, and the Playhouse District, which along with fine dining, shopping and a rich cultural environment of museums attracts many annual visitors each year. Finally, Pasadena is home to several prestigious academic and research institutions such as the California Institute of Technology and NASA's Jet Propulsion Laboratory.

In short, Pasadena is a beautiful place to live and visit. But to support all of this requires a reliable, affordable and high quality water supply. Water really is the life blood of Pasadena. Not only is water essential for drinking, public health, sanitary purposes, and fire protection; but it is also needed to maintain quality of life and to ensure a sustainable natural environment.

1.1 Overview of Water Issues

Pasadena and neighboring communities receive their water supply from the City of Pasadena Water and Power Department (PWP), which relies on two main sources: local groundwater from the Raymond Basin and purchased water from the Metropolitan Water District of Southern California (MWD).

MWD imports their water from the Sacramento-San Joaquin Delta via the State Water Project (SWP), and from the Colorado River. An eight-year drought in the Colorado Basin—more severe than any other measured

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City of Pasadena Water Awareness Day

City Hall in downtown Pasadena

in the 20th century—resulted in record lows in Colorado River water levels. Water supplies from the SWP have also been significantly reduced due to recent court restrictions to protect fisheries in the Delta and a prolonged drought. These strains on MWD's supply sources have caused it to dip into emergency storage, and impose water allocation limits to its member agencies for the first time since 1991. In addition, MWD's imported water costs have increased an average of 12 percent per year from 2006 to 2010.

In terms of local water supplies, water levels in the Raymond Basin continue to be below historical averages, and as a result PWP's overall groundwater pumping rights will be reduced by 20 percent for the foreseeable future. Groundwater contamination is also an issue that will require PWP to invest in well treatment over the next few years and potentially beyond.

In response to water supply limitations from MWD and reduced local groundwater, Pasadena recently enforced city-wide Level 1 shortage and water restrictions to its residential and commercial/institutional customers.

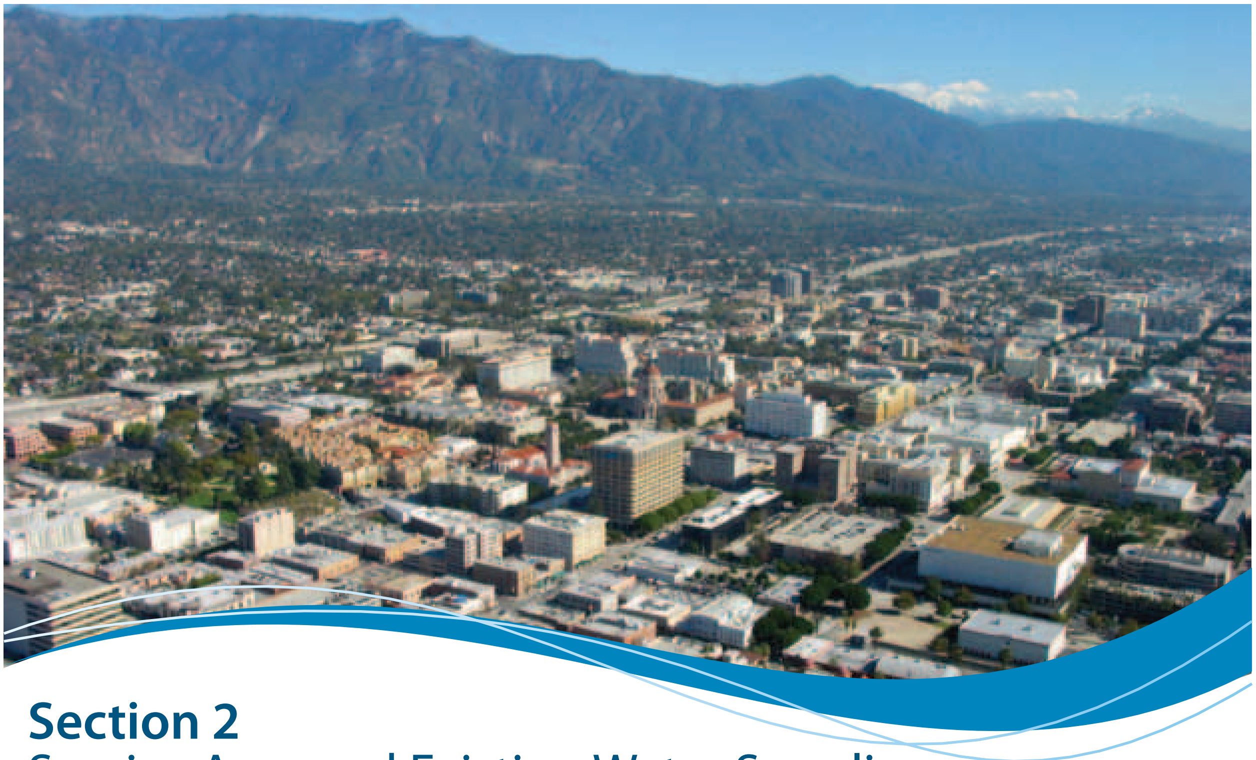
1.2 Purpose of Water Integrated Resources Plan (WIRP)

To address these critical water supply challenges, PWP has taken a proactive step to lead as a model water agency by developing a Water Integrated Resources Plan (WIRP). The WIRP was developed using an open, participatory planning process, with input from a dedicated stakeholder Advisory Committee and the public at large.

In any strategy document, it is important that a mission statement be crafted which provides the overall goal of the plan. The WIRP Advisory Committee, representing Pasadena's stakeholders, developed the following WIRP mission statement:

The Pasadena Water Integrated Resources Plan will provide an achievable, long-term strategy to meet current and future water needs. The goals of the WIRP are to sustainably and cost-effectively address local and regional water supply and demand issues, reflect community values, and adapt to changing conditions.

In addition to providing an overall water resources strategy, the WIRP is a source document for Pasadena's 2010 Urban Water Management Plan (UWMP). California law requires that all water agencies prepare an UWMP every five years. Furthermore, both the WIRP and 2010 UWMP have to indicate how Pasadena will meet the new Water Conservation Act of 2009, also known as California's "20x2020" plan. In 2009, Senate Bill 7 (SB7) was passed as part of a comprehensive legislative package to improve the state's water supply reliability and restoration of the Sacramento-San Joaquin Delta. SB7 requires that per capita water use be reduced by 20 percent by the year 2020.



Section 2
Service Area and Existing Water Supplies

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- *Service Area Description*
- *Existing Sources of Water Supplies*

2.1 Service Area Description

PWP's service area is located within the northwestern portion of the San Gabriel Valley in Los Angeles County *(see Figure 2-1)*. Encompassing approximately 23 square miles, the PWP service area is slightly larger than the legal boundary of City of Pasadena and includes portions of the unincorporated areas of Altadena, East Pasadena, and San Gabriel. The service area is bordered on the north by unincorporated Altadena and the Angeles National Forest, on the east by Arcadia and Sierra Madre, on the south by South Pasadena and San Marino, and the west by Los Angeles, Glendale, and La Canada Flintridge.

2.1.1 Demographics

Any water supply plan requires credible projections of growth to be made. To comply with state and regional water supply planning, local municipalities should use official historical estimates and projections of demographics. The California Department of Finance (DOF) and Employment Development Department (EDD) provide historical estimates of population, housing and employment using U.S. Census benchmarks, along with annual births-deaths data, employment reporting, and driver and voter registration data. The Southern California Association of Governments (SCAG) is the regional government planning agency that provides projections of demographics based on the general plans for each city in the region, along with

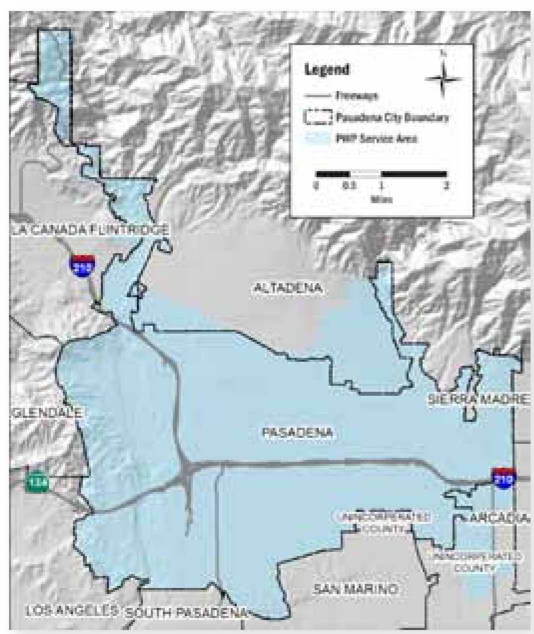
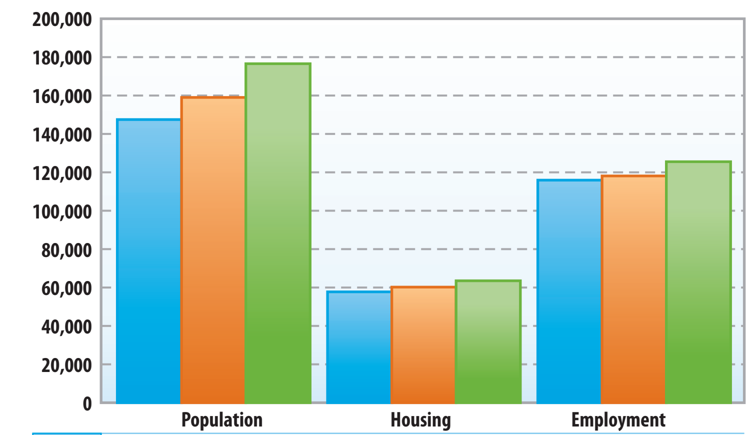


Figure 2-1. Service Area Map

key transportation data. Therefore, for consistency in reporting for preparation of official documents, such as the 2010 UWMP, PWP utilizes the aforementioned data sources for historical and projected demographics.

Historic population, housing, and employment growth for the PWP service area was very low between 1990 and 2000 as a result of an economic recession that began in 1991. A noticeable uptick in demographic growth occurred between 2000 and 2010 even though another economic recession began in 2008 *(see Figure 2-2)*. Between 1990 and 2010, the population increased from 146,840 to 175,957, representing an annual average growth rate of 0.9 percent. During the same two decades, total housing increased from 57,722 units to 64,272 (representing an average annual growth rate of 0.5 percent) and employment grew from 115,710 to 124,860 (representing an annual growth rate of 0.4 percent).



	Population	Housing	Employment
1990	146,840	57,722	115,710
2000	158,701	60,083	117,703
2010	175,957	64,272	124,860

Figure 2-2. Historic Demographics 1990-2010

According to the SCAG, minimal demographic growth is expected from 2010 to 2035 in PWP's service area. Service area population is forecasted to increase by approximately 0.5 percent annually over the period, resulting in approximately 23,600 new residents over the next 25 years. Single-family housing is expected to grow at 0.5 percent annually, as it is anticipated that household size will continue to decline over the projection period from 2.67 persons per household to 2.63 persons per household. Multi-family housing growth is expected to have a higher annual growth rate than single-family, at 0.8 percent versus 0.5 percent, respectively.

Employment growth is expected to increase at approximately one-half of the annual historic employment growth at 0.5 percent annually throughout the projection period. In contrast to overall employment growth, industrial growth is expected to decline by 0.2 percent annually. Employment growth is primarily driven by the current and long-term opportunities available from the diverse economic base within the five-county metropolitan region of Southern California. The economic base is wide-ranging and includes services, wholesale and retail trade, manufacturing, government, financial service industries, transportation, utilities, construction, education, and tourism. Table 2-1 presents the projected demographics for PWP's service area.

Table 2-1. Demographic Projections

Demographic	2010	2015	2020	2025	2030	2035
Population	175,957	180,691	185,640	190,436	195,089	199,562
Housing						
Single-Family	36,560	37,578	38,646	39,420	40,151	40,717
Multi-Family	27,713	28,907	30,184	31,236	32,264	33,157
Total Housing	64,272	66,485	68,830	70,656	72,415	73,874
Persons per Household	2.67	2.65	2.63	2.63	2.63	2.63
Employment						
Commercial	119,181	123,424	126,060	129,160	132,439	135,606
Industrial	5,679	5,562	5,527	5,493	5,482	5,441
Total Employment	124,860	128,985	131,588	134,653	137,921	141,047

Source: SCAG Regional Transportation Plan (2008), modified using MWD's land use planning to represent PWP's service area.

2.1.2 Climate

Pasadena's weather is characterized as a Mediterranean climate *(see Table 2-2)*. Temperatures are mild winter, spring and fall, and hot and dry during summer months. Average rainfall is approximately 20.09 inches, slightly more than adjoining westerly cities as a result of it geographic location at the base of the San Gabriel Mountains to the north. Approximately 71 percent of the average annual precipitation falls during the winter months of January through March. The standard annual average of evapotranspiration rate (ETo) for the service area is 57.06 inches per year based on the nearest ETo station in Monrovia.

Table 2-2. Long Term Historical Average Climate Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Daily Max. Temperature for Month (ºF)[1]	80.95	82.63	83.79	88.93	92.23	94.59	98.51	99.68	101.33	96.57	87.35	81.64	90.68
Ave. of Daily Max. Temperature for Month (ºF)[1]	66.74	68.41	70.46	73.96	76.85	81.76	88.63	89.48	87.53	81.17	73.96	67.77	77.23
Ave. Precipitation (inches)[1]	4.31	4.61	3.22	1.45	0.37	0.15	0.02	0.10	0.36	0.68	1.81	3.00	20.09
Ave. ETo (inches)[2]	1.59	2.20	3.66	5.08	6.83	7.80	8.67	7.81	5.67	4.03	2.13	1.59	57.06

1. 1928-2008, Pasadena Weather Station, ID 6719
2. Monrovia, Station Id. 159, www.cimis.water.ca.gov/cimis/welcome.jsp

2.2 Existing Sources of Water Supplies

PWP has two primary sources of water, local groundwater from the Raymond Basin and imported water purchased from MWD. Over the period 1990 to 2008 total supplies were composed of an average of 60 percent imported and 40 percent local supplies *(see Figure 2-3)*.

2.2.1 Local Groundwater

PWP produces groundwater from the Raymond Basin underlying the northwest portion of the San Gabriel Valley *(see Figure 2-4)*.

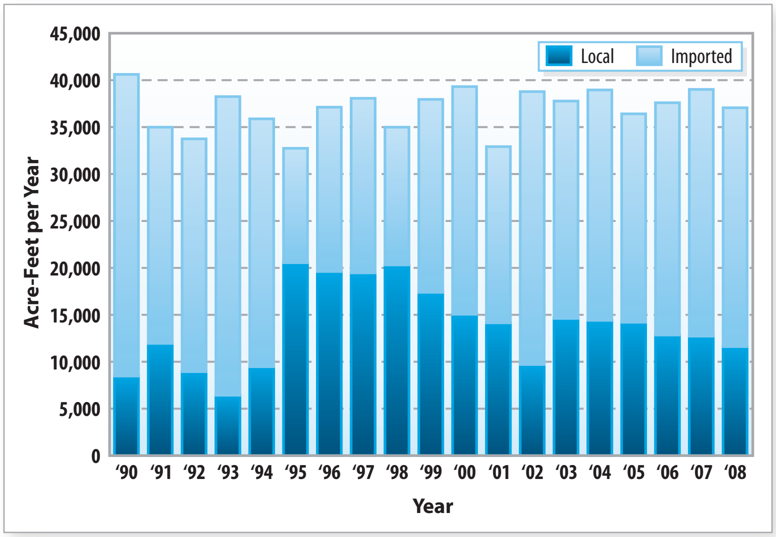


Figure 2-3. Historical Supply Mix

In 1944, the Raymond Basin was adjudicated. The resultant Raymond Basin Judgment and its successive modifications assign groundwater extraction rights based on the safe yield by three basin subareas: Monk Hill, Pasadena, and Santa Anita subareas. PWP has decreed water rights of 12,807 AFY from the Western Unit (Monk Hill and Pasadena subareas) with no rights in the Eastern Unit (Santa Anita subarea). In response to declining water levels, the Raymond Basin Management Board (RBMB) issued a resolution calling for a 30 percent deduction in pumping rights in the Pasadena subarea spread over five years effective July 1, 2009. PWP's pumping right will effectively be reduced to 10,304 AFY in 2014, which is nearly a 20 percent reduction in overall water rights.

Additional credits are available for groundwater recharge activities. PWP has water rights to divert up to 25.0 cfs from the Arroyo Seco to the Arroyo Seco spreading basins, although the current diversion capacity is limited to approximately 18 cfs due to intake structure and spreading ground capacity issues. In addition, PWP has water rights to divert 8.9 cfs from Eaton Wash to the Eaton Canyon Spreading Basins. Pumping credits set by the RBMB for groundwater recharge are 60-80 percent of total water recharged, but have historically been less than this due to losses from the credit formula methodology. On average the pumping credit from the groundwater recharge activities based on the period 1999 to 2009 is 2,160 AFY, increasing the total average pumping right in the basin to 12,464 AFY by 2014 (after water rights reductions).

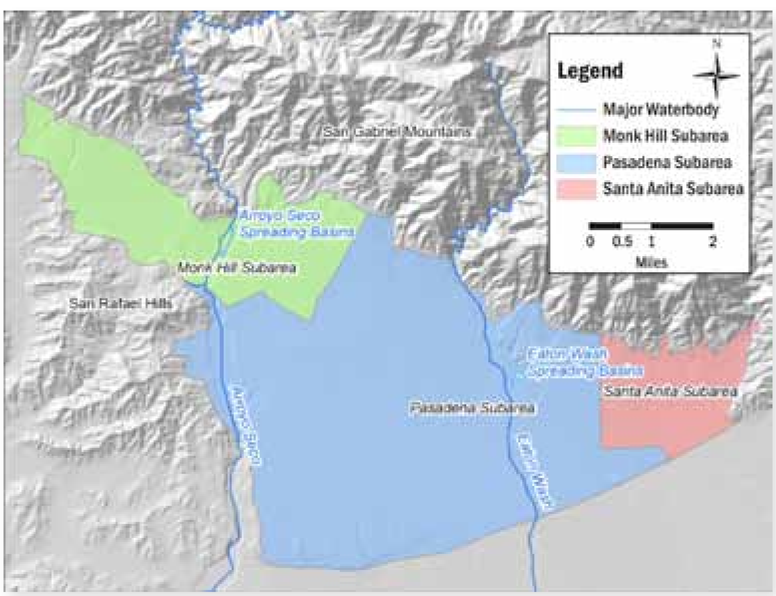


Figure 2-4. Raymond Basin

Groundwater storage (or banking) further increases the reliability of PWP's groundwater supply. PWP share of the Basin's storage volume is 38,500 AF as established by long term storage policies adopted in

1992 and 1993. PWP has further increased this storage by leasing capacity from other agencies/cities with storage volume in the basin. In the water accounting budget, PWP's allotted storage is currently full from previous carryover of annual water rights or imported water recharge, but has not been accessible due to capacity limitations in the Monk Hill subarea and declining water levels in the Pasadena subarea.

2.2.2 Imported Water

MWD is the largest water wholesaler for domestic and municipal uses in California, providing on average 1.7 billion gallons of water per day through its vast infrastructure network to a service area of approximately 5,200 square miles. Enabled by the California legislature in 1927, MWD's adopted purpose is to develop, store, and distribute water to southern California residents. Additionally, the Act allows MWD to sell additional water when it is available for other beneficial uses. In 1928 MWD was incorporated as a public agency following a vote by residents in 13 cities in southern California. Operating solely as a wholesaler MWD owns and operates the Colorado River Aqueduct (CRA), is a contractor for water from the California State Water Project (SWP), manages and owns in-basin surface storage facilities, stores imported water within local groundwater basins for conjunctive use storage, develops groundwater banking and water transfer programs to augment direct deliveries of SWP supplies, and provides incentives to local water agencies for water conservation, recycled water, groundwater recovery and desalination. Today MWD has 26 member agencies consisting of 11 water districts, one county water authority, and 14 cities, including the City of Pasadena (Pasadena). Figure 2-5 shows the major surface water supply sources and conveyance for California that MWD relies on for direct deliveries and water transfers.

Figure 2-5. Major Water Conveyance Facilities in California

As a member agency of MWD, PWP purchases imported water to supplement groundwater pumping. PWP receives treated water via five turnouts from MWD's Upper Feeder. Water is treated at MWD's Weymouth Water Treatment Plant (WTP). During outages at the Weymouth WTP, PWP can receive treated water from MWD's Jensen WTP via three of the five turnouts. Sufficient turnout capacity exists to meet existing and projected PWP demands.

Although PWP's connection capacity is adequate to meet future demands, reliability of MWD's imported water supplies have been reduced due to chronic droughts and environmental restrictions.

The main factors impacting the reliability of the SWP are:

- **Delivery of contract allocations –** The 2009 draft of the State Water Project Delivery Reliability Report indicates increased reductions in water deliveries on average when compared to previous reports as a result of environmental constraints and hydrologic changes derived from climate change.
- **Water quality issues –** Water quality issues include total organic carbon (TOC), bromide, arsenic, nutrients, N-nitrosodimethlamine (NDMA), and pharmaceuticals and personal care products (PPCPs).
- **Bay-Delta issues –** Multiple issues in the Bay-Delta region, at the confluence of the Sacramento and San Joaquin Rivers, where major SWP pumping facilities are located include pumping restrictions associated with protection of fish species protected under the Endangered Species Act and deteriorating infrastructure associated with levees.

Main factors impacting the reliability of the CRA are:

- **Supply apportionment –** MWD previously received unused supplies in excess of its apportionment, however, as other users have began to use their full apportionments excess water is no longer available. California's Colorado River Water Use Plan prepared by the California Department of Water Resources (DWR) identified actions that California will take to operate within its 4.4 million acre-feet entitlement. Completion of the Quantification Settlement Agreement (QSA), which established baseline water use for each California Party with rights to the Colorado River, is a critical component of the California Plan. On February 11, 2010 the QSA and 11 other agreements were ruled as invalid. MWD and others are currently appealing the decision. If the decision stands, programs authorized as part of the QSA will be delayed, costs may increase, or other adverse impacts may occur. Ultimately, the impact of the court's decision cannot be determined pending the outcome of the appeal.

Colorado River

- **Water quality issues –** Water quality issues associated with CRA supplies include high salinity levels, perchlorate, nutrients, uranium, chromium VI, N-nitrosodimethlamine, and PPCPs. High salinity levels present the most significant issue and the only foreseeable water quality constraint for the CRA supply.

MWD Integrated Resources Plan

To address these imported water supply issues, MWD initiated the first regional Integrated Resources Plan (IRP) in 1993 (adopted in 1996). MWD's IRP was updated in 2004, and again in 2010. The IRP represents a regional strategy to improve water reliability for its 26 member agencies, while factoring in cost, water quality, regulatory issues and other considerations.

Upon initiating the 2010 IRP Update, MWD was faced with new challenges with unknown consequences, such as climate change, environmental constraints in the Bay-Delta, and prolonged droughts. To address changing conditions and trends with the potential to disrupt water supplies, MWD conducted a strategic policy review as a component of the 2010 IRP Update. Results of this process led MWD to utilize a three-part adaptive resource management strategy as part of the latest IRP Update.

In response to the inherent uncertainty of water resources, an adaptive management strategy allows MWD to effectively respond to unplanned water supply disruptions utilizing cost effective strategies. These new challenges require adaptive management to ensure infrastructure and supplies are available when needed. The strategy serves as the centerpiece for assisting MWD in meeting uncertainties.

The 2010 MWD IRP has three main components: (1) to meet water demands by building on its existing core resources to provide reliability under foreseen conditions; (2) to implement a supply buffer of 10 percent of retail demand through multiple actions to adapt to short-term uncertainty; and (3)to implement adaptive management through low-regret foundation actions, monitoring of key vulnerabilities and bringing adaptive resource options online, if required, and using a comprehensive approach to meet specific needs and degrees of shortages. Each component contains multiple milestones to guide attainment of water resource targets.

MWD IRP Core Resources Strategy

The core resources strategy is to increase its existing resources and storage levels to maintain reliability throughout the planning horizon. Table 2-3 summarizes the targets for increasing core resources. As shown in this summary, significant increases in both imported water supplies (through a Delta "fix" for the SWP, and water transfers and banking in the Central Valley and Colorado River) and local supplies of MWD's 26 member agencies are identified. In addition, MWD is relying on compliance of the new statewide 20 percent conservation target by 2020 of all retail water providers in the region. The additional local water supply and water conservation that MWD is counting on from its member agencies and local water providers is 426,000 acre-feet per year by 2035.

Table 2-3. MWD Core Resources Strategy Targets

Forecast year	Targets (Thousands of AF per Year)				
	2015	2020	2025	2030	2035
State Water Project Improvements in Bay-Delta	151	151	283	283	283
Colorado River Aqueduct Dry Year Supply	411	303	351	386	370
Local Resources Augmentation	16	16	46	46	46
20 percent by 2020 Retail Compliance1	190	380	380	380	380
Total Core Resources Development:	768	850	1,060	1,095	1,079

1. Demand reductions are achieved by a combination of conservation and increased use of recycled water.

Source: Draft 2010 Integrated Water Resources Plan Update, Metropolitan Water District of Southern California

Since 1982, MWD has assisted local agencies with financial incentives, through the Local Resource Program (LRP), to develop local core resources with the goal of increasing regional reliability cost effectively. Existing local core resources include recycled water, groundwater recovery, and seawater desalination. Through the LRP, MWD traditionally provides incentives for actual production of supplies.

The Water Conservation Act of 2009 requires water agencies to reduce per capita water use by 20 percent by 2020. Reductions include increasing recycled water use to offset potable water use. As part of its core resources strategy MWD is accounting in its IRP Update for increased conservation associated with meeting the 20 percent by 2020 requirements. On an individual agency basis, MWD has estimated reduced potable demands in 2020 of approximately 380,000 AFY. Obtaining regional consistency with the requirements would further reduce potable demands by an additional 200,000 AFY for a total of 580,000 AFY; however this additional reduction is targeted towards MWD's buffer supplies as described below. In 2035, 20 percent by 2020 retail compliance savings through existing programs are expected to be 380,000 AFY.

MWD IRP Supply Buffer

Building upon past IRP Updates, MWD identified uncertainties and developed contingency plans while expanding its planning buffer program first developed in the 2004 IRP Update. The 2010 IRP Update seeks to create a buffer against demand uncertainty through development of a supply buffer equal to 10 percent of total retail demand, while the adaptive management concept seeks to mitigate against supply uncertainty to further increase reliability *(see Table 2-4)*.

Table 2-4. MWD's Buffer Supplies (AFY)

Supply	2015	2020	2025	2030	2035
Local Resources Augmentation	100,000	200,000	200,000	200,000	200,000
20 percent by 2020 Regional Level Compliance1	130,000	280,000	280,000	290,000	300,000
Total Buffer:	230,000	480,000	480,000	490,000	500,000

1. 20 percent by 2020 compliance is achieved by conservation and increased use of recycled water.

Source: Draft 2010 Integrated Water Resources Plan Update, Metropolitan Water District of Southern California

MWD IRP Reliability Analysis

To demonstrate the reliability of the IRP Update and resource targets through 2035, MWD analyzed regional demands, supplies, and storage and transfer availability under dry weather conditions. Through a three prong approach consisting of core supplies, buffer supplies, and adaptive management MWD will exceed 100 percent reliability through 2035, inclusive of a 10 percent supply buffer. Figure 2-6 shows regional water demands without conservation from 2015 to 2035 under dry weather. The graph also depicts the forecast supply sources, inclusive of storage and transfers.

Through the IRP Update, MWD has shown that it will be able to meet the supplemental needs of all its member agencies reliably through 2035, even during prolonged drought events. Buffer supplies provide an extra precaution to maintain reliability. MWD has implemented an adaptive management program allowing MWD to maintain reliability by rapidly responding to uncertain conditions that may impact core resources. MWD has demonstrated that it has a plan for implementing and financing the IRP targets.

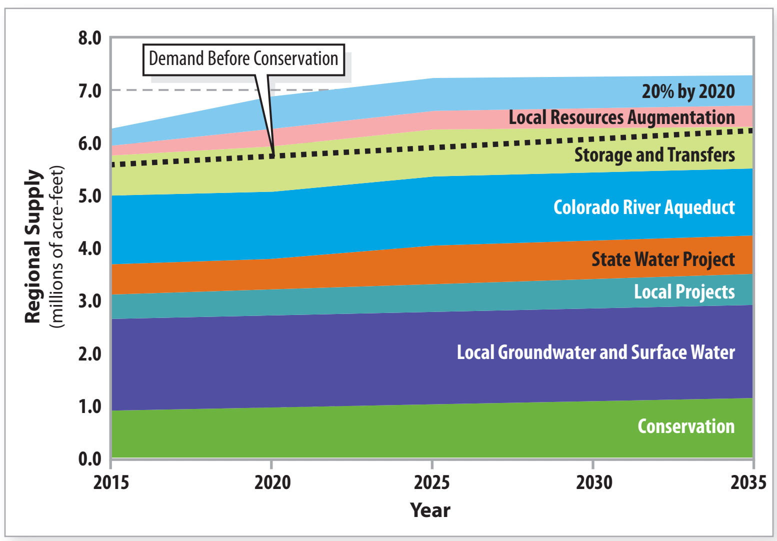


Figure 2-6. MWD Regional Water Demand and Supplies Dry Weather Scenario

However, it is important to note that achieving the levels of reliability included in MWD's IRP Update assumes the following:

1. A comprehensive solution to the decades-old conflicts in the Sacramento-San Joaquin Delta is implemented within the next 10-15 years
2. The court ruling on the Colorado QSA will not adversely impact MWD's ability to keep the CRA at nearly full most of the time
3. Significant increases in water conservation and local resources development by MWD's member agencies and local water providers, such as PWP

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Section 3
Water Demands and Needs Assessment

3.1 Current Water Use

Understanding PWP's water demands is essential to developing a long-term water supply strategy. Water demand is a function of many different factors:

- **Demographics –** number of single-family and multifamily homes, family size, and number of employees for commercial sectors
- **Socioeconomics –** income levels, unemployment rates, quality of life, price of water
- **Efficiency –** plumbing codes, ordinances, and conservation programs all increase efficiency of how water is used
- **Weather –** temperature and rainfall

In PWP's service area, there are four major categories of water demand *(see Figure 3-1)*:

1. **Single-Family –** representing detached and attached individually metered residences
2. **Multifamily –** representing apartments and condominiums that are master metered for the entire building or complex
3. **Commercial/Institutional –** representing businesses, government, academic and research institutions which could be metered individually or master metered
4. **Non Revenue Water –** representing water that is not billed to any customers and can include fire protection, system flushing, inaccurate metering, and distribution system losses

Inside

- *Current water Use*
- *Future Water Demand*
- *Needs Assessment*

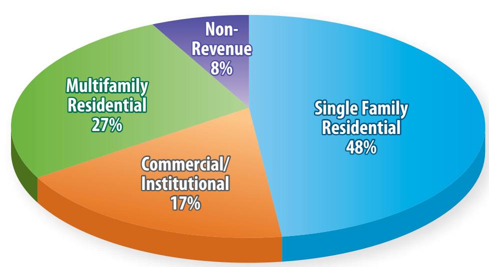

Figure 3-1. Current Breakdown of Water use in PWP's Service Area

Although water use within these categories can vary substantially, it is useful to understand the average usage within each sector for planning purposes. Figure 3-2 presents the average unit water use for each of PWP's major billing categories. Within PWP's service area, an average single-family home uses about 475 gallons per household, while an average multifamily home uses about 220 gallons per household. This large difference is mainly due to the fact that most single-family residences have yards to irrigate, whereas in multifamily the landscaping is usually a small common area which is divided among all the units in a building or complex. The average use in the commercial/institutional category is about 80 gallons for every employee working in Pasadena. Overall water use averages approximately 208 gallons per capita per day (gpcd), which includes roughly 140 gpcd for residential uses.

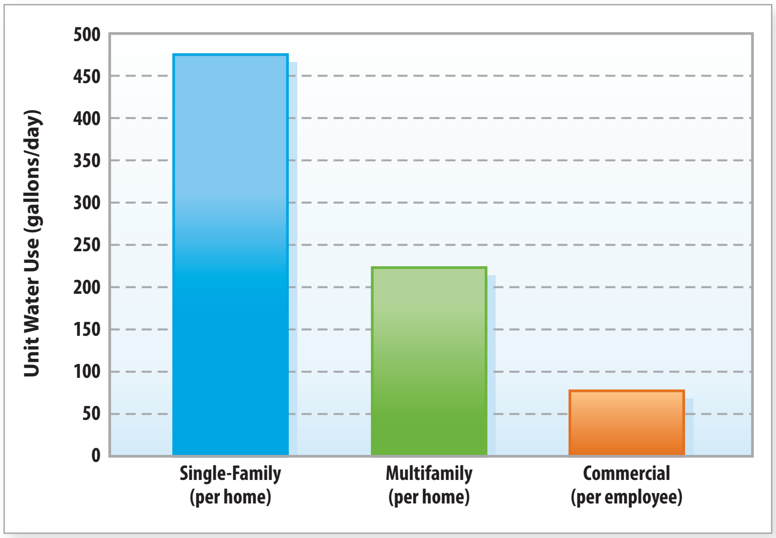

Figure 3-2. Average Unit Water Use in PWP's Service Area

Irrigation and water used for cooling purposes contributes a major demand for PWP's water supply. Pasadena can be quite warm in the summer, with average maximum temperatures reaching over 90 degrees. It is estimated that almost 60 percent of annual single-family water use is used for landscaping and other outdoor purposes (pools, cleaning of driveways, washing cars). In the multifamily and commercial sector, approximately 45 percent of water use is for irrigation, outdoor uses, and cooling towers.

Total water demands from 1990 to 2009 have varied substantially from year to year due to weather, economic conditions, and droughts *(see Figure 3-3)*. Overall, water demands during this period appear to be relatively flat, despite the fact that population increased by an estimated 0.9 percent per year. The reasons for this are: (1) there have been two major economic recessions, one starting in 1992 and the other in 2008, affecting Southern California and Pasadena; (2) there have been two periods in which MWD has allocated its imported water supplies which forced PWP to issue mandatory conservation, once in 1991 and again in 2009; and (3) PWP has been

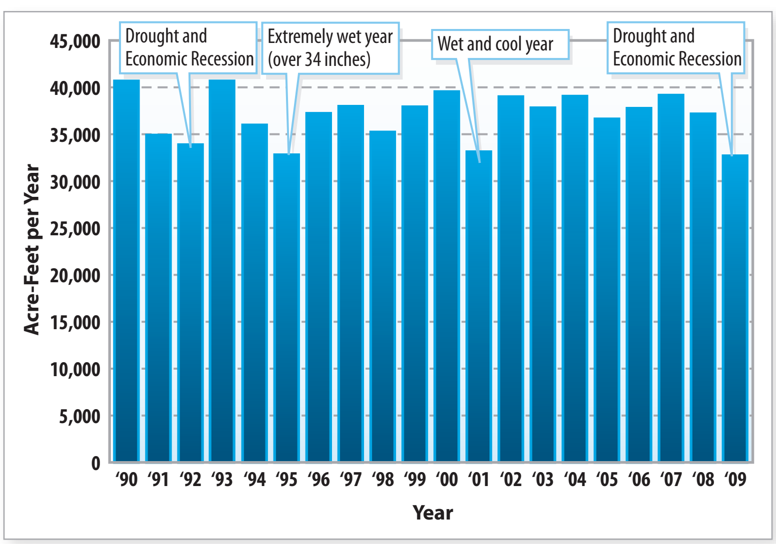

Figure 3-3. Total Water Use in PWP's Service Area

implementing water efficiency programs since 1991, such as toilet rebates, water use audits, irrigation and commercial conservation, and public education. The estimated conservation savings from PWP's efficiency programs is about 3,200 AFY.

When droughts and economic recessions are removed from the historical data there has been a slight increase in water demands of about 0.5 percent per year, which represents a third of the rate of population growth during this same period. This fact demonstrates PWP's success in implementing water conservation as increases in water demands usually trend similar to population growth absent any water use efficiencies.

3.2 Future Water Demand

Projecting future water demands requires understanding of current uses and forecasts of demographics. The official demographic forecasts presented in Section 2 are used to generate a projection of future water demands for PWP's service area. The forecast of Pasadena's demographics is based on SCAG's most recent regional transportation plan. It is important to note that SCAG's projections of future population, housing and employment are lower than historical growth rates for the service area.

Future water demands are also a function of planned water conservation efforts. However, since new water conservation will be evaluated along with new water supplies (which are presented in Section 4 of this report), the demand projection only accounts for current conservation and efficiencies that are expected to come from California's plumbing codes.

To project water demands for PWP, the following methodology was used:

- **Single-Family Residential –** Multiply the current unit water use *(see Figure 3-2)* by the projected number of single-family homes *(Table 2-1)*, and adjust for California plumbing code efficiencies (which reduces demand by 5 percent)
- **Multifamily Residential –** Multiply the current unit water use *(see Figure 3-2)* by the projected number of multifamily homes *(Table 2-1)*, and adjust for California plumbing code efficiencies (which reduces water demand by 6 percent)
- **Commercial/Institutional –** Multiply the current unit water use *(see Figure 3-2)* by the projected number of employees *(Table 2-1)*, and adjust for California plumbing code efficiencies (which reduces water demand by 6 percent)
- **Non Revenue Water –** The difference in total water production and billed water to customers represents non revenue water, which has averaged 7.9 percent - which is low compared with most other water agencies.

Table 3-1. Projected Water Demands for PWP (Acre-Feet Per Year)

Sector	2015	2020	2025	2030	2035
Single-Family	19,200	19,900	20,300	20,500	20,600
Multifamily	6,800	7,200	7,400	7,600	7,700
Commercial/Institutional	10,800	11,100	11,300	11,500	11,600
Non Revenue	3,200	3,300	3,400	3,400	3,400
Total:	**40,000**	**41,500**	**42,500**	**43,000**	**43,300**

Table 3-1 presents the water demand forecast for PWP's service area without new water conservation, under normal weather. Total water demands are projected to be 43,000 AFY in 2035, representing an annual increase of 0.5 percent (similar to the historical growth rate from 1990 to 2010). Refer to Appendix A for more details on the demand forecast assumptions and methodology.

3.3 Needs Assessment

PWP's existing water supplies were summarized in Section 2. And although during normal and non-emergency conditions MWD has been able to meet Pasadena's supplemental water supplies with imported water, there have been times where the wholesale agency has had to impose water allocations. In fact, for the first time in its history, MWD allocated its imported water supplies two years in a row, 2009 and 2010. This resulted in PWP having to impose mandatory restrictions on water use. Mandatory restrictions can be detrimental on the economy and quality of life. For example, if businesses perceive that water is not reliable they may not choose to locate in Pasadena. And although MWD's water reliability analyses show that it will be able to meet all of its future demands for water, it is based on the assumption that a comprehensive solution to the Bay Delta is implemented by 2025, and that local utilities meet the state's new conservation goal of 20 percent reduction by 2020.

Given the uncertainties surrounding the Bay Delta and how well all utilities are successful in meeting the 20 x 2020 conservation goal, it would be prudent for PWP to plan for the contingency that MWD will have to allocate water again between now and 2035.

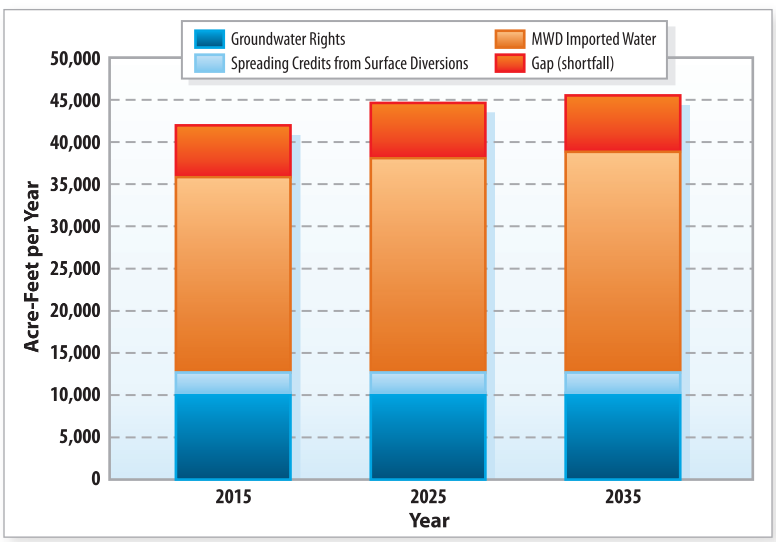

Figure 3-4. Projected Status Quo Shortfall with MWD Water Restrictions

In order to show the implication of this contingency, future water demand projections without new conservation were compared to PWP's existing groundwater and surface water diversions under an imported water allocation scenario (assuming a 20 percent regional shortage level). While it is not expected that MWD would allocate water every year from now until 2035, it is important to see what the potential water shortage (or need for mandatory rationing) would be if the wholesale agency was not fully reliable *(see Figure 3-4)*.

MWD's statistical analysis of water usage indicates that water demands can be ± 5 percent due to variations in temperature and precipitation. Therefore, demands were increased by 5 percent to account for a dry weather scenario.

The gap between the projected water demand and availability of existing water supplies indicates the potential water shortage that would have to be made up by either: (1) imposing mandatory rationing; (2) developing new sources of water supply; and/or (3) implementation of new water conservation programs. The potential shortfall in water supply under a situation in which MWD allocated water would be as much as 6,500 AFY by 2035, or 14 percent of demand.

Conservation Garden

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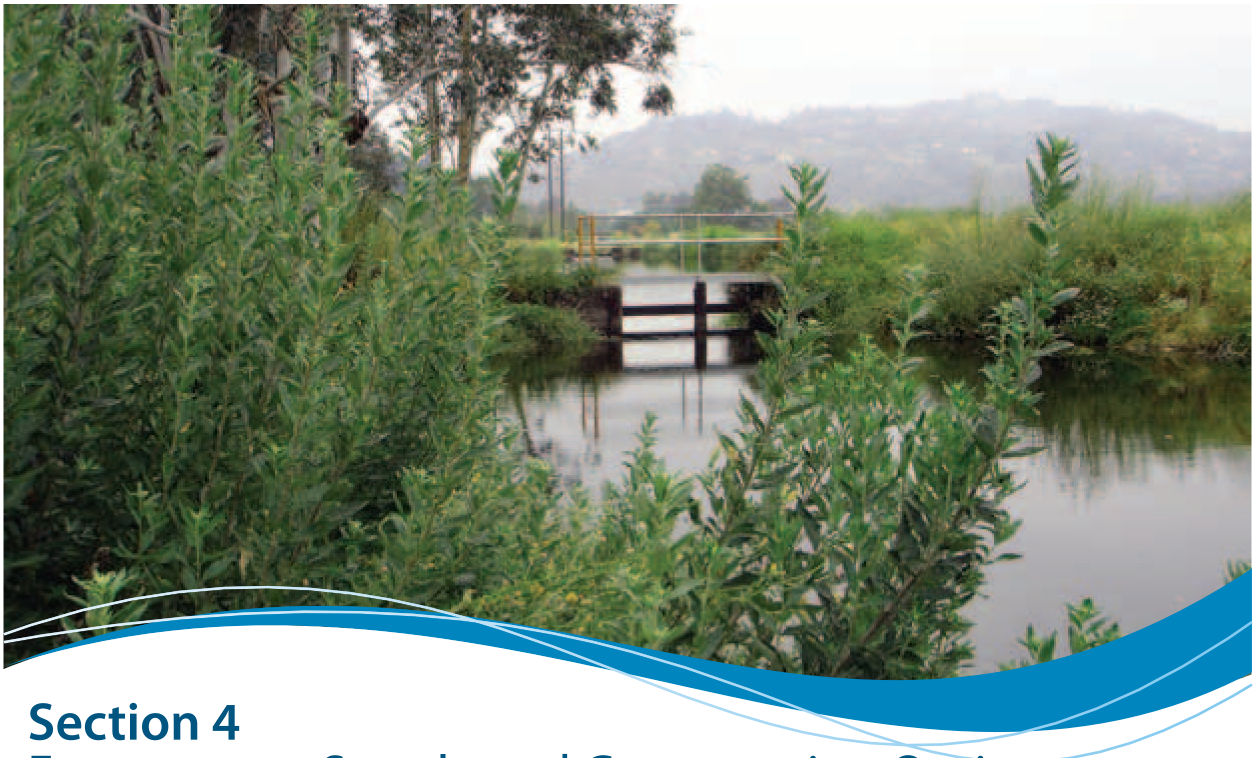

Section 4
Future water Supply and Conservation Options

Roughly 50 future water supply and conservation options were considered to help meet PWP's projected water demands. The comprehensive list of options was developed through brainstorming sessions held with the public, the WIRP Advisory Committee, and PWP staff. These options were then screened down into approximately 25 concepts based on a technical review that examined implementation feasibility, cost and other factors. The remaining options generally fall under these main categories *(see Table 4-1 for more details)*:

- Conservation
- Local Surface Water/Stormwater Diversions
- Recycled Water
- Imported Water (including transfers/banking and local recharge)
- Graywater
- On-site Stormwater/Urban Runoff
- Ocean Desalination

Planning-level analysis was performed to characterize each option's supply yields, costs, environmental impacts, water quality, and other information relevant to the WIRP objectives. Although this characterization was based on the best available technical information and professional judgment, more detailed analysis of any of these options will be required prior to implementation.

Inside

Table 4-1. Range of Options Considered

Supply Category	Number of Options	Range of Supply Yield (AFY)	Range of Unit Cost ($/AF)
Conservation Increase local conservation programs within PWP's service area	4	6,600-12,000	$545 - $787
Local Surface Water Divert flows from Arroyo Seco or Eaton Wash to groundwater replenishment, a new treatment plant, or non-potable use	9	148 - 2,164	$209 - $1,650
Recycled Water Reuse of treated wastewater for landscape irrigation or groundwater replenishment	5	410 - 3,000	$946 - $3,126
Imported Water Imported surface water from outside Pasadena's service area	6	2,000 - 30,000	$811 - $1,404
Graywater Non-sewage on-site household wastewater that can be recycled for non-potable use	1	807	$5,947
Stormwater/Urban Runoff Capture of urban storm runoff for groundwater recharge or non-potable use	7	32 - 44	$4,914 - $46,080
Ocean Desalination Partnership to receive imported water in-lieu of water from new ocean desalination plant	1	5,000	$2,650
Other Concepts Considered in WIRP Other recycled, groundwater, cloud seeding, recharge, conservation, etc.	16	NA	NA
Total:	49	32 - 30,000	$209 - $46,080

AF = acre-feet AFY = acre-feet per year

The following describes each of the options evaluated in the WIRP. More details of these options can be found in Appendices B through E. Table 4-2 at the end of this section summarizes some of the pros and cons of each of these supply categories.

4.1 Conservation

Conservation Garden

In response to California's water crisis, Governor Arnold Schwarzenegger signed the Water Conservation Act of 2009 (SB-7), which mandates that all water utilities across the state reduce their water use by 20 percent by 2020 (commonly referred to as "20x2020"). In order to comply with this progressive challenge, PWP will need to implement some level of additional conservation. Because there are alternative methods of complying with 20x2020, such as increasing non-potable recycled water use, varying levels of conservation goals and their tradeoffs were analyzed:

- **Moderate Conservation –** Essentially a continuation of PWP's current conservation program throughout the planning period, with new conservation savings growing to 6,600 AFY by 2035.
- **Aggressive Conservation –** Greater emphasis on outdoor conservation and significantly increasing PWP's current indoor conservation programs. New conservation savings would reach 9,000 AFY by 2035.
- **Maximum Conservation –** Requiring most homes to have "California Friendly" landscaping, and very aggressive indoor conservation with ordinances requiring plumbing retrofits on

resale of properties and ordinances for existing landscaping conversions. New conservation savings would reach 12,000 AFY by 2035.

Based on feedback from the WIRP advisory committee, targeting very high single-family water users with steep water pricing was also evaluated in order to partially meet the Maximum Conservation level without the need for rebates. Although the reliability of conservation from this method is uncertain, this could be a less expensive approach for PWP if it proved successful.

4.2 Local Surface Water

Local surface runoff originates in the San Gabriel Mountains and flows through the PWP service area along the Arroyo Seco and Eaton Canyon. Most runoff occurs during the rainy winter months, with very little flows in the dry summer months. PWP has existing water rights to capture and divert this water, and currently sends it to existing spreading basins for groundwater replenishment. However, there are some limitations preventing maximum yields of water rights due to capacity constraints and spreading credit methodology administered by the RBMB, the agency responsible for maintaining the health of the groundwater basin. Options considered for maximizing use of PWP's water rights included:

Arroyo Seco

- Expand Arroyo Seco Diversion and Spreading Capacity
- Re-activation of the Behner Water Treatment Plant along the Arroyo Seco
- Diversion of surface water directly to non-potable demands

Additional water is available in the Arroyo Seco, beyond PWP's water rights, that currently flows straight to the ocean without any beneficial use. The Los Angeles County Department of Public Works Water Conservation Planning Section (LACDPW) is currently considering a conservation project to capture this water behind Devil's Gate Dam. Groundwater recharge could occur behind the dam, and stored water would be pumped and diverted over the Eaton Canyon spreading basins for additional recharge. The concept in the WIRP also includes capture of urban runoff through connection of existing storm drain pipes to the conveyance pipeline from Devil's Gate Dam to Eaton Canyon. In concept, the Devil's Gate Dam project would provide an opportunity for enhanced habitat conditions for aquatic life, including more sustained environmental flows in the Arroyo Seco downstream of the dam.

Los Angeles-Glendale Water Reclamation Plant

4.3 Recycled Water

Pasadena currently has an agreement to purchase recycled water from the Los Angeles-Glendale Water Reclamation Plant (LAG WRP), and conveyance infrastructure to the vicinity of PWP's service area

Typical signage indicating non-potable reuse

is already in place. In parallel to the WIRP study, the City has been working on a Recycled Water Master Plan to evaluate potential projects to utilize this water. Select representative alternatives from the plan were evaluated in the WIRP. These included:

- Non-potable reuse (NPR): construct a recycled water distribution system to provide water to customers with traditional recycled water demands such as irrigation. Two project sizes were considered: (1) Small Phase 1 system, mainly to Brookside Golf Course and nearby potential customers, and (2) Maximum distribution system, which would extend the recycled water system further into Pasadena.
- Indirect Potable Reuse (IPR): This concept involves conveyance of recycled water to Eaton Canyon for groundwater replenishment and recovery for potable use. Per the Recycled Water Master Plan evaluations, replenishment located at Eaton Canyon spreading basins is recommended due to challenges in meeting retention time requirements and potential mounding issues at the Arroyo Seco spreading areas. Two IPR options were considered: (1) tertiary-level treatment, the current level provided by LAG WRP, and (2) advanced treatment, which requires construction of an advanced recycled water treatment plant and is more costly. Both options propose to blend recycled water with natural surface runoff from Eaton Wash along with Arroyo Seco diversions from the proposed LACDPW Devil's Gate Dam to Eaton Canyon project. Conveyance infrastructure could be shared as well.

Eaton Canyon

In addition to recycled supply from LAG WRP, a joint satellite treatment plant was analyzed to collect wastewater from the California Institute of Technology and Pasadena City College, and treat it for on-site non-potable use such as irrigation and cooling towers. This option is paired with the maximum non-potable distribution system, since some pipe conveyance could be shared with the main recycled water distribution system.

4.4 Imported Water

Sacramento-San Joaquin Delta

Treated imported water is currently purchased from MWD, and as discussed earlier, is facing challenges with reliability and costs in the future. There are various imported water partnerships and opportunities that PWP could pursue that have the potential to increase reliability of imported water. The imported water options evaluated include:

- Transfer agreement with a water rights holder located north of the Delta to deliver water via the State Water Project (SWP) and MWD system
- Partner in a groundwater banking program in the Central Valley, and deliver water via the SWP and MWD system when needed

- Purchase groundwater replenishment water from MWD when available for storage in a local banking program in Raymond Basin, also known as the Pasadena Groundwater Storage Program (PGSP)

Additional treated imported water purchases from MWD are part of the status quo scenario, but are considered an option nonetheless. In analyses presented later in this report, the estimated future supply shortages with imported water restrictions are evaluated for several portfolios that have varying levels of reliance on MWD purchases.

4.5 Graywater

Graywater is wastewater that originates from household fixtures such as showers, bathtubs, clothes washing machines, and bathroom sinks; graywater excludes wastewater from toilets, dishwashers, and kitchen sinks. On-site graywater can be collected and used for outdoor non-potable uses such as drip irrigation. It is important not to mistake graywater with recycled water, which is subject to treatment and purification to make it suitable for a range of beneficial uses.

Graywater sources include used water from some household fixtures

The California Plumbing Code was recently revised with less stringent requirements for graywater installations; however, enforcement of the regulations is administered through the local enforcing agency (Pasadena). Because graywater has not been widely used previously, code standards are still evolving to reduce potential health risks.

4.6 On-site Stormwater/Urban Runoff

Stormwater or urban runoff currently is routed to a storm drain pipe network and discharged to streams and flood control channels that leave the service area. Typically, this stormwater carries with it all the pollutants and trash that have been picked up along parking lots and streets. Other departments and agencies are already implementing programs to treat or reducing stormwater discharges to comply with Total Maximum Daily Load (TMDL) regulations that protect receiving waters (local streams and the ocean). This option proposes to capture on-site stormwater at residential homes and commercial parking lots primarily for groundwater recharge and some non-potable reuse. The options considered include:

- Residential rain barrels
- Residential rain gardens
- Residential infiltration strip/bioswales
- Commercial parking lot swales
- Permeable pavement in parking lots

Permeable Pavement

Due to current credit formulas implemented by the RBMB, these options would not provide significant supply yields, but they would add replenishment to the groundwater basin and add significant water quality benefits for TMDL compliance.

Pacific Ocean

4.7 Ocean Desalination

Ocean desalination removes dissolved minerals (salts and others) from seawater, and produces very high quality project water. Desalination facilities are typically built along coastal communities, but since Pasadena is not located near a saline body of water, the ocean desalination concept considers a potential partnership with a regional agency to construct an ocean desalination facility. There is a possibility to partner with San Diego County Water Authority (SDCWA) on a new desalination plant near Camp Pendleton. PWP would pay a purchase cost for water once the plant is constructed. This would be an exchange agreement, since the desalinated water would physically be delivered to SDCWA member agencies and in return, PWP would receive the water allocation via Metropolitan Water District's (MWD's) facilities.

4.8 Others

Other options that are less traditional supply sources were suggested at public forums and evaluated as well in terms of their benefits and tradeoffs and can be further reviewed in Appendix E.

Table 4-2. General Pros and Cons for Various Resource Categories

	Pros	Cons
Conservation	▸ Helps with meeting 20x2020 goals ▸ Improves reliability ▸ Considered a "green" alternative with low energy use ▸ Eligible for grant funding	▸ Can be expensive and difficult to implement depending on level of conservation pursued ▸ Capital costs to customers/developers
Local Surface Water	▸ High quality water source under normal conditions ▸ Relatively inexpensive ▸ Some options replenish the groundwater basin, but receive reduced supply credit	▸ Flows are highly variable with weather ▸ Most options (but not all) have some degree of negative environmental impacts associated with aquatic habitat
Recycled Water	▸ Drought-proof, reliable supply ▸ NPR options help meet 20x2020 goals ▸ IPR options would enhance recharge to the groundwater basin ▸ Eligible for grant funding	▸ Varying levels of cost-effectiveness and implementation efforts ▸ For the NPR options, there are some capital costs to customers/developers for connection to recycled system
Imported water	▸ Groundwater banking programs would improve reliability ▸ Local banking program would be eligible for grant funding	▸ Availability of water via the SWP is highly uncertain ▸ Relatively expensive ▸ High energy use to convey water
Graywater	▸ Considered a "green" technology with low energy requirements ▸ Eligible for grant funding	▸ Potential health risks if not used properly ▸ Little data for applications in California ▸ Evolving code standards ▸ Relatively expensive per unit supply ▸ Capital costs to customers/developers
On-Site Stormwater/ Urban Runoff	▸ Considered a "green" technology with low energy requirements ▸ Surface water quality benefits and potential funding partnerships ▸ Groundwater replenishment ▸ Eligible for grant funding	▸ Supply yield is very small due to groundwater credit methodology ▸ Capital costs to customers/developers
Ocean Desalination	▸ Drought-proof supply ▸ Eligible for grant funding	▸ High energy emissions ▸ Relatively high cost ▸ Potential regulatory hurdles ▸ PWP would receive imported water in-lieu of desalinated water

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Section 5
WIRP Evaluation Process

The evaluation process for the WIRP was conducted using an open, participatory planning process. Stakeholder collaboration was essential to the success of this plan's development. Throughout this process, the following terminology was used:

Objectives: The overarching criteria by which the alternatives are compared. Specific "performance measures" for the objectives were developed to indicate how well the objectives were being achieved.

Options: Individual water supply or conservation projects or programs.

Portfolios: Combinations of individual options that together have a greater chance at meeting stated objectives.

5.1 Stakeholder Involvement

At the start of the WIRP process, Pasadena's mayor formed a WIRP Advisory Committee that represented a wide range of interests and backgrounds. The purpose of forming this committee was to have an organized group that would have a focused attention for the WIRP throughout the process. A total of eight WIRP Advisory Committee meetings were held over a period of approximately eight months with the following goals:

1. Define WIRP mission statement and planning objectives
2. Weigh relative importance of objectives
3. Brainstorm supply and conservation options
4. Review preliminary option supply yields, costs, and screening

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5. Review water demand projections and "gap" analysis
6. Define initial portfolios (combinations of options)
7. Review portfolio results
8. Review WIRP strategy, potential rate implications, and draft report

Additionally, public workshops were held on November 10, 2009, March 30, 2010, and November 3, 2010 at key points in the process to share information and exchange ideas. The overall goal of the public communication effort was to inform the public about the City's water planning activities and garner public feedback and input. The public communication activities conveyed the following core messages:

- Pasadena will be proactive in water management planning via this WIRP
- The WIRP's goal is to identify the best mix of future water sources and conservation measures to meet community needs and multiple planning objectives through the 2035 planning horizon
- Public is invited/encourage to participate in the WIRP

Public workshops were held to welcome participation and feedback in the planning process

The public communication activities were intended to reach the following audiences: residents of Pasadena and surounding communities within the PWP service area, environmentalists, business and recreational interests, community organizations, and educational institutions. Attendance at these public meetings ranged from 20 to 60 people.

To provide a forum for open communication, the City developed a website and an e-mail distribution list that was used throughout the course of the WIRP to distribute relevant materials and notify interested parties (public agencies, other governments, community interest groups, individuals with an expressed interest in water supply, etc.) of upcoming meetings and events. In addition, the City conducted an open survey to capture public perspectives on water supply and demand interests. The results of this survey are provided in Appendix F.

5.2 Evaluation Process

The WIRP proceeded initially along two parallel paths: the objectives path and the options path *(see Figure 5-1)*. The objectives path develops the *"why's"* in the WIRP – *why is the planning being undertaken?, why would one option be selected over another?,* etc. These questions are answered by explicitly defining planning objectives. Planning objectives are of fundamental importance to a successful WIRP as they describe, in this case, what PWP aims to achieve with regard to its long-term management of water resources.

The options path develops the *"how's"* in the WIRP – these are the specific options that PWP can choose from as means of meeting its water supply needs. Individual supply options can be projects, programs, or contracts with other agencies and the water supplies for these options can be from sources such as stormwater, recycled water, ocean desalination, etc. Since no single supply option is going to be able to meet all of PWP's objectives, separate supply options must be combined into portfolios. The portfolios, because of their multiple sources, can increase diversity and can better meet multiple objectives.

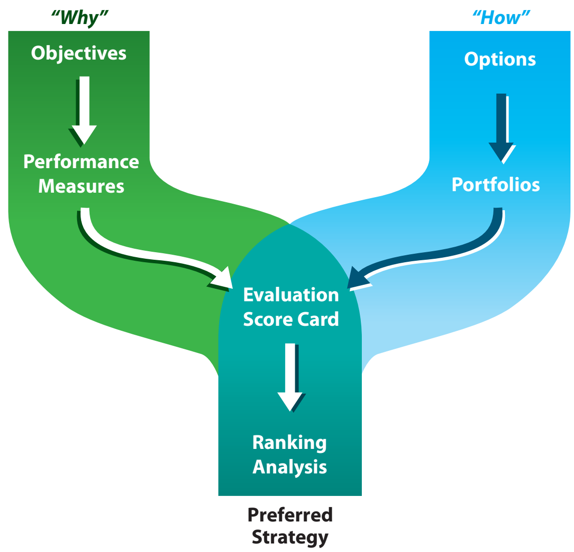

Figure 5-1. "Why" and "How" Parallel Paths

In order to be able to use the objectives and options together, there needs to be a means of quantifying the importance of the objectives relative to one another, as well as a means of quantifying how well different options satisfy those objectives. Characterizing the relative importance of the objectives is done by giving them weights. Quantifying the ability of the options to satisfy the objectives is done by defining performance measures, which are specific and measurable attributes related to the objectives. Portfolios are evaluated against the performance measures to produce a "raw" performance scorecard.

All of the planning objectives, weights, and portfolio performance scores are put together in a WIRP in what is known as a value model, which is described further in Section 5.8. Here, goals are explicitly stated and elaborated with the objectives, and the importance of the objectives relative to one another is characterized by the objective weighting. Portfolios can be evaluated and ranked based on the objective importance and the portfolio's ability to achieve the objective. Ultimately, the analysis results in the selection of a preferred portfolio and development of a long-term strategy. Figure 5-2 depicts the evaluation process followed in the WIRP.

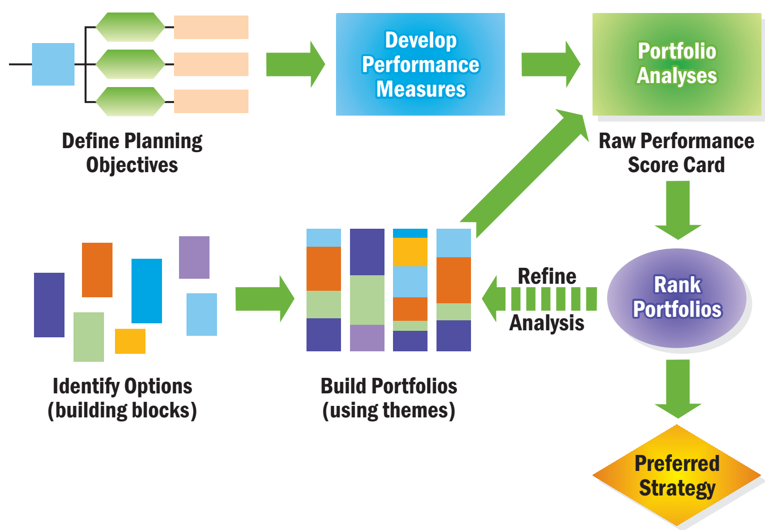

Figure 5-2. Evaluation Process

5.3 Objectives and Performance Measures

The WIRP planning objectives serve as the goals or reasons "why" the WIRP is being undertaken. Objectives are usually categorized into primary and secondary (with the secondary objectives being termed *sub-objectives*). Primary objectives are more general; while secondary help define the primary objectives in more specific terms.

For each sub-objective, a performance measure is required. The performance measure is used to indicate whether an objective is being achieved.

The following example illustrates the hierarchy of objectives, sub-objectives, and performance measures.

Primary Objective	Sub-objectives	Performance Measures
Provide a reliable water supply	Hydrologic Variability	Score of 1 to 5: ▸ 1- high vulnerability, ▸ 5- low vulnerability
	Vulnerability to Delta Restrictions	2035 supply shortages under imported water restrictions in acre-feet per year (AFY)

Swimming Pool at Pasadena City College

For effective decision-making, primary objectives should be developed such that they are:

Distinctive: objectives should be developed to distinguish between one project (or portfolio) and another

Measurable: objectives should be able to be measured, either quantitatively or qualitatively, in order to determine if they are being achieved

Non-Redundant: objectives should not overlap with each other

Understandable: objectives should be easily explainable

Concise: objectives should be kept to manageable numbers

The objectives, sub-objectives and performance measures defined for the WIRP are shown in Table 5-1. In any decision-making process, the objectives are generally not equally important for every stakeholder. Some objectives may be more relevant for one stakeholder than others (e.g., for a given individual, reliability may be more important than affordability). Thus, weighting objectives is necessary to better reflect the values and preferences of stakeholders and decision-makers.

Table 5-1. Objectives, Sub-objectives, and Performance Measures

Objective	Sub-Objective	Performance Measure
Provide a reliable water supply	▸ Hydrologic Variability (Local or Imported)	▸ Score of 1 to 5, 1 - high variability, 5 - low variability
	▸ Vulnerability to Delta Restrictions	▸ Annual supply shortage under imported water restrictions
	▸ Vulnerability to Climate Change	▸ Score of 1 to 5, 1 - high vulnerability, 5 - low vulnerability
	▸ Vulnerability to Catastrophes (e.g. fires, earthquakes)	▸ Score of 1 to 5, 1 - high vulnerability, 5 - low vulnerability
	▸ Maintain a system that can be independent of imported water for a short-term	▸ Supply shortages during a one month shut-down of imported water
Maintain affordability, while addressing fairness and equity	▸ Total Lifecycle Cost	▸ PV dollars, including customer/developer costs
	▸ Pasadena's average cost of water	▸ Average PV $/AF of PWP costs only, over planning horizon
	▸ Fairness in allocation of costs between customer types	▸ Score of 1 to 5, 1 - no difference among customer types, 5 - allocation fairness
Protect and enhance source waters and the environment	▸ Replenish the Raymond groundwater basin	▸ 2035 total average annual replenishment to the groundwater basin in AFY
	▸ Maintain or improve the water quality of Raymond groundwater basin	▸ Score of 1 to 5, 1 - high neg impact, 5 - high pos impact
	▸ Reduce stormwater pollutant discharges to creeks and rivers	▸ mgd of stormwater flows not discharged into receiving waters
	▸ Habitat impacts in watersheds of imported water supply	▸ Score of 1 to 5, 1 - high neg impact, 5 - high pos impact
	▸ Preserve or enhance local natural areas and water courses	▸ Score of 1 to 5, 1 - natural areas are not preserved, 5 - natural areas are preserved
Protect cultural and recreational resources	▸ Maintain cultural and historically significant areas	▸ Score of 1 to 5, 1 - cultural areas not maintained, 5 - cultural areas are maintained
	▸ Maintain certain greenscapes for recreational areas and ball fields	▸ Score of 1 to 5, 1 - greenscapes not maintained, 5 - greenscapes are maintained
Maximize efficiency of water use	▸ Maximize conservation savings	▸ 2035 total average annual conservation savings in AFY
Maintain quality of life and positive economic climate	▸ Allow a variety of uses of water if done so in an efficient manner (e.g. for swimming pools)	▸ Score of 1 to 5, 1 - restricting water, 5 - allowing water for a variety of uses
	▸ Allow businesses that provide economic benefit to use water in an efficient manner	▸ Score of 1 to 5, 1 - restricting water, 5 - allowing water for a variety of uses
Reduce risk and maximize opportunities	▸ Minimize Implementation Risk	▸ Score of 1 to 5, 1 - highly complex regulatory/technical/public process, 5 - not complex
	▸ Share resources with other agencies and entities	▸ Score of 1 to 5, 1 - fully independent, 5 - maximizes partnerships
	▸ Maximize local water resources	▸ Amount of local supply in AFY
Reduce energy footprint for water operations	▸ Carbon emissions	▸ Total annual carbon emissions from water sources in metric tons

Note:
Additional objectives of the Pasadena WIRP are to ensure safe, high quality drinking water and ensure public safety. These objectives must be met, and therefore do not influence the decision among water resource alternatives.

Acronyms:

$/AF: Dollars per acre-foot

AFY: acre-feet per year

neg: negative

NPV: Net Present Value

pos: positive

PV: Present Value

PWP: City of Pasadena Water and Power Department

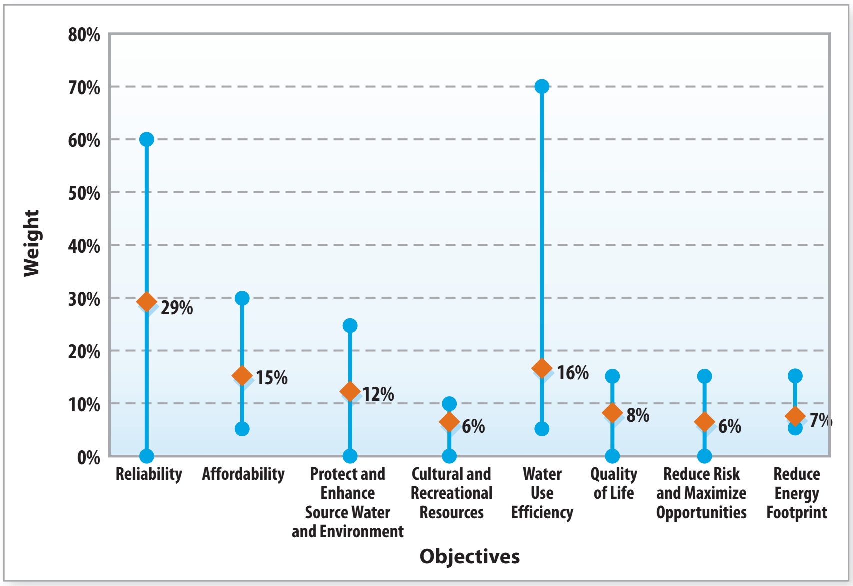

Figure 5-3. Objectives Weighting Results

Figure 5-3 presents the results from the weighting exercise for the WIRP Advisory Committee (stakeholders representing a variety of backgrounds and interests), where (1) the vertical line represents the range of weights assigned to each objective by all stakeholders; and (2) the horizontal line marker shows the average weight for all stakeholders;. The minimum and maximum weights of the group of stakeholders indicate that there are some differences in opinions, particularly regarding the importance of reliability and water use efficiency. Overall, reliability was the most important objective on average.

5.4 Definition of Portfolios

The planning objectives represent essential reasons or purposes "why" PWP is undertaking the WIRP; however, they do not specify "how" PWP should move forward to meet these objectives. Supply options represent the individual projects and programs that are the potential means for accomplishing the planning objectives. The WIRP used these options as building blocks to develop integrated portfolios with the potential to meet the planning objectives.

Even with a relatively small number of options, the different combinations to form portfolios could be fairly large. Therefore, initial portfolios are developed that tend to push the boundaries of the objectives. In other words, the first round of portfolios is developed to optimize specific objectives. But since the purpose of a WIRP is to find a solution that balances all the objectives, it is understood that these initial portfolios may not be the best overall performers.

By examining the performance of these initial portfolios, trade-offs can be seen, such as maximizing supply reliability but at very high cost. Understanding these trade-offs can be useful in developing final portfolios or hybrids, which take the best elements from top-scoring initial portfolios in order to create better performing portfolios.

Descriptions of the portfolio themes is provided below, and a "quick-reference" matrix showing which individual options are included in each portfolio is shown in Table 5-2.

- **Status Quo:** Represents the "do nothing" future, and includes only existing groundwater and surface water diversions (it has the heaviest emphasis on imported water from MWD).
- **Minimize MWD Supply:** Represents the "do everything" future by maximizing use of all local options, as well as water transfers and ocean desalination.
- **Maximize Stewardship:** Maximizes "green" solutions such as maximum water conservation, all stormwater best management practices and graywater, and also enhances habitat restoration with environmental streamflows.
- **Low Cost:** Consists of all options that have lower or comparable unit costs to the current price of MWD water.
- **Maximize Surface and Groundwater:** Maximizes use of local surface water diversions and enhanced groundwater recharge.
- **Maximize Non-potable Reuse (NPR):** Maximizes recycled water to meet non-potable demands via a new non-potable water distribution system.
- **Maximize Indirect Potable Reuse (IPR):** Maximizes recycled water for indirect potable reuse (via groundwater recharge), coupled with a smaller non-potable reuse system.
- **Hybrid 1:** Combines best elements of top performing initial alternatives and adds other compatible options: aggressive conservation, Devils Gate surface water diversion, tertiary-treated recycled water for groundwater recharge, small phase 1 non-potable recycled water, groundwater storage of imported water, and all stormwater projects.
- **Hybrid 2:** Starts by targeting top 10 percent of single-family residential users and applies very aggressive pricing in order to reduce demands by 70 percent, then implements other elements of the maximum conservation program to multifamily, commercial and the rest (90 percent) of single-family users.

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Table 5-2. Portfolio Quick Reference Guide

Category	Existing Local Supply[1]			Local Surface Water/ Stormwater Diversions[2]				Recycled Water[3]					Gray-water	On-site Stormwater/ Urban Runoff					Imported Water				Ocean Desal	Conservation			
Option	Decreed Groundwater Rights (post 2014)	Eaton Canyon Diversions	Arroyo Seco Diversions	Expanded Arroyo Seco Diversions and Recharge	Local Treatment Plant (Arroyo Seco)	Tunnel Water to Brookside Golf Course[9]	Devil's Gate storage to Eaton Canyon spreading basins	Satellite plants for On-site Non-potable Demands	Indirect Potable Reuse (Tertiary Treatment)	Indirect Potable Reuse (Advanced Treatment)	Non-Potable Demands (Maximum), with tunnel water augmentation	Non-Potable Demands (Smaller Phase 1), with tunnel water augmentation	Graywater	Residential Rain Barrels	Residential Rain Gardens	Residential infiltration strip/bioswale	Commercial Parking Lot Swales	Permeable Pavement (parking lots)	MWD Treated Imported Water	North of Delta Transfers	Groundwater Banking	Pasadena Groundwater Storage Program (PGSP)	Ocean Desalination	Moderate Conservation	Aggressive Conservation	Maximum Conservation	Maximum Conservation with SF Pricing
Stormwater Benefit (AFY)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	32	106	256	321	324	NA	NA	NA	NA	NA	NA	NA	NA	NA
Supply Yield to PWP in 2035 Planning Year (AFY)	10,304	880	1,500	664[8]	413[8]	436	627	410	921	2,610	3,000[7]	1,130[7]	807	32	11	27	34	34	Based on need, as available[4]	3,000	2,000	4,890	5,000	6,600	9,000	12,000	12,000
$/AF Supply Yield (2010 dollars)	$120[5]	$120[5]	$120[5]	$789	$1,650	$209	$674	$2,228	$946	$3,126	$1,147	$1,154	$5,947	$6,531	$34,675	$46,080	$35,877	$12,325	$811	$982	$1,210	$1,404	$2,650	$692	$724	$787	$545
PORTFOLIOS																											
1. Status Quo	●	●	●																●								
2. Minimize MWD Supply	●	●	●	●	●		●			●		●	●	●	●	●	●	●	●	●	●		●			●	
3. Maximize Stewardship	●	●	●				●						●	●	●	●	●	●	●							●	
4. Low Cost	●	●	●	●			●		●			●							●						●		
5. Maximize Surface and Groundwater	●	●	●	●	●	●	●								●	●	●	●	●			●			●		
6. Maximize NPR	●	●	●		●			●			●								●					●			
7. Maximize IPR	●	●	●				●			●		●							●					●			
8. Hybrid 1	●	●	●				●		●			●		●	●	●	●	●	●			●			●		
9. Hybrid 2	●	●	●																●								●

Notes:

1 Baseline well capacity is 18,967 AFY.

2 Yield for each option is the incremental difference (increase/decrease) from existing Eaton Canyon or Arroyo Seco spreading credits, respectively.

3 All recycled water options, except for the satellite plant, would use recycled water purchased from the LAG WRP source. Unit cost here includes source water purchases ($253/AF).

4 Treated imported water purchases from MWD will be the last priority supply after all other sources have been utilized. Yield is calculated during portfolio analyses, and varies among the portfolios.

5 Includes cost associated with groundwater well pumping to recover supply yield. Well operations currently cost approximately $120/AF.

6 This option increases well capacity and operational flexibility, but does not produce new supply unless paired with a recharge option. Therefore, unit cost per supply yield is not applicable.

7 The yield for these options represents the non-potable customer demands for the system. The demand could be satisfied with recycled water alone, or with some augmentation from tunnel water or Arroyo Seco diversions. Augmentation with these sources does not provide additional yield, but does change the costs (more capital cost but less purchases from LAG WRP).

8 When expanded diversions and spreading is combined with the Behner WTP, the total incremental new yield over existing operations is 861 AFY after credits (on average).

9 This represents the tunnel project as an independent non-potable option. The tunnel project is also included as an augmentation source to a non-potable demands under the Recycled Water options.

Acronyms:

$/AF: Dollars per Acre-Foot
AFY: Acre-feet per Year
Desal: Desalination
IPR: Indirect Potable Reuse (through use of storing recycled water in groundwater basins)
MWD: Metropolitan Water District of Southern California
NA: Not applicable
NPR: Non-Potable Reuse (delivery of recycled water through purple pipelines to meet irrigation and cooling tower water demands)
SF: Single-family
WRP: Water Reclamation Plant

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5.5 Supply Yield Analyses

Many of the planning objectives have performance measures that are based on option supply yields. Preliminary yields of all options were estimated for evaluation of the portfolios, and are summarized in Appendix E. To estimate yields of local surface water and stormwater options, a model was constructed to quantify daily runoff and streamflows and also track surface storage in reservoirs and spreading basins. The model calculates long-term average yields, as well as yields in dry years. The local surface water and stormwater analyses are presented in Appendix C.

Once the yield for each option was characterized, the future supply mix in 2035 could be calculated for each portfolio. Figure 5-4 presents the average annual supply mix for each portfolio. The colors of the bars generally correspond with the major categories of options in Table 5-2 (Portfolio Quick Reference Guide). In every case, reliance on MWD treated imported water is reduced from the status quo - and the Minimize MWD Supply portfolio reduces MWD purchases to only 6 percent of total supply on average.

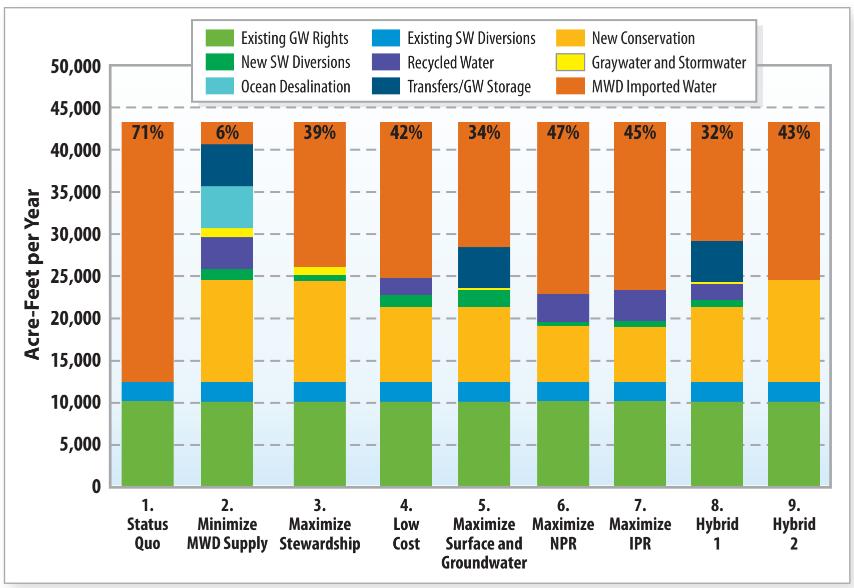

Figure 5-4. 2035 Average Annual Supply Mix of Portfolios

An important distinction to recognize is that the option supply yield to PWP, in some cases, is much less than the total option yield. This is because the supply yield represents the budgeted portion of supply to PWP after sharing with other agencies or after assumed RBMB spreading credits are applied (where the amount of water than can be recovered from the basin is less than the amount originally recharged). While the supply yield is used to measure performance for some objectives, such as "provide a reliable water supply", the total physical yield is applied when measuring performance measures such as replenishment to Raymond Basin or captured stormwater flows under the "protect and enhance source waters and environment" objective.

Options that are subject to credits and have reduced supply yields include local surface water diversions to spreading (roughly 35 percent to 80 percent supply credit), and stormwater/urban runoff options that replenish the groundwater basin (approximately 10 supply credit assumed). It should be noted that credit assumptions were made for purposes of this analysis, but may be negotiated during implementation.

There are two quantitative performance measures for the 'provide a reliable water supply' objective, which are based on the supply yields:

- **Vulnerability to Delta Restrictions:** measured by the projected 2035 annual supply shortage in acre-feet per year (AFY) under imported water restrictions. For this scenario, a 20 percent regional shortage condition was assumed and the amount of MWD imported water available for each portfolio supply mix was estimated based on the drought formula presented in the 2008 MWD Water Supply Allocation Plan.
- **Maintain a system that can be independent of imported water for a short term:** measured by the acre-feet per month supply shortage during a one month shut-down of imported water. This scenario assumes that no supply is available via MWD facilities for one month. Any options that propose use of MWD facilities for delivery, such as ocean desalination, would not be available. In this type of event, PWP would utilize groundwater wells at full capacity for the month. Any new options that recharge the ground are accounted for in the lumped groundwater well capacity.

Other reliability performance measures, such as vulnerability to climate change, are qualitative in nature and are discussed later.

5.6 Cost Analyses

Over the planning horizon, projected MWD imported water purchases rates are expected to increase faster than inflation primarily due to rising energy costs, future MWD capital improvements, and the enormous cost of implementing a solution in the Delta *(see Figure 5-5)*. In the status quo scenario, which relies on MWD imported water to meet future baseline demands, the projected average annual costs for PWP to provide water would increase substantially *(Figure 5-6)*.

Note that costs for the status quo do not represent all costs for PWP. Only the variable operational cost of supply is shown (MWD imported water purchases and groundwater pumping

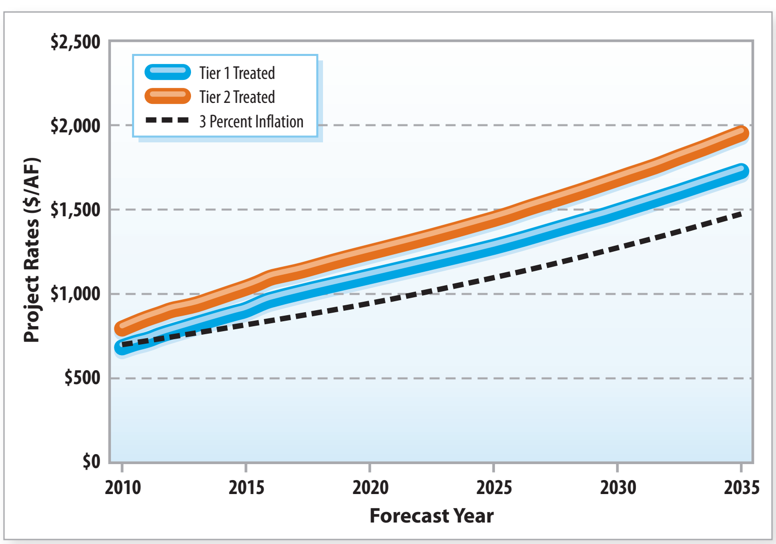

Figure 5-5. Projected MWD Imported Water Rates

costs). Typically, these represent "prospective" costs – or future costs that could be avoided if other actions are taken. Any "sunk" costs such as existing program costs or capital payments are not included in the analysis. Costs for new options represent the incremental new capital, operational, or program costs. Note that supply costs are for production of source water and do not include distribution system improvements.

There are two quantitative performance measures under the "maintain affordability" objective:

- **Total Lifecycle Cost:** based on the total cost of the portfolio, including the costs to other agencies and customers/ developers (for example, there are some costs for installation of conservation devices), and
- **Pasadena's average cost of water:** based on the cost only to PWP and represents the cost that could potentially impact water rates.

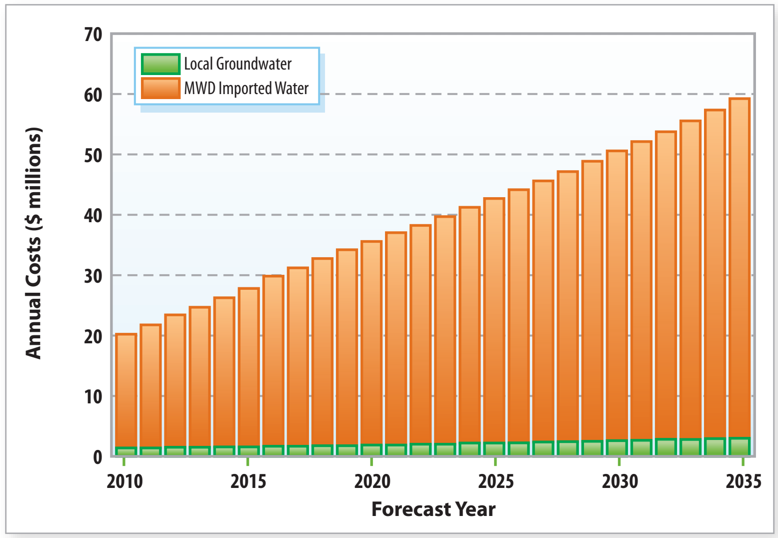

Figure 5-6. Projected Annual Cost under Status Quo Scenario (for variable cost of supply only)

In order to quantify both these performance measures, a cost model was developed (refer to Appendix D for an overview). Although the current unit cost per acre-foot of supply ($/AF in 2010 dollars) of some options is more than today's MWD water purchase rate, they could be less in the future and provide many other benefits. Therefore, portfolio costs were analyzed over the entire planning horizon and discounted back to present value (PV).

Annual portfolio costs over time include amortized capital payments, operation and maintenance costs, and MWD costs including treated water purchases and the peaking charge. Figure 5-7 shows the breakdown of estimated total costs (including customer/ develop costs) over the entire planning horizon for each portfolio, discounted back to present value.

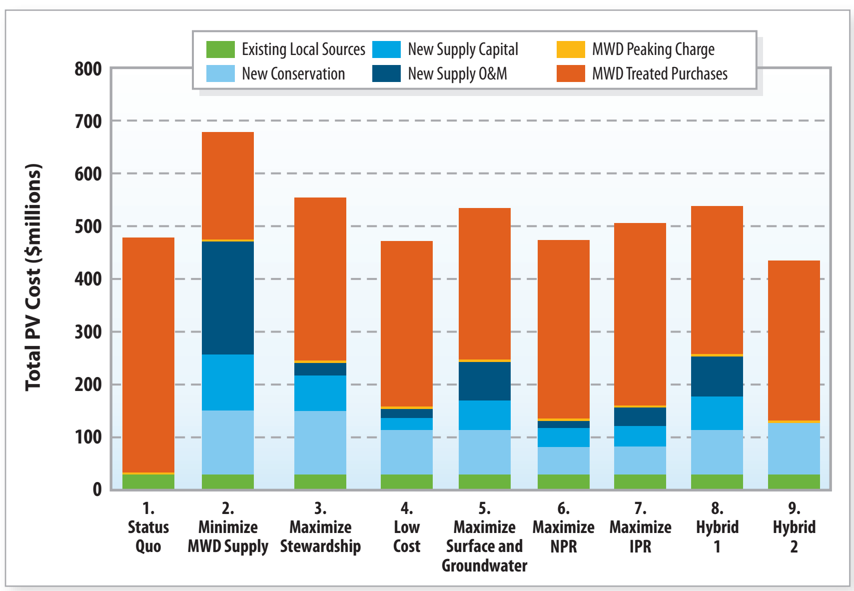

Figure 5-7. Breakdown of Total Costs over the Planning Horizon for Each Portfolio

5.7 Water Quality, Environmental and Implementation Analyses

In addition to the supply yield and cost analyses, the WIRP evaluated portfolios in terms of water quality (overall salinity of supply); groundwater basin levels, greenhouse gas emissions, reduction in stormwater to receiving waters, impacts to the natural environment, and implementation issues. Some of these evaluations used quantitative performance measures, but others had to rely on assigning qualitative scores using professional and expert opinion. Further guidance on the reasoning for how each of qualitative scores were assessed and applied is provided in Appendix G.

5.8 Portfolio Evaluation Method

After developing objectives and portfolios, the next step in the planning process was to evaluate each portfolio and develop a scorecard of raw performance, such as supply reliability, cost, carbon dioxide emissions, etc. in order to see how well a specific portfolio met the objectives.

Because the raw performance of the objectives are measured in different units (e.g., supply reliability is measured in AFY, cost measured in dollars, and carbon dioxide emissions measured in metric tons per year), a decision tool is often needed to rank the portfolios.

The WIRP planning team used the software Criterium Decision Plus (CDP), developed by Infoharvest Inc., to rank the portfolios. This software tool converts raw performance measured in different units into standardized scores so that the performance measures can be added together in order to rank portfolios. This technique is called Multi-Attribute Rating and is illustrated in Figure 5-8.

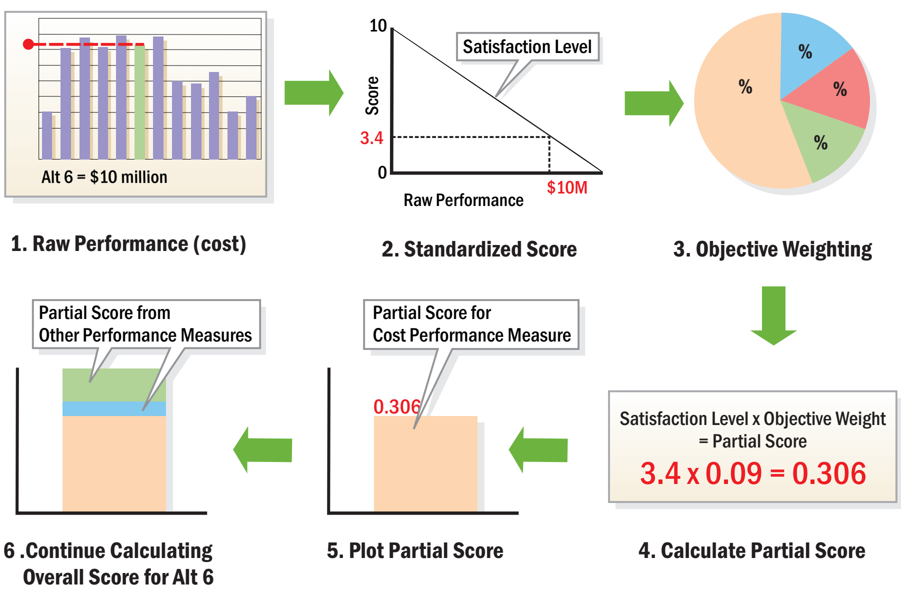

Figure 5-8. Multi-Attribute Rating Method

Step 1 is to compare the raw performance of a given objective for all the portfolios. In this example, Portfolio 6 has a raw cost (or performance) of $10 million.

Step 2 standardizes the raw performance score for each objective into comparable numeric scores (the higher the score the better the performance). In this example, Portfolio 6 has relatively high costs when compared to the other portfolios, so the standardized score for this objective (between 0 and 10) is 3.4, a fairly low performance.

Steps 3 and 4 calculate the partial score for the portfolio, based on the standardized score and the weight for the objective being calculated. In this example, the cost objective was given a weight of 9 percent (out of a possible 100 percent). The partial score for this objective is represents the standardized score (3.4) multiplied by the objective weight (0.09) which equals 0.306.

Step 5 plots the partial score of 0.306 for Portfolio 6, and this procedure repeats for all of the other objectives for Portfolio 6 until a total score for the project is calculated [see Step 6].

The WIRP planning team used this process to develop overall scores for each portfolio, and asses their rankings. Rankings were created based on the average Advisory Committee weights. In addition, sensitivity analyses were performed to determine how the rankings would change if certain objectives had more importance (per extremes in the objectives weighting results, *see Figure 5-3*).

WIRP Public Meeting

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Section 6
Portfolio Evaluation and Conclusions

Inside

6.1 Evaluation Process Overview

Water supply portfolios were evaluated and ranked using the approach described in Section 5. First, the raw performance of each portfolio was evaluated in terms of supply reliability, affordability, environmental protection, and other objectives.

This information from the raw performance scorecard was then standardized using a multi-attribute rating tool in order to determine a portfolio's overall score. Portfolios were then compared and ranked. Initial portfolios were evaluated first, and based on their performance; hybrid portfolios were developed and evaluated *(see Figure 6-1)*.

6.2 Raw Performance Scorecard

Table 6-1 presents the raw performance of the portfolios, which is the assessment of a given portfolios ability to achieve the planning objectives, regardless of the importance or weight of the objectives. It is important to recognize that the performance metrics used to evaluate portfolios are not intended to be accurate predictions, but rather they are used to determine the relative benefits that the portfolios have when compared to each other.

Appendix H provides a more detailed accounting of all the performance measures used in the analysis to compare portfolios. A few key performance metrics are summarized below in order to illustrate the analytical process.

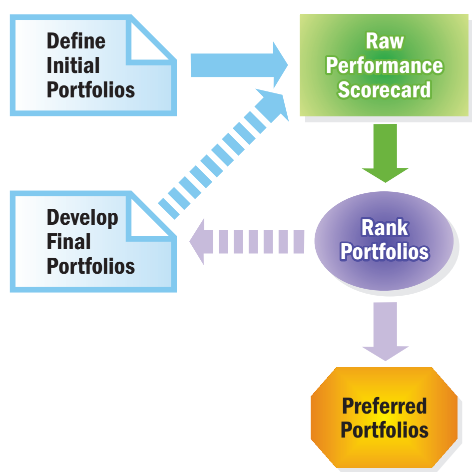

Figure 6-1. Raw Performance Scorecard

Reliability Objective - Vulnerability to Delta Water Restrictions

Water supply reliability under Delta restrictions was analyzed by applying a 20 percent MWD regional water shortage scenario to the 2035 planning year, and calculating the portion of MWD imported water supply that PWP could expect to receive based on the drought formula presented in the 2008 MWD Water Supply Allocation Plan. MWD's statistical analysis of water usage indicates that water demands can be ± 5 percent due to variations in temperature and precipitation. Therefore, demands were increased by 5 percent to account for a dry weather scenario. Figure 6-2 presents the annual projected supply mix under imported water restrictions.

Note that the drought allocation among the portfolios varies based on the type of supply projects or programs pursued and the overall reliance on MWD water supply. In general, projects that are favored in the drought formula include conservation and non-potable recycled water, along with "extra-ordinary" supply such as water transfers and banking programs.

The results show that, under a 20 percent MWD regional shortage, the status quo would face shortages of around 6,500 AFY in 2035. However, these deficits could be cut in half or eliminated depending on the portfolio of projects pursued.

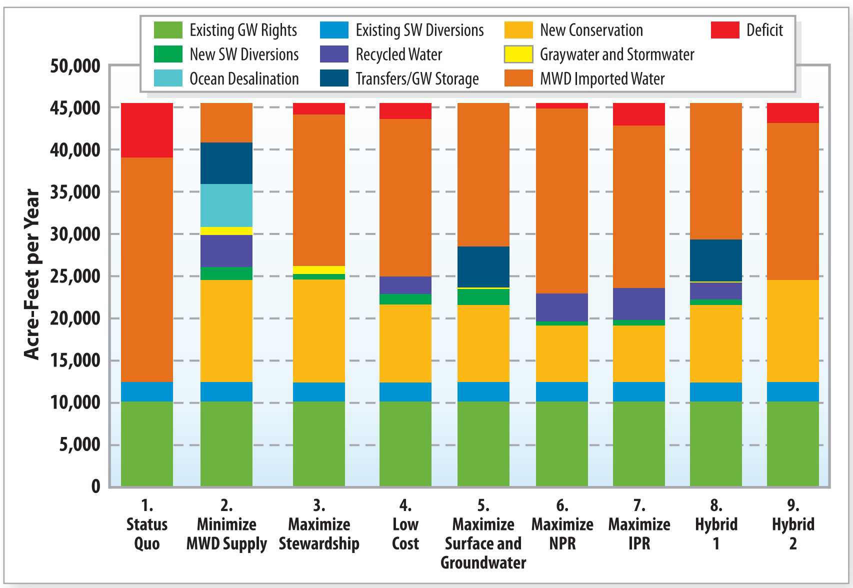

Figure 6-2. Annual Supply Mix with Delta Water Supply Restrictions

Table 6-1. Portfolio Performance Scorecard

		PORTFOLIO SCORES								
Objective	**Sub-objectives and Performance Measures**	**1. Status Quo**	**2. Minimize MWD Supply**	**3. Maximize Stewardship**	**4. Low Cost**	**5. Maximize Surface and Groundwater**	**6. Maximize NPR**	**7. Maximize IPR**	**8. Hybrid 1**	**9. Hybrid 2**
Provide a reliable water supply	Hydrologic Variability (Local or Imported) *Score of 1 to 5, 1 - high variability, 5 - low variability*	4.0	4.1	4.1	4.3	3.7	4.1	4.4	4.1	4.3
	Vulnerability to Delta Restrictions *AFY supply shortage under imported water restrictions*	6,499	0	1,300	1,941	0	673	2,620	0	2,297
	Vulnerability to Climate Change *Score of 1 to 5, 1 - high vulnerability, 5 - low vulnerability*	2.3	3.3	3.0	3.2	2.7	3.3	3.3	3.1	3.0
	Vulnerability to Catastrophes (e.g. fires, earthquakes) *Score of 1 to 5, 1 - high vulnerability, 5 - low vulnerability*	3.5	3.5	3.8	3.6	3.5	3.8	3.8	4.0	3.9
	Maintain a system that can be independent of imported water for a short-term *AFM supply shortages during a one month shut-down of imported water*	2,034	836	965	1,190	235	1,166	1,390	209	1,034
Maintain affordability, while addressing fairness and equity	Total Lifecycle Cost *PV dollars, including customer/developer costs*	$477,068,480	$676,008,450	$552,494,142	$470,919,246	$532,680,913	$473,110,730	$504,053,566	$536,931,665	$432,870,483
	Pasadena's average cost of water *Average $/AF of PWP costs only, escalated to 2035 dollars*	$853	$1,012	$795	$751	$845	$792	$839	$847	$687
	Fairness in allocation of costs between customer types *Score of 1 to 5, 1 - no difference among customer types, 5 - allocation fairness*	5	5	5	5	5	5	5	5	3
Protect and enhance source waters and the environment	Replenish the Raymond groundwater basin *2035 total average annual replenishment to the groundwater basin in AFY*	3,600	10,133	7,898	8,373	14,209	2,376	9,820	15,540	2,364
	Maintain or improve the water quality of Raymond groundwater basin *Score of 1 to 5, 1 - high neg impact, 5 - high pos impact*	3.3	3.3	3.3	3.3	3.4	3.1	3.5	3.2	3.4
	Reduce stormwater pollutant discharges to creeks and rivers *mgd of stormwater flows not discharged into receiving waters*	0.0	1.4	1.4	0.5	1.4	0.0	0.5	1.4	0.0
	Habitat impacts in watersheds of imported water supply *Score of 1 to 5, 1 - high negative impact, 5 - high positive impact*	3.7	4.3	4.3	4.3	4.1	4.3	4.3	4.1	4.0
	Preserve or enhance local natural areas and water courses *Score of 1 to 5, 1 - natural areas are not preserved, 5 - natural areas are preserved*	2.0	2.2	5.0	2.5	2.0	1.0	4.0	4.0	2.0
Protect cultural and recreational resources	Maintain cultural and historically significant areas *Score of 1 to 5, 1 - cultural areas not maintained, 5 - cultural areas are maintained*	3.0	4.0	2.0	3.0	5.0	4.0	3.0	5.0	2.0
	Maintain certain greenscapes for recreational areas and ball fields *Score of 1 to 5, 1 - greenscapes not maintained, 5 - greenscapes are maintained*	2.0	5.0	2.0	3.0	5.0	5.0	4.0	5.0	2.0
Maximize efficiency of water use	Maximize conservation savings *2035 total average annual new conservation savings in AFY*	0	12,000	12,000	9,000	9,000	6,600	6,600	9,000	12,000
Maintain quality of life and positive economic climate	Allow a variety of uses of water if done so in an efficient manner (e.g. swimming pools) *Score of 1 to 5, 1 - restricting water, 5 - allowing water for a variety of uses*	2.0	5.0	3.0	4.0	5.0	5.0	4.0	5.0	2.0
	Allow businesses that provide economic benefit to use water in an efficient manner *Score of 1 to 5, 1 - restricting water, 5 - allowing water for a variety of uses*	2.0	3.0	3.0	4.0	4.0	5.0	5.0	4.0	4.0
Reduce risk and maximize opportunities	Minimize Implementation Risk *Score of 1 to 5, 1 - highly complex regulatory/technical/public process, 5 - not complex*	5.0	3.1	3.9	3.9	4.0	4.5	4.4	3.9	4.3
	Share resources with other agencies and entities *Score of 1 to 5, 1 - fully independent, 5 - maximizes partnerships*	1.0	5.0	3.1	2.4	3.3	1.7	2.2	4.3	1.0
	Maximize local water resources *Amount of local supply in AFY*	12,684	35,857	26,256	25,026	23,714	23,107	23,651	24,500	24,684
Reduce energy footprint for water operations	Carbon dioxide (CO2) emissions *Total annual CO2 emissions from water sources in metric tons (MT)*	42,397	25,144	24,662	27,170	22,549	29,898	31,501	22,121	26,613

Notes:

1. Additional objectives of the Pasadena WIRP are to ensure safe, high quality drinking water and ensure public safety. These objectives must be met, and therefore do not influence the decision among water resource alternatives.

Acronyms:

$/AF:	Dollars per Acre-Foot
AFM:	Acre-feet per Month
AFY:	Acre-feet per Year
mgd:	million gallons per day
MT:	metric tons
PV:	present value
PWP:	City of Pasadena Water and Power Department

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Affordability Objective - Pasadena's Average Cost of Water

Over the planning horizon, projected MWD water rates for imported supply are expected to increase faster than inflation. This is due to rising energy costs, future MWD capital improvements, and the costs for implementing a solution to the Delta. One way to determine affordability for Pasadena water customers was to calculate an overall average unit cost for PWP water supply. For each portfolio, the following method was used to determine the unit cost:

- First, projecting all capital and O&M costs into the future, including impacts of inflation
- Second, bringing all future costs back to today's dollars using a present value factor that reflects the time value of money
- Third, dividing the total present value costs by the total water demand (before water conservation) to calculate the unit cost in dollars per acre-foot.

This performance measure only estimates the projected unit cost for PWP, meaning it does not include costs that would likely be paid by customers, developers, and partners. Another performance measure in the analysis captured the total present value of all costs, regardless of who pays.

Figure 6-3 presents the average unit cost for PWP. It is interesting to see that all but one portfolio has about the same or less average cost to Pasadena than the status quo (or do nothing approach). This is a significant finding given that some portfolios will provide significant benefits for the other planning objectives

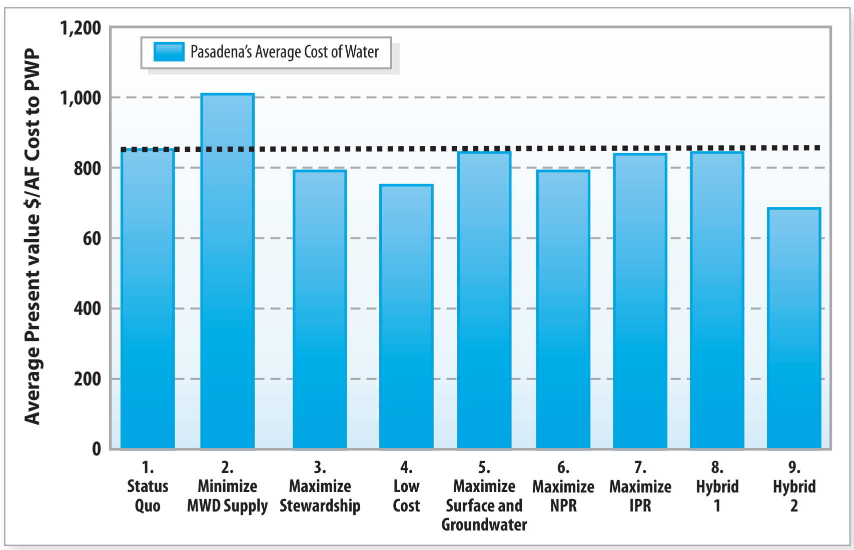


Figure 6-3. Present Value Cost per Acre-Foot over Planning Horizon

Environmental Objective - Groundwater Replenishment

Due to declining water levels in the Raymond Basin, an important performance measure to consider is the potential for replenishing the groundwater system in the future. This performance measure accounts for the total amount of water replenished to the groundwater basin, regardless of the quantity that becomes available as a supply for PWP. Figure 6-4 shows the potential average annual replenishment to the Raymond Basin for each portfolio.

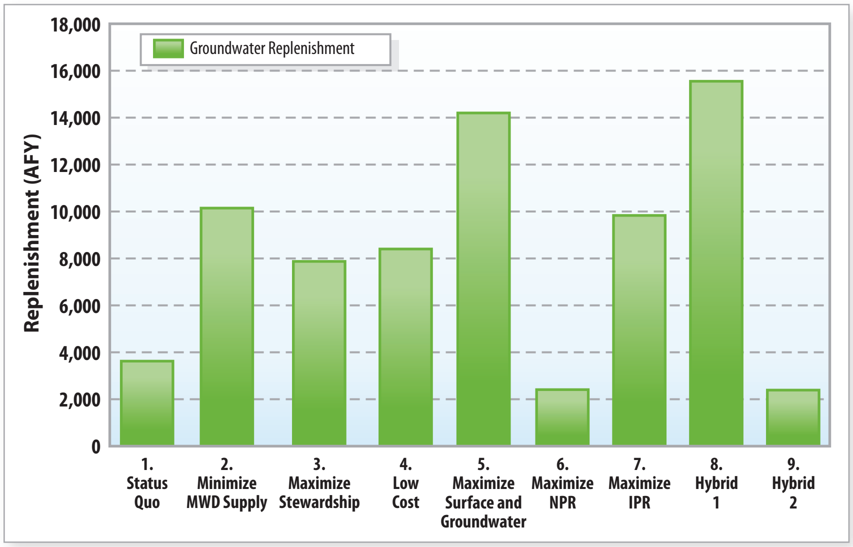


Figure 6-4. Average Annual Raymond Basin Replenishment

Replenishment in the status quo is based on recharge occurring through existing diversion and spreading operations by PWP in the Arroyo Seco and Eaton Wash watersheds. The amount of potential replenishment varies widely among the portfolios – with some portfolios showing reduced replenishment due to outdoor conservation and others showing increased replenishment by over 15,000 AFY on average.

6.3 Portfolios Rankings and Sensitivity

Using the portfolio raw performance scores in Table 6-1, the portfolios were ranked with the multi-attribute rating method described in Section 5. The portfolios were ranked based on the relative importance of each objective. Figure 6-5 shows the rankings of portfolios using the average weightings from the WIRP Advisory Committee. This analysis not only shows which portfolio ranks highest, but also shows which objectives contributed to the scoring. The larger the color bar segment, the better the portfolio does in achieving that particular objective (as shown in the figure's legend).

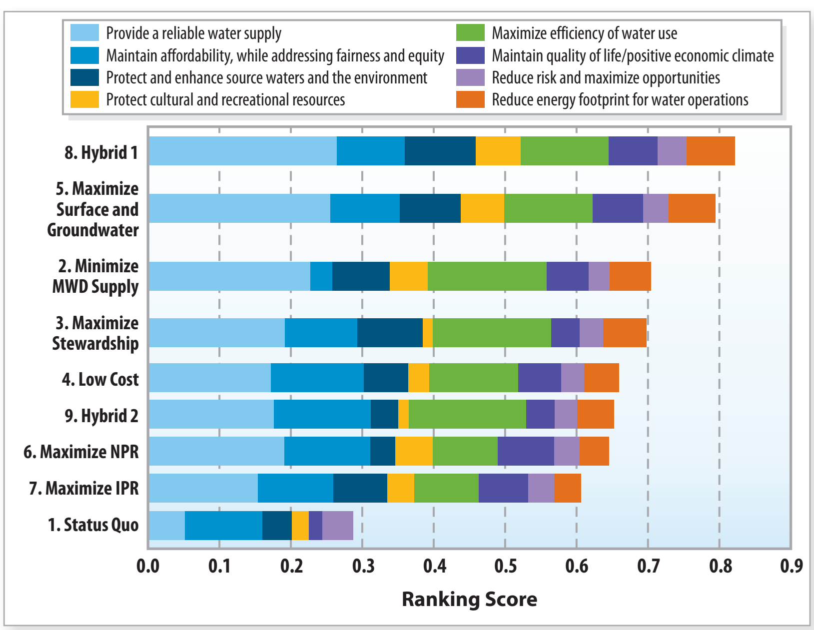


Figure 6-5. Portfolio Rankings

Two factors determine the size of each color segment for a given portfolio: (1) the raw performance of the portfolio in meeting that objective; and (2) the weight of the objective assigned by the stakeholders. In general, if the color segment is larger, then the raw performance was better, and the objective was given a relatively high weight of importance. However, if the color segment is smaller, it could be either because of poor performance, or a low weight of importance, or both.

Based on the average objective weightings from the WIRP Advisory Committee, the top two portfolios are:

- Hybrid 1
- Maximize Surface and Groundwater

Looking at the objective weightings in Figure 5-3, there were clearly some differences among the WIRP Advisory Committee members in the importance of certain objectives. In order to capture the differences in these stakeholder values, the sensitivity of portfolio rankings was tested with the following objective weights:

- Equal objective weights –
  all objectives have the same weighting
- 50 percent weight for the Reliability Objective -
  with the remaining weight distributed proportionally among the other objectives
- 50 percent weight for the Affordability Objective-
  with the remaining weight distributed proportionally among the other objectives
- 50 percent weight for the Water Use Efficiency Objective-
  with the remaining weight distributed proportionally among the other objectives

	Hybrid 1	Max SW/GW	Min MWD Supply	Max Stewardship	Low Cost	Hybrid 2	Max NPR	Max IPR	Status Quo
ACRank	1	2	3	4	5	6	7	8	9
EqualRank	1	2	3	5	6	8	4	7	9
50%Reliab	1	2	3	4	6	7	5	8	9
50%Afford	3	4	8	6	1	2	5	7	9
50%Effic	3	5	1	2	6	4	7	8	9

Figure 6-6. Ranking Sensitivity Results

The findings for each weighting sensitivity scenario are summarized in Figure 6-6. The columns of the table represent the portfolios, the rows represent the weighting scenarios, and the number shows the rank order of the portfolio (1 being the best). The weighting scenarios are compared to the baseline, which is noted as "AC Rank" for Advisory Committee average weightings. This sensitivity shows that Hybrid 1 and Maximum Surface (SW) and Groundwater (GW) portfolios consistently rank number 1 and 2 in all but two weighting scenarios.

When Affordability or Water Use Efficiency objectives are heavily weighted, the Low Cost and Minimize MWD Supply portfolios are ranked number 1, respectively. Hybrid 1 is still within the top 3 rankings for these scenarios, however. The portfolio that is consistent in its ranking regardless of the weighting sensitivity is the Status Quo, which is always ranked last. This emphasizes the finding that there is substantial opportunity for PWP to implement projects and programs that will improve its water supply without regret.

Constant Water Demand Scenario for Sensitivity Analysis

Any long-term planning requires assumptions and projections to be made. Given the uncertainty that growth may not unfold exactly as planned, portfolios were evaluated assuming demands are constant at today's levels through the future. In this scenario, water demands would be approximately 4,800 AFY lower than projected in 2035. The purpose of this sensitivity analysis is to gauge whether the recommendations would be the same if demands remain constant. In this scenario, many of the portfolios will have better reliability, since supply shortages would be reduced. While all portfolios would cost less, the relative reduction in cost is the same. This is because reduction in demands results in the same reduction in imported water purchases for all portfolios. The portfolio rankings for the constant water demand scenario are shown in Figure 6-7.

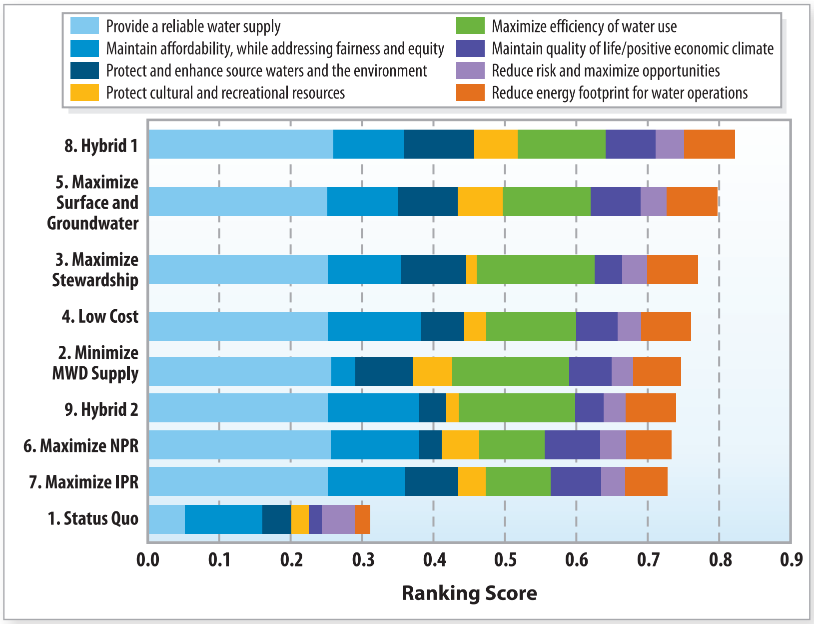


Figure 6-7. Portfolio Rankings under Constant Water Demand Scenario

The results show that the rankings are the same in the constant water demand scenario, except the Maximize Stewardship portfolio moved up to the Top 3 rankings. Hybrid 1 and Maximize Surface and Groundwater remain the top two portfolios, given their performance in other planning objectives.

The objective weighting sensitivity as previously described was also tested for the constant water demand scenario (*see results in Figure 6-8*). The findings are similar to before, except Hybrid 1 has dropped to the fourth ranking for the Affordability and Water Use Efficiency objectives.

	Hybrid 1	Max SW/GW	Max Stewardship	Low Cost	Min MWD Supply	Hybrid 2	Max NPR	Max IPR	Status Quo
ACRank	1	2	3	4	5	6	7	8	9
EqualRank	1	2	7	5	4	8	3	6	9
50%Reliab	1	2	3	4	5	6	7	8	9
50%Afford	4	5	6	1	8	2	3	7	9
50%Effic	4	5	1	6	2	3	7	8	9

Figure 6-8. Ranking Sensitivity Results under Constant Water Demand Scenario

Conclusions of Sensitivity Analyses

The two portfolios that are most frequently in the top two rankings are Hybrid 1 and Maximize Surface and Groundwater, with Hybrid 1

being the preferred portfolio. There are two scenarios, however, when Hybrid 1 is not the top performer. This occurs when Affordability or Water Use Efficiency are heavily weighted, as would be expected. The conclusion to draw from this is that there are lower cost water supply strategies that PWP could pursue in the absence of demand growth, although these strategies perform poorly relative to the other planning objectives developed with input from both the public and the WIRP Advisory Committee.

When Affordability is far more important than any other objective, Hybrid 2 and the Low Cost portfolios are ranked the highest. This finding will be incorporated into the implementation plan described in Section 7. While Hybrid 1 is the preferred portfolio, affordability should be a consideration before implementing all the elements of Hybrid 1.

Although Hybrid 1 is not a top performing portfolio when Water Use Efficiency is heavily weighted, the conservation goals included in Hybrid 1 would meet the requirements of 20x2020 (refer to Section 4.1). Additional water use efficiency beyond the conservation the levels in Hybrid 1 should be considered if financially feasible or if water supply conditions change significantly in the future.

6.4 Climate Change and Water Management

Any water utility in California should consider the potential impacts of climate change when developing a long-term water supply plan. And while climate change is a global-scale concern, it is particularly important in the West and Pacific Coast of the United States, which seems to be showing the most change with the greatest potential impacts on water resources. As such, California is leading the way with laws that require reductions in greenhouse gas emissions and requirements to incorporate climate change and impacts in water planning.

To understand some of the key issues surrounding climate change impacts, it is important to put it into the context of PWP's water supplies. California lies within multiple climate zones. Therefore, each region will experience unique impacts to climate change. Because PWP relies on both local and imported water sources, it is necessary to consider the potential impacts climate change could have on the local watershed as well as the Sierra Nevada watershed where a significant portion of MWD's imported water originates.

Generally speaking, any water supplies that are dependent on natural hydrology are vulnerable to climate change, especially if the water source originates from mountain snow pack. For Pasadena, the most vulnerable water source from climate change is imported water. However, local sources can expect to see some changes in the future as well. In addition to water supply impacts, changes in local temperature and precipitation are expected to alter water demand patterns.

Scientists predict future scenarios using highly complex computer general circulation models (GCMs). Although most of the scientific community agrees that climate change is occurring and, as a result, mean temperatures for the planet will increase, the specific degree of this temperature increase cannot be accurately predicted. Predictions of changes in precipitation are even more speculative, with some scenarios showing precipitation increasing in the future and others showing the opposite.

To place the global coarse-scale climate projections to a regional level that incorporates local weather and topography, the GCMs are "downscaled". The regional areas of interest in assessing climate change impacts to PWP include local areas (vicinity of Pasadena) and areas of imported water origin (Northern California and Colorado River Basin).

Climate Change Impacts to Local Supply and Demand

Most experts believe that because of the uncertainty involved with each model, several models should be used to test the potential impact of climate change. Future projections of precipitation and temperature was obtained for six GCMs under two greenhouse gas emission scenarios (higher and lower). [1,2] Figure 6-9 and 6-10 plot the changes in projected average annual temperature and precipitation, respectively, for the model scenarios. The bold lines represent the running average of all six models for each emission scenario.

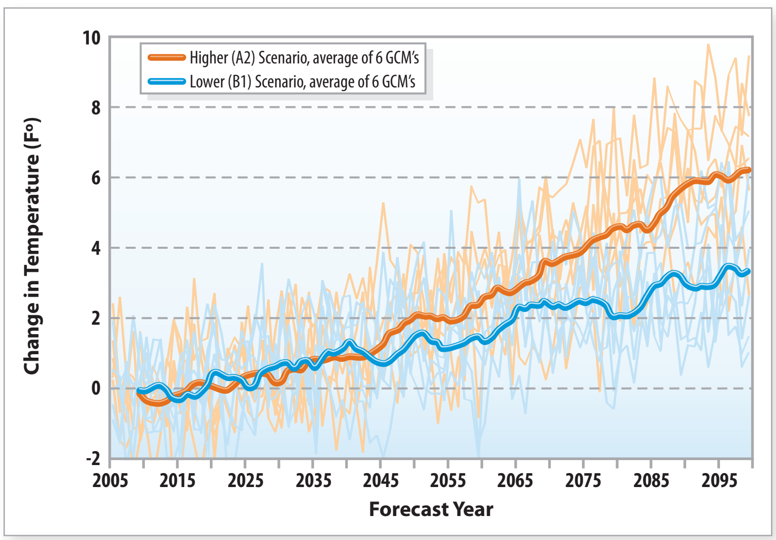


Figure 6-9. Climate Change Impacts to Local Temperatures

Local climate changes near the Pasadena vicinity are expected to include:

- An increase in average temperatures that will be more pronounced in the summer than in the winter
- An increase in heat waves and droughts that will extend for a longer duration
- A decrease in precipitation that, coupled with higher temperatures, will increase evaporation/transpiration

[1] Dan Cayan and Mary Tyree (University of California, San Diego, Scripps Institute of Oceanography) provided downscaled data for Pasadena under two emissions scenarios from six climate models: CNRM CM3, GFDL CM2.1, Miroc3.2 (medium resolution), MPI ECHAM5, NCAR CCSM3, NCAR PCM1.

[2] Note: These scenarios do not bracket the highest and lowest emission futures possible, but represent a status quo approach (A2) and a pro-active mitigation (B1) approach to reduce carbon emissions.

- An increase in short-duration/ high volume intense storm events during the winter

The impact of these climate effects will likely be increased water demands for irrigation and cooling purposes, and decreased local surface runoff. Other impacts might include increased fire events that could impact water quality and sedimentation, as well as decreased groundwater recharge due to lower soil moisture.

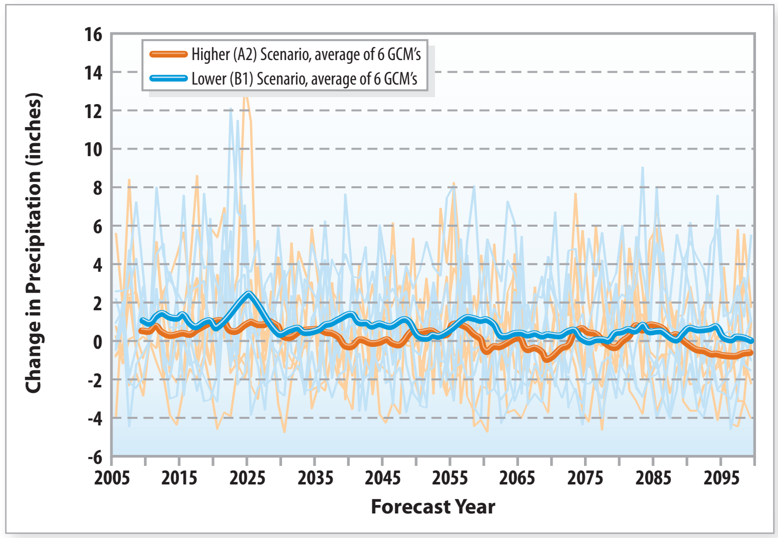


Figure 6-10. Climate Change Impacts to Local Precipitation

Climate Change Impacts to Imported Water

To date, most studies on climate change impacts to California's water supply have been conducted for the Northern California region. In 2009, the California Department of Water Resources (DWR) released a State Water Project Delivery Reliability Report, which specifically analyzes changes in volume of water available under various climate change scenarios. In this report, DWR predicted that SWP deliveries could be reduced by as much as 15 percent in some cases *(see Figure 6-11)*. The primary effects of climate change to the Delta supply include, among others:

- More precipitation will fall as rain than snow
- Reduced Sierra snowpack
- Shifted timing of snowmelt runoff into streams – spring runoff comes earlier resulting in increased winter flows and decreased spring flows
- Increased flood events

The most severe climate impacts in California are expected to occur in the Sierra watershed, which is where the State Water Project supply originates. Therefore, imported water supply is extremely vulnerable to climate change.

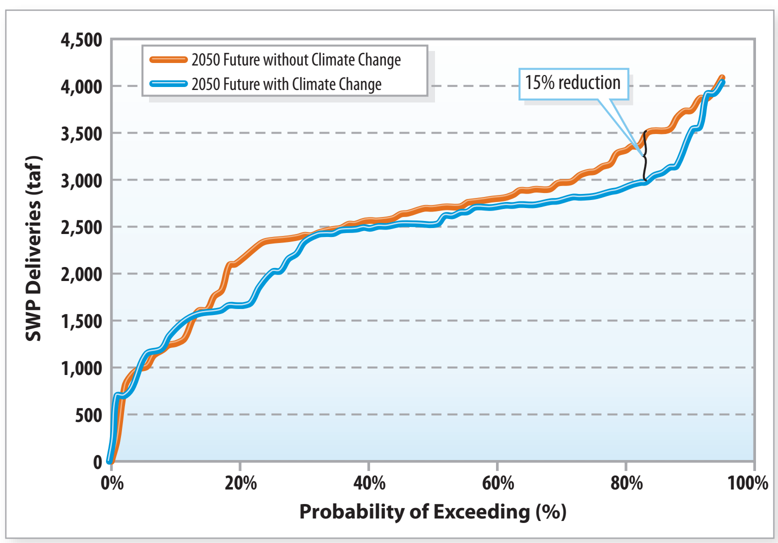


Figure 6-11. Climate Change Impacts to Imported Water

Although many research efforts are underway, there have not yet been any reports quantifying potential changes in supply to California from the Colorado River. At this time, the assumption is that there would be similar patterns as the SWP impacts.

Sierra Nevada Watershed

Climate Change Adaptation and Mitigation

Climate change strategies fall under two main categories: adaptation and mitigation. For water resources planning, a climate change adaptation strategy involves taking steps to effectively manage the impacts of climate change by making water demands more efficient and relying on supply sources that are less vulnerable to climate change. A mitigation strategy involves proactive measures that reduce greenhouse gas emissions.

It is imperative that supply options are carefully vetted and evaluated against both adaptation and mitigation goals, as they may conflict and work against each other. For example, desalination is a typical supply option that performs quite well in adapting to climate change impacts; however, due to the energy necessary to draw from and manage the supply source, it could result in higher greenhouse gas emissions if it utilized conventional energy sources.

The projects included in the top ranking portfolio, Hybrid 1, have both adaptation and mitigation benefits for climate change.

Hybrid 1 Climate Change Adaptation Benefits

- Wet weather storage for intense winter storm events (Devil's Gate Dam)
- Enhanced stormwater capture and groundwater replenishment
- Groundwater storage of imported water to provide a sustainable supply through extended heat waves and drought
- Aggressive conservation to reduce the demands for irrigation and cooling towers
- Increased utilization of recycled water, which is independent of climate impacts
- Reduced overall reliance on imported water, which is highly vulnerable to climate change

Hybrid 1 Climate Change Mitigation Benefits

- Reduction in greenhouse gas emissions of about 20,000 metric tons by 2035 (almost a 50 percent reduction from status quo), by reducing demands for imported water which utilize significant energy to pump water from Northern California and the Colorado River.

6.5 Common Elements in Top Portfolios

The two portfolios that were consistently ranked highest were the Hybrid 1 and Maximize Surface and Groundwater portfolios. The common elements for both of these top-ranking portfolios include:

- Aggressive water conservation
- On-site stormwater projects
- Devil's Gate Storage to Eaton Canyon
- Groundwater storage of imported water

Options that were only included in the top-ranked portfolio, Hybrid 1, include:

- Recycled water to non-potable reuse (Phase 1 system, with tunnel augmentation)
- Recycled water to groundwater recharge (tertiary-treated indirect potable reuse)

It is recommended that these six elements be considered for adaptive implementation. Table 6-2 summarizes the average annual yield, replenishment to the groundwater basin, and total costs for the recommended elements. It is anticipated that the costs for some of these options would not only be paid by PWP but also by customers, developers, and other partners. It is also possible that some of the costs would be offset by grant funding from the state and/or federal government.

Table 6-2. Summary of Recommended WIRP Elements

Option	Average Supply Yield (AFY)	Additional Groundwater Recharge (AFY)	Costs (in 2010 dollars)	
			Capital ($ mil)	Annual Operation and Maintenance ($ mil)
Aggressive Water Conservation	9,000	0	$0.0	$4.2
On-Site Stormwater Projects	140	1000	$31.6	$1.3
Devil's Gate Storage to Eaton Canyon	630	2,000-4,000	$11.0	$0.4
Groundwater Storage of Imported Water	5,000	6,500	$36.1	$4.4
Recycled Water to Non-Potable Reuse	1,130	0	$15.3	$0.3
Recycled Water to Groundwater Recharge	920	920	$4.0	$0.6
TOTAL (rounded):	16,820	10,400-12,400	$98.0	$11.3

The benefits of implementing these options include:

1. greater supply reliability, especially during droughts and emergency situations;
2. reduced overall lifecycle costs compared to a future in which these options are not implemented;
3. improved groundwater basin levels;
4. improved environment and surface water quality;
5. climate change adaptation and mitigation; and
6. consistency with MWD's regional strategy of increasing local conservation and supplies.

Figure 6-12 illustrates the portion of future water demands in 2035 that would be met by different water sources without any action (status quo) vs. the recommended strategy.

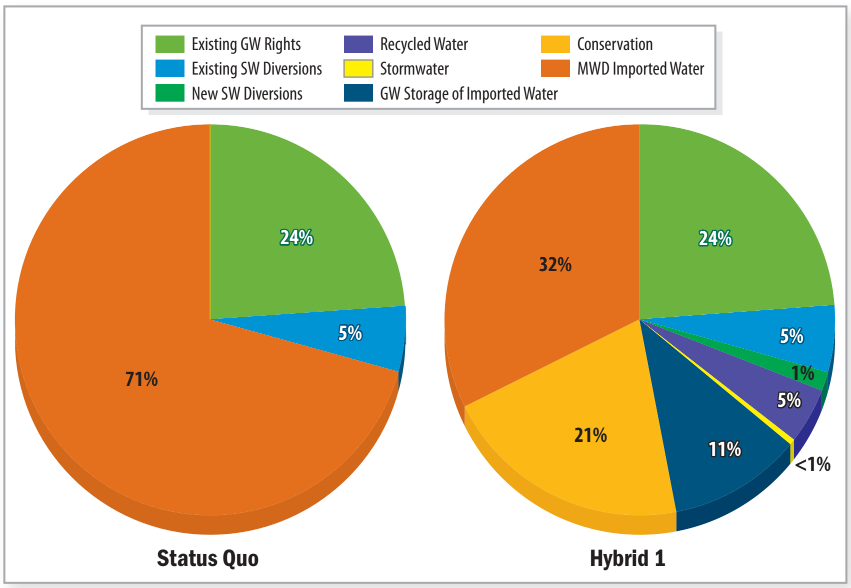


Figure 6-12. Future Supply Mix - Status Quo versus Hybrid 1

Section 7
Adaptive Implementation Strategy and Recommendations

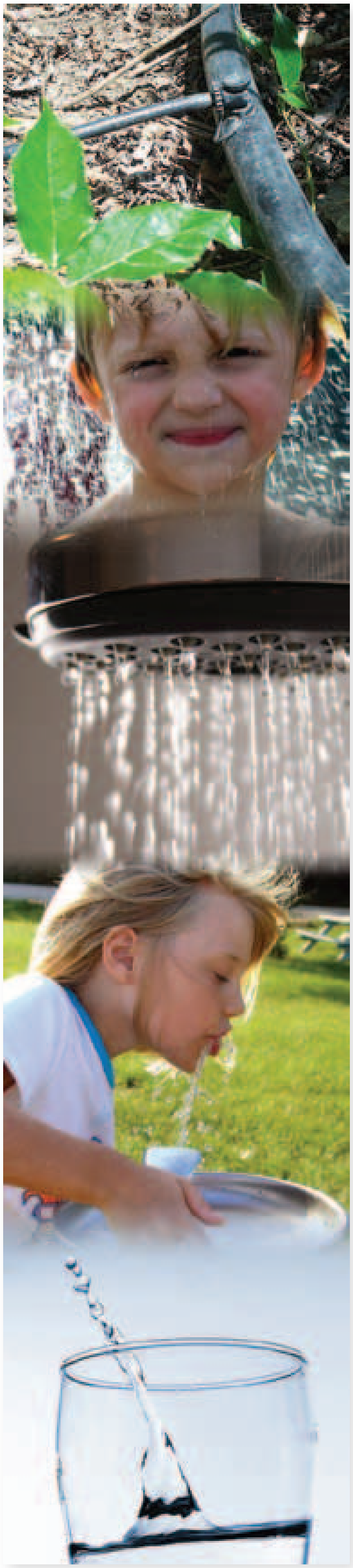
Implementing a long-term water supply strategy will undoubtedly face some uncertainty given that the future cannot be accurately predicted. Factors that may unfold differently than as projected include: population growth, reliability and cost of MWD water supplies, level of success of demand management and stormwater options, regulatory risk, technical uncertainties, and partnerships. To account for these uncertainties, an adaptive implementation strategy is recommended.

The comprehensive evaluation in Section 6 demonstrated that the Hybrid 1 Portfolio ranked highest under most scenarios—even the scenario in which there was no growth in water demands. However, when the "constant water demand" sensitivity was combined with a heavy emphasis on cost-effectiveness, the Low Cost Portfolio ranked highest. To determine a "no-regrets" strategy in which implementation of recommended projects are beneficial under even the most optimistic assumptions regarding water supply and demand growth, it is recommend that elements of Hybrid 1 be phased in over time based on their cost-effectiveness and ability to meet the planning objectives.

7.1 Potential Rate Implications

As shown in the analysis presented in Section 6, the average cost of PWP water would be lower over the planning horizon with the full implementation of the Hybrid 1 portfolio than if PWP simply relied on its current supply mix into the future. However, an important consideration in the implementation of this recommended strategy is the ability of PWP to pay for these new costs given the existing water rate structure

Inside



and financing capabilities to generate the funds for investment in the new projects and programs.

Currently, PWPs rate structure is heavily reliant on the sale of water to pay for fixed costs. Many of the recommended elements of the WIRP will require PWP to construct new capital projects, which further increase fixed costs to the department. Also, as significant levels of water conservation are implemented, water demands and the sale of water will decrease; requiring water rates to increase because fixed costs for the department will not go down proportionally. Finally, there are potential equity issues with how customers use water and the fairness in who pays for future water supplies.

All of these issues may require a new approach for how PWP charges customers for water service. To evaluate this, it is recommended that PWP conduct a comprehensive water rate study that identifies and evaluates the multiple options available to address the issues above. Once the study is complete, PWP will have the technical information necessary to make well-informed decisions about changes in how it charges customers for water service.

7.2 Adaptive Strategy

The preferred strategy, Hybrid 1, is made up of a combination of options that together provide significant benefits and achieve multiple planning objectives. Hybrid 1 includes:

- Devil's Gate storage to Eaton Canyon
- Recycled water to non-potable reuse (Phase 1 system, with tunnel augmentation)
- Recycled water to groundwater recharge (tertiary indirect potable reuse)
- Aggressive water conservation
- On-site stormwater projects
- Groundwater storage of imported water

For each element of Hybrid 1, a recommended phased implementation strategy is outlined that is adaptable to uncertain future conditions. This phased strategy prioritizes cost-effective elements (i.e. projects that are comparable or lower than the cost of projected MWD water rates) in the near-term, with other elements coming on-line when needed based on "triggers". Triggers involve a periodic assessment of whether water demands are growing as projected; is MWD supply reliability better or worse than anticipated; and are water quality and environmental goals being achieved. The following subsections describe each of the projects included in the Hybrid 1 portfolio in detail, along with recommendations for their phased implementation.

7.2.1 Devil's Gate storage to Eaton Canyon

The LACDPW is currently considering a conservation project to capture water along the Arroyo Seco downstream of PWP's diversions. The water would be stored behind the Los Angeles County Flood Control District's Devil's Gate Dam, which was originally constructed to provide detention of large storm events in the Arroyo Seco. Under current operating conditions, however, all runoff flows through Devil's Gate Reservoir and ultimately to the Pacific Ocean.

Groundwater recharge could occur behind the dam, and stored water would be pumped and diverted to the Eaton Canyon spreading basins for additional recharge *(see Figure 7-1)*. In concept, the Devil's Gate storage project would provide an opportunity for enhanced habitat conditions for aquatic life, including more sustained environmental flows in the Arroyo Seco downstream of the dam.

The concept in the WIRP includes capture of urban runoff through connection of existing storm drain pipes to the conveyance pipeline from Devil's Gate Reservoir to Eaton Canyon, which provides water quality benefits to receiving waters (streams) where stormwater pollutants would otherwise be discharged. If design for stormwater capture can't be achieved along the Devil's Gate conveyance pipeline, other centralized stormwater projects are recommended in partnership with Raymond Basin Management Board (RBMB). A concept for centralized stormwater capture to groundwater recharge was analyzed for this study, but was not included in portfolio analyses due to the low potential for supply credits.

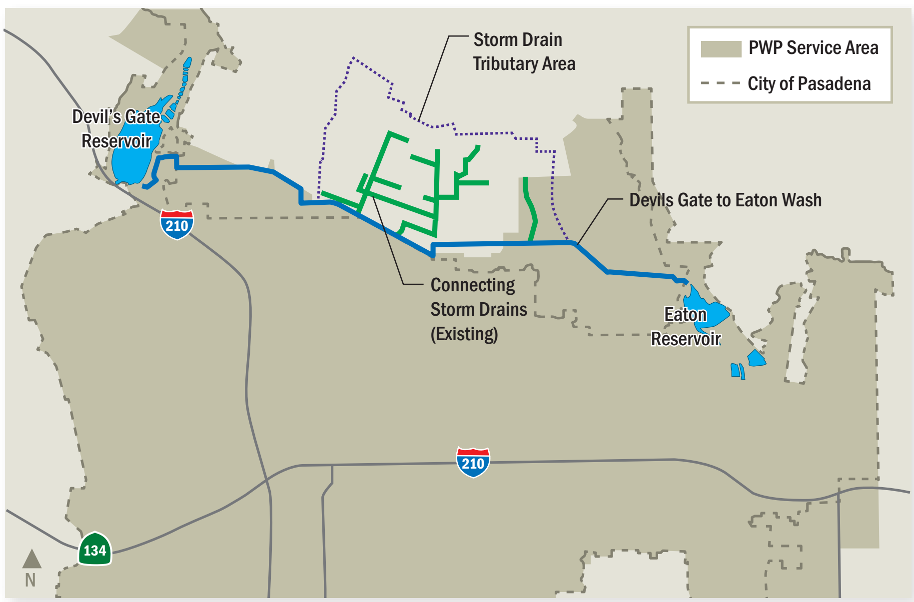


Figure 7-1. Devil's Gate Storage to Eaton Canyon

Another design concept to consider is the use of Devil's Gate storage to Eaton Canyon conveyance for recycled water going to groundwater recharge (see the recycled water discussion of this section). There is a significant segment of pipeline that could be shared in partnership with LA County.

On average, the project would send approximately 1,750 AFY of water to Eaton Canyon for recharge (including 500 AFY of flows from the urban runoff storm drain system). In this analysis, it was assumed that PWP would recover approximately 35 percent of the total recharge as supply. The remaining recharge would be intended for the health of the basin or split with other partnering agencies. Additional replenishment could occur behind the dam in Devil's Gate Reservoir. This replenishment was not included in the estimated supply yield, however, since further technical study is needed to determine infiltration potential and current RBMB spreading credit methodology does not allow supply credit unless water is diverted from the natural stream.

Potential Costs

Capital costs for this project are currently estimated to be $11-$15 million. It is anticipated that costs would be shared with LACDPW and other participating agencies, and this project will be eligible for grant funding. In this analysis, it was assumed that PWP would contribute to project costs in proportion to the amount of supply yield that could be recovered from the surface water/stormwater recharged. Operation and maintenance costs include pipeline maintenance, pumping conveyance, and groundwater pumping to recover water for supply.

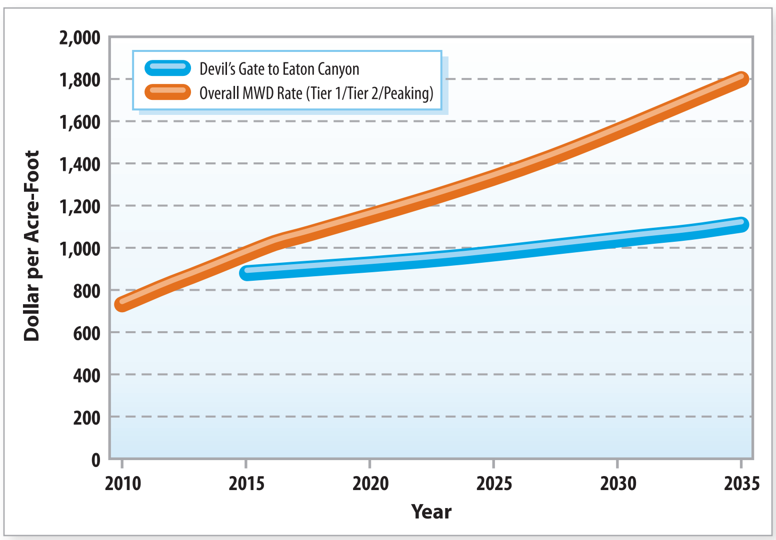


Figure 7-2. Comparison of Devil's Gate Storage to Eaton Canyon Cost with Projected MWD Water Rates

Although this project would require capital expenditures, the investment is comparable or less than the cost of MWD water rates on a dollar per acre-foot basis[1] *(refer to Figure 7-2)*. The MWD rate projection for comparison represents the overall average rate PWP would pay in the status quo scenario assuming today's demands are held constant throughout the planning horizon, accounting for Tier 1 and Tier 2 pricing, as well as peaking charges. Refer to Appendix D for details on assumed MWD rate projections.

Figure 7-2 shows that the unit cost of the Devil's Gate to Eaton Canyon project is less than projected MWD water rates, even without grant funding which would reduce the unit cost of the project further. Given its relatively low cost and significant benefits (including improved surface water quality, enhanced groundwater replenishment, improved habitat for aquatic life, and others), it is recommended that PWP implement this project within the next five years, provided partnership funding can be obtained.

[1] The dollar per acre-foot cost of the project assumes an inflation rate of 3 percent and capital amortization with a 5.5 percent interest rate over a 30 year payment period.

Implementation Challenges

The main challenges associated with implementation of this project include:

- Project is led by LACDPW, and PWP does not have full control/ownership of implementation decisions
- Feasibility of incorporating urban stormwater capture and recycled water conveyance into project design. If these elements cannot be incorporated in the near-term, the surface water project is still recommended for implementation.
- Approval of regulatory permits
- Negotiation of pumping credits with Raymond Basin Management Board for recharge occurring behind Devil's Gate Dam and in Eaton Canyon spreading basins – which may determine the level of funding PWP would contribute

Devil's Gate Spillway

Recommended Implementation Actions

2010-2015 Timeframe:

- Develop and maintain partnership with Los Angeles County and other project partners/stakeholders, and coordinate with the City of La Canada Flintridge to investigate potential TMDL benefits and cost-sharing.
- Negotiate spreading credits with Raymond Basin Management Board. It is recommended that further study of recharge potential behind Devil's Gate Dam be conducted and PWP explore opportunities to receive pumping credits for this recharge.
- Define environmental flow requirements downstream of Devil's Gate Dam and determine operational strategies
- Coordinate recycled water and stormwater capture design concepts with LA County
- Develop environmental permitting strategy – environmental permitting requirements should consider the following agencies:
  - U.S. Army Corps of Engineers, Los Angeles District
  - State Water Resources Control Board
  - U.S. Forest Service
  - U.S. Fish and Wildlife Service
  - California Department of Fish and Game
  - California Regional Water Quality Control Board, Los Angeles Region
- Develop cost estimates, financial analysis of PWP funding toward project, and potential funding sources through partnerships
- Coordinate design, permitting, and construction with Los Angeles County

2015-2035 Timeframe:

Once the project has been constructed, long-term management decisions will be related to operational strategies given the variability of flows into the proposed reservoir, potential sedimentation issues behind the dam, and environmental demands. In addition, groundwater aquifer responses will need to continue to be monitored.

7.2.2 Recycled Water

Pasadena currently has an agreement to purchase tertiary-treated recycled water from the Los Angeles-Glendale Water Reclamation Plant (LAG WRP), and conveyance infrastructure to the vicinity of PWP's service area is already in place. The recycled water options included in Hybrid 1 include:

- Phase 1 non-potable reuse: A recycled water distribution system to provide tertiary treated water to customers for landscape irrigation demands. The Phase 1 system is primarily routed to Brookside Golf Course, Brookside Park, and nearby customers. Note that the Phase 1 system is a smaller scale distribution system than other recycled water alternatives, which extended piping across the City. The Phase 1 recycled water system would serve approximately 1,130 AFY of non-potable demands, and construction could occur in two phases *(refer to Figure 7-3)*: (1) Core Phase 1 system that extends to Brookside Golf Course and connects adjacent customers along the way; and (2) Expanded Phase 1 system that provides service to additional customers in the northwest and central eastern part of the City's service area (including Brookside Park).
- Tertiary treated indirect potable reuse: This concept involves conveyance of tertiary-treated recycled water to Eaton Canyon for groundwater replenishment and recovery for potable use *(see Figure 7-3)*. The water would be conveyed through the Core Phase 1 recycled system, and a relatively short segment of additional pipe would be needed to reach the conveyance system for the Devil's Gate storage to Eaton Canyon project (the recommended project discussed previously).

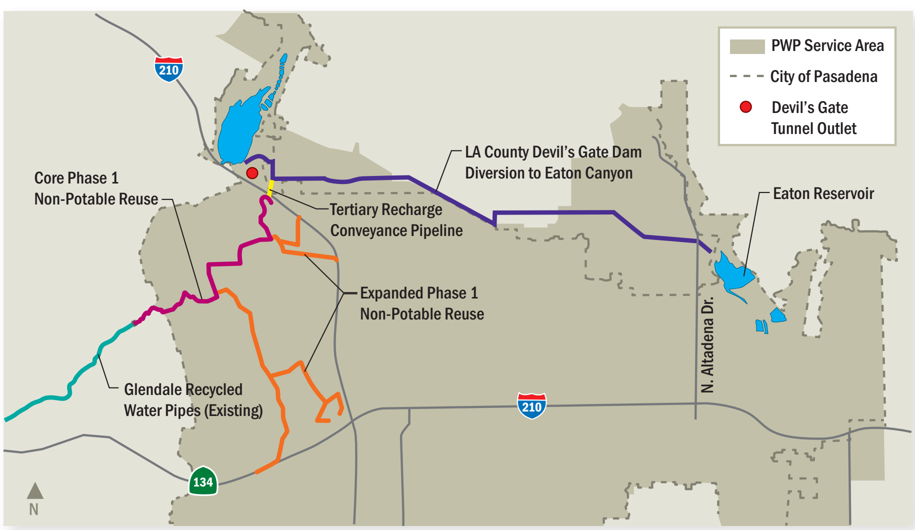


Figure 7-3. Major Recycled Water Facilities

> The tertiary recycled water would blend with natural surface runoff from Eaton Wash and the Arroyo Seco diversions from the Devil's Gate Dam to Eaton Canyon project. The tertiary treated indirect potable reuse project would provide approximately 920 AFY of supply.

In addition, a project is being considered to capture water from existing groundwater tunnels that currently discharge water to the Arroyo Seco for non-potable supply to Brookside Golf Course. The tunnel water would be routed to a storage pond and serve a portion of the irrigation demands at the golf course. The tunnel project would yield 440 AFY of supply under current hydrogeologic conditions. Yield from the tunnels would help satisfy the same demands as the Phase 1 recycled water system, but would offset recycled water purchases from the LAG WRP. It is recommended that this project be designed with the potential to connect the tunnel water to the Phase 1 recycled water system, and deliver blended water to customers.

It should be recognized that the reliability of the tunnel water is uncertain at this time since additional pumping is expected on the west side of the groundwater basin once the Monk Hill treatment plant is online. This pumping could decrease local groundwater levels and reduce tunnel flows. However, implementation of the Devil's Gate storage option is expected to replenish groundwater levels in the area and may improve tunnel yields.

Potential Costs

The potential costs of implementing the recycled water projects are presented in Table 7-1, and could be phased over time.

Table 7-1. Capital Costs for Recycled Water Projects

Project	Estimated Capital Cost[1], $ (2010 dollars)
Tunnel water to Brookside Golf Course	$950,000
Core Phase 1 non potable distribution system, with tunnel augmentation	$6.8 million for PWP's main distribution system to Brookside Golf Course; customer capital costs for on-site retrofits/connections to be phased in over time
Expanded Phase 1 system	$5.8 million for extending PWP's main distribution system to serve other Phase 1 customers; customer capital costs for on-site retrofits/connections to be phased in over time
Indirect Potable Reuse	$4.0 million assuming tertiary treatment. Up to $55.1 million if advanced treatment required

[1] Some of these costs may be offset through partnerships and state or federal grant funding.

In this analysis, it is assumed that PWP would pay for the main Phase 1 distribution system. However, there would be some capital costs to participating customers for on-site retrofits and connections to the distribution system. On-site costs vary widely on a case by case basis depending on site conditions. Further analysis is needed to determine whether financial incentives (such as reduced water rates) should be offered to participating customers.

Operation and maintenance costs are associated with recycled water purchases from LAG WRP and pipeline maintenance. In addition, indirect potable reuse would have operational costs associated with groundwater pumping and potentially recycled water treatment (if advanced treatment levels are required).

Both non-potable reuse and indirect potable reuse projects would be eligible for state and federal funding.

Cost Comparison with MWD Water Rates

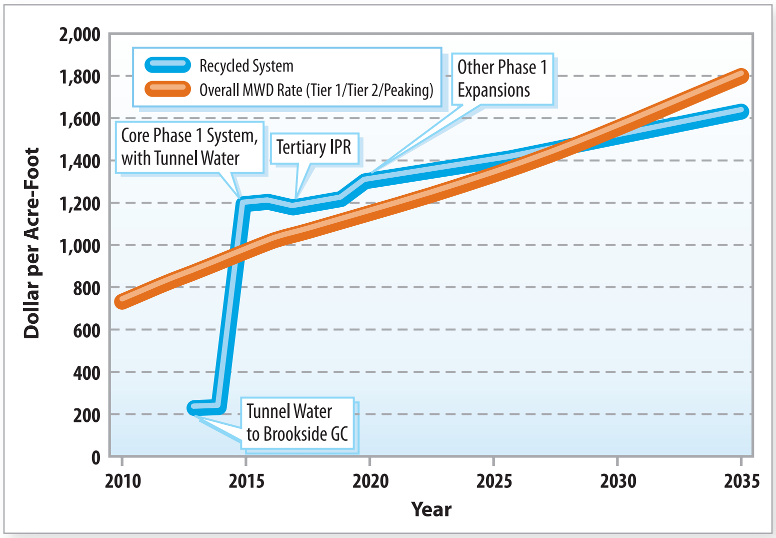


Figure 7-4. Comparison of Recycled Water System Cost with Projected MWD Rates

Similar to Devil's Gate storage to Eaton Canyon project, the recycled water system costs (in dollars per acre-foot of supply) were compared to MWD water rate projections *(refer to Figure 7-4)*. Financial assumptions are the same as previously discussed for Figure 7-2. The timing of implementing the recycled water options was optimized to be comparable to MWD water rates in the earlier years, and then ultimately be less than projected MWD rates into the future.

Implementation Challenges

The main implementation challenges associated with recycled water are:

- Non-potable reuse requires customer participation to be successful
- Regulatory challenges for indirect potable reuse of tertiary-treated water
- Extensive public education and outreach anticipated for implementation of indirect potable reuse.

Recommended Implementation Actions

2010-2015 Timeframe:

- Develop ordinances that require new developments along planned recycled water corridors to have recycled water connection capability.
- Develop cost estimates, financial analysis of PWP funding toward projects, and potential funding sources through partnerships and grants
- Financial analysis to determine non-potable water rates to customers

- Develop partnership with Brookside Golf Course and monitor progress of the tunnel project, with a goal of completion by 2013 and capability to connect tunnel water to future recycled water system.
- Acquire necessary permits, design and construct Core Phase 1 recycled water system (by 2015)
- Monitor progress of the Devil's Gate storage to Eaton Canyon project and coordinate with LACDPW regarding use conveyance infrastructure for indirect potable reuse project.
- Coordinate with Raymond Basin Management Board for indirect potable reuse project regarding spreading credits and potential cost-sharing.
- Initiate California Department of Public Health (CDPH) and Regional Water Quality Control Board (RWQCB) regulatory permitting for tertiary-treated indirect potable reuse. This may require additional groundwater modeling.

Brookside Golf Course

2015-2020 Timeframe:

If Devil's Gate storage to Eaton Canyon project is underway and PWP has received CDPH and RWQCB regulatory approval for tertiary-treated indirect potable reuse, PWP should move forward with tertiary IPR, with a goal of construction by 2017. In addition, PWP should evaluate the next step in expanding recycled water use.

Per Recycled Water Master Plan evaluations, the primary limiting factor for the amount of recycled water that can be used for tertiary-treated indirect potable reuse is the availability of diluent water for blending, which is currently assumed to require a mixture of 80 percent diluent water (such as surface water from Eaton Wash or Devil's Gate storage to Eaton Canyon) with 20 percent recycled contribution water for groundwater recharge. If regulatory requirements in the future allow for more recycled water contribution, it is recommended that additional recycled water be utilized for groundwater replenishment instead of expanding the Phase 1 non-potable system, since indirect potable reuse would be more cost effective. This next step in expanding recycled water use could be implemented within a few years after tertiary indirect potable reuse is constructed.

If tertiary indirect potable reuse does not receive regulatory approval or public support, PWP could implement phased additional non-potable reuse.

7.2.3 Aggressive Water Conservation

The aggressive water conservation option pursues a goal of 9,000 acre-feet per year of new conservation savings by 2035. If water demands track as projected, this target for water conservation will be essential to meet the state's "20 x 2020" goal of reducing per capita water use by 20 percent in year 2020. Note that recycled water use is an alternative that also helps achieve this goal.

The following conservation elements are included in Hybrid 1:

- Convert about 70 percent of existing single family homes to comply with California Model Landscape Ordinance (requires a combination of irrigation efficiency measures and turf replacement to warm season grass) – through PWP rebates and rate structure enhancements
- Require that all *new* single family homes shall have drought-tolerant landscaped front yards, and warm season lawn (model landscape compliant) back yards – through ordinances for new development and PWP rebates
- Convert 60-70 percent of existing multifamily and commercial landscapes to comply with California Model Landscape Ordinance – through PWP rebates and rate structure enhancements
- Double the implementation of PWP's current indoor conservation for single-family customers – through PWP rebates and ordinances for plumbing retrofits on resale of property

Table 7-2. Summary of Aggressive Conservation Program Costs

Conservation Measure	Assumed % of Total Conservation Costs that PWP will Incur[1]	Average Annual Cost for PWP[2] (2010 dollars)	Estimated Annual Water Savings by 2030 (AFY)
Convert existing single-family landscaping to comply with California Model Landscape requirements: ▸ Replace cool season turf with warm season turf for 70% of homes (total cost = $1000/home); and/or ▸ Replace portion of cool season turf with drought tolerant landscaping for 35% of homes (total cost = $3000/home)	55%	$495,000	1,630
Require drought tolerant landscaping in front yards and warm season turf in back yards for all new single-family homes (total cost = $1,200/home)	10%	$19,500	540
Convert existing multifamily and commercial landscaping to comply with California Model Landscape requirements (total cost = $1.1 million/year)	55%	$605,000	1,600
Double the implementation of single-family indoor conservation programs through rebates and ordinances for resale (total cost = $1.3 million/year)	55%	$715,000	2,980
Continue to implement multifamily and commercial indoor conservation programs at current levels (total cost = $517,000/year)	55%	$285,000	2,100
Require individual meters for new multifamily accounts (total cost = $600/meter)	30%	$39,000	240
TOTAL (rounded):	N/A	$2,160,000	9,000

[1] Program costs and adoption rate are expected to vary depending on what portion of costs PWP can afford to pay.

[2] Some of these PWP costs may be offset by MWD's conservation credits program and state grant funding.

- Continue PWP's current indoor conservation for multifamily and commercial customers– through PWP rebates
- Install individual meters for all *new* multifamily accounts – through ordinance

Potential Costs

Costs for the above measures are summarized in Table 7-2. Note that annual costs will vary over time depending on the levels of each conservation measure.

Implementation Challenges

The main challenges in implementing the conservation elements are:

- Approval of new conservation ordinances
- Ability of PWP to fund conservation programs, which will require rate structure analysis and modification
- Successful customer support and participation

Recommended Implementation Actions

If water demands do not increase as projected or if water customers continue to reduce water consumption through pricing and education, it may be easier for PWP to achieve the state's mandated conservation goal without investing as significantly as outlined in Table 7-2. Therefore, the following phased recommendations are:

2010-2015 Timeframe:

- Implement a rate structure that allows PWP to increase fixed revenue sources and explore ways to increase cost fairness related to how customers use water, while still providing a water conservation signal.
- Continue to implement programmatic conservation measures at similar levels as in the past.
- Consider a stewardship charge on all water sold to help pay for conservation measures and ensure that any charges comply with Propositions 218 and 26.
- Develop and implement ordinances for new development and resale that requires:
  - Landscaping to be compliant with California Model Landscape requirements for all *new* residential and commercial properties (PWP adopted this in July 2010);
  - Individual meters for all *new* multifamily developments; and
  - Plumbing retrofits on resale of residential and commercial properties.

Post-2015 Timeframe:

Every five years after 2015, PWP should assess its conservation goals to determine if more aggressive conservation needs to be implemented. Figure 7-5 presents this adaptive management strategy for water conservation.

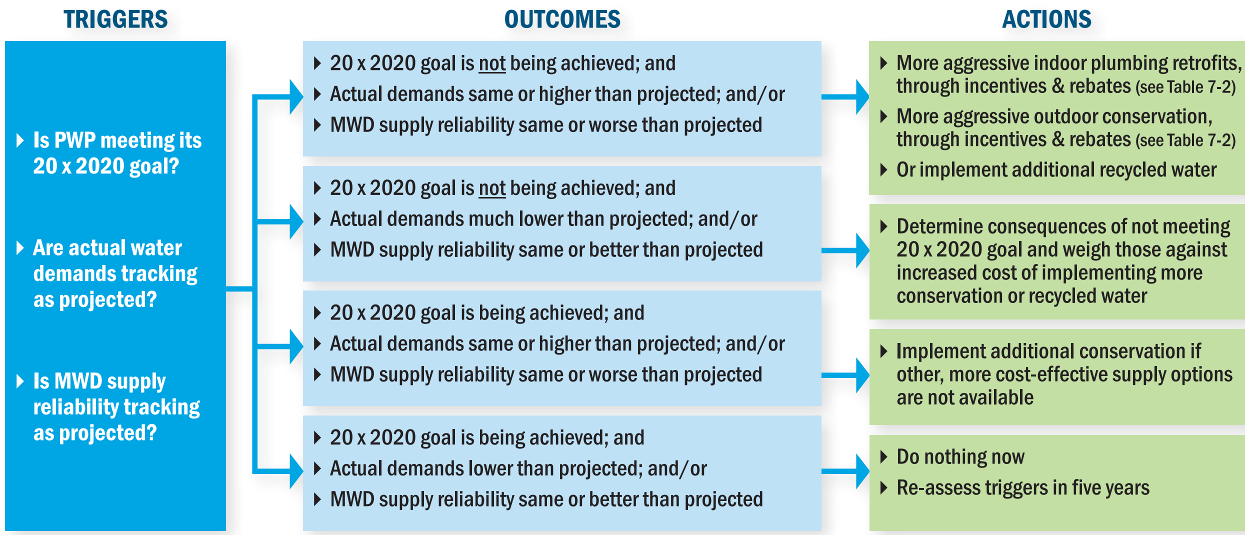


Figure 7-5. Adaptive Strategy for Conservation

7.2.4 On-site Urban Stormwater Capture

Stormwater projects within the City are led by the City of Pasadena Public Works Department (Pasadena Public Works), and are typically aimed at flood control and TMDL water quality compliance. The main goal in evaluating stormwater projects with respect to WIRP is to identify those projects which also provide water supply benefits. To the extent that cost-effective, multi-benefit stormwater projects can be identified and demonstrated, it is recommended that Pasadena Public Works and PWP coordinate and partner (along with other regional stakeholders) to implement such projects.

There were several stormwater options that were recommended as part of Hybrid 1. These included projects that would enhance groundwater recharge and also provide direct capture for onsite irrigation use. Depending on the RBMB credit for groundwater recharge some of these options may only provide a fraction of direct water supply benefits to the City. For the WIRP it was assumed that 10 percent of groundwater recharge could be recovered as a supply for PWP. However, it should be noted that all of these options would help the City achieve its TMDL water quality compliance and many of the options would, over the long-term, improve groundwater levels within the Raymond Basin.

The following stormwater projects included in Hybrid 1 would provide approximately 1,000 AFY of stormwater capture for groundwater recharge and direct onsite irrigation:

- Residential Rain Barrels: Collect rainwater from rooftops and store in 100 gallon rain barrels for onsite irrigation use - Assumes 25 percent participation across the service area (or roughly 9,000 homes)
- Residential Rain Gardens: Downspout from rooftop to garden bio-retention area (approx. 30 ft2) - Assumes 25 percent participation (or roughly 9,000 homes)
- Residential Infiltration Strip/Bioswale: Bio-retention strip at edge of lot to capture storm runoff and overwatering from property, implemented on a neighborhood scale - Assumes 25 percent participation (or roughly 9,000 homes)
- Commercial/Institutional Parking Lot Swales: Large bio-retention area to collect runoff from parking lot areas – Assumes 30 percent participation (or 1,500 parcels)
- Commercial/Institutional Permeable Pavement Parking Lots – Assumes 20 percent participation (or 80 acres)

Potential Costs

Costs for the above stormwater options are summarized in Table 7-3. Note that annual costs may vary over time depending on the number of projects that are implemented. The annual costs below assume the rate of implementing new projects is linear throughout the planning horizon.

Table 7-3. Summary of On-site Stormwater Projects Costs

Stormwater Projects	Assumed % of Total Capital Costs that City will Incur[1]	Estimated City's Average Annual Costs[2] $/year (2010 dollars)
Residential Rain Barrels	50%	$35,000
Residential Rain Gardens	50%	$65,000
Residential Infiltration Strip/Bioswale	100%	$416,000
Commercial/Institutional Parking Lot Swales	100%	$406,000
Commercial/Institutional Permeable Pavement Parking Lots	100%	$241,000
TOTAL (rounded):		$1.2 million

[1] Program costs and adoption rate are expected to vary depending on what portion of costs City decides to pay.
[2] Some of these costs may be offset through partnerships or state grant funding.

The opportunity and extent to which PWP can offer rebates and incentives will need to be determined during implementation.

It is assumed that all on-site operation and maintenance costs would be paid for by the participating customer.

Implementation Challenges

The main challenges in implementing the urban stormwater projects are:

- Successful integration of stormwater projects with Pasadena Public Works
- Availability of grant funding
- Customer support and participation

Recommended Implementation Actions

2010-2015 Timeframe:

- Evaluate and implement appropriate Low Impact Development (LID) ordinances
- Work with other City departments and agencies to develop a comprehensive stormwater strategy that will achieve the goals of the WIRP. The strategy should consider the following:
  - Coordination with other regional stakeholders, such as Reach 2 Cities
  - Coordination with RBMB for stormwater options that recharge groundwater in the Raymond Basin
  - Evaluation of costs and benefits of various approaches to achieve TMDL requirements and water supply benefits, with consideration of supply credits received from RBMB for groundwater recharge
  - Public education and outreach
  - Identification of near-term projects to implement, which might include rain barrels, cisterns, and swales. Some of these projects could be implemented through pilot programs in order to test their effectiveness and determine optimal areas for groundwater recharge
- Pursue funding through grants and partnerships and implement projects as funding becomes available. Funding strategies may include:
  - Identify early projects to include in grant funding associated with the Greater Los Angeles County Integrated Regional Water Management Plan and Proposition 84
  - Other sources of outside funding, including federal grants
  - Potential local stormwater fees and bonds, which would require voter approval

Permeable pavement and native plantings installed in Brookside Parking Lot I

Post-2015 Timeframe:

Every five years after 2015, PWP should assess its stormwater management goals to determine when the stormwater elements should be implemented. Figure 7-6 presents this adaptive management strategy for stormwater.

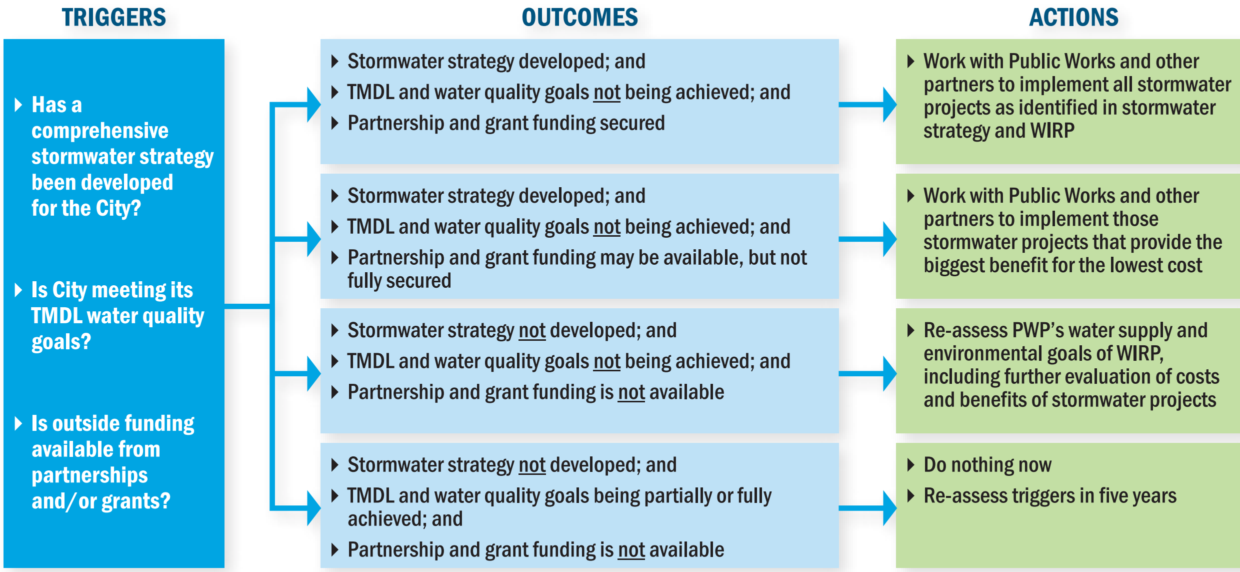


Figure 7-6. Adaptive Strategy for On-site Stormwater

7.2.5 Groundwater Storage of Imported Water

This option is known as the Pasadena Groundwater Storage Program (PGSP), and is a proposed conjunctive use program that would store additional groundwater reserves when imported replenishment water is available from MWD, which is purchased at a reduced rate. The water would be cycled and extracted as needed to reduce imported water costs, and provide increased supplies during dry years and emergency conditions when imported water is more limited. Water would be stored using any combination of the following three methods:

- Direct injection - through existing and new wells that force water into the ground
- Existing spreading basins – that allow water to percolate into the groundwater basin
- In-lieu recharge – in which PWP would reduce groundwater pumping and take more imported water in-lieu, thereby increasing storage in the basin

PWP receives treated imported water from MWD's Weymouth WTP, which historically was a blend of imported water from the State Water Project (SWP) and Colorado River Aqueduct (CRA). However, since 2008, deliveries have consisted largely of CRA as a result of environmental constraints in the Sacramento-San Joaquin Delta region of the SWP. The water quality of CRA currently does not meet Raymond Basin water quality objectives for sulfate or total dissolved solids (TDS). Therefore, it can't be used for recharge via injection wells. Spreading could be possible if imported water could be blended with surface water to improve water quality. Once Devil's Gate Dam to Eaton Wash project is online, a water quality study should be conducted to evaluate potential for blending with imported water

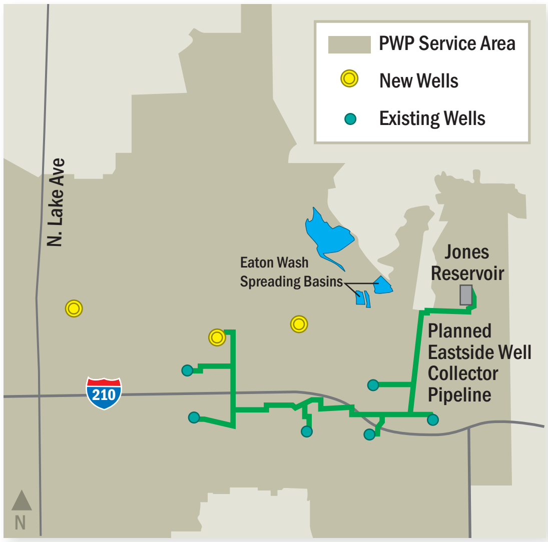


Figure 7-7. New Facilities for Pasadena Groundwater Storage Program

replenishment. It is expected that in-lieu recharge and potentially spreading will be the only methods of recharge that meet water quality objectives until at least 2020, if not longer.

Facilities include the planned Eastside Well Collector, which is a new pipeline and centralized chloramination facility at Jones Reservoir, as well as three new injection/extraction wells. Other facilities for treated imported water spreading and injection are already in place, or are already in construction. See Figure 7-7 for new facilities required.

The availability of replenishment water from MWD will vary over time depending on reliability of imported water and a solution to the Bay-Delta issues. The following assumptions are behind the long-term average yield of 5,000 AFY:

- Between 2011 and 2020, replenishment water will only be available 20 percent of the time,
- From 2021-2029, replenishment water would be available 50 percent of the time,
- From 2030-2035, replenishment water would be available 70 percent of the time.

Replenishment would occur up to 20,000 AFY in a given year, but would average approximately 6,500 AFY over time. Maximum groundwater extractions during drought year or emergency conditions would be up to 25,000 AFY. However, extractions would not occur for several years and would average 5,000 AFY over the planning horizon.

Potential Costs

To increase operational flexibility and recover water from the ground during droughts and emergencies, this program would include construction of the East-side Well Collector pipeline and three new injection/extraction wells. The total capital cost associated with new facilities is estimated to be approximately $36.1 million, which could be phased over time starting with construction of the East-side Well Collector (approximately $12.6 million) and adding new wells later.

Note that capital costs to increase well capacity as part of this program are beneficial for operational flexibility, water quality, and recovery of groundwater of other origins (such as indirect potable reuse, local surface spreading, and decreed rights), providing system-wide facility benefits regardless of whether imported water is recharged.

MWD offers a reduced water rate for replenishment water that is purchased for drought storage reserves. Currently, the MWD treated water replenishment rate is $558/AF, compared with the current treated water Tier 2 rate of $811/AF, respectively. This reduced replenishment rate is only offered when imported water is abundant (which is not expected to occur frequently in the near-term).

Other costs include typical operation and maintenance costs associated with groundwater well pumping during periods when water is recovered from storage.

This program would be eligible for state and federal grant funding.

Implementation Challenges

The main challenges associated with implementation of this program include:

- Negotiations and agreement from RBMB to activate storage accounts in the Pasadena subarea, where PWP would build storage with imported replenishment water when it is available, and extracting during drought or emergency periods. The benefits of this imported water storage program only apply when the water can be cycled in/out of storage.
- Water quality of imported water from Weymouth water treatment plant does not currently meet groundwater basin objectives, which limits flexibility in operational strategies to build storage.
- Availability of replenishment water from MWD is uncertain.

Garfield Well

Recommended Implementation Actions

2010-2015 Timeframe:

- Complete projects underway to activate wells in Monk Hill subarea and utilize Monk Hill storage account (via in-lieu).
- Construct East-side Well Collector project. This near-term benefits of this project include improved water quality of existing wells and increased operational flexibility.
- Negotiate use of storage account in Pasadena subarea with Raymond Basin Management Board. This may require additional groundwater study. It is important that imported water in storage may be recovered when needed in drought and emergency conditions. Without ability to recover the water during shortages, there is little incentive to continue replenishment.
- Update conceptual design reports and initiate design of new wells

In addition, PWP should develop refined cost estimates and investigate grant funding for capital improvements.

Post-2015 Timeframe:

Every five years after 2015, PWP should assess the imported water storage program and determine implementation actions. Figure 7-8 presents this adaptive management strategy for imported water storage.

In the future, if replenishment water from MWD is less available in today's assumptions, further study will be needed to analyze the costs and benefits of this program without the financial incentive of a reduced purchase rate.

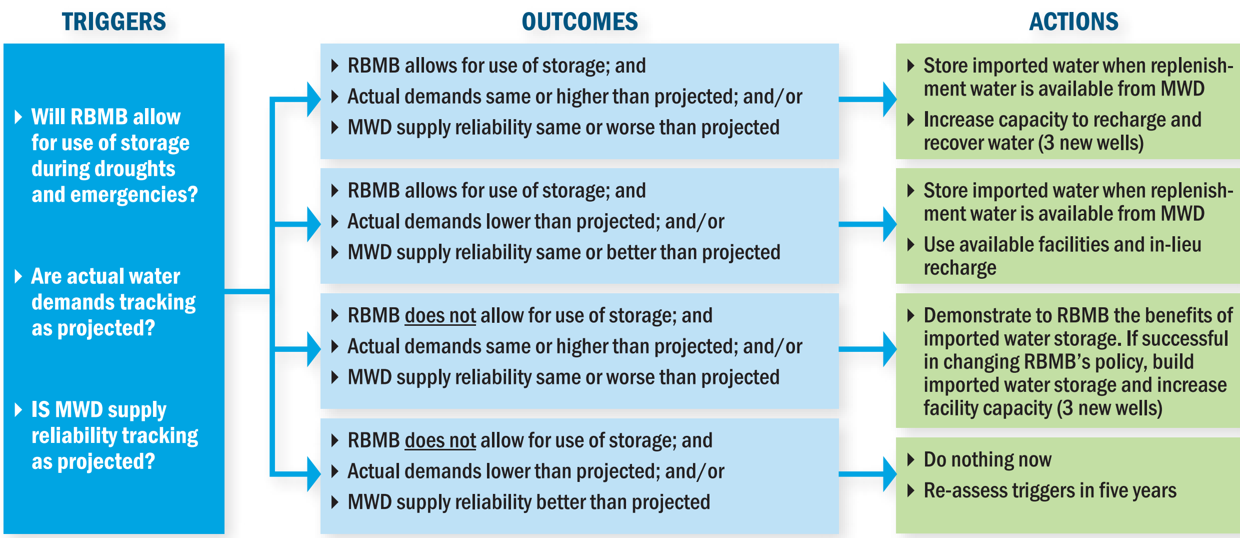


Figure 7-8. Adaptive Strategy for Groundwater Storage of Imported Water

7.2.6 Summary of Near-term Actions

An outcome of the WIRP is to provide a roadmap to help guide future water management decisions and investments for PWP. A summary of key near-term actions recommended by 2015, along with cost estimates for PWP is presented in Table 7-4.

Moving forward into the future, there may be future opportunities or constraints that were not known at the time this plan was developed. The WIRP should be a "living" document, and PWP should continue to update the plan. Because the WIRP provides input to the state mandated UWMP, it is recommended that the WIRP be updated on the same 5-year cycle as the UWMP.

Table 7-4. Summary of Near-term Actions and Costs (2010-2015)

Devil's Gate Storage to Eaton Canyon

- Pursue project in coordination with LA County, with goal of construction by 2015. Will require design coordination (to include indirect potable reuse and stormwater capture concepts), environmental permitting strategy, negotiation of spreading credits, and development of partnerships for cost-sharing.

Capital Cost: $11-15 million total capital costs

Portion of cost to be paid by PWP to be determined during implementation. Cost will be offset through partnerships and grant funding.

Recycled Water

- Develop ordinances that require new developments along planned recycled water corridors to have recycled water connection capability.
- Monitor progress of tunnel project to Brookside Golf Course with goal of construction by 2013.
- Pursue Core Phase 1 system with goal of construction by 2015.
- Investigate regulatory requirements for indirect potable reuse, with goal of constructing tertiary-treated indirect potable reuse by 2017 (pending completion of Devil's Gate Dam to Eaton Canyon and Core Phase 1 non-potable system).

Capital Cost: $1 million capital cost for tunnel project; $6.8 million capital cost for Core Phase 1 system

Some of these costs may be offset by partnerships and state or federal grant funding.

Conservation

- Implement a rate structure that allows PWP to increase fixed revenue sources and explore ways to increase cost fairness related to how customers use water.
- Continue to implement programmatic conservation measures at similar levels as in the past, and consider a stewardship fee on all water sold to help pay for these measures.
- Develop and implement ordinances for new development and resale that requires:
  - Landscaping to be compliant with California Model Landscape requirements for all *new* residential and commercial properties;
  - Individual meters for all *new* multifamily developments; and
  - Plumbing retrofits on resale of residential and commercial properties.

Average Annual Cost: $1.6 million

Some of these PWP costs may be offset by MWD's conservation credits program and state grant funding.

On-site Stormwater Capture

- Evaluate and implement appropriate Low Impact Development (LID) ordinances.
- Work with other City departments and agencies to develop a comprehensive stormwater strategy.
- Pursue funding through grants and partnerships and implement projects as funding becomes available.

Average Annual Cost: Up to $1.2 million, depending on projects pursued

Some of these costs may be offset through partnerships or state grant funding.

Imported Water to Groundwater Storage

- Complete projects underway to activate wells in Monk Hill subarea.
- Construct East-side Well Collector project.
- Negotiate use of storage accounts in with Raymond Basin Management Board.

Capital Cost: $12.6 million

Some of these costs may be offset by state or federal grant funding.

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