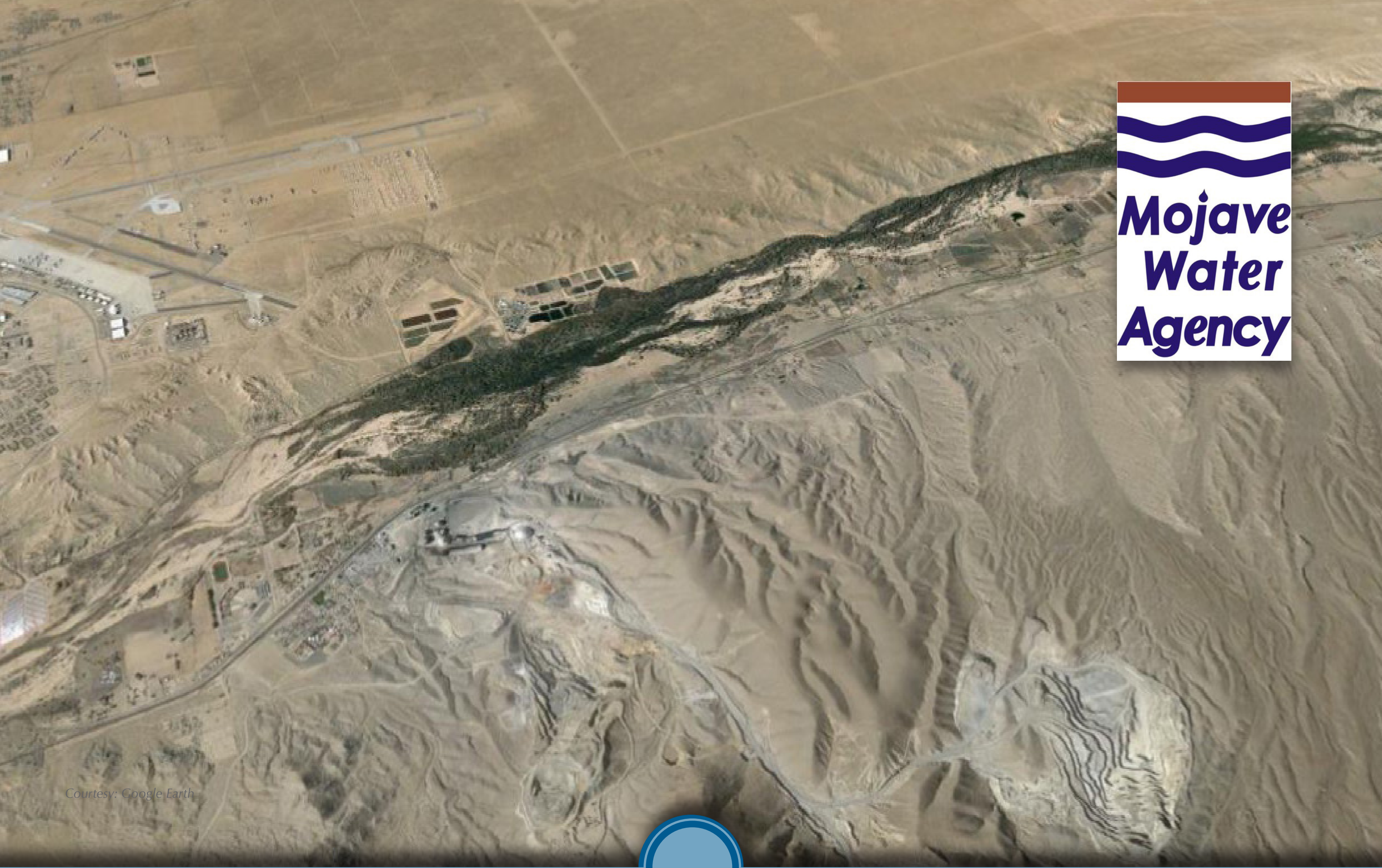


FINAL

2015 Urban Water Management Plan *for* Mojave Water Agency




Prepared by

Kennedy/Jenks Consultants

June 2016

Kennedy/Jenks Consultants

300 North Lake Avenue, Suite 1020
Pasadena, California 91101
626-568-4300
FAX: 626-683-8938

2015 Urban Water Management Plan

FINAL

Adopted
June 9, 2016

Prepared for

Mojave Water Agency
13846 Conference Center Drive
Apple Valley, California 92307

K/J Project No. 1544226*00

RESOLUTION NO. 1016-16

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE MOJAVE WATER AGENCY APPROVING THE 2015 URBAN WATER MANAGEMENT PLAN

The Board of Directors of the Mojave Water Agency hereby finds and declares as follows:

WHEREAS, Chapter 97 of Appendices to the Water Code ("MWA Law") enabled formation of the Mojave Water Agency, and prescribes the powers and duties of the MWA; and,

WHEREAS, Section 15 (a) of said Chapter 97 declares that "The Agency may do any and every act necessary so that sufficient water may be available for any present or future beneficial use or uses of the lands or inhabitants of the agency including without limiting the generality of the foregoing, irrigation, domestic, fire protection, municipal, commercial, industrial, and recreational uses."; and,

WHEREAS, Subsection (11) of Section 15 (b) of said Chapter 97 empowers the Agency "To gather data for, and to develop and implement, after consultation and coordination with all public and private water entities who are in any way affected, management and master plans to mitigate the cumulative overdraft of groundwater basins, to monitor the condition of the groundwater basins, to pursue all necessary water conservation measures, and to negotiate for additional water supplies from all federal, state and other sources."; and,

WHEREAS, the California Urban Water Management Planning Act requires a water supplier with over 3,000 customers or that supplies over 3,000 acre-feet of water per year to prepare an Urban Water Management Plan (UWMP) every 5 years ending in 0 and 5; and,

WHEREAS, in June of 2011, the Agency adopted a 2010 UWMP; and, WHEREAS, a 2015 UWMP was developed after extensive review and discussion with the Technical Advisory Committee to the Mojave Water Agency during five meetings, and reviewed and discussed with the Board of Directors during several meetings; and,

WHEREAS, a public hearing to receive comments on the 2015 UWMP has been duly publicly noticed and was conducted by this Board of Directors on May 26, 2016.

NOW THEREFORE, IT IS RESOLVED, that the Board of Directors hereby approves the "Mojave Water Agency 2015 Urban Water Management Plan."

ADOPTED this 9th day of June, 2016.

Beverly J Lowry

Beverly Lowry, President

ATTEST:

Doug Shumway, Secretary

Table of Contents

List of Tables

List of Figures

List of Appendices

G Ames Valley Basin Stipulation and Amended and Restated Judgment

H Mojave Water Agency Population Forecast, December 2015 (Beacon Report)

I Mojave Water Agency Ordinance No. 9

J Groundwater Management Plan

Executive Summary

This document presents the wholesale Urban Water Management Plan 2015 (Plan, UWMP) for the Mojave Water Agency (Agency, MWA) service area. A UWMP is a planning tool that generally guides the actions of water management agencies. It provides managers and the public with a broad perspective on a number of water supply issues.

The MWA was founded July 21, 1960, due to concerns over declining groundwater levels. The Agency was created for the explicit purpose of doing "*any and every act necessary, so that sufficient water may be available for any present or future beneficial use of the lands and inhabitants within the Agency's jurisdiction*."[1] The Mojave Water Agency is one of 29 State Water Project (SWP) contractors that together provide 25 million Californians with drinking water and irrigation water for 750,000 acres of farmland. MWA serves an area of 4,900 square miles of the High Desert in San Bernardino County as shown on the vicinity map on Figure 1-1.

It is the stated goal of MWA to manage water resources through or in conjunction with the State Water Project to meet future demands while maintaining independence during periods of water shortages. Based on conservative water supply and demand assumptions over the next 25 years and utilization of groundwater storage, the Plan successfully achieves this goal. It is important to note that this document has been completed to address regional resource management and does not address the particular conditions of any specific retail water agency or entity within the MWA service area. Retailers within the MWA service area are preparing their own separate UWMPs, and MWA has coordinated with the retailers during development of this Plan to ensure a level of consistency with the retailers.

Water Use

In order to provide water use projections, a projection of population in the service area is required. For the purposes of the UWMP, the UWMP Act provides the following direction (in California Code Section 10631):

"The projected population estimates shall be based upon data from the state, regional, or local service agency population projections within the service area of the urban water supplier."

To obtain an accurate population projection of the service area in compliance with the requirements of the UWMP Act, MWA contracted with Beacon Economics to provide a population forecast to calendar year 2060 for the MWA service area. The methodology utilizes an econometric approach, which incorporates population projection data from the California Department of Finance (DOF) and local economic factors. Their findings are summarized in Mojave Water Agency Population Forecast, December 2015, provided in Appendix H.

[1] MWA Law, Chapter 97-1.5, dated July 21, 1960.

Current and projected population estimates for the MWA service area are provided in Table ES- 1, categorized by Subarea. Overall population is estimated to grow approximately 33 percent by 2040, which equates to an annual growth rate of 1.6 percent.

Table ES- 1: Service Area Population Projections by Subarea

Subarea	2015	2020	2025	2030	2035	2040
Alto	346,665	371,356	407,344	449,520	493,686	535,002
Alto Transition Zone	24,364	26,132	28,465	31,413	34,616	37,663
Baja	4,762	4,812	4,872	4,933	4,989	5,036
Centro	35,524	36,393	37,322	38,248	39,125	39,943
Este	7,646	8,073	8,615	9,196	9,753	10,244
Oeste	11,299	12,406	13,864	15,504	17,152	18,667
Mojave Basin Area (MBA) Subtotal	430,260	459,172	500,482	548,814	599,321	646,555
Morongo	39,291	40,795	42,783	44,995	47,168	49,092
Total MWA Service Area	**469,551**	**499,967**	**543,265**	**593,809**	**646,489**	**695,647**

Source: Beacon Economics, Mojave Water Agency Population Forecast, December 2015

Predicting future water supply requires accurate historic water use patterns and water usage records. Figure ES- 1 illustrates the change in water demand since 2005. Local water demand has decreased throughout the service area in the last several years due to drought conditions, economic factors, conservation programs, land use changes, community awareness and local water restriction ordinances. These factors have resulted in changes in water use relative to historic use patterns.

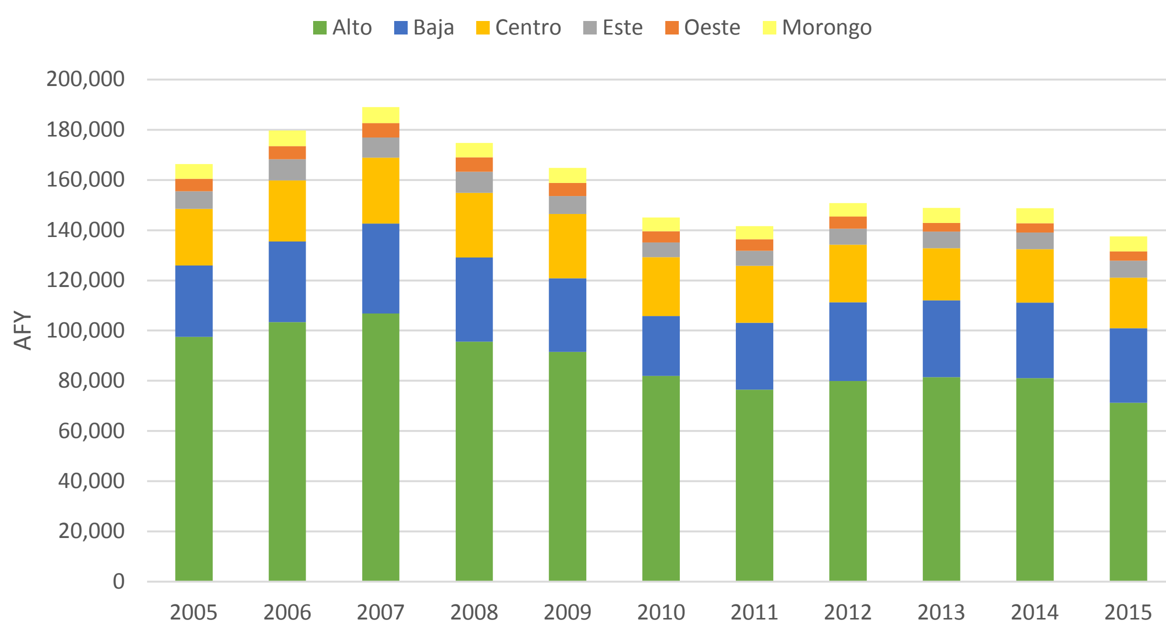


Figure ES- 1: Historical Water Demand by Subarea

Water use projections for the MWA service area, categorized by Subarea, are provided in Table ES- 2. Projected water demand is calculated by multiplying projected per capita water use by population projections (Mojave Water Agency Population Forecast, Beacon Economics December 2015). Per capita water use is projected to continue to decrease in the future due to active water savings, such as the 2014 State mandate for mandatory conservation, and passive water savings, such as building code requirements to utilize low-flow fixtures in indoor plumbing.

Table ES- 2: MWA Projected Water Demands by Subarea (AFY)

Subarea	2015	2020	2025	2030	2035	2040
Alto	71,300	80,346	84,767	90,163	95,747	100,823
Baja	29,700	29,700	29,700	29,700	29,700	29,700
Centro	20,100	20,576	20,555	20,551	20,557	20,549
Este	6,800	6,800	6,800	6,800	6,800	6,800
Oeste	3,600	4,002	4,236	4,517	4,796	5,061
MBA Subtotal	*131,500*	*141,424*	*146,058*	*151,731*	*157,600*	*162,933*
Morongo	6,509	6,942	7,128	7,349	7,564	7,767
Total	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**

Water Resources

The water resources available to MWA for the 25-year period covered by the Plan are summarized in Table ES- 3. Both currently available and planned supplies are discussed below.

Table ES- 3: Summary of Current and Planned Water Supplies (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Imported Supplies						
SWP [a]	53,196	55,676	55,676	55,676	55,676	55,676
Yuba Accord Water[b]	0	600	600	600	600	600
Local Supplies						
Net Natural Supply[c]	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow[d]	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import[e]	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[f]	0	0	0	0	0	0
Total Supplies	**161,143**	**168,781**	**170,896**	**173,482**	**176,152**	**178,582**
Projected Demand [g]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:

a) Assumes 62% of Table A amount based on the California Department of Water Resources State Water Project Final Delivery Capability Report 2015.
b) Refer to Section 3.2.2 for an explanation of this supply.
c) Refer to Section 3.3.1 for an explanation of this supply.
d) Refer to Section 3.3.2 for an explanation of this supply.
e) Refer to Section 3.3.3 for an explanation of this supply.
f) Groundwater banking (stored groundwater) would be used during dry year conditions as shown in Tables 6-4, 6-5, and 6-6. A portion of the stored water is surplus to that needed for dry years and SWP annual allocation variability. This stored water supply is described in Section 3.5.3 and could be made available for future supply in addition to the water supply shown in this table.
g) Refer to Section 2 for discussion of demand projections.
h) Unbalanced Exchange Agreements through 2020 are not included in the above table.

The MWA has four existing sources of water supply – SWP imports, natural local surface water flows, return flow from pumped groundwater not consumptively used, and wastewater imports from outside the MWA service area. In MWA's water use projection model, natural and SWP supply are expressed as an annual average, although both sources of supply vary significantly from year to year. Almost all of the water use within MWA is supplied by pumped groundwater. Natural surface supply, return flow, wastewater imports, and SWP imports recharge the groundwater basins; therefore, water management practices render the annual fluctuations in these sources of supply relatively unimportant for water supply planning.

Figure ES- 2 presents all available supplies compared with total demands through 2060. This is beyond the 25-year planning horizon included in this plan and projections beyond 2040 are for informational purposes only. The extended projection shows that existing and planned supplies are sufficient to meet project demands until 2055. It should be noted that return flow as a supply is shown to increase over time because it is a function of water demand.

Agricultural water demand within the service area, which is largely concentrated in the Baja area, is conservatively assumed to remain static in the future. It is difficult to predict water use patterns for agricultural users since their water use is largely impacted by market conditions that impact the type and timing of crops that are grown. However, it is likely that overall agricultural water use in the service area will decrease in the future due to the impact of the requirements of the Mojave River Basin Area Adjudication. If agricultural demand reduction is realized in the future, the sustainability of MWA's future water supplies will be extended even further.

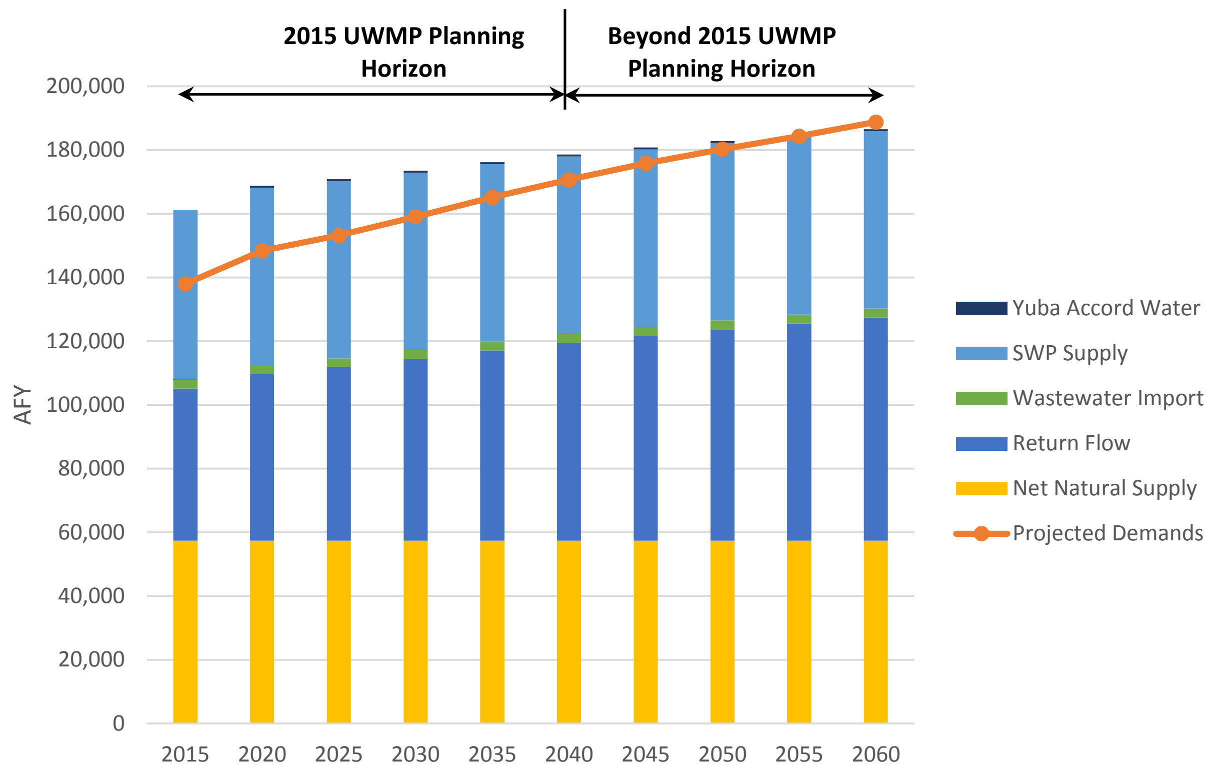


Figure ES- 2: Water Supplies versus Projected Demands Through 2060

Reliability Planning

The Act requires urban water suppliers to assess water supply reliability that compares total projected water use with the expected water supply over the next twenty years in five year increments. The Act also requires an assessment for a single-dry year and multiple-dry years.

Each water supply source has its own reliability characteristics. In any given year, the variability in weather patterns around the state may affect the availability of supplies to the MWA's service area differently. MWA's service area is typical in terms of water management in southern California; local groundwater supplies are used almost exclusively in the region. Imported water is recharged when available to sustain the local groundwater production. Local groundwater production is fairly consistent but availability of imported supplies is tied to annual climate conditions in northern California. This pattern of “conjunctive use” has been in effect since State Water Project (SWP) supplies first came to the MWA’s service area in 1978. SWP supplies have supplemented the overall supply of the MWA service area, which previously depended solely on local groundwater supplies.

To supplement these local groundwater supplies, MWA contracted with the California Department of Water Resources (DWR) for delivery of SWP water, providing an imported water supply to the groundwater basins. However, the variability in SWP supplies affects the ability of the Agency to meet the overall water supply needs for the service area. While each of the groundwater basin’s available supply sources have some variability, the variability in SWP supplies has the largest effect on overall annual supply reliability. This annual variability is mitigated through the use of the groundwater aquifer by pre-storing SWP water in the aquifer, when it is available.

Each SWP contractor’s Water Supply Contract contains a "Table A" amount that identifies the maximum amount of water that the contractor may request. However, the amount of SWP water actually allocated to contractors each year is dependent on a number of factors that can vary significantly from year to year. The primary factors affecting SWP supply availability include hydrologic conditions in northern California, the amount of water in SWP storage reservoirs at the beginning of the year, regulatory, environmental and operational constraints, and the total amount of water requested by the contractors. The availability of SWP supplies to MWA and the other SWP contractors is generally less than their full Table A amounts in many years and can be significantly less in very dry years, as shown in the last few years.

DWR prepares a biennial report to assist SWP contractors and local planners in assessing the near and long-term availability of supplies from the SWP. DWR issued its most recent update, the 2015 DWR State Water Project Delivery Capability Report (DCR), in July 2015. In the 2015 update, DWR provides SWP supply estimates for SWP contractors to use in their planning efforts, including for use in their 2015 UWMPs.

For this Plan, the availability of SWP supplies to MWA was estimated by multiplying MWA’s Table A amount (85,800 acre-feet per year (AFY) in 2015 and 89,800 in 2020) by the delivery percentages from the 2015 DCR, discussed below. The three hydrologic conditions required to be evaluated for all UWMPs include:

1) an average year condition,
2) a single-dry year condition, and
3) a multiple-dry year condition,

The delivery percentages used for SWP imported water for each of the above conditions were taken from the 2015 DCR based on the 82-year average, 1977, and the 1931-1934 average, for the average year, single-dry year, and multiple-dry year conditions, respectively. In addition, the delivery percentage for 2014, which is now the lowest historical single-dry year with an SWP allocation of five percent, is provided. The 2014 allocation is not incorporated in the 2015 DCR, but is anticipated to be included in the next update of the DCR. The delivery percentages and corresponding Table A deliveries available to MWA are provided in Table ES- 4.

Table ES- 4: Wholesale Supply Reliability – Single-Dry Year and Multiple-Dry Year Conditions

Wholesaler[(a)]	Average Year	Single-Dry Year (1977) [(b)]	Single-Dry Year (2014) [(c)]	Multiple-Dry Year[(d)]
California State Water Project (SWP)				
2015				
% of Table A Amount Available	62%	11%	5%	33%
Anticipated Deliveries (AFY)	53,196	9,438	4,290	28,314
2020				
% of Table A Amount Available	62%	11%	5%	33%
Anticipated Deliveries (AFY)	55,676	9,878	4,490	29,634

Notes:

(a) The percentages of Table A amount projected to be available are taken from Table 6-3 of the 2015 DCR. Supplies are calculated by multiplying MWA's Table A amount of 85,800 AF (2015) or 89,800 AF (2020) by these percentages. Maximum Table A amount is referenced from Department of Water Resources Bulletin 132.

(b) Based on the 2015 DCR historic single dry year of 1977.

(c) Based on worst-case single dry year of 2014, which is not captured in the 2015 DCR.

(d) Supplies shown are annual averages over four consecutive dry years, based on the worst-case historic four-year drought of 1931-1934. The allocation of each year is 33 percent.

Table ES- 5 summarizes MWA's water supplies available to meet demands over the 25-year planning period during an average/normal year. For SWP supplies it is 62 percent of Table A as the long-term average supply. As presented in the table, MWA's water supply is broken down by water supply sources, including wholesale (imported) water, local supplies, and groundwater banking projects.

Table ES- 6 summarizes the existing supplies available to meet demands for a 1977 single-dry year and Table ES- 7 summarizes existing supplies and demands for the 2014 single-dry year. Table ES- 8 summarizes the existing supplies available to meet demands during a multiple-dry year period.

As shown in the analyses above, MWA has adequate supplies to meet demands during average, single-dry, and multiple-dry years throughout the 25-year planning period.

Table ES- 5: Projected Average/Normal Year Supplies and Demand (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Wholesale (Imported)						
SWP[(a)]	53,196	55,676	55,676	55,676	55,676	55,676
Yuba Accord Water	0	600	600	600	600	600
Local Supplies[(b)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(c)]	0	0	0	0	0	0
Total Existing Supplies	**161,143**	**168,781**	**170,896**	**173,482**	**176,152**	**178,582**
Total Estimated Demands[(d)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:

(a) SWP supplies are calculated by multiplying MWA's Table A amount by the delivery percentage for a long-term average year, which is 62 percent. Sourced from the 2015 DCR.

(b) From Section 3 - Water Resources, Table 3-1.

(c) Not needed during average/normal years.

(d) See Section 2 - Water Use

Table ES- 6: Projected 1977 Single-Dry Year Supplies and Demand (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Wholesale (Imported)						
SWP[(a)]	9,438	9,878	9,878	9,878	9,878	9,878
Local Supplies[(b)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(c)]	20,624	25,983	28,688	31,995	35,410	38,516
Total Existing Supplies	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**
Total Estimated Demands[(d)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:

(a) SWP supplies are calculated by multiplying MWA's Table A amount by percentages of single-dry deliveries projected to be available for a single-dry year of 1977 (11%), taken from the 2015 DCR.

(b) From Section 3 - Water Resources, Table 3-1.

(c) Existing banked SWP water in MWA groundwater storage accounts (See Section 6.3.3 and Table 3-13). This does not include any retailers' stored water. Amounts reflect stored water needed to meet demand after all other supplies are used.

(d) See Section 2 - Water Use

Table ES- 7: Projected 2014 Single-Dry Year Supplies and Demand (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Wholesale (Imported)						
SWP[(a)]	4,290	4,490	4,490	4,490	4,490	4,490
Local Supplies[(b)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(c)]	25,772	31,371	34,076	37,383	40,798	43,904
Total Existing Supplies	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**
Total Estimated Demands[(d)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:

(a) SWP supplies are calculated by multiplying MWA's Table A amount by the delivery percentage of the historic dry year 2014, which is five percent. This year was not incorporated in the 2015 DCR.

(b) From Section 3 - Water Resources, Table 3-1.

(c) Existing banked SWP water in MWA groundwater storage accounts (See Section 6.3.3 and Table 3-13). This does not include any retailers' stored water. Amounts reflect stored water needed to meet demand after all other supplies are used.

(d) See Section 2 - Water Use

Table ES- 8: Projected Multiple-Dry Year Supplies and Demand (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Wholesale (Imported)						
SWP[(a)]	28,314	29,634	29,634	29,634	29,634	29,634
Local Supplies[(b)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(c)]	1,748	6,227	8,932	12,239	15,654	18,760
Total Existing Supplies	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**
Total Estimated Demands[(d)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:

(a) SWP supplies are calculated by multiplying MWA's Table A amount by the delivery percentage for a 4-year drought (1931-1934), which is 33 percent. Sourced from the 2015 DCR.

(b) From Section 3 - Water Resources, Table 3-1.

(c) Existing banked SWP water in MWA groundwater storage accounts (See Section 6.3.3 and Table 3-13). This does not include any retailers' stored water. Amounts reflect stored water needed to meet demand after all other supplies are used.

(d) See Section 2 - Water Use

Recycled Water

MWA understands that recycled water is an important component of achieving sustainable water supplies for the service area in the future. MWA has coordinated closely with the wastewater agencies within the service area in the past and will work closely with them in the future to best utilize the limited water resources available in the region. Although several agencies produce recycled water-quality effluent, only VVWRA and Victorville Water District utilize recycled water for direct use as power plant coolant and irrigation water. VVWRA is planning to utilize the recycled water produced at its two new water reclamation facilities for irrigation water. However, since the MWA service area is a closed basin, the remaining wastewater effluent is percolated to the groundwater basin, where it is eventually reused as groundwater.

In 2010, recycled water started being used by the VVWRA for the HDPP power plant cooling system and for irrigation at the Westwinds Golf Course. Table ES- 9 provides a summary of existing recycled water use.

Table ES- 9: Existing Recycled Water Uses

Type of Use	Treatment Level	Actual 2015 Use (AFY)
HDPP – cooling system	Disinfected tertiary	729
Landscape – golf course	Disinfected tertiary	141
Groundwater recharge[(a)]	Disinfected tertiary	12,926
	Total	**13,796**

(a) VVWRA and Victorville Water District discharge treated wastewater effluent to the Mojave River. 2015 use shown is for Water Year 2014-2015, which spans from October 2014 through September 2015. Source: Final Draft Twenty-Second Annual Report of the Mojave Basin Area Watermaster, Water Year 2014-15.

Many wastewater agencies within MWA's service area have completed planning documents for recycled water and determined potential users in their specific service area. As part of the UWMP requirements, the potential uses of recycled water need to be identified and listed. Therefore, the following list identifies the planned recycled water agency planning to develop recycled water and their proposed usage type.

- City of Adelanto - Reuse for landscape irrigation in schools and parks.
- City of Barstow - Reuse for landscape irrigation on the Sun Valley Golf Course.
- Victorville Water District - Reuse for landscape irrigation on golf course and cooling for power plant.
- VVWRA - Reuse for landscape irrigation on golf courses, parks, municipalities, and schools.
- Helendale CSD - Reuse for landscape irrigation in parks and groundwater recharge.
- MCLB – Reuse is for groundwater recharge.
- HDWD - Reuse is for groundwater recharge.

VVWRA is currently constructing the Apple Valley Subregional Water Reclamation Plant, which will provide one MGD of Title 22 recycled water. The Apple Valley Golf Course, public facilities, and parks will be the first users of the new system, utilizing recycled water for landscape irrigation. Eventually, it is anticipated that recycled water from the plant can be utilized for agricultural irrigation, construction, and other landscape irrigation.

Potential recycled water demand for the City of Hesperia is identified in the Recycled Water Master Plan Final Report, July 2008. Recycled water supply would be provided by the Hesperia Subregional Water Reclamation Plant, which is currently under construction by VVWRA. It is anticipated that the Hesperia Golf Course and Hesperia Civic Center will be the first users of the new recycled water supply, utilizing it for landscape irrigation.

Demand Management Measures

Conservation is a crucial element of MWA's water supply management program and therefore tracking the savings from conservation activities is an integral and evolving element of the program. Water savings are achieved through a combination of active (programmatic) and passive (foundational) programs. Active programs include incentives, conversions and retrofits and typically are measurable and quantifiable. Passive savings are a result of activities such as outreach, education, codes, regulations and standards — programs which are typically more challenging to quantify. In an attempt to measure program success and inform future planning, MWA monitors water use patterns and utilizes an analytic approach based on common assumptions and models.

Since 2000, per capita use has dropped by about 45 percent. There have been substantial reductions in per capita water use over the last two years due to the ongoing drought and the Governor's order for mandatory water consumption reductions. As described in Section 2, it is expected that per capita water use will decrease at a slower rate in the future due to both active and passive water conservation activities.

Population growth and per-capita municipal production volume data have been tracked and correlated with the implementation of the Alliance for Water Awareness and Conservation (AWAC) regional conservation activities starting in August 2003. Figure ES-3 shows historical population growth and per capita water use for the MWA service area. Since 2000, population within the MWA service area has grown 46 percent, while per capita water use has decreased 45 percent.

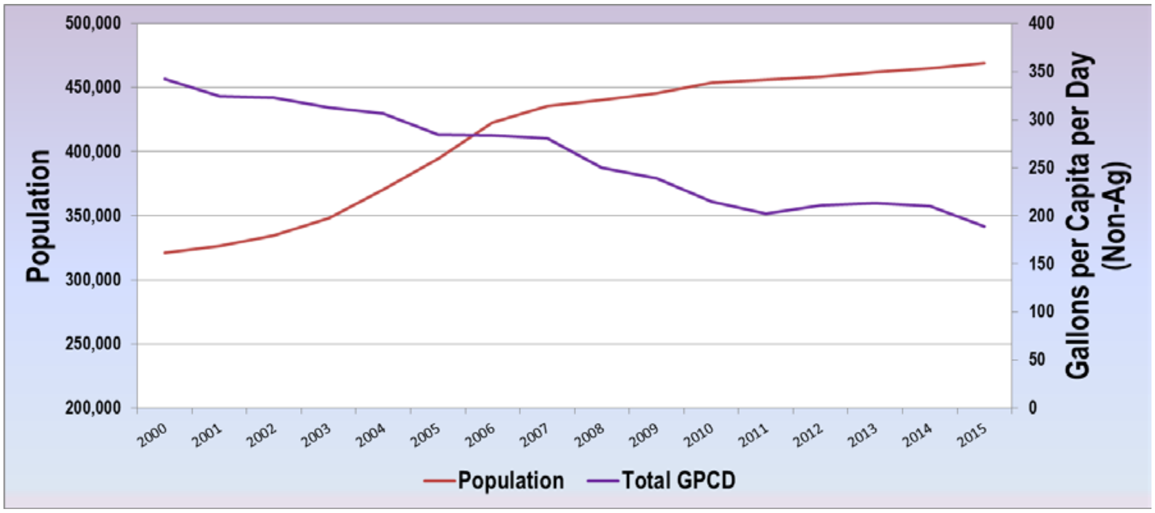


Figure ES- 3: Historical Population Growth and Urban Per Capita Water Use

Water Shortage Contingency Planning

Water supplies may be interrupted or reduced significantly in a number of ways, such as a drought that limits supplies, an earthquake that damages water delivery or storage facilities, a regional power outage, storm flood damage, environmental restrictions, or a toxic spill that affects water quality.

Cities and water agencies within MWA rely on large groundwater basins to meet potable water supply needs. Over the last decade, the Agency invested in water purchases from the State Water Project to pre-store water in order to have it available during times of drought. There is currently over 100,000 AF stored in areas of the basin where pumping exceeds the natural supply. During previous drought periods, municipal water suppliers continued to draft from these basins to meet customer needs without the need to impose restrictions on water use, but at rates exceeding natural replenishment in most areas. Large groundwater basins in the region serve as reservoirs and buffer the impacts of seasonal and year-to-year variations in precipitation and imported and natural surface water deliveries. This has been demonstrated during the recent drought, as groundwater supply was available to meet demands. In addition, the retailers have complied with the Governor's emergency order requiring mandatory conservation actions statewide. The area aquifers are either currently in balance or expected to be in balance in the near future due to the combination of water imports, State-mandated conservation requirements, and/or court ordered production "ramp-down." During multiple-year droughts or State Water Project outages, adequate groundwater supplies will be available to meet demands through the use of conjunctively banked pre-stored imported water.

Section 1: Introduction

1.1 Overview

This document presents the wholesale Urban Water Management Plan 2015 (Plan) for the Mojave Water Agency (Agency, MWA) service area. This chapter describes the general purpose of the Plan, discusses Plan implementation, and provides general information about MWA, retail water purveyors, and service area characteristics. A list of acronyms and abbreviations is also provided.

1.2 Purpose

An Urban Water Management Plan (UWMP) is a planning tool that generally guides the actions of water management agencies. It provides managers and the public with a broad perspective on a number of water supply issues. It is not a substitute for project-specific planning documents, nor was it intended to be when mandated by the State Legislature. For example, the Legislature mandated that a plan include a Section which "describes the opportunities for exchanges or water transfers on a short-term or long-term basis." (California Urban Water Management Planning Act, Article 2, Section 10630(d).) The identification of such opportunities, and the inclusion of those opportunities in a general water service reliability analysis, neither commits a water management agency to pursue a particular water exchange/transfer opportunity, nor precludes a water management agency from exploring exchange/transfer opportunities not identified in the plan. When specific projects are chosen to be implemented, detailed project plans are developed, environmental analysis, if required, is prepared, and financial and operational plans are detailed.

In short, this Plan is a management tool, providing a framework for action, but not functioning as a detailed project development or action. It is important that this Plan be viewed as a long-term, general planning document, rather than as an exact blueprint for supply and demand management. Water management in California is not a matter of certainty, and planning projections may change in response to a number of factors. From this perspective, it is appropriate to look at the Plan as a general planning framework, not a specific action plan. It is an effort to generally answer a series of planning questions including:

- What are the potential sources of supply and what is the reasonable probable yield from them?
- What is the probable demand, given a reasonable set of assumptions about growth and implementation of good water management practices?
- How well do supply and demand figures match up, assuming that the various probable supplies will be pursued by the implementing agency?

Using these "framework" questions and resulting answers, the implementing agency will pursue feasible and cost-effective options and opportunities to meet demands. MWA will explore enhancing basic supplies from traditional sources such as the State Water Project (SWP) as well as other options.

The California Urban Water Management Planning Act (Act) requires preparation of a plan that:

- Accomplishes water supply planning over a 20-year period in five year increments. (MWA and the retailers are going beyond the requirements of the Act by developing a plan which spans 45 years.)
- Identifies and quantifies adequate water supplies, including recycled water, for existing and future demands, in normal, single-dry, and multiple-dry years.
- Implements conservation and efficient use of urban water supplies. Significant new requirements for quantified demand reductions have been added by the enactment of SBX7-7, which amends the Act.

A checklist to ensure compliance of this Plan with the Act requirements is provided in Appendix A. A copy of the required standardized data tables is provided as Appendix B.

In short, the Plan answers the question: *Will there be enough water to sustain the communities within the Mojave Water Agency in future years? It also addresses what mix of programs should be explored for making this water available, and sets a framework for discussion of the priority of these programs.*

It is the stated goal of MWA to manage water resources through or in conjunction with the State Water Project to meet future demands while maintaining independence during periods of water shortages. Based on conservative water supply and demand assumptions over the next 25 years and utilization of groundwater storage, the Plan successfully achieves this goal. It is important to note that this document has been completed to address regional resource management and does not address the particular conditions of any specific retail water agency or entity within the MWA service area. Retailers within the MWA service area are preparing their own separate UWMPs, and MWA has coordinated with the retailers during development of this Plan to ensure a level of consistency with the retailers.

1.3 Implementation of the Plan

The MWA service area includes the service areas of forty-five (45) local retail water agencies, with ten being required to prepare an individual UWMP because they provide water to more than 3,000 service connections or supply more than 3,000 acre-feet (AF) of water annually. The ten retail water purveyors within MWA's service area that are required to prepare their own UWMP are as follows:

- City of Adelanto
- Liberty Utilities (Apple Valley Ranchos Water) Corp.
- San Bernardino County Service Area (CSA) 64
- San Bernardino County Service Area (CSA) 70J
- Golden State Water Company (GSWC) – Barstow System
- Hesperia Water District
- Hi-Desert Water District

- Joshua Basin Water District
- Phelan Piñon Hills Community Services District (PPHCSD)
- Victorville Water District

This subsection provides the cooperative framework within which the Plan will be implemented including agency coordination, public outreach, and resource maximization.

1.3.1 Cooperative Preparation of the Plan

Wholesale water agencies are permitted by the State to either work independently to develop a wholesale UWMP or they can coordinate their planning with retail agencies within their service area to develop a cooperative regional plan. The former approach has been adopted by the MWA; however, the Plan was developed with a high degree of coordination with the retail water agencies within the MWA service area. Water resource specialists with expertise in water resource management were retained to assist the local water agencies in preparing the details of their Plans. Agency coordination for this Plan is summarized in Table 1-1.

Table 1-1: Agency Coordination Summary

	Participated in UWMP Development	Received Copy of Draft	Comment on Draft	Attended Public Meetings	Contacted for Assist	Sent Notice of Intent to Adopt
City of Adelanto	✓	✓		✓	✓	✓
Liberty Utilities (Apple Valley Ranchos Water) Corp.	✓	✓		✓	✓	✓
California Department of Water Resources		✓				✓
County Service Area (CSA) 64	✓	✓		✓	✓	✓
CSA 70J	✓	✓		✓	✓	✓
Golden State Water Company (City of Barstow)	✓	✓	✓	✓	✓	✓
Hesperia Water District	✓	✓	✓	✓	✓	✓
Hi-Desert Water District	✓	✓		✓	✓	✓
Joshua Basin Water District	✓	✓		✓	✓	✓
Local Agency Formation Commission (LAFCO) for San Bernardino County		✓	✓			✓
Phelan Piñon Hills CSD	✓	✓	✓	✓	✓	✓
San Bernardino County Planning Department		✓				✓
Town of Apple Valley		✓	✓		✓	✓
Victorville Water District	✓	✓		✓	✓	✓

1.3.2 Plan Adoption

MWA began preparation of this Plan for the MWA service area in June 2015. The final draft of the Plan was adopted by the Agency Board in June 2016 and submitted to DWR within 30 days of Board approval, to meet the legislated July 1, 2016 due date. This Plan includes all information necessary to meet the requirements of Water Conservation Act of 2009 (Wat. Code, §§ 10608.12-10608.64) and the Urban Water Management Planning Act (Wat. Code, §§ 10610-10656).

1.3.3 Public Outreach

The MWA has encouraged community participation in water planning. For the current Plan, public sessions were held for review and to solicit input on the Draft Plan before its adoption. Interested groups were informed about the development of the Plan along with the schedule of public activities. Notices of the Public Hearing were published in the local press. Copies of the Draft Plan were made available at the water agencies' offices, local public libraries and sent to the County of San Bernardino as well as interested parties.

MWA coordinated the preparation of this Plan with the local community. MWA notified the cities and counties within its service area of the opportunity to provide input regarding the Plan. Bi-monthly Technical Advisory Committee (TAC) meetings were held at MWA between August 2015 and April 2016, where the retail purveyors and other public entities were invited to hear discussions on the development, status, and progress of MWA's 2015 UWMP. Table 1-2 presents a timeline for public participation during the development of the Plan. A copy of the public outreach materials, including paid advertisements, newsletter covers, website postings, and invitation letters are attached in Appendix C.

Table 1-2: Public Participation Timeline

Date	Event	Description
July 30, 2015	Community Kickoff Meeting	Describe UWMP requirements and process
December 17, 2015	TAC Meeting	UWMP progress update
February 4, 2016	TAC Meeting	UWMP progress update
February 26, 2016	Draft Sections 1 & 8	Released a draft of Sections 1 & 8 to retail purveyors for review
March 7, 2016	Draft Section 5	Released a draft of Section 5 to retail purveyors for review
March 17, 2016	Draft Section 6	Released a draft of Section 6 to retail purveyors for review
April 7, 2016	Public Workshop	UWMP review of supplies, demands, and reliability
April 8, 2016	Draft Sections 2 & 3	Released a draft of Sections 2 & 3 to retail purveyors for review
April 13, 2016	High Desert Water Summit	Overview of UWMP process and review of projected supplies & demands
April 18, 2016	Draft Sections 4 & 7	Released a draft of Sections 4 & 7 to retail purveyors for review
May 12, 2016	UWMP Public Draft	Released a draft of the UWMP to the public for review
May 26, 2016	Public Hearing	Public hearing for UWMP
June 9, 2016	UWMP Adoption	Board of Directors adoption of UWMP

The components of public participation include:

Local Media

- Paid advertisements in local newspapers

Community-based Outreach

- High Desert Water Summit

Water Agencies Public Participation

- Presentation(s) to MWA Board and Technical Advisory Committee – see Table 1-2
- Coordination with retail purveyors on population and demand projections
- Draft sections of UWMP sent to retail purveyors for review – see Table 1-2

City/County and Other Government Outreach

- Notice sent to various Local, County, State, and Federal agencies

Public Availability of Documents

- Mojave Water Agency website
- Local libraries

1.3.4 Resource Maximization

MWA completed a final version of an Integrated Regional Water Management Plan in June 2014, which provides a roadway for the agency and the retailers in its service area to maximize use of available water resources, minimize reliance on imported water, and promote long-term sustainability for the region. The plan identifies several resource management strategies to meet these goals, some of which are discussed in this report. A summary of resource management objectives derived out of the Integrated Regional Water Management Plan process are summarized in Section 3.6.

1.4 Water Management within the MWA Service Area

1.4.1 Mojave Water Agency

The MWA was founded July 21, 1960, due to concerns over declining groundwater levels. The Agency was created for the explicit purpose of doing "*any and every act necessary, so that sufficient water may be available for any present or future beneficial use of the lands and inhabitants within the Agency's jurisdiction*."[2] The Mojave Water Agency is one of 29 State Water Project (SWP) contractors that together provide 25 million Californians with drinking water and irrigation water for 750,000 acres of farmland. MWA serves an area of 4,900 square miles of the High Desert in San Bernardino County as shown on the vicinity map on Figure 1-1.

MWA's sphere of influence is shown in Figure 1-2. There are two areas within MWA's sphere, but not currently within its service area. One is the Wrightwood community adjacent to the southwest corner of MWA's service area, which is currently served by

---

[2] MWA Law, Chapter 97-1.5, dated July 21, 1960.

Golden State Water Company. The other area is located around the Grass Valley Creek, which is a tributary to the Mojave River. These areas are part of the headwaters connected to groundwater basins that are part of the Mojave River Basin Area Adjudication, which is described in Section 1.4.2. The Watermaster coordinates with entities within the sphere of influence to ensure established water supplies into the basins are maintained.

For management purposes, the Mojave Water Agency generally separates its service area into six management areas, including the five Subareas of the adjudicated Mojave Basin Area (Alto, Baja, Centro, Este, and Oeste) and the Morongo Basin/Johnson Valley Area (referred to throughout this document as "Morongo" or the "Morongo Area"). Section 1.4.2 describes the adjudications within the MWA, and Figure 1-3 depicts the management areas and adjudicated areas within the MWA.

SWP water is important supplemental water supply source for the MWA service area. MWA currently has a contract for up to 85,800 acre-feet per year (AFY) of "Table A" (a schedule of the maximum amount of water any SWP contractor can receive annually according to its contract with the state) water from the SWP through 2019, with an additional 4,000 AFY in 2020, for a total of 89,800 AF. Based on DWR's hydrological modeling (CalSim II) under existing conditions, the long-term average SWP supply is estimated to be 62 percent of total Table A[3], which results in an average availably SWP supply of 53,196 AFY for 2015 through 2019, and 55,676 AFY for 2020 and beyond. See Section 3.2.1 for more details. In addition the Agency has a contractual amount for 2016 to 2020 of approximately 600 AF/year of water from Yuba Water Agency. This amount can be greater than or less depending on hydrology. This agreement has been extended in the past and we have every reason to expect it to be extended in the future.

[3] DWR, The State Water Project Final Delivery Capability Report 2015, July 2015.

Figure 1-1: MWA Vicinity Map

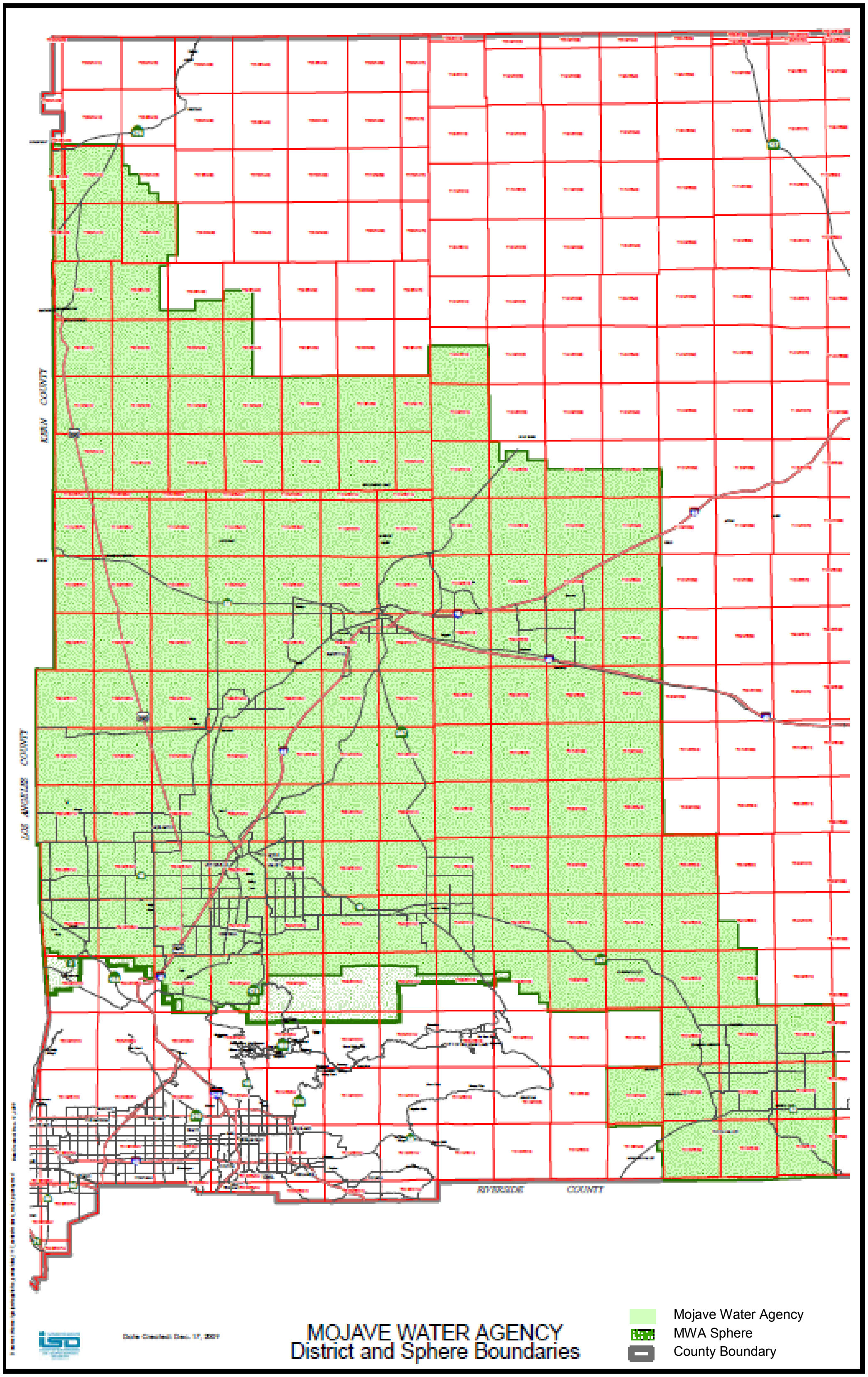


Figure 1-2: MWA Sphere of Influence

1.4.2 Adjudications within the MWA Service Area

Mojave Basin Area

The Adjudication of the Mojave Basin Area (see Figure 1-3) was the legal process that allocated the right to produce water from the available natural water supply. Until adjudication proceedings were initiated and an independent Court issued the Mojave Basin Area Judgment, water production rights and obligations had never been defined in the Mojave Basin. Triggered by the rapid growth within the Mojave Water Agency service area, particularly in the Victor Valley area (the cities of Adelanto, Apple Valley, Hesperia, Victorville and surrounding communities), the City of Barstow and the Southern California Water Company filed a complaint in 1990 against upstream water users claiming that the increased withdrawals and lowering of groundwater levels reduced the amount of natural water available to downstream users. The complaint requested that 30,000 acre-feet of water be made available to the Barstow area annually and that MWA obtain supplemental water for use in other areas of MWA's service area.

About a year later, the Mojave Water Agency filed a cross-complaint that declared that the native waters of the Mojave River and underlying groundwater were insufficient to meet the current and future demands made upon them. The cross-complaint asked the court to determine the water rights of all surface water and groundwater users within the Mojave Basin Area and the Lucerne and El Mirage Basins. During the following two years, negotiations resulted in a proposed Stipulated Judgment that: 1) formed a minimal class of producers using 10 acre-feet or less per year who were dismissed from the litigation, and 2) offered a physical solution (an equitable remedy designed to alleviate overdrafts in a basin, consistent with the constitutional mandate to prevent waste and unreasonable water use and to maximize the beneficial use of the limited resource) for water production by the remaining producers. The Riverside Superior Court bound the stipulating parties to the Stipulated Judgment in September 1993, and further bound the non-stipulating parties to the terms of the Stipulated Judgment in January 1996 following trial. The Court appointed MWA as Watermaster of the Mojave Basin Area. The text of the Stipulated Judgment can be found in Appendix E.

Some of the non-stipulating parties appealed the Judgment of the Superior Court and the Appellate Court issued a final decision in June 1998. The final decision of the Appellate Court held the stipulating parties to the terms of the Stipulated Judgment, but excluded the appealing parties, with the exception of one appellant who sought a revised water production right under the Judgment. MWA requested the California Supreme Court to review the Appellate Court's decision in July 1998. The Supreme Court affirmed the Appellate Court's decision in August 2000, regarding the Stipulated Judgment and the exclusion of the appealing parties from the Judgment, but overturned the decision of the Appeals Court as to the one party seeking additional production rights. Since 1996, most of the appealing parties have stipulated to the Judgment.

For management purposes under the Mojave Basin Judgment, MWA split the Mojave River watershed and associated groundwater basins into five separate "Subareas." The locations of the five Subareas; 1) Oeste, 2) Este, 3) Alto, 4) Centro and 5) Baja are shown on Figure 1-3. The Subarea boundaries are generally based on hydrologic divisions defined in previous studies (California Department of Water Resources (DWR) 1967), evolving over time based on a combination of hydrologic, geologic, engineering and political considerations. Also for the purposes of implementing the Judgment, the northern part of the Alto Subarea was defined as a sub-management unit – the Alto Transition

Zone; this zone was created to acknowledge local geology and to better understand the water flow from Alto to Centro.

The Mojave Basin Judgment assigned Base Annual Production (BAP) rights to each producer using 10 acre-feet or more, based on historical production during the period 1986-1990. Parties to the Judgment are assigned a variable Free Production Allowance (FPA), which is a percentage of the BAP set for each Subarea each year by the Watermaster. The BAP is reduced or "ramped-down" over time until FPA comes within 5 percent of the Production Safe Yield (PSY) as defined by the Judgment. The FPA is set as follows for each Subarea for water year 2015-2016:

- Alto Subarea - 80 percent of BAP for agriculture and 60 percent of BAP for municipal and industrial
- Oeste Subarea - 80 percent of BAP for agriculture and 60 percent of BAP for municipal and industrial (currently held in abeyance at 80 percent)
- Este Subarea - 80 percent of BAP
- Centro Subarea - 80 percent of BAP
- Baja Subarea – 50 percent of BAP

Any Producer that pumps more than their FPA must purchase Replacement Water from the Watermaster equal to the amount of production in excess of their total available FPA, or transfer unused FPA from another party within their Subarea. Funds collected for Replacement Water are then used by the MWA for purchase of SWP supplies and recharged into the Subarea they were produced from.

Warren Valley Basin

The Warren Valley Basin adjudicated area is located within the Morongo Basin/Johnson Valley Area ("Morongo"). Groundwater from the Warren Valley Basin is used to supply the Town of Yucca Valley and its environs. Extractions from the Warren Valley Basin began exceeding supply in the 1950s. The progressively increasing overdraft led to adjudication of the Warren Valley Basin in 1977. In its Warren Valley Judgment, the court appointed the Hi-Desert Water District (HDWD) as Watermaster and ordered it to develop a physical solution for halting overdraft. Objectives identified by the Watermaster Board included managing extractions, importing water supplies, conserving stormwater, encouragement of conservation and reclamation, and protecting groundwater quality. A Basin Management Plan was adopted that called for importing SWP water from MWA through the then-proposed Morongo Basin Pipeline to balance demand and replenish past overdraft. The text of the Warren Valley Judgment can be found in Appendix F.

Ames Valley Basin

Although the Ames Valley Basin is not fully adjudicated, a legal agreement has been in place since 1991 with the execution of the Ames Valley Basin Water Agreement between HDWD and Bighorn-Desert View Water Agency (BDVWA) for the construction and operation of the HDWD Mainstream Well in the Ames Valley Basin. At the time the Agreement was entered, the HDWD service area included areas within the Ames Valley Basin and the Warren Valley Basin. The 1991 agreement was superseded in 2014 with the Ames/Reche Groundwater Storage and Recovery Program and Management Agreement. The Ames/Reche Groundwater Storage and Recovery Program was established by area partners Bighorn-Desert View Water Agency, Hi-Desert Water District, County of San Bernardino Service Areas 70 W-1 and 70 W-4, with MWA providing administrative support. The Stipulation and Amended and Restated Judgment was finalized by the Superior Court of the State of California, County of Riverside on September 17, 2014. The Ames/Reche Management Area encompasses roughly 95 square miles and includes the communities of Flamingo Heights, Landers, Yucca Mesa, and Pioneertown. The text of the Stipulation and Amended and Restated Judgment can be found in Appendix G.

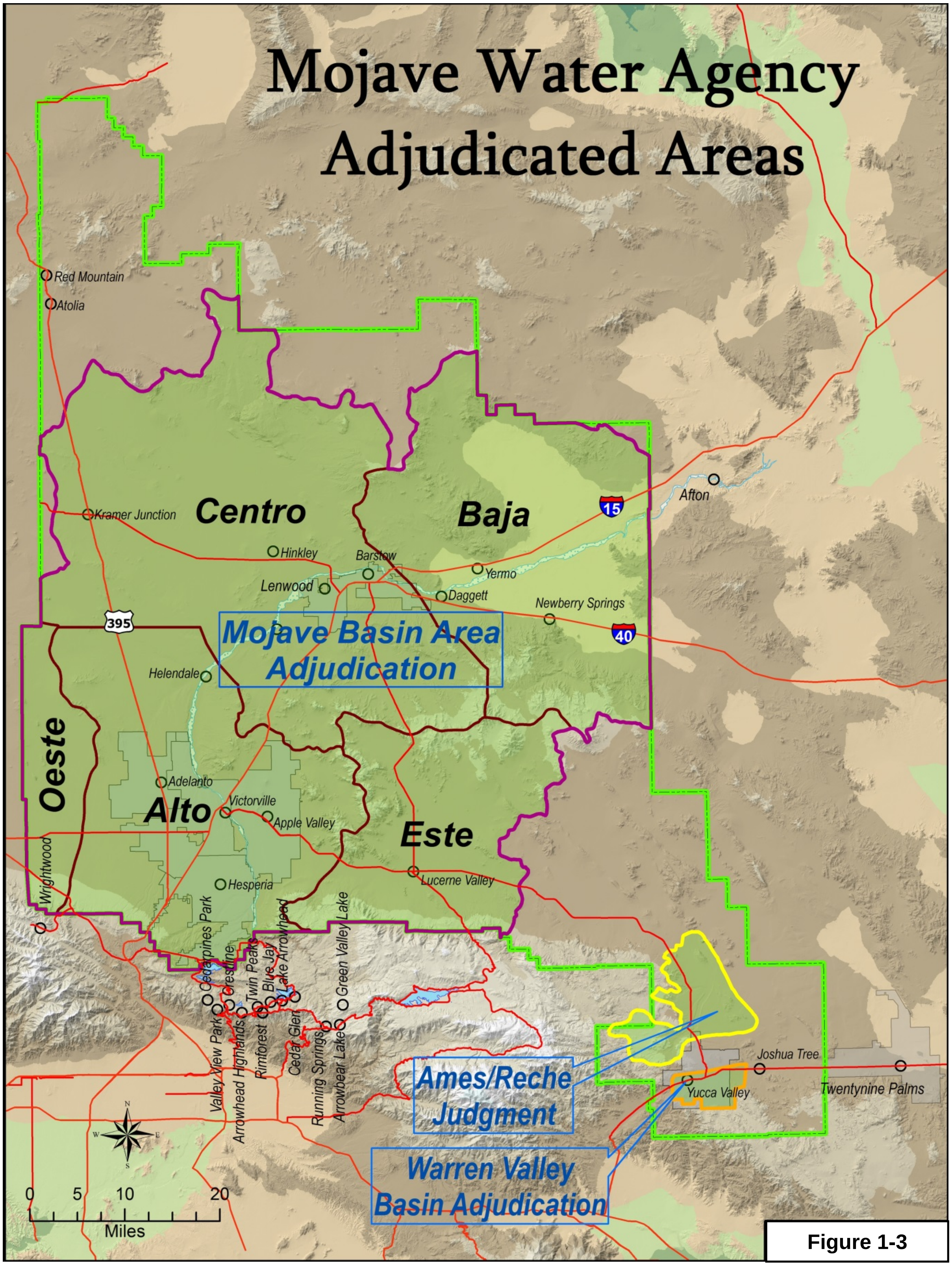


Figure 1-3: MWA Adjudicated Boundary and Subareas

1.4.3 Retail Water Purveyors

Ten retail purveyors provide water service to most residents within the MWA service area. All the retailers listed below, except those noted, supply water to their customers from local groundwater, which is replenished by MWA imported water.

- City of Adelanto's Water Department provides water service to the residents of Adelanto, which encompasses an area of approximately 53 square miles.

- Liberty Utilities (Apple Valley Ranchos Water) Corp. (LU) service area covers approximately 51 square miles within Apple Valley and portions of the unincorporated area of San Bernardino County.

- CSA 64's service area includes the Spring Valley Lake community, which encompasses approximately four square miles.

- CSA 70J's service area includes the Oak Hills community and covers approximately 28 square miles.

- Golden State Water Company's (GSWC) service area covers approximately 33 square miles in and around the City of Barstow.

- Hesperia Water District's service area includes the City of Hesperia, which encompasses approximately 78 square miles.

- Hi-Desert Water District's service area, which covers about 57 square miles, includes the Town of Yucca Valley and portions of the unincorporated area of San Bernardino County.

- Joshua Basin Water District's service area includes portions throughout a 97-square mile area between Yucca Valley, Twentynine Palms, Joshua Tree National Park and the Twentynine Palms Marine Corps Base.

- Phelan Piñon Hills CSD's service area includes approximately 118 square miles of unincorporated area located at the transition between the foothills of the San Gabriel Mountains and southwestern portion of the Mojave Desert.

- Victorville Water District serves the City of Victorville, which encompasses approximately 85 square miles.

The service areas of MWA and the retail water purveyors required to complete UWMPs are shown on Figure 1-4. As of 2009, the ten (10) large retail water purveyors served approximately 125,445 connections, as presented in Table 1-3.

Table 1-3: Retail Water Purveyors 2015 Service Area Information

Retail Water Purveyor	Service Area (sq. miles)	Connections
City of Adelanto	53	8,165
Liberty Utilities (Apple Valley Ranchos Water) Corp.	51	18,046
CSA 64	4	3,810
CSA 70J	28[(a)]	3,118
Golden State Water Company - Barstow	33	9,037
Hesperia Water District	78	26,370
Hi-Desert Water District	57	10,512
Joshua Basin Water District	97	4,493
Phelan Piñon Hills Community Services District (CSD)	118	6,794
Victorville Water District	85	35,100
Total		**125,445**

Source is DWR annual Public Water System Statistics records.
Notes:
(a) Estimated from GIS data.

1.5 Climate

A regional network of weather stations funded by MWA and various local and federal government agencies, and citizen observers, provides climate data throughout the watershed. Annual variations in evapotranspiration, precipitation and air temperature, for Victorville CA, are shown in Table 1-4. The regional Climate within the MWA service area varies considerably due to large geographic extent of the service area. Victorville is representative of the regional climate experienced by most of the population, although many areas of the service area are drier, windier, and subject to larger temperature variability.

Precipitation, temperature, and average evapotranspiration (ETo) data are reported in Table 1-4, as recorded at Victorville. Average rainfall within the lower lying areas of the Mojave Basin Area and Morongo Area is roughly five to seven inches per year. The large variation in annual rainfall within the surrounding mountains directly affects the annual water supply of the basin.

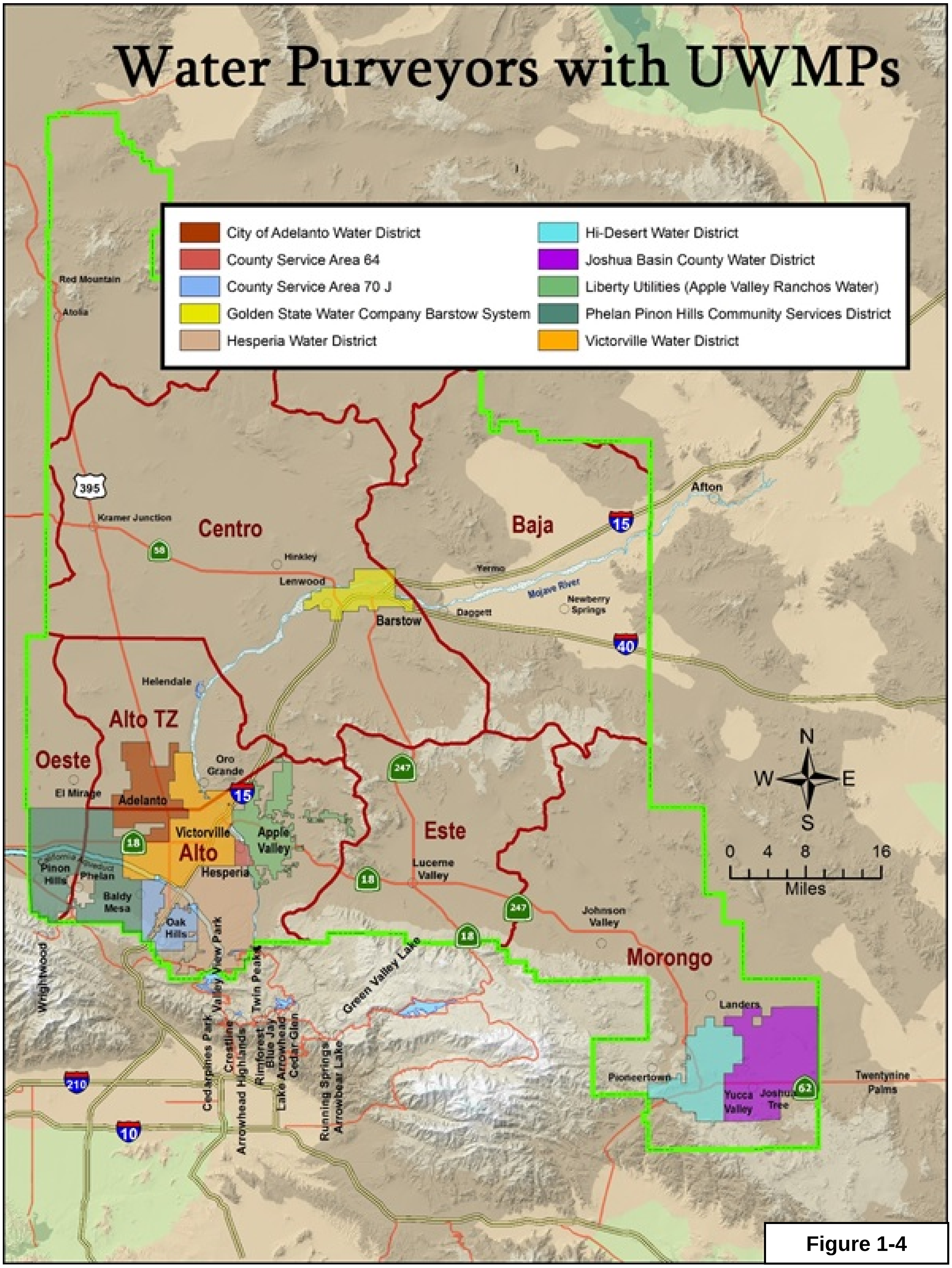


Figure 1-4: MWA Service Area and Large Retail Water Purveyors

Table 1-4: Climate Data for the Mojave Water Agency

	Victorville (Station 117)				
Station:	Total ETo (in)	Total Precipitation (in)	Avg Max. Air Temp. (F)	Avg Min. Air Temp. (F)	Avg Air Temp. (F)
1997	68.4	6.4	74.7	45.9	61.4
1998	62.0	11.4	71.2	44.2	58.3
1999	67.8	3.2	74.6	43.7	60.0
2000	68.4	3.4	75.1	45.3	61.2
2001	67.3	6.9	74.9	46.5	61.5
2002	69.6	2.4	75.5	44.8	61.0
2003	66.6	12.4	75.2	46.3	61.5
2004	66.2	13.6	74.1	45.4	60.6
2005	64.6	13.2	73.7	46.4	60.6
2006	68.1	4.1	74.6	45.2	60.8
2007	71.2	3.3	75.5	45.9	61.5
2008	68.7	3.7	75.1	46.0	61.3
2009	66.1	3.0	74.8	45.7	58.9
2010	66.2	18.9	73.2	45.4	59.9
2011	67.1	12.2	73.3	44.4	59.3
2012	70.2	5.0	76.4	46.9	62.1
2013	68.9	1.1	75.4	46.2	61.1
2014	67.7	1.5	77.4	48.1	63.3
2015	67.7	2.4	76.3	47.9	62.3
Avg	67.5	6.7	74.8	45.8	60.9

Source:
http://wwwcimis.water.ca.gov/Default.aspx

1.6 Potential Effects of Climate Change

DWR's California Water Plan Update 2013 (CWP) considers how climate change may affect water availability, water use, water quality, and the ecosystem.[4]

Volume 1, Chapter 5 of the California Water Plan, "Managing an Uncertain Future," evaluated how statewide and regional water demands that might change by 2050 in response to uncertainties both gradual and sudden. Gradual or long term factors include population growth, land use changes, and climate change. Sudden or short term changes include drought, flooding, earthquakes, the vulnerable condition of the Delta, fire, the economy, accidents, terrorist acts, and changes in policies, regulations, and laws. The uncertainties will play out differently across the regions of California. Each region will need to develop a portfolio of resource management strategies that consider regional water-management challenges and can be implemented to address regional issues.

[4] California Water Plan Update 2013 Investing in Innovation & Infrastructure: Bulletin 160-13.

The effects of climate change may increase the occurrence of droughts and floods. The 2015 Delivery Capability Report[5] was released by the State of California Natural Resources Agency Department of Water Resources to inform the public about the capabilities and operation of the SWP in the face of such uncertainties. Delta risk management and anticipation of sea level rise are among the policies and planning efforts regarding climate change.

MWA prepared a Climate Change Assessment as part of the Mojave Integrated Regional Water Management Plan, Final June 2014 Report, which describes the potential effects of climate change (changes in temperature and precipitation), the region's vulnerability to climate change, and potential strategies for adapting to climate change. Much of the assessment was based on the *Mojave River Watershed Climate Change Assessment,* which was a 2013 report published by the Technical Service Center of the US Bureau of Reclamation (USBR), in partnership with MWA. The analysis consisted of three tasks: (1) assess future surface water supplies, including native flows and imports; (2) project potential changes in flood frequency, and (3) conduct a GHG emissions inventory for the water sector.

1.7 Other Demographic Factors

The past several years have been marked by both an economic recession and drought conditions in California, which have combined to substantially reduce water consumption in the MWA service area. The Governor issued an Executive Order in 2015 for mandatory water conservation calling for a 25 percent reduction in water consumption across the state in response to the severity of the drought.

It is anticipated that per capita water consumption will continue to decrease in the future, even with an economic recovery. This is due to the actions taken by local and state water agencies in response to the drought and the Governor's mandate, which are anticipated to remain in place moving into the future, as well as passive savings that will be realized through legislated codes, fixture and appliance standards, ordinances and education coupled with changing water use habits. Overall water consumption may stay relatively flat in the future as lower per capita water consumption is offset by increased population and economic activity.

1.8 List of Abbreviations and Acronyms

The following abbreviations and acronyms are used in this report.

AB	Assembly Bill
ACOE	US Army Corps of Engineers
Act	California Urban Water Management Planning Act
AF	acre-feet
AFY	acre-feet per year
AVEK	Antelope Valley-East Kern Water Agency

[5] State Water Project Final Delivery Capability Report, 2015 - State of California Natural Resources Agency Department of Water Resources

AWAC	Alliance for Water Awareness and Conservation
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
BAP	Base Annual Production
BBARWA	Big Bear Area Regional Wastewater Agency
BDCP	Bay Delta Conservation Plan
BDVWA	Bighorn-Desert View Water Agency
BMOs	Basin Management Objectives
BMPs	Best Management Practices
CCF	One Hundred Cubic Feet
CCR	Consumer Confidence Report or California Code of Regulations
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
CERCLA Act	Comprehensive Environmental Response, Compensation and Liability
CII	Commercial Industrial and Institutional
CIMIS	California Irrigation Management Information System
County	San Bernardino County
CSA	County Service Area
CSD	Community Services District
CUWCC	California Urban Water Conservation Council
CVP	Central Valley Project
CWRP	Cooperative Water Resources Program
CWP	California Water Plan
DBP	Disinfection by-products
DCR	DWR State Water Project Delivery Capability Report
Delta	Sacramento-San Joaquin Delta
DFW	California Department of Fish and Wildlife
DMM	Demand Management Measure
DOF	California Department of Finance
DPSG	Dr. Pepper Snapple Group
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EC	Electrical conductivity
Edison	Southern California Edison
EDU	Equivalent Dwelling Unit
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELT	Early Long Term scenario
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Institute
ETo	Evapotranspiration
FPA	Free Production Allowance
GIS	Geographic Information Systems

GPCD	gallons per capita per day
GPD	gallons per day
GPM	gallons per minute
GSWC	Golden State Water Company
GW	Groundwater
GWMP	Groundwater Management Plan
HDPP	High Desert Power Project
HDWD	Hi-Desert Water District
HECW	High efficiency clothes washer
HET	high efficiency toilet
JBWD	Joshua Basin Water District
LU	Liberty Utilities (Apple Valley Ranchos Water) Corp.
MAF	Million acre-feet
M&I	Municipal and Industrial
MCLs	Maximum Contaminant Levels
MCLB	Marine Corps Logistics Base
MBA	Mojave Basin Area
MBAW	Mojave Basin Area Watermaster
MEEC	Mojave Environmental Education Consortium
Metropolitan	Metropolitan Water District of Southern California
MFR	Multi-Family Residential
MGD	million gallons per day
mg/L	milligrams per liter
MP	Minimal Producers
Morongo	Morongo Basin/Johnson Valley Area
MOU	Memorandum of Understanding
MMRP	Mitigation, Monitoring and Reporting Program
MWA	Mojave Water Agency
MWQI	Municipal Water Quality Investigations
NPDES	National Pollutant Discharge Elimination System
NWIS	National Water Information System
PG&E	Pacific Gas and Electric
PID	Public Improvement District
Plan	Urban Water Management Plan 2015
PPHCSD	Phelan Piñon Hills Community Services District
PSY	Production Safe Yield
PUC	California Public Utilities Commission
PWSS	Public Water System Statistics
QWEL	Qualified Water Efficient Landscaper
R^3	Regional Recharge and Recovery Project
RAP	Remedial Action Plan
RO	Reverse Osmosis
RTP	Regional Transportation Plan
RWQCB	Regional Water Quality Control Board

SB	Senate Bill
SBX7-7	Senate Bill 7 of Special Extended Session 7
SD	Sanitation District
SCAG	Southern California Association of Governments
SCG	Southern California Gas
SCLA	Southern California Logistics Airport
SDD	Special Districts Department
SFR	Single Family Residential
SGMA	Sustainable Groundwater Management Act
SMCL	Secondary Maximum Contaminant Level
SNMP	Salt and Nutrient Management Plan
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TAZ	Traffic Analysis Zones
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
umhos/cm	Micromhos per centimeter
USBR	US Bureau of Reclamation
USGS	US Geological Survey
UWMP	Urban Water Management Plan
VVWRA	Victor Valley Wastewater Reclamation Authority
VWD	Victorville Water District
WBIC	Weather Based Irrigation Controller
WC	water conservation
WCIP	Water Conservation Incentive Program
WIRP	Water Infrastructure Restoration Program
WRF	Water Reclamation Facility
WRP	Wastewater Reclamation Plant
WWTP	Wastewater Treatment Plant

Section 2: Water Use

2.1 Overview

This chapter describes historic and current water usage and the methodology used to project future demands within the Mojave Water Agency's (MWA's) service area. Water usage is divided into sectors such as residential, industrial, institutional, landscape, agricultural, and other purposes.

2.2 Population

In order to provide water use projections, a projection of population in the service area is required. For the purposes of the UWMP, the UWMP Act provides the following direction (in California Code Section 10631):

"The projected population estimates shall be based upon data from the state, regional, or local service agency population projections within the service area of the urban water supplier."

To obtain an accurate population projection of the service area in compliance with the requirements of the UWMP Act, MWA contracted with Beacon Economics to provide a population forecast to calendar year 2060 for the MWA service area. The methodology utilizes an econometric approach, which incorporates population projection data from the California Department of Finance (DOF) and local economic factors. Their findings are summarized in Mojave Water Agency Population Forecast, December 2015, provided in Appendix H.

Beacon Economics forecast of the MWA service area and its incorporated cities, Subareas, and water purveyors is based on historic correlations with population trends in the surrounding area. MWA's service area is shown in Figure 1-4. A long-run driver of future population in the surrounding area was used to forecast population growth out to the year 2060. In the case of the incorporated portions of the MWA service area, historic population trends were correlated with population growth in San Bernardino County overall. In the case of the sub areas and water purveyors in unincorporated regions of the MWA service area, the historical population data was correlated with the nearest incorporated city.

Historical data used in the forecast of the incorporated cities were obtained from the California DOF, which makes estimates available from 1970 forward on an annual basis. With this data in hand, an econometric time series model was created to capture the historical correlations with countywide population growth. Future population growth for the incorporated cities of the MWA service area was then estimated using these historic correlations and a long-run driver of countywide population growth.

Population projections for San Bernardino County from the DOF were used as the long-run driver for the forecasts of incorporated cities. The DOF uses a baseline cohort-component method to produce their population projections out to the calendar year 2060. This method traces people born in a given year throughout their lives. As each year passes, cohorts change due to mortality and migration assumptions. Applying fertility assumptions to women of childbearing age forms new cohorts. Where possible, projected migration flows are evaluated in consultation with county planning agencies and Councils of Government, which contribute assessments of future migration and notable future developments for their jurisdictions. Where local input is not available, the migration assumptions are made by the DOF based on a historical analysis of the county's migration patterns.

Several Subareas and water purveyors in the MWA service area are closely associated with the boundaries of one or more incorporated cities. In these cases the forecasted population growth rates from the incorporated cities were applied to historical population counts for these areas to produce a forecast of future population. For Subareas or water purveyors in an unincorporated portion of the MWA service area, the historical correlations between the respective area and the nearest incorporated city were used to project future population growth. Due to the long-run nature of this forecast, DOF countywide population estimates were the primary driver of the estimates for future population in the MWA service area. Other factors, such as building permits or planned developments, were not used as they represent a very short term outlook and are not a driver of population growth in and of themselves. A forecast of long-run population growth carries with it the assumption that there will be sufficient residential development to accommodate future population growth.

It should be noted that long-run forecasts of any nature have a greater margin of error the longer the forecast time frame. Forecasts of one to two years can be quite accurate, whereas forecasts several years into the future are less likely to be as accurate. Several factors, most notably business cycle effects, can have strong impacts on population or other socioeconomic indicators, over the long run.

Current and projected population estimates for the MWA service area are provided in Table 2-1, categorized by Subarea. Overall population is estimated to grow approximately 33 percent by 2040, which equates to an annual growth rate of 1.6 percent. Population projections for large water purveyors within MWA's service area are provided in Table 2-2. Note that the table does not include small water purveyors that serve less than 3,000 AFY and have fewer than 3,000 connections, or private water users.

Table 2-1: MWA Service Area Current and Projected Population Estimates by Subarea

Subarea	2015	2020	2025	2030	2035	2040
Alto	346,665	371,356	407,344	449,520	493,686	535,002
Alto Transition Zone	24,364	26,132	28,465	31,413	34,616	37,663
Baja	4,762	4,812	4,872	4,933	4,989	5,036
Centro	35,524	36,393	37,322	38,248	39,125	39,943
Este	7,646	8,073	8,615	9,196	9,753	10,244
Oeste	11,299	12,406	13,864	15,504	17,152	18,667
Mojave Basin Area (MBA) Subtotal	430,260	459,172	500,482	548,814	599,321	646,555
Morongo	39,291	40,795	42,783	44,995	47,168	49,092
Total MWA Service Area	**469,551**	**499,967**	**543,265**	**593,809**	**646,489**	**695,647**

Source: Beacon Economics, Mojave Water Agency Population Forecast, December 2015

Table 2-2: Current and Projected Population Estimates by Large Purveyor

Agency	2015	2020	2025	2030	2035	2040
Liberty Utilities (Apple Valley Ranchos Water) Corp.	59,779	63,357	68,240	73,427	78,526	82,983
Bighorn-Desert View Water Agency	4,116	4,554	5,135	5,794	6,463	7,082
Adelanto, City of	33,080	35,476	38,453	42,221	46,311	50,182
County Service Area 64	9,541	10,267	11,205	12,236	13,246	14,156
County Service Area 70J	10,227	11,433	13,049	14,906	16,811	18,597
Golden State Water Company - Barstow System	31,261	31,951	32,684	33,412	34,096	34,732
Helendale Community Services District	6,535	7,090	7,812	8,613	9,407	10,127
Hesperia Water District	91,864	99,242	108,143	118,411	129,123	139,185
Hi-Desert Water District	24,520	25,548	26,911	28,435	29,939	31,276
Joshua Basin Water District	9,830	10,287	10,860	11,469	12,047	12,551
Phelan Piñon Hills Community Services District	20,814	23,009	25,919	29,219	32,561	35,655
Victorville Water District	128,005	139,151	155,167	172,144	188,896	204,986
Other Purveyors & Private Water Users	39,979	38,602	39,687	43,522	49,063	54,135
Total	**469,551**	**499,967**	**543,265**	**593,809**	**646,489**	**695,647**

Source: Beacon Economics, Mojave Water Agency Population Forecast, December 2015
Note: Some small water purveyors and private water users are not included in Table 2-2 (by purveyor) but have been included in the regional Sub-Area population estimates in Table 2-1.

San Bernardino County and the broader Inland Empire region are anticipated to see more population growth in the near term than the coastal regions of southern California, and in the longer run, it is anticipated that the MWA service area will see even stronger population growth. As housing has become more unaffordable in the coastal counties of Los Angeles, Orange, and San Diego, the Inland Empire has been a destination of choice for many residents willing to commute to those areas.

This has boosted economic activity within the Inland Empire as these commuters spend their wages locally, creating a positive feedback effect which drives further growth and attracts more residents to the area. The MWA service area is, in terms of housing prices, even more affordable than other parts of San Bernardino County, and it is expected that these dynamics will help drive future population growth above and beyond growth in the County overall.

In comparison to other planning agencies' population projections for the MWA service area, such as those published by the San Bernardino Associated Governments, the projection provided by Beacon Economics shows greater population growth through 2040, in large part due to the economic factors described previously. Given that more people equates to higher water consumption, the population projection presents a conservative yet reasonable estimate of future water demand and provides a good basis for the analysis of future water supply needs.

2.3 Historic Water Use

Predicting future water supply requires accurate historic water use patterns and water usage records. Figure 2-1 and Table 2-3 illustrate the change in water demand since 2005.

Local water demand has decreased throughout the service area in the last several years due to drought conditions, economic factors, conservation programs, land use changes, community awareness and local water restriction ordinances. These factors have resulted in changes in water use relative to historic use patterns.

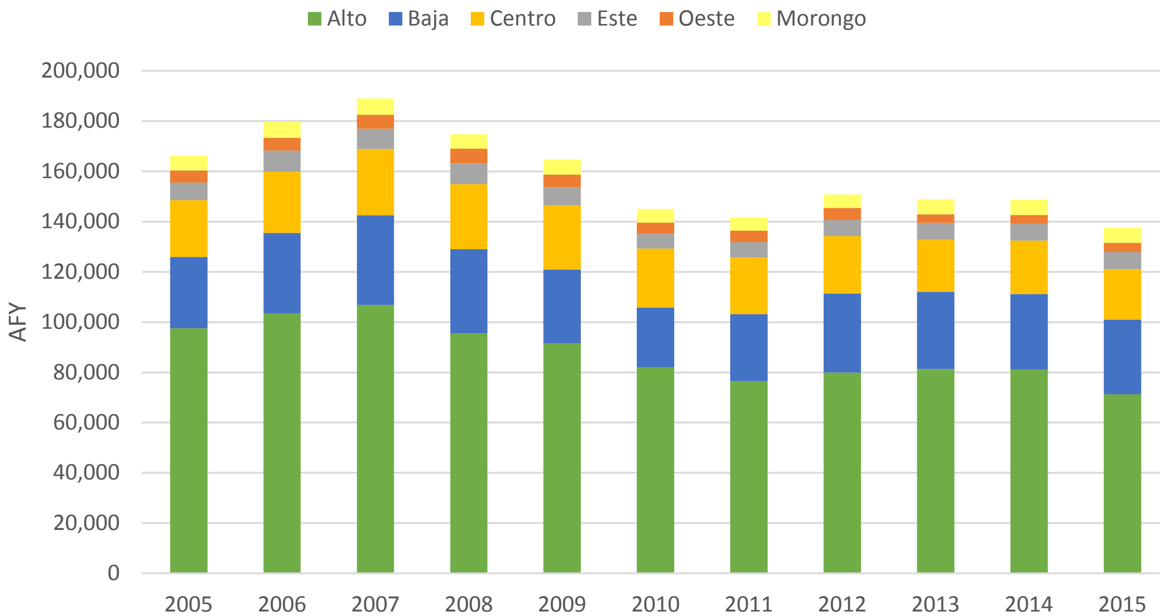


Figure 2-1: Historical Water Demand by Subarea

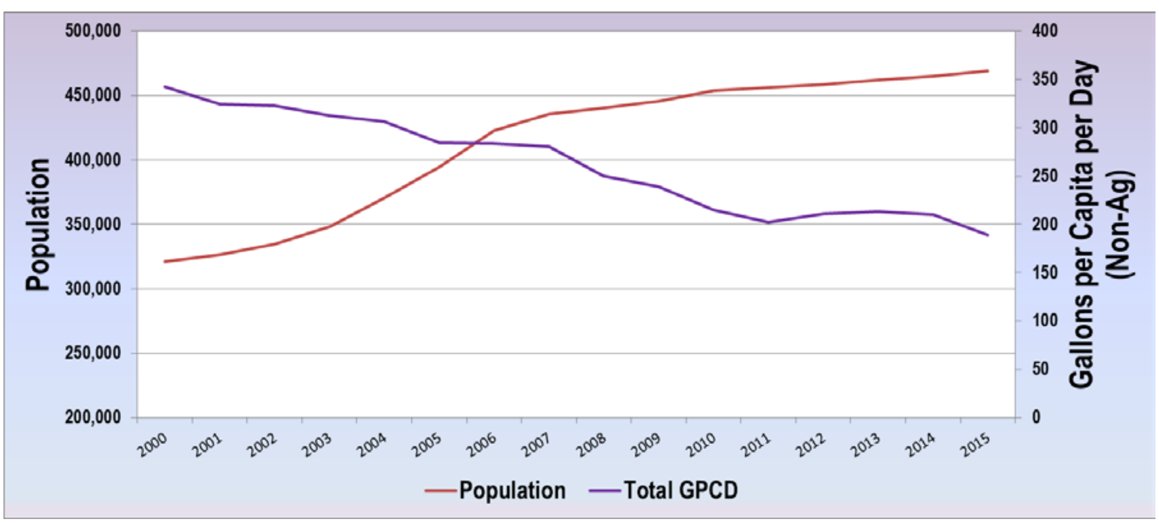


Figure 2-2: Historical Population Growth and Urban Per Capita Use

Table 2-3: Historical Water Demand by Subarea (AFY)

Subarea	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alto	97,491	103,413	106,838	95,552	91,531	82,000	76,500	79,900	81,400	81,100	71,300
Baja	28,484	32,118	35,735	33,514	29,279	23,800	26,600	31,400	30,600	30,100	29,700
Centro	22,563	24,313	26,262	25,843	25,644	23,500	22,700	22,900	20,800	21,200	20,100
Este	6,981	8,411	8,050	8,299	7,101	5,800	6,000	6,400	6,600	6,700	6,800
Oeste	4,882	5,152	5,690	5,766	5,207	4,500	4,600	4,800	3,500	3,600	3,600
MBA Subtotal	*160,401*	*173,407*	*182,575*	*168,974*	*158,762*	*139,600*	*136,400*	*145,400*	*142,900*	*142,700*	*131,500*
Morongo	5,879	6,300	6,403	5,797	5,990	5,466	5,185	5,367	5,979	5,999	6,509
Total	**166,280**	**179,707**	**188,978**	**174,771**	**164,752**	**145,066**	**141,585**	**150,767**	**148,879**	**148,699**	**138,009**

2.4 Projected Water Use

Water use projections for the MWA service area, categorized by Subarea, are provided in Table 2-4. Water use projections for the largest purveyors within MWA's service area are provided in Table 2-5. Projected water demand is calculated by multiplying the per capita water use (estimated from 2010 to 2015 purveyor data) by population projections (Mojave Water Agency Population Forecast, Beacon Economics December 2015).

Table 2-4: MWA Projected Water Demands by Subarea (AFY)

Subarea	2015	2020	2025	2030	2035	2040
Alto	71,300	80,346	84,767	90,163	95,747	100,823
Baja	29,700	29,700	29,700	29,700	29,700	29,700
Centro	20,100	20,576	20,555	20,551	20,557	20,549
Este	6,800	6,800	6,800	6,800	6,800	6,800
Oeste	3,600	4,002	4,236	4,517	4,796	5,061
MBA Subtotal	*131,500*	*141,424*	*146,058*	*151,731*	*157,600*	*162,933*
Morongo	6,509	6,942	7,128	7,349	7,564	7,767
Total	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**

Table 2-5: MWA Projected Water Demands by Purveyor (AFY)

Purveyor	2015	2020	2025	2030	2035	2040
Adelanto, City of	4,047	4,578	4,872	5,292	5,737	6,195
Liberty Utilities (Apple Valley Ranchos Water) Corp.	9,571	11,657	12,292	12,996	13,674	14,252
County Service Area 64	2,362	2,914	3,126	3,364	3,582	3,790
County Service Area 70J	1,470	1,909	2,141	2,411	2,685	2,939
Hesperia Water District	12,685	15,078	16,298	17,743	19,297	20,641
Golden State Water Company - Barstow	5,254	5,730	5,709	5,705	5,711	5,703
Hi-Desert Water District	2,838	3,056	3,195	3,357	3,518	3,668
Joshua Basin Water District	1,369	1,583	1,630	1,689	1,744	1,797
Phelan Piñon Hills CSD	2,685	3,460	3,921	4,435	4,975	5,478
Victorville Water District	20,853	22,927	25,157	27,582	29,949	32,243
Other Water Purveyors	74,877	75,473	74,845	74,505	74,292	73,995
Total	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**

2.4.1 Water Use Projection Methodology

MWA's projected water use is calculated by analyzing historical per capita water use and utilizing the population projections described in Section 2.2. For each water purveyor within MWA's service area, historical per capita water use is calculated for each available water use sector, such as residential, commercial, industrial, landscape irrigation, etc. A logarithmic regression is applied for the historical per capita water use of each sector, which projects future per capita water use to 2060. The projected future per capita water use for each sector is aggregated into an overall future per capita water use for the water purveyor. The projected per capita water use is multiplied by the water purveyor's population projection to calculate a water use projection. The water use projection for each water purveyor is aggregated into an overall water use projection for the MWA service area, as summarized in Figure 2-3.

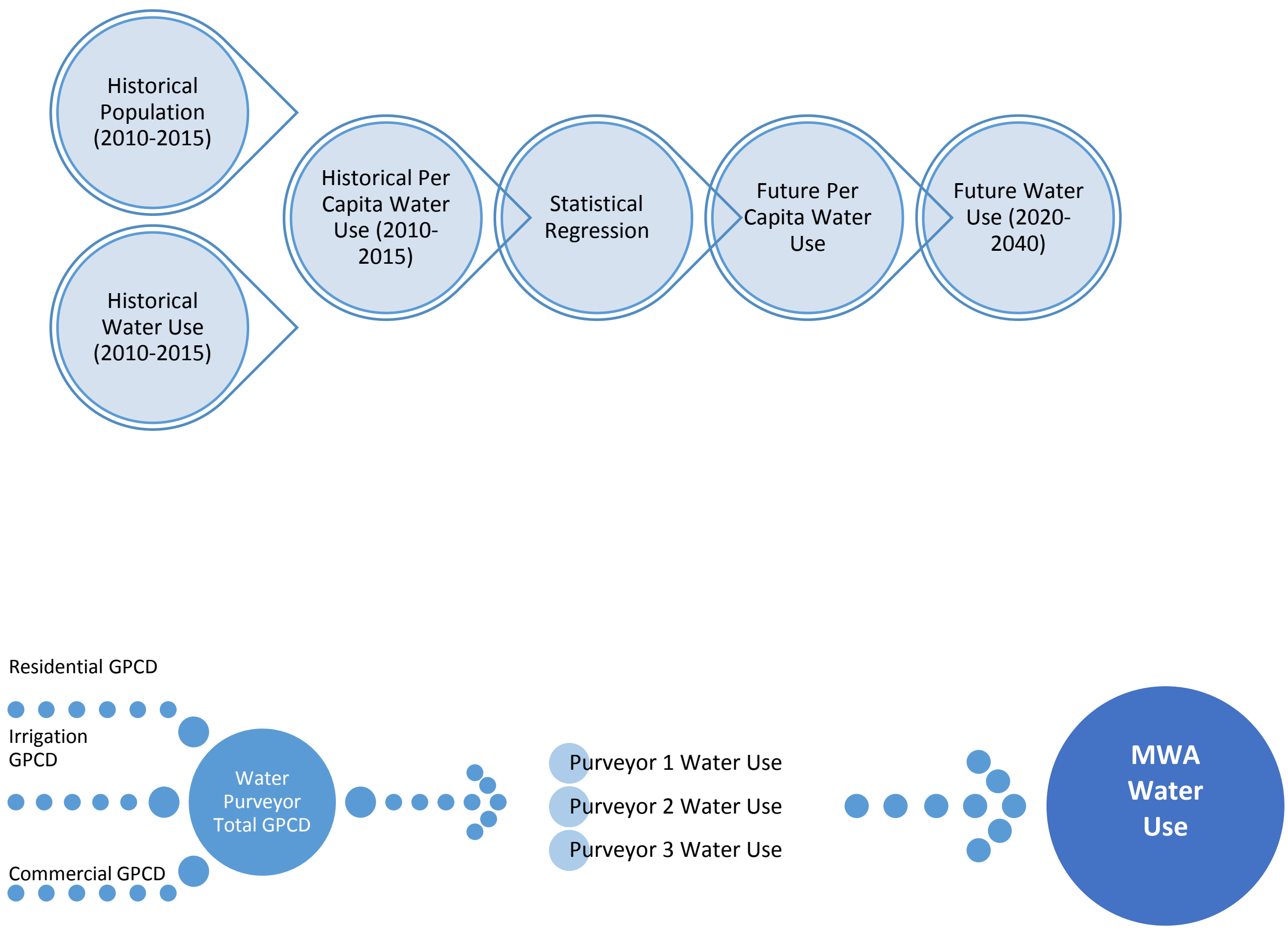


Figure 2-3: Water Use Projection Methodology Process Flow Diagrams

Generally, local urban potable water demand has decreased in the last several years due to the ongoing drought conditions, economic factors, conservation programs, land use changes and optimization/efficiencies and general changes in water use practices. In addition, the Governor's emergency order requiring mandatory conservation actions statewide has affected local demands. The logarithmic regression analysis allows for recognition of the aggressive reductions in per capita water use over the last several years, while also allowing for future reductions in per capita water use, albeit at a slower rate of change. Future reduction in per capita water demand will be realized through passive savings from laws and ordinances requiring utilization of low-flow housing fixtures and water-efficient landscaping. An example of this regression analysis is provided as Figure 2-4.

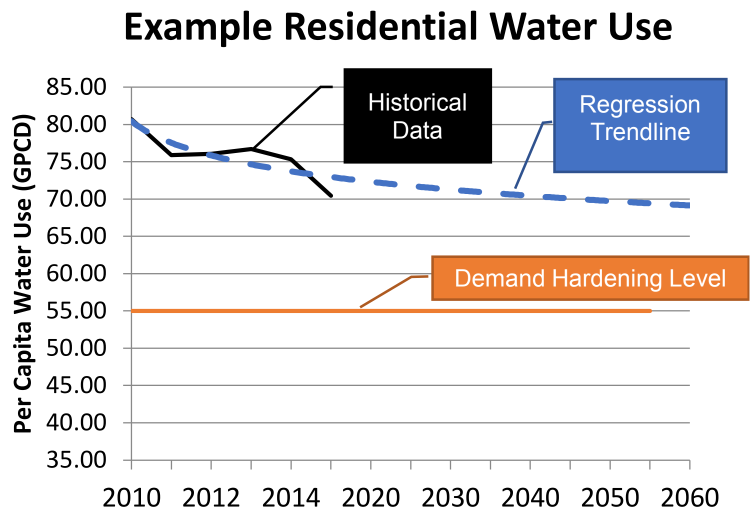


Figure 2-4: Example Per Capita Water Use Regression Analysis

As a reasonable check to the statistically-projected per capita water use, a theoretical point at which water demand would lower to a level likely to make it very difficult to conserve any additional water is calculated (i.e., demand hardening). These "hard demand" estimates are determined by analyzing both indoor residential and outdoor landscaping per capita water use, and maintaining other types of water uses constant. For indoor water use, the State Water Resources Control Board and AWWA per capita indoor water use standard of 55 gallons per capita per day is utilized to represent a reasonable future target. For outdoor water use, a future minimum target is calculated by taking the average outdoor landscaping per capita water use from 2010 through 2015 and applying a 40 percent reference evapotranspiration (ET_o) factor, which is based on the 2015 State Model Efficient Landscape Ordinance.

Agricultural water demand within the service area, which is largely concentrated in the Baja area, is conservatively assumed to remain static in the future. It is difficult to predict water use patterns for agricultural users since their water use is largely impacted by market conditions that impact the type and timing of crops that are grown. However, it is likely that overall agricultural water use in the service area will decrease in the future due to the impact of the Judgment's requirements.

2.5 Other Factors Affecting Water Usage

A major factor that affects water usage is weather. Historically, when the weather is hot and dry, water use increases. The amount of increase varies according to the number of consecutive years of hot, dry weather and the conservation activities imposed. During cool, wet years, historical water usage has decreased to reflect less water usage for exterior landscaping. This factor is discussed below in detail.

2.5.1 Weather Effects on Water Usage

California, as a whole, faces the prospect of significant water management challenges due to a variety of issues including population growth, regulatory restrictions and climate change. Climate change is of special concern because of the range of possibilities and their potential impacts on essential operations, particularly operations of the SWP. The most likely scenarios involve increased temperatures, which will reduce the Sierra Nevada snowpack and shift more runoff to winter months, and accelerate sea level rise. These changes can cause major problems for the maintenance of the present water export system since water supplies are conveyed through the levee system of the Sacramento-San Joaquin Delta. The other much-discussed climate scenario or impact is an increase in precipitation variability, with more extreme drought and flood events posing additional challenges to water managers.

These changes would impact MWA's water supply by changing how much water is available, when it is available, how it can be captured and how it is used due to changes in priorities. Expected impacts to the SWP imported water supply include pumping less water south of the Delta due to reduced supply, and pumping more local groundwater to augment reductions in surface water supplies and reliability issues since groundwater is a more reliable source of water.

Typically in the MWA service area, the largest amount of water use occurs during the hot summer months of July through September, whereas the smallest amount of water use occurs in the cooler winter months of January through March.

2.5.2 Conservation Effects on Water Usage

Conservation is a key strategy for meeting future demand, especially amidst the current prolonged drought conditions in California. In 2014, the Governor issued an emergency order requiring mandatory conservation actions statewide to reduce overall water consumption by 25 percent. Public water agencies throughout the state have responded with action to the Governor's mandate, with most agencies having met their specific conservation goals. Table 2-6 reflects the initial goals of the Governor's mandate and the new conservation standard for suppliers after the March 2016 extension of the emergency regulations.

Table 2-6: SWRCB Conservation Goals

Water Supplier	Goal	New Goal[1]
City of Adelanto	20%	16%
Liberty Utilities (Apple Valley Ranchos Water) Corp.	28%	24%
Golden State Water – Barstow System	24%	20%
City of Hesperia	32%	28%
Hi-Desert Water District	16%	13%
Joshua Basin Water District	28%	20%
Phelan Pinon Hills CSD	32%	28%

Water Supplier	Goal	New Goal[1]
County Service Area 64	32%	28%
County Service Area 70	28%	25%
City of Victorville	28%	24%

(1) Urban Water Supplier Conservation Standard for Extended Emergency Regulation Rulemaking – 2016 Supplier Conservation Standards - Effective 1 March 2016. Based on revised R-GPCD, Default Climate Adjustment, and supplier-submitted adjustments.

In addition to the Governor's mandate, the Water Conservation Bill of 2009, or SBX7-7, provides the regulatory framework to support the statewide reduction in urban per capita water use. Each water retailer must determine and report its existing baseline water consumption and establish an interim target for 2020 in their 2015 UWMP. Although water wholesalers are not required to meet the targets outlined in SBX7-7, MWA implements conservation programs and policies in partnership with and/or on behalf of its water retail agencies. This not only helps the compliance with SBX7-7, it also helps to ensure long-term water supply reliability goals are met.

In addition to statewide regulations, MWA and the Alliance for Water Awareness and Conservation (AWAC) have formed water use efficiency goals for the service area. AWAC is a coalition of 25 local water agencies and other regional organizations with the goal of reducing consumption by 20 percent by 2020 for the Mojave Basin Area and 5 percent by 2015 for the Morongo Area. AWAC Goals, updated in 2011 are:

- Serve as a network to assist agencies in educating the public on water conservation.
- Provide resources with a consistent message to help agencies meet their respective conservation goals.
- Maintain current GPCD or lower and continue to position agencies for meeting future conservation needs.
- Exchange ideas between agencies, especially at quarterly meetings.

Section 3: Water Resources

3.1 Overview

This Section describes the water resources available to the Mojave Water Agency (MWA) for the 25-year period covered by the Plan. These are summarized in Table 3-1 and discussed in more detail below. Both currently available and planned supplies are discussed.

Table 3-1: Summary of Current and Planned Water Supplies (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Imported Supplies						
SWP [(a)]	53,196	55,676	55,676	55,676	55,676	55,676
Yuba Accord Water[(b)]	0	600	600	600	600	600
Local Supplies						
Net Natural Supply[(c)]	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow[(d)]	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import[(e)]	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(f)]	0	0	0	0	0	0
Total Supplies	**161,143**	**168,781**	**170,896**	**173,482**	**176,152**	**178,582**
Projected Demand [(g)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:

a) Assumes 62% of Table A amount based on the California Department of Water Resources State Water Project Final Delivery Capability Report 2015.
b) Refer to Section 3.2.2 for an explanation of this supply.
c) Refer to Section 3.3.1 for an explanation of this supply.
d) Refer to Section 3.3.2 for an explanation of this supply.
e) Refer to Section 3.3.3 for an explanation of this supply.
f) Groundwater banking (stored groundwater) would be used during dry year conditions as shown in Tables 6-4, 6-5, and 6-6. A portion of the stored water is surplus to that needed for dry years and SWP annual allocation variability. This stored water supply is described in Section 3.5.3 and could be made available for future supply in addition to the water supply shown in this table.
g) Refer to Section 2 for discussion of demand projections.
h) Unbalanced Exchange Agreements through 2020 are not included in the above table.

The MWA has four existing sources of water supply – SWP imports, natural local surface water flows, return flow from pumped groundwater not consumptively used, and wastewater imports from outside the MWA service area. In MWA's water use projection model, natural and SWP supply are expressed as an annual average, although both sources of supply vary significantly from year to year. Almost all of the water use within MWA is supplied by pumped groundwater. Natural surface supply, return flow, wastewater imports, and SWP imports recharge the groundwater basins; therefore, water management practices render the annual fluctuations in these sources of supply relatively unimportant for water supply planning.

The projected demands shown in Table 3-1 represent total demands within MWA, including pumped groundwater and direct SWP use, as described in Section 2. Figure 3-1 presents all available supplies compared with total demands through 2060. This is beyond the 25-year planning horizon included in this plan and projections beyond 2040 are for informational purposes only. The extended projection shows that existing and planned supplies are sufficient to meet project demands until 2055. It should be noted that return flow as a supply is shown to increase over time because it is a function of water demand.

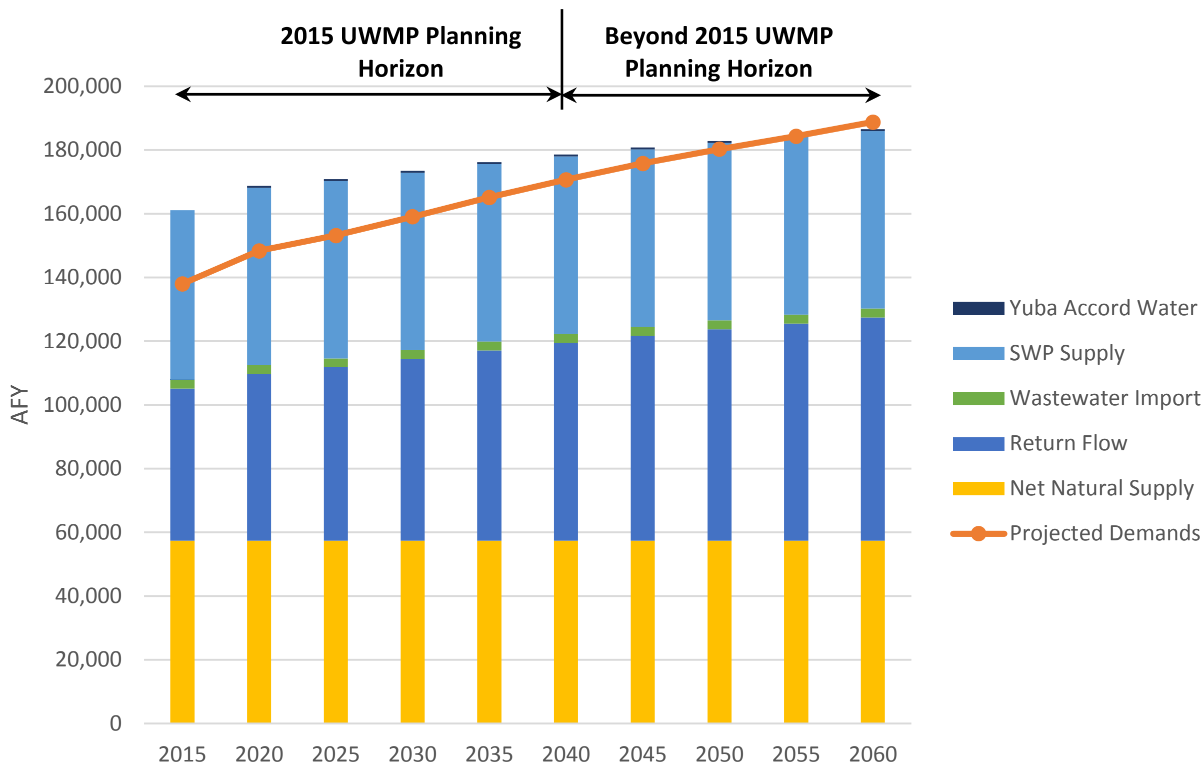


Figure 3-1: Water Supplies versus Projected Demands Through 2060

The term "dry" is used throughout this section and in subsequent sections concerning water resources and reliability as a measure of supply availability. As used in this Plan, dry years are those years when supplies are the lowest, which occurs primarily when precipitation is lower than the long-term average precipitation. The impact of low precipitation in a given year on a particular supply may differ based on how low the precipitation is, or whether the year follows a high-precipitation year or another low-precipitation year. For the SWP, a low-precipitation year may or may not affect supplies, depending on how much water is in SWP storage at the beginning of the year. Also, dry conditions can differ geographically. For example, a dry year can be local to the MWA service area (thereby affecting local groundwater replenishment and production), local to northern California (thereby affecting SWP water deliveries), or statewide (thereby affecting both local groundwater and the SWP). When the term "dry" is used in this Plan, statewide drought conditions are assumed, affecting both local groundwater and SWP supplies at the same time.

3.2 Imported Water Supplies

3.2.1 SWP Table A Water Supplies

According to the water supply contract between the California Department of Water Resources (DWR) and MWA revised on October 12, 2009, MWA's maximum annual entitlement from the SWP ("Table A amount") is 85,800 AFY from 2015 to 2019; and 89,800 AFY from 2020 to 2035 and beyond, assuming continuation of the agreement.

The SWP is the largest state-built, multi-purpose water project in the country. It was authorized by the California State Legislature in 1959, with the construction of most facilities completed by 1973. Today, the SWP includes 28 dams and reservoirs, 26 pumping and generating plants, and approximately 660 miles of aqueducts. The primary water source for the SWP is the Feather River, a tributary of the Sacramento River. Storage released from Oroville Dam on the Feather River flows down natural river channels to the Sacramento-San Joaquin River Delta (Delta). While some SWP supplies are pumped from the northern Delta into the North Bay Aqueduct, the vast majority of SWP supplies are pumped from the southern Delta into the 444-mile-long California Aqueduct. The California Aqueduct conveys water along the west side of the San Joaquin Valley to the Edmonston Pumping Plant, where water is pumped over the Tehachapi Mountains and the California Aqueduct then divides into the East and West Branches. MWA delivers its SWP supplies to recharge local groundwater basins through extensive transmission pipeline and recharge systems and direct releases from Silverwood Lake, a SWP regulating reservoir.

In the early 1960s, DWR began entering into individual SWP Water Supply Contracts with urban and agricultural public water supply agencies located throughout northern, central, and southern California for SWP water supplies. MWA is one of 29 water agencies (commonly referred to as "contractors") that have a SWP Water Supply Contract with DWR.

Each SWP contractor's SWP Water Supply Contract contains a "Table A," which lists the maximum amount of water an agency may request each year throughout the life of the contract. Table A is used in determining each contractor's proportionate share, or "allocation," of the total SWP water supply DWR determines to be available each year. The total planned annual delivery capability of the SWP and the sum of all contractors' maximum Table A amounts was originally 4.23 million acre-feet. The initial SWP storage and conveyance facilities were designed to meet contractors' water demands in the early years of the SWP, with the construction of additional storage facilities planned as demands increased. However, essentially no additional SWP storage facilities have been constructed since the early 1970s and a portion of the original conveyance design ("peripheral canal") was never completed. SWP conveyance facilities were generally designed and have been constructed to deliver maximum Table A amounts to all contractors. After the permanent retirement of some Table A amount by two agricultural contractors in 1996, the maximum Table A amounts of all SWP contractors now totals about 4.17 million AF.

As mentioned above, currently MWA's contractual Table A amount is 85,800 AFY. Prior to two purchases by MWA of additional Table A supplies, MWA's Table A amount was 50,800 AF. In 1997, MWA purchased 25,000 AF from Berrenda Mesa Water District, bringing MWA's Table A amount to 75,800 AF. In 2009, MWA purchased an additional

14,000 AF of Table A from Dudley Ridge Water District in Kings County, which will be transferred incrementally to MWA. The first transfer of 7,000 AF occurred in 2010, with 3,000 AF transferred in 2015 and 4,000 AF to be transferred in 2020. These transfers are reflected in Table 3-3 below, which indicates MWA's Table A amounts from 2015 to 2040.

While Table A identifies the maximum annual amount of water a SWP contractor may request, the amount of SWP water actually available and allocated to SWP contractors each year is dependent on a number of factors and can vary significantly from year to year. The primary factors affecting SWP supply availability include hydrology, the amount of water in SWP storage at the beginning of the year, regulatory and operational constraints, and the total amount of water requested by SWP contractors.

Imported SWP water has been historically supplied to the MWA service area through the Mojave River and Morongo Basin pipelines and releases from Silverwood Lake. In 1997, MWA entered into an agreement with AVEK to deliver up to 4,800 acre feet per year through their facilities to the Luz solar facility located within the boundaries of the MWA, however closer to delivery facilities owned by AVEK. In 2012 the agreement was amended to reduce the annual deliveries to 1,800 acre feet per year plus the ability to store up 3,000 acre feet as a backup supply. Luz currently has a storage balance of approximately 800 acre feet. Table 3-2 presents historical total SWP deliveries to MWA.

Table 3-2: Historical Total SWP Deliveries

Year	Deliveries (AFY)[(a)]	Year	Deliveries (AFY)[(b)]
1978	0	**1997**	10,374
1979	4,000	**1998**	3,925
1980	4,000	**1999**	8,144
1981	4,000	**2000**	11,380
1982	10,500	**2001**	4,433
1983	0	**2002**	4,346
1984	0	**2003**	14,435
1985	0	**2004**	13,176
1986	0	**2005**	13,561
1987	17	**2006**	34,014
1988	9	**2007**	46,109
1989	200	**2008**	25,396
1990	0	**2009**	29,047
1991	3,423	**2010**	38,152
1992	10,686	**2011**	5,099
1993	11,514	**2012**	11,244
1994	16,852	**2013**	7,483
1995	8,722	**2014**	3,581
1996	7,427	**2015**	8,130

Notes:
(a) Source: Mojave Water Agency
(b) Deliveries from 1978 to 2001 include releases from Lake Silverwood, Rock Springs, Hodge, Lenwood, the Morongo Basin Pipeline, and to the LUZ Solar facility at Kramer Junction. Deliveries from 2002 to 2009 also include releases to Daggett, Newberry Springs, Oro Grande, Local Construction Projects and High Desert Power Project.

Table 3-3: Current and Planned Wholesale Water Supplies (AFY)

Water Supply Sources	2015	2020	2025	2030	2035	2040
California State Water Project (SWP)	85,800	89,800	89,800	89,800	89,800	89,800

3.2.2 Yuba Accord Water

In 2014, MWA entered into the Yuba Accord Agreement (Appendix D), which allows for the purchase of water from the Yuba County Water Agency through the Department of Water Resources to 21 SWP contractors (including MWA) and the San Luis and Delta-Mendota Water Authority. Yuba Accord water comes from north of the Delta, and the water purchased under this agreement is subject to losses associated with transporting it through the Delta. These losses can vary from year to year, depending on Delta conditions at the time the water is transported. Under the agreement, approximately 600 AF of water is available to MWA in critically dry years. Under certain hydrologic conditions, additional water may be available to MWA from this program. This agreement is through 2020 but it is anticipated that it will be extended.

3.2.3 Imported Water Supply Reliability

The amount of the SWP water supply delivered to the state water contractors in a given year depends on a number of factors, including the amount of rainfall, snowpack, runoff, water in storage, pumping capacity from the Delta, and legal/regulatory constraints on SWP operation and demand for the supply. Water delivery reliability depends on three general factors: the availability of water at the source, the ability to convey water from the source to the desired point of delivery, and the magnitude of demand for the water. Urban SWP contractors' requests for SWP water, which were low in the early years of the SWP, have been steadily increasing over time, which increases the competition for limited SWP dry-year supplies. Regulatory constraints also change over time and have become increasingly more restrictive.

DWR prepares a biennial report to assist SWP contractors and local planners in assessing the near and long-term availability of supplies from the SWP. DWR issued its most recent update, the 2015 DWR State Water Project Delivery Capability Report (DCR), in July 2015. In the 2015 update, DWR provides SWP supply estimates for SWP contractors to use in their planning efforts, including for use in their 2015 UWMPs. The 2015 DCR includes DWR's estimates of SWP water supply availability under both current and future conditions.

DWR's estimates of SWP deliveries are based on a computer model (CalSim II) that simulates monthly operations of the SWP and Central Valley Project systems. Key assumptions and inputs to the model include the facilities included in the system, inflow to the system, regulatory and operational constraints on system operations, and projected contractor demands for SWP water. For example, the 2015 DCR uses the following assumptions to model current conditions: existing facilities, inflow to the model based on 82 years of historical inflows (1922 through 2003), current regulatory and operational constraints, and contractor demands at maximum Table A Amounts.

To evaluate SWP supply availability under future conditions, the 2015 DCR included four model studies. The first of the future-conditions studies, the Early Long Term (ELT) scenario, used all of the same model assumptions for current conditions, but reflected changes expected to occur from climate change, specifically, a 2025 emission level and a 15 cm sea level rise. The other three future-conditions include varying model assumptions related to the Bay Delta Conservation Plan/California Water Fix ("BDCP"), such as changes to facilities and/or regulatory and operational constraints.

In spring 2015, DWR announced that the BDCP would move from a Section 10 permit to a Section 7 permit process under the Federal Endangered Species Act. As a practical matter, this split the project into two distinct parts known as Cal WaterFix (Alternative 4A), the conveyance portion, and Cal EcoRestore, the restoration portion. Cal WaterFix is Alternative 4A in the recirculated environmental document, and the preferred alternative. Alternative 4A is different than any of the future scenarios modeled by DWR in the DCR. While there is widespread support for the BDCP/Cal WaterFix project, it would be speculative at this time to assume they will move forward. While there is significant support for the BDCP, plans are currently in flux- environmental review is ongoing and is not anticipated to be final until at least 2016, and several regulatory and legal requirements must be met prior to construction.

This UWMP uses the ELT scenario to estimate future SWP supply availability because it is based on existing facilities and regulatory constraints, with hydrology adjusted for the expected effects of climate change. This scenario is consistent with the studies DWR has used in its previous SWP Delivery Reliability Reports for supply availability under future conditions. Therefore, in this UWMP, future SWP supply availability is based on the ELT study included in the 2015 DCR.

The availability of supply to MWA is calculated by multiplying MWA's Table A amount by the delivery availability percentages provided by the 2015 DCR, ELT scenario. For a long-term average scenario, Table 3-4 provides the projected SWP water available to MWA over the next 25 years. The projected SWP supply availability for a long-term average scenario is 62 percent.

Table 3-4: Current and Planned Wholesale Water Supplies Available (Long-Term Average)

Wholesaler (Supply Source)	2015	2020	2025	2030[(a)]	2035[(b)]	2040
California State Water Project (SWP)						
% of Table A Amount Available	62%	62%	62%	62%	62%	62%
Anticipated Deliveries (AFY)	53,196	55,676	55,676	55,676	55,676	55,676

Notes:

(e) The percentages of Table A amount projected to be available are taken from Table 6-3 of the 2015 DCR. Supplies are calculated by multiplying MWA's Table A amount of 85,800 AF (2015) or 89,800 AF (2020) by these percentages. Maximum Table A amount is referenced from Department of Water Resources Bulletin 132.

While the primary supply of water available from the SWP is allocated Table A supply, SWP supplies in addition to Table A water may periodically be available, including "Article 56C" carryover water, "Article 21" water, Turnback Pool water, and DWR Dry Year

Purchase Programs. Pursuant to the long-term water supply contracts, SWP contractors have the opportunity to carry over a portion of their allocated water approved for delivery in the current year for delivery during the next or future year(s). Contractors can "carry over" water under Article 12 (e) and Article 56(c) of the SWP long-term water supply contract with advance notice when they submit their initial request for Table A water, or within the last three months of the delivery year. The carryover program was designed to encourage the most efficient and beneficial use of water and to avoid obligating the contractors to "use or lose" the water by December 31 of each year. The water supply contracts state the criteria of carrying over Table A water from one year to the next. Normally, carryover water is water that has been exported during the year, has not been delivered to the contractor during that year, and has remained stored in the SWP share of San Luis Reservoir. Under Article 12(e), that portion of carryover water must be taken during the first three months of the following year. Article 56(c) limits the amount of water that may be carried over in a single year, however has no limits on the cumulative amount to remain in storage nor does it require a specific timeframe for when this water must be used. However, storage for carryover water no longer becomes available to the contractors if it interferes with storage of SWP water for project needs (DWR, 2009).

Article 21 water (which refers to the SWP contract provision defining this supply) is water that may be made available by DWR when excess flows are available in the Delta (i.e., when Delta outflow requirements have been met, SWP storage south of the Delta is full, and conveyance capacity is available beyond that being used for SWP operations and delivery of allocated and scheduled Table A supplies). Article 21 water is made available on an unscheduled and interruptible basis and is typically available only in average to wet years, generally only for a limited time in the late winter.

The Turnback Pool is a program where contractors with allocated Table A supplies in excess of their needs in a given year may turn back that excess supply for purchase by other contractors who need additional supplies that year. The Turnback Pool can make water available in all types of hydrologic years, although generally less excess water is turned back in dry years. Currently, there is very limited participation in the Turnback Pool with only one contractor in 2014 electing to place water into the pool. Future amounts are likely to render this program void by default.

As urban SWP contractor demands increase in the future, the amount of water turned back and available for purchase will likely diminish. In critical dry years, DWR has formed Dry Year Water Purchase Programs for contractors needing additional supplies. Through these programs, water is purchased by DWR from willing sellers in areas that have available supplies and is then sold by DWR to contractors willing to purchase those supplies. MWA has sold excess supplies to DWR in the past.

Because the availability of these supplies is somewhat uncertain, they are not included as supplies to MWA in this Plan. However, MWA's access to these supplies when they are available may enable it to improve the reliability of its SWP supplies beyond the values used throughout this report.

3.2.4 Existing Imported SWP Supply Facilities

MWA has available turnouts for SWP water at five locations off the East Branch of the California Aqueduct. The first of five turnouts to the MWA service area is located at Sheep Creek, which is essentially an undeveloped turnout stub in the Phelan area and is not used at this time. The second is the fully constructed and operational Mojave River Pipeline turnout, also known as the White Road Siphon, located in the west Victorville Area. The third is the fully constructed and operational Oro Grande Wash Pipeline turnout, also known as the Highway 395 turnout, which is used for the Oro Grande Wash Recharge Project. The fourth turnout is the fully constructed and operational Morongo Basin Pipeline turnout, also known as the Antelope Siphon which is located near the City of Hesperia and was constructed to deliver SWP water from the California Aqueduct to the Morongo Subarea and the Deep Creek and Rock Springs recharge facilities. The fifth turnout is also an undeveloped turnout stub from the Aqueduct in what has been labeled the Unnamed Wash Southeast Hesperia. All of these turnouts are along Reach 22b of the California Aqueduct. In addition to the turnouts, MWA takes water delivery from Cedar Springs Dam at Silverwood Lake, for groundwater recharge beginning at the headwaters of the Mojave River. Figure 3-2 shows the location of the MWA turnouts and existing and planned water delivery facilities.

The Mojave River Pipeline extends approximately 76 miles from the California Aqueduct to recharge sites along the Mojave River to Newberry Springs. The large-diameter pipeline project was started in 1996 and completed in 2006 to deliver up to 45,000 AFY to the Mojave Basin Area to offset growing depletion of native water supplies caused by the region's growth and the overpumping of groundwater. There are four groundwater recharge basins that have been constructed at Hodge, Lenwood, Daggett/Yermo, and Newberry Springs.

The Morongo Basin Pipeline extends approximately 71 miles from the California Aqueduct to recharge sites along the Mojave River in Hesperia (delivers to Rock Springs and Deep Creek Recharge sites approx. 45,000 AFY) and south Apple Valley and to recharge sites (delivers approx. 7,300 AFY) in the Warren Valley in an effort to reduce overdraft in the Warren Valley Basin. The Morongo Basin Pipeline was completed in 1994 and deliveries began in 1995. The pipeline was financed by General Obligation bonds as well as contributions from the local retailers - the HDWD, the Joshua Basin Water District (JBWD), the Bighorn-Desert View Water Agency (BDVWA), and San Bernardino County Service Area 70 (CSA 70) and MWA. Pipeline turnouts serve recharge sites for JBWD, BDVWA, CSA 70, and HDWD.

The Oro Grande Wash Pipeline extends approximately 2.7 miles from the California Aqueduct to a recharge site in the Oro Grande Wash in Southwest Victorville. The pipeline construction was completed and became operational in 2011. The Phase 1 Interim recharge area has a recharge capacity of 1,500 AFY. The conjunctive use San Bernardino County flood control detention basin is planned to be constructed in 2016. Once completed the Phase 1 recharge capacity is expected to be approximately 3,000 AFY. The phase 2 pipeline to the additional recharge area is planned to be constructed once the capacity of the Phase 1 facilities is exceeded.

The R^3 Facilities are described in Section 3.5.3.1. These facilities are not considered supply facilities but instead are groundwater management facilities moving imported SWP water from groundwater storage sites to purveyors, which reduces groundwater pumping from existing purveyor well sites allowing partial recovery of localized pumping depressions.

3.3 Local Water Supplies

MWA's local supply of water includes natural surface water, return flow from pumped groundwater not consumptively used, and wastewater imports from outside the MWA service area. All three sources are discussed in the following subsections.

3.3.1 Net Natural Supply

MWA has a net natural supply of 57,349 AFY, including surface water and groundwater in the five Subareas of the Mojave Basin Area (MBA) and in the Morongo Basin/Johnson Valley Area ("Morongo"), as shown in Table 3-1. The estimates for the MBA are derived by the MBA Watermaster and were used in the updated MWA water use projection model discussed in Section 2.

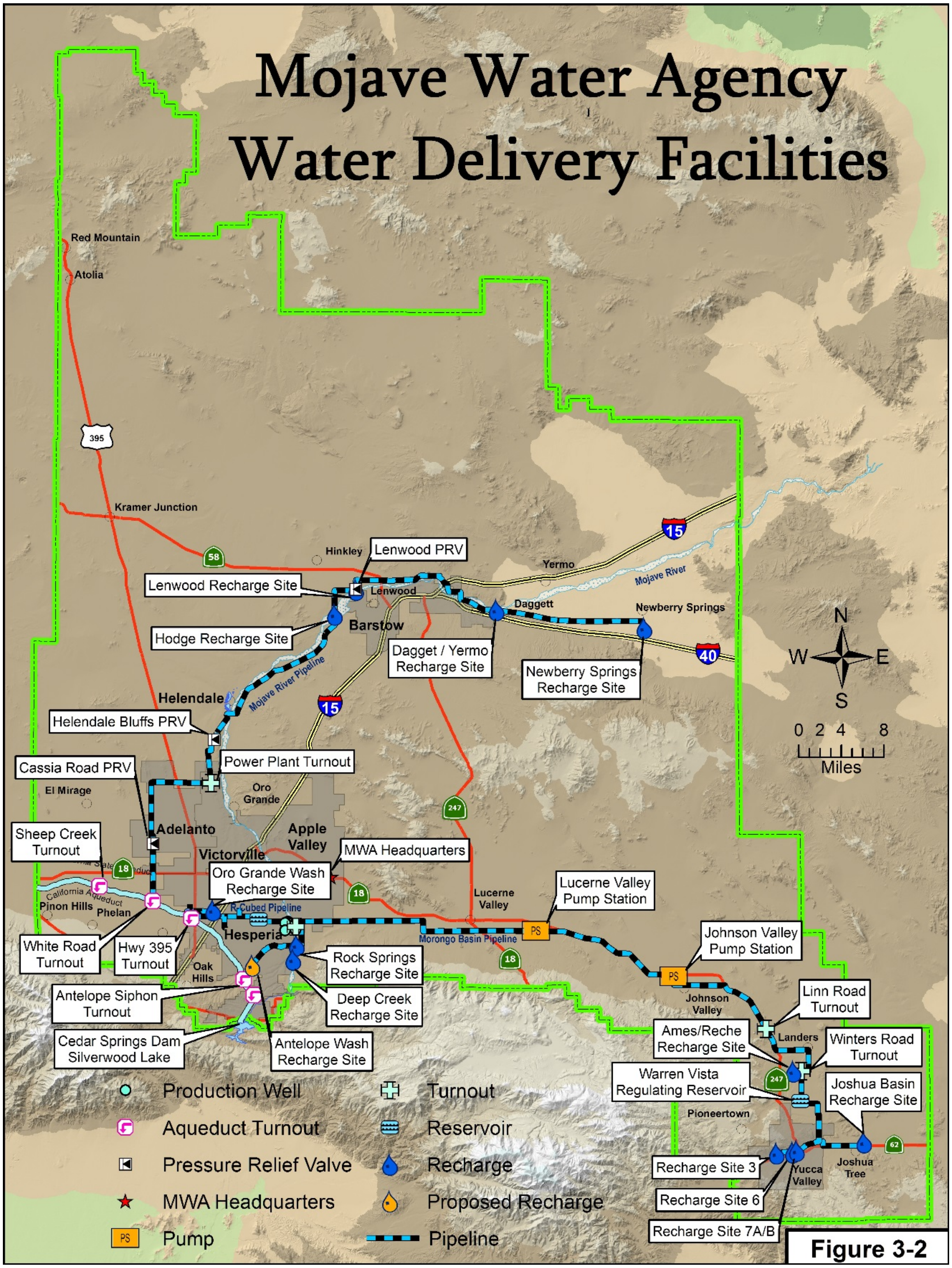


Figure 3-2: MWA Water Delivery Facilities

3.3.2 Return Flow

A portion of the water pumped from the ground is returned to the groundwater aquifer and becomes part of the available water supply; this is defined as the return flow. For example, nearly all indoor water use is assumed to be returned to the basin either by percolation from septic tanks or treated wastewater effluent produced by municipal wastewater facilities. The portion of the groundwater pumped that does not return to the aquifer is referred to as consumptive use.

Watermaster Engineer (Watermaster Annual Reports, Robert C. Wagner, P.E.; 2013, 2014, 2015, 2016) calculates consumptive use for each producer in each subarea of the Adjudicated area. The calculation is based on production amount, type of use, and an evaluation of processes that consume water. Indoor domestic use is based on estimated gallons per day per capita (GDPC) and population. Outdoor domestic water use is assumed to be 100 percent consumptively used (based on estimated domestic lawn irrigation and recent trends in conservation). Golf course irrigation and recreational lake evaporation are based on CIMIS data, to the extent possible. Commercial return flow estimates were made on square foot basis of commercial space in the Alto Subarea from information compiled by VVWRA (Flow Projection Update - Update 3, April 2009). In all other Subareas, commercial water use is assumed to be 100 percent consumptively used. Likewise, industrial uses are assumed to be 100 percent consumptively used. Agricultural consumptive use is estimated from CIMIS data, cropping patterns, crop coefficients, and irrigation practices. Return flow from each source and producer is calculated by subtraction as: Total Water Production minus Estimated Consumptive Use equals Return Flow (TWP-ECU=RF).

Return flow shown in Table 3-1 is calculated as a percent of the previous years' water production for each water use category, as defined by the Watermaster Engineer. Return flow factors, on a regional basis, average approximately 35 percent of the groundwater production, although this amount can vary significantly by Subarea, as shown in Table 3-5. The return flows shown in Table 3-1 represent aggregate flows from all sources.

Projected return flow for future years is based on the character and distribution of pumping and consumptive use in various Subareas for water year 2013-2014. Estimated consumptive use for 2013-2014 is imbedded in the State Of The Basin analysis in the Watermaster's 21st Annual Report. The return flow as a percentage of production is shown in the following table.

Table 3-5: Return Flow Percentages by Water Use

Water Use	Alto	Centro	Baja	Este	Oeste	Morongo
Agriculture	19.1%	21.6%	14.0%	29.7%	0.0%	N/A
Urban	44.2%	41.9%	11.2%	54.6%	43.3%	36.7%

3.3.3 Wastewater Import

Treated wastewater effluent is imported to the MWA service area from three wastewater entities serving communities in the San Bernardino Mountains outside MWA's service area. Treated wastewater effluent from the Lake Arrowhead Community Services District is imported to the Alto Subarea and effluent from the Big Bear Area Regional Wastewater Agency is imported to the Este Subarea. MWA also receives treated wastewater flow from Crestline Sanitation District, which is captured at the USGS gaging station, West Fork Mojave River. Since this flow is already accounted for with net natural supply, it is not accounted for as a separate wastewater import flow source. Wastewater imports from outside MWA represent a relatively small portion of MWA's overall water supply portfolio, and are described in more detail in Chapter 4 Recycled Water.

3.4 Groundwater

This Section presents information about MWA's groundwater supplies, including a summary of the adopted Groundwater Management Plan (GWMP), which is provided as Appendix J.

3.4.1 Groundwater Basin Description

The MWA service area overlies all or a portion of 36 groundwater basins and subbasins as defined by DWR Bulletin 118-03 (Figure 3-3). Collectively, these basins and subbasins are grouped into two larger hydrogeologically distinct areas. Basins along the Mojave River and adjacent areas are referred to as the Mojave River Groundwater Basin; the area is referred to as the Mojave Basin Area. Remaining basins in the southeastern Mojave Region are referred to as the Morongo Basin/Johnson Valley Area or "Morongo Area" with the exception of the Lucerne Valley. The Lucerne Valley subbasin divided along the Helendale Fault with the southwest portion in the Mojave River Groundwater Basin and the northeast portion in the Morongo Area. The surface water drainage of Lucerne Valley is in the Colorado River Hydrologic Region but is not included in with the "Morongo Basin Area," thus creating an "island effect" due to the hydrogeologic conditions.

The Mojave River Groundwater Basin is the larger and more developed of the two areas. The 36 basins overlie two broad hydrologic regions also defined in DWR Bulletin 118-03. Most of the Mojave River Groundwater Basin lies within the South Lahontan Hydrologic Region while the Morongo Area and a portion of the Este Subarea of the Morongo Groundwater Basin are in the Colorado River Hydrologic Region. The 36 groundwater basins and subbasins are listed in Table 3-6 and grouped by the South Lahontan (Region 6) and Colorado River (Region 7) Hydrologic Regions. The Mojave Region also overlaps a small portion of a DWR basin in the South Coast Hydrologic Region (Region 8) as shown by the last subbasin in Table 3-6; however, because this is such a small overlap, the Mojave Region is not involved with any jurisdictional issues with this groundwater basin.

Table 3-6: DWR Groundwater Basins

DWR Basin	Sub-Basin	Groundwater Basin	Sub-Basin Name	Budget Type[a]
South Lahontan Hydrologic Region				
6-35		Cronise Valley		C
6-36	6-36.01	Langford Valley	Langford Well Lake	C
6-37		Coyote Lake Valley		A
6-38		Caves Canyon Valley		A
6-40		Lower Mojave River Valley		A
6-41		Middle Mojave River Valley		A
6-42		Upper Mojave River Valley		A
6-43		El Mirage Valley		A
6-44		Antelope Valley		A
6-46		Fremont Valley		C
6-47		Harper Valley		A
6-48		Goldstone Valley		C
6-49		Superior Valley		C
6-50		Cuddeback Valley		C
6-51		Pilot Knob Valley		C
6-52		Searles Valley		C
6-53		Salt Wells Valley		C
6-54		Indian Wells Valley		A
6-77		Grass Valley		C
6-89		Kane Wash Area		C
Colorado River Hydrologic Region				
7-10		Twentynine Palms Valley		C
7-11		Copper Mountain Valley		A
7-12		Warren Valley		A
7-13	7-13.02	Deadman Valley	Surprise Spring	C
7-13	7-13.01	Deadman Valley	Deadman Lake	C
7-15		Bessemer Valley		C
7-16		Ames Valley		C
7-17		Means Valley		C
7-18	7-18.01	Johnson Valley	Soggy Lake	C
7-18	7-18.02	Johnson Valley	Upper Johnson Valley	C
7-19		Lucerne Valley		A
7-20		Morongo Valley		C
7-50		Iron Ridge Area		C
7-51		Lost Horse Valley		C
7-62		Joshua Tree		A
8-2	8-2.05	Upper Santa Ana Valley	Cajon	C

Notes:
Source: DWR
(a) Type A – either a groundwater budget or model exists, or actual extraction data is available. Type C – not enough available data to provide an estimate of the groundwater budget or basin extraction.

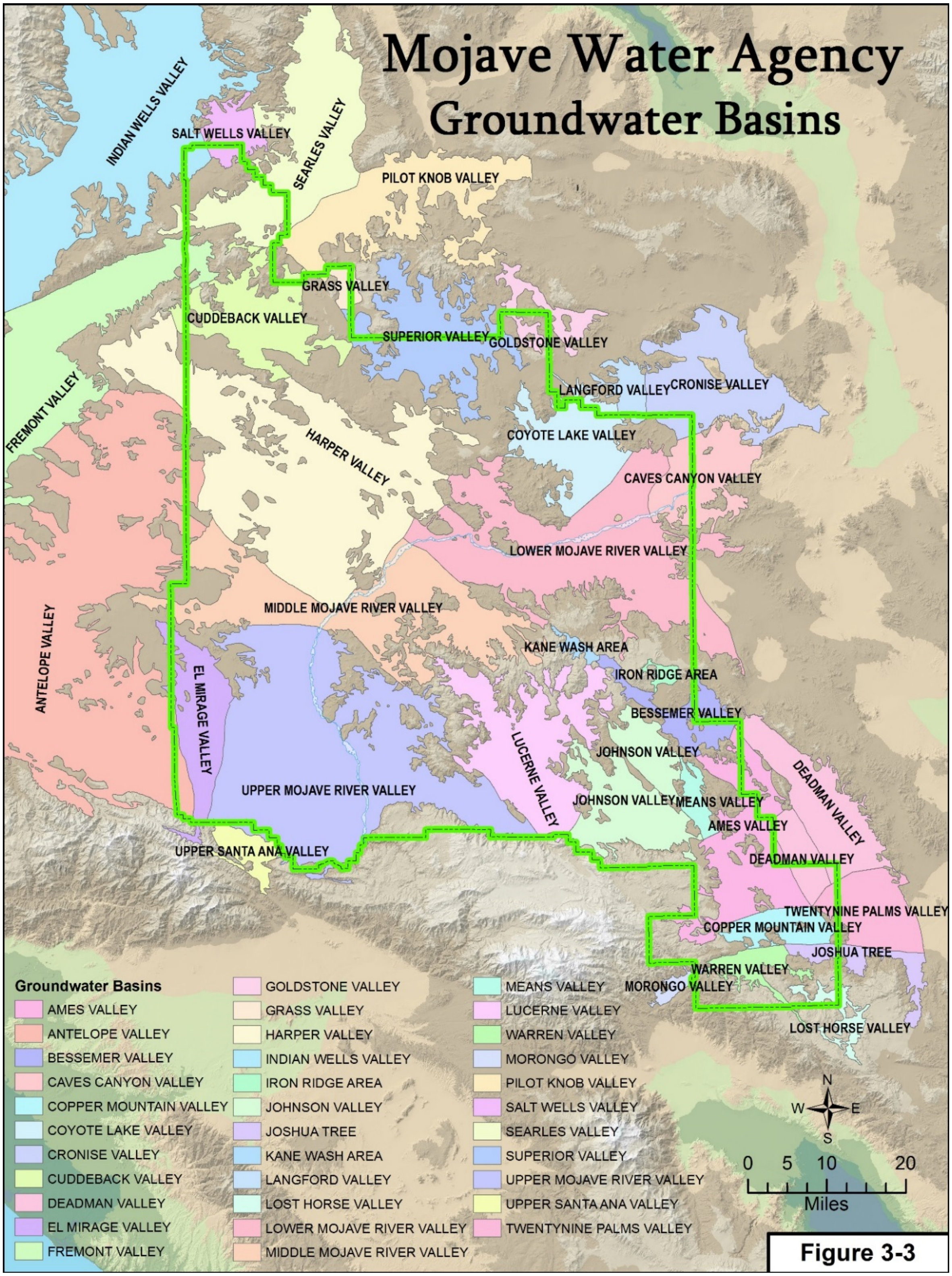


Figure 3-3: Mojave Service Area Groundwater Basins

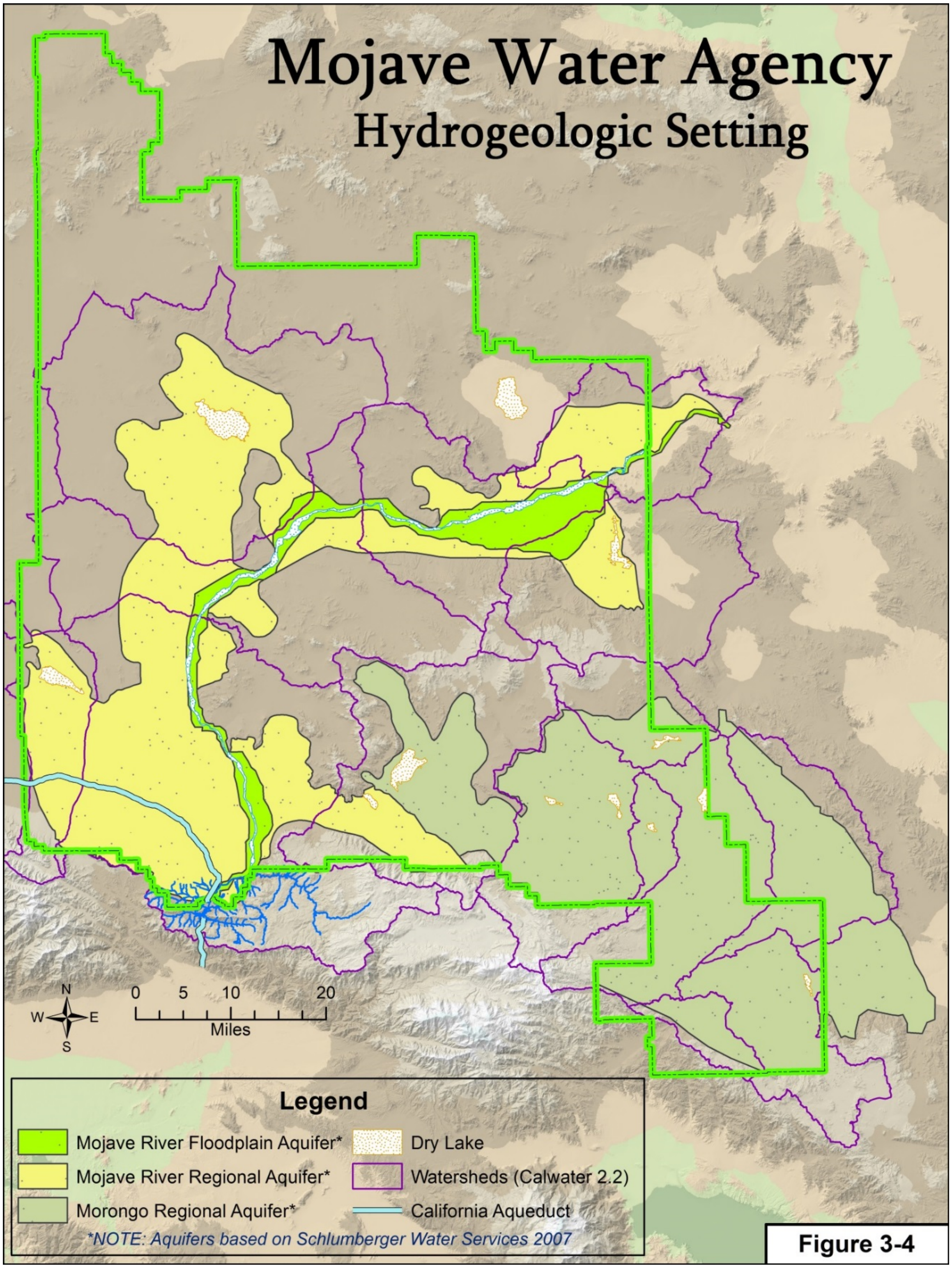


Figure 3-4: Hydrogeologic Setting

Groundwater flow in the Morongo Area is generally from south to north in Johnson Valley and from west to east-northeast elsewhere in the area. Natural recharge originates from the mountains on the southern and western boundaries of the Area, resulting in groundwater flow gradients to the north, east, and south adjacent to the boundaries, before turning to the east-northeast. The east- northeast flow direction is maintained to the eastern boundary of the Mojave Region. Groundwater flow is complicated locally by pumping, faulting, shallow bedrock, and enhanced recharge basins. For example, in the vicinity of the developed area of Yucca Valley, groundwater flow is controlled to some extent by local recharge basins.

3.4.2 Adopted Groundwater Management Plan

The California State Legislature passed Assembly Bill 3030 (AB 3030) during the 1992 legislative session allowing local agencies to develop Groundwater Management Plans (GWMPs). The legislation declares that groundwater is a valuable resource that should be carefully managed to ensure its safe production and quality. The legislation also encourages local agencies to work cooperatively to manage groundwater resources within their jurisdiction. Senate Bill 1938 (SB 1938) was passed by the Legislature September 16, 2002 and made changes and additions to sections of the Water Code created by AB 3030.

MWA's 2004 Regional Water Management Plan (RWMP), adopted on February 24, 2005 by Resolution 798-05, also serves as the GWMP for MWA as it contains all the relevant components related to Groundwater Management Plans in California Water Code Sections 10750-10753.10., as well as the components recommended by DWR in California's Groundwater, Bulletin 118 (DWR, 2003). The 2004 RWMP Update both complements and formalizes a number of existing water supply and water resource planning and management activities in the MWA service area that overlies several groundwater basins (see above), as defined by DWR in Bulletin 118.

A draft update of the GWMP was published in 2014, as part of the Mojave Region Integrated Regional Water Management Plan, which can be found online at this web address: http://www.mywaterplan.com/files/mwa_gmp_draft_toc_sect1.pdf. The draft update included revisions to Section 1 – Introduction of the GWMP. A full update was deferred given that the Sustainable Groundwater Management Act (SGMA) was not finalized yet. Deferring the full update would ensure that the GWMP is in full compliance with the SGMA. An update of the entire GWMP is currently being prepared and is expected to be completed by the end of 2016.

As part of the 2004 RWMP Update, the following Basin Management Objectives (BMOs) were established to plan water supplies through 2020:

- Balance future water demands with available supplies recognizing the need to:
    - Stabilize the groundwater basin storage balance over long-term hydrologic cycles
    - Protect and restore riparian habitat areas as identified in the Mojave Basin Area Judgment and the Department of Fish and Wildlife Habitat Water Supply Management Plan

- Limit the potential for well dewatering, land subsidence, and migration of poor quality water
- Maintain a sustainable water supply through extended drought periods
- Select projects with the highest likelihood of being implemented

- Maximize the overall beneficial use of water throughout MWA by:
  - Supplying water in quantity and of quality suitable to the various beneficial uses
  - Addressing issues throughout the MWA service area recognizing the interconnection and interaction between different areas
  - Distributing benefits that can be provided by MWA in an equitable and fair manner
  - Ensuring that costs incurred to meet beneficial uses provide the greatest potential return to beneficiaries of the project(s)
  - Avoiding redirected impacts
  - Identifying sustainable funding sources including consideration of affordability

Balancing future water demands with available supplies will increase water supply reliability by preventing overdraft of the groundwater. With groundwater storage stabilized, there will be groundwater available during surface water supply shortages and delivery interruptions. With a balanced basin, groundwater elevations will be relatively stable. This will reduce the potential for land subsidence and associated aquifer compaction.

The adopted 2004 RWMP also identified several water supply projects and management actions to provide a means to achieve the BMOs. Management actions can be grouped into the following seven major elements:

1. Monitoring regional groundwater quantity and quality
2. Improve characterization of the basin
3. Continue long-term planning
4. Groundwater protection
5. Construction and implementation
6. Financing
7. Public participation

The MWA Board acts as Watermaster for administration of the Mojave Basin Area Judgment. In the Mojave Basin Area, the Mojave Basin Area Judgment requires that annual water production records be collected and verified by producers exceeding 10 AFY of production within each of the five Mojave Basin Area Subareas. As the current Court-appointed Watermaster, much of the monitoring and studies in the Mojave Basin Area is conducted by MWA, based on the monitoring requirements described in the Judgment After Trial (1996). Data collected are reported in the Mojave Basin Area Watermaster

Annual Reports to satisfy the mandates of the monitoring requirements. The Warren Valley Basin is also subject to a Court judgment that is administered by the Hi-Desert Water District acting as the Court-appointed Watermaster. The Management Actions identified neither supersede nor conflict with the Mojave Basin Area Judgment or the Warren Valley Judgment. The Ames/Reche Groundwater Storage and Recovery Program was established by area partners Bighorn-Desert View Water Agency, Hi-Desert Water District, San Bernardino County Service Area (CSA) No. 70, with MWA providing administrative support. The Stipulation and Amended and Restated Judgment was finalized by the Superior Court of the State of California, County of Riverside in 2014. All provisions of these Judgments are integral parts of the foundation of this Plan.

In addition to conducting regional groundwater management, in 1990 MWA entered into a joint agreement with the USGS to develop and fund the Cooperative Water Resources Program (CWRP). The CWRP provides funding for a) groundwater level measurement and groundwater quality sampling activities across the Mojave River and Morongo groundwater basins; b) stream gage maintenance and continuous flow monitoring of the Mojave River; c) continuous and discrete sampling of Mojave River water quality; and d) review and uploading of data collected under the CWRP and other MWA groundwater monitoring programs to the publicly available USGS National Water Information System (NWIS) website. Using these data, MWA tracks water level trends and fluctuations throughout the service area. Groundwater production in the Mojave Basin is monitored and managed by the Watermaster.

As part of basin characterization activities, six groundwater models have been developed in the MWA service area to aid in management of groundwater. MWA continues to apply and refine these models in key management areas to better manage water quantity and quality.

3.4.3 Mojave River Groundwater Basin

In the Mojave River Groundwater Basin, the Mojave River is the largest stream, formed by the confluence of two smaller streams, West Fork Mojave River and Deep Creek, which originate in the San Bernardino Mountains. With the exception of small streams in the San Gabriel and the San Bernardino Mountains and short reaches of the Mojave River, there are no perennial streams in the Mojave Basin Area. Prior to groundwater development, the Mojave River flowed at a series of discharge areas near Victorville, at Camp Cady, at Afton Canyon, and at other areas where faults cause groundwater to discharge at land surface, such as near the Helendale or the Waterman Faults. Under present-day conditions the Mojave River does not flow perennially except at Deep Creek, the Narrows near Victorville, downstream from the Victor Valley Wastewater Reclamation Authority Facility(the Alto Transition Zone), and near Afton Canyon.

The Mojave River Groundwater Basin Area is essentially a closed basin – limited groundwater enters or exits the basin. However, within the basin groundwater movement occurs between the different Subareas, as well as groundwater-surface water and groundwater-atmosphere interchanges. Groundwater is recharged into the basin predominantly by infiltration of water from the Mojave River, which accounts for approximately 80 percent of the total basin natural recharge. Other sources of recharge include infiltration of storm runoff from the mountain, desert washes and recharge from human activities such as irrigation return flows, wastewater discharge, and enhanced recharge with imported water. Over 90 percent of the basin groundwater recharge originates in the San Gabriel and San Bernardino Mountains. Groundwater is discharged from the basin primarily by well pumping, evaporation through soil, transpiration by plants, seepage into dry lakes where accumulated water evaporates, and seepage into the Mojave River.

Recent investigations by MWA, USGS, and others have resulted in an improved understanding of the geology and hydrogeology of the Mojave Basin Area. Specifically, a more refined examination of the hydrostratigraphy has allowed for differentiation between the more permeable Floodplain Aquifer that has a limited extent along the Mojave River and the more extensive but less permeable Regional Aquifer. The aerial extent of the Floodplain and Regional aquifers is shown on Figure 3-4. In the Mojave Basin Area, Alto, Centro, and Baja Subareas contain both the Floodplain Aquifer and the Regional Aquifer while Oeste and Este Subareas only contain the Regional Aquifer.

The Floodplain Aquifer is composed of sand and gravel weathered from metamorphic and granitic rocks of the San Gabriel and the San Bernardino Mountains, respectively, and deposited in a fluvial depositional environment. These highly permeable sediments can yield large quantities of water to wells. The Floodplain Aquifer is directly recharged by infiltration of surface flows from the Mojave River during the winter rainy season (Figure 3-4). Recharge is greater near the mountain front where surface flows are more frequent.

The Regional Aquifer underlies and surrounds the Floodplain Aquifer with interconnected alluvial fan and basin fill deposits that drain toward the Mojave River (Figure 3-4). In some areas, permeable deposits from the ancestral Mojave River are present, but overall the aquifer is much less permeable than the Floodplain Aquifer. The Regional Aquifer is generally recharged by groundwater movement from the Floodplain Aquifer to the Regional Aquifer, infiltration of runoff from the higher altitudes of the San Gabriel and San Bernardino Mountains, and smaller amounts of runoff from local intermittent streams and washes.

Prior to recent population growth, most of the groundwater production occurred in the Floodplain Aquifer. Groundwater production was initially developed along the Mojave River in the early 1900s. In the mid-1950's, groundwater production had increased to about 190,000 AF, with most of the production still occurring along the river. By 1994, about half of the total basin production came from wells located away from the Mojave River in the Regional Aquifer (Stamos et al., 2001). The increase in water production and the re-distribution of pumping in the basin have significantly influenced the interaction between the Floodplain and Regional Aquifers. Prior to development in the area, groundwater flowed primarily from the Regional Aquifer into the Floodplain Aquifer. However, vertical groundwater gradients have been reversed in recent years, and downward flow from the Floodplain Aquifer is currently the primary recharge mechanism for the Regional Aquifer.

3.4.3.1 Groundwater Levels

Essentially all water supplies within MWA are pumped from the local groundwater basins and historically groundwater levels generally had been declining for 50 years or more in many parts of the region. Adjudication proceedings were initiated due to concerns that rapid population growth would lead to further overdraft. The resulting Mojave Basin Area Judgment requires that surface water be imported to help balance the basins.

The MWA maintains a comprehensive groundwater monitoring program consisting of approximately 850 wells from which approximately 150 water quality samples are collected annually. The Mojave Basin Area Watermaster tracks water production within each of the five Subareas in the Mojave Basin Area as part of the Watermaster's investigation into Subarea conditions and recommendations on groundwater pumping amounts. The Watermaster relies on the MWA groundwater level monitoring program along with production records to make recommendations regarding the sustainability for each of the Subareas. Figure 3-5 shows the locations of groundwater level monitoring. A summary of the recent water level trends for each of the five Subareas in the Mojave Basin Area is presented below.

Alto Subarea - Alto Subarea water levels near the Mojave River are relatively stable exhibiting seasonal fluctuations with rising levels in winter and declining levels in summer. It is expected that under current pumping conditions and long-term average flows in the river, water levels in the Floodplain Aquifer will generally remain stable. Water levels in the western portion of Alto in the Regional Aquifer have historically exhibited declines consistent with heavy pumping and limited local recharge. Currently water levels in the western Alto area show stability or slight recovery. Water levels in the eastern portion of Alto indicate similar trends although to a lesser extent; most likely due to limited pumping in the regional aquifer east of the river and possibly higher localized septic return flow due to the lack of sewers in some areas. Continued pumping in depleted areas of the Regional Aquifer may result in long-term local negative impacts such as declining yields and water quality problems. As a whole, the Alto Subarea presently appears to be in relative regional balance.

Centro Subarea - Water levels in Centro have been relatively stable with seasonal fluctuations and declines during dry years followed by recovery during wet periods. Water levels in the Harper Lake area indicate a slow recovery due primarily to reduced pumping during the past several years. Declines in water levels in wells in the vicinity of Hinkley (away from the river) show the effects of pumping and limited recharge, primarily due to agriculture.

Baja Subarea - Baja water levels continue to decline due to over-pumping and limited recharge. Wells near the river in the Daggett area respond to recharge when it is available following large storm events. Water levels elsewhere in Baja, especially areas away from the Mojave River, indicate declines that are not significantly impacted from storm events.

Este Subarea - Water levels in Este have remained relatively stable for the past 15 years. The water level data indicates that inflow is about equal to outflow.

Oeste Subarea – Hydrographs for the southern portion of Oeste Subarea indicate a long-term decline in water levels, but declines in most wells appear relatively small (less than or about one foot per year). More significant declines occur locally, especially in the vicinity of heavy pumping. Water levels in the north to central portion of Oeste near El Mirage indicate relatively stable conditions.

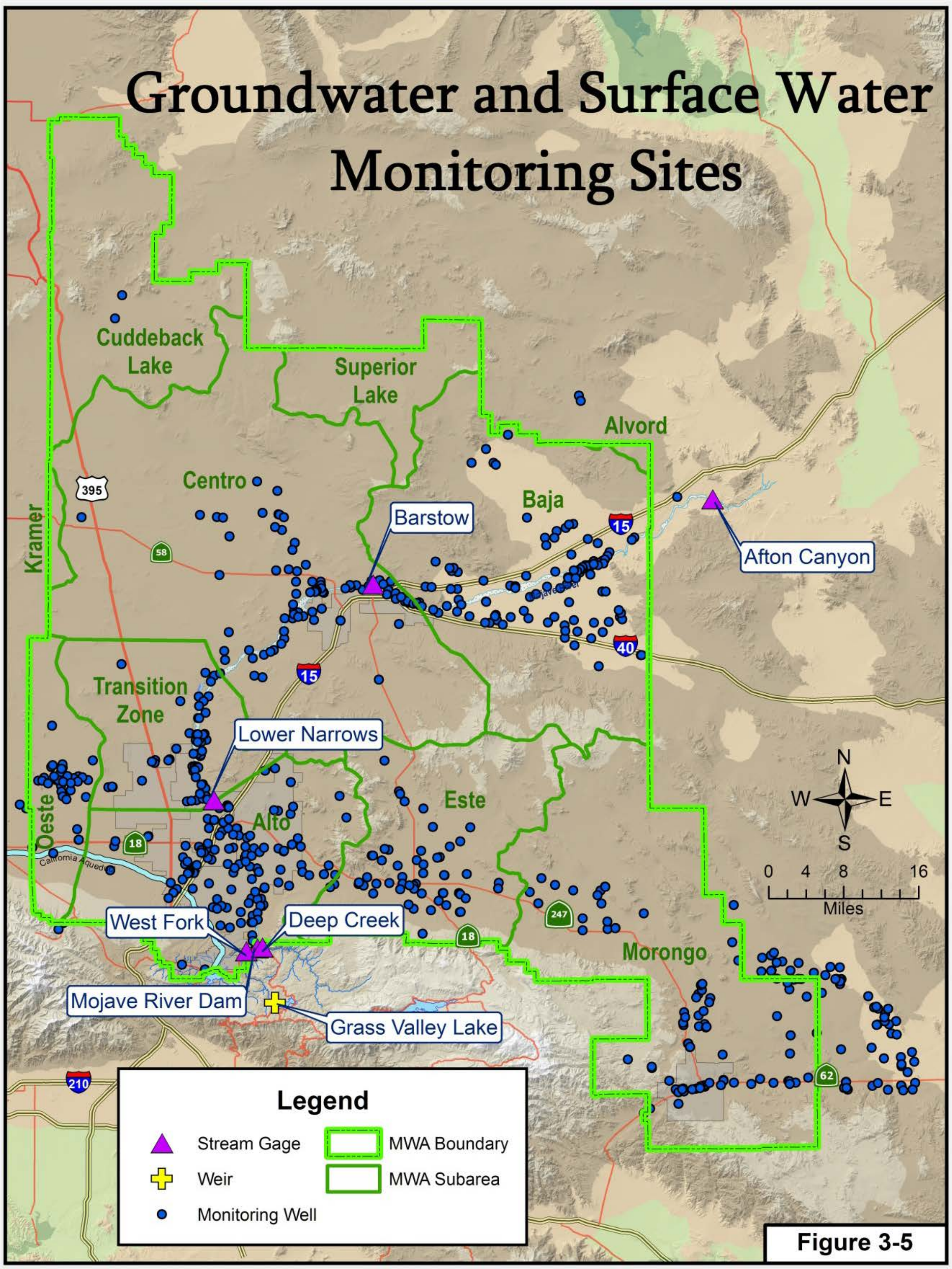


Figure 3-5: Groundwater/Surface Water Monitoring Sites

3.4.3.2 Available Groundwater Supplies

Projected groundwater pumping within each Subarea of the Mojave Basin Area is summarized in Table 3-7. In the Mojave Basin Area, Base Annual Production (BAP) rights were assigned by the Mojave Basin Area Judgment to each producer using 10 AFY or more, based on historical production. BAP is defined as the producer's highest annual water production for the five-year base period from 1986-90. Parties to the Judgment are assigned a variable Free Production Allowance (FPA) by the Watermaster, which is a percentage of BAP set for each Subarea for each year. The allocated FPA represents each producer's share of the water supply available for that Subarea. This FPA is reduced or "ramped-down" over time until total FPA comes into balance with available supplies.

Table 3-7: Mojave Basin Area Projected Groundwater Production (AFY)

Mojave Basin Area[(a)]	2015	2020	2025	2030	2035	2040
Subareas						
Alto	71,300	80,346	84,767	90,163	95,747	100,823
Baja	29,700	29,700	29,700	29,700	29,700	29,700
Centro	20,100	20,576	20,555	20,551	20,557	20,549
Este	6,800	6,800	6,800	6,800	6,800	6,800
Oeste	3,600	4,002	4,236	4,517	4,796	5,061
Total	**131,500**	**141,424**	**146,058**	**151,731**	**157,600**	**162,933**

Note:
(a) Acre-foot numbers represent groundwater production only and do not include demands met directly with SWP sources.

Production Safe Yield (PSY) is defined in the Judgment. Exhibit H of the Judgment requires that in the event the FPA exceeds the estimated PSY by five percent or more of BAP, Watermaster recommends a reduction in FPA equal to, but not more than, a full five percent of the aggregate Subarea BAP. Any water user that pumps more than their FPA in any year is required to buy "Replacement Water" equal to the amount of production in excess of their FPA. Replacement Obligations can be satisfied either by paying the Mojave Basin Area Watermaster to purchase imported water from MWA or by temporarily transferring unused FPA within that Subarea from another party to the Judgment.

Table 3-8 shows the current FPA for water year 2015-2016 for each Subarea and the estimated PSY. Also shown in Table 3-8 is the verified production for water year 2014-2015 for comparison. The Judgment provides that producers can pump, without replacement water obligations to Watermaster an amount up to the producers' share of the Subarea FPA. Producers who pump in excess of their FPA are required to buy replacement water from Watermaster or purchase FPA from another party in the Subarea. The transfer provision of the Judgment, one of the fundamental underpinnings, allows producers who chose to not pump to sell FPA to those parties who over-pump. This provision allows parties who stipulated to the Judgment the option of compensation in lieu of pumping. The transfer market is a means of equitably allocating the limited supply within a Subarea. The following summarizes the status of each Subarea and provides the Court adopted FPA for Water Year 2015-16.

- Alto Subarea - 80 percent of BAP for agriculture and 60 percent of BAP for municipal and industrial
  Baja Subarea – 50 percent of BAP
  Centro Subarea - 80 percent of BAP
  Este Subarea - 80 percent of BAP
  Oeste Subarea - 80 percent of BAP for agriculture and 60 percent of BAP for municipal and industrial (held in abeyance at 80 percent)

Table 3-8: Mojave Basin Area Production Safe Yield and Current Free Production Allowance (AFY)

Mojave Basin Area	Base Annual Production	2015-2016 FPA	Production Safe Yield	Percent Difference(1)	2014-2015 Verified Production
Subareas					
Alto	116,412	72,867	69,862	2.6%	68,002
Baja	66,157	34,232	20,679	20.5%	27,452
Centro	51,030	41,155	33,375	15.2%	18,522
Este	20,205	16,376	7,156	45.6%	5,823
Oeste	7,095	5,726	4,052	23.6%	3,424

Source: Twenty-second Annual Report of the Mojave Basin Area Watermaster, Water Year 2014-15
(1) This value represents the percent of BAP that PSY departs from FPA.

Table 3-9 summarizes the long term average net natural water supply estimates for each of the Subareas that comprise the Mojave Basin Area. The long term supply to each Subarea, and the Basin Area as a whole, is assumed to available in all year types, normal, single dry year and multiple dry year. A premise of the Judgment is that all demands are met. The Judgment requires that any deficit in any year, must be purchased and recharged the following year. During dry periods water will be depleted from groundwater storage (as measured against the long term average) and replaced into storage during wet periods. Annual Deficits in each Subarea are to be resolved by importation of SWP imports.

Table 3-9: Mojave Basin Area Groundwater Basin Supply Reliability

Anticipated Supply	Normal Year (a) (AFY)	Single-Dry Water Year (AFY)	Multiple Dry Water Year (AFY)
Subareas			
Alto	25,900	25,900	25,900
Baja	11,428	11,428	11,428
Centro	15,713	15,713	15,713
Este	1,500	1,500	1,500
Oeste	700	700	700
Total	**55,241**	**55,241**	**55,241**

Note:

(a) Water supply balance in Table 5-2 from the Twenty-second Annual Report of the Mojave Basin Area Watermaster, Water Year 2014-15, based on long-term average net natural water supply and outflow.

3.4.3.3 Adequacy of Supply

Essentially all of the water used within the MWA is supplied by pumping groundwater. The physical solution to the Mojave Basin Judgment sets limits on the amount of groundwater production that can occur in each Subarea without incurring an obligation to buy imported water. Subareas upstream have an annual obligation to provide specific inflows to Subareas downstream based on long-term averages between 1931 and 1990.

Because water use within the MWA service area is supplied entirely by groundwater, MWA does not have any inconsistent water sources that cause reduced deliveries to users within the service area. Natural supply estimates are based on the long-term averages which account for inconsistency in supplies (i.e. historic periods of drought are included in the long-term average). A potential exception is any area where water quality could limit use as a potable supply. Wellhead treatment or provision of an alternative supply is planned for these areas.

MWA directly supplies imported SWP water to two power plants. The supply to the High Desert Power Project (HDPP) is annual, interruptible and only available if adequate SWP water is available on a year-to-year basis. The HDPP is converting to recycled water and has stored SWP water in the Mojave River Groundwater Basin to offset shortages. In September 2010, HDPP signed an agreement to purchase 4,000 AFY of recycled water from the City of Victorville, which can come from any combination of SWP, recycled water from Victor Valley Wastewater Reclamation Authority (VVWRA), or the City of Victorville's new recycled treatment plant at the Southern California Logistics Airport (SCLA) site. The other power plant (LUZ Solar Plant) is entirely dependent upon SWP water delivered by exchange through the Antelope Valley-East Kern Water Agency (AVEK) system. LUZ currently has water stored in the Alto Subarea to offset potential SWP delivery reductions when allocations are low as well as in AVEK's service area.

3.4.3.4 Sustainability

Producers in the Mojave Basin Area are allowed to produce as much water as they need annually to meet their requirements, subject only to compliance with the physical solution set forth in the Mojave Basin Area Judgment. An underlying assumption of the Judgment is that sufficient water will be made available to meet the needs of the Basin in the future from a combination of natural supply, imported water, water conservation, water reuse and transfers of FPA among parties.

MWA is actively operating recharge sites for conjunctive use along the Mojave River Pipeline, Oro Grande Wash Pipeline, Morongo Basin Pipeline and Silverwood Dam. Recharge sites including Hodge, Lenwood, Daggett, Newberry Springs, Oro Grande Wash, upper Mojave River, Deep Creek and Rock Springs which provide MWA with the ability to recharge SWP water into the Subareas where replacement water is purchased. These sites also provide MWA with the ability to bank excess SWP water as available. R^3 facilities allow MWA to manage Alto groundwater basins by delivering imported SWP water stored in upper Mojave River recharge areas to purveyors that can reduce pumping from their wells when taking R^3 water which allows partial recovery of local pumping depressions.

Water levels within each of the five Subareas are evaluated as part of the Watermaster's investigation into Subarea conditions and recommendations on FPA. The Judgment does not specifically require that Watermaster consider changes in water levels in its investigation but Paragraph 24 (o) of the Judgment requires Watermaster to consider changes in water in storage. Rising and falling water levels within the Mojave Basin Area are indications of changes in storage over time. If after full implementation of the Judgment, water levels continue to fall in certain parts of the Basin Area, the Court, at Watermaster's recommendation may direct recharge or further reductions in FPA as necessary to achieve long term sustainability. Such action is not anticipated given the current projections of use and availability of supplemental water to MWA.

3.4.4 Morongo Basin/Johnson Valley Area

The groundwater basins within the Morongo Basin/Johnson Valley Area ("Morongo Area") are bounded by the Ord and Granite Mountains to the north, the Bullion Mountains to the east, the San Bernardino Mountains to the southwest, and the Pinto and Little San Bernardino Mountains to the south. The larger Morongo Area includes numerous small alluvial basins that maintain relatively compartmentalized groundwater flow systems typically terminating in dry lakes scattered throughout the area. These smaller alluvial basins are separated by faults and bedrock outcrops.

DWR defines 15 groundwater basins/subbasins that cover a portion of the Morongo Area as defined in this plan. Several of these basins lie mostly outside of the MWA service area, have low population, and are essentially undeveloped with respect to groundwater. The remaining basins have been grouped into six regions for the Morongo Area as previously described and shown on Figure 3-3.

The hydrogeology of the Morongo Area has not been investigated to the same extent as the Mojave River Groundwater Basin, but recent investigations have resulted in an improved understanding, especially in areas where the need for active groundwater management has been identified. These basins were formed in the Tertiary Period from movement along the San Andreas Fault to the south and the Garlock Fault to the north, creating the Mojave structural block. As such, the Morongo Area is characterized by numerous northwest trending strike-slip faults. The San Bernardino Mountains and bedrock underlying the groundwater basins consist mainly of Jurassic and Cretaceous granitic rocks. The bedrock surface dips steeply to the north and east, providing a large thickness of alluvial sediments a short distance from the mountain front. The Tertiary and Quaternary age alluvial sediments are the main aquifers in the groundwater basin.

Groundwater flow in the Morongo Area is generally from south to north in Johnson Valley and from west to east-northeast elsewhere in the area. Natural recharge originates from the mountains on the southern and western boundaries of the Area, resulting in groundwater flow gradients to the north, east, and south adjacent to the boundaries, before turning to the east-northeast. The east-northeast flow direction is maintained to the eastern boundary of the MWA service area. Groundwater flow is complicated locally by pumping, faulting, shallow bedrock, and enhanced recharge basins. For example, in the vicinity of the developed area of Yucca Valley, groundwater flow is controlled to some extent by local recharge basins.

3.4.4.1 Available Groundwater Supplies

Recent historical and projected groundwater pumping for the Morongo Area is summarized in Table 3-10 and Table 3-11.

Table 3-10: Morongo Area Historical Groundwater Production by Water Year (AFY)

	2011	2012	2013	2014	2015
Morongo Area	5,685	5,867	6,479	6,494	6,509

Source: Production data reported by retail water agencies plus MWA estimate of minimal producers (approximately 200 AFY) within the Morongo Area.

Table 3-11: Morongo Area Projected Groundwater Production (AFY)

	2015	2020	2025	2030	2035	2040
Morongo Area	6,509	6,942	7,128	7,349	7,564	7,767

Two of the Morongo Area regions have been documented as having either historical or current overdraft conditions including the Ames Valley and Copper Mountain Valley/Joshua Tree regions. MWA is currently assisting the retailers in these regions with enhanced recharge projects to alleviate overdraft and provide an alternative source of water supply.

In the Ames Valley and Johnson Valley regions, the Bighorn-Desert View Water Agency (BDVWA) has implemented a Water Infrastructure Restoration Program (WIRP) that outlines specific system improvements to remediate deficiencies in infrastructure and operations. Recently, two WIRP projects have been implemented, including the Ames/Reche Groundwater Storage and Recovery Program and a Groundwater Management Plan (BDVWA GWMP). Local groundwater is currently the sole source of its water supply, but BDVWA has an annual 9 percent capacity in the Morongo Basin Pipeline and may purchase SWP water from MWA.

BDVWA is the Lead Agency for the WIRP and the GWMP, but the implementation also includes other participating agencies. MWA is a financial participant, while Hi-Desert Water District (HDWD) and San Bernardino County Service Area (CSA) No. 70 are cooperative partners who will benefit through participation in the groundwater storage and recovery program.

To assist with the Joshua Tree subbasin overdraft, the recently completed Joshua Basin Recharge Project has created a mechanism for the Joshua Basin Water District (JBWD) to make use of SWP water via the Morongo Basin Pipeline. Currently, JBWD has an agreement in place with MWA in which JBWD has an annual 27 percent capacity in the Morongo Basin Pipeline and may purchase SWP water via the Morongo Basin Pipeline. The Joshua Basin Recharge Project provides JBWD the ability to purchase and deliver needed recharge into the Joshua Tree subbasin to relieve overdraft conditions.

Table 3-12 summarizes the net average annual water supply estimates for each of the regions that comprise the Morongo Area. The net average water yield of the entire Morongo Area is about 2,108 AFY. These numbers generally represent the perennial yield of the basins based on varying levels of data as summarized below.

For the Ames Valley Region, a perennial yield of 888 AFY was derived from the *Hydrogeologic Feasibility Study and Groundwater Management Plan for the Ames/Reche Project* by Todd Engineers for BDVWA. Although the model also considered septic return flows, those totals are not included in the perennial yield calculation.

Current production wells in the Ames Valley are located to limit subsurface outflow from the recharge project's subbasin and should be able to capture perennial yield as needed. In addition, the supply estimate of 888 AFY is somewhat under-estimated, given that no recharge or groundwater storage was assigned to a large downgradient area that has not been adequately investigated due a lack of significant groundwater development.

The supplies for the Morongo Area are shown in Table 3-12. These estimates of perennial yield were derived from a water balance from the 2007 Basin Conceptual Model Report, prepared by Kennedy/Jenks/Todd. Groundwater supplies for Copper Mountain Valley/Joshua Tree and the Warren Valley are documented in the 2004 USGS Evaluation completed by Nishikawa, Izbicki et al. in cooperation with JBWD (USGS Nishikawa, Izbicki, et al., 2004) and the 2003 USGS Evaluation completed by Nishikawa, Densmore et al. in cooperation with HDWD (USGS Nishikawa, Densmore et al., 2003), respectively.

The perennial yields described above are maintained for both a single-dry year and multiple-dry year scenarios in Table 3-12. Although recharge to the groundwater basin is typically less during dry years, the perennial yield values account for the transient nature of recharge in the groundwater system. Due to the time lag associated between recharge and change in groundwater storage near supply wells, these basins are considered reliable in both dry and wet years if long-term overdraft is avoided.

As discussed later in this Chapter, MWA has planned for water shortages by banking excess and available SWP in the groundwater basins for use at a later time. MWA also improves their reliability of water supply by using some of this banked water as operational storage during the year. For operational reliability, a portion of the banked supply is used to accommodate the day to day or month to month variances in supply that can occur during the year and leave retailers short of supply.

Table 3-12: Morongo Basin/Johnson Valley Area Groundwater Basins Supply Reliability

Anticipated Supply	Normal Year[(a)] (AFY)	Single-Dry Water Year (AFY)	Multiple Dry Water Year (AFY)
Regions			
Ames Valley[(b)]	888	888	888
Johnson Valley[(c)]	900	900	900
Means Valley[(c)]	20	20	20
Copper Mountain Valley/Joshua Tree[(d)]	200	200	200
Warren Valley[(e)]	100	100	100
Total	**2,108**	**2,108**	**2,108**

Notes:

(a) To avoid double counting with MWA's demand forecast model which includes return flows from septic tanks, this normal year has been calculated as the safe or perennial yield of the basin and does not include return flows in the safe yield calculation.

(b) Bighorn Desert View Water Agency, Groundwater Management Plan Pipes and Reche Groundwater Subbasins, Ames Valley Groundwater Basin, San Bernardino County, California, February 2012

(c) Source: "Basin Conceptual Model and Assessment of Water Supply and Demand for the Ames Valley, Johnson Valley, and Means Valley Groundwater Basins", April 2007, Kennedy/Jenks/Todd. Tables in ES.

(d) USGS Nishikawa, Izbicki et al., 2004.

(e) USGS Nishikawa, Densmore et al., 2003.

There are three water supply agreements that are applicable to groundwater management in the Morongo Area, including (1) the Warren Valley Basin Agreement, (2) Ames/Reche Groundwater Storage and Recovery Program and Management Agreement, and (3) an agreement for the users of the Morongo Basin Pipeline. The purpose of the agreement is to improve reliability of the shared water supply.

The Warren Valley Basin Agreement is an agreement between MWA, HDWD, and the Warren Valley Basin Watermaster. This agreement affects the use of the Morongo Basin Pipeline including pipeline users in the Ames Valley, Means Valley, and Johnson Valley groundwater basins. The primary purpose of the agreement is to more efficiently use available water supply and to provide supplemental water to the Watermaster in the event that water levels drop too low to support the adjudicated water rights.

The Morongo Basin Pipeline Agreement of 1991 is an agreement between BDVWA, HDWD, JBWD, CSA No. 70, and MWA for construction, operation, and financing of the Morongo Basin Pipeline Project.

The Ames Valley Basin Water Agreement is a 1991 Agreement between HDWD and BDVWA for the construction and operation of the HDWD Mainstream Well in the Ames Valley basin. At the time the Agreement was entered, the HDWD service area included areas within the Ames Valley basin and the Warren Valley basin. The 1991 Ames Valley Basin Water Agreement has been superseded by the 2014 Ames/Reche Groundwater Storage and Recovery Program and Management Agreement, which is intended to support long-term management of local groundwater resources within portions of the Ames Valley and Copper Mountain Valley basins.

3.4.4.2 Adequacy of Supply

The entire Morongo Area has limited natural supply, with a large portion of the Area relying on MWA's ability to provide SWP water through the Morongo Basin Pipeline. The Warren Basin (i.e. Town of Yucca Valley) was the first to experience obvious overdraft issues and relies on imported water and the three associated recharge sites to support the adjudication. Remaining water districts in the region consisting of BDVWA, CSA No. 70, and JBWD are at or close to surpassing their natural supply and these agencies have constructed recharge facilities which allow them to purchase and deliver imported SWP water to address their own supply issues. The Morongo Basin Pipeline has capacity to deliver water to the benefit of the BDVWA, HDWD, JBWD and the CSA No. 70. There are five separate recharge facilities in use for the purpose of maintaining a sustainable groundwater supply to the region(s).

3.4.4.2 Sustainability

The Warren Valley adjudication mandates that groundwater extraction in the adjudicated portion of the Warren Valley Basin does not exceed the estimated annual supplies and empowers the HDWD as Watermaster to enforce pumping limits as mandated by the Court. The Watermaster performs monitoring in accordance with the Rules and Regulations of the Warren Valley Watermaster (1995). Monitoring activities currently performed by the Watermaster include water production and verification, water level measurement, and water quality.

The Ames-Reche Groundwater Storage and Recovery Program and Management Agreement establishes groundwater production and storage rights and mechanisms for the management of water supply and reliability within the basin management area. Collectively, the agreement and associated Monitoring Program Plan will provide the institutional framework for the purchase, recharge, and recovery of imported SWP water through the Morongo Basin Pipeline Agreement. A basin-wide groundwater monitoring program will provide the necessary data for effective management into the future.

For the Copper Mountain Valley/Joshua Tree Region, ongoing implementation of an enhanced recharge project and the GWMP will ensure sustainability in the region. In the Johnson Valley Region, BDVWA is undertaking an evaluation of the estimated water supply as part of their WIRP as discussed previously. The Means Valley Region is small and sparsely populated with only limited domestic groundwater development. No impediments to sustainable management are envisioned for these regions.

3.4.5 Potential Supply Inconsistency

Because water use within the MWA service area is supplied almost entirely by groundwater, MWA does not have any inconsistent water sources that cause reduced deliveries to users within the service area. A potential exception is areas where water quality could limit use as a potable supply or the LUZ Solar Power Plant which is supplied directly with SWP water and has no alternative supply. While many of the sources that recharge the groundwater basin have high annual variability, including flows on the Mojave River and supplies from the SWP, the groundwater basins used within the MWA service area are sufficiently large to allow for continued water use during dry periods with only a temporary decline in groundwater levels.

MWA's groundwater basins contain several areas with water quality issues, as described in Section 5. Key contaminants include arsenic, nitrates, iron, manganese, Chromium VI, and total dissolved solids (TDS). Measurements in excess of drinking water standards have been found for some of these constituents in local areas of each Subarea in the Mojave Basin Area and each region within the Morongo Area. Ongoing water quality monitoring allows identification of more sensitive areas. Groundwater pumping in these localized areas will have to be avoided, treated or blended.

Over the past several years, the MWA has made efforts to greatly increase the understanding of the water quantity and quality of the groundwater basins that lie within its service area. The Agency currently maintains a monitoring network of approximately 850 monitoring wells that record water levels on a regular basis. Many monitoring wells in the MWA monitoring network are sampled to analyze water quality. Additional information concerning water quality issues and replacement capacity is also provided in Section 5.

3.5 Transfers, Exchanges, and Groundwater Banking Programs

In addition to SWP water supplies and groundwater, MWA is currently exploring opportunities to sell water supplies to other water agencies and shore up some additional dry year programs for dry year supply reliability for those that need or want a reliable supply other than SWP (i.e. power plants). Transfers, exchanges, and groundwater banking programs, such as those described below, are important elements to enhancing the long-term reliability of the total mix of supplies currently available to meet water demand.

3.5.1 Transfers and Exchanges

An opportunity available to MWA to increase water supplies is to participate in voluntary water transfer programs. Since the drought of 1987-1992, the concept of water transfers has evolved into a viable supplemental source to improve supply reliability. The initial concept for water transfers was codified into law in 1986 when the California Legislature adopted the "Katz" Law (California Water Code, Sections 1810-1814) and the Costa-Isenberg Water Transfer Law of 1986 (California Water Code, Sections 470, 475, 480-483). These laws help define parameters for water transfers and set up a variety of approaches through which water or water rights can be transferred among individuals or agencies.

According to the California Water Plan Update 2013, approximately 25 million AFY of water are delivered for agricultural use every year. Over half of this water use is in the Central Valley, and much of it is delivered by, or adjacent to, SWP and Central Valley Project (CVP) conveyance facilities. This proximity to existing water conveyance facilities could allow for the voluntary transfer of water to many urban areas, including MWA, via the SWP. Such water transfers can involve water sales, conjunctive use and groundwater substitution, and water sharing and usually occur as a form of spot, option, or core transfers agreement. The costs of a water transfer would vary depending on the type, term, and location of the transfer. The most likely voluntary water transfer programs would probably involve the Sacramento or southern San Joaquin Valley areas.

One of the most important aspects of any resource planning process is flexibility. A flexible strategy minimizes unnecessary or redundant investments (or stranded costs). The voluntary purchase of water between willing sellers and buyers can be an effective means of achieving flexibility. However, not all water transfers have the same effectiveness in meeting resource needs. Through the resource planning process and ultimate implementation, several different types of water transfers could be undertaken.

3.5.2 Opportunities for Short and Long-Term Transfers and Exchanges

Prior to purchases of Table A amount (permanent transfers) from other water agencies, MWA's Table A amount was 50,800 AFY. In January 1997, MWA purchased 25,000 AF of Table A from Berrenda Mesa Water District/Kern County Water Agency. It was transferred to MWA in 1998, bringing MWA's Table A to 75,800 AFY. In October 2009, MWA purchased 14,000 AF from Dudley Ridge Water District; the transfer of Table A from Dudley to MWA is occurring in three stages:

- 7,000 AF in 2010 for a total of 82,800;
- 3,000 AF in 2015 for a total of 85,800;
- 4,000 AF in 2020 for a total of 89,800

Table 3-13 summarizes the potential water transfer and exchange opportunities identified by MWA at this time. One option of utilizing unused SWP water would be to transfer a portion of it to another party as part of a storage agreement or exchange program. MWA and Metropolitan Water District of Southern California (Metropolitan) agreed on a Water Exchange Pilot Program with the goals of facilitating a water exchange in the short-term and helping to determine the feasibility of a similar long-term exchange program between the two parties. Under the terms of the Exchange Pilot Program, Metropolitan delivers to MWA up to 75,000 AF of its SWP deliveries or other water. In exchange, in years when Metropolitan requests water, MWA will provide water to Metropolitan through exchange of MWA's SWP deliveries for that year. Through the program, there were two deliveries to storage by Metropolitan in 2003 and 2005 for a total of almost 45,000 AF, which has been returned. In 2011, MWA and MWD extended the program for up to an additional 390,000 acre feet of water. In 2011 and 2012, MWA received a total of 60,067 acre feet. So far, 29,243 acre feet of water has been returned leaving a balance owed of 30,824. The MWA retains the first 10 percent of annual allocations for its own use through 2021 plus 20 percent in 2022 and anything above that is eligible to be returned to MWD.

In 2014, MWA entered into two agreements with the Central Coast Water Authority (CCWA) to exchange 1,000 acre feet of water. Under one agreement, MWA and CCWA agreed to a balanced exchange with a cost recovery component for 500 acre feet. When allocations are above 40 percent, CCWA will return the water to MWA according to a schedule at varying allocations. The second agreement was an unbalanced exchange for 500 acre feet and CCWA will return 1,125 acre feet when allocations are above 40 percent according to a schedule at varying allocations.

MWA also had a Table A exchange program in place with the Solano County Water Agency (SCWA). This agreement allowed MWA to receive Table A deliveries from the SCWA during hydrologic periods when the SCWA had approved Table A allocations in excess of their needs. MWA is no longer storing SCWA water for future exchanges, with the last exchange occurring in 2015.

Another MWA transfer program consists of an existing agreement to transfer up to 1,800 AFY to the Antelope Valley-East Kern Water Agency (AVEK). The water is transported by AVEK to the LUZ Solar Power Plant located near Kramer Junction within the MWA service area. The agreement also allows LUZ Solar to store up to 3,000 acre feet for reliability of service that they require, of which there is currently about 800 acre feet in storage.

Although the exchange programs described are limited in scope and duration, they represent the types of exchange opportunities MWA and other SWP contractors have to maximize their utilization of available water supplies from the SWP. MWA continues to explore opportunities for these types of exchanges.

In addition, the rules of the Mojave Basin Area Judgment allow for the possibility of in-basin transfers. Under the rules of the Judgment, producers are allowed to sell or lease unused BAP and FPA to other parties within the same Subarea.

Table 3-13: Water Transfer and Exchange Opportunities in MWA Service Area

Name/Type	Exchange/Transfer	Duration	Proposed Quantities
Pre-delivery of Unused SWP Supplies	Current water contract	Permanent	Up to 220,000 AF total from 2010 to 2030
Solano County Water Agency	Exchange Pilot Program	Ended in 2015. No further action.	Pilot program only
Antelope Valley-East Kern Water Agency	Transfer	Ongoing	1,800 AF
Central Coast Water Authority	Exchange	Ongoing	1,000 AF
Metropolitan Water District Water Exchange Program	Exchange	Ongoing	465,000 AF
Other SWP Contractors	Water transfer, exchange, or banking	Under consideration	Not defined
Transfers within Mojave Basin Subareas	Base Annual Production (BAP) and/or Free Production Allowance (FPA)	Ongoing	Variable

Source: MWA.

3.5.3 Groundwater Banking Programs

With recent developments in conjunctive use and groundwater banking, significant opportunities exist to improve water supply reliability for MWA. Conjunctive use is the coordinated operation of multiple water supplies to achieve improved supply reliability. Most conjunctive use concepts are based on storing surface water supplies in a local groundwater basin during times of surplus for use during dry periods when surface water supplies would likely be reduced.

Groundwater banking programs involve storing available SWP surface water supplies during wet years in groundwater basins. Water would be stored either directly by surface spreading or injection, or indirectly by supplying surface water to farmers for use in lieu of their intended groundwater pumping. During water shortages, the stored water could be extracted and conveyed through the California Aqueduct to MWA as the banking partner, or used by the farmers in exchange for their surface water allocations, which would be delivered to MWA as the banking partner through the California Aqueduct. Several conjunctive use and groundwater banking opportunities are available to MWA.

MWA operates its own conjunctive use program to take advantage of the fact that the available MWA supply on average is greater than the demand in the service area. A portion of the groundwater stored by this program is used in dry years (see Tables 6-4, 6-5, and 6-6), along with addressing the variability of SWP allocation on an annual basis. Water stored in the groundwater basin surplus to that needed for dry year supply or to address SWP annual allocation variability is a supply of stored water for the future. This program allows MWA to take advantage of wet year supplies because of the groundwater storage space available in the basin.

Table 3-14 shows the storage available in MWA's existing banked accounts by Subarea as of December 31, 2015. Unless otherwise noted, the water was all excess SWP water that MWA has purchased over the past years and stored in various groundwater basins for use when SWP is limited or there are groundwater shortages. MWA will continue to make such purchases when available to ensure the supply of water to their retailers. Some individual retailers in the MWA service area have their own individual banked storage accounts that are included in a separate column in the table below.

Table 3-14: Status of MWA Groundwater Storage Accounts

Subarea	MWA-Owned Stored Water[a] (AF)	Retailer-Owned Stored Water[b] (AF)	Total Stored Water (AF)
Alto	85,185	15,113	100,298
Baja	21,236	0	21,236
Centro	20,224	0	20,224
Este	1,341	0	1,341
Oeste	0	0	0
Morongo	0	11,451	11,451
Total	**127,986**	**26,564**	**154,550**

Notes:
(a) MWA's banked groundwater storage accounts as of December 31, 2015.
(b) Retailer-owned water is owned by one of MWA's retailer agencies and consists of excess SWP purchased by MWA and then bought by the retailer.

3.5.3.1 Regional Recharge and Recovery Project ("R³ Project")

The Regional Recharge and Recovery Project, known as "R³," is a conjunctive use project that imports and recharges SWP water to be stored underground in the local aquifer and later recovers and distributes water to local retail water purveyors in lieu of them pumping water from their production wells. R³ is part of a comprehensive solution developed by the MWA and the region's stakeholders to manage a sustainable water supply for the region. MWA-owned production wells on either side of the Mojave River located immediately downstream of the recharge area recover and deliver the water through pipelines directly to retail water agencies in lieu of these agencies utilizing some of their own production wells, which allows the pumping depressions some recovery. Water pumped is billed through the Watermaster and any water pumped in excess of the retailers FPA is billed as Replacement Obligation and met through MWA's groundwater storage account. This method of water basin management targets the specific local well pumping depressions for the wells the retail agencies would normally use so they can reduce or eliminate pumping from them while taking R^3 water.

This project provides access to an alternative delivery system for the major water providers in the Mojave Basin and partially offsets their need to continue pumping within the local regional aquifer system. Water providers that benefit or can benefit from the R^3 Project include Liberty Utilities (Apple Valley Ranchos Water) Corp., City of Adelanto, City of Hesperia, Golden State Water Company, San Bernardino County Service Area 64 and the Victorville Water District. Phase 1 of the project was constructed to allow delivery of 15,000 acre-feet per year of imported SWP supply previously recharged. The Phase 1 facilities were completed and began operating in 2013. Phase 2 is planned to be completed once the capacity of the Phase 1 facilities is reached.

3.6 Planned Water Supply Projects and Programs

MWA, as part of the Regional Water Management Group, completed the Mojave Integrated Regional Water Management (IRWM) Plan in 2014. The IRWM Plan was a collaborative, stakeholder-driven effort to manage all aspects of water resources in the region, and will set a vision for the next 10-plus years of water management in the High Desert. The IRWM Plan updates and expands upon the original 2004 IRWM Plan, documents progress towards meeting IRWM Plan goals, identifies current regional water resource management needs and issues, and evaluates strategies for addressing the region's challenges. As part of the IRWM planning process, stakeholders identified 14 objectives to be addressed by the IRWM Plan, as summarized in Table 3-15.

Table 3-15: IRWM Plan Objectives

Summary of Objective	Importance (a)	Urgency (b)
Tier 1 Priority Objectives		
1. Balance average annual future water demands with available future supplies to ensure sustainability throughout the Region between now and the 2035 planning horizon and beyond.	High	High
3. Maintain stability in previously overdrafted groundwater basins and reduce overdraft in groundwater basins experiencing ongoing water table declines.	High	High
7. Provide support and assistance to disadvantaged communities and help facilitate projects and programs that benefit those communities.	High	High
Tier 2 Priority Objectives		
2. Continue improving regional water use efficiency by implementing a portfolio of conservation actions that are regionally cost-effective.	High	Medium
4. Address the State policy goal of reducing reliance on the Delta by meeting water demands with alternative sources of supply during times when SWP supplies are reduced or unavailable due to droughts, outages, environmental and regulatory restrictions, or other reasons.	High	Medium

Summary of Objective	Importance [(a)]	Urgency [(b)]
5. Optimize the use of the Region's water-related assets to maximize available supplies to meet projected demands while mitigating against risks. Water-related assets to be optimized include financial resources, groundwater storage programs, available imported water supplies, transfer and exchange opportunities, available physical infrastructure, and management policies.	High	Medium
8. Improve environmental stewardship related to waterways and water management in the Region.	High	Medium
9. Improve floodplain management throughout the Plan area.	High	Medium
10. Preserve water quality as it relates to local beneficial uses of water supplied by each source, including groundwater, stormwater, surface water, imported water, and recycled water.	High	Medium
11. Obtain financial assistance from outside sources to help implement this Plan across a range of project sizes during the planning horizon.	High	Medium
12. Improve public awareness of water supply, conservation, water quality, and environmental stewardship challenges and opportunities throughout the planning horizon.	High	Medium
Tier 3 Priority Objectives		
13. Identify and establish reliable funding sources to maintain, modernize and improve water infrastructure to ensure a high quality, resilient and reliable water supply.	Medium	Medium
14. Increase the use of recycled water in the Region while maintaining compliance with the Mojave Basin Area Judgment as applicable.	Medium	Medium
Tier 4 Priority Objectives		
6. Prevent land subsidence throughout the Region.	Low	Low

Source: Kennedy/Jenks Consultants, *Final Mojave Integrated Regional Water Management Plan*, Table 4-3, 2014

Notes:

(a) The "importance" assigned to each objective reflects the significance or consequence to the Region of satisfying this objective compared with other objectives.

(b) The "urgency" assigned to each objective reflects the degree to which this objective warrants speedy attention or action compared with other objectives.

The IRWM Plan identified dozens of projects and programs to address the objectives identified above. The projects and programs related to water supply are provided in Table 3-16.

Table 3-16: Proposed Water Supply Projects and Programs in MWA Service Area

Project Title	Project Description	Project Type	Project Benefits
Ames/Reche Groundwater Storage and Recovery Program - Phase II Expansion	Expand the Ames/Reche Recharge Facility to accommodate the maximum potential delivery capacity of 3,000 acre-feet per year (AFY) (currently permitted for 1,500 AFY).	Complete	1,000+ acre-feet (AF) groundwater recharge
Deep Creek Off-River Recharge And Storage Basins	Off River recharge and storage basins on the Deep Creek Properties: In conjunction with current recharge in the Mojave River, off river basins could be constructed that can be filled from the Morongo basin pipeline.	Conceptual Design	Extended groundwater recharge and less regulatory restrictions.
Oro Grande Wash Groundwater Recharge Project	The Oro Grande Wash Groundwater Recharge Project has an ultimate delivery capacity for approximately 8,000 AF. The trunk facilities are designed to flow the full capacity. The Flow control facility and pipeline into the wash is designed to flow half of the capacity into a joint use San Bernardino County Flood Control Detention/Recharge Basin. This project (Phase 2 of the Oro Grande Wash Project) is to construct a second pipeline to the Wash and to another groundwater recharge area between Amethyst and Bear Valley Road.	In Process	Increased groundwater recharge.
Alto Subarea Regional Aquifer Storage and Restoration (ASR2)	The Alto Subarea Regional Aquifer Storage and Restoration (ASR2) project would use water from the Mojave Water Agency R^3 infrastructure to inject potable water into existing municipal wells in the regional aquifer. Injection would be timed to periods when these wells would not normally be in service (fall-winter). Injected water would be available for immediate use by purveyors during normal demand periods (spring/summer). This project uses existing equipment with very little new infrastructure. Costs incurred would be for minimal retrofitting at wellheads, periodic well cleaning, and injected water.	Conceptual; Implementable Project	Improves water banking; enhances flood control and riparian restoration.

Project Title	Project Description	Project Type	Project Benefits
Regional Aquifer Recharge Capacity	MWA has very little off-river aquifer recharge capacity. MWA needs to be able to accept a large quantity of water in a relatively short (wet) period. This could be accomplished through a variety of infrastructure. Once such infrastructure combination could include surface water impoundment for later distribution to recharge ponds, ASR injection wells, etc. In addition this project could easily be expanded to a water bank with an aqueduct pump-back component for "buy low/sell high" of banked water.	Conceptual	1-100 AF groundwater recharge; reduction in flood damage.
State Water Project Utilization and Efficiency Strategy	Conceptual program with an overall goal to make the best use of the Region's State Water Project resources for maximum benefit to the Region. This would be an ongoing program with many possible elements and would explore a variety of opportunities to achieve the goal, including transfers, exchanges, purchases and sales of SWP water in concert with conjunctive use, groundwater and surface water storage programs, etc.	Conceptual	1,000+ AF new water supply; 1,000+ AF groundwater recharge.
State Water Project Water Treatment Plant in conjunction with R^3 project	Construct a Water treatment plant to treat State Water Project Water and deliver directly into the potable R^3 water delivery system. This can be done instead of pumping groundwater wells.	Conceptual	1,000+ AF new water supply; 1,000+ AF groundwater recharge.
Wrightwood Imported Water Project	Installation of a well near Desert Front Road, including a pump station and transmission main to import water from the lower elevations south of the town into the higher elevations in the north. Includes study, design and facilities.	Study, Design, Construction	N/A
Lucerne Valley Recharge Ponds	This project provides an opportunity for recharge in the Este Subarea. Recharge sites have been contemplated both east and west of the Helendale Fault. The 1994 RWMP recommended constructing a facility east of the fault because the majority of pumping occurs east of fault. MWA has purchased land for a recharge facility, prepared preliminary construction plans, and performed the necessary environmental reviews.	Implementable Project	1,000+ AF new water supply; 1,000+ AF groundwater recharge.

Project Title	Project Description	Project Type	Project Benefits
Sheep Creek Recharge Basin and Two Wells	This project consists of the construction of a recharge basin along with 2 pumping wells. The District is looking at utilizing the Sheep Creek California Aqueduct turn-out to extract State Water Project water to recharge the proposed basin utilizing the proposed pipeline. The two proposed wells will be used to pump water into our distribution system and will serve to monitor static and pumping levels of the ground water.	Conceptual	1,000+ AF new recycled water supply; 1,000+ AF groundwater recharge.
Replacement Water Supply for Perchlorate/Nitrate Affected Groundwater - Barstow Area	Perform a feasibility study to determine the most cost effective and sustainable manner to design, construct and operate an alternative water supply for residents adversely affected by perchlorate and nitrate polluted groundwater in an unincorporated area northeast of Barstow.	Feasibility Study	1-100 AF new water supply.
R^3 Enhanced Purveyor Supply System	Design and install conveyance from R^3 to purveyors not currently connected to R^3. This may be through direct conveyance or via interconnections with purveyors currently receiving R^3 water to “wheel” water to purveyors adjacent to their systems.	Conceptual	Increased water supply and reliability.
Antelope Valley Wash / Ranchero Basin Recharge Ponds	The Ponds would provide groundwater recharge upgradient from Hesperia Water District wells. The Hesperia Master Plan of Drainage identifies a 65 acre site for a storm water detention basin in the Antelope Valley Wash south of the newly constructed Ranchero Road. In addition to storm water detention, the site would be able to accommodate groundwater recharge.	Conceptual Design	1,000+ AF groundwater recharge; reduction in flood damage.
Cedar Street / Bandicoot Detention Basin	The Basin would provide groundwater recharge upgradient from Hesperia Water District wells. The Hesperia Master Plan of Drainage identifies a 120 acre site for a storm water detention basin at the east end of Cedar Street and southwesterly of the California Aqueduct. In addition to storm water detention, the site would be able to accommodate groundwater recharge.	Conceptual Design	1,000+ AF groundwater recharge; reduction in flood damage.

Source: Final Mojave Region Integrated Regional Water Management Plan, June 2014

3.7 Development of Desalination

The California UWMP Act requires a discussion of potential opportunities for use of desalinated water (Water Code Section 10631[i]). In the past, MWA has evaluated potential options for developing desalination projects. However, at this time, none of the opportunities are practical or economically feasible for MWA, and MWA has no current plans to pursue them. Therefore, desalinated supplies are not included in the supply summaries in this Plan. However, should a future opportunity emerge for MWA to consider development of desalination, these potential future supply opportunities are described in the following section, including opportunities for desalination of brackish water, groundwater, and seawater.

3.7.1 Opportunities for Brackish Water and/or Groundwater Desalination

As discussed in Section 5, the groundwater supplies in the MWA service area are not considered brackish in nature, and desalination is not required. There are brackish supplies near the dry lakes but it is not practical to pump, treat and potentially induce migration of better quality water to the dry lake areas and potentially cause subsidence. However, MWA and the retail water purveyors could partner with other SWP contractors and provide financial assistance in construction of other regional groundwater desalination facilities in exchange for SWP supplies. The desalinated water would be supplied to users in communities near the desalination plant, and a similar amount of SWP supplies would be exchanged and allocated to MWA from the SWP contractor. A list summarizing the groundwater desalination plans of other SWP contractors is not available; however, MWA would begin this planning effort should the need arise.

In addition, should an opportunity emerge with a local agency other than an SWP contractor, an exchange of SWP deliveries would most likely involve a third party, such as Metropolitan Water District. Most local groundwater desalination facilities would be projects implemented by retailers of SWP contractors and, if an exchange program was implemented, would involve coordination and wheeling of water through the contractor’s facilities to MWA.

3.7.2 Opportunities for Seawater Desalination

Because the MWA service area is not in a coastal area, it is neither practical nor economically feasible for MWA to implement a seawater desalination program. However, similar to the brackish water and groundwater desalination opportunities described above, MWA could provide financial assistance to other SWP contractors in the construction of their seawater desalination facilities in exchange for SWP supplies.

Section 4: Recycled Water

4.1 Overview

This section describes the existing and future recycled water opportunities available to the MWA service area. The description includes estimates of potential supply and demand for 2015 to 2040 in five year increments. MWA does not have the authority to determine how or where recycled water is used. This section simply identifies existing and projected wastewater flows by the wastewater agencies within the MWA service area, and potential opportunities for the use of recycled water.

4.2 Recycled Water Plan

Table 4-1 identifies the local water, wastewater, imported wastewater, and planning agencies that are within MWA's service area and could potentially have a role in any recycled water activities related to MWA. Local water agencies within the MWA service area share many issues related to local and regional water supplies. Wastewater agencies that collect and treat wastewater within the MWA service area share a common interest in maximizing the beneficial uses of treated wastewater. Wastewater is also imported to the Mojave Basin Area from several agencies as shown in Table 4-1. Lastly, the various planning agencies with general land use plans are included because they will coordinate where future growth is to occur.

Table 4-1: Participating Agencies in Recycled Water

Water Agencies	Wastewater Agencies	Imported Wastewater Agencies	Planning Agencies
City of Adelanto	City of Adelanto	Lake Arrowhead CSD	City of Adelanto
Golden State Water Company - Barstow	City of Barstow	Big Bear Area Regional Wastewater Agency	City of Barstow
Helendale Community Services District (CSD)	Helendale (CSD)	Crestline Sanitation District (SD)	City of Hesperia
Hesperia Water District	Marine Corps Logistics Base (MCLB)		City of Victorville
Hi-Desert Water District	Victor Valley Wastewater Reclamation Authority (VVWRA)		San Bernardino County Department of Public Works and Flood Control
San Bernardino County Service Areas 42 and 64			San Bernardino County Planning Department
Victorville Water District			Town of Apple Valley
			Town of Yucca Valley

4.3 Potential Sources of Recycled Wastewater

MWA understands that recycled water is an important component of achieving sustainable water supplies for the service area in the future. MWA has coordinated closely with the wastewater agencies within the service area in the past and will work closely with them in the future to best utilize the limited water resources available in the region. MWA and

VVWRA are partners in the Mojave River Watershed Coalition (MSWC), with support from the USBR, South Lahontan Regional Board, and Pacific Gas and Electric Company. The MSWC is planning on conducting a study to address the water supply needs of the South Lahontan watershed region of the MWA service area with a holistic watershed approach that focuses on local water supplies, such as recycled water.

There are two categories of potential sources of recycled water in the MWA service area: wastewater generated within the service area and wastewater imported into the service area.

1. **Wastewater Generated within MWA:** The City of Adelanto, the City of Barstow, Victorville Water District, the Helendale Community Services District (CSD) and the Victor Valley Wastewater Reclamation Authority (VVWRA) provide wastewater collection and treatment services within the MWA boundary. The VVWRA serves portions of Victorville, Hesperia, Apple Valley, and San Bernardino County Service Areas 42 and 64. Helendale CSD serves the community of Silver Lakes. Also, the US Marine Corps has a Marine Corps Logistics Base (MCLB), at Barstow and has two on-site wastewater treatment facilities for the Base population. The remainder of the wastewater generated within the MWA service area is handled by individual septic systems.

   VVWRA was originally formed by the Mojave Water Agency to help meet the requirements of the federal Clean Water Act and provide wastewater treatment for the growing area. The original treatment plant, with supporting pipelines and infrastructure, began operating in 1981, providing tertiary level treatment for up to 4.5 million gallons per day (MGD). The VVWRA is now a joint powers authority and public agency of the state of California.

   In addition, the Hi-Desert Water District (HDWD) is planning to build a sewer collection system and water reclamation facility to serve the Town of Yucca Valley, which is currently utilizing septic systems. The first phase of this project is anticipated to be completed by 2020.

2. **Imported Wastewater:** Wastewater is imported to the MWA service area from the Lake Arrowhead Community Services District (LACSD), Big Bear Area Regional Wastewater Agency (BBARWA), and Crestline Sanitation District (SD). Treated wastewater from the Lake Arrowhead CSD is discharged into retention ponds adjacent to the Mojave River near the Hesperia Lakes recreation area. Wastewater from the BBARWA is discharged onto alfalfa crops or a retention basin within the Este Subarea. The Crestline SD wastewater is discharged at the Los Flores Ranch with some discharge making its way off the ranch and into the West Fork of the Mojave River.

4.3.1 Existing Wastewater Treatment Facilities

4.3.1.1 The City of Adelanto

The City of Adelanto provides water and wastewater services to over 30,000 people within its 54 square mile service area. The City owns a 1.5-MGD activated sludge wastewater treatment facility through an operations and maintenance contract with PERC Water Corporation. The wastewater treatment facility effluent is discharged to percolation ponds in northern Adelanto.

4.3.1.2 The City of Barstow

The City of Barstow collects, treats and disposes of municipal wastewater generated within its city limits. The Barstow Regional Wastewater Treatment Facility (WWTF) is a modified biological nutrient removal activated sludge facility that provides primary and secondary treatment. The design capacity for the Barstow Regional WWTF is 4.5 MGD. Currently, Barstow Regional WWTF discharges the effluent into eight percolation ponds and a 60-acre reclamation field. The Barstow Regional WWTF does not treat any of the effluent to meet recycled water standards set forth in Title 22 of the California Code of Regulations.

4.3.1.3 Victorville Water District

The Victorville Water District (VWD) has constructed a 2.5-MGD wastewater treatment plant at the Southern California Logistics Airport (SCLA) to process waste from the Dr. Pepper/Snapple processing and bottling plant and sanitary wastewater from portions of the City of Victorville. The treatment plant is sized for treating 1.0 MGD of industrial wastewater flows and 1.5 MGD of sanitary flows from the City of Victorville. Industrial wastewater consists of food and beverage clients in the SCLA Industrial Park as well as from the Dr. Pepper Snapple Group (DPSG). The treatment plant is designed in a modular fashion consisting of equalization, aeration and anaerobic sludge holding tanks and membrane bioreactor tanks.

The effluent is discharged as recycled water (disinfected, tertiary recycled water as defined in California Code of Regulations (CCR), Title 22) for use as coolant at the High Desert Power Project (HDPP) and irrigation at the City-run Westwinds Golf Course .

4.3.1.4 Victor Valley Wastewater Reclamation Authority

The Victor Valley Wastewater Reclamation Authority (VVWRA) was originally formed by MWA to help meet the requirements of the federal Clean Water Act and provide wastewater treatment for the growing area. The original treatment plant (Regional Treatment Plant), with supporting pipelines and infrastructure, began operating in 1981, providing tertiary level treatment for up to 4.5 million gallons per day (MGD). The VVWRA is now a joint powers authority and public agency of the state of California and serves portions of Victorville, Hesperia, Apple Valley, and San Bernardino County Service Areas (CSA) 42 and 64.

The Regional Treatment Plant, which has a capacity of 18.0 MGD, is currently capable of treating a portion of the flow to a tertiary level and the remaining flow to a secondary level for percolation. A majority of the tertiary treated wastewater is discharged into the Mojave River Basin and a smaller amount is currently used to irrigate landscaping at the treatment plant and the nearby Westwinds Golf Course. The Lahontan Regional Water Quality Control Board (RWQCB, Regional Board) Order R6V-2008-004, along with the National Pollutant Discharge Elimination System (NPDES) Permit No. CA0102822, allows the facility to discharge up to 14.0 MGD of tertiary-treated effluent as surface water to the Mojave River bed.

4.3.1.5 Helendale CSD

The Helendale CSD provides utility services, including wastewater collection and treatment, for the Silver Lakes community, which has an approximate population of 7,000. The Helendale CSD owns and operates a 1.2-MGD wastewater treatment plant. The majority of the plant effluent is utilized for groundwater recharge, while a small portion of the effluent utilized for agricultural irrigation on the plant site. Based on the 2002 CSA 70C Sewer Master Plan, it is anticipated that the treatment plant will have sufficient capacity until at least 2035. Note that the formation of the Helendale CSD began with the dissolution of County Service Area 70 Improvement Zone B (CSA 70C) in 2006.

4.3.1.6 US Marine Corps Logistics Base

Another small wastewater agency within the MWA service area is the United States Marine Corps Marine Corps Logistics Base (MCLB) at Barstow that is separated into two divisions: (1) Nebo and (2) Yermo Annex, with both divisions providing wastewater treatment services.

The disposal plan for both treatment facilities is to discharge tertiary-treated effluent to percolation ponds. The Nebo Base is permitted to discharge up to 225,000 gallons per day (GPD) and the Yermo Annex is permitted to discharge up to 180,000 GPD.

A summary of 2015 wastewater flows, treatment levels, and disposal methods for each wastewater agency is provided as Table 4-2.

Table 4-2: Existing Wastewater Treatment Flows, Treatment, and Disposal

Wastewater Agency	2015 Wastewater Treated (MGD)	Level of Treatment	Method of Disposal
Adelanto, City of	1.5 [a]	Tertiary	Groundwater recharge
Barstow, City of	4.5 [a]	Secondary	Groundwater recharge
Victorville Water District	0.7 [b]	Recycled water	Power plant coolant, golf course irrigation
Victor Valley Wastewater Reclamation Agency	11.6 [c]	Recycled water	Groundwater recharge, golf course irrigation
Helendale Community Services District	1.2 [a]	Secondary	Groundwater recharge, agricultural irrigation
U.S. Marine Corp Logistics Base	0.4 [a]	Tertiary	Groundwater recharge
Total	19.9		

Notes:

a) Based on the wastewater treatment plant capacity
b) Based on data provided by Victorville Water District
c) For Water Year 2014-2015 (October 2014 to September 2015); based on MWA Watermaster data

4.3.2 Planned Improvements and Expansions

4.3.2.1 The City of Adelanto

The City of Adelanto is currently constructing a 2.5-MGD upgrade that will increase the wastewater treatment plant capacity to 4.0 MGD and produce Title 22 recycled water that can be used for lawn/public parks irrigation, construction and dust control and other beneficial uses.

According to the City of Adelanto's *2007 Sewer Master Plan*, the ultimate capacity for the wastewater treatment plant is planned to be 8.0 MGD, when the City nears build-out. Also, two sub-regional wastewater treatment plants (6.0 MGD and 3.0 MGD) are proposed to be constructed in incremental capacities. Because no exact dates were provided for the planned expansions in the *2007 Sewer Master Plan*, the dates used in the summary tables at the end of this Section are assumed.

4.3.2.2 The City of Barstow

As noted in Section 4.3.1.2, the City of Barstow owns and operates the Barstow Regional WWTF, which has a design capacity of 4.5 MGD. The City of Barstow's *2009 Draft Sewer Master Plan* recommends that the Barstow Regional WWTF will require an expansion of 1.0 MGD when the projects within the Public Improvement District (PID) Scenario approach build-out. Expanding the existing WWTF could maximize the capacity of the existing interceptor sewer system. To address this limitation, the City of Barstow plans to construct a new 2.2 MGD West Side WWTP by the year 2020. The City plans to further expand the West Side WWTP to handle 4.6 MGD by the year 2030. This new facility would consist of secondary and tertiary treatment processes with the tertiary reclaimed water being treated to Title 22 standards and produced for local reuse.

4.3.2.3 Victor Valley Wastewater Reclamation Authority

The VVWRA is currently constructing two 1 MGD recycled water scalping facilities: the Hesperia Subregional Water Reclamation Plant and the Apple Valley Subregional Water Reclamation Plant. The identical facilities are expected to be completed in 2017. Both facilities will utilize a membrane bioreactor (MBR) process for biological treatment to produce disinfected, tertiary recycled water as defined by CCR, Title 22. In the initial production phase of the treatment facilities, recycled water will be provided to local golf courses for irrigation water.

4.3.2.4 Hi-Desert Water District

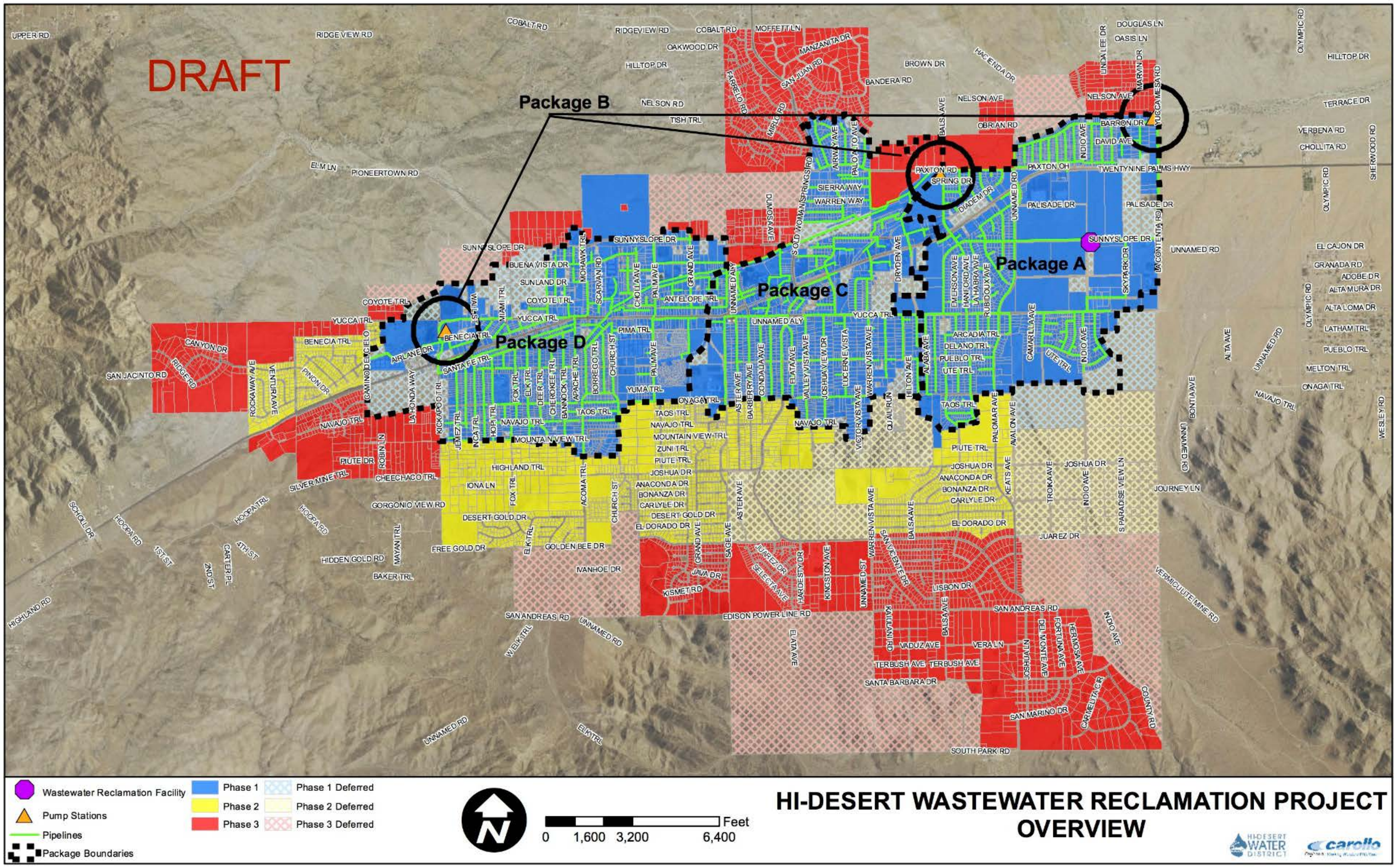
The Hi-Desert Water District's (HDWD) service area contains the entire Town of Yucca Valley along with some unincorporated areas. The District is divided topographically into the Yucca Valley area in the south and the Yucca Mesa area in the north. With all of its customers utilizing septic tank systems, groundwater quality has become a concern in the more populated Yucca Valley drainage area. In accordance with the Colorado River Region of the California Regional Water Quality Control Board (RWQCB) Resolution No. R7-2011-0004, septic tank systems will be prohibited for the Yucca Valley area.

To improve groundwater quality and meet the requirements of the RWQCB resolution, HDWD is currently constructing a wastewater collection and treatment system for the Yucca Valley area. The sewer collection and treatment system will be implemented in three phases, with Phase 1 expected to be completed by the end of 2020. Both Phases 2 and 3 are expected to be completed by 2025. The planned phases of the sewer collection system are shown in Figure 4-1.

The HDWD is constructing a water reclamation facility that will utilize MBR biological treatment and ultraviolet disinfection. The facility will produce disinfected, tertiary recycled water as defined by CCR, Title 22. Initially, the produced recycled water will be percolated in recharge ponds located near the water reclamation facility. HDWD will explore opportunities for direct recycled water use in the future. The anticipated capacity of the water reclamation facility for each phase is shown in Table 4-3.

Table 4-3: Hi-Desert Water District Water Reclamation Facility Anticipated Capacity by Phase

Water Reclamation Facility Capacity	Phase 1 (2020) [MGD]	Phase 3 (2025) [MGD]	Phase 3 (2025) [MGD]
Average Annual Daily Flow (AADF)	1.02	1.33	1.61



Source: http://protectgroundwater.org/wp-content/uploads/2016/02/HWDWD-Regional-Board-11x17-Overview.jpg

Figure 4-1: Hi-Desert Water District Planned Sewer Collection System Phases

4.3.2.5 Summary of Planned Wastewater Treatment Capacity

While some of the wastewater agencies are planning to expand their treatment capacity in the near future to be able to produce recycled water, others will continue to use their existing treatment facilities. Table 4-4 provides the projected wastewater treatment capacity for the MWA service area.

Table 4-4: Projected Capacity for Collected and Treated Wastewater

Wastewater Collected and Treated in Service Area	Capacity (MGD)					
	2015	2020	2025	2030	2035	2040
City of Adelanto[(a)]	1.5	8.0	11.0	17.0	17.0	17.0
City of Barstow[(b)]	4.5	6.7	6.7	9.1	9.1	9.1
Victorville Water District[(c)]	2.5	2.5	2.5	2.5	2.5	2.5
VVWRA[(d)]	18.0	20.0	20.0	20.0	20.0	20.0
Helendale CSD[(e)]	1.2	1.2	1.2	1.2	1.2	1.2
MCLB[(f)]	0.4	0.4	0.4	0.4	0.4	0.4
Hi-Desert Water District[(g)]	0.0	1.0	1.6	1.6	1.6	1.6
Total	**28.1**	**39.8**	**43.4**	**51.8**	**51.8**	**51.8**

Notes:

(a) In the City's "2007 Sewer Master Plan", no exact dates are given for the planned expansions, so the dates provided in the table are assumed.
(b) Quantities are taken from the GSWC-Barstow's 2015 UWMP.
(c) Victorville Water District information came from Lahontan Regional Board Order No. R6V-2010-0023.
(d) Information provided from http://www.vvwra.com/index.aspx?page=123 and http://www.vvwra.com/index.aspx?page=122.
(e) Information provided from 2002 CSA 70C Sewer Master Plan.
(f) 0.225 MGD capacity for Nebo Base and 0.18 MGD capacity for Yermo Annex.
(g) See Table 4-3.

4.3.3 Imported Wastewater

Treated wastewater effluent is imported to MWA from three wastewater entities serving communities in the San Bernardino Mountains outside MWA's service area. The Alto Subarea receives treated wastewater effluent from the Lake Arrowhead CSD, discharged into retention ponds along the Mojave River about two miles downstream of the Forks, just south of the City of Hesperia. The Forks is located where the Mojave River is formed by the confluence of two smaller streams (Deep Creek and West Fork) descending from the mountains near the southeast corner boundary of the City of Hesperia and north of Silverwood Lake. The Crestline SD discharges treated wastewater effluent to the Alto Subarea upstream of the West Fork gage at the Los Flores Ranch. Finally, the Este Subarea receives treated wastewater effluent from the Big Bear Area Regional Wastewater Agency discharged near Camp Rock Road and Highway 247 in the Lucerne Valley.

Table 4-5 summarizes the wastewater flows imported into the Mojave basin from water year 2010-2011 to the present. This data was compiled from the Watermaster's annual reports and are provided by water year, which starts in October and ends in September of the following year.

Table 4-5: Imported Wastewater Historical Flow

Imported Wastewater Agency	Flow (MGD)					
	2010-11	2011-12	2012-13	2013-14	2014-15	Average Flow
Lake Arrowhead CSD	1.1	0.9	0.7	0.7	0.7	0.8
Crestline SD	0.9	0.5	0.5	0.5	0.5	0.6
Big Bear Area Regional Wastewater Agency	3.2	2.3	1.7	1.7	1.8	2.1
Total	**5.2**	**3.7**	**3.0**	**2.9**	**3.0**	**3.6**

Source: MWA Watermaster Reports.
Data in water years starting in October.

Table 4-6 provides the projected imported wastewater flow for the MWA service area from the Lake Arrowhead CSD, Crestline SD, and BBARWA, as discussed in Section 4.3.1.7. Using the 2009 flows listed in Table 4-2, the projections have been estimated using the MWA demand forecast model and assuming approximately a one (1) percent increase from 2010 through 2035.

Table 4-6: Projected Imported Wastewater Flow

Imported Wastewater Agency	Flow (MGD)					
	2015	2020	2025	2030	2035	2040
Lake Arrowhead CSD	0.7	0.7	0.7	0.7	0.7	0.7
Crestline SD	0.9	0.9	0.9	0.9	0.9	0.9
Big Bear Area Regional Wastewater Agency	1.8	1.8	1.8	1.8	1.8	1.8
Total	**3.4**	**3.4**	**3.4**	**3.4**	**3.4**	**3.4**

Source: MWA water use projection model

4.3.4 Summary of Available Wastewater

Based on the wastewater flows described in Section 4.3, Table 4-7 provides a summary of the available wastewater flows for the MWA service area.

Table 4-7: Summary of Future Available Wastewater Flow

Wastewater Collected and Treated in Service Area	Wastewater Flow (MGD)					
	2015	2020	2025	2030	2035	2040
City of Adelanto	4.0	8.0	11.0	17.0	17.0	17.0
City of Barstow	4.5	6.7	6.7	9.1	9.1	9.1
Victorville Water District	2.5	2.5	2.5	2.5	2.5	2.5
VVWRA	18.0	20.0	20.0	20.0	20.0	20.0
Helendale CSD	1.2	1.2	1.2	1.2	1.2	1.2
MCLB	0.4	0.4	0.4	0.4	0.4	0.4
Hi-Desert Water District	0.0	1.0	1.6	1.6	1.6	1.6
Imported Wastewater	3.4	3.4	3.4	3.4	3.4	3.4
Total	**34.0**	**43.2**	**46.8**	**55.2**	**55.2**	**55.2**

4.4 Recycled Water Demand

In this section, current recycled water use is discussed, and potential recycled water users within MWA's service area are identified. For each potential user, estimates are provided for annual demand.

4.4.1 Current Use

Although several agencies produce recycled water-quality effluent, VVWRA and Victorville Water District utilize recycled water for direct use as power plant coolant and irrigation water. VVWRA is planning to utilize the recycled water produced at its two new water reclamation facilities for irrigation water. However, since the MWA service area is a closed basin, the remaining wastewater effluent is percolated to the groundwater basin, where it is eventually reused as groundwater.

In 2010, recycled water started being used by the VVWRA for the HDPP power plant cooling system and for irrigation at the Westwinds Golf Course. Table 4-8 provides a summary of existing recycled water use.

Table 4-8: Existing Recycled Water Uses

Type of Use	Treatment Level	Actual 2015 Use (AFY)
HDPP – cooling system	Disinfected tertiary	729
Landscape – golf course	Disinfected tertiary	141
Groundwater recharge[(a)]	Disinfected tertiary	12,926
	Total	**13,796**

(b) VVWRA and Victorville Water District discharge treated wastewater effluent to the Mojave River. 2015 use shown is for Water Year 2014-2015, which spans from October 2014 through September 2015. Source: Final Draft Twenty-Second Annual Report of the Mojave Basin Area Watermaster, Water Year 2014-15.

4.4.2 Potential Uses

Many wastewater agencies within MWA's service area have completed planning documents for recycled water and determined potential users in their specific service area. As part of the UWMP requirements, the potential uses of recycled water need to be identified and listed. Therefore, the following list identifies the planned recycled water agency planning to develop recycled water and their proposed usage type.

- City of Adelanto - Reuse for landscape irrigation in schools and parks.
- City of Barstow - Reuse for landscape irrigation on the Sun Valley Golf Course.
- Victorville Water District - Reuse for landscape irrigation on golf course and cooling for power plant.
- VVWRA - Reuse for landscape irrigation on golf courses, parks, municipalities, and schools.
- Helendale CSD - Reuse for landscape irrigation in parks, golf courses, and common areas; and groundwater recharge.
- MCLB – Reuse is for groundwater recharge.
- HDWD - Reuse is for groundwater recharge.

Based on the assumption that all of the additional flows would be recycled, and that the possible users are identified, the projected recycled wastewater that will be produced and used is shown in Table 4-9.

Table 4-9: Potential Recycled Water Projections

Agency	Flow (MGD)					
	2015	2020	2025	2030	2035	2040
City of Adelanto[a]	4.0	8.0	11.0	17.0	17.0	17.0
City of Barstow[b]	4.5	6.7	6.7	9.1	9.1	9.1
Victorville Water District[c]	2.5	2.5	2.5	2.5	2.5	2.5
VVWRA[d]	18.0	20.0	20.0	20.0	20.0	20.0
Helendale CSD[e]	1.2	1.2	1.2	1.2	1.2	1.2
MCLB[f]	0.4	0.4	0.4	0.4	0.4	0.4
Hi-Desert Water District[g]	0.0	1.0	1.6	1.6	1.6	1.6
Total	**30.6**	**39.8**	**43.4**	**51.8**	**51.8**	**51.8**

Notes:
a) See 4.3.2.1
b) See 4.3.2.2.
c) See 4.3.1.3.
d) See 4.3.2.3.
e) See 4.3.1.5.
f) See 4.3.1.6.
g) See 4.3.2.4.

The recycled water projects from all of the agencies listed in Table 4-9 will potentially be funded from local funds, a number of federal or state grants and low-interest loans obtained through the State Revolving Fund. The cost of providing recycled water, transmission infrastructure, and ownership of distribution facilities has yet to be determined.

4.4.3 Projected Recycled Water Demand

While some cities are in the planning stages and plan to produce recycled water, they are not yet at the planning level and thus have not actually developed customer lists at this point in time. They are assuming that potential customers are there, once the recycled water is available.

As described in Section 4.3.2.3, VVWRA is currently constructing the Apple Valley Subregional Water Reclamation Plant, which will provide one MGD of Title 22 recycled water. The Apple Valley Golf Course, public facilities, and parks will be the first users of the new system, utilizing recycled water for landscape irrigation. Eventually, it is anticipated that recycled water from the plant can be utilized for agricultural irrigation, construction, and other landscape irrigation.

Potential recycled water demand for the City of Hesperia is identified in the Recycled Water Master Plan Final Report, July 2008. Recycled water supply would be provided by the Hesperia Subregional Water Reclamation Plant, which is currently under construction by VVWRA. It is anticipated that the Hesperia Golf Course and Hesperia Civic Center will be the first users of the new recycled water supply, utilizing it for landscape irrigation. All of the potential recycled water demand is summarized in Figure 4-2. Phasing of when these recycled water demands would be served is undetermined at this point.

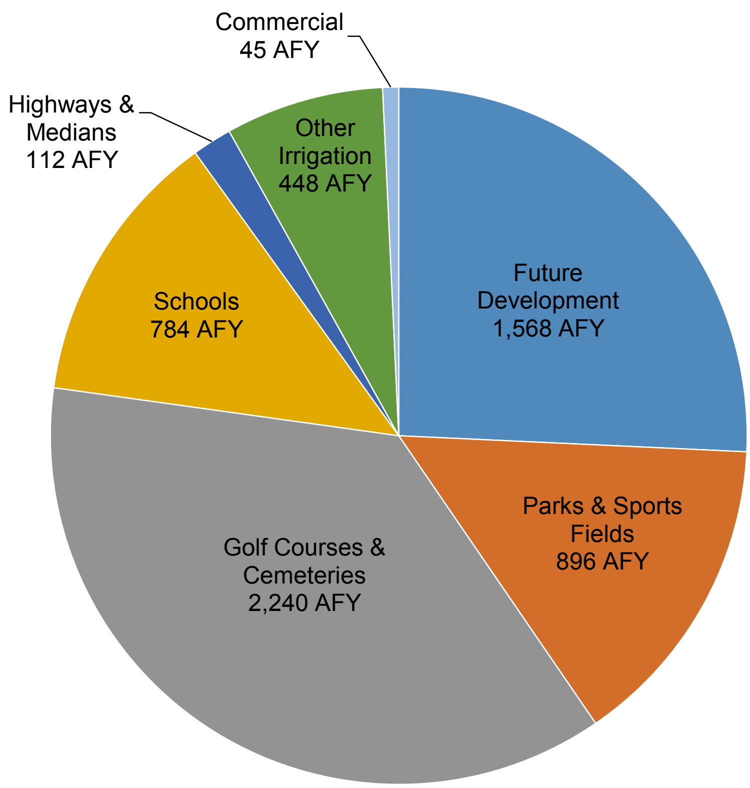


Figure 4-2: City of Hesperia Potential Recycled Water Demand

4.4.4 Projected Recycled Water Comparison

MWA's 2010 UWMP projected a total recycled water usage of 29,627 AFY by the year 2015. Approximately 141 AFY was served in 2015 to the Westwinds Golf Course at the SCLA for landscape irrigation and 729 AFY was served to the HDPP for power plant cooling. The remainder of the recycled water produced within the MWA service area was discharged to the Mojave River by VVWRA and Victorville Water District for recharge of the groundwater basin. Table 4-10 provides a comparison of the 2010 projected demand versus the actual 2015 use.

Table 4-10: Recycled Water Uses – 2010 Projection of 2015 Use Compared with 2015 Actual Use

User Type	2010 Projection for 2015 (AFY)	2015 Actual Use (AFY)
Landscape Irrigation	11,963	141
Power Plant Cooling	1,118	729
Groundwater Recharge	16,546	12,926[(a)]
Total	**29,627**	**13,796**

Notes:

(a) VVWRA and Victorville Water District discharge treated wastewater effluent to the Mojave River. 2015 use shown is for Water Year 2014-2015, which spans from October 2014 through September 2015. Source: Final Draft Twenty-Second Annual Report of the Mojave Basin Area Watermaster, Water Year 2014-15.

4.5 Methods to Encourage Recycled Water Use

The retail water purveyors are the entities that will develop future recycled water delivery systems. Methods to encourage recycled water use, such as financial incentives, will be analyzed at the retail level.

Section 5: Water Quality

Water is an important resource and its quality is of vital importance. The quality of water affects the ability to use it, affects the cost of providing treated drinking water, affects habitat conditions, and can impair or enhance recreation. Water quality management in the MWA service area is therefore focused on maintaining and improving existing water quality and preventing future degradation.

5.1 Overview

The quality of any natural water is dynamic in nature. This is also true for the State Water Project (SWP) water brought into the MWA service area. During periods of intense rainfall or snowmelt, pathways of surface water movement may change; new constituents may be mobilized and enter the water while other constituents may be diluted or eliminated. These same basic principles apply to groundwater. Depending on water depth, groundwater will pass through different layers of rock and sediment and leach and adsorb different materials from those strata. Water quality is not a static feature of water, and these dynamic variables must be recognized.

Water quality regulations also change. This is the result of the discovery of new contaminants, a changing understanding of the health effects of previously known as well as new contaminants, development of new analytical technology, and the introduction of new treatment technology. All retail water purveyors are subject to drinking water standards set by the Federal Environmental Protection Agency (EPA) and the California State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW). MWA imports SWP water from Northern California for groundwater basin recharge. Retail purveyors extract groundwater from these groundwater basins for delivery which may be native water or a mixture of native and imported water.

This section provides a general description of the water quality of both imported water and groundwater supplies. A discussion of potential water quality impacts on the reliability of these supplies is also provided.

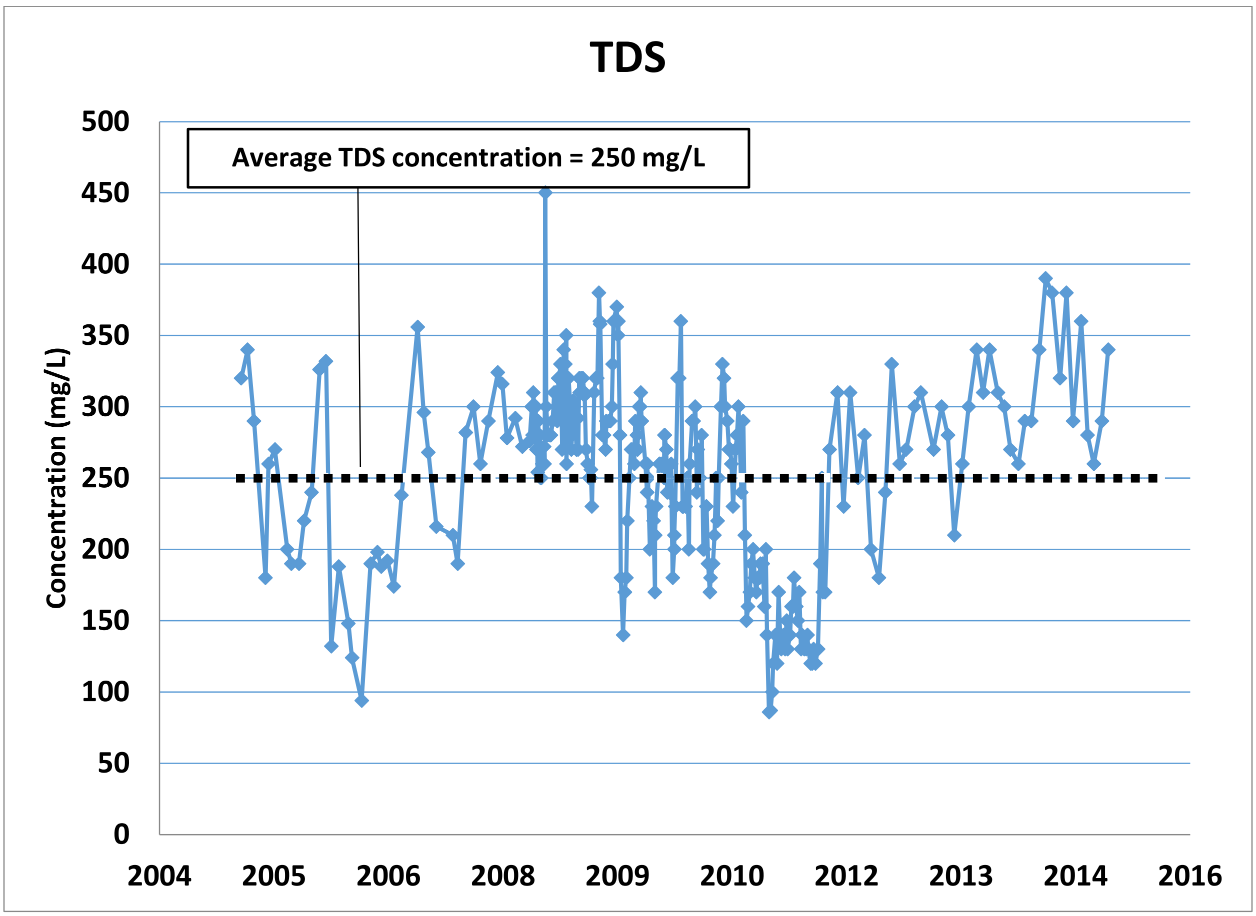
Several state, regional and county agencies have jurisdiction and responsibility for monitoring water quality and contaminant sites. Programs administered by these agencies include basin management, waste regulation, contaminant cleanup, public outreach, and emergency spill response.

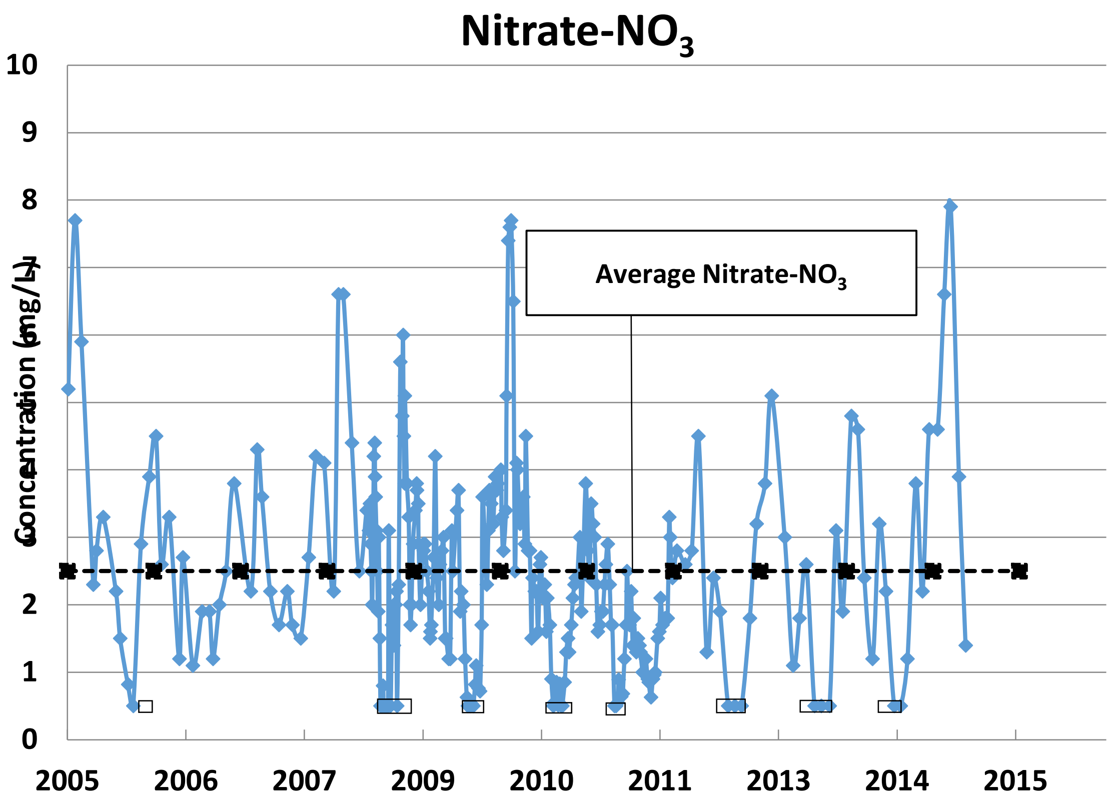
5.2 Imported Water Quality

MWA provides imported SWP water to its service area. The source of SWP water is rain and snowmelt runoff from the Sierra Nevada, Cascade, and Coastal mountain ranges. This water travels to the Sacramento-San Joaquin Delta, which is a network of natural and artificial channels and reclaimed islands at the confluence of the Sacramento and San Joaquin rivers. The Delta forms the eastern portion of the San Francisco estuary and receives runoff from more than 40 percent of the state’s land area. The Delta is a low-lying region interlaced with hundreds of miles of waterways. From there, the water is pumped into a series of canals and reservoirs, which provide water to urban and agricultural users throughout the San Francisco Bay Area and Central and Southern California. As discussed in Section 3, MWA receives SWP water at four locations off the East Branch of the SWP.

An important property of SWP water is the chemical make-up, which fluctuates and is influenced by its passage through the Delta. The Delta is essentially a very large marsh (or estuary) with large plant and peat soil masses. These contribute organic materials to the water. Salt water can also move into the Delta from San Francisco Bay and the Pacific Ocean.

Figure 5-1 shows the TDS and nitrate-NO_3 concentrations from 2005 to 2015 for SWP water grab samples collected just upstream of the turnout to the MWA's Mojave River and Morongo Basin pipelines (the station is referred to internally as CAAQUEDCT01 by MWA). The figure shows that the quality of SWP water fluctuates seasonally and annually, but is overall very good. The average TDS concentration over this 10-year period is 250 mg/L and the average nitrate-NO_3 concentration is 2.5 mg/L.





Notes:
Box values in nitrate chart represent non-detect values (i.e., concentration is less than laboratory reporting limit). The value shown on chart is the laboratory reporting limit.

Figure 5-1: TDS and Nitrate Concentrations of SWP Water (2005 to 2015)

5.2.1 Municipal Water Quality Investigations Program

MWA participates in the California DWR Municipal Water Quality Investigations (MWQI) Program. The MWQI Program is funded by the sixteen State Water Project Contractors that provide water to their customers for municipal and industrial uses. The mission of the MWQI Program is to: a) support the effective and efficient use of the Sacramento-San Joaquin Delta (Delta) and the SWP as a source water supply for municipal purposes through monitoring, forecasting, and reporting water quality; b) provide early warning of changing conditions in source water quality used for municipal purposes; c) provide data and knowledge based support for operational decision-making on the SWP; d) conduct scientific studies of drinking water importance; and e) provide scientific support to DWR, the State Water Project Contractors Authority MWQI-Specific Project Committee, and other governmental entities.

The MWQI Program conducts extensive monitoring in the Delta and the outlet to San Luis Reservoir. The data from this program, combined with data collected throughout the SWP by the DWR Division of Operations and Maintenance, are used to understand how water quality changes from the Delta to the turn outs of the SWP Municipal and Industrial (M&I) Contractors. The MWQI Program has also developed a forecasting model to forecast organic carbon concentrations and salinity levels throughout the SWP. A daily report is sent out via email to the M&I Contractors with recent water quality data at key locations and information on Delta conditions and pumping at the Banks and Jones pumping plants.

Ongoing work includes refinement of the forecasting model to more accurately predict water quality conditions and to better model the impacts of groundwater and surface water pump-ins. The MWQI Program is also conducting studies to better understand the dynamics of algal and aquatic plant growth in the SWP. Algae and aquatic plants create a number of problems, including taste and odor issues, wide swings in pH, filter clogging, and clogging of conveyance structures. The MWQI Program also conducts the sanitary survey of the SWP which must be submitted to the State Water Resources Control Board, Division of Drinking Water every five years.

5.3 Groundwater Quality

MWA has made efforts to greatly increase the understanding of the water quantity and quality of the groundwater basins that lie within its service area. The Agency established a Cooperative Water Resources Program (CWRP) with the USGS to maintain a monitoring network that currently includes approximately 850 monitoring wells. Water levels from these wells are recorded on a regular basis and several of the wells are tested for water quality on a rotating sampling schedule. Water quality monitoring is discussed further in Section 5.4.

Numerous studies dating back to the early 1900's have been conducted by various agencies to characterize groundwater quality in the Mojave service area and further the understanding of the Mojave River and Morongo Groundwater Basins. Many of the studies completed by the USGS are available online at the website http://ca.water.usgs.gov/mojave/index.html. The USGS reviewed concentrations for total dissolved solids, arsenic, boron, fluoride, and nitrite-nitrate across the MWA Service Area in Open-File Report (OFR) 93-568 by Christensen and Fields-Garland (2001). This report can be accessed online at http://pubs.er.usgs.gov/publication/ofr0184. In 2015, the USGS mapped selected trace elements and major ions in the Mojave River and Morongo Groundwater Basins. This work by the USGS can be accessed at: http://ca.water.usgs.gov/mojave/water-quality.html.

Regional studies containing water quality information have also been completed by MWA through work with consulting teams including URS Corp., Todd Groundwater, Kennedy/Jenks Consultants and Richard C. Slade & Associates LLC. These regional studies are available at http://www.mojavewater.org/regional-studies.html.

Despite local groundwater quality degradation in Barstow and variability elsewhere, these studies generally confirmed the suitability of groundwater for beneficial uses in the Region. According to the most recent hydrogeologic study completed in the Baja and Centro Subareas, general mineral quality is affected by the barrier effects of the Helendale and Harper Lake (Waterman) faults, leaching from evaporative lake deposits (and other geochemical processes) and effluent discharges from the Barstow WWTP.

Groundwater quality data, including intrinsic tracers, have been used to confirm sources of groundwater recharge and travel times along interpreted flowpaths in the Floodplain and Regional aquifers. Investigations have also been conducted to identify the source and occurrence of key naturally occurring groundwater contaminants, including hexavalent chromium (chromium-6) and arsenic, in the Mojave Desert region.

The impairment of groundwater for the beneficial use of drinking water is determined by comparing concentrations of constituents of concern in the groundwater against drinking water maximum contaminant levels (MCLs) and agricultural water quality parameters needed for specific crops. MCLs consist of primary and secondary MCLs. Primary MCLs are assigned to constituents for which a health-based risk is associated with consumption of water that exceeds a particular concentration. Secondary MCLs are assigned to constituents for which there is no considered health risk, but for which there may be aesthetic concerns such as taste, odor, color, etc. above a particular concentration.

There are numerous groundwater quality issues within the MWA service area. Key groundwater constituents of concern include arsenic, nitrates, iron, manganese, Cr-VI, fluoride, and total dissolved solids (TDS). Some of these constituents are naturally occurring in desert environments while others are associated with human (anthropogenic) activities. Measurements in excess of drinking water standards have been found for some of these constituents within the Mojave River Basin and the Morongo Basin. Groundwater in these areas may have to be treated prior to consumption.

5.3.1 Total Dissolved Solids and Nitrate

In December 2015, MWA completed a Salt and Nutrient Management Plan (SNMP), which provides an evaluation of potential groundwater quality issues that may result from sources of salts and nutrients and determine if these constituents would unreasonably degrade groundwater quality and potentially decrease the beneficial uses of groundwater within the basin. For the MWA SNMP, TDS and nitrate were analyzed as appropriate indicator constituents of salts and nutrients (S/Ns). These two constituents are the focus of the characterization of existing S/N groundwater quality.

Total salinity is commonly expressed in terms of TDS as milligrams per liter (mg/L). TDS concentrations in the groundwater are influenced by the chemistry of the aquifer and quality of water recharging the aquifer. TDS is not a health hazard at typical groundwater concentrations but can be an aesthetic issue and can shorten the useful life of pipes and water-based appliances in homes and businesses. TDS monitoring data are widely available for source waters (both inflows and outflows) in the service area, and because TDS is a general indicator of total salinity, TDS is an appropriate indicator of salt loading. TDS can be an indicator of anthropogenic impacts, but there are also naturally occurring background TDS concentrations in groundwater. The background TDS concentrations in groundwater can vary considerably based on purity and crystal size of the minerals, rock texture and porosity, the regional structure, origin of sediments, the age of the groundwater, and other factors.

TDS concentrations generally increase in downgradient portions of the Mojave River Basin and along groundwater flowpaths away from the primary recharge source in the basin, the Mojave River. Elevated TDS concentrations (greater than 1,000 mg/L) are generally associated with natural processes including mineralization and evaporation beneath dry lake beds. In the Morongo Basin, groundwater TDS concentrations generally increase along groundwater flowpaths away from the southwestern margins of the basin where mountain-front recharge occurs.

Nitrate is a widespread contaminant in California groundwater. In drinking water, high nitrate levels can have acute health problems in infants less than six months old, causing a condition called methemoglobinemia, commonly known as "blue baby syndrome". Long-term health impacts in adults are not well-known. High levels of nitrate in groundwater are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facilities. Nitrate does occur naturally in groundwater; however, natural nitrate levels in groundwater are generally very low (typically less than about 10 mg/L as nitrate (NO_3)).

Water quality objectives and existing water quality data, as provided in the SNMP, are described in the next two subsections.

5.3.1.1 Water Quality Objectives

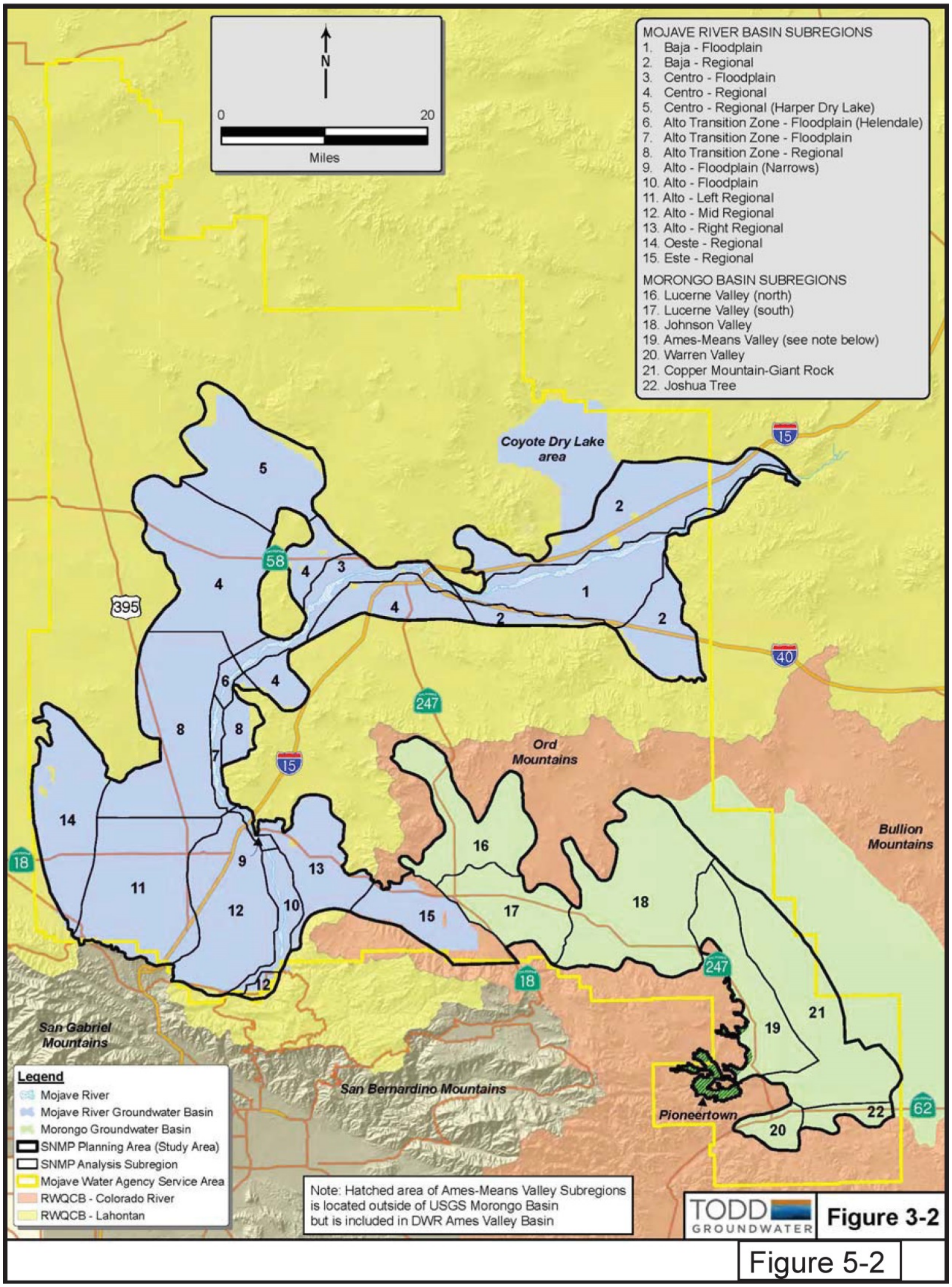
According to the Lahontan and Colorado River Region basin plans, groundwater designated for municipal or domestic supply shall not contain concentrations of chemical constituents exceeding their respective maximum contaminant level (MCL) or secondary maximum contaminant level (SMCL) based upon drinking water standards specified in Title 22 of the California Code of Regulations (CCR).

Title 22 of the CCR designates SMCLs for TDS to address aesthetic issues related to taste, odor, or appearance of the water and are not considered related to health effects. The recommended SMCL for TDS is 500 mg/L with an upper limit of 1,000 mg/L and a short-term limit of 1,500 mg/L.

Title 22 of the CCR designates a primary MCL for nitrate-nitrite as nitrogen (as N) of 10 mg/L and for nitrate as nitrate (nitrate-NO_3) of 45 mg/L. These MCLs are based on a health concern due to methemoglobinemia, or "blue baby syndrome," which affects infants, ruminant animals (such as cows and sheep) and infant monogastrics (such as baby pigs and chickens). Elevated levels may also be unhealthy for pregnant women.

5.3.1.2 Average Existing TDS and Nitrate Concentrations by Subregion

Due to the complexity of hydrogeologic conditions and variability in water quality, the SNMP study area was divided into 22 subregions to evaluate water quality and to facilitate understanding of the distribution of S/Ns and potential implementation measures. The boundaries of the analysis subregions are shown on Figure 5-2.



Source: MWA, Salt and Nutrient Management Plan, Final, December 2015, Figure 3-2

Figure 5-2: SNMP Study Area and Analysis Subregions

The volume-weighted average of existing TDS and nitrate-NO_3 concentrations were calculated for each of the 22 analysis subregions. Results are summarized in Table 5-1 (with the estimated volume of groundwater in operational storage) and also depicted on Figure 5-3.

Average subregional TDS concentrations vary considerably, ranging from 153 mg/L to 1,716 mg/L across the MWA service area. Average TDS concentrations are very low in the upgradient portions of the Mojave River Basin (less than 300 mg/L) and increase along the pathways along and away from the Mojave River due to natural processes (e.g., mineralization) and impacts from anthropogenic loading. As shown in the upper chart on Figure 5-3, eight of the nine downgradient analysis subregions composing the Alto Transition Zone, Centro, and Baja Subareas have average TDS concentrations at or above 500 mg/L (Baja - Floodplain is the lone exception). In the Morongo Basin, average TDS concentrations are generally below the recommended SMCL for TDS of 500 mg/L. Exceptions include Lucerne Valley (north) (1,716 mg/L) and Johnson Valley (678 mg/L), where elevated TDS concentrations primarily reflect a high degree of mineralization and dry lake bed evaporation. Elevated TDS concentrations are characteristic of dry lakes in arid desert environments.

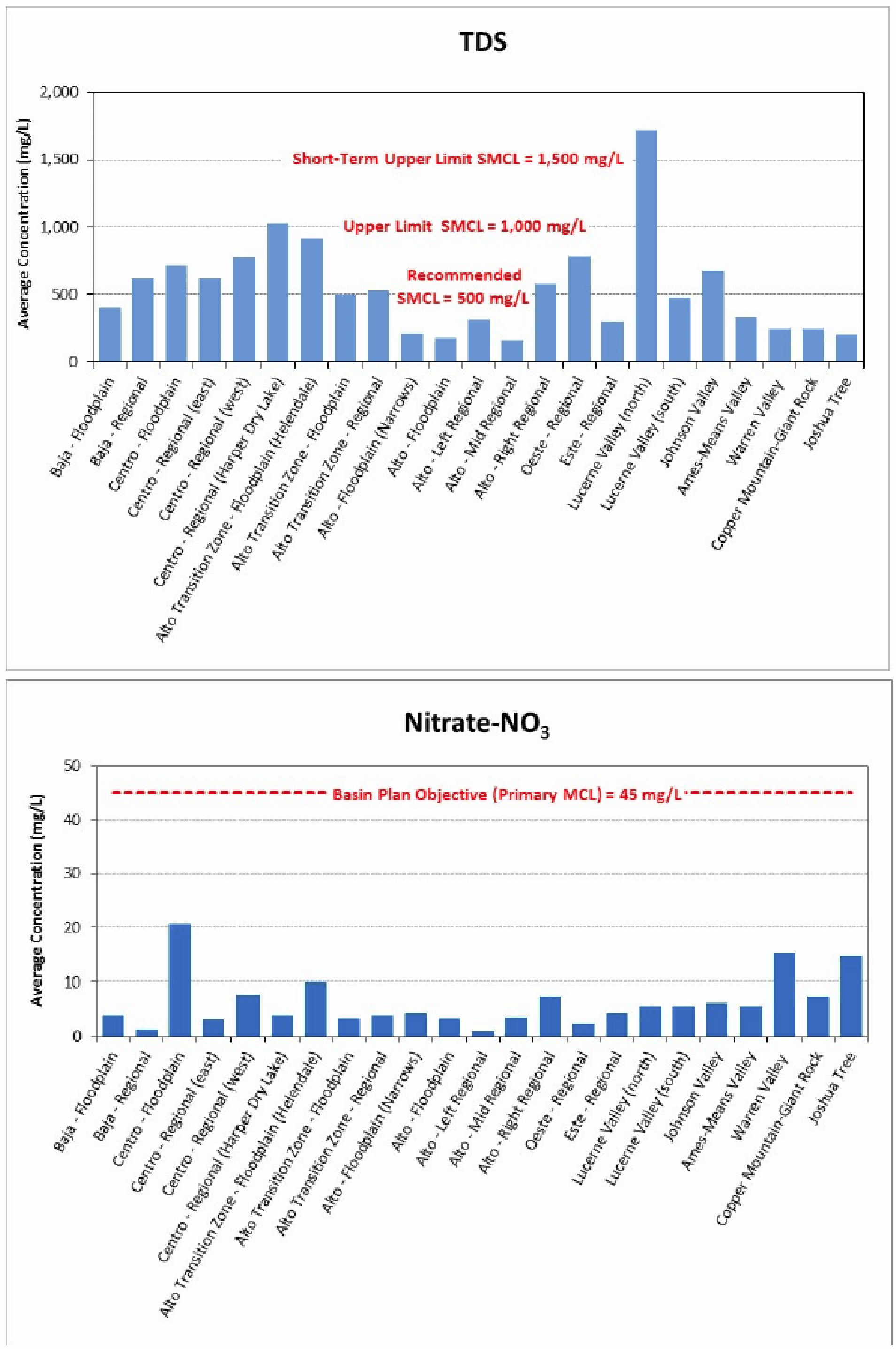
Nitrate-NO_3 concentrations are generally low across the service area. Average subregional concentrations range from 0.9 to 20.7 mg/L, with an average of 6.0 mg/L. Average nitrate-NO_3 concentrations exceed 15 mg/L in Centro – Floodplain and Warren Valley. Additionally, nitrate-NO_3 concentrations are slightly elevated (between 7.5 and 10 mg/L) in Centro – Regional (west), Alto Transition Zone – Floodplain (Helendale), and Alto – Right Regional. In the Centro Subarea, elevated nitrate concentrations are associated with historical and existing agricultural operations (crop field and dairies) and other naturally-occurring processes. In the Alto-Right Regional Subregion, septic tank return flows are likely the most significant contributing factor to slightly elevated groundwater nitrate concentrations. In the Warren Valley, elevated nitrate concentrations are associated with historical entrainment of septage following managed aquifer recharge operations and a high density of septic tanks in the subregion.

Table 5-1 also shows the estimated volume of groundwater in operational storage for the 22 analysis subregions. These volumes were developed for the 2015 Mojave SNMP using 2012 groundwater elevations and elevations representing the base of the groundwater production zone to calculate the thickness of saturated unconsolidated sediments. The thickness of saturated unconsolidated sediments was then multiplied by the estimated aquifer storativity to estimate the volume of groundwater in storage. The groundwater volumes estimated using this approach represent the amount of stored groundwater that theoretically could be pumped with existing wells (albeit without consideration of long-term sustainability, economic or environmental factors) and is herein termed the groundwater in operational storage. These values do not represent all of the water contained within a particular basin.

Table 5-1: Average Existing TDS and Nitrate Concentrations by Subregion

SNMP Analysis Subregion	Estimated Groundwater in Operational Storage[a] (acre-feet)	Volume-Weighted Average Existing TDS Concentration (mg/L)	Volume-Weighted Average Existing Nitrate-NO_3 Concentration (mg/L)
MOJAVE RIVER BASIN			
Baja - Floodplain	4,886,000	401	3.9
Baja - Regional	2,014,000	617	1.4
Centro - Floodplain	1,405,000	711	20.7
Centro - Regional (east)	301,000	618	3.2
Centro - Regional (west)	1,580,000	771	7.7
Centro - Regional (Harper Dry Lake)	2,128,000	1,028	4.0
Alto Transition Zone - Floodplain (Helendale)	269,000	915	10.0
Alto Transition Zone - Floodplain	431,000	500	3.4
Alto Transition Zone - Regional	5,067,000	529	3.9
Alto - Floodplain (Narrows)	264,000	205	4.3
Alto - Floodplain	801,000	177	3.3
Alto - Left Regional	1,812,000	310	0.9
Alto - Mid Regional	1,893,000	153	3.5
Alto - Right Regional	1,052,000	579	7.5
Oeste - Regional	807,000	781	2.5
Este - Regional	840,000	299	4.3
Mojave River Basin Total	**25,550,000**		
MORONGO BASIN			
Lucerne Valley (north)	869,000	1,716	5.6
Lucerne Valley (south)	996,000	472	5.7
Johnson Valley	2,273,000	678	6.2
Ames-Means Valley	692,000	330	5.7
Warren Valley	330,033	243	15.4
Copper Mountain-Giant Rock	3,827,410	247	7.5
Joshua Tree	376,748	202	14.7
Morongo Basin Total	**9,364,190**		
MOJAVE RIVER BASIN AND MORONGO BASIN TOTAL	**34,914,190**		

Notes:
mg/L = milligrams per liter
(a) Volume of groundwater above estimated base of groundwater production zone



Notes:
SMCL = Secondary Maximum Contaminant Level; MCL = Maximum Contaminant Level

Figure 5-3: Average TDS and Nitrate Concentrations by Subregion

5.3.2 Arsenic

Arsenic is a naturally occurring element in groundwater. Ingestion of water containing arsenic at or above the MCL may result in short-term discomfort and long-term health effects such as skin discoloration, circulatory system impacts, and increased cancer risks, and in high concentrations, arsenic consumption can lead to death. California has established a primary MCL of 10 µg/L for arsenic. Arsenic can also be toxic to plants, but the toxicity varies depending on plant species. Within the MWA service area, arsenic concentrations have been measured at levels above the MCL at depth in the Regional Aquifer of the Alto Subarea, in the Transition Zone (TZ) portion of the Alto Subarea, and in the Centro, Baja and Morongo Subareas.

5.3.3 Iron and Manganese

Iron and manganese are both naturally occurring elements in groundwater and often occur together. High levels of these contaminants in drinking water are not known to pose direct adverse health risks. However high levels of iron and manganese in drinking and irrigation water can be associated with aesthetic issues and can cause damage and reduced effectiveness of water distribution and treatment systems. Within the region, iron and manganese levels have been detected above the MCL in the Centro Subarea along the Mojave River in the vicinity of Barstow, in the Alto TZ subbasin, and in localized areas of the Morongo Subarea. Localized elevated concentrations of manganese were also identified in Lucerne Valley in the Este Subarea.

5.3.4 Hexavalent Chromium

Total chromium has been regulated by the SWRCB at an MCL of 50 µg/L, which includes both chromium-3 and chromium-6. In 2011, California Environmental Protection Agency (EPA) Office of Environmental Health Hazard Assessment (OEHHA) set a Public Health Goal (PHG) of 0.02 µg/L for chormium-6. California Department of Public Health (CDPH) then reviewed the PHG and recommended an MCL for chromium-6 at the level of 10 µg/L, which went into effect July 1st, 2014. In 2015, SB385 was passed and signed by Governor Jerry Brown that effectively pushed the enforcement of the new chromium-6 MCL out to 2020, if the water purveyor submitted a compliance plan to their local DDW. In the compliance plan submitted to DDW, quarterly progress reports and quarterly sampling for chromium-6 is required. SB385 is designed to give water purveyors extra time to plan, perform feasibility studies, design treatment options, go through environmental review, acquire funding for treatment and land if applicable, and finally construction and testing of said treatment plan. Chromium-3 is still regulated at the level of 50 µg/L.

Sources of chromium-6 inside the MWA service area are largely due to a metamorphic rock found in the San Gabriel Mountains that contains naturally occurring chromium called Pelona Schist. The nature of the water that is interacting with the sediment also has an effect on chromium-6 concentrations. Recent studies performed by the USGS found that elevated pH levels in the groundwater as well as oxic groundwater conditions can be associated with elevated concentrations of chromium-6 in groundwater. Within the MWA service area, chromium-6 concentrations have been measured at levels above the MCL at depth in the Regional Aquifer of the Alto Subarea, and in the Centro, Baja and Morongo Subareas.

5.4 Groundwater Protection

The general goal of groundwater protection activities is to maintain the groundwater and the aquifer to ensure a reliable high quality water supply. Activities to meet this goal include continued and increased monitoring, data sharing, education and coordination with other agencies that have local or regional authority or programs. To increase its groundwater protection activities, MWA has been taking the following actions as presented below.

5.4.1 Water Quality Monitoring

Groundwater quality investigations in MWA's service area date back to the 1930s. The current MWA groundwater monitoring program includes groundwater quality data collected by MWA and the USGS through their cooperative water resources program and through the Drinking Water Program directed by the SWRCB DDW.

In 1990, MWA entered into a joint agreement with the USGS to develop and fund the CWRP. The CWRP provides funding for a) groundwater level measurement and groundwater quality sampling activities across the Mojave River and Morongo groundwater basins; b) stream gage maintenance and continuous flow monitoring of the Mojave River; c) continuous and discrete sampling of Mojave River water quality; and d) review and uploading of data collected under the CWRP and other MWA groundwater monitoring programs to the publicly available USGS National Water Information System (NWIS) website. Under the CWRP program, MWA technical field staff participate in annual workshops led by members of the USGS California Water Science Center Quality Assurance Team to review and audit field techniques and QA/QC protocols related to equipment maintenance, instrument calibration, groundwater level measurement, and groundwater quality sampling.

The SWRCB DDW enforces the monitoring requirements established in Title 22 of the CCRs for drinking water wells and all the data collected must be reported to the DDW. Title 22 also designates the regulatory limits (e.g., MCLs for various water contaminants, including volatile organic compounds, non-volatile synthetic organic compounds, inorganic chemicals, radionuclides, disinfection byproducts, general physical constituents, and other parameters). Title 22 testing applies to potable public drinking water systems. The MWA performs Title 22 testing only on water produced for the R^3 distribution system which supplies wholesale potable water to retail water suppliers.

Groundwater quality data are submitted electronically and are available for download online at the SWRCB water quality analyses data and download page: http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/EDTlibrary.shtml. MWA downloads the DDW water quality database on a semi-annual to annual basis. Data are screened by MWA technical staff, and data satisfying reliability criteria are archived in the MWA water quality database.

Since the early 1990s, MWA has developed and actively maintained a Key Well program to support ongoing groundwater management activities, including monitoring of groundwater levels and water quality within the MWA service area. Wells in the Key Well program include a combination of dedicated monitoring wells, scientific investigation wells, domestic water supply wells, and agricultural irrigation wells. Public water supply wells are not included in the Key Well program but data from these wells are tracked and included in the MWA database. Important wells identified or installed during scientific studies are continually added to the Key Well program.

The cooperative water resources program between MWA and USGS includes a network of approximately 850 wells from which approximately 150 water quality samples are collected annually. Individual water purveyors are required by CDPH to monitor and report drinking water quality. Water quality enforcement responsibilities reside with the RWQCBs and the CDPH.

There are a range of groundwater contamination sites across the region. These sites are regulated by the Lahontan and Colorado River Basin Regional Water Quality Control Boards and are not a major concern regarding a detriment to water supply at this time.

5.4.2 Hazardous Materials Response

Currently, local and county hazardous materials teams handle responses to hazardous materials incidents. Increased coordination between MWA and hazardous materials teams will allow for assessment of the potential for chemical spills to impact groundwater and recharge sites.

The Lahontan RWQCB has worked with MWA in the past to share data and help assess situations where contamination may affect water wells. MWA has and will assist regulatory agencies as needed, while regulatory agencies have relied on MWA as a data repository or utilized some of MWA's monitoring network in the past.

5.5 Water Quality Impacts on Reliability

The quality of water dictates numerous management strategies a water purveyor will implement, including, but not limited to, the selection of raw water sources, treatment alternatives, blending options, and modifications to existing treatment facilities. Maintaining and utilizing high quality sources of water simplifies management strategies by increasing water supply alternatives, water supply reliability, and decreasing the cost of treatment. Maintaining high quality source water allows for efficient management of water resources by minimizing costs.

Maintaining the quality of water supplies increases the reliability of each source by ensuring that deliveries are not interrupted due to water quality concerns. A direct result from the degradation of a water supply source is increased treatment cost before consumption. The poorer the quality of the source water, the greater the treatment cost. Groundwater may degrade in quality to the point that is not economically feasible for treatment. In this scenario the degraded source water is taken off-line. This in turn can decrease water supply reliability by potentially decreasing the total supply and increasing demands on alternative water supplies.

Currently, water quality does not materially affect water supply reliability in the region. Maintaining the current level of quality is vital to maintaining a reliable water supply. Some small areas have undesirable local concentrations of some constituents for which wellhead treatment or an alternative water supply has been identified as a remedial action.

Limiting migration of poor quality water is an objective of the MWA. A goal of the MWA's regional monitoring program is to detect long-term changes in groundwater quality. This includes migration of poor quality water. By understanding the occurrence and movement of poor quality groundwater, management actions can be taken to avoid these areas and/or limit migration of poorer quality water into regions of higher quality water. Monitoring along with water management actions will help maintain and increase long-term water supply reliability.

One of the ways limiting migration has been addressed is through the installation of multi-level monitoring wells to facilitate water quality sampling and wellhead monitoring at discreet levels within the well. This technique has been used successfully to identify the source of arsenic and other constituents of concern, often found in deeper aquifer zones, to ensure that new wells being constructed do not facilitate the migration of poor quality water into high quality water within a well column. This information has been particularly critical to development of new production wells to serve the R^3 Project and identifying the source of known arsenic in groundwater in Hesperia and southern Apple Valley.

Section 6: Reliability Planning

6.1 Overview

The Act requires urban water suppliers to assess water supply reliability that compares total projected water use with the expected water supply over the next twenty years in five year increments. The Act also requires an assessment for a single-dry year and multiple-dry years. This chapter presents the reliability assessment for Mojave Water Agency's (MWA's) service area.

The general goal of MWA's groundwater protection activities is to maintain the groundwater and the aquifer to ensure a reliable high quality supply. This Plan helps MWA to achieve this goal even during dry periods based on conservative water supply and demand assumptions over the next 25 years, as discussed in the following sections.

6.2 Reliability of Water Supplies

Each water supply source has its own reliability characteristics. In any given year, the variability in weather patterns around the state may affect the availability of supplies to the MWA's service area differently. MWA's service area is typical in terms of water management in southern California; local groundwater supplies are used almost exclusively in the region. Imported water is recharged when available to sustain the local groundwater production. Local groundwater production is fairly consistent but availability of imported supplies are tied to annual climate conditions in northern California. This pattern of "conjunctive use" has been in effect since State Water Project (SWP) supplies first came to the MWA's service area in 1978. SWP supplies have supplemented the overall supply of the MWA service area, which previously depended solely on local groundwater supplies.

To supplement these local groundwater supplies, MWA contracted with the California Department of Water Resources (DWR) for delivery of SWP water, providing an imported water supply to the groundwater basins. However, the variability in SWP supplies affects the ability of the Agency to meet the overall water supply needs for the service area. While each of the groundwater basin's available supply sources have some variability, the variability in SWP supplies has the largest effect on overall annual supply reliability. This annual variability is mitigated through the use of the groundwater aquifer by pre-storing SWP water when it is available.

Each SWP contractor's Water Supply Contract contains a "Table A" amount that identifies the maximum amount of water that the contractor may request. However, the amount of SWP water actually allocated to contractors each year is dependent on a number of factors that can vary significantly from year to year. The primary factors affecting SWP supply availability include hydrologic conditions in northern California, the amount of water in SWP storage reservoirs at the beginning of the year, regulatory, environmental and operational constraints, and the total amount of water requested by the contractors. The availability of SWP supplies to MWA and the other SWP contractors is generally less than their full Table A amounts in many years and can be significantly less in very dry years, as shown in the last few years.

DWR prepares a biennial report to assist SWP contractors and local planners in assessing the near and long-term availability of supplies from the SWP. DWR issued its most recent update, the 2015 DWR State Water Project Delivery Capability Report (DCR), in July 2015. In the 2015 update, DWR provides SWP supply estimates for SWP contractors to use in their planning efforts, including for use in their 2015 UWMPs. The 2015 DCR includes DWR's estimates of SWP water supply availability under both current and future conditions.

DWR's estimates of SWP deliveries are based on a computer model (CalSim II) that simulates monthly operations of the SWP and Central Valley Project (CVP) systems. Key assumptions and inputs to the model include the facilities included in the system, hydrologic inflows to the system, regulatory and operational constraints on system operations, and projected contractor demands for SWP water. For example, the 2015 DCR uses the following assumptions to model current conditions: existing facilities, hydrologic inflows to the model based on 82 years of historical inflows (1922 through 2003), current regulatory and operational constraints, and contractor demands at maximum Table A amounts.

To evaluate SWP supply availability under future conditions, the 2015 DCR included four model studies. The first of the future-conditions studies, the Early Long Term (ELT) scenario, used all of the same model assumptions for current conditions, but reflected changes expected to occur from climate change, specifically, a 2025 emission level and a 15 cm sea level rise. The other three future-conditions include varying model assumptions related to the Bay Delta Conservation Plan/California Water Fix ("BDCP"), such as changes to facilities and/or regulatory and operational constraints.

In spring 2015, DWR announced that BDCP would move from a Section 10 permit to a Section 7 permit process under the Federal Endangered Species Act. As a practical matter, this split the project into two distinct parts known as Cal WaterFix (Alternative 4A), the conveyance portion, and Cal EcoRestore, the restoration portion. Cal WaterFix is Alternative 4A in the recirculated environmental document, and the preferred alternative. Alternative 4A is different than any of the future scenarios modeled by DWR in the DCR. While there is widespread support for the BDCP/Cal WaterFix project, it would be speculative at this time to assume they will move forward. While there is significant support for BDCP, plans are currently in flux- environmental review is ongoing and is not anticipated to be final until at least 2016, and several regulatory and legal requirements must be met prior to construction.

For purposes of this UWMP, the ELT scenario analyzed in DWR's 2015 DCR is deemed to be the most conservative and appropriate study to use for long-term planning estimates of future SWP supply availability. The ELT scenario, based on existing facilities and current operations, adjusted for the expected effects of climate change, is consistent with the studies DWR has used in its previous SWP Delivery Reliability Reports for supply availability under future conditions. Therefore, in this UWMP, future SWP supply availability is based on the ELT study included in the 2015 DCR. In the 2015 Report, DWR presents the results of its analysis of the reliability of SWP supplies, based on model studies of SWP operations. In general, DWR model studies show the anticipated amount of SWP supply that would be available for a given SWP water demand, given an assumed set of physical facilities and operating constraints, based on over 80 years of historic hydrology. The results are interpreted as the capability of the SWP to meet the assumed SWP demand, over a range of hydrologic conditions, for that assumed set of physical facilities and operating constraints. DWR presents the anticipated long-term average SWP delivery reliability as a percent of full contractor Table A amounts, which is 62 percent of Table A as the long-term average supply.

The extremely dry sequence from the beginning of January 2013 through the end of 2014 was one of the driest two-year periods in the historical record. Water year 2013 was a year with two hydrologic extremes.[6] October through December 2012 was one of the wettest fall periods on record, but was followed by the driest consecutive 12 months on record. Accordingly, the 2013 SWP supply allocation was a low 35 percent of SWP Table A amounts. The 2013 hydrology ended up being even drier than DWR's conservative hydrologic forecast, so the SWP began 2014 with reservoir storage lower than targeted levels and less stored water available for 2014 supplies. Compounding this low storage situation, 2014 also was an extremely dry year, with runoff for water year 2014 the fourth driest on record. Due to extraordinarily dry conditions in 2013 and 2014, the 2014 SWP water supply allocation was a historically low 5 percent of Table A amounts. The dry hydrologic conditions that led to the low 2014 SWP water supply allocation were extremely unusual, and to date have not been included in the SWP delivery estimates presented in DWR's 2015 Delivery Capability Report.[7] It is anticipated that the hydrologic record used in the DWR model will be extended to include the period through 2014 during the next update of the model, which is expected to be completed prior to issuance of the next update to the biennial SWP Delivery Capability Report. For the reasons stated above, this UWMP uses a conservative assumption that a 5 percent allocation of SWP Table A amounts represents the "worst case" scenario.

6.3 Average, Single-Dry, and Multiple-Dry Year Planning

As discussed previously in Section 3, the MWA has four sources of water supply – SWP imported water, natural surface water flow, return flow from pumped groundwater not consumptively used, and wastewater imports from outside the MWA service area. What is unusual about MWA is that almost all of the water use within MWA is supplied by pumped groundwater. Native surface supply and SWP imports recharge the groundwater basins and are not supplied directly to any retailers, with the exception of two power plants.

These supplies are available to meet demands during average, single-dry, and multiple-dry years. The following sections elaborate on the different supplies available to MWA during each of the various dry year conditions and what supplies can be expected. Included in the return flow supply is the recycled water used within MWA's service area. Each subsection will explain the criteria used for estimating single-dry and multiple dry supplies that are then used in the comparison tables in Section 6.4.

6.3.1 Wholesale Imported State Water Project Supply

For this Plan, the availability of SWP supplies to MWA was estimated by multiplying MWA's Table A amount (85,800 acre-feet per year (AFY) in 2015 and 89,800 in 2020) by

---

[6] A water year begins in October and runs through September. For example, water year 2013 is October 2012 through September 2013.

[7] SWP delivery estimates from DWR's 2015 SWP Delivery Capability Report are from computer model studies, which use 82 years of historical hydrologic inflows from 1922 through 2003.

the delivery percentages from the 2015 DCR, discussed below. The three hydrologic conditions required to be evaluated for all UWMPs include:

4) an average year condition,
5) a single-dry year condition, and
6) a multiple-dry year condition,

The delivery percentages used for SWP imported water for each of the above conditions were taken from the 2015 DCR based on the 82-year average, 1977, and the 1931-1934 average, for the average year, single-dry year, and multiple-dry year conditions, respectively. In addition, the delivery percentage for 2014, which is now the historical single-dry year with an allocation of five percent, is provided. The 2014 allocation is not incorporated in the 2015 DCR, but is anticipated to be included in the next release of the DCR. The delivery percentages for MWA are detailed in Table 6-1.

The DWR analyses projected that the SWP deliveries during multiple-dry year periods could average about 33 percent of Table A amounts and could drop as low as 11 percent during an unusually dry single year. Table 6-1 summarizes the estimated SWP supply availability in a single dry year (based on a repeat of the worst-case historic hydrologic conditions of 1977) and over a multiple dry year period (based on a repeat of the worst-case historic four-year drought of 1931-1934).

Table 6-1: Wholesale Supply Reliability – Single-Dry Year and Multiple-Dry Year Conditions

Wholesaler[(a)]	Average Year	Single-Dry Year (1977) [(b)]	Single-Dry Year (2014) [(c)]	Multiple-Dry Year[(d)]
California State Water Project (SWP)				
2015				
% of Table A Amount Available	62%	11%	5%	33%
Anticipated Deliveries (AFY)	53,196	9,438	4,290	28,314
2020				
% of Table A Amount Available	62%	11%	5%	33%
Anticipated Deliveries (AFY)	55,676	9,878	4,490	29,634

Notes:

(f) The percentages of Table A amount projected to be available are taken from Table 6-3 of the 2015 DCR. Supplies are calculated by multiplying MWA's Table A amount of 85,800 AF (2015) or 89,800 AF (2020) by these percentages. Maximum Table A amount is referenced from Department of Water Resources Bulletin 132.

(g) Based on the 2015 DCR historic single dry year of 1977.

(h) Based on worst-case single dry year of 2014, which is not captured in the 2015 DCR.

(i) Supplies shown are annual averages over four consecutive dry years, based on the worst-case historic four-year drought of 1931-1934. The allocation of each year is 33 percent.

6.3.2 Local Supplies

The MWA local water supplies are each discussed below with an explanation of how the estimates by supply source were derived for average, single-dry and multiple-dry year periods.

6.3.2.1 Net Natural Supply

MWA has a net natural supply of 57,349 AFY, including surface and subsurface water flows to the five Subareas in the Mojave Basin area and to the Morongo Area, as shown in Section 3. Because the definition of the net natural supply is long-term natural supply estimates, the supplies are going to remain constant regardless of any annual changes in hydrology. Annual fluctuations in natural supplies do not impact the long-term sustainability of the groundwater basins; therefore, the supply is assumed to be 100 percent available in single-dry year and multiple-dry year conditions.

6.3.2.2 Return Flow

As previously discussed in Section 3.3, the return flow is the portion of pumped groundwater not consumptively used. Return flow becomes part of the water supply via treated wastewater effluent discharge (offsite disposal), septic system discharge (onsite disposal), return flow from agricultural uses, and to a much lesser extent from the irrigation of golf courses, parks and other outdoor uses. Return flow in the form of treated effluent becomes supply to a different part of the basin than where the pumping, or the water use occurred. The timing of return flow is also important when considering return flow as supply as the return flow may not become available for many years.

In both dry year conditions: single-dry year and multiple-dry year, the return flow supplied by onsite disposal and discharge of treated effluent is assumed to be available immediately; this assumption is based on the prior uses of water generating returns that are continuing or have come online recently. Consequently, for planning purposes assuming the water uses remain similar in the future as in the past, the return flow supplied is considered 100 percent available.

6.3.2.2.1 Treated Wastewater Effluent

Treated wastewater effluent is available from a number of agencies within the MWA service area. Treated wastewater as a source of supply has the advantage of consistently being available during any type of single-dry, or multiple-dry year. The water agencies and cities planning wastewater facilities are discussed in Section 4 of this Plan.

Even though MWA currently has no rights to any of the treated wastewater or recycled water, the regional water supply balance still benefits from these supplies because the groundwater basin is a closed system. In Section 3, the treated wastewater supply is included in the return flow, as it is in the MWA demand forecast model.

In this Plan, 100 percent of the existing supply of treated wastewater, 22,068 AFY is assumed to be available every year. As shown in Table 4-10, the supply of treated wastewater is projected to increase to a total of 62,843 AFY (56.1 MGD) by 2035. Similar to the existing treated wastewater supply, 100 percent of the 62,843 AFY of planned treated wastewater supply is assumed to be available every year.

6.3.2.3 Local Supply Summary - Groundwater

The sum of the net natural supply, wastewater imports and return flow from pumped groundwater not consumptively used is the total local supplies for MWA. Therefore, the total local supply added to the SWP imported supply is the combined total available to the Mojave Basin Area and the Morongo Area.

The net natural supply from the Mojave Basin Area is projected to be approximately 55,241 AFY in average and dry years. Supplies from the Morongo Area are projected to be approximately 2,108 AFY (Table 3-12) in average years and in dry years.

6.3.3 Banked Groundwater Storage

MWA has a conjunctive use program to take advantage of the fact that the available MWA SWP supply on average is greater than the demand in the service area. MWA is able to store this water for future use when SWP supplies may not be available. This activity also allows MWA to take advantage of wet year supplies because of the abundant groundwater storage capacity available in the Basins.

During normal and wet years, MWA delivers SWP water in excess of local demands and stores the surpluses as a part of the groundwater storage program. During dry years when SWP supplies are not sufficient to meet demands, MWA debits from banked supplies to meet demands. Some retail water agencies also have banked storage accounts which they may choose to draw from during any year, regardless of weather conditions. Table 3-14 in Chapter 3 shows the storage available as of December 31, 2015, in MWA's existing banked accounts by Subarea. The individual retailers' banked storage accounts are included in a separate column in that table. Currently, MWA has approximately 128,000 AF of banked groundwater for future use. Retailers of MWA have a total of 45,997 AF.

6.4 Supply And Demand Comparisons

The available supplies and water demands for MWA's service area were analyzed to assess the region's ability to satisfy demands during three scenarios: an average water year, single-dry year, and multiple-dry years. The tables in this Section present the supplies and demands for the various drought scenarios for the projected planning period of 2015 to 2040 in five year increments. Table 6-2 presents the data set for selecting Average, Single-Dry, and Multiple-Dry Years. Table 6-3, Table 6-4, and Table 6-6 at the end of this Section summarize, respectively, Average Water Year, Single-Dry Water Year, and Multiple-Dry Year supplies.

Table 6-2: Basis of Water Year Data

Water Year Type	Base Years	Historical Sequence
Average Water Year	Average	1922-2003
Single-Dry Water Year	1977, 2014 [a]	--
Multiple-Dry Water Years	1931-1934	--

Note:

(a) The 2015 DCR utilizes 1977 as the historic single-dry water year, with an allocation of 11 percent. The allocation was lower in 2014 with a delivery percentage of five percent, but this year is not incorporated in the 2015 DCR. However, it is anticipated that it will be included in the next update of the DCR. Both years are shown in this report to represent a single-dry water year.

6.4.1 Average Water Year

Table 6-3 summarizes MWA's water supplies available to meet demands over the 25-year planning period during an average/normal year. For SWP supplies it is 62 percent of Table A as the long-term average supply. As presented in the table, MWA's water supply is broken down by water supply sources, including wholesale (imported) water, local supplies, and groundwater banking projects.

6.4.2 Single-Dry Year

The water supplies and demands for MWA's service area over the 25-year planning period were analyzed in the event that a single-dry year occurs. The 2015 DCR utilizes 1977 as the historic single-dry water year, with an allocation of 11 percent. The allocation was lower in 2014 however, with a delivery percentage of five percent, but this year is not incorporated in the 2015 DCR. It is anticipated that it will be included in the next update of the DCR. Both years are shown in this report to represent a single-dry water year. Table 6-4 summarizes the existing supplies available to meet demands for a 1977 single-dry year and Table 6-5 summarizes existing supplies and demands for a 2014 single-dry year.

6.4.3 Multiple-Dry Year

The water supplies and demands for MWA's service area over the 25-year planning period were analyzed in the event that a four-year multiple-dry year event occurs, similar to the drought that occurred during the years 1931 to 1934. During multiple-dry years, SWP availability is anticipated to be reduced to 33 percent. Table 6-6 summarizes the existing supplies available to meet demands during multiple-dry years.

6.4.4 Summary of Comparisons

As shown in the analyses above, MWA has adequate supplies to meet demands during average, single-dry, and multiple-dry years throughout the 25-year planning period.

Table 6-3: Projected Average/Normal Year Supplies and Demand (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Wholesale (Imported)						
SWP[(a)]	53,196	55,676	55,676	55,676	55,676	55,676
Yuba Accord	0	600	600	600	600	600
Local Supplies[(b)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(c)]	0	0	0	0	0	0
Total Existing Supplies	**161,143**	**168,781**	**170,896**	**173,482**	**176,152**	**178,582**
Total Estimated Demands[(d)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:
(a) SWP supplies are calculated by multiplying MWA's Table A amount by the delivery percentage for a long-term average year, which is 62 percent. Sourced from the 2015 DCR.
(b) From Section 3 - Water Resources, Table 3-1.
(c) Not needed during average/normal years.
(d) See Section 2 - Water Use

Table 6-4: Projected 1977 Single-Dry Year Supplies and Demand (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Wholesale (Imported)						
SWP[(a)]	9,438	9,878	9,878	9,878	9,878	9,878
Local Supplies[(b)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(c)]	20,624	25,983	28,688	31,995	35,410	38,516
Total Existing Supplies	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**
Total Estimated Demands[(d)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:
(a) SWP supplies are calculated by multiplying MWA's Table A amount by percentages of single-dry deliveries projected to be available for a single-dry year of 1977 (11%), taken from the 2015 DCR.
(b) From Section 3 - Water Resources, Table 3-1.
(c) Existing banked SWP water in MWA groundwater storage accounts (See Section 6.3.3 and Table 3-13). This does not include any retailers' stored water. Amounts reflect stored water needed to meet demand after all other supplies are used.
(d) See Section 2 - Water Use

Table 6-5: Projected 2014 Single-Dry Year Supplies and Demand (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Wholesale (Imported)						
SWP[(a)]	4,290	4,490	4,490	4,490	4,490	4,490
Local Supplies[(b)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(c)]	25,772	31,371	34,076	37,383	40,798	43,904
Total Existing Supplies	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**
Total Estimated Demands[(d)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:

(a) SWP supplies are calculated by multiplying MWA's Table A amount by the delivery percentage of the historic dry year 2014, which is five percent. This year was not incorporated in the 2015 DCR.

(b) From Section 3 - Water Resources, Table 3-1.

(c) Existing banked SWP water in MWA groundwater storage accounts (See Section 6.3.3 and Table 3-13). This does not include any retailers' stored water. Amounts reflect stored water needed to meet demand after all other supplies are used.

(d) See Section 2 - Water Use

Table 6-6: Projected Multiple-Dry Year Supplies and Demand (AFY)

Water Supply Source	2015	2020	2025	2030	2035	2040
Existing Supplies						
Wholesale (Imported)						
SWP[(a)]	28,314	29,634	29,634	29,634	29,634	29,634
Local Supplies[(b)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Groundwater Banking Projects[(c)]	1,748	6,227	8,932	12,239	15,654	18,760
Total Existing Supplies	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**
Total Estimated Demands[(d)]	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:

(a) SWP supplies are calculated by multiplying MWA's Table A amount by the delivery percentage for a 4-year drought (1931-1934), which is 33 percent. Sourced from the 2015 DCR.

(b) From Section 3 - Water Resources, Table 3-1.

(c) Existing banked SWP water in MWA groundwater storage accounts (See Section 6.3.3 and Table 3-13). This does not include any retailers' stored water. Amounts reflect stored water needed to meet demand after all other supplies are used.

(d) See Section 2 - Water Use

6.4.5 Potential Future SWP Supplies

An ongoing planning effort to increase long-term supply reliability for both the SWP and CVP is taking place through the Bay Delta Conservation Plan (BDCP) process. The co-equal goals of the BDCP are to improve water supply reliability and restore the Delta ecosystem. The BDCP is being prepared through a collaboration of state, federal, and local water agencies, state and federal fish agencies environmental organizations, and other interested parties. Several “isolated conveyance system” alternatives are being considered in the plan that would divert water from the north Delta to the south Delta where water is pumped into the south-of-Delta stretches of the SWP and CVP. The new conveyance facilities would allow for greater flexibility in balancing the needs of the estuary with the reliability of water supplies. The plan would also provide other benefits, such as reducing the risk of long outages from Delta levee failures.

The BDCP has been in development since 2006 and is currently undergoing extensive environmental review. The Draft BDCP and its associated Draft Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) were released for public review in December 2013. In response to public comments, the BDCP was reevaluated, and in April 2015 the lead agencies announced a modified alternative which effectively split the project into two parts: the conveyance portion (known as Cal WaterFix), and the restoration portion (known as EcoRestore). The Cal WaterFix alternative is evaluated in a partially recirculated draft environmental document (Recirculated Draft EIR/Supplemental Draft EIR) that was released for public review in July 2015. That environmental document is not anticipated to be final until at least 2016.

While there is widespread support for the BDCP/Cal WaterFix project, plans are currently in flux and environmental review is ongoing. Additionally, several regulatory and legal requirements must be met prior to any construction. Because of this uncertainty, any improvements in SWP supply reliability or other benefits that could result from this proposed project are not included in this report.

In addition, MWA will address the State policy goal of reducing reliance on the Delta by promoting and investing in projects and programs that allow the Mojave region to meet water demands with alternative sources of supply, demand management actions, or both, during times when supplies from the Delta watershed are impacted by dry conditions, system outages, environmental constraints and/or other circumstances that negatively impact the availability or reliability of those supplies.

Section 7: Water Demand Management Measures

7.1 Overview

In 2006 Mojave Water Agency became a signatory to the Memorandum of Understanding Regarding Water Conservation in California (MOU) of the California Urban Water Conservation Council (CUWCC) and is firmly committed to the implementation of the Best Management Practices (BMPs) or Demand Management Measures. The CUWCC is a consensus-based partnership of agencies and organizations concerned with water supply and conservation of natural resources in California. By becoming a signatory, MWA agreed to implement a series of locally cost-effective conservation methods in the MWA service area through cooperation with, and participation of, the retail water purveyors.

Those signing the CUWCC MOU have pledged to develop and implement fourteen comprehensive conservation BMPs. The MOU was compiled with two primary purposes: to expedite implementation of reasonable water conservation measures in urban areas; and, to establish assumptions for use in calculating estimates of reliable future water conservation savings resulting from proven and reasonable conservation measures.

7.2 Conservation Program Background

MWA is a wholesale water agency serving ten (10) retail water purveyors that are required to complete a 2015 Urban Water Management Plan (UWMP) due to having more than 3,000 connections or delivering more than 3,000 acre-feet per year (AFY). MWA and these 10 retailers are therefore subject to the Urban Water Management Planning Act, AB 1420 and SBX7-7 requirements, in addition to the commitment of compliance with the BMPs as a signatory to the MOU. The Agency also supports 36 small water systems. All of the systems can participate in the MWA conservation programs. In the MWA service area, demand management is addressed both at the local (retail agency) and wholesale level.

MWA first started addressing and quantifying conservation goals in its 2004 Regional Water Management Plan (RWMP), which called for a reduction in the water consumption by ten percent in the Mojave River Basin and five percent in the Morongo Area by the year 2020. The conservation priorities identified in the Plan were based on the CUWCC's 14 BMPs.

In August 2003, local stakeholders decided that a united regional water conservation program was needed and the Alliance for Water Awareness and Conservation (AWAC) was formed. AWAC developed several conservation goals including reducing overall water use by 20 percent by 2020 for the entire MWA service are. This goal was adopted by MWA in 2006. The AWAC goal is a locally determined baseline and savings reduction target that predates the adoption of SBX7-7, and therefore was not intended to be consistent with the new requirement, although they may be complimentary.

According to the AWAC enabling MOU, the purpose of the AWAC is to "provide a vehicle to attract support for a regional water conservation program and coordinate implementation of activities by forming partnerships to obtain common, measurable goals." AWAC set three goals that aim to change water-use habits and empower High

Desert communities with the tools to ensure adequate supplies of water for future generations:

1. Educate the local communities with the understanding of the importance of water conservation;
2. Provide the local communities with the tools to effectively reduce per capita consumption to targeted goals; and,
3. Reduce regional water use by 10 percent gross per capita by 2010 and 20 percent gross per capita by 2020 to achieve a sustainable, reliable supply to meet regional water demands.

In accordance with the UWMP Act, a wholesale agency is required to report on the following demand management measures: metering, public education and outreach, water conservation program coordination and staffing support, and any other demand management measure that have a significant impact on water use. In addition, a wholesale agency is required to report on distribution system asset management and wholesale supplier assistance programs. The following sections describe MWA's activities in each of these categories.

7.3 Metering

MWA does not provide water directly to water users, hence it does not have a traditional metering system. MWA does replenish the groundwater basin by recharging imported SWP water at several locations throughout the service area, as described in Section 3. The SWP water is metered at the turnouts from where MWA receives the water into its service area.

As part of the Regional Recharge and Recovery Project ("R³ Project"), MWA operates recharge basins, groundwater wells, and conveyance facilities around the Mojave River to provide water to Liberty Utilities (Apple Valley Ranchos Water) Corp., City of Adelanto, City of Hesperia, Golden State Water Company, San Bernardino County Service Area 64 and the Victorville Water District. This offsets local pumping within the service areas of these retail water purveyors to alleviate local well pumping depressions. The water that is delivered to these purveyors is metered.

7.4 Public Education and Outreach

7.4.1 Public Information Programs

Public information programs that promote efficient water use are implemented throughout the service area. MWA works in conjunction with AWAC to provide outreach, educational and informational materials and literature; public service announcements and paid advertisements; flyers and bill inserts for retailers; conservation website; and articles in newsletters, Chamber of Commerce publications and regional newspapers. Additionally, MWA assists in hosting and staffing workshops on conservation, sponsors and hosts public events and booths at community functions, and works with retailers to further their conservation goals through special projects based on their individual needs.

Reaching beyond traditional partners, MWA created and funds a Strategic Partners Program. This program offers grants to community organizations and educational facilities to promote water conservation. One of the key achievements of this program is the funding of the Water Management Academy in conjunction with Victor Valley College. This program is training future water managers in proper conservation and water resource management. In addition to funding, MWA assists with curriculum development and provides speakers for this program.

Taking the lead in conservation messaging, MWA working with AWAC has developed a new conservation slogan and campaign. The campaign, Save Water: Live Like a Desert Native, which reminds citizens that living in a desert region requires continual conservation The message focuses on learning how to efficiently use water resources by taking tips from the native plants that not only survive but thrive in the arid, desert region The Agency has invested heavily in this campaign, placing billboards, signs, flyers, as well as public presentations.

Figure 7-1: MWA Water Conservation Slogan

Continuing with the theme of embracing life in the desert, MWA initiated a Qualified Water Efficient Landscaper (QWEL) program to educate local landscapers in native plant selection and maintenance, and proper use of drip irrigation. To date, two workshops have been held, with one in English and one in Spanish. Additional classes will be scheduled.

7.4.2 School Education Programs

School education programs are run by the retailers with MWA's support. MWA provides literature, staff support and in-kind services through funding for, and participation in, teacher training workshops known as "Project Wet". These training courses on water education curriculum for students in grades K-12 are done in collaboration with the retailers and the Mojave Environmental Education Consortium (MEEC).

7.5 Water Conservation Program Coordination and Staffing Support

MWA has two full-time staff that work on developing and implementing water conservation (WC) programs and has an approximate annual budget of $1,000,000. Additionally, other MWA staff from various departments provide technical and administrative support, as well as serve as speakers at a variety of events. The conservation budget is used to fund various rebate and conservation and education programs. The Agency has supported a Cash for Grass rebate program since 2008, which has facilitated the removal of 10 million square feet of turf to date. Other programs that have been funded include toilet rebates, Weather Based Irrigation Controller (WBIC) rebates, and clothes washer rebates. The Agency has also utilized this budget to fund showerhead replacements and faucet aerator retrofit parts.

7.6 Distribution System Asset Management

Water received from the SWP is conveyed to recharge basins within the service area for replenishment of the groundwater basin. Retail water purveyors utilize their own distribution systems to pump water from the groundwater basin and convey it to their users. The exception to this is the R^3 Project, which consists of recharge basins around the Mojave River, groundwater wells, and conveyance facilities to provide water to Liberty Utilities (Apple Valley Ranchos Water) Corp., City of Adelanto, City of Hesperia, Golden State Water Company, San Bernardino County Service Area 64 and the Victorville Water District. As mentioned in Section 7.3, this offsets local pumping within the service areas of these retail water purveyors to alleviate local well pumping depressions. This facility is interruptible and not designed to be a replacement for local pumping and distribution facilities. All of the MWA R^3 facilities for delivery of water supply are redundant facilities to the retail purveyors, so service interruptions over short or long periods of time do not impact the retail purveyors' ability to serve water to their communities.

MWA has the following maintenance and repair programs in place for management of facilities:

- Valve inspection/exercise program - annual basis
- Blow-off and air vacuum relief valve inspection program - annual basis
- Daily inspections and reports of pump stations. Reports provide data and information to predict and schedule repairs and replacements.
- SCADA system integration – as-needed equipment replacement that are obsolete and not compatible with the SCADA system
- Cathodic protection program - 10 year program in which every 5 years, visual inspection is provided for portions of pipeline interior sections and is followed in the next 5 years with electrical readings to compare against baseline criteria.
- Motor service program - motors are serviced in place every 3,000 hours of service or annually
- Facility operators are on call 24 hours per day, every day with an Emergency Response Program in place

7.7 Wholesale Supplier Assistance Programs

MWA provides both technical and financial assistance to the retail agencies for implementing conservation programs and strategies. MWA works with water agencies and cities individually, collectively and through AWAC to provide conservation support. Budget for the last three years of program support was $1,000,000 annually.

MWA provides the following support to its retailers, individually or through AWAC:

- Free conservation devices: faucet aerators, showerheads, and hose nozzles
- Residential Cash for Grass rebates: Customers were offered $0.50/sq. ft. for turf removed from a home or business. This program started in 2008 and has been the Agency's most popular and successful rebate program to date. Program requirements included the removal of turf, installation of drought tolerant plants, as well as removal of sprinklers and installation of new drip irrigation. This program was limited to projects totaling 20,000 sq. ft. or less.
- Large landscape Cash for Grass rebates: Customers are offered $1.00 per sq. ft. of turf converted to desert adaptive landscaping with a 25 percent canopy coverage for lot sizes ranging from 20,000 to 500,000 sq. ft.
- Public Information and Education Programs

Currently, MWA is also developing a program to provide technical support to its retailers for addressing the new American Water Works Association (AWWA) requirements for System Water Audit BMP implementation.

7.8 Program Results

Conservation is a crucial element of MWA's water supply management program and therefore tracking the savings from conservation activities is an integral and evolving element of the program. Water savings are achieved through a combination of active (programmatic) and passive (foundational) programs. Active programs include incentives, conversions and retrofits and typically are measurable and quantifiable. Passive savings are a result of activities such as outreach, education, regulations and standards — programs which are typically more challenging to quantify. In an attempt to measure program success and inform future planning MWA monitors water use patterns and utilizes an analytic approach based on common assumptions and models.

Water savings indicate that MWA is well on track to meeting its AWAC goals. Since 2000, per capita use has dropped by about 45 percent and since 2004, when the AWAC goals were set, per capita use has dropped by about 39 percent. There have been substantial reduction in per capita water use over the last two years due to the ongoing drought and the Governor's order for mandatory water consumption reduction. As described in Section 2, it is expected that per capita water use will decrease at a slower rate in the future due to both active and passive water conservation activities.

Population growth and per-capita municipal production volume data have been tracked and correlated with the implementation of the AWAC regional conservation activities starting in August 2003. Figure 7-2 shows historical population growth and per capita water use for the MWA service area. Since 2000, population within the MWA service area has grown 46 percent, while per capita water use has decreased 45 percent.

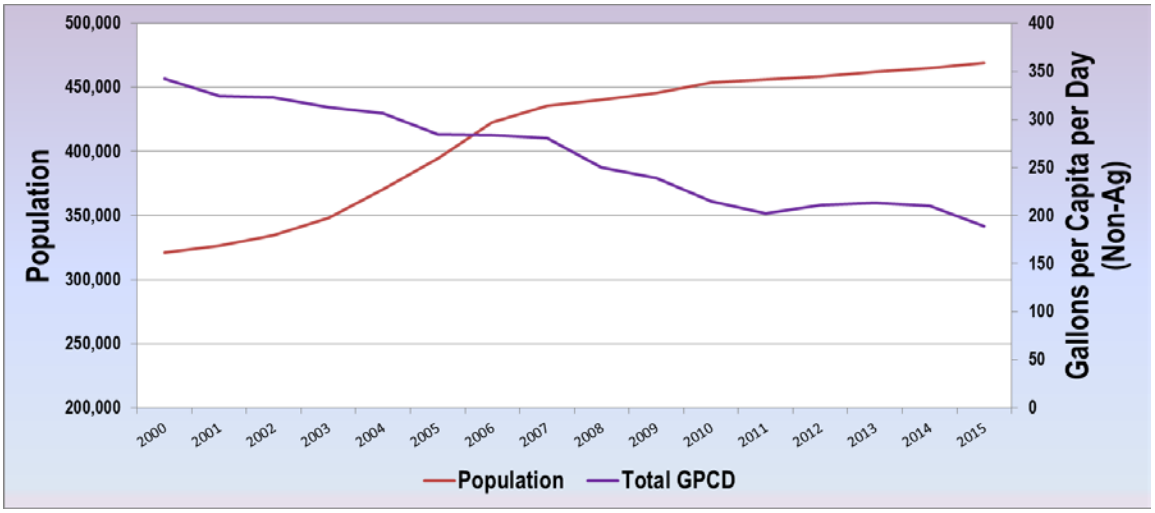


Figure 7-2: Historical Population Growth and Urban Per Capita Water Use

The savings in Figure 7-2 represent the impacts of both the foundational and active programs. MWA also applies an analytic approach to determine and predict impacts of its programmatic activities. The calculations indicate that water conservation incentive program activities saved about 1,840 AFY since August 2008 (Figure 7-3). The largest portion of the savings is from the turf replacement program (Cash for Grass), followed by toilet and washer replacements.

The savings calculations are based on the fresh water avoided cost approach recommended by the CUWCC. Savings from HETs and High Efficiency Clothes Washers (HECWs) are estimated based on CUWCC water savings studies. Landscape conversion calculations are based on recorded evapotranspiration rates and other regional climatic factors which are used to develop a water savings coefficient that is applied to the number of units or area of landscape converted and rebated.

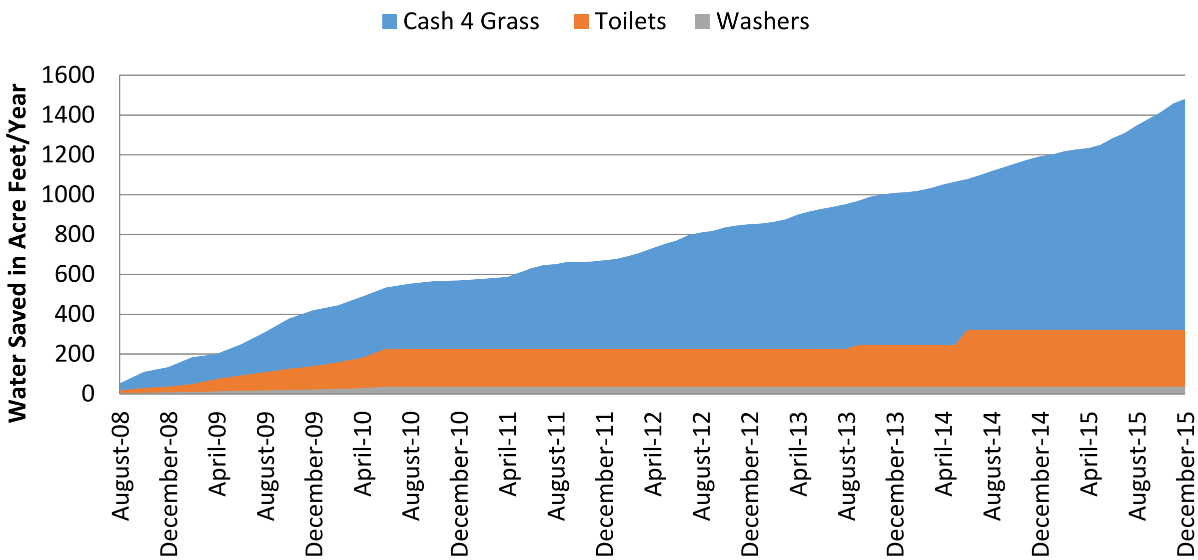


Figure 7-3: Cumulative Water Savings from Conservation Incentives

7.9 Conclusion

MWA is on track to meeting, and potentially even exceeding, its AWAC water reduction goals with municipal per capita consumption having dropped from 342 to 189 gpcd since 2000. This reduction provides both long-term supply reliability as well as insulation from short-term variations. Through aggressive programs and wholesale planning and collaboration, MWA has succeeded in decoupling population growth and demand from historic patterns. MWA continues to work with its retailers on a voluntary basis through a variety of incentive, outreach, education and support programs.

The Agency's partnership with the AWAC group has helped to maximize the conservation effort in the service area. With its help the Agency has been able to remove more than a total of 10 million square feet of turf through the large and small scale Cash for Grass programs. AWAC is also an instrumental part of the Agency's education programs providing the front line of contact for many customers. They are able to spread the regional message of water conservation. The Agency will not only be able to meet the goals set forth when AWAC was formed, but will be equipped to meet any potential conservation standards set forth by the state.

In May 2016, Governor Brown issued Executive Order B-37-16, which directs state agencies to develop draft reporting requirements for a new long term water use efficiency framework by January 10, 2017. As the framework is developed and implemented over the coming years, the Agency will develop or revise local programs to meet the new requirements and document the results in the next iteration of the UWMP in 2020.

Building on a foundation of culture change, the region's future in water sustainability is bright. Further optimization of water resources through collaboration also offers new avenues for conservation. Among the new opportunities is the Agency's Small Water Systems Assistance Program that provides resources for disadvantaged and severely disadvantaged small water systems that lack staff, expertise, and funding to meet their individual water reliability, conservation and quality standards. The MWA service area includes 36 small water systems of which 65 percent meet the criteria of disadvantaged communities.

Section 8: Water Shortage Contingency Planning

8.1 Overview

Water supplies may be interrupted or reduced significantly in a number of ways, such as a drought that limits supplies, an earthquake that damages water delivery or storage facilities, a regional power outage, storm flood damage, environmental restrictions, or a toxic spill that affects water quality. This chapter of the Plan describes how the MWA plans to respond to such emergencies so that emergency needs are met promptly and equitably.

Cities and water agencies within MWA rely on large groundwater basins to meet potable water supply needs. Over the last decade, the Agency invested in water purchases from the State Water Project to pre-store water to have available during times of drought. There is currently over 100,000 AF stored where pumping exceeds the natural supply. During previous drought periods, municipal water suppliers continued to draft from these basins to meet customer needs without the need to impose restrictions on water use, but at rates exceeding natural replenishment in most areas. Large groundwater basins in the region serve as reservoirs and buffer the impacts of seasonal and year-to-year variations in precipitation and imported and natural surface water deliveries. This has been demonstrated during the recent drought, as groundwater supply was available to meet demands; in addition, the retailers have complied with the Governor's emergency order requiring mandatory conservation actions statewide. The area aquifers are either currently in balance or expected to be in balance in the near future due to the combination of water imports, State-mandated conservation requirements, and/or court ordered production "ramp-down." During multiple-year droughts or State Water Project outages, adequate groundwater supplies will be available to meet demands through the use of conjunctively banked pre-stored imported water. Actions of the MWA to address water shortages are summarized below.

8.2 Coordinated Planning

The Mojave Water Agency was formed to manage water resources within the Agency's service area. In this capacity, MWA has been planning and implementing projects to increase water supply reliability and prevent future water shortages. MWA is a State Water Project (SWP) contractor and has a contract Table A amount of 85,800 AF, increasing to 89,800 in 2020. This water is diverted from the California Aqueduct and distributed to recharge sites throughout the area to replace groundwater withdrawn by retailers and others, as well as pre-store water for future use. Deliveries from the SWP are variable and MWA's full Table A amount is not available every year. During dry and multiple dry years, it is expected that SWP deliveries will be significantly reduced. However this imported water source is banked in the groundwater basin when available so it is available to retail producers by pumping from the groundwater basin in years the SWP water is limited or unavailable.

The Mojave Basin Judgment calls for charging groundwater producers for use above their production allowance and using these funds to import "Replacement Water" from the SWP so that over time extractions come into balance with available supplies. Similar principles are employed in the Warren Valley Basin Ames-Reche Management Area, and JBWD Service Area to achieve long-term balance of supply and demand. All imported SWP water is currently recharged into the groundwater basins. This allows the groundwater basin to accept SWP imported water when available and banked/stored in the groundwater basin so that production from the groundwater basin in years when the SWP imported supply is less or not available can continue without interruption or decrease.

For the Morongo Basin/Johnson Valley Area ("Morongo Area"), there are three water supply agreements that deal with coordinated water supplies throughout the area, including (1) the Warren Valley Basin Agreement, (2) a Stipulated and Amended and Restated Judgment for the Ames-Reche Management Area and (3) an agreement for the users of the Morongo Basin Pipeline.

For the non-adjudicated regions in the Morongo Area such as Joshua Basin, Johnson Valley, and the Means Valley, each of these groundwater basins is being coordinated by MWA as well. Joshua Basin Water District (JBWD) is the retailer using the supply from the Joshua Tree/Copper Mountain Valley Region and completed construction on a groundwater recharge pond for imported SWP water in 2014 that will supply SWP water to the groundwater basins to address current overdraft conditions. The Johnson Valley area is not yet materially populated; however, the MWA is monitoring the basin so if development does occur, the MWA will have a data set to act from. This is also true for the Means Valley Region, which is small and sparsely populated with only limited domestic groundwater development.

8.2.1 MWA and the Retail Water Purveyors

All of the retail potable water agencies within MWA boundaries that are required to complete their own individual 2015 UWMPs have Water Shortage Contingency Plans included in their 2015 UWMPs which are not discussed in this section.

The Water Shortage Contingency Plans of these retail agencies utilize a variety of methods to reduce water demand including mandatory prohibitions on water wasting, voluntary water conservation measures, mandatory water conservation measures and prohibitions on certain uses of water during severe shortages, specific triggering mechanisms for determining the appropriate stage of alert, and water supply allotments for each stage of alert. As a wholesale agency, MWA does not have the authority to impose mandatory restrictions on retail customers due to water shortages. Therefore, this level of contingency planning is conducted by the retail water agencies. By agreement, MWA potable water deliveries (R^3) from pumped groundwater storage to these retail customers is interruptible and can be shut off at any time by MWA. The retail potable water supply agencies are required to have production facilities to supply their customers without water deliveries from the R^3 facilities. In other words, the R^3 facilities are redundant water facilities to the retail agencies facilities. Currently, all imported SWP water for potable water use is first recharged into the various groundwater basins from which all potable water is then extracted by groundwater wells. No imported SWP water is used directly for potable water deliveries.

8.3 Minimum Water Supply Available During Next Three Years

The minimum water supply available during the next three years would occur during a three-year multiple-dry year event between the years 2016 and 2018. MWA actively implements a conjunctive use program utilizing State Water Project water to recharge local groundwater basin aquifers. In addition to meeting Replacement Water obligations under the Mojave Basin Area Judgment, when SWP supplies are high (in surplus of Replacement Water needs), MWA meets the demands of individual stakeholders that request additional imported water supply and also stores surplus imported SWP water in local groundwater aquifers. When SWP supplies are low during dry periods, groundwater stored in basins is used to meet demands that exceed the natural supply. As shown in Table 8-1, the total supplies are approximately 141,700 acre-feet per year (AFY) during the next three years. It is assumed that reduced SWP supplies will be met with pumping from groundwater basins where imported water has been stored, with the total water demand remaining the same as during normal years. When comparing these supplies to the demand projections provided in Chapters 2 and 6 of this Plan, MWA has adequate SWP supplies available to meet projected imported SWP demands should a multiple-dry year period occur during the next three years and SWP imported supply be reduced.

Table 8-1: Estimate of Minimum Supply for the Next Three Years

	Supply (AFY)		
Source	**2016**	**2017**	**2018**
Existing Supplies			
Wholesale (Imported)			
SWP Table A Supply[(a)]	28,314	28,314	28,314
Local Supply[(b)]			
Net Natural Supply	57,349	57,349	57,349
Return Flow	48,731	49,637	50,544
Wastewater Import	2,800	2,800	2,800
Recharge Banking Projects[(c)]	2,886	4,051	5,217
Total Existing Supplies	**140,080**	**142,152**	**144,223**
Total Estimated Demands[(d)]	***140,080***	***142,152***	***144,223***

Notes:

(a) SWP supplies are calculated by multiplying MWA's Table A amount of 85,800 AF by 33 percent of total deliveries projected to be available based on the worst-case historic four-year drought of 1931-1934 (State of California, The SWP Final Delivery Capability Report 2015, July 2015)

(b) See Section 3 - Water Resources, Table 3-1. Local supplies are assumed to be 100% available. Only SWP supplies are reduced. Linear interpolation is utilized to estimate supplies between 2015 and 2020.

(c) Banked groundwater is used to meet demand under drought conditions.

(d) See Section 2 – Water Use. Linear interpolation is utilized to estimate demands between 2015 and 2020.

8.4 Actions to Prepare For Catastrophic Interruption

8.4.1 General

The MWA service area is bounded on the west by a major portion of the San Andreas Fault. A major earthquake along the southern portion of the San Andreas Fault would affect the MWA service area. The California Division of Mines and Geology has stated two of the aqueduct systems that import water to southern California (including the California Aqueduct) could be ruptured by displacement on the San Andreas Fault, and supply may not be restored for a three to six-week period. The situation would be further complicated by physical damage to pumping equipment and local loss of electrical power.

DWR has a contingency aqueduct outage plan for restoring the California Aqueduct to service should a major break occur, which it estimates would take approximately four months to repair.

Experts agree it may be at least three days after the earthquake before outside help could get to the area. Extended supply shortages of both groundwater and imported water, due to power outages and/or equipment damage would have to be managed although local effects of these type of outages would not materially affect the region based on local native groundwater and banked imported water supplies.

All SWP imported supply for potable water goes to groundwater recharge facilities where the water is stored in the groundwater basin. In this kind of outage on the SWP, the water being taken from the SWP facilities would be turned off. Once water is again available from the SWP facilities then turnouts to the Aqueduct would be again opened and deliveries to recharge areas would begin again. Since the MWA facilities have flexibility for recharge, the flowrate and number of turnouts being used from the Aqueduct can vary to increase flows over shorter periods of time based on availability in the SWP facilities. If only power is interrupted, then once power is restored then deliveries to recharge areas would begin again and the flow rates would be increased if needed. An interruption of several weeks or longer in SWP supplies would not provide any immediate threat to potable water deliveries from groundwater production wells.

MWA completed the first phase of the Regional Recharge and Recovery Project, known as "R^3," in 2013. These Phase 1 facilities can deliver up to 15,000 Af/yr to retail potable water agencies. The R^3 project is a basin management tool and conjunctive use project that distributes the water via groundwater wells pumping from the aquifer from a conjunctively managed area of the basin to local retail water purveyors. This groundwater pumping production is done on behalf of each of the retail water agencies and in lieu of pumping from other groundwater production facilities of these retail agencies. All production on behalf of a retail water agency is under the oversight of the Watermaster. This is a groundwater management project that allows water to be pumped in a portion of the basin to be used in lieu of other groundwater production in other portions of the basin so that the various areas of the basin can be actively managed. The R^3 project includes groundwater recharge facilities, groundwater production wells, booster pumps, storage reservoirs, interconnections to the retail customer water system, water meters, and chlorination facilities which are vulnerable to power outages. These R^3 facilities are in addition to the facilities of each retail water agency. Each Agency must have sufficient supply facilities to serve their customers without R^3 facilities. This means the R^3 facilities are totally redundant capacity to the retail agencies. MWA by agreement can stop deliveries in the R^3 facilities to the retail agencies at any time. In an emergency, these facilities are not required but are certainly available if the R^3 facilities are undamaged and functioning.

Each of the retailers that is served by the R^3 project takes delivery through a flow regulating, metering, chlorinating interconnection facility to their system. The MWA has stressed and incorporated in various agreements with the retailers that R^3 cannot be their primary source of supply or available for peaking – they have to maintain a primary system of wells and associated storage separate from R^3. R^3 facilities provide redundant capacity to the retailer's facilities.

For the retailer water agencies, all of the water systems have some form of storage as both regulating reservoirs and emergency supply. MWA does not monitor the various pressure zones that the retailers operate and the storage that they actually have available to them. During an acute shortage, the public would be asked by the retail agencies to reduce consumption to minimum health and safety levels, potentially extending the supply to seven days. MWA would work to get R^3 facilities operational and once operational could allow utilization by the retail agencies as needed to help bring back full service to their customers. Working in parallel with the retail agencies the redundant R^3 facility capacity would help provide the retail agencies sufficient time to restore a significant amount of their groundwater production. After the groundwater supply is restored, the pumping capacity of the retail purveyors is restored, full system demands could be met. Until full well production is totally restored, R^3 facilities, once operational, would be available to help the retail water agencies meet full system demands. Updates on the water situation would be made as often as necessary.

The area's water sources are generally of good quality, and no insurmountable problems resulting from industrial or agricultural contamination are foreseen. If contamination did result from a toxic spill or similar accident, the contamination would be isolated and should not significantly impact the total water supply. In addition, such an event would be addressed in the retailers' emergency response plan.

8.4.2 SWP Emergency Outage Scenarios

In addition to earthquakes, the SWP could experience other emergency outage scenarios. Past examples include slippage of aqueduct side panels into the California Aqueduct near Patterson in the mid-1990s, the Arroyo Pasajero flood event in 1995 (which also destroyed part of Interstate 5 near Los Baños), Flood damage to the East Branch of the Aqueduct in 2015, and various subsidence and leakage repairs needed along the Main Branch and East Branch of the Aqueduct since the 1980s. All these outages were short-term in nature (on the order of weeks to several months), and DWR's Operations and Maintenance Division worked diligently to devise methods to keep the Aqueduct in operation and continue SWP deliveries while repairs were made. Thus, the SWP contractors generally experienced no interruption in total annual deliveries.

One of the SWP's important design engineering features is the ability to isolate parts of the system. The Aqueduct is divided into "pools." Thus, if one reservoir or portion of the California Aqueduct is damaged in some way, other portions of the system can still remain in operation. The primary SWP facilities are shown on Figure 8-1.

Other events could result in significant outages and potential interruption of service. Examples of possible nature-caused events include a levee breach in the Delta near the Harvey O. Banks Pumping Plant, a flood or earthquake event that severely damages the Aqueduct along its San Joaquin Valley traverse, or an earthquake event along either the West or East Branches. Such events could impact some or all SWP contractors south of the Delta.

The response of DWR, MWA, and other SWP contractors to such events would be highly dependent on the type and location of any such event. In typical SWP operations, water flowing through the Delta is diverted at the SWP's main pumping facility, located in the southern Delta, and is pumped into the California Aqueduct. During the relatively heavier runoff period in the winter and early spring, Delta diversions generally exceed SWP contractor demands, and the excess is stored in San Luis Reservoir. SWP aqueduct terminal reservoirs, such as Pyramid and Castaic Lakes, are also replenished during these periods. During the summer and fall, when diversions from the Delta are generally more limited and less than contractor demands, releases from San Luis Reservoir are used to make up the difference in deliveries to contractors. The SWP share of maximum storage capacity at San Luis Reservoir is 1,062,000 AF.

MWA receives its SWP deliveries through the East Branch of the California Aqueduct. The other contractors receiving deliveries from the East Branch are Metropolitan Water District, Antelope Valley-East Kern Water Agency, Palmdale Water District, Crestline-Lake Arrowhead Water Agency, Desert Water Agency, San Gabriel Valley Municipal Water District, San Bernardino Valley Municipal Water District, San Gorgonio Pass Water Agency, and Coachella Valley Water District. The East Branch has two terminal reservoirs, Silverwood Lake and Lake Perris, which were designed to provide emergency storage and regulatory storage (i.e., storage to help meet peak summer deliveries) for several of the East Branch contractors. However, MWA does not have contract rights to storage capacity in those reservoirs. Silverwood Lake is within the MWA service area and releases from the lake flow into the primary groundwater basins within the MWA service area.

In addition to SWP storage south of the Delta in San Luis and the terminal reservoirs, a number of contractors have stored water in groundwater banking programs in the San Joaquin Valley and more recently along the East Branch, and many also have surface and groundwater storage within their own service areas.

Three scenarios that could impact the delivery to MWA of its SWP supply or other supplies delivered to it through the California Aqueduct are described below. For each of these scenarios, it was assumed that an outage of six months could occur. MWA's ability to meet demands during the worst of these scenarios is presented following the scenario descriptions.

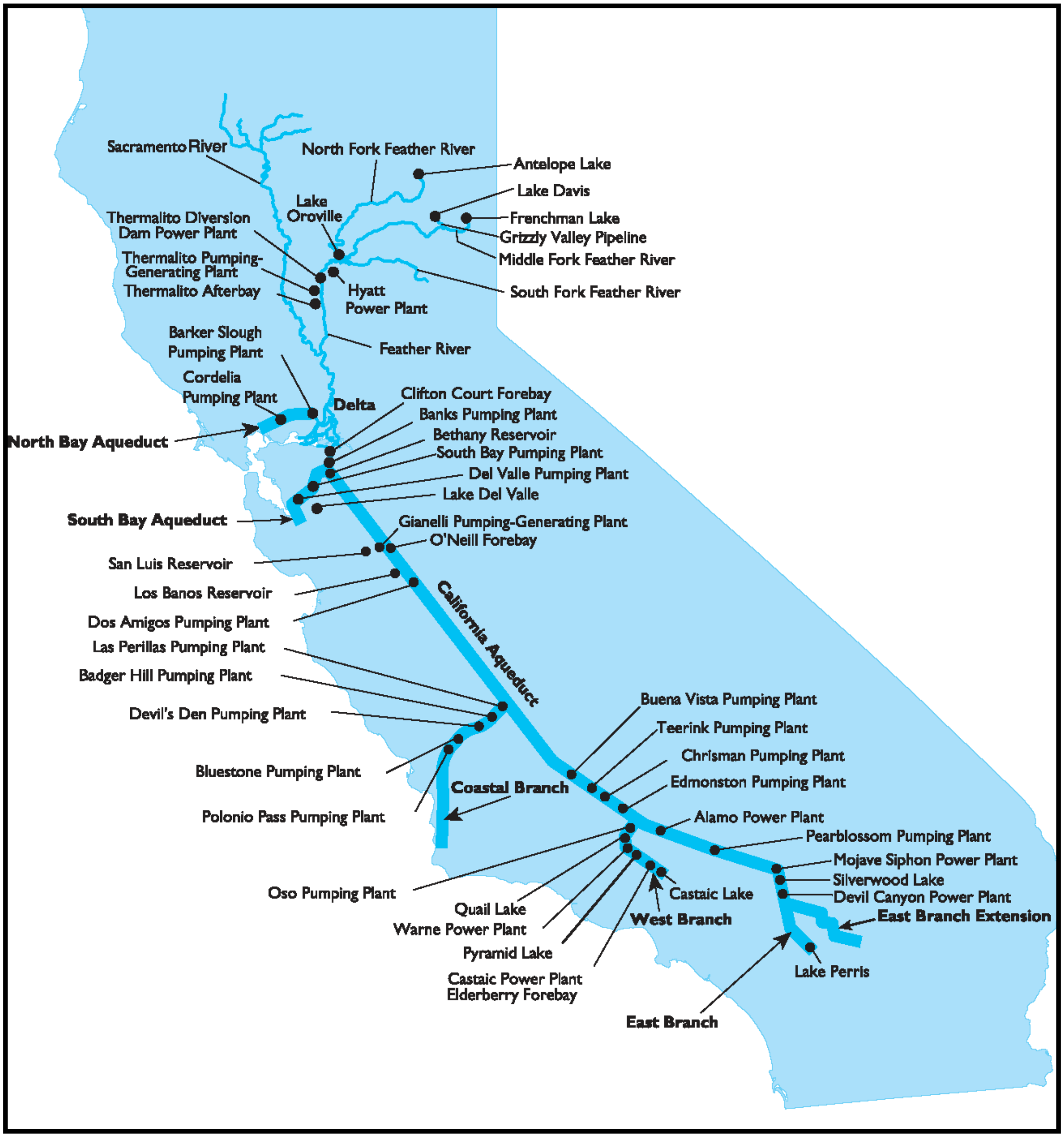


Figure 8-1: Primary SWP Facilities

Scenario 1: Levee Breach near the Sacramento-San Joaquin Delta

The California Department of Water Resources (DWR) has estimated that in the event of a major earthquake in or near the Delta, regular water supply deliveries from the SWP could be interrupted for up to three years, posing a substantial risk to the California business economy. Accordingly, a post-event strategy has been developed which would provide necessary water supply protections. The plan has been coordinated through DWR, the Army Corps of Engineers (Corps), Bureau of Reclamation, California Office of Emergency Services (Cal OES), the Metropolitan Water District of Southern California, and the State Water Contractors. Full implementation of the plan would enable resumption of at least partial deliveries from the SWP in less than six months.

DWR Delta Flood Emergency Management Plan ("Emergency Pathway"). DWR has developed the Delta Flood Emergency Management Plan to provide strategies for a response to Delta levee failures, which addresses a range of failures up to and including earthquake-induced multiple island failures during dry conditions when the volume of flooded islands and salt water intrusion are large. Under such severe conditions, the plan includes a strategy to establish an emergency freshwater pathway from the central Delta along Middle River and Victoria Canal to the export pumps in the south Delta. The plan includes the pre-positioning of emergency construction materials at existing and new stockpiles and warehouse sites in the Delta, and development of tactical modeling tools (DWR Emergency Response Tool) to predict levee repair logistics, water quality conditions, and timelines of levee repair and suitable water quality to restore exports. The Delta Flood Emergency Management Plan has been extensively coordinated with state, federal and local emergency response agencies. DWR, in conjunction with local agencies, the Corps and Cal OES, regularly conduct simulated and field exercises to test and revise the plan under real time conditions.

DWR and the Corps provide vital Delta region response to flood and earthquake emergencies, complementary to an overall Cal OES structure. Cal OES is preparing its Northern California Catastrophic Flood Response Plan that incorporates the DWR Delta Flood Emergency Management Plan. These agencies utilize a unified command structure and response and recovery framework. DWR and the Corps, through a Draft Delta Emergency Operations Integration Plan (April 2015), would integrate personnel and resources during emergency operations.

Levee Improvements and Prioritization. The DWR Delta Levees Subvention Program has prioritized, funded, and implemented levee improvements along the emergency freshwater pathway and other water supply corridors in the central and south Delta region. These efforts have been complementary to the DWR Delta Flood Emergency Management Plan, which along with use of pre-positioned emergency flood fight materials in the Delta, relies on pathway and other levees providing reasonable seismic performance to facilitate restoration of the freshwater pathway after a severe earthquake. Together, these two DWR programs have been successful in implementing a coordinated strategy of emergency preparedness for the benefit of SWP and CVP export systems.

Significant improvements to the central and south Delta levee systems along Old and Middle Rivers began in 2010 and are continuing to the present time at Holland Island, Bacon Island, Upper and Lower Jones Tracts, Palm Tract and Orwood Tract. This complements substantially improved levees at Mandeville and McDonald Islands and portions of Victoria and Union Islands. Together, levee improvements along the pathway and Old River levees consisting of crest raising, crest widening, landside slope fill and toe berms, meet the needs of local reclamation districts and substantially improve seismic stability to reduce levee slumping and create a more robust flood-fighting platform. Many urban water supply agencies have participated or are currently participating in levee improvement projects along the Old and Middle River corridors.

Scenario 2: Complete Disruption of the California Aqueduct in the San Joaquin Valley

The 1995 flood event at Arroyo Pasajero demonstrated vulnerabilities of the California Aqueduct (the portion that traverses the San Joaquin Valley from San Luis Reservoir to Edmonston Pumping Plant). Should a similar flood event or an earthquake damage this portion of the aqueduct, deliveries from San Luis Reservoir could be interrupted for a period of time. DWR has informed the SWP contractors that a four-month outage could be expected in such an event. MWA's assumption is a six-month outage.

Arroyo Pasajero is located downstream of San Luis Reservoir and upstream of the primary groundwater banking programs in the San Joaquin Valley. Assuming an outage at a location near Arroyo Pasajero that resulted in the California Aqueduct being out of service for six months, supplies from San Luis Reservoir would not be available to those SWP contractors located downstream of that point. This would include MWA.

Scenario 3: Complete Disruption of the East Branch of the California Aqueduct

The East Branch of the California Aqueduct begins at a bifurcation of the Aqueduct south of Edmonston Pumping Plant, which pumps SWP water through and across the Tehachapi Mountains. From the point of bifurcation, the East Branch is an open canal. Water is conveyed through the canal to the Pearblossom Pumping Plant, where the first of five turnouts to the MWA service area is located at Sheep Creek, which is essentially a stub out in the Phelan area and not used at this time. The second is the Mojave River turnout, also known as the White Road Siphon, located north of Lake Silverwood. The third turnout is the Highway 395 turnout, which is used for the Oro Grande Wash Recharge Project. The fourth turnout is the Antelope Siphon which is located near the City of Hesperia and was constructed to supply the Morongo Basin Pipeline, which delivers SWP water from the Alto Subarea recharge facilities in the Morongo Subarea. The last turnout is also an unutilized stub out from the Aqueduct in what has been labeled the Unnamed Wash. All of these turnouts are along Reach 22b of the Aqueduct. In addition, occasionally, MWA takes water delivery from Cedar Springs Dam at Silverwood Lake, for groundwater recharge.

If a major earthquake (an event similar to or greater than the 1994 Northridge Earthquake) were to damage a portion of the East Branch, deliveries could be interrupted. The exact location of such damage along the East Branch would be key to determining emergency operations by DWR and the East Branch SWP contractors. For this scenario, it was assumed that the East Branch would suffer a single-location break and deliveries of SWP water from north of the Tehachapi Mountains or of contractor water stored in groundwater banking programs in the San Joaquin Valley would not be available. It was also assumed that Silverwood and Perris dams would not be damaged by the event and that water in Silverwood and Perris Lakes would be available to the East Branch SWP contractors.

In any of these three SWP emergency outage scenarios, DWR and the SWP contractors would coordinate operations to minimize supply disruptions. Depending on the particular outage scenario or outage location, some or all of the SWP contractors south of the Delta might be affected. But even among those contractors, potential impacts would differ given each contractor's specific mix of other supplies and available storage. During past SWP outages, the SWP contractors have worked cooperatively to minimize supply impacts among all contractors. Past examples of such cooperation have included certain SWP contractors agreeing to rely more heavily on alternate supplies, allowing more of the outage-limited SWP supply to be delivered to other contractors; and exchanges among SWP contractors, allowing delivery of one contractor's SWP supply or other water to another contractor, with that water being returned after the outage was over.

Of these three SWP outage scenarios, the scenario of an East Branch outage along with no delivery of stored water from Silverwood Lake presents the worst-case scenario for MWA. In this scenario, MWA would continue to rely solely on local groundwater supplies (native and banked imported water). An assessment of the supplies available to meet demands in MWA's service area during a six-month East Branch outage is presented in Table 8-2 for 2015 through 2040.

During an outage, the local supplies available would consist of native and banked groundwater. It was assumed that local well production would be unimpaired by the outage and that the outage would occur during a year when average/normal supplies would be available. Note that adequate well and aquifer capacity exists to pump at levels higher than those assumed in this assessment, particularly during a temporary period such as an outage.

Table 8-2: Projected Supplies and Demand during Six-Month Disruption of Imported Supply System

Water Supply Source	2015	2020	2025	2030	2035	2040
Local Supplies[(a)]						
Net Natural Supply	57,349	57,349	57,349	57,349	57,349	57,349
Return Flow	47,825	52,356	54,471	57,057	59,727	62,157
Wastewater Import	2,773	2,800	2,800	2,800	2,800	2,800
Recharge Banking Projects[(c)]	30,062	35,861	38,566	41,873	45,288	48,394
Total Existing Local Supplies	**138,009**	**148,366**	**153,186**	**159,079**	**165,164**	**170,700**
Total Estimated Demands	***138,009***	***148,366***	***153,186***	***159,079***	***165,164***	***170,700***

Notes:
(a) Assumes complete disruption in SWP supplies and in deliveries through the California Aqueduct for six months.
(b) See Section 3 – Water Resources, Table 3-1.
(c) Banked groundwater would be utilized to meet demand during an outage. See Section 3 – Water Resources for more details on MWA's groundwater banking projects.

8.4.3 Regional Power Outage Scenarios

For a major emergency such as an earthquake, Southern California Edison (Edison) has declared that in the event of an outage, power would be restored within a 24 hour period. For example, following the 1994 Northridge Earthquake, Edison was able to restore power within 19 hours. Edison experienced extensive damage to several key power stations, yet was still able to recover within a 24-hour timeframe.

8.5 Mandatory Prohibitions During Shortages

As explained earlier, MWA is not a direct purveyor of retail water supplies and does not have any emergency powers or the authority to implement water shortage plans within its boundaries. It relies instead on efforts of the individual cities and water agencies. However, MWA does have its Ordinance No. 9 that allows the Agency to sell and deliver SWP water to two power plants. MWA Ordinance 9 requires customers taking direct delivery of SWP water from MWA to maintain a backup supply in the event of outages or shortages in supply from the SWP. No retail water agencies use imported SWP directly. All water is first recharged and stored in the groundwater basin for later extraction through groundwater wells. MWA maintains a bank of stored imported water in the groundwater basin. MWA informs customers under Ordinance 9 that supplies are variable and interruptible, with no guarantee of a specified delivery quantity. Ordinance 9 is MWA's only authority to reduce water supplies to its customers during shortages. However, customers under Ordinance 9 represent only a small portion of the overall water use within the MWA service area, with a majority of water users receiving water supply from groundwater production. Highlights of the Ordinance (Appendix I) are discussed below:

- Each application shall contain such information as is necessary to assure the Board of MWA that the application is for service of a wholesale nature and that the MWA will not thereby become subject to the obligations of a retail water purveyor providing direct retail service to consumers. In the event the Applicant seeks a waiver of such requirement, the application shall so state and there shall be attached thereto a statement of the reasons for seeking a waiver any documentary evidence in support thereof.

- Each application shall contain information indicating that the Applicant is capable of sustaining its service requirements from independent sources during the period of any interruption or curtailment of service from Agency facilities. In no instance shall MWA be the sole source of water supply to any water retailer for any development within the retailer's service area.

- In any year in which there may occur a shortage in available supply of SWP, the MWA shall reduce the delivery of SWP proportionately to all parties to which the MWA supplies imported SWP water, including Improvement District M of Division 2 (entities that lie within the greater Morongo Basin/Johnson Valley Area ("Morongo Area") and take water from the Morongo Basin Pipeline). It is provided that the MWA may apportion available SWP on some other basis if such is required to meet minimum demands for domestic supply, fire protection, fire suppression or sanitation to a specific area of the Agency during the year. No vested rights are obtained by the Customer upon the sale and delivery of water apportioned by this Section nor is any such rights inferred by virtue of an MWA decision to provide water to a Customer in a specific year.

- In any year due to hydrogeologic conditions in the upper Mojave River groundwater basin, water production from the R^3 facilities can be restricted or stopped. However, the retail agencies taking water from R^3 will still have their own redundant facilities to continue to deliver water.

8.6 Consumptive Reduction Methods during Restrictions

As explained in the previous section, MWA does not have the power to implement mandatory prohibitions during water supply shortages, with the exception of customers receiving direct SWP supplies or water deliveries through R^3 under MWA Ordinance 9.

8.7 Penalties for Excessive Use

The penalties for excessive water use are stated in the text of the Judgment for the Mojave Groundwater Basin and the text of the Warren Valley Judgment for the Warren Groundwater Basin. The Court has continuing jurisdiction for the Mojave Basin Area Judgment and water producers in noncompliance can readily be taken to court.

8.8 Financial Impacts of Actions during Shortages

There will be no financial impacts to MWA during a water shortage because of the available water that is banked in the MWA service area and able to be sold to retailers.

8.9 Water Shortage Contingency Resolution

As explained in Section 8.5, the only ordinance or resolution that MWA has for assisting in water shortages is Ordinance 9, which only deals with a small portion of the water users within MWA service area.

8.10 Mechanism to Determine Reductions in Water Use

As explained in Section 8.5, MWA does not have the power to implement mandatory prohibitions during water supply shortages, with the exception of customers receiving direct SWP supplies or R^3 water deliveries under Ordinance 9.